

Integrating monetary and non-monetary valuation of cultural ecosystem services provided by marine protected areas

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Marine ecosystems deliver substantial cultural benefits, but there has only been limited development of methods that assess the value of these marine cultural ecosystem services (ES). Additionally, it has been recognised that economic valuation alone does not fully elicit the value that people attach to ES, yet few studies bring together monetary and non-monetary approaches to develop a more comprehensive picture. This study, part of the second phase of the UK National Ecosystem Assessment, elicited the values of divers and sea anglers for using and protecting 151 potential marine protected areas (MPAs) across the UK. Values were elicited using a range of monetary (transport cost, contingent valuation, and deliberative monetary valuation) and non-monetary methods (wellbeing questionnaires, storytelling and multi-criteria analysis [MCA]). Over 1600 divers and sea anglers responded to an online valuation survey, followed by a series of sixteen deliberative valuation workshops involving over 200 participants. Monetary valuation indicated that divers and anglers had clear use values for most of the 13 habitat types considered. In the online survey, non-use values associated with protecting potential MPAs were mostly correlated with participants' level of support for MPAs and restrictions on other users. Following group deliberation support for management restrictions increased, but nonetheless willingness to pay (WTP) decreased as it became less generic and more clearly defined preferences were formed for different habitats. Deliberation also brought out specific concerns around access and responsibility that were reflected in decreased WTP. Here, discussions pointed towards an arising sense of solidarity between users around access rights. Non-monetary valuation suggested divers and anglers well-being values revolved around six shared dimensions: engagement & connectedness to

nature, place identity, therapeutic values, transformative & memory values, spiritual values and social bonding. By using a map-based elicitation approach it was possible to rank potential MPAs for these non-monetary benefits, with Scottish and Southwest-English sites scoring highest on average. In the storytelling exercise the majority of diver stories related to connection with and immersion in the environment. Experiences were often conveyed as spiritual, magical and imbued with colour. Stories also related to the exploratory, adventurous aspect of diving and the feeling of freedom felt as a result. Stories told by anglers tended to present this activity more as a solitary, reflective and therapeutic activity. Anglers also tended to share stories about introducing angling to others, in particular discussing the importance of passing on knowledge or experience to a younger person. In the MCA, there was strong support for more restrictive management scenarios. Structuring deliberation and scoring around site-based values helped tie values to specific seascapes. Ranking results indicated that participants expressed different values as a group to those expressed as individuals, with the group rankings of criteria more strongly orientated towards education and less strongly towards protecting recreational opportunities. The research demonstrates how an integrated mixed-method approach can help to better incorporate shared and cultural values into environmental valuation and decision-making. This makes it possible to not only answer 'how much' questions, but also the 'why', 'where', and 'how' of values, and deal with the often complex and subtle nature of cultural ES.

New studies cast doubt on the legitimacy of the conservation status of *Sabellaria spinulosa* reefs: A case study that demonstrates the importance of evidence to support MPA design.

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Reef habitats created by *S. spinulosa* are listed as a priority for conservation efforts in International and European conservation legislation, most notably the Habitats Directive and the OSPAR Convention for the Protection of the Marine Environment of the North East Atlantic. The priorities outlined in the Habitats Directive and the OSPAR list of threatened and / or declining species and habitats have also been incorporated into national conservation legislation meaning that *S. spinulosa* reefs are subject to the highest level of protection afforded to marine habitats in the UK. *S. spinulosa* reefs are protected from damaging activities where they have been identified as designated features of Special Areas of Conservation (SACs) and form part of the UK's network of Marine Protected Areas (MPAs).

Sabellaria spinulosa reefs have been identified as a priority for protection due to their historic losses, sensitivity to anthropogenic disturbance and their ability to enhance biodiversity. However, with the exception of historic losses, there is no robust evidence to support or challenge the underlying assumptions upon which the conservation status of this habitat have been built.

Here we bring together the results of recent studies exploring the relationship between macrofauna associated with *S. spinulosa* reefs and adjacent sedimentary habitats in the eastern English Channel and southern North Sea in an attempt to test the assumption that biodiversity is enhanced by the presence of the reefs, and in doing so to test the legitimacy of the high conservation status of this habitat. At the individual sample level *S. spinulosa* reefs were found to increase the number of species (S) by 20-40%, although this increase does not extend to measures of taxonomic distinctness (relatedness of species), community composition or beta-diversity indicating that the reefs are associated

with an increased density of species rather than an increase in biodiversity in its truest sense. Indeed, the abundance of macrofauna (N) exhibited a 2-4 fold increase in the presence of reefs across all sediment types and in all areas examined. The influence exerted by *S. spinulosa* reefs in the eastern English Channel and southern North Sea can therefore be characterised as increasing the density of both animals and species.

These studies cast significant doubt over the assumption that *S. spinulosa* reefs increase biodiversity and hence raise questions about the legitimacy of the high conservation status afforded to this habitat. The economic cost of protecting this habitat is not insignificant, but perhaps more damaging are the impacts of undermining efforts, that have been made to encourage environmental stewardship amongst developers, through the continued application of conservation priorities based on incomplete evidence. Filling known knowledge gaps and regularly reviewing conservation priorities therefore needs to be a priority in the future development of the UKs MPAs.

Inter- and intra-year variation in foraging areas of breeding kittiwakes (*Rissa tridactyla*): consequences for MPA identification

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While seabird conservation efforts have largely focused on protection from threats at the colony (e.g. reducing disturbance and predation), attention is increasingly being given to implementing protection measures for foraging areas at sea. For this to be effective, important foraging areas must be identified. Although numerous studies have examined seabird foraging behaviour, information is still lacking on the variability in area utilisation within and among breeding seasons. GPS devices were attached to adult kittiwakes breeding at an expanding North Sea colony (55° 37' N, 1° 32' W) during both incubation and chick-rearing in 2012 and during chick-rearing in 2011, to determine whether foraging areas remained consistent and to identify the oceanographic characteristics of areas used for foraging. The type and size of prey items consumed at different stages of the breeding cycle was also examined. During incubation (April - May 2012), kittiwakes foraged substantially further from the colony and fed on larger sandeels than when feeding chicks, and there was significant inter-annual variation in foraging areas used during the chick-rearing period (June - July 2011 and 2012). Foraging areas were characterised by cooler sea surface temperatures (SST) and areas of high chlorophyll *a* concentration, although association with specific oceanographic features changed within

the breeding season and between years. These results emphasise the importance of considering how foraging areas and reliance on specific oceanographic conditions change over time when seeking to identify important marine protected areas for seabirds.

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Mapping Cumulative Noise from shipping within a Marine Spatial Plan to help inform policy

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With the demands placed on the natural environment reaching new extremes, marine spatial planning (MSP) is becoming a well-recognised, important tool for the sustainable management of marine ecosystems (Douvere, 2008). Although there are many definitions for MSP, UNESCO defines it as a 'a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to ecological, economic and social objectives that usually have been specified through a political process' (Ehler & Douvere, 2009). All over the world, governments and stakeholders are coming together to put MSP policy into place (Ehler & Douvere, 2009). In the UK, a legal framework for the development of marine spatial plans have been initiated under a number of government acts. In Scotland, preparation for the development of MSP across Scotland led to the Scottish Sustainable Marine Environment Initiative (SSMI) under which the Shetland Marine Spatial Plan was developed (Shucksmith & Kelly, 2014). Today, it is one of the most advanced in the UK. The SMSP have used GIS to incorporate spatial data on existing coastal and marine environments as well as the socio-economic and cultural features and activities within the policy (Shucksmith & Kelly, 2014). However, the effects of noise pollution such as that generated from shipping needs to be studied in greater detail.

Commercial shipping has increased both in the number of ships used as well as the size of ship itself, propulsion power and sophistication (McKenna et al., 2012). This increase might be related to trend analysis studies that show there has been an approximate doubling of background noise per decade in certain areas of the ocean (Gotz et al., 2009) (McDonald et al., 2006). To truly understand the effect of change in background noise, long-term trend analysis needs to be utilized. Whilst most regulations focus on the effects of acute and impulsive noise production, chronic long-term noise pollution such as shipping noise is highly unregulated (Erbe et al., 2014).

Although a number of countries recognise the need for acoustic attributes to be considered when dealing with critical habitats for acoustically sensitive organisms, they do not specify thresholds or limits with regards to acceptable change (Erbe et al., 2012). In the UK, DEFRA acknowledge that underwater noise is of concern and urgently requires more research. However, it on goes on to state that as yet there is not enough data available to provide a quantitative assessment of underwater noise in the UK. It concludes that further studies need to focus on mapping and modelling ambient noise (DEFRA, 2010). The work done aims to collect and collate the necessary data with respect to noise from shipping so as to map cumulative noise within the SMSP. It will hopefully serve as the foundations needed to help develop policy associated with the future management of noise pollution.

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Recognising Essential Fish Habitat in MPAs: the impact of marine management measures on rural communities.

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Biogenic reefs, such as those formed by horse mussels (*Modiolus modiolus*), are biodiversity hotspots (eg Rees *et al.* 2008), and recognised for their conservation importance. They are 'reefs' in Marine Protected Areas (MPAs) under the EU Habitats Directive and are a Priority Marine Feature in MPAs under the Marine (Scotland) Act 2010. However, very little is known about the functional importance of such reefs and the ecosystem services that they provide to society.

Essential Fish Habitats (EFH) are areas of the seabed necessary for spawning, feeding or growth to maturity. Identifying and prioritising EFH for protection can help to sustain healthy fish stocks and provide food for an ever-growing human population.

The North Llŷn horse mussel reef complex is substantive and has been mapped: It constitutes two reefs, which cover a total of 500 hectares of the seabed (Lindenbaum *et al.*, 2008; Lindenbaum *pers. comm.* 2012). The area in this study has been closed to mobile fishing activity since November 2012, however, the use of static gear is permitted and common whelks (*Buccinum undatum*) have been harvested from this area for the past 25 years by between three and five vessels from the local town of Mofa Nefyn. Scallop dredging continues in the area adjacent to the reefs for part of the year (November to April), by vessels from further afield such as Holyhead and Milford Haven.

The aim of this study was to find out if the North Llŷn horse mussel reef is an essential habitat for whelks and to investigate the functional role this habitat plays in the production of whelks.

By working with the local whelk fishermen data were collected on whelk catch rates, size distributions and growth rates at stations on and off the reef using baited pots. Drop-down video footage was used to confirm the habitat in the area.

Ultimately, understanding the functional role of this horse mussel reef and the benefits that it can provide to local communities, can make an important contribution to conservation management. Involving stakeholders in the process of gathering the evidence that underpins the MPA network can facilitate effective management of MPAs in the UK.

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Monitoring habitats: how useful are points on a map, predicted habitats, and historic data?

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In order to help conserve priority marine features from the impacts of scallop dredging, Shetland introduced a set of voluntary closed areas during 2010, proposed by the local industry. Closed areas were based on available historic information and predicted habitats focusing on priority marine features, primarily horse mussel (*Modiolus modiolus*) and maerl beds.

Each voluntary closed area was surveyed with the aim of producing habitat maps of each area with all the horse mussel and maerl beds detailed. Surveys were carried out using the survey vessel, MV *Moder Dy*, fitted with a hull mounted multibeam and drop down video system for groundtruthing. The majority of closed areas were based on historic point records with a small portion of sites containing predicted habitats which were also based on point data. Predicted habitats were not found to accurately represent the findings of the survey. Point data was found to be highly inaccurate with the voluntary closed area either not protecting any UK BAP habitats or not fully protecting the UK BAP habitat. The survey illustrated the lack of good quality, robust, accurate, and up to date habitat information for the waters around Shetland and highlighted the need for good quality, up-to-date marine survey data with a need for defined area outputs, rather than point information. The results from this survey were used to legally alter the closed area boundaries which were legalized in 2011.

Survey outputs produced polygon areas for each horse mussel and maerl bed surveyed. Defined habitat areas (polygons) provide a quantifiable method of monitoring habitats over time and are essential for any future habitat monitoring in closed areas or MPAs.

Taking forward management of Nature Conservation MPAs: process and research needs

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How Nature Conservation MPAs are managed is of interest to many – to Government, to the Statutory Nature Conservation Bodies (SNCBs), to those whose activities/developments are likely to be managed and to others with an interest in the marine environment including environmental non-governmental organisations, academics and local communities.

Discussions on management have been ongoing since the early stages of the Scottish MPA Project. Management discussions started in 2012 through the national MPA stakeholder workshops. They continued in 2013 through various stakeholder meetings, including regional fisheries events and drop-in sessions as part of Marine Scotland's formal consultation on the MPA network in Scotland's seas. To support the consultation, Management Options Papers were provided by Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) to give an indication of how management for the sites was likely to develop. From the start of 2014, Marine Scotland led much more detailed discussions with the fishing industry as part of their study into the possible effects of displacement that could arise as a result of implementing management.

Work is now underway to develop proposed fisheries management measures to protect Nature Conservation MPA proposals that can then be put out to public consultation. The focus will initially be on those features considered to be at most risk and/or those that are likely to only be represented once within the Scottish MPA network. Alongside Nature Conservation MPAs, the work will also consider any further management that might be required for fisheries activity within European Marine Sites.

Throughout the Scottish MPA Project, there have been requests for all the information used by the

SNCBs in developing advice. Various pieces of guidance and tools are now available (see references below). These summarise our current understanding of the sensitivities of the different marine habitats and species. It is clear from these documents that the evidence base tends to be better developed and more clear-cut for those features where there is a longer history of management and where they are more sensitive. For example, for maerl beds and seagrass beds that may form part of the Annex I qualifying habitat 'sandbanks which are slightly covered by seawater all the time'. For those features that are less sensitive and where management may therefore be likely to focus on effort restrictions (e.g. around the intensity and/or frequency of operations) rather than on avoiding an activity taking place within a specified area, there is a need to think clearly about what additional data might be required to support implementation of management.

This session will include discussion of work underway but will focus on identifying further work that may be required to underpin management and opportunities to undertake this work.

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References

Scottish Government FEAST (Feature Activity Sensitivity Tool) at: <http://www.marine.scotland.gov.uk/FEAST/Index.aspx>

JNCC and SNH Fisheries management guidance documents: <http://jncc.defra.gov.uk/page-6498>