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FOREWORD

Marine Protected Areas and marine spatial planning for the benefit of marine mammals

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The world's oceans, that make up more than 70% of the earth's surface, face a wide range of human pressures (Halpern *et al.*, 2008, 2015). This applies particularly to the coastal zone (Ramesh *et al.*, 2015), where marine mammal communities in almost 50% of the world's coastal waters are considered at high-risk (Avila *et al.*, 2018). One means of tackling conservation pressures facing marine species has been to establish Marine Protected Areas (Gubbay, 1995; Kelleher *et al.*, 1995; Agardy, 1997; Gjerde & Breide, 2003; Edgar *et al.*, 2014), although, as yet, these apply to only 5% of the world's seas (UNEP-WCMC, IUCN, 2016).

The first Marine Protected Area (MPA) for cetaceans was established in 1971 in Laguna Ojo de Liebre, otherwise known as Scammon's Lagoon, in Baja California, Mexico to protect the winter breeding grounds of the gray whale (*Eschrichtius robustus*). Forty years later, there were at least 650 protected areas which included marine mammals (Hoyt, 2011). However, many of these were not established specifically for marine mammals, and have no detailed management measures targeting them. Even when supposedly designated for them (e.g. the Irish Whale & Dolphin Sanctuary), they provide little in the way of specific conservation measures. On the other hand, if implemented properly, they can be effective, as shown for example in the case of the Banks Peninsula Marine Mammal Sanctuary in New Zealand, which appears to have been successful in enabling the local population of the endangered Hector's dolphin to increase by 6% per annum (Gormley *et al.*, 2012). Although frequently not followed, there have been a number of attempts to provide guidelines for how to make MPAs effective (Kelleher, 1999; Roberts & Hawkins, 2000; Salm & Clark, 2000; Agardy, 2010), including some focused upon MPAs for marine mammals (Reeves, 2000; Hooker & Gerber, 2004; Evans, 2008; Hooker *et al.*, 2011; Hoyt, 2011; Notarbartolo di Sciara *et al.*, 2016).

Marine mammal scientists and practitioners are divided over the value of establishing MPAs generally for such a mobile group as cetaceans (see, for example, Reeves, 2000; Evans, 2008; Notarbartolo di Sciara *et al.*, 2016; Wilson, 2016; Hoyt, 2017), and it is often argued that focusing upon the particular anthropogenic pressures/stressors rather than setting boundaries around specific areas may be more effective for those species that do not have discrete identifiable home ranges. The strengths and limitations of each approach are summarized in Table 1. It is likely that conservation can best be achieved by integrating both approaches.

Most MPAs are small, and do not encompass the feeding or breeding hotspots (often referred to as 'critical habitat') of these highly mobile species. In the past, we have been limited by our lack of knowledge of where these are and the ecological factors shaping their importance, but with more extensive survey effort combined with ever more sophisticated habitat modelling approaches, in some of the more accessible regions at least, this no longer applies (see, for example, Kaschner *et al.*, 2006; Hooker *et al.*, 2011).

The need for increasing the size of protected areas to form a network embracing critical habitats has formed the basis of the European Union's Habitats & Species Directive's *Natura 2000* network of Special Areas of Conservation (SACs) across Europe. It is applied to just a few marine mammal species: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), Atlantic grey seal (*Halichoerus grypus*), harbour seal (*Phoca vitulina*), ringed seal (*Phoca hispida*) and Mediterranean monk seal (*Monachus monachus*), and there are obvious species that could have been included but are not, for example white-beaked dolphin (*Lagenorhynchus albirostris*), Risso's dolphin (*Grampus griseus*) and minke whale (*Balaenoptera acutorostrata*). Member states have been slow to designate SACs, and even where established, very few possess management plans designed to protect those species let alone ones that are fully enforced. Furthermore, there has been no real attempt as yet to develop protective measures in an integrated and cooperative manner across the network, taking account of issues relating to biological connectivity.

In most cases, management within MPAs allows for multiple use. This is the case, for example, within the Special Areas of Conservation created under the European Union Habitats & Species Directive. However, this can result in tensions between conservation interests and other marine stakeholders who press to use those areas for their own interests and livelihoods.

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Table 1. The strengths and limitations of area-based *vs* issue-based conservation measures.

Area-based conservation measures	
Pros	**Cons**
Provides focus to areas/habitats that are of particular importance for the species	Those important areas may change over time; requires adaptive management
Some features of the ocean (e.g. bathymetry, high energy sites) are stable over time, thus affording favourable conditions which may be applicable to a variety of species	If environmental conditions do vary, area-based legislation traditionally takes time to respond
Many human activities (e.g. recreation, seismic, offshore renewables) are area-based	Fishing activities in particular tend to move around
Encourages developers to conduct fuller HRAs/EIAs before starting activities	Boundaries have to be meaningful
Encourages development of a management plan involving all users	Can lead to conflicts between users and regulators/conservation groups
Raises public awareness and conservation focus for the species in that area	If the species occurs significantly outside that area, those regions may receive less attention
Pressure-based conservation measures	
Can be designed to target particular human pressures wherever they occur	Conservation measures can be expensive; so with limited resources, often a need to target areas where potential conflict will be greatest
Provides greater focus upon issue-based mitigation measures, e.g. net modification, bubble curtains	The most effective management measure may simply be to ensure that cetaceans and the conflicting activity are separated in space and time
Since fisheries move around as do their target prey, it is difficult to regulate within the confines of a particular area whereas measures can be introduced throughout a fishery	The establishment of some safe havens for fish may not only benefit top predators like cetaceans and seabirds that feed upon them but also help local fish stocks to recover
Although pollutant point sources can effectively be managed spatially, pollutants disperse over wide areas and so are not easily controlled by area-based measures	Most regions identified as highly polluted are enclosed areas of sea where ocean circulation is reduced, for which area-based measures can be applied

Because of such potential conflicts, governments may avoid designating certain areas which are earmarked for development in one way or another, and are reluctant to set aside areas of the size required to provide adequate protection for wide-ranging animals like marine mammals. A good example of where these tensions have arisen is in the North and Baltic Seas with the designation of SACs for harbour porpoise having to take account of a programme of offshore renewable energy development which may result in long-term disturbance following large-scale pile driving activities (Teilmann & Carstensen, 2012; Mann & Teilmann, 2013).

The desire to enlarge Marine Protected Areas for more effective protection, whilst managing multi-user activities, led to calls for marine spatial planning to be applied both within the coastal zone (Agardy, 2010; Agardy *et al.*, 2011) and on the high seas (Ardron *et al.*, 2008). Marine spatial planning (MSP), as defined by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, is 'a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that usually have been specified through a political process' (Ehler & Douvere, 2007, 2009). They propose that characteristics of effective marine spatial planning should include that it is ecosystem-based, place-based or area-based, integrated across sectors and agencies and among levels of government, adaptive in response to experience, strategic and anticipatory focusing upon the long-term, and participatory with stakeholders actively involved. The need to zone areas of sea for different uses, with some parts containing the more critical habitats for marine wildlife afforded full protection, has long been advocated (Batisse, 1990; Hyrenbach *et al.*, 2000; Agardy, 2010).

MSP is viewed as a practical way to create and establish a more rational use of marine space and the interactions between its uses, balancing demands for development with the need to protect marine ecosystems, and to deliver on social and economic objectives in an open and planned way (Ehler & Douvere, 2009). Thus, although it should be ecosystem-based (Crowder & Norse, 2008; Gilliland & Laffoley, 2008), MSP involves managing human activities in marine areas rather than a much more challenging target of managing ecosystems themselves (Ehler & Douvere, 2009).

Planning is a dynamic process and needs to be responsive to changes as it evolves over time. This form of adaptive management needs to be incorporated into both MPAs and wider-scale ocean management. However, it requires regular monitoring both of human activities and marine organisms, so that actions are fully evidence-based.

The concept of MSP has been embraced by many countries in the last 10 years, and the means to achieve it continues to be refined (Douvere & Ehler, 2009; Portman, 2011; Qiu & Jones, 2013; Stelzenmüller *et al.*, 2013), with attention paid to how best to integrate it into legislation (Schafer, 2009; Zervaki, 2015). A prerequisite is a good understanding of the spatial and temporal patterns of different human activities, and of marine animal taxa, through mapping supported by informed modelling. Significant progress has been made in the more accessible parts of the world to survey marine mammals and map their distributions and abundance. Ironically, it is actually the mapping of some human activities that is falling behind even in the most populated regions. Whereas tools such as AIS (Automatic Identification System) and VMS (Vessel Monitoring System) have enabled the plotting of vessel traffic, this is not possible for those not equipped with a transmitter (such as most vessels below 12 m length, which includes a large number of fishing and recreational craft). Thus, for the most part, maps of recreational and small boat fishing activities are lacking. Two other pressures

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upon marine mammals, that are by-products of human activities, are challenging to map: noise and pollutants. Continuous noise is mostly generated from shipping, and models now exist that will predict noise levels derived from plots of vessel movements using AIS/VMS. Impulsive noise (e.g. from seismic surveys, active sonar during military exercises, pile driving during marine construction) can also theoretically be measured but in practice this is not done on a routine basis. In Europe, ICES maintain an impulsive noise register (http://www.ices.dk/marine-data/data-portals/Pages/underwater-noise.aspx) from data submitted by member states, to support the EU Marine Strategy Framework Directive. This was started in February 2016 and still has many gaps. Mapping pollutant concentrations is even more challenging, and so far in NW Europe has relied upon regular sampling of particular indicator contaminants at 50 sites per OSPAR biogeographic region (OSPAR, 2010).

Marine mammal species vary in their sensitivity to different human pressures. They also vary in terms of life history characteristics, range and conservation status, all of which affect their vulnerability to particular pressures. These clearly need to be taken into consideration in the MSP process. An additional complication is how different human stressors may interact with one another, and the study of cumulative effects remains in its infancy (National Academies of Science, Engineering & Medicine, 2017).

Finally, although top predators like marine mammals can serve as flagship species indicating the regional health of the marine environment, it is important to take consideration of other marine taxa that may have different ecological requirements. This need is reflected in the recent initiatives by the Convention on Biological Diversity to identify Ecologically or Biologically Significant Areas (EBSAs) and by IUCN for Key Biodiversity Areas (KBAs), even if they have no legal standing. At least they alert human society to Particularly Sensitive Sea Areas (PSSAs), a concept that the International Maritime Organisation (IMO) is already implementing within some MPAs through the compulsory routing of vessels. Such approaches need to be extended across a range of human pressures and then incorporated in international legislation.

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