CHAPTER

2

Marine protected areas and marine spatial planning – allocation of resource use and environmental protection

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Abstract

Rarely is the strong link that exists between Marine Spatial Planning (MSP) and Marine Protected Areas (MPAs) explicitly recognised. MSP is the process by which the use of marine space is identified and used to inform development decisions made by regulators. Marine areas that are important for marine conservation/ecology form one of the most common data layers within marine plans. Some of these marine areas will be formally adopted/designated and have legal protection as MPAs; other marine areas may be protected culturally or through informal agreements. Where MPAs do not exist, marine plans can aid in the identification of areas where they could be sited optimally (taking into account environmental, social, economic and political considerations). MPAs and marine plans are generally based on current information, be it habitat/species distribution or marine uses; however, both marine plans and MPAs may be used as tools to drive future sustainable use of the marine environment. This requires recognising existing uses and identifying how these uses may be affected by climate change, economic development, marine users' social licence to operate and also how the government of the day sees the future use of its seas.

Keywords:

Marine protected areas; MPA; Marine spatial planning; MSP; Dynamic ocean management; Real time closures; Real time incentives; Co-location; Fishing effort displacement; Ecologically coherent network.

Introduction

Whether you consider yourself a practitioner (conservation ecologist, philanthropist, funder, manager, government advisor or regulator) in Marine Protected Area (MPA) management or a marine spatial planner, at the heart of your work will be the identification of particularly important or valuable marine space and the management of activities within

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it. Such management may include the proactive allocation of activities within that space so that marine space is used in the best way to deliver all of the activities that occur within the marine environment along with environmental protection to enable the continued and sustainable use of that marine space.

The terms Marine Spatial Planning (MSP), maritime spatial planning and marine planning are used interchangeably by many practitioners. Marine planning can be thought of as the general process of understanding marine spatial use whereas marine spatial planning can be thought of as the actual development of plans and policies that set out how marine space is to be used. Although there are subtle differences in the definitions, for the purposes of this chapter, the authors use the term marine spatial planning with the following definition - the identification of marine natural resources and the current and potential use of those resources, and the allocation of marine space through a formal framework.

Although MSP underlies the identification of sites important for conservation and influences the design of future MPAs, professionals from the MPA and MSP domain rarely work together. This chapter is aimed at practitioners and attempts to highlight the myriad ways that the two subject specialisms can work hand-in-hand to deliver more for the marine environment. At the most basic level, effective MSP can ensure that new MPAs are sited appropriately and that MPA network outcomes are better delivered.

The drivers behind MPA designation and MSP adoption

Whereas the impetus for the designation of MPAs can generally be easily defined (in many cases this is derived from international commitments), the drivers for MSP will vary from country to country. MSP may be used as a mechanism to deliver blue growth or an ecosystem based approach to management (Santos et al., 2014). MSP may be used to proactively identify suitable areas for MPA designation (Smith et al., 2008) or for the allocation of space for marine industries such as offshore wind energy (Azzellino et al., 2013). In some cases, the drivers for MSP may not be well defined (Collie et al., 2013; Foley et al., 2010). The United Kingdom (UK), for example, has an explicit Marine Policy Statement (MPS) (2011) that sets out the government's vision and expectations on how the marine environment should be used and protected. A comprehensive marine planning system in England is being developed to implement the MPS; however, the MPS provides little in the way of direction, or ranking or hierarchical guidance in how marine space should be used. This lack of clarity makes it difficult to determine the effectiveness of marine plans once they are developed and implemented. The Netherlands takes a very different marine planning approach compared with England, in that five strategic and hierarchical elements are set out which implicitly establish winners and losers in the race for marine space (Vaughan, 2018).

MSP is also used within the context of large, multiple-use MPAs to accomplish zoning, by which particularly important and sensitive marine areas are strictly protected. A good example of this is the Great Barrier Reef Marine Park in Australia, which, through its representative areas program, accomplished a zoning plan across its 345,000 km^2 expanse (an area roughly the size of Japan) (Fernandes et al., 2005).

In the developing world, MSP is commonly used to identify areas for new MPA designation, or for protected zones within a marine plan that become somewhat analogous to

MPAs. In Belize, for instance, scenario planning and trade-off analysis has led to the identification of coastal and marine areas of particular importance (Verutes et al., 2017). These areas are then afforded extra protections in coastal management. In Rodrigues Island in the Indian Ocean, MSP specifically for the aim of maximising conservation benefits has been employed to identify various types of MPAs (Pasnin et al., 2016). In South Africa, a participatory planning process has led to the recent establishment of an extensive network of MPAs (Mann, 2018).

Differing approaches to marine planning can be traced back to the social, political, cultural and legal constructs of a country, the strategic importance of a country's maritime space, the economic value of the resources within that marine space, the current and historical use of that space, and the extent of a country's marine space, as well as the financial resources and technical ability that a country has to map and manage its marine space (Cormier et al., 2018). Whether marine plans provide benefits to the marine environment depends on what the plan was intended to achieve and how the plan is implemented.

The importance of scale and management response

The requirement to manage our marine environment in a holistic manner, focusing not only on those areas of sea that fall within MPAs but also on the wider seas, is now widely understood and essential with widespread impacts of human pressures (Ehler and Douvere, 2009; Agardy, 2010; Ardron et al., 2008; Halpern et al., 2008, 2015). Our seas are interconnected, with fish, marine mammals and seabirds moving vast distances between breeding, nursery and feeding areas. We understand the importance of ocean gyres in entraining and also dispersing marine larvae. We also understand that the interconnectedness of our seas and oceans means that no one country is able to manifestly improve the health of the seas, yet each country has the ability to damage this global resource.

Collective action can be taken by governments to minimise the dangers of unregulated use or poor management. In many regions of the world, collaborative frameworks are adopted, such as that taken by those Member States of the European Union (EU) through the Marine Strategy Framework Directive (MSFD) (2008).

The EU has mandated that EU maritime member states develop marine plans through the implementation of the EU Maritime Spatial Planning Directive (2014a). Indeed, marine plans form one of the key measures that countries will rely upon to achieve Good Environmental Status as required under MSFD.

At the regional seas level, countries that share a body of water have, in many cases, developed international agreements to set standards on pollution control and other marine management, share information on marine systems and their use, develop specific protocols on marine biodiversity and habitat protection, and provide the framework for trans-boundary cooperation. Regional Seas Conventions exist in the North Atlantic (Convention for the Protection of the Marine Environment of the North-East Atlantic or OSPAR Convention; this came into force in 1998), the Baltic Sea (the Convention on Protection of the Marine Environment of the Baltic Sea; this came into force in 1992), the Mediterranean (the Convention for the Protection of the Marine Environment and Coastal Region of the Mediterranean, or Barcelona Convention; adopted in 1995), the Caribbean (Convention for the Protection and

Development of the Marine Environment of the Wider Caribbean Region; established in 1983), the West African region (The Convention on Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the Atlantic Coast of the West, Central and Southern Africa Region, ratified in 1984) and East Africa (the Nairobi Convention for the Management, Protection, and Development of the Marine and Coastal Environment of the Western Indian Ocean, entered into force in 1996), among others. Regional Seas programs are administered through the UN Environment Programme (UNEP) and help countries share information and build capacity to undertake marine planning and to manage their seas sustainably. Many of these regional seas have initiatives to undertake MSP, and in the process perform gap analyses to detect what important marine areas are missing from the suite of MPAs in that region.

At an even larger scale, collective action is needed to respond to the challenges posed by global warming and associated sea level rise, ocean warming and acidification. Just as there is a growing global realisation that we need to protect our seas at a macro level, there is a global thrust for blue growth whereby counties look to develop and monetise their marine resources. Countries seek to do this using the United Nations Convention of the Law of the Sea (UNCLOS) (1982) to either establish or extend existing Exclusive Economic Zones (EEZs). Commercial operations also look to exploit seabed minerals or fishery resources in the high seas and the Area Beyond National Jurisdiction (ABNJ).

The 'high seas' comprises all parts of the sea that are not included in the EEZ, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State (UNCLOS article 86). The 'Area' is the seabed, ocean floor and subsoil thereof, beyond the limits of national jurisdiction (UNCLOS Article 1).

The increasing demand for marine space within the ABNJ and the pressure that this demand places on species, habitats and the ecosystem services that the marine environment provides, require appropriate and effective institutions and the legal framework to ensure the sustainable use of the marine environment. Although under both UNCLOS and the Convention on Biological Diversity (CBD) (1992), nations are committed to preventing harm to the environment and biodiversity beyond national jurisdiction, few countries have developed assessment procedures or other oversight mechanisms to identify potentially harmful activities under their jurisdiction or control (Ardron et al., 2008; Maes, 2008).

To put the current extent of marine protection in the ABNJ into context, 61% of the planet's ocean lies within this area (2018). Within this area there is limited effective protection of species and habitats. Where there is management in place, this is often sectoral and directed at activities such as shipping (e.g. the International Maritime Organisation) or fishing (e.g. Regional Fisheries Management Organisations (RMFOs)) (Ardron et al., 2008; Blanchard, 2017). In the case of the RMFOs, their remit can vary widely. For some RFMOs, their stated mandate is the management of a particular fish species such as tuna (Indian Ocean Tuna Commission (IOTC)), while the mandate of others can extend to wider marine resources within a particular region (e.g. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLRs)). This sectoral approach to managing activities and the pressures from these activities within the ABNJ mirror the approach most commonly taken to managing these sectors within EEZs. And just as MPA designation and management seek to provide protection for species and habitats inshore, this approach is also being advanced within ABNJ. To date, 12 MPAs within ABNJ have been established − two in the Southern Ocean

and 10 in the North-East Atlantic region – and more are proposed (Smith et al., 2017). The Southern Ocean MPAs were adopted by members of CCAMLR whereas those in the North-East Atlantic were established under the OSPAR Convention.

Recognising that MPAs alone within will not provide sufficient protection of the marine environment, the UN adopted resolution 69/292 in June 2015 to develop an international legally binding instrument under the UNCLOS on the conservation and sustainable use of marine biological diversity of ABNJ (2015a). The UN subsequently, in December 2017 through resolution 72/249, decided to convene an intergovernmental conference in September 2018 to consider an international legally binding instrument under the UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, with a view to developing the instrument with negotiations addressing measures such as area-based management tools, which include MPAs (2017). And on 24 December 2017, nations agreed to convene an intergovernmental conference, leading to a legally binding treaty under UNCLOS for ABNJ protections that would be negotiated over two years. Time will tell whether an adequately ambitious and integrated approach to management of the ABNJ is agreed, subsequently developed, and adopted.

A brief history of MPA development

MPAs can trace their roots back to tenurial arrangements and taboos, through which community authorities decreed areas prohibited to fishing or other uses. Many of these marine tenure patterns reflect an innate understanding that some areas of the sea are critical for maintaining ocean health and productivity; for example, fish spawning sites form the base for many taboo areas in Oceania. Fisheries managers started planning fishing closed areas in the late 1950s with the specific aim of protecting stocks and enhancing fisheries production. As protected areas on land began springing up all over the world, marine authorities began to designate multiple-use MPAs, including Marine National Parks, and later, Marine World Heritage sites. Modern MPAs were designated in large numbers beginning in the 1970s, when Pacific nations began pioneering spatial restrictions to protect 'the commons' (this was spurred by the first World Park Congress, held in Japan in 1975).

There are currently 15,334 protected areas covering 26,945,395 km^2, which represents 7.44% of our seas and oceans. In terms of marine space under national jurisdiction, the current coverage of marine protected areas is 17.23% (UNEP-WCMC and IUCN, 2018).

MPAs, whether free-standing, in multiple MPA networks or as protected zones within larger multiple-use marine managed areas, are designated based on both need and opportunity. Ecologically important, vulnerable or particularly valuable areas do get highlighted through systematic and strategic planning efforts on the part of coastal and marine management regulators and international agencies that backstop regional seas agreements (e.g. the Regional Activity Centre for Specially Protected Areas, supporting the Mediterranean regional seas member states), and then these key areas sometimes become designated as MPAs. More often than not, however, MPAs are designated because a threat to a particular place arises and needs to be countered with spatial protection, or an opportunity to holistically manage an area arises. In general, these opportunistic MPAs can be considered low-hanging fruit, and they have value beyond the protection of biodiversity or habitat they encompass, in that they can serve as demonstrations of the benefits that MPAs can provide.

A brief history of MSP development

While it is not within the scope of this chapter to synthesise the history of marine planning in its entirety, it is worth noting that many countries embark on MSP at the national or sub-national scale only after designating MPAs. This was certainly case in the UK. In 1986, the Lundy Marine Nature Reserve was designated as the first MPA in the UK. In 2014, 28 years later, the East Inshore and East Offshore Marine Plans were adopted in England (2014b). These were the first large-scale marine plans to be developed in the UK. The pattern of a country first designating MPAs and then developing marine plans at a later date is mirrored around the world. Virtually all coastal states have implemented at least one MPA ranging on the IUCN scale of protected areas categories from Ia (strict nature reserve) to VI (protected area with sustainable use of natural resources). Very rarely have marine plans been established in places without designated MPAs.

In terms of managing marine space, MSP is already catching up with MPAs as a management discipline with a major influence over the future use of our seas and oceans. Whilst countries have been designating MPAs for several decades, the first International Marine Protected Areas Congress (IMPAC I) was held in Geelong, Australia, in 2005. This was only a short time before UNESCO held the first International Workshop in 2006 on MSP, which is thought of as the birthplace of MSP internationally. The seminal text (*Marine Spatial Planning: a step-by-step approach towards ecosystem-based management*) on the subject, authored by Ehler and Douvere, was published in 2009 (Ehler and Douvere, 2009). And while there is no MSP dataset comparable to the World Database on Protected Areas that tallies the number of marine plans globally, in August 2018, approximately 70 countries were preparing or had prepared approximately 140 MSP plans at the national, regional or local levels (UNESCO, 2018). Approved MSP now cover almost 10% of the world's EEZs (UNESCO et al., 2017).

How the aims of MPAs can be assisted by MSP

There are at least two ways that MSP can help create MPAs that deliver benefits to humans and nature simultaneously: first, by utilising MSP to locate MPAs and delimit their boundaries in such a way that they capture the most important ecological processes and productivity; and second, by utilising MSP to design zonation of MPAs to ensure maximisation of benefits. Examples of the former abound in the academic literature, but few organisations have implemented plans of strategically designed MPA networks. Nascent examples include North Ari planning in the Maldives (Agardy et al., 2017) and UK MPA planning. Another noteworthy example of a case in which MSP was used to create zonation within a large, multi-use MPA is the Great Barrier Reef Marine Park (Day et al., in prep). Recently, an MPA network was designed in South Africa based on systematic conservation planning and MSP (Haupt et al., 2017). And in the Northern Adriatic region of the Mediterranean, ecosystem services assessment and analysis of trade-offs has allowed MSP to identify priority areas for management and MPA designation (Gissi et al., 2018).

The involvement of relevant stakeholders, who ultimately need to be on board in order to ensure the efficacy of MPAs, can also be enhanced by MSP. The reason that this is the case relates to how people perceive MPAs versus MSPs. The general perception is that MPAs

serve conservation purposes; they are often cast as tools for safeguarding nature, not nurturing people. In contrast, MSP is often perceived as a process that can lead to economic development and a blossoming Blue Economy (commonly understood to be the sustainable use of ocean resources, for economic growth, improved livelihoods and jobs, and ocean ecosystem growth (World Bank, 2018b)). In fact, many governments commit to funding MSP processes because they anticipate that the resulting plans will unlock the 'blue growth potential' of their territorial seas and EEZs (Howard, 2018).

MSP can therefore encompass a significant stakeholder-driven process. This often requires that those involved not only set out their ambitions for marine space as well as their concerns, but also engage with other stakeholders. This creates a shared understanding, if not agreement, of different stakeholder requirements on how marine space should be used. Ultimately, a better and shared understanding of competing needs should aid marine management, including that applicable to MPAs. Stakeholder involvement is key for societal acceptance of management measures. Effective stakeholder engagement can smooth MPA designation and the designation of boundaries, along with regulations and management regimes within them. The engagement of people is a good starting point and should not be undervalued.

Many MPAs have been designated opportunistically, and though they may have conservation value, they are sometimes not in the optimal place to confer either significant conservation benefits or benefits to humans. Many large MPAs are in areas of historically low pressures; therefore, interventions often do not result in tangible environmental improvements. These large and relatively pristine MPAs in remote areas do have value in future-proofing (Leenhardt et al., 2013), but it must be recognised that this potential future-proofing may be undermined by climate change. The marine environment is under pressure, and for environmental gains to be made, interventions are generally needed to bring about change.

Similarly, many MPA networks established within a country or across a trans-boundary area are developed for very specific purposes of protection of species or habitats. These MPA networks thus have conservation value but limited wider value – i.e. limited recovery of seas/ocean areas that were degraded and limited enhancement of benefits to human users.

The most egregious examples of opportunistic MPAs, established with little ecological understanding, have been of limited utility and rarely demonstrate the effectiveness potential of well-designed MPAs (Agardy et al., 2016). The drivers behind such rushed declarations include a country's need to keep commitments made under international treaty negotiations (e.g. Aichi Targets of the CBD), commitments made under soft law or declarations made in public fora (e.g. Sustainable Development Goal declarations), or even domestic politics and legacy concerns (Leenhardt et al., 2013; Rife et al., 2013).

Enduring effectiveness of MPAs is challenged by a number of factors. In some cases the MPAs can actually enhance some threats while abating others – an example is the case of displacement of native species in the Mediterranean by invasive species, which is sometimes thought to have been enhanced by the establishment of no-take MPAs that act as stepping stones for alien species (Giakoumi et al., 2016). In other cases MPAs can act as islands of protection, but without enough impact to prevent the seas in which they sit from spiralling downhill. Some MPAs can also be impacted from land-based activities, and interventions outside of the MPA may be needed to enable the MPA to deliver its intended outcomes. This calls for more integrated marine management and is a further argument for integrated coastal zone management and MSP to go hand-in-hand with MPA establishment (Agardy et al., 2011).

MSP can aid in greater integration of management activities within an area, and a more holistic approach: first, because MSP is meant to include a number of different sectors in spatial management, and second, because MSP is meant to have at its foundation the ecosystem-based approach to management that recognises ecological and human connections across vast landscapes/seascapes (Douvere, 2008; Ehler and Douvere, 2009). Using MSP to identify where new MPAs should be designated requires an understanding of the broader ecosystem ecology, and is usually based on some sort of gap analysis that looks at not only the existing array of protections, but also their effectiveness.

How MPAs can assist in the delivery of MSP

The general goal of MSP is to steer marine use in a direction that is sustainable. This may be accomplished by limiting uses that are degrading, enhancing or expanding uses that are not, and treating interconnected ecosystems in such a way that linkages are maintained and ecological processes continue to provide benefit flows to communities and countries. MSP and the ecosystem-based management approach it encompasses are the foundation for emerging Blue Economies around the world.

By protecting key pockets of biological diversity and key ecosystem processes, MPAs can serve as a foundation for continued delivery of the things that people value in coastal and marine areas: resources such as fisheries and minerals, recreational values, sites for tourism activities, cultural and spiritual values, etc. (Jones et al., 2017; Lillebø et al., 2017). In essence, MPAs can act as the blueprint for continued ecosystem functioning and delivery of ecosystem services — but only when MPAs are designed carefully, systematically and with the big picture in mind (Agardy et al., 2011). MPAs can act as refugia (Green et al., 2014), insurance policies, and the bank of natural capital through which people can live off the interest. MPAs can also, importantly, enhance production through spillover, thus increasing value over a wider area (2009; Harrison et al., 2012; Roberts, 2012).

The EU Blue Growth strategy supports the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth. Blue Growth seeks to support sustainable growth in the marine and maritime sectors as a whole. Maritime economic activities are supported by marine ecosystem services in combination, or not, with abiotic outputs from the marine natural capital (Lillebø et al., 2017). In order to balance concurrent sectoral interests and achieve sustainable use of marine resources, there is the need to consider the ecosystem's capacity to provide the required marine ecosystem services. Blue Growth options require navigating trade-offs between economic, social and environmental aspects. Fundamentally, MPAs may ensure the continued maintenance of ecosystem services that then enables marine development to be conducted in a measured manner (Agardy, 2019).

In line with global targets agreed under the CBD (1992), the number of MPAs is increasing rapidly, yet socio-economic benefits generated by MPAs remain difficult to predict and under debate (Mizrahi et al., 2018). MPAs often fail to reach their full potential as a consequence of factors such as illegal harvesting, regulations that legally allow detrimental harvesting, or emigration of animals outside boundaries because of continuous habitat or inadequate size of the reserve (Agardy et al., 2011). Edgar and colleagues have summarised the elements that contribute

to MPAs that successfully meet conservation goals, based on analysis of 87 MPAs investigated worldwide: MPAs designed as no take, or restricting all extractive activity, MPAs that are well enforced, MPAs that have been established for >10 years, MPAs that are large (>100 km^2), and MPAs isolated by deep water or sand (Edgar et al., 2014). These results, and the findings of other assessments of MPA effectiveness in delivering broad positive outcomes, suggest that MPAs should be carefully planned, sufficient in their coverage, regulations and enforcement, and taken as a part of broader planning and management that can be achieved with MSP.

From data to information, to insights, to decision-making

Critical to ensuring sustainable use of marine resources is a basic understanding of five parameters: (1) where resources occur throughout marine space, (2) how, if at all, the location and quantity of those resources changes over time and (3) how the resources are exploited, (4) the impacts on the wider environment that arise from that exploitation and (5) who is doing the exploitation. An additional important element to consider is why a resource is being exploited in any particular way. This information provides the context for the resource use and provides resource managers with important insights that enable them to engage with the resource users, understand the concerns of stakeholders, empathise with them and ultimately develop management measures, if needed, that are appropriate and will be accepted, or at least understood, by the resource users.

Our collective understanding of the state of the marine environment and the pressures to which it is exposed is furthered by the work conducted to underpin MSP development and MPA designation as well as the subsequent assessment of: (a) the effectiveness of marine plans in delivering their objectives and (b) the condition of protected species and habitats within MPAs.

Accountability and transparency throughout the designation process for MPAs and marine plan adoption can be secured through legislation. Legislation can require those responsible for designating MPAs or making plans to: consult in a meaningful way with stakeholders; set out options for achieving the objectives for the MPA or the marine plan and; and set out potential management measures. Legislation can require management bodies to report on the condition of MPAs as well as the efficacy of marine plans and the policies within them. The very fact that there is a requirement to report on the effectiveness of MPAs or marine plans should drive improvements in management and, therefore, protection levels. For reporting on MPA designation or marine plan effectiveness to be meaningful and enlightening, condition monitoring of the marine environment will often be required, which further increases the knowledge base upon which to make management decisions (Pomeroy et al., 2005; Day et al., 2002; Bennett and Dearden, 2014).

A meaningful stakeholder engagement process can increase awareness of the MPA or marine plans and how they may impact the stakeholder. Increased understanding of the process by which end products are delivered can help ensure that difficult discussions between managers and stakeholders are then focused on management measures rather than the processes (i.e. disagreement on the evidence − such as data layers − that is used to base management decisions on) that have led to management measures being developed and introduced. In essence, individuals or stakeholder groups may not agree with or like the outcomes, but

can understand how they have been arrived at. If those outcomes are borne out of a transparent, accountable and evidence-based process, then there is an increased likelihood of acceptance for the outcomes and therefore voluntary compliance with management measures and, ultimately, success of the MPA or marine plan.

The MSP process whereby the spatial and temporal distribution of marines resources and marine activities are captured and presented in a way that can be understood by the various stakeholder groups (e.g. from fishers to policy makers) is critical. The ability to effectively present the evidence base and the confidence in that information upon which decision-making will rely are extremely important.

As in many other situations, there are in essence three ways to proactively bring about change in the marine environment. These are to start, modify or stop an activity. This can be achieved through various mechanisms ranging from voluntary agreements to incentives, compensation schemes, formal regulation, enforcement and sanctions. Bringing about change invariably incurs costs, to those impacted by the change and also those bringing about change. Therefore, this provides a further imperative to understanding not only how the marine environment is being used, but also how it is changing.

More than the sum of its parts

Whilst the origins of MPA designation within any one country will have been the establishment of a single or small number of MPAs to protect a specific species or habitat, there has been a gradual shift to the development of MPA networks within a single country and at a regional seas scale. One example of this is the Regional Seas Convention for the North-East Atlantic (OSPAR), which facilitates the development of an ecologically coherent MPA network in the North Atlantic. Creating representative networks of MPAs as part of an ecosystem-based management approach is generally advocated to protect the full spectrum of marine ecosystems and vulnerable species (Johnson et al., 2014). This shift towards the development of MPA networks is directly linked to the CBD Decision X/2 of COP10 (2010), which requires that by 2020, 10% 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 landscape and seascape. As Johnson et al. (2014) point out, ecological coherence in itself is not the end-point or 'Holy Grail'; rather, the ambition is ultimately effective management of such networks to secure conservation objectives.

Just like a single MPA that protects a single species or habitat directly, but fails to provide protection for important supporting habitats or species within that MPA, a network of MPAs also has the potential to overstate the level of protection that it can provide. Whereas a network of MPAs may provide protection for habitats, sessile species or for mobile species at particular stages in their life cycle where their movements are spatially constrained, networks provide limited protection for more mobile species (see Evans (2018) for a detailed analysis of the strengths and weaknesses of area-based management versus issue-based conservation measures). The conservation benefits of an ecological network of MPA are also unlikely to be achieved unless the ecological connections between MPAs are maintained.

Recognising this, the use of MSP and the regulatory/licencing mechanisms that are either embedded or ancillary to it can provide the joined-up management that provides the levels of environmental protection for vulnerable mobile species and the water-borne life-history stages of species that form the habitats of MPAs. Even in the situation in which an ecologically coherent and extensive MPA network is in place and is effectively managed, there is a growing realisation that this network provides a starting point for protection and the raising of environmental protection. It is now recognised that the remainder of the marine environment is an important source of natural capital. It is worth noting that the spatial coverage of MPAs is not a true reflection of the actual spatial footprint of protection; in many cases, an MPA only confers protection to a proportion of the benthic habitat within that MPA. Within the unprotected area of a country's marine space there will be areas of high ecological value that could and should be protected. MSP provides a process and a mechanism to achieve this. MSP can aid in the identification of activities that interact spatially and temporally with important ecological processes and migratory routes. MSP and its associated management mechanisms can ensure that the ecological connectivity of MPAs is protected by minimising harmful interactions. As such, MSP is an essential tool for delivering an ecosystem approach and should add value to existing management measures for the marine environment (Crowder and Norse, 2008; Gilliland and Laffoley, 2008).

Moving the goal posts or upping the game?

The marine environment and its use are highly dynamic; therefore, static management measures may need to be augmented in order to optimise both marine use and environmental protection. Recognising this, there is increased focus on securing the health of the wider seas by governments, their advisors and regulators. This pivot (from designating MPAs and introducing management measures within them, to wider seas management measures) may be viewed by some sectors as moving the goal posts in terms of environmental protection. It is likely that further constraints on their activities will be deemed unpalatable yet inevitable. Attention needs to be paid to these sectors and their concerns to ensure that wider seas management measures are workable and effective. Many of the types of measures that can be introduced rely upon marine users working collaboratively in order for the measures to be successful.

Dynamic ocean management

The ability to protect Migratory Marine Species (MMS), which constitute a large portion of marine taxa, is becoming more sophisticated. Management measures have historically looked to (a) protect specific habitats that species rely upon during specific periods of their life cycle through conventional MPA designation, and (b) licence activities that can have an adverse effect on the species, requiring marine activities to design their operations to avoid, minimise, mitigate or compensate for their impacts.

Dynamic Ocean Management (DOM) is now gaining attention as a useful management tool (Lascelles et al., 2014) to augment existing management responses. DOM is defined as management that rapidly changes in space and time in response to changes in the ocean and its users through the integration of near-real-time biological, oceanographic, social

and/or economic data (Maxwell et al., 2015). These changes in environmental parameters (such as sea surface temperature) could be instigated as a result of predicted or measurable changes in those parameters. DOM can refine the temporal and spatial scale of managed areas, thereby better balancing ecological and economic objectives. DOM was developed out of the need to identify a more responsive management tool to protect MMS. Marine users can now modify their activities to minimise the impacts of their activities on the marine environment when they are presented with the information on which to act. Maxwell et al. (2015) sets out how passive acoustic buoys and aerial surveys are used to detect the real-time presence of North Atlantic right whales (*Eubalaena glacialis*) along the US East Coast to reduce lethal ship strikes of this critically endangered species. DOM area locations are distributed to ship captains via mobile applications to alert them to the whales' presence and to recommend avoiding areas or reducing speeds when whales are present (Wiley et al., 2013; Conn and Silber, 2013; Silber et al., 2012). Dynamic management areas are also paired with traditional seasonal closures of the whales' breeding grounds (Van Parijs et al., 2009).

DOM also has a significant and growing role to play in fisheries management. Bycatch of threatened species in capture fisheries remains a major impediment to fisheries sustainability. Management measures designed to reduce bycatch can result in significant economic losses and even fisheries closures. Static spatial management approaches can also be rendered ineffective by environmental variability and climate change, as productive habitats shift and following the introduction of new interactions between human activities and protected species (Hazen et al., 2018; Little et al., 2015). Increased accessibility to environmental data, computing power and the need to reduce the impact of fishing activities and to minimise the catch of choke species (a term used to describe a species with a low volume quota, which, if reached, would lead to vessels having to stop fishing even if they still had quota for other species) has also led to the development of both Real Time Closures (RTCs) and Real Time Incentive (RTI) fisheries management.

Real time closures

Real-time spatial management in fisheries, a type of DOM, uses near real-time data collection and dissemination of information to reduce susceptibility of certain species (or age classes of that species) to being caught in mixed fisheries (Woods et al., 2017). RTCs for managing fisheries bycatch and discards can be implemented under either a co-management or a self-governance approach (Little et al., 2015). Real-time catch and discard information is shared among fishers to incentivise and encourage vessels to leave areas of high bycatch which may include protected species. RTCs can therefore augment the protection that static MPAs provide MMS.

Real time incentives

Under an RTI fisheries management approach, fishers are allocated fishing-impact credits to spend according to spatiotemporally varying tariffs. Fishers choose how to spend their credits, e.g. by limited fishing in sensitive areas and fishing longer in less sensitive areas (Kraak et al., 2012, 2014, 2015). One can argue that DOM, RTC and RTI are examples of recent MSP advances as they all seek to manage the use of marine space. The use of these dynamic management tools can deliver significant environmental benefits to the wider environment;

however, their use has the potential to increase conflict between different marine stakeholder groups as activities are moved or displaced as a result of the dynamic management.

Future-proofing marine protection

Scenario analysis

MSP could be used as a tool in several ways to aid the delivery of environmental protection and sustainable use of the marine environment. MSP provides a snapshot of what activities are occurring where and when in the marine environment. It also reflects how marine space is allocated at that particular time. This information provides a baseline for discussions on how the marine environment should, or could, be both developed and protected in the future. An important task of natural resource management is deciding between alternative policy options, including how interventions will affect the dynamics of resource exploitation. Yet predicting the behaviour of natural resource users in complex, changeable systems presents a significant challenge for managers (Davies et al., 2015). To develop a better understanding of how the existing situation may change, which in turn may impact the effectiveness of policy options, varying scenarios can be developed (although to date, most spatial planning processes have not selected specific outcomes, such as preferred use scenarios (Collie et al., 2013)). Scenarios can be simplistic in that they may only consider how a particular marine sector is likely to change over a period of time (i.e. offshore wind), or they can be far more complex. In the Celtic Sea, three scenarios (ABPmer and International, 2016) were considered as part of a project to bring together key stakeholders to support the implementation of environmental and maritime policy. The scenarios were:

1) *Business as usual:* The marine economy develops as expected. There are no major changes in attitudes, priorities, technology or economics. Economic growth remains the priority, with society and industry reluctant to adopt environmental policies that radically change the status quo.
2) *Nature at work:* The environment takes centre stage. Population growth, new technology and making the most of a healthy environment are the driving forces. Environmental protection is strong, with an extensive network of strongly managed protected areas.
3) *Local stewardship:* Society seeks greater local self-sufficiency. More decisions are taken locally and there is increased pride in local produce. Environmental policy varies across the region as decisions reflect local issues and concerns. Tourism and recreation grow strongly as people choose to holiday at home.

Each scenario considered variables such as population, economic equality, technical innovation, globalisation and environmental policy. Furthermore, each scenario highlights that, as is the case now, there will be trade-offs, winners and losers in terms of economy, society and the environment.

Scenario analysis is helpful as it highlights difficult decisions that will need to be addressed by policy makers in the future, and in some situations can provide a time frame for those decisions to be made within. Scenario analysis can therefore guide stakeholder discussions and prioritise research to inform decision-making. In the context of marine protection it can help managers

anticipate the future use of existing MPAs. This is especially useful when the current effectiveness of the MPA in delivering its objectives is known because this will enable managers to consider how management may need to change to continue delivering effective management. Anticipating not only the future needs of existing marine space users but also those needs of potential new users enables policy makers to proactively allocate and prioritise in a hierarchy how marine space should be used in the future. Scenario analysis may also aid the resolution of potential problems relating to cumulative environmental impacts proactively, i.e. recognising that multiple users of marine space will have a future impact on protected species and therefore measures can be put in place to mitigate or offset those impacts before they are realised.

Improving feature-based protection

Many, if not most, MPAs have been established to protect specific species or habitats (features) rather than all species or habitats within that particular site (Solandt, 2018). However, there is increasingly a realisation that this approach can have significant limitations, especially where the MPA is of limited size. In many cases, the boundaries of MPAs are drawn close to the protected features of the sites, recognising that management measures to protect the features will impact marine users; therefore, to ensure that the designation of the site is secured, efforts are taken to provide the required level of protection using the smallest spatial footprint possible. For this reason, MPAs may not deliver significant 'additional' protection other than that directed at the formally designated features. Ironically, as some MPA networks are deemed to be nearing completion — in that they provide an ecologically coherent network of MPAs — there is concern that climate change is altering the distribution and abundance of the very features that the network of MPAs has been designated to protect. This may not be a concern if the network has adequate network connectivity and functioning as it was intended to.

In some instances, protected features may migrate out of the MPA, requiring: (1) the MPA boundaries to be altered, (2) the MPA to be de-designated and (3) a replacement MPA to be identified and designated, or (4) those features that were to be protected to be added as protected features within other MPAs where those features are not already protected. In the latter case, suitable management measures to protect those previously unprotected features would need to be introduced. Where this happens, stakeholders may consider that the goals of the original MPA have altered significantly and thus they may be less inclined to support the MPA and the management regulations applicable to it.

This feature-based approach makes it hard for the MPA and the protection it provides to adapt to changing environmental conditions (e.g. temperature, salinity, acidification, sea level, wave exposure, ocean currents). Conservation management approaches are often primarily focused towards the designated features, with no specific conservation measures applying to other (non-feature) areas within the site boundary. Areas of 'non-designated habitat' may still harbour significant biodiversity interest and support the designated features by providing additional resilience to human impacts. Recognising this, the UK Government has set out its intention to move to a whole-site approach to protect sites of the greatest biodiversity interest (UK, 2018a).

Through the incorporation of data layers that indicate how climate change and human activities are likely to alter, MSP can show how pressures on protected features may change

over time. These data layers may also highlight where protected features are likely to migrate or be displaced to over time. Once this information has been discerned, then a determination can be made as to how effective the existing protection will be in the future and how the MPA network will need to evolve in order to continue providing adequate, or indeed improved, levels of protection.

There is a growing recognition that there is a need to increase the protection of features outside of MPAs. One method of achieving this was recently employed by the Scottish Government. It adopted a list of 81 Priority Marine Features (Wilding et al., 2016.). To produce the list, species and habitats on existing conservation schedules were assessed against criteria that considered: the abundance/extent of the feature, its conservation status (threatened, in decline, etc.) and the functional role that the feature plays. The list will be used to: focus future conservation action and marine planning, direct research and education, and promote a consistent approach to marine nature conservation advice. The Scottish National Marine Plan states that 'Development and use of the marine environment must not result in significant impact on the national status of Priority Marine Features', thus conferring these features with additional protection (Scottish Government 2015b).

A focus on a feature-based approach is not without its problems, especially when this is extended across an MPA network. The requirement to provide timely and accurate conservation advice on features, their location and condition is resource intensive (Rush and Solandt, 2017). In England, for example, conservation advice packages for MPAs set out the protected features, the objectives for the site, the conditions of the features and the sensitivity of features to pressures exerted by different activities.

The need for integration

Co-location and space partitioning: considering displacement of activities

It is clear that competition for marine space is increasing. With this, the interactions and potential conflict between different activities and the marine environment is also increasing and is set to continue to do so. The drive to designate MPAs (especially those with higher protection classifications) results in the removal of marine space available for certain activities. If the area to be designated was identified separately from a wider MSP process, it is possible that the use of marine space may be suboptimal. It may have been the case that the desired protection could have been achieved through the designation of other areas that would have had a reduced impact on other activities. The suboptimal use of marine space may also work the other way, in that the planning of the MPA may not maximise conservation goals when concessions are being made to users to maintain their access to space and resources. Under this scenario, a decision to introduce either an MPA or an MPA network may require that the protection is introduced in such a way that existing activities are not, or are minimally, impacted. This approach may be taken for a variety of reasons – stakeholder support (or lack of it) for the process, strength of different stakeholder groups or political will. A lack of support for the MPAs may subsequently result in a lack of compliance with management measures.

It must be noted that the use of marine space need not be mutually exclusive (all MPAs within England, for example, are considered multiple-use sites) (Solandt, 2018). There are

many instances in which activities can either be co-located (both activities occur in the same location and at the same time) or managed to ensure that a different users of the same piece of marine space can be accommodated at different times of the year (Stelzenmüller et al., 2016; Yates et al., 2015; Hooper and Austen, 2014). The ability to co-locate activities and manage this process is potentially more difficult where there is a lack of a clear policy steer on which activity is to take precedence. In this situation, there is the danger that the engagement between differing stakeholders becomes adversarial rather than cooperative. Where activities cannot co-locate, two issues arise: (1) increased environmental impacts may result from a displaced activity (Vaughan, 2017) and (2) potential financial compensation for displacement of an activity may be raised.

The impacts resulting from fishing effort displacement have been considered within fisheries management, but the displacement of fishing and other activities is rarely considered in MPA planning in depth. McLeod (2014) defined displacement as: 'the changes in fishing behaviour and patterns that could occur in response to new management measures'. Changes in fishing behaviour could be 'the adoption of a new fishing method, or target species, or stopping fishing', whereas changes in fishing pattern could be 'moving to other fishing grounds near or far'. It is likely that activities (that exert pressures on the marine environment) other than fishing that are displaced from an area through competition for marine space, or in response to explicit MSP measures, potentially expose protected species and habitats to new, or additional, pressures within MPAs and also the wider seas. This mirrors the fishing effort displacement threat (Vaughan, 2017; ABPmer, 2017). Recognising that MSP may lead to the displacement of activities enables a strategic view to be taken on how best to avoid, minimise, mitigate or compensate for the impacts of displaced activities on protected species, habitats and the wider environment. However, assessing and managing the cumulative impacts of human activities on the environment remains a major challenge to sustainable development (Willsteed et al., 2017).

To ensure that co-location is effective, significant efforts must be expended ensuring that different marine space users are engaged in meaningful and timely dialogue so that their needs are understood and are accommodated as far as possible (Hooper and Austen, 2014; Vaughan, 2017; Gray et al., 2005). In the case of offshore renewable energy, this may involve the use of fisheries liaison officers employed by developers.

Where multiple activities seek to operate in the same marine space, this may result in the displacement of fishing activities either voluntarily or involuntarily. In the Netherlands, for example, fishers are excluded from fishing within offshore windfarms, yet in the UK, restrictions on fishers may be limited to construction phases of the development. While not prohibited from fishing within windfarms once they are operational, some fishers may not wish to continue fishing within windfarms due to safety concerns or a requirement to incorporate differing fishing patterns or gear types, and therefore they look to operate elsewhere (Christie et al., 2014; Hooper et al., 2015; Mackinson et al., 2006).

The development of comprehensive data layers to inform MSP can aid discussions on co-location and also compensation payments (e.g. between fishers and offshore wind developers), as these can provide a robust and third party evidence base, i.e. information on how and when fishing vessels use marine space, derived through satellite vessel monitoring systems (Campbell et al., 2014), as well as verified catch and landing data that can be linked

back to sea areas, e.g. International Council for the Exploration of the Seas statistical rectangles.

Marine plans that have high levels of spatial specificity within them bring to the fore the issues of equity, justice and power. Consideration of compensation for those individuals whose activities may be altered as a result of policy decisions may also be required. These issues have been considered extensively in the context of MPAs (Jones, 2009), yet they are likely to increasingly occur outside of MPAs as demand for marine space increases.

MSP is developing as a management tool, and there is increasing interest in exploring how proactive co-location of offshore developments and protected areas can develop (Yates et al., 2015; Christie et al., 2014; Ashley et al., 2014). However, developers have significant concerns, as to date they have sought to actively avoid, where possible, interactions with the MPA network. This interaction can increase development costs, time scales (project inception to operation) and the general regulatory burden, whereby marine users need to demonstrate that they are not having an adverse impact on the protected species or habitats of the MPA. In many cases, this requirement is ongoing. There is also the concern that declines in the conservation status of protected species or habitats within MPAs that are co-located with developments may therefore require action to be taken on behalf of the developer to curtail their activity, therefore placing investment returns at risk (Christie et al., 2014).

Political imperative

Santos states that 'large investments in MSP around the world have resulted in many planning processes that have not been implemented, or will likely not be implemented, because of resource constraints or sociopolitical and "realpolitik" factors' (Santos et al., 2019).

Managing the need for marine space and the conflict that is sometimes generated by competing or incompatible interests requires decisions to be made on how that marine space should be used. It is usually the case that different marine sectors are managed by differing regulators with departments or ministries for shipping, defence, environment, fisheries, coastal resources, protected areas and energy (Lloyd et al., 2011). In these situations, there is the danger of considering the activities under the remit of these regulators in isolation. Regulators are assessed on their performance in managing activities under their responsibilities by government and also stakeholders. As such, these regulators have little to gain by stepping back and taking a view on the wider use of marine space as this may result in difficult decisions to be taken and implemented. It may also result in regulators ceding their power to other departments or ministries. MSP provides both a mechanism and outputs that can encourage and compel a more holistic approach to the use and management of marine space than could or would otherwise be taken by individual regulators acting alone. Where plans are not sufficiently spatially prescriptive and rely on overarching policy statements that do not explicitly set out winners and losers, regulators can make decisions in accordance with the plan, but this may not represent the best use (depending on your perspective) of that marine space.

Unless there is a significant push for an integrated approach to MSP from the outset, without potential changes to a nation's marine governance arrangements to facilitate this (such as the development of an overarching maritime regulator), it is likely that marine plans

will be initially developed with non-spatial, sectoral polices prevalent. Where policies are not spatially explicit enough and apply to significant proportions of the area covered by the marine plan, the policies may lack value in that they do not aid decision-makers. Furthermore, unless there is integration of these policies and their coverage, these policies may either compete with each other or be so broad in scope and interpretation that prioritisation of marine space for certain activities does not occur. Ultimately, it is likely that MSP will require a political process that leads to the allocation of sea space to meet social, ecological and economic objectives (Qiu and Jones, 2013) to resolve conflicts through prioritisation and prescriptive policies (Sander, 2018).

Conclusions

Although the two disciplines of marine management embodied by MPA planning and MSP are distinct, each is focused on how we allocate and use our marine space. Practitioners in these disciplines will naturally have different marine management goals, and will seek to achieve these goals using their experience, skills and knowledge. Yet, these professionals will invariably liaise with the same stakeholder groups. This can be confusing for stakeholders and therefore lead to suboptimal outcomes because of stakeholder fatigue and lack of engagement, especially where there is a lack of clarity on the problems practitioners are trying to be solve, over what time frames and what the outputs will be from either process.

For MSP, marine protection is but one of the key drivers, and may not be the main driver, whereas with MPA management and designation, marine protection is the key driver. Because of this, understanding the aims and objectives of those working on MPAs and MSP is important when considering how best environmental benefits can be secured through collaborative working. This is important because working in an interdisciplinary manner is required if publicly acceptable and effective marine management is to be introduced that will provide the long-term protection and enhancement of the marine environment. We do not have a blank piece of paper when drawing up MPAs and/or undertaking MSP within marine space. Developers such as those engaged in aggregate dredging may view MPAs as a restriction on their existing or future activities, whereas conservationists may view current aggregate dredging sites or leases as a constraint when seeking to locate an MPA.

The act of designating MPAs has the effect of displacing and condensing marine developments and activities in the remaining marine space, which has the potential to increase stakeholder conflict. Designating MPAs may have the unintended effect of weakening management in areas outside of MPAs, by lending credence to the view that the remainder of marine space can now be developed with limited oversight. Yet it is vitally important to ensure that the wider marine space is managed so that it is not degraded and thus fails to provide important ecological services and MPA connectivity. MPA designation continues across the globe; continued designation of these sites is important as they play a key role in protecting core areas of conservation benefit. However, there is the danger that human impacts in general and in particular marine use and the impacts from this use, continue to increase, and therefore lead to the degradation of these MPAs. The risk therefore is that once designated, we expend a disproportional amount of management resources trying to manage change within MPAs and MPA networks at a local scale when we need to be taking a broader

view and ensuring that impacts in the wider environment are understood and addressed – in essence, where should we deploy our limited management resources for best effect? Recognising that MPAs might be best treated as one part of a unified conservation strategy means that MSP needs to be harnessed to create better, more durable MPAs. Conversely, incorporating MPA planning into MSP can reduce conflict for marine space through optimisation of that space.

There is real potential for MSP to provide the mechanism for driving change in the protection and use of the marine environment as our global understanding of the marine environment, its importance and its interconnectedness develops. This is because marine plans generally have: (a) spatial elements that identify how marine space is currently used and could be used in the future; and (b) a requirement to update the plans in terms of not only how marine space is being used and is anticipated to be used, but also how the marine environment has changed or is likely to change. These requirements enable plans to be updated to reflect the economic, environmental, social and political requirements at any particular time. When MPAs that are located within a marine plan undergo assessment as to their effectiveness, a decision can be taken when updating the plan to reflect recommendations from this assessment where appropriate. Similarly, MSP may highlight that marine use is evolving in a manner such that additional measures may be required within MPAs, or indeed that marine use is changing such that existing measures are no longer appropriate. Marine plans are likely to evolve slowly because the process to develop, agree, adopt, implement and review them is generally lengthy, resource intensive and iterative. Thus, plans provide the users of marine space with some degree of certainty regarding their use of that space.

The demand for marine space and the impacts on the marine environment continue to increase. This requires the increased proactive consideration of these demands. MSP provides a mechanism to take forward stakeholder/societal discussions on what appropriate use and protection of the marine environment should be, at both a micro and a macro level. Regardless of the level considered, managing marine space is complicated, and often the responsibility for doing this is shared across different governmental regulators and advisers at a local or regional level, and across different governments and global institutions at a macro level. MSP, by its very nature, requires, encourages and/or compels these different bodies to share information and their vision on how marine space should be used, which should enable a view to be developed (locally, regionally, nationally and internationally) that also sets out how the marine environment should be protected and enhanced over the short, medium and long term. It is clear that MPAs and MSP are both key elements required to achieve this vision.

Disclaimer

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