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Subjective well-being indicators for large-scale assessment of cultural ecosystem services

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ABSTRACT

The substantial importance of cultural benefits as a source of human well-being is increasingly recognised in society-environment interactions. The integration of cultural ecosystem services (CES) into the ecosystem services framework remains a challenge due to the difficulties associated with defining, articulating and measuring CES. We operationalise a novel framework developed by the UK National Ecosystem Assessment that identifies CES as the interactions between environmental spaces (i.e. physical localities or landscapes), and the activities that occur there. We evaluate the benefits of the CES provided by 151 UK marine sites to recreational sea anglers and divers, using subjective well-being indicators. Factor analysis of an online questionnaire with 1220 participants revealed multiple CES benefits that contribute to human wellbeing e.g. including 'engagement with nature', 'place identity' and 'therapeutic value'. In addition to regional differences, we also found that biophysical attributes of sites, such as the presence of charismatic species and species diversity, were positively associated with provision of CES benefits. The study provides evidence that could be used to inform designation of protected areas. The indicators used in the study may also be adapted for use across a range of marine and terrestrial spaces for improved integration of CES in environmental decision-making.

1. Introduction

Many studies highlight the importance of accounting for the cultural benefits of the environment to human well-being in environmental decision making (e.g. Chan et al., 2012a, 2012b; Church et al., 2014; Fish and Church, 2014; Satz et al., 2013). Cultural interactions between humans and nature are fundamental, in that they lay the foundations for our broader attitudes to the natural environment and its importance to human well-being (Ewert et al., 2005; Lohr and Pearson-Mims, 2005). Our cultural heritage, such as traditional land and sea use, or the iconic status of certain species (e.g. popularity of whale watching) also demonstrates the significant inter-relationships between wider society and the environment, and the contributions these make to human well-being through a sense of place or place identity (Satz et al., 2013). The cultural dimensions of well-being are multi-faceted and complex (Russell et al., 2013). While there is strong

evidence that nature has a positive effect on physical and mental health, and many studies have considered place attachment and identity, few studies have sought to systematically integrate diverse cultural elements of subjective well-being into ecosystem service assessments. While there is strong evidence that nature has a positive effect on physical and mental health (Hartig et al., 2014), few studies have sought to systematically integrate multiple elements of human well-being into ecosystem service assessments.

The cultural benefits derived from the natural environment can be conceptualised as cultural ecosystem services (CES). Within the ES framework, CES are a recognised category alongside provisioning, regulating and supporting ecosystem services. The Millenium Ecosystem Assessment (MEA, 2005) defined these as the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences. Despite its widespread use, both the definition and categorisation can

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be criticised on a number of grounds, including (i) lack of recognition of the role of material objects in the provision of non-material benefits (for example the value of catching fish for a recreational anger); (ii) a conflation of services and benefits; (iii) simplification of complex interactions between human and non-human domains; (iv) the intangibility of the categories and their overlap, e.g. recreation can include aesthetic and spiritual experiences.; and (v) the categorisation can lead to unevenness in the analysis of different services, as it is rarely possible to assess all these categories and unidentified categories of cultural experience may be overlooked.

To address problems associated with the previous definitions of CES, Fish et al., (2016) defined cultural ecosystem services as the *interactions* between environmental spaces (i.e. physical settings such as coasts, woodlands, allotments) and the cultural or recreational practices (e.g. fishing, walking, gardening) that take place within them. This places CES in a geographic or place-based context. Within their framework, cultural benefits in terms of experiences, identities and capabilities are seen to arise from the mutually reinforcing relationships between environmental spaces and cultural practices. In this paper we seek to explore these benefits in terms of their contribution to subjective wellbeing.

While arguments have been made in favour of the monetisation of ecosystem services so they can be better used in policy and decision making, this is particularly challenging for CES, as they are difficult to define in terms of measurable services and do not fit the ontological and axiological assumptions of economic valuation (Cooper et al., 2016). Currently, there are no obvious indicators or standard metrics for measuring CES benefits, particularly identity and experiential aspects such as spiritual and aesthetic aspects, as there are for measuring provisioning ecosystem services such as food production, or regulating services that have direct material benefits, such as flood protection. Indeed, the challenges of incorporating CES into a framework with other services mean they may be undervalued in favour of economic and ecological priorities (Milcu et al., 2013). Even for recreational benefits, where monetisation is commonplace, it has been argued that the symbolic and experiential value of CES may not be sufficiently reflected, let alone understood, in monetary metrics (Edwards et al., 2016; Daniel et al., 2012). Thus, to recognise the extensive reach of CES, there is a need for reinterpretation of the relation between CES and benefits, and for non-monetary methods to measure CES contributions to human well-being (Daily et al., 2009), to enable more balanced decision making (Kenter et al., 2016b).

Human well-being is a broad concept encapsulating numerous dimensions that can be influenced and mediated in various ways by natural environments (McMichael et al., 2005). An international body of evidence supports the idea that interaction with the natural environment plays an important role in human health and well-being (for reviews see, Bowler et al., 2010; Frumkin, 2001; Hartig et al., 2014; Irvine and Warber, 2002; Keniger et al., 2013). Keniger et al., (2013) developed a typology of benefits from interacting with nature based on a review of the literature across a range of environmental settings, which included physiological and cognitive health and also social and spiritual benefits. Russell et al., (2013) synthesised research evidence on the benefits arising from cultural connections to ecosystems, and suggested that in addition to physical and mental health, 'sense of place, 'identity/autonomy' and connectedness/belonging' are among a broader range of cultural well-being aspects influenced. Recent research has focused on synthesising existing frameworks for human-environment-health interactions that contribute to wellbeing (e.g. Irvine et al., 2013). Methods of measurement are developing, providing insights into the contribution that different types (agricultural, coastal, etc.; e.g. Marselle et al., 2013) or qualities (biodiversity, etc.; e.g. Lovell et al., 2014) of natural environments might have on health and well-being (Wheeler et al., 2015), and studies have begun to examine the mechanisms underpinning these relationships (e.g. Carrus et al., 2015).

Studies of coastal environments find that people living closer to the coast self-report higher levels of good health (Wheeler et al., 2012) and that recreational use of the maritime environment is beneficial for physical and mental health (Bell et al., 2015). Other studies have identified the strong cultural importance of the marine environment to stakeholders through interviews and participatory mapping (Gee and Burkhard, 2010; Klain and Chan, 2012) and, in an aquarium-based study, Cracknell et al., 2015 examined the relationship between marine biota and psychological well-being. Yet, while the marine environment includes environmental spaces of major cultural and recreational significance (e.g. historical ship wreck sites, fishing grounds), there has been little research to evidence a broader suite of CES benefits it provides (Turner et al., 2014), particularly at larger scales.

The degradation of marine ecosystems is a global issue (Ranger et al., 2016). As society seeks to protect and restore habitats to ensure both biodiversity conservation and the provision of multiple ecosystem services, more attention needs to be given to CES in marine planning and management plans (Potts et al., 2014). This requires a more nuanced understanding of how management of marine sites might influence societal well-being and a more expansive understanding of the concept of environmentally derived well-being than currently exists (Fish, 2011).

This study was specifically undertaken to inform decision-making on designation of marine protected areas (MPAs) in the United Kingdom (UK). Signatories to international agreements including the Convention on Biological Diversity and The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) are tasked with establishing an 'ecologically coherent' network of MPAs, while the EU Marine Strategy Framework Directive requires EU member states to put in place measures to achieve or maintain good environmental status in their seas by 2020. The UK is working towards these goals by identifying sites to complement existing designations where limitations would be placed on extractive, damaging and disturbing activities. These new sites include Marine Conservation Zones (MCZs) to protect nationally important marine wildlife, habitats, geology and geomorphology inshore and offshore in England and Wales, and Scottish MPAs for the protection of nationally important marine biodiversity and geodiversity features in Scottish waters. In addition to ecological data, and in recognition of the multiple demands on UK sea space, socio-economic factors (e.g. avoidance of restrictions in busy harbours) have been incorporated into the planning process. However there remains a paucity of valuation data for sites, particularly for CES benefits. There is thus a clear gap in the evidence base as the process moves forward.

This paper presents an assessment of subjective well-being linked to CES reported by key groups of recreational users users of 151 potential[1] MPAS across the UK. It draws on a large-scale integrated valuation study undertaken as part of the UK National Ecosystem Assessment (UK NEA) follow-on phase (Kenter et al., 2014) which also included monetary choice experiments and contingent valuation (Jobstvogt et al., 2014) and deliberative monetary valuation and storytelling (Kenter et al., 2016a). This paper aims to operationalise the conceptual links between ecosystems and CES benefits to wellbeing through development of a novel set of indicators that was developed for this purpose, but which could be generalised to undertake similar CES valuation research in other marine or terrestrial locations. As such it presents a new way of valuing ES that recognises the plural, multi-faceted, and place-based nature of CES values, recognising critiques of monetary valuation and the emerging discourse of shared values of ES, discussed by authors throughout this issue of *Ecosystem Services*. However, an important strength of the approach taken here is that it

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[1] The locations chosen were proposed either as a Scottish MPA or an English MCZ in 2013. Since that time, many of these locations have since been designated. In Wales, the process had ground to a halt due to stakeholder opposition; hence six existing Welsh Marine Special Areas of Conservation were also assessed for comparison.

also transcends purely idiosyncratic, localised approaches, providing practical metrics that can be used for cost-effective and rapid large-scale assessments and for cross-comparison by decision-makers. Finally, this paper also investigates how CES well-being benefits can be linked empirically to specific biophysical attributes.

Section 2 provides an overview of the CES framework developed by the UK NEA (2011) and its follow-on phase UK NEA (2014). Section 3 describes our methods, including explanation of our large scale approach to assessing the benefits provided by a diverse range of marine areas and the data analysis undertaken to understand the links between cultural benefits and the biophysical attributes of the areas. Section 4 details the results, while Section 5 interprets their significance for improving methods for measuring CES and implementing them in environmental decision-making.

2. A place-based cultural ecosystem services framework

The UK NEA CES framework (Church et al., 2014, Fish et al., 2016) provides an innovative perspective to the assessment and valuation of cultural services. Fig. 1 illustrates an adaptation of the framework for considering cultural benefits of the marine environment. Central are the environmental spaces where cultural practices take place, together forming a 'service' that generates benefits. Environmental spaces can be assessed in terms of quality and quantity, to gain a measure of their capacity to provide CES along with an assessment of the demand for these spaces and the cultural practices which take place there. The framework describes three broad categories of cultural benefits that are derived from CES: (i) identities which describes peoples' perceptions of the relationships they have with their environment; (ii) experiences, which are derived from directly interacting with ecosystems, which may for example take the form of aesthetic experience, or experience of connecting with nature in situ; and (iii) capabilities which encompasses the role of nature in facilitating personal development. However, these different benefits, which may be experienced by individuals and communally, are strongly interdependent.

Benefits vary depending on environmental space and practice. For example, someone might dive for the thrill of testing one's capacities in a tide swept channel, developing different skills and identity compared to someone who enjoys contentment by peacefully floating around in a kelp forest. Conceptualising CES as emerging from the relation

between place and practice in this way also directly links diversity of natural habitats with use through practices and CES benefits; a link which has so far largely escaped the assessment of CES (Fish and Church, 2014). For example, while the leisure industry depends directly on diversity of sites, prior environmental valuation studies for recreation have not addressed this dependency (Rees et al., 2010; Ruiz-Frau et al., 2012). The way that different practices are manifested and benefits are enjoyed will also depend on cultural values, which may be seen as the sense of the overarching, transcendental values that inform our culture and guide our life choices (Kenter et al., 2015; Raymond and Kenter, 2016).

The contribution of spaces to CES can be considered in terms of the supply and conditions of certain habitats as might be measured by their extent as well as intactness and the presence and diversity of species. Cultural practices can be measured using metrics such as visitor numbers, participation rates or using participatory approaches such as participatory GIS (Kenter, 2016). Measuring the emergent cultural benefits requires the development of indicators reflecting place-based subjective well-being (Church et al., 2014). Certain aspects of cultural benefit have been poorly represented in the development of CES indicators. For example, few indicators exist for knowledge, inspiration or spiritual benefits (Hernández-Morcillo et al., 2013).

3. Methods

In this section, we describe how we sought to measure environmental spaces (marine sites) and their biophysical aspects), the cultural practices (recreational activities) and cultural benefits for marine recreational users, specifically anglers and divers using subjective well-being indicators. This section also details our approach to data collection and data analysis.

3.1. Measurement of cultural benefits

We operationalised cultural benefits as the aspects of human well-being experienced as a result of interactions between the marine setting and the recreational activities of diving and angling. Our aim was to design a novel instrument to measure well-being associated with the range of benefits illustrated in Fig. 1. To assess subjective well-being, we developed a set of 15 indicator statements to reflect constructs of
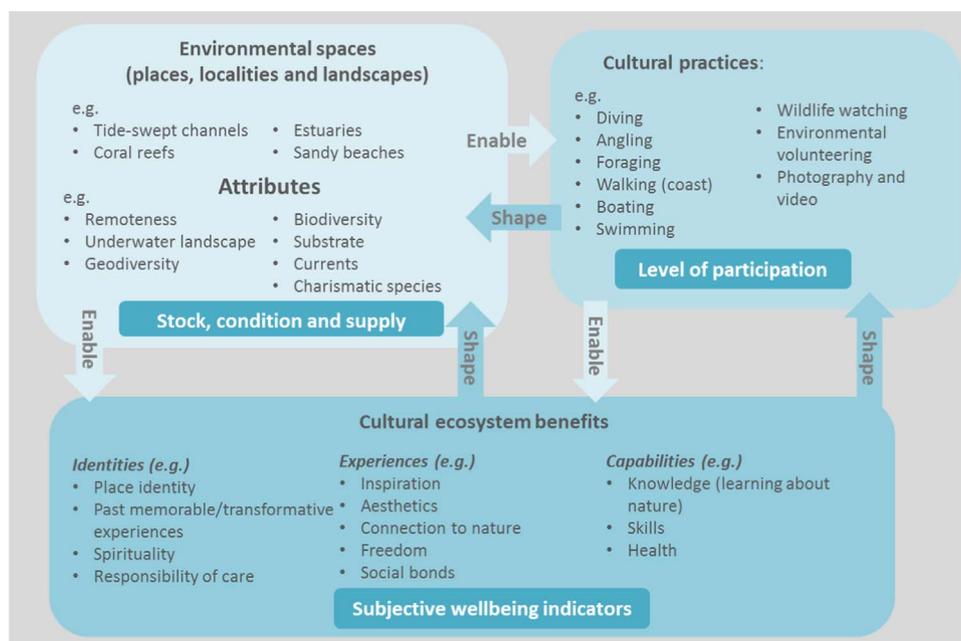

Fig. 1. Cultural ecosystem services framework for recreational users of marine areas (adapted from UK NEA Follow-on CES framework in Church et al. (2014)).

well-being that we a priori identified as potentially relevant for recreational uses of marine sites. The selection of constructs was informed by previous research on well-being benefits of green space and biodiversity (Dallimer et al., 2012; Fuller et al., 2007; Irvine et al., 2010, 2013), the UK NEA CES framework, the Human Scale Development Matrix (Cruz et al., 2009; Max-Neef, 1989), recent thinking on CES, goods and values (Chan et al., 2012a, 2012b) and the relation between cultural services, identity and landscapes (Tengberg et al., 2012). The indicators reflect an eudaimonic conception of well-being (Ryan and Deci, 2001) and can be considered subjective in terms of being self-reported (rather than assessed through objective indicators).

Indicator statements were specifically created for this study or adapted for use from previous research including Natural England's Monitor of Engagement with the Natural Environment (2012) that was implemented in the National Ecosystem Assessment Follow On (Church et al., 2014). Indicators were refined using stakeholder input from: (i) an online public survey on attitudes towards designation of marine protected areas (www.yourseasyourvoice.com); and (ii) four focus groups with recreational marine users. Table 1 lists the 15 indicator statements alongside the literature that underpins them. Well-being was considered in relation to specific marine sites that participants had visited; see Section 3.2 for further details.

3.2. Data collection process

The 15 well-being indicators were implemented as part of an online

Table 1
Indicators statements used to assess cultural well-being.

Indicator statement	A priori constructs; ilnks to literature & existing instruments
1. Visiting these sites clears my head.	1–4: Reflection and sense of wholeness (Dallimer et al., 2012; Fuller et al., 2007; Irvine et al., 2010)
2. I gain perspective on life during my visits to these sites.	
3. Visiting these sites makes me feel more connected to nature.	3: Connection to nature (MENE)
4. At these sites I feel part of something that is greater than myself.	4: Spiritual value (NEA; (Chan et al., 2012a, 2012b)
5. These sites feel almost like a part of me.	5–8: Sense of place: place identity and continuity with past (Dallimer et al., 2012; Fuller et al., 2007; Tengberg et al., 2012)
6. I feel a sense of belonging in these sites.	
7. I've had a lot of memorable experiences in these sites.	5: Identity (MENE)
8. I miss these sites when I have been away from them for a long time.	7: Transformative values (Chan et al., 2012a, 2012b);
9. Visiting these sites has made me learn more about nature.	9: Knowledge (NEA; MENE)
10. I have made or strengthened bonds with others through visiting these sites.	10: Social bonds (HSDM)
11. I feel like I can contribute to taking care of these sites.	11: Participation (NEME; HSDM)
12. I have felt touched by the beauty of these sites.	12: Aesthetics (NEA)
13. These sites inspire me.	13: Appreciation (MENE)
	13: Inspiration (Chan et al., 2012a, 2012b)
14. Visiting these sites leaves me feeling more healthy.	14: Health (NEA; MENE)
15. Visiting these sites gives me a sense of freedom.	15: Freedom (HSDM)

HDSM: Human Scale Development Matrix (Cruz et al., 2009; Max-Neef, 1989).
MENE: Monitor of Engagement with the Natural Environment (Natural England, 2012).
NEA: UK National Ecosystem Assessment: Cultural Services (Church et al., 2011).
Indicator statements 1-8 were drawn from previous research; indicator statements 9-15 were developed specifically for this study.

questionnaire of 1,220[2] recreational divers and anglers on the value of CES provided by areas proposed for inclusion in a network of marine protected areas in the UK (Kenter, et al., 2013) The questionnaire was circulated via email to members of recreational diving and angling organisations (primarily The British Sub-aqua Club and The Angling Trust) in addition to advertisement on organisational websites, via social media and in key user magazines.

Prior to completion of the questions about well-being, participants were asked to identify marine sites in their region (Scotland, Wales/north-west England, south-west England, south-east England or north-east England) that they had visited over the previous 12 months. Participants selected from fifteen randomly selected, region-specific sites that were spatially located in an interactive mapping application. These sites were drawn from lists of 127 recommended Marine Conservation Zones (RMCZs) in England, 39 potential marine protected areas (pMPAs) or search areas in Scotland and existing marine Special Areas of Conservation (SACs) in Wales, with sites entirely at more than 100 m water depth excluded. Participants were asked to base their responses to the well-being indicators on those sites they had visited. Participants were prompted with the question: "*The following questions are about the many ways in which the sites that you indicated you visited might be important to you. Please indicate how much you agree with each statement in relation to these sites*". Participants responded using a 5-point Likert scale (1=strongly disagree; 5=strongly agree).

3.3. Marine site attributes and visitor numbers

A database of attributes for each of the 151 marine sites which included underwater habitat type, presence of species and features of interest to recreational users such as wrecks, piers and reefs. Marine landscape characteristics were composed of habitat categories of conservation interest underpinning the designation of MPAs in the UK. These were based on substrate type and underwater biotic communities. Sea-life was defined by the presence or absence of several non-protected species of interest to recreational marine users e.g. large fish, seals, and also the number of vulnerable species targeted for protection in each site. Sea-life data were sourced from the English MCZ Impact Assessment, Scottish Government MPA Progress Reports, Welsh Special Area of Conservation Reports, the UK National Biodiversity Network Gateway (http://data.nbn.org.uk/) and from the Joint Nature Conservation Committee seabird colony database (2010 data). Appendix A lists the presence of site attributes by region. The attributes provide a measure of stock, supply and condition of marine sites as CES and were used in analysis to assess the influence of the objective qualities of sites on subjective well-being. The size of marine areas varied from very small sites (0.7 km^2) to very large areas (1614 km^2) with a median of 42 km^2.

Cultural practices were operationalised through the lens of engagement or participation in certain activities. An estimate of actual visitor numbers per annum was calculated for each site based on the ratio of study participants to have been asked about their visits to that site divided by those who reported visits to the site multiplied by the ratio of estimated recreational users in the UK over the total number of participants (Kenter et al., 2013).

3.4. Data analysis

All analyses were implemented using R (R Core Development Team, 2008). Although development of our measurement instrument was underpinned by *a priori* constructs of well-being, these were

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[2] In total 1683 respondents participated in the survey, but only 1220 completed the well-being indicator section, which followed on from the monetary valuation section (see Kenter et al., 2016a).

drawn from literature pertaining primarily to terrestrial environments. We thus used an exploratory factor analysis (EFA; Gorsuch, 1983) approach (R: psych package) to examine the data for any underlying structure. All the indicator statements were correlated at least 0.3 with at least one other statement showing that the data is suitable for factor analysis (see Appendix B).

Participant responses were treated as continuous over the 5-point Likert scale and screened for outliers and normality. We used principal axis factoring (PAF) with oblique rotation (oblimin) following the approach outlined in Tabachnick and Fidell (2013), and as done in previous studies (Dallimer et al., 2012; Fuller et al., 2007). Factors were constructed from indicators with factor loadings of ±0.4 and above, equivalent to approximately 16% explained variance and above the minimum of 0.32 recommended by Tabachnick and Fidell (2013). Cronbach's alpha was calculated to evaluate reliability of the resulting aspects of well-being. Confirmatory factor analysis (CFA) was then used to test the fit of models identified from the EFA (R: sem package).

CFA factor scores were extracted for each of the identified aspects of well-being by participant. Partial least squares regression (PLS)(R: plsdpot) was used to generate predicted scores for: (i) each PAF identified aspect of well-being; and, (ii) each of the 15 indicator scores for individual marine sites by analysing the influence of the sites visited by individuals on their responses to the well-being indicators. PLS is a multivariate data analysis method that identifies relationships between two data matrices using a linear regression model. This method is suitable for data with a large number of collinear predictors. In this study we have predictors that are highly correlated (visits to sites, site attributes) which violates the assumptions of multiple regression. PLS deals with this multi-collinearity. PLS is related to Principal Components Analysis (PCA), but additionally it allows us to capture information on the relationship between predictive and target variables. This method provides a versatile alternative to more traditional regression methods (Carrascal et al., 2009). The standardised coefficients for each site for each indicator were then used as the response variables in a second PLS analysis to evaluate the influence of marine site attributes on well-being at the site level.

4. Results

4.1. Aspects of well-being experienced by individuals

Factor analyses revealed distinct aspects of cultural well-being experienced by individuals. Table 2 provides summary details for the results of the EFA. Three multi-statement factors emerged which explained 58% variance; eleven of the fifteen indicator statements loaded onto these factors. The number of factors was determined based on inspection of loadings, eigenvalues and proportion of variance explained. While factors two and three both had eigenvalues below 1 (0.9 and 0.7, respectively; see Table 2), we chose to retain these as they explained a non-trivial proportion of variability in the data (Costello and Osborne, 2005) and clearly reflected recognised concepts of well-being. Internal consistency for each of the factors was examined using Cronbach's alpha; scores were above 0.8 indicating reliability of the factors (Table 2) and providing support for retaining all three factors.

Factors were interpreted as: (i) *engagement and interaction with nature* (explaining 23% of variation); (ii) *place identity* (18% variation explained); and, (iii) *therapeutic value* (17% of variation explained). The place identity factor corresponded well with our a priori construct of place identity (Table 1); three of the four indicator statements loaded. The other two factors encompassed distinct aspects of well-being at a broader conceptual level than our a priori constructs. Composite scores were calculated for each factor, based on the mean of the indicator statements which had their primary loadings on the factor. Higher scores indicated greater engagement and interaction with nature, place identity and therapeutic value from visited sites. Of the four statements that did not load, three of these were considered on

grounds of face validity to pertain to distinct a priori constructs: social bonding, spiritual value and memory/transformative value. We included the three factors and the three single indicator aspects of well-being in subsequent analysis. We used confirmatory factor analysis to test the fit of the model that emerged from the EFA. Results supported inclusion of the single indicator statements whereby the six aspect model showed improved fit over the model containing only the three multi-statement factors (Table 3). CFA factor scores were extracted and used in the next stage of the analysis.

4.2. Well-being across marine sites

Analysis using partial least squares regression to predict the influence of marine sites on the well-being scores showed that the six aspects of well-being were not consistently associated with particular sites. However, when we repeated the site analysis using the original 15 indicator scores (in place of the factor scores), we found variation in the correlations between indicators and sites (Fig. 2). The first two axes explain 80% of the variation and are both positively correlated with all 15 indicators. Several of the indicators were more closely aligned with either axis 1 or 2 suggesting that they may represent different aspects of well-being which are then associated with different clusters of marine sites. Table 4 shows that axis 1 is particularly characterised by aesthetic appreciation, inspiration, connection to nature, memory, and spirituality, benefits clearly most positively associated with sites in Scotland (Fig. 2). The residual variation explained by axis 2 is more strongly characterised by the therapeutic value of sites, sense of place and freedom and a feeling of responsibility for their care (Table 4); axis 2 is most positively associated with sites in SE England suggesting that they are valued more highly for their therapeutic value than the more aesthetic and nature inspired benefits associated with sites in Scotland. However, as respondents were presented with a subset of the 151 sites within their region, it is not possible to state to what degree this regional variation in well-being can be ascribed to regional differences between the characteristics of sites, or of respondents.

4.3. What marine attributes are associated with well-being?

A second PLS analysis was used to analyse the influence of marine site attributes on the site-based well-being indicator derived coefficients from the first PLS analysis. It was not possible to detect differences between the different well-being indicators themselves in relation to marine site attributes, as predicted scores were similar for each indicator, but overall higher well-being coefficients showed a clear association with certain site attributes. Of the sea-life attributes, sites with both charismatic fauna (i.e. large fish, seals and birds) and a higher number of species of conservation importance (e.g. Long snouted seahorse *Hippocampus guttulatus*, Native oyster *Ostrea edulis*) were more strongly aligned with well-being on the first axis of the second PLS (Fig. 3; see Appendix C for complete list of correlation coefficients). The presence of wrecks and certain habitats (seaweed and eelgrass beds, rocky tide-swept channels and muddy intertidal areas) were similarly associated with greater subjective well-being. Offshore sites and mussel and other shell bed habitats, on the other hand, were negatively related to well-being on axis one, (Fig. 3). However, offshore sites did show a weak positive correlation with the second axis. This suggests that some well-being value is associated with offshore sites after accounting for the role of species and habitats which are important for users of coastal sites.

5. Discussion

We operationalized the CES conceptual framework devised by Fish et al., (2016) to investigate the cultural benefits derived from a large number of marine areas across the UK. We found that recreational users interact with marine sites with a range of biophysical attributes,

Table 2

Result of exploratory factor analysis for well-being indicators (principle axis factoring with oblique rotation). The indicators that loaded onto three factors at a cut-off loading value of 0.4 are shown in addition to three single indicators that were taken forward to subsequent analysis as single indicator aspects. Composite mean scores (+SD) for the indicators in each factor (based on likert-scale responses) are shown followed by variation explained, cronbach's alpha values and eigenvalues.

Factor	Factor theme	Factor mean ($\pm$ SD)	% variation explained	Cronboach's alpha	Eigenvalue	Indicator	Loading
1	**Engagement and interaction with nature**	4.04 ± 0.6	23	0.87	7.7	Visiting these sites has made me learn more about nature	0.86
						Visiting these sites makes me feel more connected to nature	0.71
						I have felt touched by the beauty of these sites	0.60
						I feel like I can contribute to taking care of these sites	0.49
						These sites inspire me	0.48
2	**Place Identity**	3.63 ± 0.81	18	0.83	0.9	These sites feel almost like a part of me	0.92
						I feel a sense of belonging in these sites	0.68
						I miss these sites when I have been away from them for a long time	0.46
3	**Therapeutic value**	4.02 ± 0.74	17	0.83	0.7	Visiting these sites clears my head	0.84
						Visiting these sites gives me a sense of freedom	0.58
						Visiting these sites leaves me feeling more healthy	0.52
Single item indicators	**Spiritual value**	3.85 ± 0.95	NA	NA	NA	At these sites I feel part of something that is greater than myself	NA
	Social bonds	3.95 ± 0.88	NA	NA	NA	I have made or strengthened bonds with others through visiting these sites	NA
	Memory/ transformative value	4.26 ± 0.76	NA	NA	NA	I've had a lot of memorable experiences in these sites	NA

Table 3

Model fit indices for confirmatory factor analyses. Chi-squared tests (χ2) and degrees of freedom (df),*p < 0.05, goodness of fit index (GFI, acceptable model fit ≥0.9) and the root mean square error of approximation (RMSEA, acceptable model fit ≤0.05) are provided.

Model	χ^2	df	GFI	RMSEA
Three Factor	2226.1	44	0.77	0.20
Three Factor & three single indicators	294.8*	65	0.97	0.05

via cultural practices - recreational diving and angling - deriving a range of cultural benefits, with positive effects on subjective well-being. In our study, multiple cultural well-being benefits associated with the marine environment emerged, including engagement and interaction with nature, place identity, therapeutic value, social bonding, spiritual value, and memory/transformative value. This study is one of the first to consider CES impacts in terms of plural well-being benefits and to link subjective well-being and the biophysical domain at a large scale. The approach has the potential to be further developed and applied to assess the cultural services and benefits associated with diverse marine and terrestrial ecosystems, and the communal values of different groups of users.

Each of the six aspects of well-being identified in the study were characterised by positive responses to the underlying indicator statements, showing that participants experienced the range of CES benefits presented in the questionnaire. Factor analysis allowed us to identify which indicators composed distinct aspects of cultural well-being. *Place identity* describes the significance that certain areas have for people where, through attachment and a sense of belonging, place becomes a part of individual identity. This aspect of one's place-related well-being may develop and strengthen over time and thus is linked to a sense of belonging and a sense of continuity in peoples' lives (Horwitz et al., 2002; Manzo, 2003; Proshansky et al., 1983; Twigger-Ross and Uzzel, 1996). *Therapeutic value* included indicators describing the value of sites for clearing one's head, providing a sense of freedom and health. The identification of this aspect of cultural well-being mirrors the 'green' space literature (e.g. Bell et al., 2003; Irvine et al., 2013) and

emerging literature on 'blue' space (e.g. Bell et al., 2015). *Engagement and interaction with nature* included indicator statements about learning, feeling connected to nature and aesthetic appreciation. The indicator statements for *engagement and interaction with nature* and for *therapeutic value* met with the highest levels of agreement suggesting the marine sites are important spaces for these aspects of well-being. Indeed the benefits associated with wildlife and aesthetic beauty are well described e.g. Church et al. (2011); Klain and Chan (2012), and can perhaps be most intuitively associated with specific habitats and landscapes in the sites visited by participants. Other distinct aspects were represented by single indicator statements, specifically spiritual value, social bonds, and memory/transformative value. Inclusion of these indicators improved the fit of the CFA model. However, we recommend further research to deepen understanding of the constructs represented by these single indicators in order to improve the precision and reliability of the wellbeing instrument for use across a range of contexts. We would also anticipate future research to work towards integration of established well-being frameworks (e.g. Hartig et al., 2014; Korpela et al., 2014; Russell et al., 2013).

The need to further develop indicators for these less studied dimensions of cultural well-being has been noted by many (e.g. Hernández-Morcillo et al., 2013). While less often articulated, such benefits may be an important basis of environmental attitudes and contextual values around different management options (Irvine, et al., 2016). In the series of UK NEA valuation workshops discussed by Kenter et al., (2016a), the importance of the social, transformative and spiritual aspects of marine sites to recreational users readily surfaced through facilitated deliberative and participatory exercises, such as recounting personal experiences and discussion of how these experiences help shape individual and shared values; their qualitative findings complement our quantitative results in this study. This wider body of research also suggested that the subjective well-being benefits we report in this paper interact with transcendental values, for example values in relation to our responsibility towards the environment and how benefits should be shared, to shape attitudes towards ecosystem protection (Raymond and Kenter, 2016).

Individual sites could not be characterised as consistently providing visitors with one aspect of cultural well-being or another. This suggests
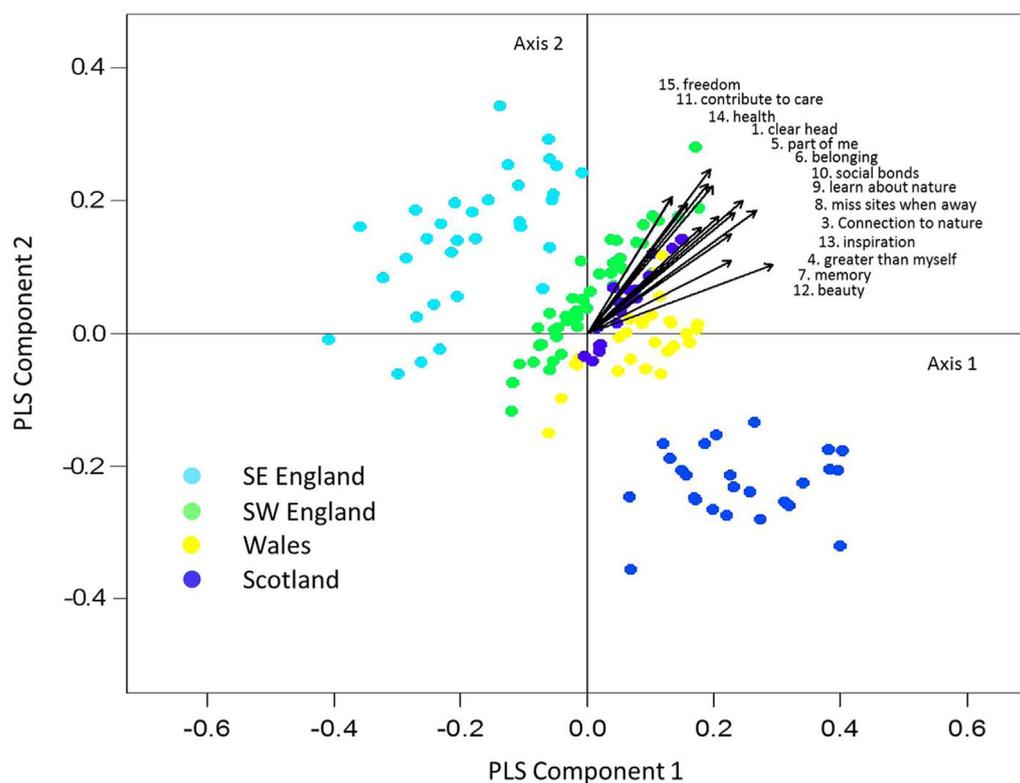
Fig. 2. Results of a partial least squares regression analysis (PLS) showing the correlations between well-being indicators (shown by arrows and corresponding labels) and sites by region (coloured dots). The first two axes which correspond to PLS components 1 and 2 are shown. The lengths of the arrows represent the strength of correlation with each axis and their alignment shows the relative extent they contribute to the variation explained by each axis. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

that peoples' experience of cultural benefits is highly variable and that marine areas do not necessarily have attributes which are specifically linked to particular aspects of well-being such as place identity and therapeutic value. However, this was a large scale assessment where participants were asked to consider groups of sites. There was a trade-off between scale and precision, and it is possible that more localised studies that conduct analysis at the individual site level for each participant may yet show more specific associations between sites and particular wellbeing aspects.

Our results indicate that biophysical assessments alone will not predict the range of CES provided, supporting the UK NEA conceptualisation that cultural benefits arise from a complex interaction between the characteristics of environmental spaces, practices, and transcendental cultural values. However some spatial patterns were evident at a larger regional scale. A detailed examination of specific well-being indicator scores showed regional gradients; sites in Scotland were valued considerably more for connection to nature and beauty, and sites in southern England were more associated with feeling more healthy and a sense of freedom and belonging. As southern England is the most populated area of the UK, recreational marine users may receive primarily therapeutic benefit from their pursuits. Visitors may feel that sites they return to, and become attached to, become a part of their identity.

Disentangling the influence of the biophysical attributes of the marine areas on well-being was challenging due to the fact that the well-being indicator responses for each participant covered several sites. However, partial least squares regression proved an effective analytical approach which showed correlations between attributes and overall well-being; while the correlation coefficients are weak, it is likely that we have underestimated the size of the effects at the site level due to responses being based on multiple sites.

A particularly striking finding was the significant positive correlation

between the number of species of conservation interest present in the site and overall well-being. In one way or another, it appears that the presence of rare species may be an effective indicator for the quality of the habitat in terms of the well-being experience of recreational users. It is important to recognise that the list of 40 conservation species were chosen on solely ecological grounds, and though they included some charismatic species (e.g. basking sharks, sea horses) the vast majority of them would not be considered charismatic, neither are they likely to be found easily by divers, let alone anglers. Presence of more common charismatic species (bird colonies, seals) were also important for well-being but less so than conservation species. This suggests the important implication that broader biodiversity conservation efforts based on ecological criteria can directly generate an increase in CES benefits. This is an important finding, because in many cases there is a lack of spatial congruence between biodiversity conservation and ecosystem service provision (Cimon-morin et al., 2013), in which case the value to human well-being would be limited to existence values.

While to our knowledge there are no other studies that have considered the association between CES wellbeing benefits and marine biodiversity, there are some terrestrial examples with comparable findings. For example, Fuller et al. (2007) found higher levels of subjective well-being in more diverse and species rich urban greenspaces. Bryan et al. (2010) compared landscape maps of ecological value with human importance for natural capital assets and ecosystem services. While human benefits were positively associated with some aspects of ecological value i.e. habitat of threatened species, there was a negative relationship with others including plant species richness. Relationships varied across the study area and the authors recommended local conservation strategies based on the results. However, further research is needed to understand in more depth the interactions between ecological variables and the cultural aspects of human well-being. Dallimer et al. (2012) found that it was perceived rather

Table 4
The correlation of the indicator statement with the first two axes of a partial least squares regression analysis against marine sites. The correlation coefficients are coloured on a gradient of white to dark red to show their relative strength.

Indicator	Axis 1	Axis 2
Visiting these sites clears my head	0.16	0.19
Visiting these sites makes me feel more connected to nature	0.23	0.18
At these sites I feel part of something that is greater than myself	0.23	0.15
These sites feel almost like a part of me	0.19	0.22
I feel a sense of belonging in these sites	0.20	0.22
I've had a lot of memorable experiences in these sites	0.23	0.11
I miss these sites when I have been away from them for a long time	0.25	0.20
Visiting these sites has made me learn more about nature	0.21	0.18
I have made or strengthened bonds with others through visiting these sites	0.18	0.16
I have felt touched by the beauty of these sites	0.29	0.10
These sites inspire me	0.27	0.19
Visiting these sites leaves me feeling more healthy	0.19	0.25
Visiting these sites gives me a sense of freedom	0.13	0.20
I feel like I can contribute to taking care of these sites	0.13	0.21

Fig. 3. The marine attributes significantly positively associated with to overall subjective well-being on axis one from the PLS analysis. The correlation coefficients are given on the x-axis. Correlation coefficients were considered significant if they had a variable importance of projection (VIP) greater than 1 (Chong and Jun, 2005).

than objective biodiversity that influenced well-being and research by Carrus et al. (2015) suggests that the links between biodiversity and well-being are mediated by the perceived restorativeness of the environmental setting.

It is recognised that effective conservation requires a large scale approach and our approach has allowed us to collect data on CES across a national network of potential protected areas presenting a powerful case for inclusion of CES in future designation decisions. Of course, it is likely that other social and cultural factors such as local history, knowledge and community identity have a strong influence on the experiences of recreational users, especially those whom are regular visitors or local residents, and arguments have been made to integrate these factors with biophysical considerations in the designation of protected areas (Charles and Wilson, 2009). In a more localised application of the subjective well-being indicator approach, it may be possible to more completely tease out (either through statistical or through qualitative exploration) the relative importance of biophysical features and of local sociocultural contexts.

CES provide an important link between the biophysical environment and human well-being, and thus need explicit consideration in decision making. The subjective well-being indicators developed here can be used independently, or integrated with established (Dallimer et al., 2014) or novel deliberative monetary valuation methods for a more holistic assessment of ecosystem value (Kenter et al., 2016a), better balancing plural and cultural aspects of value with economic and ecological factors that usually dominate.

Fish (2011) argues that a greater focus on well-being is necessary to achieve the ecosystem approach where ecosystem services are embedded in a decision making framework that seeks to achieve environmentally and socially sustainable resource use. Elaboration of CES in the ES framework may provide a useful conceptual bridge between the biophysical and social aspects of ecosystem service provision (Fish and Church, 2014; Milcu et al., 2013). However, a better understanding is needed of how CES are affected by changes in other ecosystem services (Rey Benayas et al., 2009). For example, how might designation of MPAs, and change in ecological function influence the cultural benefits experienced? As this paper has found a relationship between biodiversity and cultural ecosystem services, then policy that seeks to influence the ecological functions of specific marine habitats e.g. the designation and management of new MPAS in the UK, needs to consider the implications for the cultural benefits arising from these locations.

The well-being indicator instrument we have developed may contribute to improved well-being assessment in a range of contexts, cost-effectively and at a large scale. Moreover, it needs to be recognised that our relationship to the environment changes over time (Everard, et al., 2016), and the use of a set of pluralistic quantitative indicators can enable understanding of these changes in response to different environmental, sociocultural and policy drivers. Further research could consider integration of the cultural dimension of environment-derived wellbeing studied here with physiological aspects and psychological aspects such as attention restoration. Improving human well-being and promoting the conservation and sustainable use of marine and terrestrial ecosystems are among the United Nations Sustainable Development Goals (United Nations, 2015) and an improved understanding and assessment of the multiple dimensions of well-being will contribute to achieving these.

Acknowledgements

APPENDIX A. The attributes of marine sites for five regions in the UK. Only those sites reported as being visited at least once by survey respondents are included. Shown are the percentages of sites where features/species and habitat types are present

Sites	SW England	SE England	Wales	NE England	Scotland
No. sites	43	32	28	21	25
Attributes					
Visitor no (mean ± sd)	442.6 ± 367.1	489.7 ± 270.5	167.5 ± 126.9	193.6 ± 156.5	85.2 ± 84.2
No. vulnerable species (mean ± sd)	2.8 ± 2.8	1.6 ± 1.8	1.6 ± 2.5	0.4 ± 1.0	3.0 ± 2.9
Features/species: % presence					
REEF	45.2	65.6	39.3	52.4	100
WRECK	57.1	90.6	60.7	76.2	100
PIER	40.5	75	39.3	52.4	100
OFFSHORE	40.0	34.4	35.7	33.3	16
LARGE FISH	35.7	43.8	21.4	23.8	56
SEAL	0	6.3	7.1	0	24
OCTOPUS	7.1	0	21.4	4.8	28
BIRD	28.6	43.8	35.7	14.3	68
Habitat types: % presence					
Hab4	2.4	12.5	14.3	4.8	8
Mostly sandy or gravelly seafloor with oyster, mussel or flame shell beds					
Hab5	0	12.5	14.31	4.8	0
Mostly muddy seafloor with oyster, mussel or flame shell beds					
Hab6	0	12.5	10.7	4.8	0
Mostly rocky seafloor with oyster, mussel or flame shell beds					
Hab7	19.0	15.6	3.69	4.8	0
Mostly rocky seafloor with large kelp and seaweeds					
Hab8	4.8	6.2	0	0	0
Mostly rocky seafloor with anemones, soft corals, and sponges					
Hab9	7.1	6.3	10.7	0	0
Mostly muddy seafloor with sea-pens, burrowing animals and fireworks anemones					
Hab10	9.5	31.3	10.7	14.3	0
Mostly sandy or gravelly seafloor with honeycomb or rossworm colonies					
Hab11	9.5	25	10.7	9.5	0
Mostly rocky seafloor with honeycomb or rossworm colonies					
Hab12	14.3	15.6	0	4.8	0
Mostly sandy or gravelly seafloor with sea grass or eel grass beds					
Hab13	0	0	0	0	12
Mostly muddy seafloor with burrowing sea urchins and brittle stars					
Hab14	0	28.1	21.4	28.6	0
Mostly sandy or gravelly seafloor with scallops and sea urchins					
Hab15Mostly sandy or gravelly seafloor in tide swept channel	2.4	0	3.6	0	8
Hab16	2.4	0	0	0	0
Mostly rocky seafloor in tide swept channel					
Hab17	12.0	12.5	3.6	4.8	0
Mostly rocky seafloor with rocky habitats in estuary					
Hab18	9.5	9.4	3.6	9.5	0
Mostly muddy seafloor with intertidal boulders					

Appendix B. Correlation matrix showing correlation coefficients for indicators used in factor analyses

Indicator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1.00	0.72	0.73	0.66	0.79	0.59	0.52	0.54	0.52	0.45	0.62	0.60	0.63	0.58	0.26
2	0.72	1.00	0.61	0.63	0.58	0.50	0.42	0.46	0.52	0.29	0.65	0.54	0.60	0.48	0.32
3	0.73	0.61	1.00	0.65	0.66	0.56	0.58	0.55	0.59	0.35	0.66	0.55	0.64	0.53	0.30
4	0.66	0.63	0.65	1.00	0.66	0.60	0.47	0.58	0.49	0.45	0.55	0.47	0.63	0.53	0.32
5	0.79	0.58	0.66	0.66	1.00	0.67	0.54	0.69	0.59	0.48	0.60	0.63	0.56	0.48	0.29
6	0.59	0.50	0.56	0.60	0.67	1.00	0.39	0.45	0.49	0.40	0.58	0.61	0.54	0.49	0.20
7	0.52	0.42	0.58	0.47	0.54	0.39	1.00	0.53	0.48	0.31	0.61	0.45	0.46	0.47	0.29
8	0.54	0.46	0.55	0.58	0.69	0.45	0.53	1.00	0.45	0.43	0.60	0.57	0.57	0.43	0.24
9	0.52	0.52	0.59	0.49	0.59	0.49	0.48	0.45	1.00	0.35	0.65	0.61	0.48	0.48	0.48
10	0.45	0.29	0.35	0.45	0.48	0.40	0.31	0.43	0.35	1.00	0.30	0.24	0.53	0.35	0.00
11	0.62	0.65	0.66	0.55	0.60	0.58	0.61	0.60	0.65	0.30	1.00	0.60	0.54	0.42	0.32
12	0.60	0.54	0.55	0.47	0.63	0.61	0.45	0.57	0.61	0.24	0.60	1.00	0.60	0.60	0.30
13	0.63	0.60	0.64	0.63	0.56	0.54	0.46	0.57	0.48	0.53	0.54	0.60	1.00	0.60	0.21
14	0.58	0.48	0.53	0.53	0.48	0.49	0.47	0.43	0.48	0.35	0.42	0.60	0.60	1.00	0.32
15	0.26	0.32	0.30	0.32	0.29	0.20	0.29	0.24	0.48	0.00	0.32	0.30	0.21	0.32	1.00

Appendix C. Correlations between MPA features /regions and the first 2 axes of the PLS model. Asterices signify the significance of the predicator variables according to their variable importance in projection (VIP). Predictors can be considered significant when VIP > 1 and are marked (**). Marginally significant predictors with VIP > 0.8 are marked (*)

MPA Features and Regions	Description	Axis 1	Axis 2
VISITNo	Estimated visitor no. per annum	0.2340**	0.0517
REEF	Presence of reef	0.3547	−0.5511
WRECK	Presence of wreck	0.3829**	−0.4961**
PIER	Presence of pier	0.4536	−0.5122**
OFFSHORE	Site > 6 nautical miles from coast	−0.6565**	0.1097**
FISH	Presence of large fish i.e. atlantic cod, wrasse spp, ray spp. black seabream, dover sole, goldsinny, pollack, rock cook, seabass, mullet spp.	0.4624**	−0.2329**
SEAL	Presence of seal	0.3238*	−0.1663*
OCTOPUS	Presence of octopus	0.1853	−0.4800
BIRD	Presence of seabird colony	0.5637**	−0.2672**
SPEC	Number of species of conservation importance (i.e. Features of Conservation Interest)	0.6433**	−0.1663**
Habitat 4	Mostly sandy or gravelly seafloor with oyster, mussel or flame shell beds	−0.1560*	−0.1994
Habitat 5	Mostly muddy seafloor with oyster, mussel or flame shell beds	−0.1199*	−0.2628*
Habitat 6	Mostly rocky seafloor with oyster, mussel or flame shell beds	−0.2428**	−0.0134
Habitat 7	Mostly rocky seafloor with large kelp and seaweeds	0.4961**	−0.0187**
Habitat 8	Mostly rocky seafloor with anemones, soft corals, and sponges	−0.0391	−0.2935
Habitat 9	Mostly muddy seafloor with sea-pens, burrowing animals and fireworks anemones	−0.0252*	−0.3461**
Habitat 10	Mostly sandy or gravelly seafloor with honeycomb or rossworm colonies	−0.1842	−0.0261
Habitat 11	Mostly rocky seafloor with honeycomb or rossworm colonies	−0.1512	−0.0178
Habitat 12	Mostly sandy or gravelly seafloor with sea grass or eel grass beds	0.4653**	−0.1086**
Habitat 13	Mostly muddy seafloor with burrowing sea urchins and brittle stars	0.2332	−0.0565
Habitat 14	Mostly sandy or gravelly seafloor with scallops and sea urchins	−0.4665**	−0.0080**
Habitat 15	Mostly sandy or gravelly seafloor with scallops and sea urchins	0.1098	−0.5324*
Habitat 16	Mostly rocky seafloor in tide swept channel	0.0881	−0.4196**
Habitat 17	Mostly rocky seafloor in tide swept channel in estuary	0.1870**	0.2368**
Habitat 18	Mostly muddy seafloor with intertidal boulders	0.2616**	0.1423**
Region NE England		−0.0868	0.2760
Region Scotland		0.2327**	−0.4481**
Region SE England		−0.1231	−0.1581
Region SW		0.2665*	0.2969
Region Wales		−0.3241	0.0125

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