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EXPERT WORKSHOP ON MARINE PROTECTED AREAS AND OTHER EFFECTIVE AREA-BASED CONSERVATION MEASURES FOR ACHIEVING AICHI BIODIVERSITY TARGET 11 IN MARINE AND COASTAL AREAS
Montreal, Canada, 6-9 February 2018

BACKGROUND DOCUMENT ON DEFINING THE QUALITATIVE ELEMENTS OF AICHI BIODIVERSITY TARGET 11 WITH REGARD TO THE MARINE AND COASTAL ENVIRONMENT

Note by the Executive Secretary

1. The Executive Secretary is circulating herewith for the information of participants in the Expert Workshop on Marine Protected Areas and Other Effective Area-based Conservation Measures for Achieving Aichi Biodiversity Target 11 in Marine and Coastal Areas, a background document on defining the qualitative elements of Aichi Biodiversity Target 11 with regard to the marine and coastal environment. The document was prepared by the Marine Institute at Plymouth University and Seascape Consultants Ltd, as commissioned by Secretariat of the Convention on Biological Diversity, with financial support from the European Commission.

2. The present document was initially prepared for a previous meeting in 2016. The figures on the achievement of the quantitative elements of Aichi Biodiversity Target 11 have been updated. However, other parts of the report have not been updated and may be out of date.

3. The document is being circulated in the form and language in which it was received by the Secretariat

Defining the qualitative elements of Aichi Biodiversity Target 11 with regard to the marine and coastal environment

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1 Introduction

Parties to the Convention on Biological Diversity (CBD) have consistently recognised the contribution networks of Marine Protected Areas (MPAs) can make to sustainable use of marine and coastal biological diversity and resources, together with other conservation areas and biosphere reserves, consistent with customary international law. In particular, the 7th meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP 7) echoed commitments made in the Plan of Implementation of the World Summit on Sustainable Development (10% by 2012) and agreed that marine and coastal protected areas are one of the essential tools and approaches in the conservation and sustainable use of marine and coastal biodiversity.

In 2010, delegates to the 10th meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP 10) agreed to extend the deadline for signatory countries to reach the target of conserving 10% of their marine and coastal ecoregions in protected areas from 2012 to 2020 (see Section 3.1). CBD COP 10 also agreed on a Strategic Plan for Biodiversity 2011-2020. The Plan set out 20 Aichi Biodiversity Targets, organised under five strategic goals that seek to ensure that "By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people." Aichi Target 11 is within Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity. The CBD Secretariat has published a 'quick guide' explaining each target, its implications, relevance for national targets, actions and milestones, and possible indicators (see https://www.cbd.int/doc/strategic-plan/targets/T11-quick-guide-en.pdf).

The technical rationale for the Aichi Biodiversity Targets, as set out in COP/10/INF/12/Rev.1, highlights the merits of 'well governed and effectively managed MPAs as a proven method for safeguarding both habitats and populations of species and for delivering important ecosystem services'. To achieve this there is a need to expand coverage of MPAs, focusing on 'representativity' within a broader Ecosystem Approach.

Aichi Target 11 states that, 'by 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes' (CBD 2010a). The text comprises both quantitative targets and qualitative elements that define how Aichi Target 11

may be achieved (Table 1). A detailed scoping paper for the legal aspects of Target 11 sets out explanations of both quantitative targets and qualitative elements http://www.iccaconsortium.org/wp-content/uploads/SBSTTA-T11-Scoping-Paper-Final.pdf

It is also important to note that measures to achieve Aichi Target 11 can also support achievement of other Aichi Targets, including Target 6 and Target 10.

Quantitative targets	17% terrestrial
	10% coastal and marine
Means of conservation	Protected areas
	Other effective area-based conservation measures
Qualitative elements	Ecologically representative
	Areas of particular importance for biodiversity and ecosystem services
	Management equity and effectiveness
	Well-connected
	Integration into wider landscape and seascape

Table 1: The quantitative targets and qualitative elements that define how Aichi Target 11 may be achieved. Adapted from Jonas and Lucas (2011).

Aichi Target 11 broadens the scope of efforts of conservation by including MPAs alongside 'other effective area-based conservation measures (OECM)' as a 'means of conservation'. The qualitative aspects also provide the means to integrate ecology and socio-economics into conservation to support progress towards sustainable development.

The purpose of this working document is to characterize progress towards the quantitative elements of Aichi Target 11, to present current knowledge on the qualitative elements of Aichi Target 11 with regard to the marine and coastal environment and to highlight gaps in this knowledge. Key pertinent questions to be considered further are listed in boxes at the end of each section.

2. Quantitative targets (marine and coastal)

2.1 "10 percent of coastal and marine areas"

In 2004, the Convention on Biological Diversity (CBD) called for Party states to establish, by 2012, comprehensive, effectively managed, and ecologically representative national and regional systems of Marine Protected Areas (MPAs), and that there should be effective conservation of at least 10% of

each of the world's ecological regions by 2010 (UNEP-WCMC 2008). Aichi Target 11 revises this target deadline to 2020 (CBD 2010b).

As of December 2017, MPA coverage was 16.02% for areas under national jurisdiction, 1.18% for areas beyond national jurisdiction and 6.96% for the global ocean. If all national commitments are met by 2020, it would lead to a 4.0% increase for marine protected areas in the global ocean (0.1% from National Priority Actions identified in six regional workshops, 0.09% from approved GEF-5 and GEF-6 projects, 2.18% from Ocean Conference voluntary commitments, 0.96% from other large MPA proposals, 0.55% from NBSAP targets and 0.08% from Micronesia and Caribbean challenges). Marine protected area coverage for areas under national jurisdiction would reach 23.7%; global ocean coverage would reach 10.3%.[1]

3 Means of conservation

3.1 "Marine Protected Areas"

The term "protected area" is defined in Article 2 of the CBD as "a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives" (CBD 1992). In 2004 the Conference of Parties agreed decision VII/5 that 'marine and coastal protected areas are an essential tool for the conservation and sustainable use of marine and coastal biodiversity and that the Conference of the Parties also agreed that a national framework of marine and coastal protected areas should include a range of levels of protection, encompassing both areas that allow sustainable uses and those that prohibit extractive uses (i.e., "no-take" areas)' (CBD 2004).

3.2 "Other effective area-based conservation measures"

The potential for 'other effective area-based conservation measures' (OECM) aside from statutory MPAs to contribute to ecologically representative and well connected MPA networks is increasingly receiving attention (Borrini-Feyerabend et al. 2014; Dunn et al. 2016; Jonas et al. 2014; Spalding et al. 2013; Woodley et al. 2012). Areas that may be included as an OECM include private, local or non-legal protected areas; areas where protection levels are increased for biodiversity conservation or resource management; and areas of 'incidental' or 'de facto' conservation benefits, such as military areas, areas under fisheries management, ports and renewable energy sites (Spalding et al. 2013).

[1] Figures provided by the CBD Secretariat.

There is potential for these areas that have some form of spatial and temporal management to help to meet area-based biodiversity conservation targets and support sustainable use of resources within the broader seascape. The identification of OECMs that can contribute to ecologically representative and well-connected MPA networks and progress toward the 10% spatial target, is a key challenge recognised by the IUCN World Commission on Protected Areas (WCPA) Protected Planet Report (Juffe-Bignoli et al. 2014). The report states that OECMs should only include sites "that truly complement protected areas in conserving biodiversity in the long term, and exclude those that have no conservation value or no security of protection into the future (Juffe-Bignoli et al. 2014).

The IUCN Task Force on 'Other Effective Area based Conservation Measures' has previously defined OECMs as "a geographical space where de-facto conservation of nature and associated ecosystem services and cultural values is achieved and expected to be maintained in the long term regardless of specific recognition and dedication" (Borrini-Feyerabend et al. 2014). The Canadian Council on Ecological Areas (MPA News 2015) have proposed a set of criteria to define an OECM:

- They should be well-defined geographically;
- They should have objectives for biodiversity conservation, achieved through conservation of biodiversity as a whole;
- Their conservation objectives must receive first priority when in conflict with other objectives;
- The mechanisms by which the areas are established must have the comprehensive ability to exclude, control, and manage all activities likely to have impacts on biodiversity, and must compel the prohibition of incompatible activities;
- They should be in place for the long term;
- The mechanisms by which they are established must be difficult to reverse; and
- They should be in effect year-round.

In a study of the benefits of other spatial protection measures for limited an low mobility benthic species in the Celtic Seas UK, Rees et al (2015a) conclude that permanent fisheries closures, protected wrecks, voluntary marine conservation areas and offshore renewable energy installations (with spatially defined zones) all meet the criteria to be included in current MPA networks as OECMs. Though the inclusion of these OECMs within the current network does not address the major gaps in the ecological coherence of the Celtic Seas network identified in the offshore areas and across bathymetric zones (Rees et al. 2015a). In the USA de-facto MPAs, as defined in the USA's National

Marine Protected Areas Report (2008), have been identified as a potential major spatial contributor to protected area networks. For example, in the Gulf of Mexico, areas established to protect oil and gas infrastructure, military areas and shipping channels exceed the area designated for MPAs with biodiversity conservation objectives (National Marine Protected Areas Center 2008). In Australia, Fishery Management Zones, larger than adjacent MPAs, have been recognised in Australian waters for Australian Sea Lion (*Neophoca cinerea*) and deepwater sharks. Regional Fisheries Management Organisations (RMFO) provide spatial management measures, many of which overlap with identified Vulnerable Marine Ecosystems and Ecologically and Biologically Significant Areas (EBSAs) described by CBD Regional Workshops. The North East Atlantic Fisheries Commission (NEAFC) has been identified as an RFMO that has implemented 'good practice' though enacting closures to protect deep sea ecosystems from bottom towed fishing gear (Wright et al. 2015). In Australia, spatial closures that are enacted for fisheries by the Australian Fisheries Management Authority (AFMA) exceed the spatial extent of areas that designated as Commonwealth Marine Reserves. It is argued by Bax and Cresswell (2012) that AMFA regulated areas are more restrictive on fishing activities than the proposed zonation of fisheries activities in the CMRs. On a smaller scale fisheries management can support the sustainability of resource use. For example, the use of rotational harvest for Alaskan and Canadian west coast sea cucumber (*Parastichopus californicus*) has maintained the harvestable populations (Plagányi et al. 2015).

Spalding et al. (2013) point out that through tightening up definitions on OECMs a dichotomy may be created in which there may be MPAs that are afforded IUCN Protected Area status following designation even though there is no change in the status quo of current legal and management regimes. There are also other spatially managed areas, such as the area of the Southern Ocean (35 million km^2) that falls under the remit of the Convention of Antarctic Marine Living Resources (CCAMLR), which is considered to be 'effectively managed' to the extent that it had been assigned an IUCN management category as an MPA. A question is therefore raised as to the complementarity, efficacy and overall benefits for biodiversity of areas that are managed for sustainable use and areas that are managed for biodiversity conservation (Bax and Cresswell 2012). Spalding (2013) suggests that rather than making a decision as to whether an area is an MPA or an OECM, that global biodiversity will benefit more from effective monitoring and reporting on the variety of management approaches that currently exist under both definitions.

OECMs are not considered further in this report as currently there is no formal guidance from the CBD as to what kind of spatial and legal arrangements comprise an OECM (Jonas et al. 2014).

Key questions:

1. Can common criteria to define OECMs be developed and adopted by the CBD?
2. How might the biodiversity outcomes and management effectiveness of OECMs be assessed and centrally collated?
3. How do OECMs contribute to achieving the 10% target?
4. How might MPA network designs be optimised to ensure that OECMs contribute synergistically to aspects of ecological coherence and vice versa (representativity, replication, adequacy, viability, connectivity and management)?
5. Where are the most gains likely to be made for conservation through different types of OECMs (e.g. renewables, fisheries)?
6. How do conservation gains of OECMs compare with those of MPAs, especially multiple-use MPAs (IUCN III-VI)?
7. How do OECMs compare with MPAs in meeting the criterion for equitable management in Aichi Target 11?

4 Qualitative elements

4.1 "Ecologically representative and well-connected"

To date, the most comprehensive working definition put forward for an ecologically coherent network of MPAs is that by the OSPAR Commission, OSPAR (2007a) and Ardron (2008) based on previous work by OSPAR (2006) and Laffoley et al (2006). An ecologically coherent network of MPAs:

- Interacts and supports the wider environment (OSPAR 2006, Sects. 5.3, 6);
- Maintains the processes, functions, and structures of the intended protected features across their natural range (Laffoley et al. 2006);
- Functions synergistically as a whole, such that the individual protected sites benefit from each other to achieve the above two objectives (based on OSPAR 2006, Sect. 5.2);
- May be designed to be resilient to changing conditions (OSPAR 2006, Sect. 5).

Several criteria have been proposed as a basis for assessing the ecological coherence of MPA networks (Bennett and Wit 2001; Catchpole 2012; Day and Roff 2000; HELCOM 2010; Lawton 2010; Natural England and the Joint Nature Conservation Committee 2010; OSPAR 2007a, 2008; Piekäinen

and Korpinen 2008; Sundblad et al. 2011; UNEP-MED 2009). The following criteria for ecological coherence are further described below and have only been applied to ecological coherence assessments of MPA networks (referenced below) and have not included an assessment of how OECMs contribute to ecological coherence.

4.1.1 Representativity

Representativity refers to the inclusion of the full range of ecosystems, habitats, biotic diversity, ecological processes, and environmental gradients (e.g. depth, wave exposure) within the MPA network (HELCOM 2010; OSPAR 2006; Roberts et al. 2003a; Rondinini 2010; UNEP-WCMC 2008). The objective in applying this criterion to MPA networks is to ensure representative coverage of all biodiversity and biogeographic regions by the network (Jackson et al. 2008; Roberts et al. 2003a). The CBD target of the inclusion of 10% of coastal and marine areas within MPAs (CBD 2010a) can be applied as a general threshold for spatial representativity.

4.1.2 Replication

To ensure natural variation and to minimise the effects of damaging events and long-term changes (resilience), adequate replication of all habitats and species is recommended within MPA networks (HELCOM 2010; OSPAR 2007a). Replication enhances the resilience of ecosystems to change and reduces the possibility that catastrophic events may wipe out entire populations of species or habitats within the network (HELCOM 2010; OSPAR 2007a; Roberts et al. 2003a). A habitat is considered by the OSPAR Commission to be replicated if it is contained within an MPA with a minimum patch size of 0.24 km^2 (OSPAR 2013). The recommended thresholds for the replication of habitats within MPA networks has yet to be clearly defined, with suggested values ranging from one example of each to five or more replicates (HELCOM 2010; Jackson et al. 2008; OSPAR 2008; Roberts et al. 2003b).

4.1.3 Adequacy

Adequacy refers to the concept of ensuring that the individual components of an MPA network are of sufficient size, shape and appropriate spatial distribution to ensure ecological viability and integrity of populations and species (HELCOM 2010; UNEP-WCMC 2008). In addition to the size and shape of the MPA network, adequacy also refers to the proportion of each feature protected within the network (OSPAR 2013). Adequacy thresholds vary. OSPAR recommend that 20%-60% of threatened and declining species and habitats should be included within the network. The IUCN

recommend that at least 20-30% of each habitat should be included within the network (IUCN 2003). It has been suggested that such thresholds may be unrealistic for planning purposes and that adequacy should be based on the biological needs of individual species, communities and ecosystems, and that rather than using a blanket threshold across habitats, habitat-specific thresholds should be applied (Rondinini 2010).

4.1.4 Viability

Viability refers to the inclusion of self-sustaining, geographically dispersed MPA sites of sufficient size within an MPA network to ensure species and habitats can persist through natural cycles of variation (Rondinini 2010). Thus, the objective in applying this criterion to MPA networks is to determine if MPAs within the network are of sufficient size and shape, and are appropriately spaced to incorporate most naturally occurring ecological processes and the home ranges of the species characteristic of the habitats of interest (Hill et al. 2010), to enable them to be resilient to, and recover from, natural variation and human impacts. Viability can also apply to the size of habitat patches that occur within the MPA network, with larger habitat patches preferred over smaller ones, as they are likely to protect sessile and low mobility species as well as widely dispersing species.

4.1.5 Connectivity

Connectivity describes the extent to which populations in different parts of a species' range are linked by the exchange of eggs, larvae, recruits or other propagules, juveniles or adults (Palumbi, 2003). The connectivity between two populations is dependent on: (i) the larval characteristics of the species (e.g. duration of the planktonic stage and swimming behaviour of propagules), (ii) the abundance of the source population, (iii) the availability and suitability of surrounding habitat, and (iv) the characteristics of the physical environment (e.g. speed and direction of ocean currents, temperature, salinity) (Shanks et al. 2003; Treml et al. 2008). The movements of adult life stages also influences connectivity and MPA performance and therefore requires consideration in MPA network design (Green et al. 2015; IUCN-WCPA 2008). There are no universally agreed targets for connectivity as optimal spacing of MPAs in a network is strongly influenced by the spatial scale of movement of the target species (Gaines et al. 2010; Palumbi 2004). While the 40 km buffer used for connectivity assessments (or site proximity test) on broad-scale habitat classes has limited ecological relevance, it is a common threshold applied to ecological coherence assessments as a first stage filter (Lieberknecht et al. 2014; Rees et al. 2015a; Ridgeway et al. 2014). In addition, little is known about the transport pathways across a network of MPAs. There are also differences in how larvae

are dispersed in shallow and deep ocean ecosystems due to differing adventive and diffusive processes (Etter and Bower 2015). Such information is needed to understand the strength of connectivity and environmental factors that can facilitate or impede network connectivity.

4.1.6 Management/Level of protection

Across all the different MPA designation categories there are varying levels of protection afforded to the habitats and species. The conservation objectives set for the MPA, levels of enforcement, methods and timescales for monitoring and assessment, and processes for adaptive management are all considered to be influential on the ability of the network of MPAs to be ecologically coherent and to be effective in conserving and/or restoring the features for which it was established (Hockings et al. 2006). The WCPA state that the ecological coherence of MPA networks is supported by sites with a range of protection levels that are designed to meet objectives that a single reserve cannot achieve (WCPA/IUCN 2007). At the recent World Parks Congress in Sydney in 2015, a working group proposed that 30% of MPAs should meet the highest protection level (IUCN Protected Areas Category Ia).

4.1.7 Working towards greater representativity

The global drive for 10% area coverage of MPAs from the CBD, and the recent trend to designate large MPAs, has resulted in a dramatic increase in the number and spatial coverage of MPAs designated around the world. The most recent estimates report that 3.5% of the world's oceans are protected (Lubchenco and Grorud-Colvert 2015). Spalding et al (2013) confirm that the 10% area-based target may be attainable, but suggest that other parameters of ecological coherence, such as representativity of biogeographic regions, depth, and biodiversity, are not integrated into these broad area-based targets. The key premise behind representativity at the global scale is that the full range of biodiversity is protected worldwide. This includes the species, genes and higher taxa, as well as evolutionary patterns, distinct communities and ecological processes that sustain global biodiversity (Spalding et al. 2007). At a global scale representation of all biogeographic regions is considered to be a prerequisite for protection of marine biodiversity (Airamé et al. 2003; Roberts et al. 2003). Though it must be noted that this pre requisite is scale dependent and that marine biodiversity can be protected in a given area even if all biogeographic regions are not represented.

Biogeographic classifications, such as the system proposed by Spalding et al (2007), that map patterns of biodiversity into distinct realms, provinces and ecoregions, provide a spatial reference to

support conservation planning. Woodley et al (2012) recommend that the CBD 10% area protection threshold under Aichi Target 11 be altered to designate "10% of each *coastal marine ecoregion* as protected areas by 2020" to ensure greater ecological representivity in the overall 10% spatial target. Similar details of biogeography are poorly understood in the offshore environment (O'Hara et al. 2011). This 10% target that includes coastal ecoregions excludes a large part of the global ocean in an assessment of representativity.

Key questions:

- What attributes does an individual protected area have to have, in order to be "representative"?
- How can OECMs be integrated?
- What are the key challenges faced by countries at national or regional levels in addressing representativity?
- What are the research needs to improve understanding of marine biogeography in support of representativity?
- How will greater representativity of MPAs be realised/achieved in the face of uncertainty over the distribution of the world's ecoregions?
- What is needed to improve representativity of MPAs across bathymetric zones?
- How will the current trend for the designation of large MPAs contribute to addressing representativity?

4.1.8 Progress towards ecologically coherent networks of MPAs

Looking beyond global progress towards the CBD 10% spatial target for protection, at a network level, a number of assessments have been undertaken to assess whether MPA networks are ecologically coherent. To date, OECMs have not been included in these assessments. Along with measures of spatial representativity that are defined by the CBD, there are a handful of studies that have attempted to assess MPA networks against elements of the broader criteria for ecological coherence. These examples provide assessments of ecological coherence of MPA networks and do not infer any corresponding changes in the state of the protected habitats or species.

The Californian Marine Life Protection Act has increased the number and size of MPAs in the region, as well as increasing protection levels for vulnerable habitats and species (Kirlin et al. 2013). The process which was led by a public-private partnership increased the area of the State waters within MPAs from less than 3% in 1999 to 16% in 2013. The 124 MPAs meet the project agreed thresholds for connectivity, replication and representativity (Gleason et al. 2013). Significant public-private investment (approximately $38m over 7 years), a 'Blue Ribbon Task Force' that guided the planning process, effective statutes, robust stakeholder engagement processes, strong scientific guidance and overarching support from state officials and private foundations have enabled successful implementation of the MPA network (Gleason et al. 2013; Kirlin et al. 2013). Establishing processes to assess the effectiveness of the network to enable periodic review against the intended goals of the network and to inform adaptive management remains a challenge (Gleason et al. 2013). There is, at present, no information as to whether there have been successful outcomes for biodiversity as a result of this network. At the national scale, the United States of America with more than 1,700 MPAs ranging from fully protected reserves to multiple-use areas, has developed a National System of Marine Protected Areas framework in response to Presidential Executive Order 13158. The framework (updated in 2015) recognises the importance of developing ecologically connected MPAs that link key habitats for important marine species to grow and reproduce throughout their life cycles. Ecological networks are considered a key tool for reducing the vulnerability of marine species and their habitats to the impact of climate change. Furthermore, the national system aims to identify and highlight gaps in protection of important places in the ocean to inform future planning to protect representative example of the nations' diverse marine ecosystems and cultural resources (NOAA-DOI 2015).

In Northern Ireland (Barnard et al. 2014), the English Channel (between France and England)(Foster et al. 2014) and in the Celtic Seas (UK, French and Irish waters)(Rees et al. 2015a), assessments are

overwhelmingly demonstrating that the 10% area based target is broadly being achieved. However, there is underrepresentation of offshore regions (beyond 12 nm) and bathymetric zones within MPA networks (see example Figure 2) and thresholds for replication of habitats and species, adequacy, viability and connectivity are not currently being met (Barnard et al. 2014; Foster et al. 2014; Rees et al. 2015a).

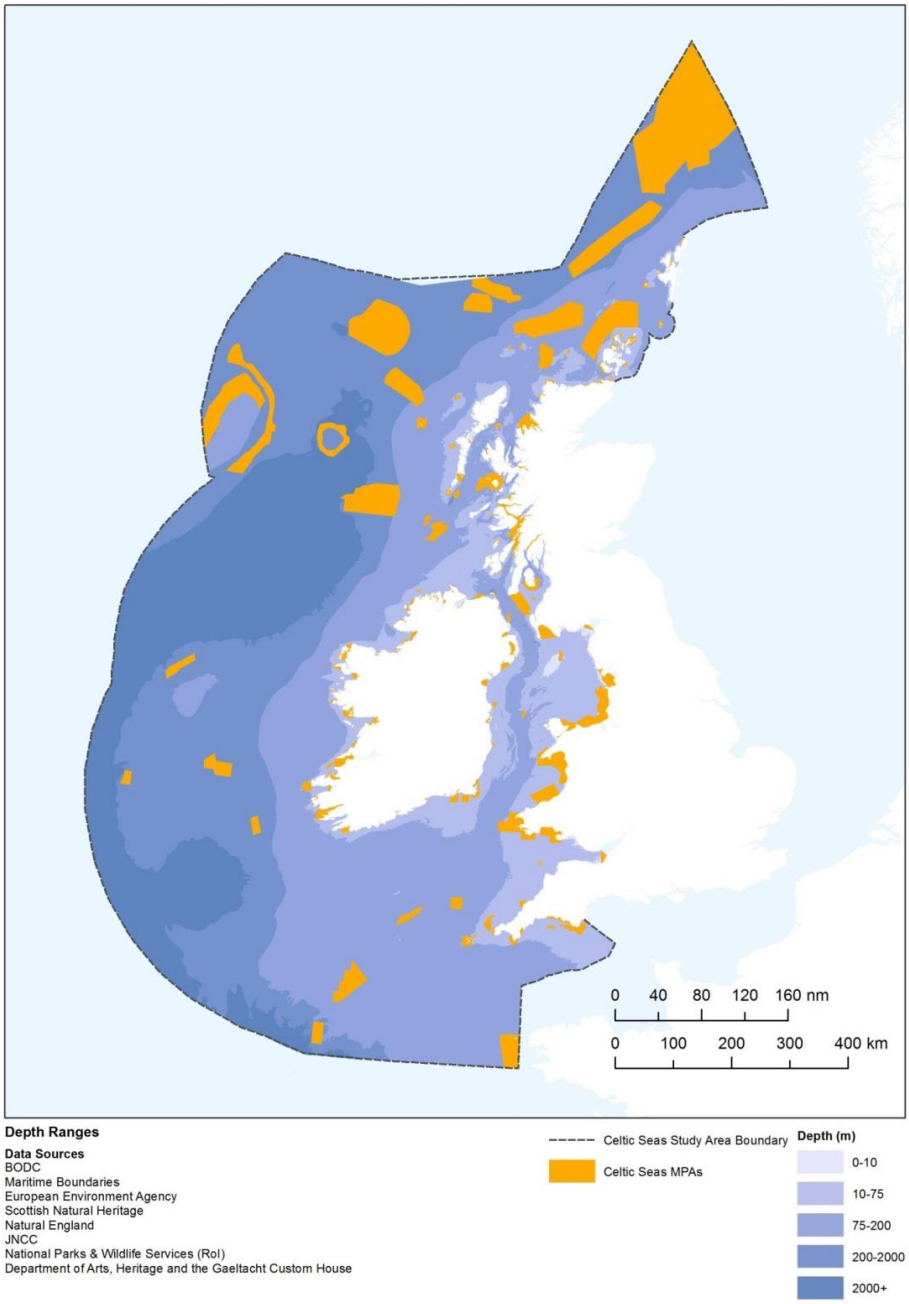

Figure 1 Marine protected areas and seafloor bathymetry of the Celtic Seas study area (Source Rees et al 2015).

For the North-East Atlantic, a spatial assessment of MPA sites demonstrated that overall the OSPAR MPA network cannot yet be judged to be well-distributed across the whole OSPAR Maritime Area, with underrepresentation of biogeographic provinces and bathymetric zones (Johnson et al. 2014; OSPAR 2013). It is considered that as the MPAs are not well distributed then it follows that the MPAs are also not connected and/or representative, replicated and/or adequate (OSPAR 2013). In the Baltic Sea marine region, a similar pattern emerges from the assessment of the ecological coherence of the Baltic Seas MPA network. In order to work towards ecological coherence of the Baltic Seas MPA network there is a need to designate more MPAs to cover all representative habitats and depth zones (Piekäinen and Korpinen 2008).The lack of large MPAs to support intra-site connectivity for limited and low mobility features of conservation importance is recognised as being a major shortcoming of the current MPA network configuration (Piekäinen and Korpinen 2008). In Chile, a retrospective analysis of the ecological coherence of the MPA network showed that whilst the existing MPA network was effectively protecting Chilean marine biodiversity, further sites are needed to protect low mobility species that currently have no formal protection from chronic human pressure (Tognelli et al. 2009).

In a recent assessment of the High Seas network in the North-East Atlantic, Evans et al. (2015) demonstrate that the network is not representative of the range of habitats present in the deep sea environment, particularly with regard to abyssal habitats. The authors note that the precautionary approach should be applied to the designation of MPAs in the abyssal habitats due to a growing scientific understanding of the important role of abyssal functional diversity in driving large scale ecological and biogeochemical processes (Evans et al. 2015). Similarly, in a study of the representativity of MPAs to protect the full range of marine ecosystems (IUCN category I and II) in the Australian MPA network, Barr and Possingham (2013) argue that the network is not currently representative.

Highlighted in these examples presented here is a need to scale up efforts to work towards ecologically coherent networks. To improve ecological coherence of networks more MPAs are required that incorporate the full range of ecosystems, habitats, biotic diversity, ecological processes, and environmental gradients (e.g. depth, wave exposure); that replicate species and habitats of conservation interest; that incorporate greater proportional areas of conservation features within MPAs (adequacy); that are designed to be of sufficient size and spacing within an MPA network to ensure species and habitats can persist through natural cycles of variation (viability and connectivity) and; are effectively managed. There is a need to define clear guidance’s as to what arrangements

constitute an OECM and include OECMs within these networks. An network that is spatially configured to protect and enhance important ecological resources and the ecosystem services that they provide will also be optimally connected in such a way as to confer high resilience to disturbance and be flexible enough to respond to dynamic environmental changes, (McLeod et al. 2008).

Key questions:

- What attributes does a collection of protected areas have to have, in order to be "coherent"?
- What are the key challenges faced by countries at national or regional levels in addressing ecological coherence?
- What can be done to accelerate progress towards ecologically coherent networks of MPAs and OECM?
- Which measures of ecological coherence can be monitored and reported against?

4.1.9 Improving the connectivity of networks

Connectivity describes the extent to which populations in different parts of a species' range are linked by the exchange of larvae, recruits, juveniles or adults (Palumbi 2003). Connectivity forms a vital component of meta-population and landscape ecology, influencing a number of fundamental processes, including population dynamics, evolution and community responses to climate change (Kool et al. 2013). Understanding the extent to which populations and sites are connected is critical both for the design of MPA networks to protect biodiversity and for the development of conservation strategies to protect species associated with degrading and fragmenting habitats (Jones et al. 2009; Kritzer and Sale 2004; UNEP-WCMC 2008). There has been significant progress in the methods used to assess connectivity in recent decades; however, connectivity varies greatly depending on the abundance and density of individuals, species and habitat characteristics, and the temporal and spatial scale of studies (Kool et al. 2013), which poses challenges in terms of its assessment and its use in reserve design and management. Connectivity can be assessed in a number of ways, including direct and indirect studies of larval, juvenile, and adult movements using tracking, mark and recapture, chemical markers or genetic techniques (Kool et al. 2013; Pittman and McAlpine 2003). An alternative to such empirical studies is a biophysical modelling approach based

on distance between habitat patches, the hydrodynamics of the surrounding area and the behavior of individuals within the populations, which provides an estimate of potential connectivity which may differ from actual connectivity (Kool et al. 2013; Magris et al. 2015). Significant progress has been made in both empirical and modelling studies of connectivity in the past decade; however, challenges remain in understanding how best to include connectivity in conservation management (Green et al. 2015; Kool et al. 2013).

Assessing connectivity of populations within MPA networks is often overlooked or completed on a very coarse scale, particularly in the UK and the EU, due to the limited timeframe and financial restrictions of such assessments. By their very nature, MPA networks typically cover large spatial scales and incorporate a diverse range of species. Larval dispersal and movement of individuals varies significantly between species, yet most connectivity studies undertaken in relation to management focus on only one or a small number of species (Magris et al. 2015), or are based on a buffer distance between habitats or even MPA sites, with minimal ecological relevance or consideration of the distances typically moved by various species during different life history stages. While conservation planning software that includes aspects of connectivity is available, this is not always appropriate for retrospective assessments of MPA networks that are already established. Including accurate connectivity measures in MPA network assessments requires an understanding of the needs of multiple species and habitats, habitat quality and connectivity, population dynamics and short-term and long-term objectives (Kool et al. 2013; Magris et al. 2015). Thus, more accurate and comprehensive assessments of connectivity within MPA networks will require greater financial and time investment to undertake detailed biophysical modelling or empirical studies of the connectivity of a number of species within the network that could represent the life history strategies of a range of species. For example, modelling the connectivity of a number of key species that include sessile, low mobility and high mobility species, and those with and without or with long and short planktonic larval stages would go some way to improving connectivity assessments. Recent technological advances mean that this is no longer inconceivable. However, such detailed assessments need to be balanced against the time constraints of conservation planning and MPA network assessments. In many situations, implementation of certain management actions may be too urgent to wait for comprehensive knowledge on the connectivity of a wide range of species (McCook et al. 2009).

Progress towards ecologically coherent networks of MPAs is largely driven forward by individual countries. In the recent assessment of the ecological coherence of MPAs in the shared marine space

between England and France (the English Channel), the potential connectivity between MPAs along the respective coastlines was considered to be good, though potential connectivity among MPAs across the Channel was assessed as being "virtually non-existent"(Foster et al. 2014). Additionally, in the Celtic Seas, there was found to be high potential connectivity of shallow sublittoral and littoral habitat types but low to moderate potential connectivity of deep-sea habitats (Rees et al. 2015a). There are numerous shared resources across transboundary areas. For example, commercial fisheries that rely on both coastal and offshore marine areas during essential life history stages, such as the European bass (*Dicentrarchus labrax*), which spawn in open water and larvae develop and move to coastal and estuarine habitats (Vinagre et al. 2012). Similarly, the Namibian hake fishery, which targets two species of hake *Merluccius capensis* and *Merluccius paradoxus*, is one of the most important fisheries in the northern Benguela region (Paterson and Kainge 2014). Both species of hake return from deep waters to spawn in the inshore area. Efforts by the Namibian government to rebuild the commercial fish stocks are severely hampered by the fishing impact of foreign fishing vessels operating far offshore (Paterson and Kainge 2014). Managing these fisheries sustainably requires transboundary agreements between countries to set catch limits and provide protected areas during essential life history stages. Pittman et al.(2014) compared the distances moved by fishes in the eastern Caribbean with the dimensions (length and width) of existing MPAs to reveal that many coastal fishes, including those important to the region's fisheries, were capable of moving over greater distances than the dimensions of the majority of MPAs and therefore are likely to spend considerable time in unprotected waters.

From a socio-economic perspective it could be considered that improving connectivity between MPAs will require integration of broader forms of spatial management regimes (e.g. OECMs) into ecologically coherent networks along with investment in capacity building to train practitioners with interdisciplinary skills who can facilitate the inclusion of a diverse setoff stakeholders into new shared governance structures to develop equitable rights and management with regards to offshore/transboundary MPAs and OECMs.

Key questions:

- What are the key challenges faced by countries at national or regional levels in addressing connectivity?
- How to address connectivity when considering a diverse set of phyla, families and species with many different modes and domains of dispersal?

- What are the minimum information needs for an assessment of connectivity that would inform network design and management?
- What aspects of connectivity need to be considered to improve area based management network design and management?
- What scale(s) should connectivity be assessed at within MPA networks?

4.2 "Areas of particular importance for biodiversity and ecosystem services"

Aichi Target 11 tasks countries to include within their protected area network "areas that are of particular importance for biodiversity and ecosystem services". From the text of the CBD, "Biological diversity means the variability among living organisms from all sources, including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (United Nations 1992). The Millennium Ecosystem Assessment (MEA) established the concept of ecosystem services on the global agenda as "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment 2005) and although ecosystem services are defined in a variety of ways (Balmford et al. 2008; Costanza et al. 1998; Defra 2007) the common theme is the translation of ecosystem functions and processes into direct or indirect benefits for human wellbeing (Potschin and Haines-Young 2011).

Linking biodiversity to ecosystem services, in that biodiversity underpins elements of human well-being through the provision of ecosystem services, is a didactically motivated interpretation that serves to draw attention to the need for biodiversity conservation (Jax and Heink 2015). Indeed, there are clear links between the impacts of broadscale biodiversity loss on the resilience of ecosystems (Palumbi et al. 2009) and declines in ecosystem services, such as food provision and water quality (Worm et al. 2006). However, it is less clear exactly how biodiversity *per se,* if measured in terms of species richness, species diversity or functional diversity, is linked to levels of ecological function and thus the delivery of ecosystem services (Chapin Iii et al. 2000; Stuart-Smith et al. 2013).

The protection of biodiversity forms a central component of MPA network planning through the generation of lists to protect habitats and species considered to be important at various scales, e.g. The European Union (EU) Habitats Directive list of Annex I habitats and Annex II species 92/43/EEC, which form the backbone of the EU Natura 2000 protected area network. Where these habitats and species have been identified *in situ,* these are considered as being important areas for biodiversity.

Linking biodiversity to ecosystem service provision is more complex and there are known difficulties in defining the complex spatial patterns of ecosystem service provision (Levin et al. 2013). Spalding (2013) points out that "areas of greatest importance for biodiversity often lie some distance from human populations, but those of greatest importance for their ecosystem services are likely to lie close to human populations". This is perhaps over simplistic as there are systems that do not fit this model. For example, estuaries can be considered to have high levels of biodiversity and ecosystem function, as well as having a high value under the ecosystem service framework for activities, such as recreation and amenity value. However, there may also be areas of high ecosystem service value, such as beaches that are valued due to their proximity to human populations and amenity but, have relatively low levels of biodiversity and ecological function. By highlighting areas that are 'particularly important' this potentially moves conservation planning away from the ecological goals of a network (supporting broadscale ecological functions and processes though representativity) towards a network which is iconic whereby sites are chosen due to their particular importance for final ecosystem services, e.g. recreation. Therefore, when it comes down to spatial applications of how "areas of particular importance for biodiversity and ecosystem services" are assessed for conservation planning purposes, more specific conceptualisations of "biodiversity" (beyond the current statutory measures) and "ecosystem services" are required to determine specific areas of importance (Jax and Heink 2015). The most recent developments in defining areas that are of "particular importance for biodiversity and ecosystem services" are discussed in the following sections.

4.2.1 Ecologically or Biologically Significant Areas

The protection of biodiversity has historically taken precedent in conservation planning in so far that it forms a central component of MPA network planning through the generation of lists to identify and protect habitats and species considered to be important at various scales, e.g. The European Union (EU) Habitats Directive list of Annex 1 habitats and Annex II species 92/43/EEC, which form the backbone of the EU Natura 2000 protected area network. It can be considered that where these habitats and species have been identified *in situ,* that these are considered as being important areas for biodiversity in regional planning systems.

CBD note that 'areas of particular importance for biodiversity or Key Biodiversity Areas (KBAs) are areas that are locally, nationally and globally important for the manifestation of biodiversity at the genetic, species and/or ecosystem level; they are identified using global criteria and thresholds.

Different areas important for biodiversity are important bird and biodiversity areas (IBAs), Alliance for Zero Extinction sites (AZEs), Biodiversity Hotspots, high biodiversity wilderness and global 200 priority ecoregions' (UNEP/CBD/SBSTTA/20/INF/43, §32, p.13).

At the global scale in 2008 the COP9 to the CBD approved scientific criteria (see Table 3) for the identification of Ecologically or Biologically Significant marine Areas (EBSAs). In 2010, the CBD endorsed a science-led process for the description of EBSAs across the world's oceans against these criteria (Dunn et al., 2014). The purpose of the description and identification of EBSA is to inform States and competent intergovernmental organisations that have a responsibility to take measures to protect important areas for ecological functioning, so future planning can take into account the need for the integrated management of resource use and conservation (Weaver and Johnson 2012). EBSAs information can also be used by national and sub-national governments, and to inform research planning. There are currently 204 EBSAs identified by a series of nine regional EBSA Workshops. Three further regional workshops were held in 2015 and EBSAs described by these have been considered by CBD COP13 in December 2016. These EBSA workshops encompass 72% of the world's oceans including coastal areas, continental shelf areas and Area Beyond National Jurisdiction (ABNJ). For the 204 EBSAs identified by CBD prior to CBD COP13 that have been recognised by the CBD Parties, information has been placed in the CBD EBSA Repository and Information Sharing Mechanism and details have been conveyed to the United Nations General Assembly.

Criteria	Definition	Rationale
Uniqueness or rarity	Area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features	• Irreplaceable • Loss would mean the probable permanent disappearance of diversity or a feature, or reduction of the diversity at any level
Special importance for life-history stages of species	Areas that are required for a population to survive and thrive	Various biotic and abiotic conditions coupled with species-specific physiological constraints and preferences tend to make some parts of marine regions more suitable to particular life-stages and functions than other parts
Importance for threatened, endangered or declining species and/or habitats	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species	To ensure the restoration and recovery of such species and habitats
Vulnerability, fragility, sensitivity, or slow recovery	Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery	The criteria indicate the degree of risk that will be incurred if human activities or natural events in the area or component cannot be managed effectively, or are pursued at an unsustainable rate
Biological productivity	Area containing species, populations or communities with comparatively higher natural biological productivity	Important role in fuelling ecosystems and increasing the growth rates of organisms and their capacity for reproduction
Biological diversity	Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity	Important for evolution and maintaining the resilience of marine species and ecosystems
Naturalness	Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation	To protect areas with near natural structure, processes and functions • To maintain these areas as reference sites • To safeguard and enhance ecosystem resilience

Table 2: Definitions and rationale for each of the EBSA scientific criteria (CBD 2009)

4.2.2 Areas important for ecosystem services

The MEA identified four categories of ecosystem services: provisioning services that supply material resources; regulating services that control ecological systems; cultural services that provide non-material aesthetic, spiritual and recreational benefits; and supporting services that provide the basic ecological functions and structures that underpin all other services, such as primary production, biodiversity, oxygen production, soil formation and nutrient cycling (Millennium Ecosystem

Assessment 2005). The Economics of Ecosystems and Biodiversity (TEEB) project builds upon the MEA classification, distinguishing between the core ecosystem processes that support beneficial ecosystem processes, which in turn deliver beneficial ecosystem services in the form of material or non-material benefits for human well-being (Figure 3) (Balmford et al. 2008). The biophysical structures and processes provide the prerequisites for ecosystem functions, which in turn have the potential to deliver services that contribute to human well-being and as such have a value to humans. Nutrient cycling (process), for example, is a prerequisite for water purification (function) to provide freshwater (provisioning service), which is essential for human health (benefit) (TEEB 2010).

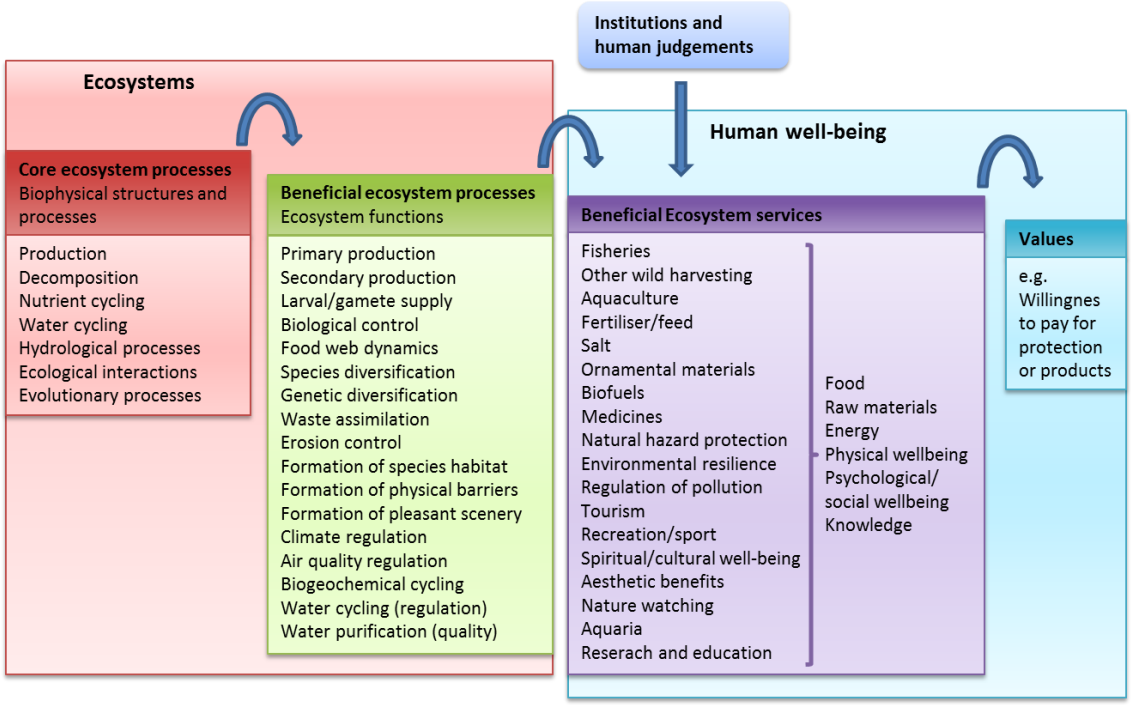

Figure 2 The links from ecosystems to human wellbeing (adapted from Balmford et al., 2008; TEEB, 2010 and Fletcher et al., 2012; Rees et al 2014).

In the broadest sense, areas that are 'important for biodiversity' (whether this includes, for example, areas that are species rich, functionally diverse or are important for charismatic species) and areas that are important for ecosystem services are linked. For example, by effectively managing and conserving areas that are recognised as being important for ecological functioning (e.g. EBSAs), there is the potential for underpinning those beneficial ecosystem services that contribute to human well-being (Figure 3). If an iconic species is protected via management measures, e.g. whale sharks, then recreation/tourism benefits can be realised as the final ecosystem service. The literature has a wide

range of different and evolving interpretations of what constitutes an ecosystem service and whether ecosystem services are defined as the final realised benefits (beneficial ecosystem services) or are a combination of ecological processes and functions (also often referred to as ecosystem services). The most recent advancements in this field of research recognise that there are both intrinsic values and anthropogenic values associated with nature and the natural environment. Intrinsic values are independent of human judgement. Anthropogenic values are associated with the 'benefits' received from nature insofar as they support an individual's ability to achieve a 'good quality of life' comprising of aesthetic pleasure, the production or consumption of a commodity or though spiritual enlightenment (Díaz et al. 2015).

Here the final ecosystem services (benefits) are considered. Costanza et al. (1997) linked the value (monetary) of ecosystem services to habitats largely in the coastal zone (seagrass/algal beds, estuaries, coral reefs). The continental shelf areas and open ocean in terms of their important contributions towards broadscale ecological processes and functions were not spatially explicit. A preliminary global map of the marine ecosystem service values derived from mangroves and coral reefs has been produced by Spalding et al (2014). The benefits of the ecosystem services were defined as fisheries, tourism, coastal protection and carbon storage. The initial results show that at present 32% of coral reefs and 36% of mangroves are currently in protected areas (Spalding et al. 2014). There is also considered to be large spatial variation in the extent to which different reef and mangrove areas provide these ecosystem services due to habitat quality and natural environmental factors (Spalding et al. 2014). Additionally, the ability to realise the ecosystem service benefits from the habitats depends on the distribution of human populations, infrastructure and markets (Spalding et al. 2014).

Valuing ecosystem service benefits also can influence decision-making. For example, Jackson et al. (2015) demonstrate that, by providing habitat for species during essential life history stages, seagrass *(Posidonia oceanica)* meadows are worth around **€**78 million (US$82.8 million) every year to commercial fishing and **€**112 million (US$ 119 million) to recreational fishing in the Mediterranean, prompting calls for more effective habitat management. McCook et al. (2010) demonstrate that the economic returns of the rezoning of the Great Barrier Reef Marine Park are estimated to be 130 times greater than the cost of management. Further protection for corals and fish could potentially have knock-on benefits (opportunity costs) for the tourist industry and commercial fisheries (McCook et al. 2010). There is unfortunately no published research on the actual costs and benefits to date of this rezoning exercise. Arkema et al. (2013) show that presence of intact reefs and coastal

vegetation reduces the likelihood and magnitude of losses resulting from extreme weather events and sea level rise. Economic investment by the US government to restore degraded coastal habitat (blue infrastructure) has led to job creation in the short term and will potentially yield further economic benefits via future job creation linked to rebuilt fisheries and coastal tourism and benefits to coastal economies, such as higher property values and improved water quality (Edwards et al. 2013). Non-monetary valuations also support decision making, recognising that integrating measures of social well-being (including spiritual and cultural connections to marine resources) into scientific and technical approaches to marine resource use management can support progress towards sustainability (Coulthard et al. 2011). The ecosystem services framework can provide powerful socio-political arguments for wider conservation.

From a spatial perspective, the reality of applying the ecosystem services framework (focussing the benefits) to decision making for conservation planning reveals that ecosystem services are user defined and site specific (Woodley et al. 2012). The social and economic benefits of ecosystem functioning are realised by humans in their own natural habitat, therefore MPAs identified as generating important ecosystem service benefits (e.g. recreation) are generally linked to accessible areas close to the coast. Defining the relative 'importance' of ecosystem services favours those services that are easy to quantify and that have a market value (Robinson 2011).

Identifying areas that are 'important for biodiversity' (concurrent with traditional statutory approaches) along with 'areas important for ecosystem services' remains essential for furthering conservation, but from a spatial perspective it is important to be aware of scale and context. The EBSA process provides a set of scientific criteria to further the process of integrated marine management through the identification of sites that support broadscale ecological functioning and are essential for underpinning human well-being. At a regional scale the language of ecosystem services can be used to identify and potentially re-emphasise the fundamental links between nature and human well-being (Armsworth et al. 2007). However, whilst biologists and ecologists value areas that are 'important for biodiversity' in line with their academic frame of reference, outside of this mind-set the decision making context for judgements regarding human well-being are deeply rooted in an individual's actual, subjective and perceived relationship with the natural environment and how this supports material well-being, quality of life and relational well-being (Hicks et al. 2016). In a planning scenario where values are qualified (e.g. cost-benefit) and an end user identified, these EBSAs, particularly in ABNJ are unlikely to be deemed to have 'value' because the beneficiaries (of the ecosystem service) are so far removed.

Identifying "areas important for ecosystem services" in terms of 'benefits' and for planning purposes is applied more successfully in coastal areas where there are direct benefits, e.g. food provision or recreation. Indeed, where ecosystems have a critical role in supporting human well-being it is recognised that there needs to be a more systematic representation of ecosystem services in the planning of protected areas (Spalding et al. 2014). It is known that individuals base their decisions within a social context (Videras et al. 2012) and it can be argued that the ecological approach to MPA designation may not be successful in driving forward the necessary policy measures and igniting political will to designate ecologically coherent networks of MPAs. There are new and novel methods for the assessment of changing ecosystem services that can support decision makers to define what types of ecosystem services should be assessed to inform policy and planning (Arkema et al. 2015; Jackson et al. 2015).

Key questions:

- What are the key challenges faced by countries at national or regional levels in identifying areas of particular importance for biodiversity and ecosystem services?
- How might EBSA descriptions and areas important for ecosystem services be aligned?
- What are the most pressing information/research needs for "areas of particular importance for biodiversity and ecosystem services"?

4.3 "Effective and equitably managed"

It follows that once an MPA is identified and designated then there is a need to effectively manage the site to achieve the desired conservation objectives/biodiversity targets. Protected area management is typically challenging, complex, and can potentially touch upon numerous socially charged issues (Mascia et al. 2010), which, if ignored or compartmentalised, can result in the failure of the protected area to meet the objectives for which it was primarily designed (Christie 2004). Indeed, research shows that because MPAs are at the interface between social and ecological systems, short term biological gains associated with designation may be compromised unless social issues, specifically notions of equity, are addressed in the planning and management process (Christie 2004; Christie et al. 2003; Klein et al. 2008; Leleu et al. 2012; Norse 2010; Pollnac et al. 2010; Rees et al. 2013; Rosendo et al. 2011). Woodley et al. (2012) argue that effectiveness and equity are both essential parts of protected area management but they are different concepts and should be

considered as separate elements. For the purpose of this report, “effectively managed MPAs” and “equitably managed MPAs” are considered separately.

4.3.1 Effectively managed MPAs

In recognition that setting spatial targets for protected areas is not enough to address the global decline in biodiversity, the CBD established the Programme of Work on Protected Areas (PoWPA) and set a global target for 30% of the world’s protected areas to have the effectiveness of their management assessed by 2010 (Goal 4.2, CBD PoWPA). The subsequent CBD Aichi Targets expanded the global target of 30% to “institutionalize management effectiveness assessments to work towards assessing 60% of the total area of protected areas by 2015 using various national and regional tools and report the results into the global database on management effectiveness” (CBD Aichi Targets, COP 10 Decision X/31, 19a). In response to this revised target, the IUCN World Commission on Protected Areas (WCPA) developed a framework to guide assessment of management effectiveness (Hockings et al. 2006).

The management of protected areas needs to be specifically designed to consider the diversity of biological and social characteristics, uses and pressures (Hockings et al. 2006). To determine if management is effective or not there are three central themes by which management effectiveness may be evaluated:

- design issues relating to both individual sites and protected area systems;
- adequacy and appropriateness of management systems and processes; and
- delivery of protected area objectives, including conservation values (Hockings et al. 2006)

In terms of progress towards the 60% target, Coad et al. (2013) demonstrate that globally 29% of the area protected (marine and terrestrial) has been assessed and 23% of countries have reached the 60% target. However, very few MPAs were considered in this global assessment (Figure 4).

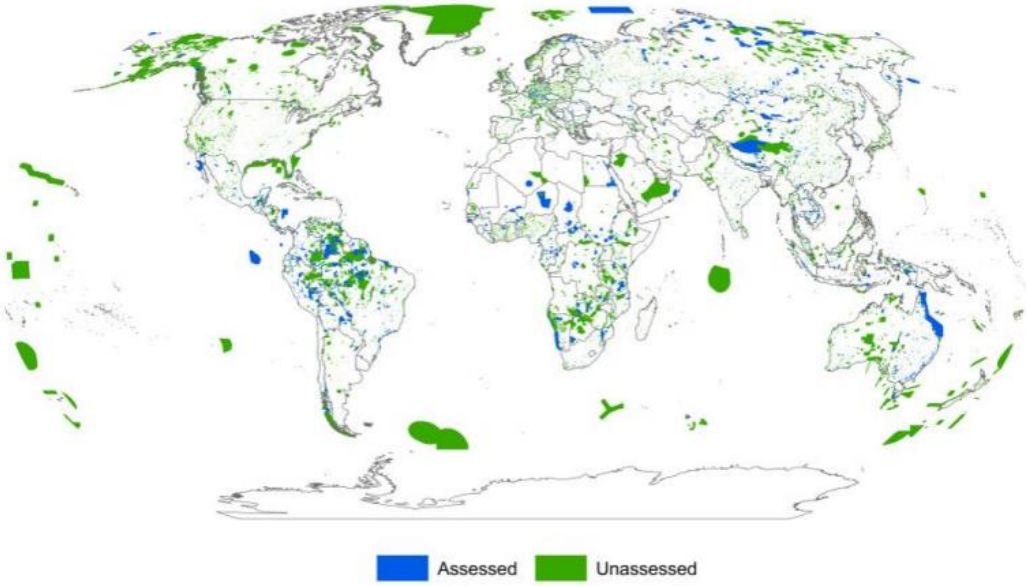

Figure 4 The location of protected areas that have conducted a Protected Area Management Effectiveness (PAME) assessment. Source: Coad et al. (2013).

At a regional scale, the OSPAR Commission has begun to address the need to establish protocols for assessing management effectiveness of MPAs. OSPAR has developed and agreed upon 'Guidelines for the Management of Marine Protected Areas in the OSPAR maritime area' (OSPAR 2003) and 'Guidance to assess the effectiveness of management of OSPAR MPAs: a self-assessment scorecard' (OSPAR 2007b). In a review of the 'effective management' of the OSPAR MPAs, it was found that management varied substantially between countries (Denmark, Germany, Iceland, Ireland, The Netherlands, Norway, Portugal, Spain, Sweden and the UK). Whilst some countries have established conservation objectives and management plans, many countries are still in the preparation phase and, in many, effective management is far from being implemented (OSPAR 2013). The report concludes that "as no sufficiently detailed information on the effectiveness of the management in their respective MPAs has been made available by Contracting Parties, it remains impossible at this time to comprehensively conclude on the extent to which OSPAR MPAs are well managed"(OSPAR 2013).

A regional study of the management effectiveness of MPAs in the English Channel was undertaken by the Protected Areas across the Channel Ecosystem Project (PANACHE) in 2014 (Figure 5) (Foster et al. 2014). These results of this assessment indicate that in terms of management, the Channel MPA network is moving towards providing some protection to the species and habitats for which the

respective sites were designated. It must be noted though that the results are highly subjective. It is not considered compulsory for MPA managers to report on management effectiveness and it may be that the least well-managed MPAs were not evaluated during this assessment resulting in misleading results when assessing the management status of the network as a whole. Furthermore, responses were received from different statutory bodies involved in the management of single MPAs. In some instances, the results differed significantly for the same site highlighting the subjective nature of using a questionnaire for this type of assessment and its dependency on the role and knowledge of the participant. Thus, gaining an accurate reflection of the effectiveness of MPA management is likely to be very challenging.

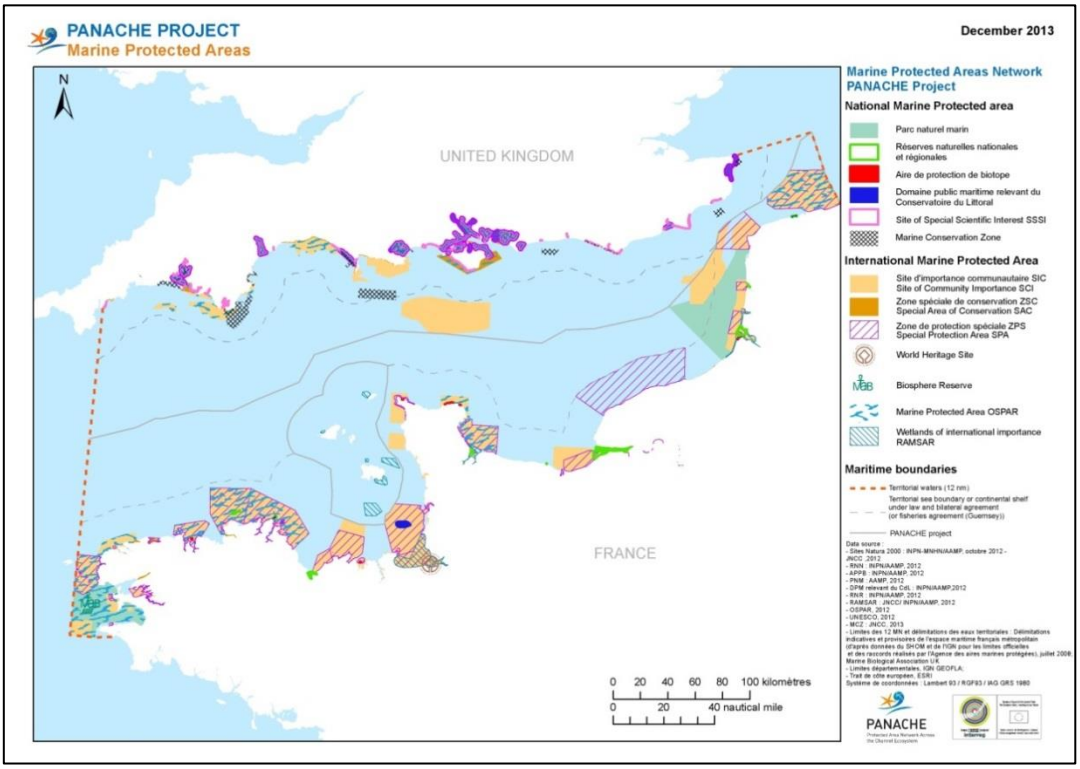

Figure 5 The PANACHE study area highlighting the range of MPA designation types within the network (Source: Foster et al. 2014).

In a recent assessment of the management effectiveness of the MPA network in the Mediterranean, the results show that even though the MPA network in the Mediterranean is largely representative (6.45%) (Rodríguez-Rodríguez et al. 2016b), management effectiveness is poor with over 87% of MPAs having only legal protection and limited resources to support management planning and implementation (Rodríguez-Rodríguez et al. 2016a). Kemp et al. (2012) undertook a global review of the performance of spatial management in relation to the management objectives of the site. Their

research concludes that the objectives of spatial management are often poorly defined and not specific (Kemp et al. 2012). The authors recommend that:

- The objectives of spatial management need to be measureable;
- That performance assessments need to be built into the long term management of the site rather than relying on ad-hoc opportunities and;
- Management objectives should be set and assessed at a regional scale to assess the overall performance of the system rather than a focus on isolated sites.

Key questions:

- What are the key challenges faced by countries at national or regional levels in ensuring effective management of MPAs within the context of Target 11?
- How extensive is the evaluation of effectiveness of MPAs?
- Can OECMs be evaluated against the same criteria?
- How might the assessment of management effectiveness be improved for all types of area-based measures?
- What are the drivers/tools to move beyond spatial targets towards effective management?
- What would be the challenges and benefits of quantitative ecological performance targets for spatial management measures?
- How could such quantitative (and other types of) targets be used in adaptive management framework?
- How could such quantitative (and other types of) targets be used to track performance of these measures?

4.3.2 Equitably managed MPAs

It is recognised within conservation planning that humans are integral to, and can influence, ecosystem functions. This dynamic is often referred to as the social-ecological system where the human and ecological domains interact bilaterally and at different spatio-temporal scales (Armsworth et al. 2007; Berkes et al. 2003; Curtin and Prellezo 2010; Liu et al. 2007; Ostrom 2009; Pollnac et al. 2010). Equity, the premise that there is a fair distribution of benefits and costs between

individuals and/or groups of people, is a subject that is rarely assessed in MPA planning even though it is recognised as having the potential to influence intended conservation outcomes (Tallis et al. 2012). In conservation planning, equity can be addressed in a number of ways; the distribution of economic benefits (money, resource rights); the impact and benefit of conservation actions across individuals and/or groups; and the process by which stakeholders are included and provided with the opportunity to be involved in planning (Halpern et al. 2013). The distribution of equity is also often considered in the policy appraisal process via a cost-benefit analysis (Fletcher and Rees 2015).

MPAs that are equitably designed and managed can support conservation outcomes along with supporting economic and social objectives. For example, a statutory 206 km^2 'closed area' in Lyme Bay, UK (The Lyme Bay Marine Protected Area (MPA) entered into force on the 11 July 2008 to protect the reef substrate and the associated biodiversity from the impacts of trawling and dredging with mobile demersal fishing gear. From the outset, the closure was highly contentious and impacted heavily on sectors of the local fishing community (Hattam et al. 2014; Mangi et al. 2011; Rees et al. 2010a). Following the closure, the UK Government invested in research that annually monitored the ecological and social-economic impact of the MPA (Attrill MJ et al. 2012). The presentation of non-biased, evidence-based research results were used to instigate discussions with local stakeholders and ease local tensions in the years following the closure (Mangi et al. 2011; Rees et al. 2013; Rees et al. 2010b; Sheehan et al. 2013a; Sheehan et al. 2012; Sheehan et al. 2013b). In 2011, a non-governmental organisation (NGO), the Blue Marine Foundation, formed a proactive working group for the Lyme Bay MPA (now called the Lyme Bay Consultative Committee), which led to the implementation of more specific MPA management measures, including a Voluntary Code of Conduct and experimental fishing areas to determine sustainable harvesting of the resource. Wider partnership activities by the Lyme Bay Consultative Committee include development of real-time monitoring and marketing technologies, investment in post-harvest icing infrastructure, and knowledge-sharing and training activities. In addition to providing supporting technologies, these partnership activities have enabled participation of fishers in decisions that affect them and may, thus, have enhanced voluntary compliance to MPA management measures and built trust among Lyme Bay stakeholders. The ecological monitoring studies, results of which have been shared with the local fishing community, demonstrate that there have been positive responses for species richness, total abundance and assemblage composition for seven out of thirteen indicator taxa (Sheehan et al. 2013b). These sessile species were found in greater abundance on pebbly-sand habitat in areas closed to fishing compared to those where bottom towed fishing continues (Sheehan et al. 2013a; Sheehan et al. 2012). The closure in Lyme Bay has also had profound effects

within the social and economic system as the removal of bottom towed fishing gear in the Lyme Bay MPA has allowed a redistribution of equity. Alternative commercial fishing activities have proliferated within the closed area (Mangi et al. 2011), and recreation participants and providers have increased their use of the MPA (Rees et al. 2015b).

How equity is distributed in planning and management can be relative, perceived or actual, making evaluation of equity in MPA management a significant challenge. Exactly how equity affects conservation success is an underdeveloped area of research (Klein et al. 2015). There is growing concern that decisions to implement management measures for MPAs and OECMs are undermining existing customary and communal fisheries tenure rights in many parts of the world stunting or ending individuals and communities ability to make a livelihood from small scale fishing and the associated industries (Bennett et al. 2015). Examples are given by Pederson et al. (2014) of the displacement of fishers from their traditional fishing ground by the establishment of an MPA as part of the Coral Triangle Initiative and, the sale of fishing licences to foreign fishing vessels in Mauritius who will target the same species as local small scale fishers leading to potential over-exploitation of the resource.

By stating that protected areas should be effectively and equitably managed Aichi Target 11 highlights the interconnected nature of social and ecological systems and is redirecting biodiversity conservation towards the development of linked social-ecological criteria and thresholds. How equity is quantified in MPA planning and management remains a challenge (Halpern et al. 2013; Klein et al. 2015). It could be considered that integrating equity into conservation planning can compromise the overall biodiversity objectives by creating new and complex avenues for trade-offs between ecological and socio-economic objectives (Halpern et al. 2013). Evaluation of management is vital to identify learning and good practice to support improved sustainability in marine management. There is a need to develop protocols for the monitoring and reporting on the effectiveness of MPAs from a combined social, economic and ecological perspective in order to provide insights into the relationship between social equity and successful biodiversity conservation (Ban et al. 2013; Klein et al. 2015).

Key questions:

- How can equitable management be defined so that it represents the social,

economic and conservation trade-offs that will need to be considered in industrial and developing economies?

- How can equitable management on the High Seas take into account the aspirations of developing countries to benefit from these areas to which they have no capacity to access?
- How will equitable management vary between MPAs and OECMs and is it more likely to be achieved in one or the other?
- How are the stakeholders defined to determine where equity needs to be considered?
- At what point does equitable management reduce the potential for effective management and how can this be addressed?
- How might the tradeoff between equity and biodiversity conservation be defined by the CBD?

4.4 "Integrated into the wider landscapes and seascapes"

The functional integrity and health of marine ecosystems within protected areas is dependent not only on the protection provided, but also on the ecological interactions with surrounding areas. Protected area boundaries are permeable and therefore represent an open system. For coastal seascapes, marine ecosystem health is influenced by landscape condition. This is particularly relevant where runoff from land impacts water quality and the biological health of marine communities. In addition, many marine species are dependent on land for part of their lifecycle, for example, turtles nesting on beaches, fishes that migrate upriver to spawn. Even for very large MPAs, highly mobile animals that traverse land-sea boundaries may not receive high levels of protection because some critical habitats on land exist outside of the administrative jurisdiction of the protected area regulations (Dryden et al. 2008). In many cases, the patterns and processes occurring outside the MPAs have far greater effects on protected resources than activities within the MPAs (Cicin-Sain & Belfiore 2005). Not considering the broader context for an MPA network within the wider seascape could result in sub-optimal conservation outcomes. For example, displacement of human activities from protected areas should be anticipated and managed because of potential increased impacts to areas of commercial and conservation importance outside of the protected area network. Yet, typically the management of MPAs has taken place within the context of a larger ocean governance system, but often with little or no integration with it (Cicin-Sain & Belfiore 2005).

Marine Spatial Planning (MSP) is defined as 'an area-based management framework that addresses multiple management objectives. It is not a single tool, but rather an approach or framework to provide a means for improving decision making as it relates to the use of marine resources and space' (Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel 2012). MSP enables the integration of key aspects of Ecosystem Based Management (EBM) in area based planning and management to address spatial and temporal resource use and the interactive and cumulative effects arising from multiple human uses and stressors. There have been a number of large and small scale processes to progress MSP, these are reviewed in 'Marine Spatial Planning in the Context of the Convention on Biological Diversity' (Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel 2012).

Though providing an operational framework the creation of marine spatial plans can support both biodiversity and development objectives. It is logical that networks of MPAs will need to be considered as an important component in development of marine spatial plans. A marine spatial plan can be designed to optimize and boost performance of an MPA network through consideration of complementary space use regulations through zoning (Agardy et al. 2011). Within the planning area, the creation of buffer zones around vulnerable MPAs and the design of compatible zoning for areas outside of MPAs, such as recognising blue corridors, to provide positive synergy with MPAs, may ensure returns on investments in MPA networks. Furthermore, a broader perspective of MPAs (including OECMs) nested within a marine spatial plan can increase representativeness through protection of important areas not selected as sites for MPAs, including high human impact areas considered too threatened for the establishment of an MPA. MSP can also enable the integration of management measures for the sustainable use of marine resources implemented in OECMs.

In a recent review of 16 existing marine spatial plans, their attributes and actual implementation Collie et al. (2013) report that whilst almost all plans were designed with stakeholder involvement and had clear protocols and criteria for data inclusion, there were no clearly identified outcomes or benchmarks against which progress towards outcomes could be measured. Additionally processes for monitoring, reporting and review were not included in the majority of plans (Collie et al. 2013). In recognising the complexity of information needs for MSP Halpern et al. (2012) identify priorities for advancing Coastal and Marine Spatial Planning (CMSP):

Process

- Provide guidance on how Regional Planning Bodies (RPBs) should establish operational, location-specific objectives, and boundaries nested within the national goals for CMSP.
- Develop methods for CMSP processes that are proactive rather than reactive, in particular with respect to locally new or emerging uses of the oceans and climate change.
- Build coordination in planning, objective setting, and governance across nested geographic scales and laterally among existing and emerging local, state, and regional plans.
- Conduct a legal gap, obstacle, and opportunity assessment at national, state, regional, and international levels that evaluates the potential of existing laws, obligations to aboriginal peoples, and regulatory mechanisms to support CMSP and promote cross-border cooperation.
- Take advantage of opportunities to learn-by-doing in contexts ripe for moving forward with CMSP (contexts may be particular locations, sets of uses/pressures or services, combinations of agencies/sectors, or motivated communities) and quickly document lessons learned.
- Recommend how RPBs can build transparency and accountability for agencies, industries, and other users into their CMSP processes and outputs.
- Recognize and include aboriginal rights and other treaties in CMSP processes.

Communication and engagement

- Develop a compelling 'business case' that clearly presents why CMSP is needed and is an essential addition to both current sectoral and future integrated management. The business case should identify and describe the potential benefits (to whom), the costs and risks of inaction, and the incentives for engagement, while also identifying potential challenges with equal clarity.
- Develop and implement strategic communication plans – initially broadly about CMSP, and more regionally focused as planning efforts gain momentum – that articulate the business case in easily understood language. These plans should use a variety of media and incorporate concrete, regionally pertinent examples where possible.
- Develop and disseminate guidance on best practices for full engagement of and cooperation among national, state, tribal/indigenous, public, private, and other stakeholder interests in the CMSP process.
- Develop guidance on approaches to balance top-down development of mandates for CMSP with bottom-up engagement within CMSP processes.

Tradeoffs and valuation

- Provide guidance and science-based approaches for how to evaluate the relative compatibility and incompatibility of existing or proposed uses in CMSP plans under alterative management schemes.
- Develop or refine models and methods for assessing and optimizing tradeoffs among social, economic, and environmental objectives at multiple spatial and temporal scales.
- Identify a currency (or currencies) for comparing outcomes of alternative CMSP plans, noting the critical need to include market and non-market benefits from nature in the overall assessment.
- Recognize and develop methods for addressing diverse value systems within and among human communities that can lead to different core objectives within a single CMSP process.

Decision support

- Assess which information is necessary to develop different types of CMSP plans, including traditional and local knowledge, and identify the best scale(s) for collecting and reporting data.
- Compile available data, models and other information and identify gaps relevant to assessing:
    - Cumulative impacts across a range of spatial scales;
    - Potential interactions among human uses;
    - Non-linear responses of systems to increasing human use and natural forces, including social and economic tipping points;
    - Connectivity (of positive and negative impacts) among locations, via ecological or social processes, within and outside the planning area;
- Develop user-friendly, open-source, efficient and transparent tools for data visualization, integration, and sharing
- Advance and refine existing decision support tools to address CMSP-specific needs, including but not limited to:
    - moving from (past) impact analysis to (predictive) vulnerability assessment;
    - shifting from cost-benefit analysis to full valuation assessments.
- Develop clear, reliable, and measurable indicators for monitoring effectiveness of CMSP at achieving objectives set during the planning process.

Source: Near-term priorities for the science, policy and practice of Coastal and Marine Spatial Planning (CMSP) (Halpern et al. 2012)

Key questions:

- What attributes are required for "integration into landscape and seascape approaches?
- What are the key challenges faced by countries at national or regional levels in implementing landscapes and seascapes approach to address various elements of Target 11?
- How can Aichi Target 11 ensure better integration of MPAs and OECMs within wider landscapes and seascapes?
- How does the level of effective management required through MPAs (area and level of protection) vary depend on the local availability of OECMS and effective environmental management of the remaining seascape?

References

Agardy, T., di Sciara, G.N., Christie, P., 2011. Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning. Marine Policy 35, 226-232.

Airamé, S., Dugan, J.E., Lafferty, K.D., Leslie, H., McArdle, D.A., Warner, R.R., 2003. APPLYING ECOLOGICAL CRITERIA TO MARINE RESERVE DESIGN: A CASE STUDY FROM THE CALIFORNIA CHANNEL ISLANDS. Ecological Applications 13, 170-184.

Ardron, J.A., 2008. The challenge of assessing whether the OSPAR network of marine protected areas is ecologically coherent. Hydrobiologia 606, 45-53.

Arkema, K.K., Guannel, G., Verutes, G., Wood, S.A., Guerry, A., Ruckelshaus, M., Kareiva, P., Lacayo, M., Silver, J.M., 2013. Coastal habitats shield people and property from sea-level rise and storms. Nature Clim. Change 3, 913-918.

Arkema, K.K., Verutes, G.M., Wood, S.A., Clarke-Samuels, C., Rosado, S., Canto, M., Rosenthal, A., Ruckelshaus, M., Guannel, G., Toft, J., Faries, J., Silver, J.M., Griffin, R., Guerry, A.D., 2015. Embedding ecosystem services in coastal planning leads to better outcomes for people and nature. Proceedings of the National Academy of Sciences 112, 7390-7395.

Armsworth, P.R., Chan, K.M.A., Daily, G.C., Ehrlich, P.R., Kremen, C., Ricketts, T.H., Sanjayan, M.A., 2007. Ecosystem-Service Science and the Way Forward for Conservation. Conservation Biology 21, 1383-1384.

Attrill MJ, Austen MC, Cousens SL, Gall SC, Hattam C, Mangi S, Rees A, Rees S, Rodwell LD, Sheehan EV, Stevens, T., 2012. Lyme Bay – a case-study: measuring recovery of benthic species; assessing potential "spillover" effects and socio-economic changes, three years after the closure. Report 1: Response of the benthos to the zoned exclusion of bottom towed fishing gear in Lyme Bay, In Report to the Department of Environment, Food and Rural Affairs from the University of Plymouth-led consortium. Plymouth: University of Plymouth Enterprise Ltd. p. 82

Balmford, A., Rodrigues, A.S.L., Walpole, M., ten Brink, P., Kettunen, M., Braat, L., de Groot, R., 2008. The economics of biodiversity and ecosystems: scoping the science, Cambridge, UK (contract: ENV/070307/2007/486089/ETU/B2).

Ban, N.C., Mills, M., Tam, J., Hicks, C.C., Klain, S., Stoeckl, N., Bottrill, M.C., Levine, J., Pressey, R.L., Satterfield, T., Chan, K.M.A., 2013. A social–ecological approach to conservation planning: embedding social considerations. Frontiers in Ecology and the Environment 11, 194-202.

Barnard, S., Burdon, D., Strong, J., Atkins, J., 2014. The Ecological Coherence and Economic & Social Benefits of the Northern Ireland MPA Network, Hull, UK.

Barr, L.M., Possingham, H.P., 2013. Are outcomes matching policy commitments in Australian marine conservation planning? Marine Policy 42, 39-48.

Bax, N., Cresswell, I., 2012. Marine reserves not about closing fisheries, but about preserving ocean health, In The Conversation.

Bennett, G., Wit, P., 2001. The development and application of ecological networks. A review of proposals, plans and programmes, p. 133. AIDEnvironment and IUCN, Amsterdam, the Netherlands, Cambridge, UK, and Gland, Switzerland.

Bennett, N.J., Govan, H., Satterfield, T., 2015. Ocean grabbing. Marine Policy 57, 61-68.

Berkes, F., Colding, J., Folke, C., 2003. Navigating social-ecological systems: Building resilience for complexity and change. Cambridge University Press, Cambridge, UK.

Borrini-Feyerabend, G., P. , Bueno, T., Hay-Edie, B., Lang, A., Rastogi, A., Sandwith, T., 2014. A primer on governance for protected and conserved areas, Stream on Enhancing Diversity and Quality of Governance, In IUCN World Parks Congress. IUCN, Gland, Switzerland.

Catchpole, R., 2012. Ecological Coherence Definitions in Policy and Practice - Final Report for SHN, pp. 1-28. Aspen International.

CBD, 1992. Convention on Biological Diversity. United Nations.

CBD, 2004. COP 7 Decision VII/5. Marine and coastal biological diversity. Review of the programme of work on marine and coastal biodiversity. Convention on Biological Diveristy.

CBD, 2009. Azores Scientific Criteria and Guidence for identifying ecologically or biologically significant marine areas and designing representative networks of marine protected areas in open ocean waters and deep sea habitats, p. 12. Secretariat of the Convention on Biological Diversity, Canada.

CBD, 2010a. Aichi Biodiversity Targets. Convention on Biological Diversity.

CBD, 2010b. Convention on Biological Diversity. COP 10. Decision X/2.Strategic Plan for Biodiversity 2011-2020.

Chapin Iii, F.S., Zavaleta, E.S., Eviner, V.T., Naylor, R.L., Vitousek, P.M., Reynolds, H.L., Hooper, D.U., Lavorel, S., Sala, O.E., Hobbie, S.E., Mack, M.C., Diaz, S., 2000. Consequences of changing biodiversity. Nature 405, 234-242.

Christie, P., 2004. Marine Protected Areas as Biological Successes and Social Failures in South East Asia. American Fisheries Society Symposium 42, 155-164.

Christie, P., McCay, B.J., Miller, M.L., Lowe, C., White, A.T., Stoffle, R., Fluharty, D.L., McManus, L.T., Chuenpagdee, R., Pomeroy, C., Suman, D.O., Blount, B.G., Huppert, D., Eisma, R.V., Oracion, E.G., Lowry, G.K., Pollnac, R.B., 2003. Toward Developing a Complete Understanding: A Social Science Research Agenda for Marine Protected Areas. Fisheries 28.

Coad, L., Leverington, F., Burgess, N.D., Cuadros, I.C., Geldmann, J., Marthews, T.R., Mee, J., Nolte, C., Stoll-Kleemann, S., Vansteelant, N., Zamora, C., Zimsky, M., Hockings, M., 2013. Progress towards the CBD protected area management effectiveness targets. PARKS 19.

Collie, J.S., Adamowicz, W.L., Beck, M.W., Craig, B., Essington, T.E., Fluharty, D., Rice, J., Sanchirico, J.N., 2013. Marine spatial planning in practice. Estuarine, Coastal and Shelf Science 117, 1-11.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253-260.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1998. The value of the world's ecosystem services and natural capital. Ecological Economics 25, 3-15.

Coulthard, S., Johnson, D., McGregor, J.A., 2011. Poverty, sustainability and human wellbeing: A social wellbeing approach to the global fisheries crisis. Global Environmental Change 21, 453-463.

Curtin, R., Prellezo, R., 2010. Understanding marine ecosystem based management: A literature review. Marine Policy 34, 821-830.

Day, J.C., Roff, J.C., 2000. Planning for Representative Marine Protected Areas: A Framework for Canada’s Oceans, pp. 1-134. World Wildlife Fund Canada, Toronto.

Defra, 2007. An introductory guide to valuing ecosystem services. Department for Environment, Food and Rural Affairs.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J.R., Arico, S., Báldi, A., Bartuska, A., Baste, I.A., Bilgin, A., Brondizio, E., Chan, K.M.A., Figueroa, V.E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G.M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Pérez, E.S., Reyers, B., Roth, E., Saito, O., Scholes, R.J., Sharma, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z.A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E., Asah, S.T., Asfaw, Z., Bartus, G., Brooks, L.A., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A.M.M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W.A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J.P., Mikissa, J.B., Moller, H., Mooney, H.A., Mumby,

P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A.A., Pataki, G., Roué, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., Zlatanova, D., 2015. The IPBES Conceptual Framework — connecting nature and people. Current Opinion in Environmental Sustainability 14, 1-16.

Dryden, J., Grech, A., Moloney, J., Hamann, M., 2008. Rezoning of the Great Barrier Reef World Heritage Area: does it afford greater protection for marine turtles? Wildlife Research 35, 477-485.

Dunn, D.C., Maxwell, S.M., Boustany, A.M., Halpin, P.N., 2016. Dynamic ocean management increases the efficiency and efficacy of fisheries management. Proceedings of the National Academy of Sciences 113, 668-673.

Edwards, P.E.T., Sutton-Grier, A.E., Coyle, G.E., 2013. Investing in nature: Restoring coastal habitat blue infrastructure and green job creation. Marine Policy 38, 65-71.

Etter, R.J., Bower, A.S., 2015. Dispersal and population connectivity in the deep North Atlantic estimated from physical transport processes. Deep Sea Research Part I: Oceanographic Research Papers 104, 159-172.

Evans, J.L., Peckett, F., Howell, K.L., 2015. Combined application of biophysical habitat mapping and systematic conservation planning to assess efficiency and representativeness of the existing High Seas MPA network in the Northeast Atlantic. ICES Journal of Marine Science: Journal du Conseil.

Fletcher, S., Rees, S., 2015. Marine Conservation Zone Impact Assessment Review. A report for The Wildlife Trusts by the Centre for Marine and Coastal Policy Research, Plymouth University., p. 31.

Foster, N.L., Sciberras, M., Jackson, E., Ponge, B., Toison, V., Carrier, S., Christiansen, S., Lemasson, A., Wort, E., Attrill, M., 2014. Assessing the Ecological Coherence of the Channel MPA Network. Report prepared by the Marine Institute for the Protected Area Network Across the Channel Ecosystem (PANACHE) project. INTERREG programme France (Channel) England funded project., p. 156.

Gaines, S.D., White, C., Carr, M.H., Palumbi, S.R., 2010. Designing marine reserve networks for both conservation and fisheries management. Proceedings Of The National Academy Of Sciences Of The United States Of America 107, 18286-18293.

Gleason, M., Fox, E., Ashcraft, S., Vasques, J., Whiteman, E., Serpa, P., Saarman, E., Caldwell, M., Frimodig, A., Miller-Henson, M., Kirlin, J., Ota, B., Pope, E., Weber, M., Wiseman, K., 2013. Designing a network of marine protected areas in California: Achievements, costs, lessons learned, and challenges ahead. Ocean & Coastal Management 74, 90-101.

Green, A.L., Maypa, A.P., Almany, G.R., Rhodes, K.L., Weeks, R., Abesamis, R.A., Gleason, M.G., Mumby, P.J., White, A.T., 2015. Larval dispersal and movement patterns of coral reef fishes, and implications for marine reserve network design. Biological Reviews 90, 1215-1247.

Halpern, B.S., Diamond, J., Gaines, S., Gelcich, S., Gleason, M., Jennings, S., Lester, S., Mace, A., McCook, L., McLeod, K., Napoli, N., Rawson, K., Rice, J., Rosenberg, A., Ruckelshaus, M., Saier, B., Sandifer, P., Scholz, A., Zivian, A., 2012. Near-term priorities for the science, policy and practice of Coastal and Marine Spatial Planning (CMSP). Marine Policy 36, 198-205.

Halpern, B.S., Klein, C.J., Brown, C.J., Beger, M., Grantham, H.S., Mangubhai, S., Ruckelshaus, M., Tulloch, V.J., Watts, M., White, C., Possingham, H.P., 2013. Achieving the triple bottom line in the face of inherent trade-offs among social equity, economic return, and conservation. Proceedings of the National Academy of Sciences 110, 6229-6234.

Hattam, C.E., Mangi, S.C., Gall, S.C., Rodwell, L.D., 2014. Social impacts of a temperate fisheries closure: understanding stakeholders' views. Marine Policy 45, 269-278.

HELCOM, 2010. Towards an ecologically coherent network of well-managed Marine Protected Areas – Implementation report on the status and ecological coherence of the HELCOM BSPA network. Balt. Sea Environ. Proc. No. 124B, p. 148.

Hicks, C.C., Levine, A., Agrawal, A., Basurto, X., Breslow, S.J., Carothers, C., Charnley, S., Coulthard, S., Dolsak, N., Donatuto, J., Garcia-Quijano, C., Mascia, M.B., Norman, K., Poe, M.R., Satterfield, T., St. Martin, K., Levin, P.S., 2016. Engage key social concepts for sustainability. Science 352, 38-40.

Hill, J., Pearce, B., Georgiou, L., Pinnion, J., Gallyot, J., 2010. Meeting the MPA Network Principle of Viability: Feature specific recommendations for species and habitats of conservation importance, pp. 1-189, Natural England Commissioned Reports, Number 043.

Hockings, M., Stolton, S., Leverington, F., Dudley, N., Courrau, J., 2006. Evaluating Effectiveness: A framework for assessing management effectiveness of protected areas. 2nd Edition, ed. P. Valentine, p. 121. IUCN, Gland, Switzerland and Cambridge, UK.

IUCN-WCPA, 2008. Establishing Marine Protected Area Networks—Making It Happen. , p. 118. IUCN, World Commission on Protected Areas, National Oceanic and Atmospheric Administration and The Nature Conservancy, Washington, D.C.

IUCN, 2003. Recommendation 5.22, 5th IUCN World Parks Congress, Durban, South Africa (8-17th September, 2003).

Jackson, E.L., Hiscock, K., Evans, J.L., Seeley, B., Lear, D.B., 2008. Investigating the existing coverage and subsequent gaps in protection and providing guidance on representativity and replication for a coherent network of Marine Protected Areas in England's territorial waters., pp. 1-138, Plymouth: Marine Life Information Network (MarLIN), Marine Biological Association of the UK. Natural England Commissioned Reports, Number 018.

Jackson, E.L., Rees, S.E., Wilding, C., Attrill, M.J., 2015. Use of a seagrass residency index to apportion commercial fishery landing values and recreation fisheries expenditure to seagrass habitat service. Conservation Biology 29, 899-909.

Jax, K., Heink, U., 2015. Searching for the place of biodiversity in the ecosystem services discourse. Biological Conservation 191, 198-205.

Johnson, D., Ardron, J., Billett, D., Hooper, T., Mullier, T., Chaniotis, P., Ponge, B., Corcoran, E., 2014. When is a marine protected area network ecologically coherent? A case study from the North-east Atlantic. Aquatic Conservation: Marine and Freshwater Ecosystems 24, 44-58.

Jonas, H.D., Barbuto, V., Jonas, H.C., Kothari, A., Nelson, F., 2014. New Steps of Change: Looking Beyond Protected Areas to Consider Other Effective Area-Based Conservation Measures. PARKS 20.

Jonas, H.D., Lucas, S., 2011. Woking paper: Legal Aspects of Aichi Biodiveristy Target 11: A Scoping Study. Vesion 1.0, p. 23. International Development Law Organisation.

Jones, G.P., Russ, G.R., Sale, P.F., Steneck, R.S., 2009. Theme section on "Larval connectivity, resilience and the future of coral reefs". Coral Reefs 28, 303-305.

Juffe-Bignoli, D., Burgess, N.D., Bingham, H., Belle, E.M.S., de Lima, M.G., Deguignet, M., Bertzky, B., Milam, A.N., Martinez-Lopez, J., Lewis, E., Eassom, A., Wicander, S., Geldmann, J., van Soesbergen, A., Arnell, A.P., O'Connor, B., Park, S., Shi, Y.N., Danks, F.S., MacSharry, B., Kingston, N., 2014. Protected Planet Report, p. 80. UNEP-WCMC, Cambridge, UK.

Kemp, J., Jenkins, G.P., Smith, D.C., Fulton, E., 2012. Measuring the performance of spatial management in marine protected areas, In Oceanography and Marine Biology. pp. 287-314. CRC Press.

Kirlin, J., Caldwell, M., Gleason, M., Weber, M., Ugoretz, J., Fox, E., Miller-Henson, M., 2013. California's Marine Life Protection Act Initiative: Supporting implementation of legislation establishing a statewide network of marine protected areas. Ocean & Coastal Management 74, 3-13.

Klein, C., McKinnon, M.C., Wright, B.T., Possingham, H.P., Halpern, B.S., 2015. Social equity and the probability of success of biodiversity conservation. Global Environmental Change 35, 299-306.

Klein, C.J., Chan, A., Kircher, L., Cundiff, A.J., Gardner, N., Hrovat, Y., Scholz, A., Kendall, B.E., Airama, S., 2008. Striking a Balance between Biodiversity Conservation and Socioeconomic Viability in the Design of Marine Protected Areas. Conservation Biology 00022, 691-701.

Kool, J., Moilanen, A., Treml, E., 2013. Population connectivity: recent advances and new perspectives. Landscape Ecology 28, 165-185.

Kritzer, J.P., Sale, P.F., 2004. Metapopulation ecology in the sea: from Levins' model to marine ecology and fisheries science. Fish and Fisheries 5, 131-140.

Laffoley, D.D.A., Brockington, S., Gililand, P.M., 2006. Developing the concepts of good environmental status and marine ecosystem objectives: some important considerations, p. 38. English Nature Research Reports, No 689, Peterborough, UK.

Lawton, J.H., Brotherton, P.N.M., Brown, V.K., Elphick, C., Fitter, A.H., Forshaw, J., Haddow, R.W., Hilborne, S., Leafe, R.N., Mace, G.M., Southgate, M.P., Sutherland, W.J., Tew, T.E., Varley, J., and Wynne, G.R. , 2010. Making Space for Nature: a review of England's wildlife sites and ecological network. Report to Defra. .

Leleu, K., Alban, F., Pelletier, D., Charbonnel, E., Letourneur, Y., Boudouresque, C.F., 2012. Fishers' perceptions as indicators of the performance of Marine Protected Areas (MPAs). Marine Policy 36, 414-422.

Levin, S., Xepapadeas, T., Crépin, A.-S., Norberg, J., de Zeeuw, A., Folke, C., Hughes, T., Arrow, K., Barrett, S., Daily, G., Ehrlich, P., Kautsky, N., Mäler, K.-G., Polasky, S., Troell, M., Vincent, J.R., Walker, B., 2013. Social-ecological systems as complex adaptive systems: modeling and policy implications. Environment and Development Economics 18, 111-132.

Lieberknecht, L., Mullier, T., Ardron, J., 2014. Assessment of the ecological coherence of the UK's marine protected area network. A report prepared for the Joint Links.

Liu , J., Dietz, T., Carpenter, S.R., Alberti, M., Folke, C., Moran, E., Pell, A.N., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C.L., Schneider, S.H., Taylor, W.W., 2007. Complexity of Coupled Human and Natural Systems. Science 317, 1513-1516.

Lubchenco, J., Grorud-Colvert, K., 2015. Making waves: The science and politics of ocean protection. Science 350, 382-383.

Magris, R.A., Treml, E.A., Pressey, R.L., Weeks, R., 2015. Integrating multiple species connectivity and habitat quality into conservation planning for coral reefs. Ecography, n/a-n/a.

Mangi, S.C., Rodwell, L.D., Hattam, C., 2011. Assessing the Impacts of Establishing MPAs on Fishermen and Fish Merchants: The Case of Lyme Bay, UK. Ambio 40, 457-468.

Marine Conservation Institute, 2016. MPAtlas [On-line]. Available at www.mpatlas.org, Seattle, WA.

Mascia, M.B., Claus, C.A., Naidoo, R., 2010. Impacts of Marine Protected Areas on Fishing Communities. Conservation Biology 24, 1424-1429.

McCook, L.J., Almany, G.R., Berumen, M.L., Day, J.C., Green, A.L., Jones, G.P., Leis, J.M., Planes, S., Russ, G.R., Sale, P.F., Thorrold, S.R., 2009. Management under uncertainty: guide-lines for incorporating connectivity into the protection of coral reefs. Coral Reefs 28, 353-366.

McCook, L.J., Ayling, T., Cappo, M., Choat, J.H., Evans, R.D., De Freitas, D.M., Heupel, M., Hughes, T.P., Jones, G.P., Mapstone, B., Marsh, H., Mills, M., Molloy, F.J., Pitcher, C.R., Pressey, R.L., Russ, G.R., Sutton, S., Sweatman, H., Tobin, R., Wachenfeld, D.R., Williamson, D.H., 2010. Adaptive management of the Great Barrier Reef: A globally significant demonstration of the benefits of networks of marine reserves. Proceedings of the National Academy of Sciences 107, 18278-18285.

McLeod, E., Salm, R., Green, A., Almany, J., 2008. Designing marine protected area networks to address the impacts of climate change. Frontiers in Ecology and the Environment 7, 362-370.

Millennium Ecosystem Assessment, 2005. Ecosystems and human well-being: Synthesis, In The Millennium Ecosystem Assessment series. p. 155. World Resources Institute, Washington, D.C.

MPA News, 2015. A brief examination of "other effective area-based conservation measures" and what they mean for MPAs. Open Channels.

National Marine Protected Areas Center, 2008. State of the Nation’s De Facto Marine Protected Areas, eds R. Grober-Dunsmore, L. Wooninck, p. 84. NOAA, Silver Spring, Maryland.

Natural England and the Joint Nature Conservation Committee, 2010. The Marine Conservation Zone Project: Ecological Network Guidance, pp. 1-144, Sheffield and Peterborough, UK.

NOAA-DOI, 2015. Framework for the National System of Marine Protected Areas of the United States of America. National Marine Protected Areas Center. National Oceanic and Atmospheric Administration and US Department of Interior.

Norse, E.A., 2010. Ecosystem-based spatial planning and management of marine fisheries: why and how? Bulletin of Marine Science 86, 179-195.

O'Hara, T.D., Rowden, A.A., Bax, N.J., 2011. A Southern Hemisphere Bathyal Fauna Is Distributed in Latitudinal Bands. Current Biology 21, 226-230.

OSPAR, 2003. Guidelines for the management of marine protected areas in the OSPAR maritime area. Reference number: 2003-18. OSPAR Convention for the protection of the marine environment of the north-east Atlantic.

OSPAR, 2006. Guidance on developing an ecologically coherent network of OSPAR marine protected areas, p. 11. OSPAR Commission, London, UK.

OSPAR, 2007a. Background document to support the assessment of whether the OSPAR Network of Marine Protected Areas is ecologically coherent. OSPAR Commission, London, UK.

OSPAR, 2007b. Guidance to assess the effectiveness of management of OSPAR MPAs: a self-assessment scorecard. Reference number: 2007-5. OSPAR Convention for the protection of the marine environment of the north-east Atlantic.

OSPAR, 2008. Background document on three initial spatial tests used for assessing the ecological coherence of the OSPAR MPA network OSPAR Commission 2008, pp. 1-21. OSPAR Commission, London, UK.

OSPAR, 2013. An assessment of the ecological coherence of the OSPAR Network of Marine Protected Areas in 2012, p. 76. OSPAR Commission, London, UK.

Ostrom, E., 2009. A General Framework for Analyzing Sustainability of Social-Ecological Systems. Science 325, 419-422.

Palumbi, S.R., 2003. POPULATION GENETICS, DEMOGRAPHIC CONNECTIVITY, AND THE DESIGN OF MARINE RESERVES. Ecological Applications 13, 146-158.

Palumbi, S.R., 2004. MARINE RESERVES AND OCEAN NEIGHBORHOODS: The Spatial Scale of Marine Populations and Their Management. Annual Review of Environment and Resources 29, 31-68.

Palumbi, S.R., Sandifer, P.A., Allan, J.D., Beck, M.W., Fautin, D.G., Fogarty, M.J., Halpern, B.S., Incze, L.S., Leong, J.A., Norse, E., Stachowicz, J.J., Wall, D.H., 2009. Managing for ocean biodiversity to sustain marine ecosystem services. Frontiers in Ecology and the Environment 7, 204-211.

Paterson, B., Kainge, P., 2014. Rebuilding the Namibian hake fishery: a case for collaboration between scientists and fishermen. Ecology and Society 19.

Pedersen, C., Feodoroff, T., Reuter, R., Franco, J., Buxton, N., Barbesgaard, M.C., 2014. The global ocean grab: a primer. Transnational Institute, Masifundise, Afrika Kontakt and World Forum of Fisher Peoples, Amsterdam, The Netherlands.

Piekäinen, H., Korpinen, S., 2008. Towards an Assessment of Ecological Coherence of the Marine Protected Areas Network in the Baltic Sea Region.

Pittman, S.J., McAlpine, C.A., 2003. Movements of Marine Fish and Decapod Crustaceans: Process, Theory and Application, In Advances in Marine Biology. eds P.A.T.C.M.Y. A.J. Southward, L.A. Fuiman, pp. 205-294. Academic Press.

Pittman, S.J., Monaco, M.E., Friedlander, A.M., Legare, B., Nemeth, R.S., Kendall, M.S., Poti, M., Clark, R.D., Wedding, L.M., Caldow, C., 2014. Fish with Chips: Tracking Reef Fish Movements to Evaluate Size and Connectivity of Caribbean Marine Protected Areas. PLoS ONE 9, e96028.

Plagányi, É.E., Skewes, T., Murphy, N., Pascual, R., Fischer, M., 2015. Crop rotations in the sea: Increasing returns and reducing risk of collapse in sea cucumber fisheries. Proceedings Of The National Academy Of Sciences Of The United States Of America 112, 6760-6765.

Pollnac, R., Christie, P., Cinner, J., Dalton, T., Daw, T., Forrester, G., Graham, N., McClanahan, T., 2010. Marine reserves as linked social-ecological systems. Proc Natl Acad Sci U S A. 107, 18262-18265.

Potschin, M.B., Haines-Young, R.H., 2011. Ecosystem services: Exploring a geographical perspective. Progress in Physical Geography 35, 575-594.

Rees, S., Foster, N., Langmead, O., Griffiths, C., 2015a. Assessment of the Ecological Coherence of the MPA Network in the Celtic Seas: A report for WWF-UK by the Marine Institute, Plymouth University and The Marine Biological Association of the United Kingdom. , p. 167.

Rees, S.E., Attrill, M.J., Austen, M.C., Mangi, S.C., Richards, J.P., Rodwell, L.D., 2010a. Is there a win–win scenario for marine nature conservation? A case study of Lyme Bay, England. Ocean & Coastal Management 53, 135-145.

Rees, S.E., Attrill, M.J., Austen, M.C., Mangi, S.C., Rodwell, L.D., 2013. A thematic cost-benefit analysis of a marine protected area. Journal of Environmental Management 114, 476-485.

Rees, S.E., Mangi, S.C., Hattam, C., Gall, S.C., Rodwell, L.D., Peckett, F.J., Attrill, M.J., 2015b. The socio-economic effects of a Marine Protected Area on the ecosystem service of leisure and recreation. Marine Policy 62, 144-152.

Rees, S.E., Rodwell, L.D., Attrill, M.J., Austen, M.C., Mangi, S.C., 2010b. The value of marine biodiversity to the leisure and recreation industry and its application to marine spatial planning. Marine Policy 34, 868-875.

Ridgeway, A., Cornthwaite, A., Wright, H., Davies, J., 2014. Identifying the remaining MCZ site options that would fill big gaps in the existing MPA network around England and offshore waters of Wales & Northern Ireland, p. 27. Joint Nature Conservation Committee.

Roberts, C.M., Branch, G., Bustamante, R.H., Castilla, J.C., Dugan, J., Halpern, B.S., Lafferty, K.D., Leslie, H., Lubchenco, J., McArdle, D., Ruckelshaus, M., Warner, R.R., 2003a. Application of ecological criteria in selecting marine reserves and developing reserve networks. Ecological Applications 13, S215-S228.

Roberts, C.M., Branch, G., Bustamante, R.H., Castilla, J.C., Dugan , J., Halpern, B.S., Lafferty, K.D., Leslie, H., Lubchenco, J., McArdle, D., Ruckelshaus, M., Warner, R.R., 2003 Application of ecological criteria in selecting marine reserves and developing reserve networks. Ecological Applications,: 13, S215-S228.

Roberts, C.M., Gell, F.R., Hawkins, J.P., 2003b. Protecting nationally important marine areas in the Irish Sea Pilot Project Region, p. 133, Environment Department, University of York, York.

Robinson, J.G., 2011. Ethical pluralism, pragmatism, and sustainability in conservation practice. Biological Conservation 144, 958-965.

Rodríguez-Rodríguez, D., Rodríguez, J., Abdul Malak, D., 2016a. Development and testing of a new framework for rapidly assessing legal and managerial protection afforded by marine protected areas: Mediterranean Sea case study. Journal of Environmental Management 167, 29-37.

Rodríguez-Rodríguez, D., Rodríguez, J., Abdul Malak, D., Nastasi, A., Hernández, P., 2016b. Marine protected areas and fisheries restricted areas in the Mediterranean: assessing “actual” marine biodiversity protection coverage at multiple scales. Marine Policy 64, 24-30.

Rondinini, C., 2010. Meeting the MPA network design principles of representation and adequacy: developing species-area curves for habitats., pp. 1-45, JNCC Report No. 439.

Rosendo, S., Brown, K., Joubert, A., Jiddawi, N., Mechisso, M., 2011. A clash of values and approaches: A case study of marine protected area planning in Mozambique. Ocean & Coastal Management 54, 55-65.

Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel, 2012. Marine Spatial Planning in the Context of the Convention on Biological Diversity: A study carried out in response to CBD COP 10 decision X/29, In Technical Series No. 68. p. 44, Montreal.

Shanks, A.L., Grantham, B.A., Carr, M.H., 2003. Propagule Dispersal Distance and the Size and Spacing of Marine Reserves. Ecological Applications 13, S159-S169.

Sheehan, E.V., Cousens, S.L., Nancollas, S.J., Stauss, C., Royle, J., Attrill, M.J., 2013a. Drawing lines at the sand: Evidence for functional vs. visual reef boundaries in temperate Marine Protected Areas. Marine Pollution Bulletin 76, 194-202.

Sheehan, E.V., Gall, S.C., Cousens, S.L., 2012. Between the reefs: the occurrance of sessile organisms on pebbly-sand habitats in the Lyme Bay cSAC compared to areas open to fishing. A report to the Wildlife Trusts., http://www.wildlifetrusts.org/sites/default/files/analysis%20of%20pebbly%20sand%20communities%20-%20Report%20to%20RSWT%20June%202012%20FINAL.pdf.

Sheehan, E.V., Stevens, T.F., Gall, S.C., Cousens, S.L., Attrill, M.J., 2013b. Recovery of a Temperate Reef Assemblage in a Marine Protected Area following the Exclusion of Towed Demersal Fishing. PLoS ONE 8, e83883.

Spalding, M., Burke, L., Hutchison, J., Ermgassen, P.z., Thomas, H., Ashpole, J., Balmford, A., Butchart, S., McIvor, A., McOwen, C., McSharry, B., Merriman, J., Spencer, T., 2014. Attaining Aichi Target 11: How well are marine ecosystem services covered by protected areas?, In Discussion Paper prepared for the World Parks Congress, Sydney p. 7. The Nature Conservancy, University of Cambridge, UNEP, WCMC.

Spalding, M., Meliane, I., Milam, A., Fitzgerald, C., Hale, L., 2013. Protecting Marine Spaces: Global Targets and Changing Approaches. Ocean Yearbook 27, 213-248.

Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdaña, Z.A., Finlayson, M., Halpern, B.S., Jorge, M.A., Lombana, A., Lourie, S.A., Martin, K.D., McManus, E., Molnar, J., Recchia, C.A., Robertson, J., 2007. Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. BioScience 57, 573-583.

Stuart-Smith, R.D., Bates, A.E., Lefcheck, J.S., Duffy, J.E., Baker, S.C., Thomson, R.J., Stuart-Smith, J.F., Hill, N.A., Kininmonth, S.J., Airoldi, L., Becerro, M.A., Campbell, S.J., Dawson, T.P., Navarrete, S.A., Soler, G.A., Strain, E.M.A., Willis, T.J., Edgar, G.J., 2013. Integrating abundance and functional traits reveals new global hotspots of fish diversity. Nature 501, 539-542.

Sundblad, G., Bergstrom, U., Sandstrom, A., 2011. Ecological coherence of marine protected area networks: a spatial assessment using species distribution models. Journal of Applied Ecology 48, 112-120.

Tallis, H., Polasky, S., Lozano, J.S., Wolny, S., 2012. Inclusive wealth accounting for regulating ecosystem services. Inclusive Wealth Report 2012. Measuring progress toward sustainability Cambridge, uk.

TEEB, 2010. The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations., ed. P. Kumar, p. 411. UNEP, London, Washington DC.

Tognelli, M.F., Fernández, M., Marquet, P.A., 2009. Assessing the performance of the existing and proposed network of marine protected areas to conserve marine biodiversity in Chile. Biological Conservation 142, 3147-3153.

Treml, E., Halpin, P., Urban, D., Pratson, L., 2008. Modeling population connectivity by ocean currents, a graph-theoretic approach for marine conservation. Landscape Ecology 23, 19-36.

UNEP-MED, 2009. IG.19/8. Annex II Decision IG. 19/13. Regarding a regional working programme for the coastal and marine protected areas in the Mediterranean including the High Sea. .

UNEP-WCMC, 2008. National and Regional Networks of Marine Protected Areas: A Review of Progress, p. 156. UNEP-WCMC, Cambridge, UK.

United Nations, 1992. Convention on Biological Diversity. 28.

Videras, J., Owen, A.L., Conover, E., Wu, S., 2012. The influence of social relationships on pro-environment behaviors. Journal of Environmental Economics and Management 63, 35-50.

Vinagre, C., Narciso, L., Cabral, H.N., Costa, M.J., Rosa, R., 2012. Coastal versus estuarine nursery grounds: Effect of differential temperature and heat waves on juvenile seabass, Dicentrarchus labrax. Estuarine, Coastal and Shelf Science 109, 133-137.

WCPA/IUCN, 2007. Establishing networks of marine protected areas: A guide for developing national and regional capacity for building MPA networks. Non-technical summary report., p. 16. IUCN, Gland, Switzerland.

Weaver, P., Johnson, D., 2012. Biodiversity: Think big for marine conservation. Nature 483, 399-399.

Woodley, S., Bertzky, B., Crawhall, N., Dudley, N., Londoño, J.M., MacKinnon, K., Redford, K., Sandwith, T., 2012. MEETING AICHI TARGET 11: WHAT DOES SUCCESS LOOK LIKE FOR PROTECTED AREA SYSTEMS? PARKS 18, 23-34.

Worm, B., Barbier, E.B., Beaumont, N., Duffy, J.E., Folke, C., Halpern, B.S., Jackson, J.B.C., Lotze, H.K., Micheli, F., Palumbi, S.R., Sala, E., Selkoe, K.A., Stachowicz, J.J., Watson, R., 2006. Impacts of Biodiversity Loss on Ocean Ecosystem Services. Science 314, 787-790.

Wright, G., Ardron, J., Gjerde, K., Currie, D., Rochette, J., 2015. Advancing marine biodiversity protection through regional fisheries management: A review of bottom fisheries closures in areas beyond national jurisdiction. Marine Policy 61, 134-148.