Ecosystem-Based Integrated Ocean Management:

A Framework for Sustainable Ocean Economy Development

A report for WWF-Norway by GRID-Arendal
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Foreword by WWF-Norway

The pressure on nature from climate change and human activity has never been greater. We have lost a staggering 60% of life on the planet in only the last 50 years and these trends show no sign of abating. 60% of fish stocks are fully exploited and 33% are overfished. Coral reefs, which cover 0.1% of the ocean and have 25% of all marine species depending on them, are severely threatened by a warmer and more acidic ocean. Deep sea mining, should it be permitted, would pose an additional threat to an already stressed ocean. World-wide, billions of people rely on the ocean to sustain themselves and their communities. Considering the current state of ocean decline, further exploitation of natural resources without implementation of an ecosystem approach to marine management, will continue to undermine the health and resilience of our ocean as well as all who depend upon it. The identification of systems and solutions to avoid collapse of our marine ecosystems are urgently needed; securing a sustainable ocean economy, or blue economy is our collective challenge.

The good news is that working to achieve a sustainable ocean-, or sustainable blue economy, can contribute a large piece of the puzzle of turning the tide and building the resilience of our ocean as well as the communities who are dependent upon it. WWF and partners define a sustainable blue economy as one that: provides social and economic benefits for current and future generations, by contributing to food security, poverty eradication, livelihoods, income, employment, health, safety, equity, and political stability. Such an economy restores, protects, and maintains the diversity, productivity, resilience, core functions, and intrinsic value of marine ecosystems – the natural capital upon which prosperity depends. A sustainable ocean economy or blue economy, is based on clean technologies, renewable energy, and circular material flows to secure economic and social stability over time, while keeping within the limits of one planet.

When working toward a sustainable ocean-, or sustainable blue economy, Ecosystem-Based Integrated Ocean Management (EB-IOM) provides the fundamental framework. Applying the ecosystem approach to managing ocean use must be at the heart of policy making and practice. It means to manage our combined effects on ecosystems so that they can continue to provide for themselves and for us. It provides a framework for decision makers and practitioners to help manage activities within the capacity of our natural world, from local to global scales. As ecosystems are constantly changing in response to human pressures and climate change, EB-IOM processes must be iterative, adaptive and empowered to make changes to the management of all human activities that affect the ocean.

Extensive knowledge about nature, ecosystems and the ocean is available, however there are still significant gaps. Improving our knowledge is therefore paramount. Lack of knowledge is often used as an argument against conservation measures, and conservationists are often left with the burden of evidence to prove negative effects on the environment. Considering the state of the planet, this needs to be turned upside down: if we cannot assess the state and vulnerability of natural resources and potential effects on them before human activity is initiated, there is no basis to permit the activity. The application of the Precautionary Approach is an essential aspect of EB-IOM.

WWF is pushing on all fronts for a healthy ocean for the benefit of people and nature. We hope this report can contribute to clarify good ocean management, providing the tools needed to manage ocean space holistically and sustainably. Based on this report and others, WWF will proceed to create a set of recommendations and principles on how to accomplish this goal, which is vital for sustainable development and the wellbeing of nature and people. We have no time to lose, but we are of the firm belief that a healthy ocean is achievable when the ecosystems and the people who depend upon it, are placed at the core and centre of everything we do.

Karoline Andaur
CEO, WWF-Norway

Foreword by GRID-Arendal

In this era of the Anthropocene, the global ocean is under unprecedented stress. It is accumulating the waste products of a global throwaway consumer economy at a time that the unfolding climate emergency is driving ecosystem changes at a scale that is only just beginning to be understood. Meanwhile, direct demand for ocean space and resources is increasing as the drive for economic growth continues unabated across the world. Ocean managers (those who manage human activities at sea) are tasked with the development of a sustainable ocean economy that will provide people worldwide with a fair share of ocean resources while also returning the ocean ecosystem to a healthy and thriving condition, thus ensuring its stability for the long term.

The task of ocean managers is, in essence, the collective challenge of humankind in the twenty-first century: creating an economy that meets human needs, justly and fairly, within planetary boundaries. A task of this scale requires a clear vision for a better future. Based on the idea by Kate Raworth (2017), this report calls for the sustainable ocean economy to be envisioned as a 'blue doughnut', the ecologically safe and socially just space between an outer circle representing ecosystem boundaries and an inner circle representing the wellbeing benchmarks every human deserves to have met. The image of the blue doughnut aims to reframe the conversation about the purpose of the blue economy of the future, shifting focus away from the pursuit of elusive 'sustainable blue growth' to goals that truly matter to humans and the planet we depend on.

In addition to a clear vision for the future, ocean managers also need a management approach suited to the scale of the task they face. This report provides a structured and well-researched orientation around Ecosystem-Based Integrated Ocean Management, a well-established and tested multidisciplinary approach with several decades' worth of associated literature. The report not only covers concepts and theory, but also aims to provide a tangible sense of the huge range of relevant practical tools available and the growing number of empirical case studies that lessons can be drawn from.

This report is relevant for anyone with an interest in ocean management, but above all, it is aimed at those with professional roles in the field: researchers, technical experts, managers, planners and decision makers within public sector bodies with an ocean or coastal management remit, as well as those working at non-governmental organizations (NGOs), at academic institutions and in private industry, all of whom have vital roles to play in building ocean economies in which people and nature can thrive.

Peter Harris
Managing Director, GRID-Arendal

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List of acronyms

ABNJ	Areas Beyond National Jurisdiction
BBNJ	Biodiversity Beyond National Jurisdiction
BCC	Benguela Current Commission
BMU	German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety
CBD	Convention on Biological Diversity
CZMAI	Coastal Zone Management Authority and Institute
DPSIR	Drivers, Pressures, State, Impacts, Response
DSS	Decision Support System
DST	Decision Support Tool
EB-IOM	Ecosystem-Based Integrated Ocean Management
EBM	Ecosystem-based Management
EBSA	Ecologically or Biologically Significant marine Areas
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ELI	Environmental Law Institute
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information System
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
GVA	Gross Value Added
ICZM	Integrated Coastal Zone Management
IMO	International Maritime Organization
InVEST	Integrated Valuation of Ecosystem Services and Trade-offs
IOC	Intergovernmental Oceanographic Commission

IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported, Unregulated
JNCC	Joint Nature Conservation Committee
MAP	Mediterranean Action Plan
MARISMA	Marine Spatial Management and Governance Programme
MCA	Multi-criteria Analysis
MPA	Marine Protected Area
MSP	Marine Spatial Planning
NEAFC	North East Atlantic Fisheries Commission
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
OECD	Organisation of Economic Co-operation and Development
PAME	Protection of the Arctic Marine Environment
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SLOSS	Single Large or Several Small
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
SNA	Social Network Analysis
SOME	State of the Marine Environment
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNITAR	United Nations Institute for Training and Research
WCMC	World Conservation Monitoring Centre
WWF	World Wide Fund for Nature

Executive summary

The global ocean is the largest ecosystem on the planet and is vital to the livelihoods, food security and wellbeing of billions. However, the cumulative impacts of human activities are increasingly degrading this ecosystem, while a drive for growth in maritime industries is leading to conflicts among sea users competing for ocean space and access to resources.

Ocean managers are faced with an urgent task: the development of a sustainable ocean economy that meets the United Nations Sustainable Development Goals (SDGs) and that occupies the safe and just operating space for humanity, which lies between planetary ecosystem boundaries and the social foundation of wellbeing benchmarks at which every human's needs for a healthy and fulfilling life are met. The wellbeing benefits of the ocean economy depend on a healthy global ocean ecosystem capable of sustainably providing ecosystem goods and services that range from food to energy and oxygen, and on balanced, fair and just access to ocean space and resources.

Ecosystem-Based Integrated Ocean Management (EB-IOM) provides a framework for a strategic governance approach that can help build a sustainable ocean economy. **This report defines EB-IOM as an adaptive approach for governing human activities at sea, rooted in the ecosystem approach**, **guided by the SDGs, with a strong focus on improving the ecological status of the ocean and on strategic integration across governance, knowledge and stakeholder silos.** It is a conglomerate of multiple concepts, including marine spatial planning (MSP), that share a focus on more holistic and strategic management, with ecosystem-based management (EBM) at its core.

Integration is central to EB-IOM, including horizontal integration across sectoral governance structures, vertical integration across multiple tiers of administration, as well as integration of stakeholders, multi- and transdisciplinary integration (bringing together multiple spheres of knowledge), and integration across geographical scales and jurisdictional boundaries. EB-IOM thereby provides a basis for the protection of the ocean ecosystem from unsustainable cumulative impacts caused by multiple maritime activities in different parts of the global ocean, as well as for the fair and balanced management of competition and conflicts between ocean users. This will benefit ocean ecosystems, the habitats and species within them, and humans who depend on them.

Another core element of EB-IOM is adaptive management, an approach for continuous improvement that, together with the precautionary principle, serves to iteratively develop, implement, evaluate and improve management measures, even in the context of uncertainties about the complex socio-ecological systems that are being managed. Ocean managers can draw from a plethora of practical tools and approaches at each stage of the adaptive management cycle. These include Strategic Environmental Assessments (SEAs) and economic impact assessments, decision support tools to develop future management scenarios, methods for characterizing and analysing conflicts relating to the use of marine space and practical approaches for managing those conflicts, as well as for designing effective and constructive stakeholder engagement processes and facilitating successful transdisciplinary collaboration.

The suggested EB-IOM implementation frameworks and related tools have been developed in reaction to empirical observations of ineffective and unsustainable current practices and outcomes, and are continuously being refined based on expert input from a growing number of disciplines. Their implementation in real-world planning faces a number of barriers, which range from historical data and knowledge gaps and resource limitations to a lack of political will, though these are increasingly being overcome, as demonstrated in a growing number of empirical case studies, some of which are showcased at the end of this report. Far from being a purely theoretical construct, EB-IOM is a well-established, living and evolving approach that can enable us to live within planetary ecosystem boundaries, backed by decades of research, with a multitude of practical tools, a global pool of expertise and an increasing amount of real-world experience. It is an approach whose time has come.

1. Introduction

1.1. About this report

This report examines and makes a case for Ecosystem-Based Integrated Ocean management (EB-IOM) as an instrument for developing a sustainable ocean economy. EB-IOM is defined here as **an adaptive approach for governing human activities at sea, rooted in the ecosystem approach, guided by the SDGs, with a strong focus on improving the ecological status of the ocean and on strategic integration across governance, knowledge and stakeholder silos.**

EB-IOM is a conglomerate of interrelated concepts and management approaches that complement and reinforce each other in many ways, including marine spatial planning (MSP), integrated coastal zone management (ICZM), adaptive management, and systematic conservation planning, among others. EB-IOM brings these together under the umbrella of the ecosystem approach or ecosystem-based management (EBM)[1], on the basis that a sustainable ocean economy can only flourish within ecosystem boundaries, and therefore has to be underpinned by the foundation of a healthy ocean ecosystem.

EBM has been discussed in environmental literature and by international environmental bodies for several decades (for example, see chapter 2 in UNEP GPA 2006). At the core of EBM is the recognition of the interconnectedness of ecosystems and of the place occupied by humans and human wellbeing within them. EBM is a holistic approach that requires managers to analyse and address cumulative impacts of multiple human activities on ecosystems, to understand resulting transboundary effects as well as medium-and long term ecosystem changes, and their knock-on effects on human wellbeing. EBM is generally framed as an adaptive learning process that integrates multiple governance bodies and stakeholders, as well as best available knowledge and science from multiple disciplines. Section 3 of this report examines the concept of EB-IOM in more detail, which includes further background on the overarching concept of EBM.

The remainder of this introduction provides a brief overview of the current state of the global ocean environment (illustrating how far it is from being in a healthy state) and outlines some of the shortcomings of current ocean management and governance practices, focusing on marine areas beyond national jurisdiction (ABNJ) as an illustrative example. In doing so, the introduction highlights some of the reasons **why** a change from the status quo of ocean management is needed.

Section 2 discusses **where** EB-IOM should take us by examining the concept of a sustainable ocean economy, focusing primarily on the SDGs as overarching strategic goals that should guide EB-IOM and building a rationale for how these should be organized and prioritized in line with the ecosystem approach.

The remaining sections of the report address the **what** and **how** of EB-IOM, moving from the conceptual and theoretical level to the applied and empirical level. Section 3 examines EB-IOM as a concept, beginning with the overarching idea of the ecosystem approach and EBM before delving into related ocean and coastal management concepts more specifically, then deconstructing the meaning of 'integration' in detail. Section 4 outlines the adaptive management cycle as an implementation framework for EB-IOM and describes some of the tools that practitioners can use to support different steps in the cycle. Section 5 examines EB-IOM in practice, discussing the challenges faced by practitioners in the real world, and presents a short summary of case studies that illustrate how elements of EB-IOM have been successfully implemented.

1.2. Why is a better approach to ocean management needed?

1.2.1. The state of the global ocean environment

The global ocean is the largest ecosystem on the planet. It is vital to the livelihoods and food security of billions, and to the economic prosperity of most countries (OECD 2016). However, there is increasing evidence that unsustainable human activities are degrading the global ocean ecosystem, thereby threatening the human wellbeing benefits it can provide, and undermining the foundation for the development of a healthy ocean economy.

Climate change is impacting the structure and function of marine ecosystems around the world, including through ocean acidification, increased frequency and intensity of marine heatwaves, rises in sea surface temperature, and a loss of oxygen from waters up to a depth of 1,000 m (IPCC 2019). Erosion from sea level rise and an increased frequency of severe weather events are leading to

1 Arguably, 'ecosystem approach' refers to a concept, while 'ecosystem-based management' refers to the process of its implementation. In practice, however, the two terms are used interchangeably and effectively mean the same thing (UNEP 2011, p.11, PAME 2014, Long et al. 2015).

the loss of coastal habitats, and are also posing a serious threat to human coastal communities (Hoegh-Guldberg & Bruno 2010, IPCC 2019).

Climate change impacts are indirect effects of atmospheric pollution on the ocean. There are also direct pollution impacts, with marine litter (plastic, in particular) having become a prominent issue in recent years. Most ocean plastic originates from land, though lost or discarded fishing gear also forms a substantial contribution (Fabres et al. 2016). Chemical pollution is further impacting the ocean. Oil spills have been making headlines for half a century, and the negative impacts of diffuse oil pollution from shipping and the marine petrochemicals industry (which have been well-studied for the same amount of time) continue to be a challenge for marine planners today (Barale & Gade 2014, Blumer 1969, Chang et al. 2014). It has also been apparent for decades that nutrients in agricultural run-off and sewage can cause eutrophication and anoxic 'dead zones', especially in shallow coastal areas and enclosed seas (Diaz et al. 2008, Meier et al. 2019, Nixon 1995, Wang et al. 2016). Other pollutants include pesticides in agricultural run-off (Elias et al. 2018), antifoulants (Amara et al. 2018) and an array of chemicals from mining activities (Vogt & Skei 2018).

Noise pollution from marine traffic, construction work and seismic surveys is an ongoing management challenge due to its serious impacts on marine mammals and other organisms (Williams et al. 2015). The accidental transportation of marine organisms across the globe in ships' ballast water is also severely impacting some ecosystems, due to the introduction of non-native species (Bailey 2015). The impacts of marine light pollution (from lights on shorelines and ships, as well as lights used in some fisheries) are only beginning to be explored (Davies et al. 2014).

The most significant direct impact that humans have on the ocean, however, is through unsustainable fishing, from legal but inadequately managed fishing to illegal, unreported and unregulated (IUU) fishing (Interpol 2014). The latter occurs in the high seas and in waters within the jurisdiction of nations that either lack the capacity or the political will to implement and enforce effective and sustainable management measures. Global fishing activities are especially concentrated in shallow shelf seas, which are more productive and easier to access than deeper and more remote areas. However, deep-sea fisheries for certain species occur across the global ocean. It is estimated that 49–55% of the world's oceans are subject to intense fishing pressure, an area about four times the size of the global agricultural footprint (Amoroso et al. 2018, Kroodsma et al. 2018).

Overfishing around the globe has led to significant declines in fish populations and a collapse in many fish stocks, a loss of genetic diversity and changes to the size structure of fish populations, significant declines in catch per unit effort, declines in absolute catch sizes, a shift from food webs with abundant and diverse predators to food webs dominated by species at lower trophic levels ('fishing down the food web'), a loss of resilience of marine ecosystems to other perturbations, and fundamental shifts in the structure of whole ecosystems (Pauly 2007, Pauly et al. 1998, Pauly et al. 2005, Pauly & Maclean 2003, Pauly & Palomares 2005, Pauly & Zeller 2016, Worm et al. 2006, Worm et al. 2009, Worm 2016).

The ecosystem-level impacts of fishing are caused by the removal of target species and mortality of non-target species that are often discarded as by-catch (Zeller et al. 2018), as well as the physical destruction of seafloor habitat through bottom-towed fishing gear (Kaiser et al. 2006) and the use of explosives (Jennings & Polunin 1996, Slade & Kalangahe 2015). Impacts from bottom-towed fishing gear have been documented at depths of over 1,000 m (Clark et al. 2015, Hall-Spencer et al. 2002,) and can affect entire sea basins (Kaiser et al. 2000, Tillin et al. 2006).

Physical disturbance of seabed habitats is exacerbated by a range of other activities that involve the construction of physical infrastructure (offshore oil and gas infrastructure, submarine cables and pipelines, renewable energy infrastructure, aquaculture installations, and coastal infrastructure ranging from ports and marinas to groynes, jetties and seawalls), dredging and removal of seabed sediments (to maintain the depth of shipping channels or to mine aggregates) or disposal of material (such as dredged material from elsewhere) on the seabed. In future, the impacts of mining the deep seabed for rare earth minerals may pose a significant additional threat to ocean biodiversity (Niner et al. 2018).

Thus, the widespread impacts of climate change are layered on top of the impacts of overfishing, direct pollution and physical damage, cumulatively threatening the integrity of the structure and function of marine ecosystems around the world, even posing existential threats to some, such as coral reefs (IPCC 2019). These cumulative impacts of human activities on the global ocean are geographically widespread (Halpern et al. 2015) (Figure 1)

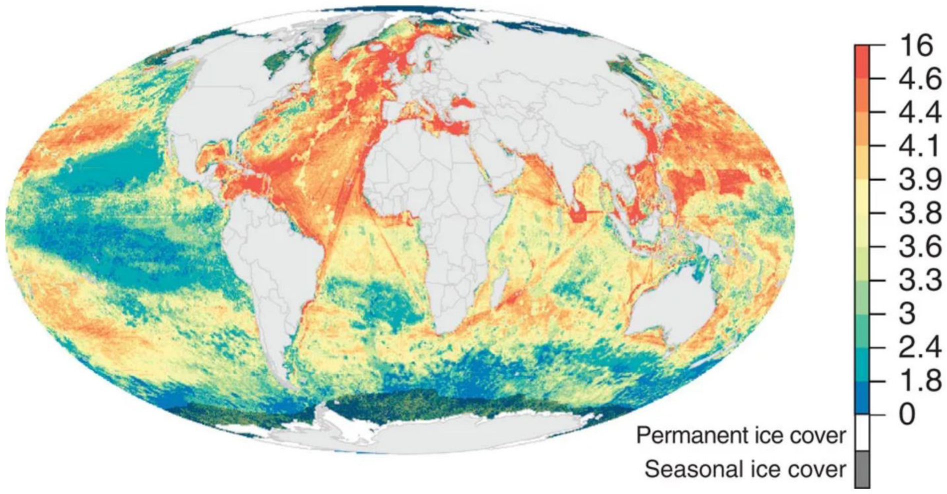


Figure 1. Global cumulative impacts on the world's ocean.
Red indicates the highest level of cumulative human impacts.
Source: Halpern et al. 2015.

1.2.2. Shortcomings in the status quo of ocean management

Ocean management focuses primarily on the management of human activities in, on and under seawater, i.e. on who can do what, where, how and when at sea[2]. Broadly, these activities encompass[3]:

1) Commercial fishing, which includes legal fishing as well as IUU fishing
2) Shipping (transport of goods and passengers)
3) Activities relating to surveys and site exploration, construction, use, maintenance, and decommissioning of marine energy production installations (oil/gas, marine renewables)
4) Aquaculture,
5) Recreational activities, including extractive (recreational fishing) and non-extractive (recreational boating, scuba diving, etc.) activities
6) Seabed mining (marine aggregates, and, in the future, potential deep-sea mining for a range of rare earth metals)
7) Activities relating to surveys, installation and maintenance of submarine cables
8) Military activities
9) Activities relating to the construction, maintenance and decommissioning of necessary infrastructure for supporting any of the above (ports and marinas, shipping channels, etc.).

The management of these activities often lacks a strategic approach. Governance tends to be siloed, with different laws and governing bodies each managing activities in a specific sector, without always considering the impacts of management decisions on other sea users or adequately managing cumulative impacts on the ecosystem. Similarly, conservation legislation has often focused on individual species or particular habitat types without adequately safeguarding the wider ecosystem. This piecemeal approach has contributed to environmental degradation, overexploitation of marine resources, and conflicts between marine users. This is true at multiple scales and in different geographical areas, with many highlighting the need for more integrated approaches (Arbo & Thủy 2016, Douvere 2007, Ehler & Douvere 2007, Ehler & Douvere 2008, Grip 2017, Schupp et al. 2019).

The governance landscape in marine areas beyond national jurisdiction (ABNJ) illustrates the issue. The United Nations Convention on the Law of the Sea (UNCLOS) provides an overarching legal framework for global ocean governance, though it does not provide a mechanism for the coordinated management of all human activities, nor does it fully address conservation and sustainable use of the ocean's ecosystems (Ban et al. 2014). The institutional landscape governing human activities in marine ABNJ is both complex and fragmented, involving a plethora of multilateral agreements and

2 Ocean management also includes direct manipulation of the environment to improve its ecological condition, for example, ocean clean-ups or coastal habitat restoration. Ocean clean-ups tend to be costly and/or technically and logistically challenging, with their effectiveness disputed. Habitat restoration (for example, of coral reefs) tends to be restricted to shallow, easily accessible coastal areas, and is not feasible in deep sea environments. This may change in future, but for now, the main focus of ocean management is on managing maritime activities.

3 There is no single, globally applicable classification of marine activities because they can be grouped in different ways. For example, sea angling is a type of fishery, but it is also a recreational pursuit like scuba diving and recreational boating. Depending on the purpose of a given study, it may be preferable to group all marine recreational uses together (for example, when assessing the contribution of marine activities to a local tourism economy), or it may be more important to differentiate between extractive and non-extractive activities (for example, when assessing the impacts of marine activities on local ecosystems).

related management bodies that have a mandate to manage specific types of activity, or promote measures to protect particular groups of species, some operating at a global scale and others at a regional scale (UNEP WCMC 2017, Durussel et al. 2018, UNEP WCMC 2017).

The governance silos that exist for ABNJ are replicated at national scales (for waters that fall under the jurisdiction of states), where different ministries govern transport, energy, tourism, food production (including aquaculture and fisheries) and environmental protection, often with a lack of cross-ministerial mechanisms for coordination with respect to marine activities. The equivalent is often true at the subnational level (state, province, municipality). Legal frameworks governing jurisdictional waters can also lack coherence, sometimes containing multiple layers with competing, overlapping or contradictory elements (Boyes & Elliott 2014, Qiu & Jones 2013).

This lack of governance integration means that there can be a lack of effective mechanisms for addressing cumulative impacts on the environment or for implementing conservation measures that cut across multiple sectors. It also means a lack of effective mechanisms for addressing user-user conflicts which arise in a multitude of contexts and between a wide variety of users, especially when some users are granted exclusive use of marine areas (Ackah-Baidoo 2013, Arbo & Thủy 2016, Bonnevie et al. 2019, Lieberknecht et al. 2016, Röckmann et al. 2015, Schupp et al. 2019, Tuda et al. 2014). Rather than existing as isolated binary conflicts, user-user conflicts interact with each other, creating indirect knock-on effects that are not always easy to predict (Röckmann et al. 2015). Without better integration in ocean management, user-user conflicts and user-environment conflicts are almost guaranteed to be exacerbated as demands for ocean space and ocean resources increase.

The need for better integration mechanisms is increasingly being recognized, both to better manage user-user conflicts and to improve environmental management. In the case of ABNJ, at the time of writing this report, the Intergovernmental Conference to negotiate a new legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ Conference) had met for its third session. In agreeing to negotiate a new legally binding instrument for biodiversity beyond national jurisdiction (BBNJ), states have recognized the problem of fragmentation and gaps in existing arrangements for managing ocean space and resources in ABNJ and are committed to changing the status quo (UNGA 2015).

The new BBNJ instrument is expected to create enhanced cooperation mechanisms that will facilitate better integration of decision-making by states, regional and global sectoral bodies, and existing biodiversity agreements. If a robust enough treaty text is finally adopted, this may mean the internationalization of Environmental Impact Assessments (EIAs), the routine use of Strategic Environmental Assessments (SEAs) (section 4.2.3) and the systematic use of area-based management tools, including marine protected areas (MPAs), to ensure the conservation and sustainable use of biodiversity in ABNJ. This represents an opportunity to move from a fragmented and sector-based ocean management approach towards EB-IOM and to help break down governance silos, better manage cumulative impacts, reduce conflicts between sea users, conserve biodiversity and improve the overall state of the marine environment.

2. Where to? A vision for a sustainable ocean economy

2.1. About this section

The introduction stated that EBM is centred on ecosystem health and the interconnected ways in which humans impact on it and human wellbeing is linked to it. This means that EB-IOM intrinsically places priority on a healthy ecosystem and on human wellbeing as its desired outcomes, with the latter recognized as being dependent on the former. This report goes a step further in proposing EB-IOM as an approach to help create a sustainable ocean economy. This section reflects on how to define what that is, and on how it relates to the goals that are intrinsic to EB-IOM.

This section therefore begins by briefly examining what is meant by ocean economy, before moving on to the concept of sustainability. A comprehensive discussion of this vast topic is beyond the scope of this document, so the focus is placed on strategic sustainability goals, specifically on the global SDGs, their relevance to the ocean economy and how they should be prioritized to deliver wellbeing within ecosystem boundaries. The result is a comprehensive vision of the strategic priorities that should characterize a sustainable ocean economy, in other words, a high-level vision of where we should go, before subsequent sections of the report delve into the concept and process of EB-IOM as a means to make the vision a reality.

2.2. The ocean economy

The term ocean economy generally encompasses marine activities as well as land-based activities that support or derive benefits from them (Park et al. 2014). This includes upstream services (for example, boat yards, suppliers of materials and equipment, technical and scientific consultancy services, relevant higher education, etc.), downstream industries (for example, fish and aquaculture processing and product retail, construction industries using marine aggregates, etc.) and services highly linked with marine activities (such as hotels and restaurants in dive resorts). The ocean economy is therefore embedded within wider local, national, regional and global economies. Depending on how many steps along supply and value chains are considered, it can extend far inland (Weig & Schultz-Zehden 2019).

Different assessments draw the boundaries of the ocean economy in different ways. This makes it difficult to draw direct comparisons between assessments of the ocean economies of different countries or regions, or to scale up from national to regional and global assessments (OECD 2016, Park et al. 2014). The global assessments that do exist, however, illustrate the ocean's global economic importance. Hoegh-Guldberg et al. (2015) estimate the value of the global ocean asset base at $24 trillion, and the annual global gross marine product at $2.5 trillion. The OECD (2016) estimates that ocean-based industries (including offshore energy industries) contributed $1.5 trillion to annual global gross value added (GVA) in 2010 and accounted for 31 million jobs (1.5% of the global workforce). By 2030 the authors project that the ocean economy has much greater potential for growth than the global economy as a whole, and that it could more than double its contribution to global GVA.

The ocean economy also encompasses values and benefits that are not directly related to money-generating activities (Hoegh-Guldberg 2015, OECD 2016), such as the production of oxygen by ocean organisms and the climate-regulating functions of the ocean, as well as a wide range of cultural, spiritual and health benefits for humans. These intangible elements of the ocean economy can be difficult to quantify in terms of monetary value (though there are methods to do so; see section 4.3.5 on ecosystem services valuation). As a result, they are often not adequately incorporated into headline figures about the overall ocean economy, despite including some of its aspects that matter the most to human beings: half the oxygen in the earth's atmosphere is produced by oceanic phytoplankton (Behrenfeld et al. 2001, Field et al. 1998). In this sense, the ocean economy is literally vital to humans and ensuring its sustainability is a matter of survival.

2.3. The Sustainable Development Goals and a sustainable ocean economy

Sustainability generally refers to the persistent and long-term safeguarding of value, benefits and wellbeing in three spheres: economic, ecological, and social. In 2015, the United Nations General Assembly set 17 global SDGs, each broken into a series of targets and indicators, to be met by 2030 (see Figure 2). The SDGs represent the culmination of a process that began with the Brundtland Report (Brundtland 1987), the formulation of Agenda 21 at the 1992 Rio Summit, the Johannesburg Plan of Implementation at the 2002 World Summit on Sustainable Development (Rio+10) (Johannesburg 2002) and "The Future We Want" outcome document at the 2012 United Nations Conference on Sustainable Development (Rio+20) in Rio de Janeiro. The goals represent an internationally agreed definition of global sustainability that spans the environmental, social, and economic spheres and is granular enough to be a useful framework for definitions at finer scales.

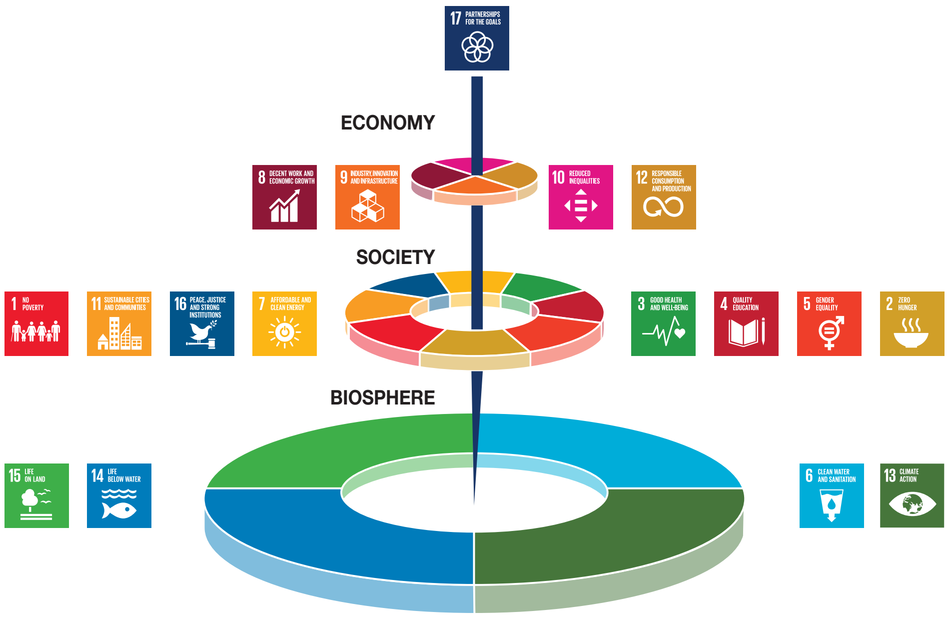
Figure 2. The 17 United Nations Sustainable Development Goals.
Source: United Nations

Ocean managers tend to focus on SDG 14, which has the most direct link with the ocean (Wright et al. 2017). However, in addition to safeguarding ecosystem health, a truly sustainable ocean economy is one that reduces poverty and hunger (e.g. by providing food from the ocean and income from jobs related to marine activities), improves health and wellbeing (e.g. by providing opportunities for recreation in clean and healthy coastal and ocean environments), provides educational opportunities, clean energy from marine renewables, ensures equal access to these benefits for both men and women, as well as people from different social backgrounds, etc.: to fully define a sustainable ocean economy, every SDG is relevant. This presents ocean managers with a challenge: if all SDGs are relevant to a sustainable ocean economy, where should the priorities lie?

Historically, it was sometimes argued that values in the different spheres of sustainability can be traded off against each other freely, as long as net benefits are maximised (the weak sustainability paradigm, as summarized in Dietz & Neumayer 2007 and Neumayer 2003, pp. 1–2). If applied to the SDGs, this would mean regarding them as independent and mutually interchangeable, with gains in any one SDG compensating for losses or lack of progress in any other. However, this would fail to recognize that human societies and economies depend on healthy ecosystems and the ecosystem services they provide. As an absolute minimum, the life support functions of the natural environment must be regarded as entirely non-substitutable, since their loss makes the creation of a sustainable economy impossible (Dietz & Neumayer 2007).

Protecting nature matters in its own right, and also because our wellbeing depends on it. Breaching ecosystem boundaries will destabilize natural systems to the point that it will undermine the foundation of social and economic systems. The development of sustainable economies therefore depends on recognizing multiple ways in which human wellbeing is interlinked with ecosystem health, and how the SDGs are linked and dependent upon each other (Nilsson et al. 2016, Miola et al. 2019). For example, SDG 14 – the ocean SDG – depends in part on SDG 13 (effective climate action will reduce climate change impacts on the ocean ecosystem), and SDG 6 and SDG 15 (improved sanitation and effective protection of terrestrial habitats both reduce pollution of waterways that flow into the ocean). In turn, SDG 14 positively supports every other SDG, including those that fall into the social and economic spheres (Singh et al. 2018). WWF (2020) shows that 38% of all interrelationships between SDGs are positive links between SDG 14 and other goals, with SDG 1 and SDG 2 (no poverty and zero hunger) particularly strongly linked to ocean health: human wellbeing is intertwined with a healthy ocean.

Instead of visually representing the SDGs as separate boxes arranged alongside each other as equals (Figure 2), it would therefore arguably be better to arrange them in three tiers (Figure 3), as suggested by Rockström and Sukhdef (2016). In this representation, the environmental SDGs form a joined (interlinked) circle as the foundation for achieving social goals (represented as a joined circle in the middle tier). These, in turn, form the foundation for economic goals (the top tier). The ecosystem approach inherently recognizes system-scale interlinkages and the dependence of human wellbeing on healthy ecosystems that is reflected in this representation of the SDGs, underlining the relevance of EB-IOM as a strategic approach for building a sustainable ocean economy.



Source: Rockström and Sukhdev (2016).

Figure 3. The "wedding cake" illustration of the SDGs.

Four environmental SDGs form the bottom tier, eight social SDGs form the middle tier and four economic SDGs form the top tier: A healthy economy is built on a healthy society, which in turn is built on a healthy ecosystem. This illustration represents the fact that a healthy ecosystem is a necessary and non-substitutable foundation for achieving goals in the social and economic realms. SDG 17, which relates to building partnerships for achieving all other SDGs, runs through the three tiers. Adapted from an illustration created by Azote for the Stockholm Resilience Centre, Stockholm University, based on Rockström & Sukhdev (2016).

2.4. From blue growth to the blue doughnut

For the past decades, the central goal of economic policy around the world has been economic growth, with GDP (or GVA) used as a measure of economic success at local, national, and regional scales. However, economic models that allow growth to continue in perpetuity depend on the weak sustainability paradigm critiqued in the previous section (Dietz & Neumayer 2007). Once it is acknowledged that humans are dependent on healthy ecosystems and that these ecosystems have boundaries, an obvious question emerges, debated since "The Limits of Growth" (Meadows et al. 1972): is it possible to achieve perpetual economic growth within a bounded natural system?

To some extent, growth can be decoupled from concurrent increases in resource use and environmental impacts. Technological innovations can increase energy and material use efficiency, and circular economy approaches can maximize the re-use of products and recycling of materials, for example. As a result, qualified phrases such as 'green growth' and 'sustainable growth' (or the marine equivalent, 'blue growth') are gaining traction in the economic development discourse (Ward et al. 2016). However, while technological innovations and circular flows should be central to the creation of sustainable economies, it is questionable whether decoupling can be achieved to the extent that would be necessary to sustain growth while reducing cumulative impacts that are already transgressing ecosystem boundaries (Ghisellini et al. 2016, Næss & Høyer 2009, Steffen et al. 2015, Ward et al. 2016).

A much more fundamental question is: do we need perpetual economic growth for humans and the planet to thrive? Growth of what, exactly? For whom? The economic narratives that cast growth as a necessary driver and guarantor of human wellbeing and nature conservation are increasingly being questioned (Felber 2015, Raworth

2017). While the period of global economic growth over the past half century has undeniably coincided with the creation of unprecedented levels of wealth and the lifting of millions out of poverty, increasing life expectancies and greatly expanding access to nutrition, sanitation, healthcare, education, and consumer goods around the globe, these achievements have not been spread fairly (millions still live in extreme poverty). Furthermore, these achievements have come at extreme environmental cost: the same period has witnessed unprecedented deterioration of the earth's natural systems. Several critical planetary boundaries are now being breached (Steffen et al. 2015), leaving us facing the existential threats of climate breakdown and mass biodiversity extinction. We have left the Holocene and entered the Anthropocene (Waters et al. 2016).

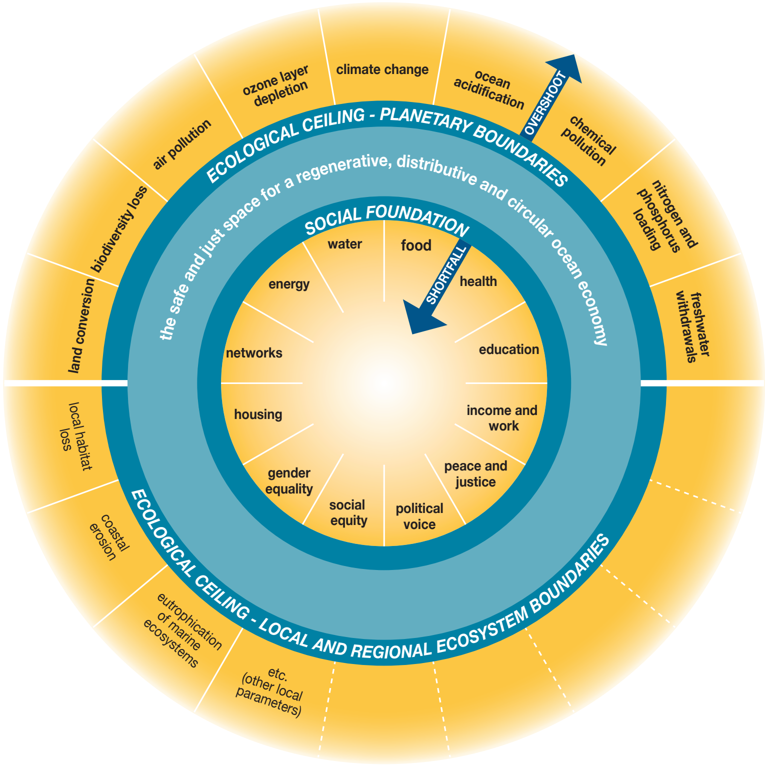
Sustainable development urgently requires us to re-frame and re-design our economies, including our ocean economies. Nevertheless, economic growth continues to be a central political goal that is shaping the research and the policies that are driving the development of ocean economies around the world. For example, blue growth has been anchored in European Union (EU) policy since 2012 (European Commission 2017, European Commission 2019), as well as in global ocean policy (FAO 2014, FAO 2015, FAO 2016).

EU research funding focused on blue growth has recently given rise to academic literature that goes as far as re-casting integrated ocean management and related concepts (such as MSP) mainly as vehicles for economic growth (Depellegrin et al. 2019, Klinger et al. 2018, Lillebø et al. 2017). Klinger et al. (2018), for example, frame integrated ocean management as a way to reduce user-user conflicts, capitalize on synergies between compatible economic activities, maximize efficient economic use of marine space and pursue opportunities for growth. The environment is described as an economic resource, and environmental degradation as "suboptimal natural resource use". This framing is starkly different from that of most ecosystem-based ocean management literature (cited throughout this report), in which integrated management concepts are conceived and framed primarily as approaches for safeguarding the environment and ensuring human wellbeing within safe ecological limits.

What emerges is a disconnect between two predominating narratives concerning what the main objectives of integrated ocean management should be, which go hand in hand with different narratives of what the ocean economy should be *for*. On the one hand, there is a "blue growth" narrative centred on growth as a driver of prosperity and a measure of economic success. On the other hand, there is an ecosystem-based narrative centred on a healthy environment. This emerging tension effectively pitches growth against nature conservation as competing central objectives, and attempts to bridge this tension by promoting "win-wins" for growth and the environment have been questioned (Chaigneau & Brown 2016). Meanwhile, it has been argued that the social sphere of sustainability has been receiving altogether insufficient attention in ocean management (Bennett 2019a, Bennett 2018).

It is therefore time to re-frame what a sustainable ocean economy should be, and to formulate a holistic range of strategic objectives that it should pursue. There are emerging new economic paradigms that can support this process, shifting the focus away from growth as a central objective in favour of a plurality of environmental, social, and human wellbeing objectives. The central aim of these new paradigms is to achieve a fair distribution of human wellbeing within ecosystem boundaries (Felber 2015, Raworth 2017, Rockström et al. 2009a, Rockström et al. 2009b).

Rockström et al. (2009a, 2009b) articulated this as the need for a "safe operating space for humanity", bounded on one side by social and wellbeing benchmarks below which no human should fall and on the other side by environmental boundaries that cannot be transgressed. Raworth (2017) describes this as "a safe and just space for humanity", using the visual metaphor of a doughnut with a hole at the centre: the outer edge of the doughnut represents the ecosystem ceiling, i.e. the planetary boundaries that the economy cannot overshoot, while the inner edge represents the social foundation, i.e. the wellbeing objectives that must be achieved to prevent people from falling into the hole (Figure 4).



Source: adapted from Raworth (2017).

Figure 4. The blue doughnut.

The figure illustrates the safe and just space for a sustainable ocean economy that is regenerative, distributive and circular. The inner boundary represents universally applicable wellbeing benchmarks that form the social foundation below which no human should fall. The outer boundary represents ecosystem boundaries that cannot be transgressed, with universally applicable planetary boundaries located along the top half, and local ecosystem boundaries (which need to be defined for each specific study area) illustrated with some examples along the bottom half. The activities comprising the ocean economy should contribute towards the social foundation (prioritising those parameters for which there are the most significant shortfalls in a given region) while safeguarding the local and planetary ecosystem boundaries. Figure adapted from Raworth (2017).

A sustainable ocean economy can thus be visualized as a 'blue doughnut' of safe and just space where people and the ocean ecosystem can thrive. Activities and investments that most directly address human wellbeing shortfalls within a given planning area should be prioritized (pulling people out of the hole or preventing them from falling in), along with those that most reduce contributions to existing planetary ecosystem boundary overshoots, that address or prevent local environmental degradation and that restore local ecosystems (particularly in heavily impacted coastal areas). This should include investments in resource-efficient technologies, distributive and regenerative activities, and circular material flows. In every investment or planning decision made, both edges of the doughnut must be considered. Framed this way, blue growth per se is neither good nor bad; rather, it shifts from being a central goal to a potential side effect of achieving the goals that really matter.

This vision of the blue doughnut represents the definition of a sustainable blue economy by WWF (2015, p.4), which encompasses a wide range of people-centred objectives and ecosystem goals:
"a sustainable blue economy is a marine-based economy that...

- Provides social and economic benefits for current and future generations, by contributing to food security, poverty eradication, livelihoods, income, employment, health, safety, equity, and political stability.
- Restores, protects and maintains the diversity, productivity, resilience, core functions, and intrinsic value of marine ecosystems – the natural capital upon which its prosperity depends.
- Is based on clean technologies, renewable energy, and circular material flows to secure economic and social stability over time, while keeping within the limits of one planet."

It also aligns with the WWF Sustainable Blue Economy Finance Principles[4,5] (see box 1), and the discussion of the previous section. Crucially, the blue doughnut fully encapsulates the intrinsic values of EBM: the outer edge represents the interlinked ecosystems that humans depend on, and the inner edge represents what is meant by human wellbeing. The blue doughnut thus represents a vision of where EB-IOM should take us. The remainder of this report will focus on what EB-IOM is and how it can get us there.

Box 1. WWF Sustainable Blue Economy Finance Principles

WE COMMIT TO APPLYING THE FOLLOWING PRINCIPLES ACROSS OUR PORTFOLIOS, REGARDLESS OF WHETHER WE ARE MAJORITY OR MINORITY INVESTORS.

1. **Protective:** We will support investments, activities and projects that take all possible measures to restore, protect or maintain the diversity, productivity, resilience, core functions, value and the overall health of marine ecosystems, as well as the livelihoods and communities dependent upon them.
2. **Compliant:** We will support investments, activities and projects that are compliant with international, regional, national legal and other relevant frameworks which underpin sustainable development and ocean health.
3. **Risk-aware:** We will endeavour to base our investment decisions on holistic and long-term assessments that account for economic, social and environmental values, quantified risks and systemic impacts and will adapt our decision-making processes and activities to reflect new knowledge of the potential risks, cumulative impacts and opportunities associated with our business activities.
4. **Systemic:** We will endeavour to identify the systemic and cumulative impacts of our investments, activities and projects across value chains.
5. **Inclusive**: We will support investments, activities and projects that include, support and enhance local livelihoods, and engage effectively with relevant stakeholders, identifying, responding to, and mitigating any issues arising from affected parties.
6. **Cooperative:** We will cooperate with other financial institutions and relevant stakeholders to promote and implement these principles through sharing of knowledge about the ocean, best practices for a sustainable Blue Economy, lessons learned, perspectives and ideas.
7. **Transparent**: We will make information available on our investments and their social, environmental and economic impacts (positive and negative), with due respect to confidentiality. We will endeavour to report on progress in terms of implementation of these Principles.
8. **Purposeful**: We will endeavour to direct investment to projects and activities that contribute directly to the achievement of Sustainable Development Goal 14 ("Conserve and sustainably use the oceans, seas and marine resources for sustainable development") and other Sustainable Development Goals especially those which contribute to good governance of the ocean.
9. **Impactful**: We will support investments, projects and activities that go beyond the avoidance of harm to provide social, environmental and economic benefits from our ocean for both current and future generations.
10. **Precautionary**: We will support investments, activities and projects in our ocean that have assessed the environmental and social risks and impacts of their activities based on sound scientific evidence. The precautionary principle will prevail, especially when scientific data is not available.
11. **Diversified**: Recognising the importance of small to medium enterprises in the Blue Economy, we will endeavour to diversify our investment instruments to reach a wider range of sustainable development projects, for example in traditional and non-traditional maritime sectors, and in small and large-scale projects.
12. **Solution-driven**: We will endeavour to direct investments to innovative commercial solutions to maritime issues (both land- and ocean-based), that have a positive impact on marine ecosystems and ocean-dependent livelihoods. We will work to identify and to foster the business case for such projects, and to encourage the spread of best practice thus developed.
13. **Partnering:** We will partner with public, private and non-government sector entities to accelerate progress towards a sustainable Blue Economy, including in the establishment and implementation of coastal and maritime spatial planning approaches.
14. **Science-led**: We will actively seek to develop knowledge and data on the potential risks and impacts associated with our investments, as well as encouraging sustainable investment opportunities in the Blue Economy. More broadly, we will endeavour to share scientific information and data on the marine environment.

4 https://www.wwf.org.uk/updates/sustainable-blue-economy-finance-principles

5 https://ec.europa.eu/maritimeaffairs/befp

3. What is Ecosystem-Based Integrated Ocean Management?

3.1. About this section

As highlighted in the introduction, EB-IOM is a conglomerate of approaches that complement and reinforce each other, including MSP, adaptive management, and systematic conservation planning, among others. Their shared characteristic is the ambition for more holistic, integrated and effective ocean and coastal management. EB-IOM brings these together under the umbrella of the ecosystem approach/EBM, emphasizing the need to respect ecosystem boundaries.

This section begins with a discussion of these umbrella terms and then defines a set of more specific, related ocean and coastal management concepts. The second part of this section deconstructs and examines the concept of 'integration', which runs through the core of EB-IOM, but often fails to be properly defined in the literature. This report proposes five categories of integration that are relevant for ocean management, and provides orientation on each one.

The main purpose of this section is to provide a conceptual examination of EB-IOM (the 'what'), while section 4 discusses its implementation (the 'how'). However, because the 'what' and the 'how' are often intertwined, it is not possible to completely separate them. As a result, there is a gradual shift in focus, rather than a clean break between these two sections.

3.2. The ecosystem approach and ecosystem-based management

The ecosystem approach/EBM[6] is a multifaceted concept that emerged in environmental literature in the 1970s, though its underpinning philosophies have been practised for millennia in many cultures (Long et al. 2015). At its core is the recognition that ecosystems and human wellbeing are interconnected. Human activities should therefore be managed to safeguard ecosystem integrity, through integrated approaches at ecological scales of time and space, while explicitly recognizing that ecosystems have boundaries that cannot be transgressed without destabilizing them. The concept gained significant traction in the 1990s when environmental conservation literature increasingly developed holistic principles and approaches for managing humans as part of ecosystems. Mangel et al. (1996), for example, encapsulated the principles of the ecosystem approach in all but name (box 2).

Box 2. Seven Principles for the Conservation of Wild Living Resources

1. Maintenance of healthy populations of wild living resources in perpetuity is inconsistent with unlimited growth of human consumption of and demand for those resources.
2. The goal of conservation should be to secure present and future options by maintaining biological diversity at genetic, species, population and ecosystem levels; as a general rule neither the resource nor other components of the ecosystem should be perturbed beyond natural boundaries of variation.
3. Assessment of the possible ecological and sociological effects of resource use should precede both proposed use and proposed restriction or expansion of ongoing use of a resource.
4. Regulation of the use of living resources must be based on understanding the structure and dynamics of the ecosystem of which the resource is a part and must take into account the ecological and sociological influences that directly and indirectly affect resource use.
5. The full range of knowledge and skills from the natural and social sciences must be brought to bear on conservation problems.
6. Effective conservation requires understanding and taking account of the motives, interests, and values of all users and stakeholders, but not by simply averaging their positions.
7. Effective conservation requires communication that is interactive, reciprocal, and continuous.

The ecosystem approach was formally adopted by the Convention on Biological Diversity (CBD) in 2000 (COP5, Decision V/6), defined in 12 principles (box 3[7]). Building on this definition, McLeod et al. (2005) define EBM as "an integrated approach to

6 As stated in the introduction, the terms 'ecosystem approach' and 'ecosystem-based management' or EBM are used interchangeably in the literature. They broadly refer to the same thing.

7 https://www.cbd.int/decision/cop/?id=7148

Box 3. The 12 principles of the ecosystem approach, as defined for the Convention on Biological Diversity (the Malawi Principles)

1. The objectives of management of land, water and living resources are a matter of societal choice.
2. Management should be decentralized to the lowest appropriate level.
3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
4. Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:
    a) Reduce those market distortions that adversely affect biological diversity;
    b) Align incentives to promote biodiversity conservation and sustainable use;
    c) Internalize costs and benefits in the given ecosystem to the extent feasible.
5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
6. Ecosystems must be managed within the limits to their functioning.
7. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
8. Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
9. Management must recognize that change is inevitable.
10. The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
11. The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

management that considers the entire ecosystem, including humans. The goal of [EBM] is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. [EBM] differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors." They further state that EBM "focuses on managing human activities, rather than deliberately manipulating or managing entire ecosystems".

Long et al. (2015) identified 15 key principles that are consistently mentioned in EBM definitions. Top among these were the consideration of ecosystem connections, management at spatial and temporal scales that are appropriate to ecosystems and ecosystem dynamics, adaptive management and a range of principles related to the different forms of integration outlined later in this section. Although there is broad agreement on these core principles, there are different perspectives on EBM's more detailed facets. Waylen et al. (2014) identified three clusters of interpretations that emphasize different aspects. The first cluster has an ecologically-centred perspective focused primarily on ecosystem conservation, with the second cluster centred more on addressing human needs within ecosystem boundaries and the third cluster on the analysis and valuation of ecosystem services. These three perspectives are interrelated, complementary and all relevant for EB-IOM.

Many sources stress that uncertainties should be articulated clearly in EBM (Long et al. 2015). However, they shouldn't unduly delay management actions to prevent ecosystem degradation. In fact, adaptive management (a central element of EBM, section 4.2) is designed specifically to facilitate planning in the context of uncertainties. To prevent breaches of ecosystem boundaries, adaptive management should go hand in hand with the precautionary principle (Curtin and Prellezo 2010), which can be summarized as follows: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically" (Science & Environmental Health Network 2013).

The ecosystem approach has been adopted into marine policy in several places. The Norwegian Ministry of the Environment (2009), for example, advocates for "integrated, ecosystem-based management" for the Norwegian Sea, while the Arctic Council, in its 2013 Kiruna Declaration, adopts and defines EBM as "Comprehensive, integrated management of human activities based on best available scientific and traditional knowledge about the ecosystem and its dynamics, in order to identify and take action on influences that are critical to the health of ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity" (Logerwell and Skjoldal 2019). The report by UNEP (2011) provides a comprehensive, marine-focused discussion of the ecosystem approach, with clear text and graphics that guide non-technical audiences through the topic.

3.3. Related ocean management concepts

3.3.1. Ecologically or Biologically Significant Marine Areas (EBSAs)

Central to EBM is an understanding of the ecosystem within which human activities are to be managed. For EB-IOM, this includes understanding which areas in a given planning region are of particular importance to the wider marine ecosystem. There is an established approach for this (CBD 2008, Clarke & Jamieson 2007, DFO 2004, Dunn et al. 2014): Ecologically or Biologically Significant Marine Areas (EBSAs). These are defined as discrete geographic or oceanographic areas that provide important services to one or more species, populations, or ecosystems, as defined by the EBSA criteria of the CBD (box 4, CBD 2008). While these criteria should be differentiated from MPA site selection criteria (see section 3.3.2), identifying EBSAs ensures that an understanding of the most ecologically important areas can be built into MPA planning processes from the outset (CBD 2008, Dunn et al. 2014, Lieberknecht et al. 2014).

3.3.2. Marine protected area networks

With growing competition for the use of maritime space, MPAs safeguard space for nature to thrive in, protecting biodiversity within their boundaries and supporting ecosystem services beyond (Arbo & Thủy 2016, Gell & Roberts 2003). Several international targets have been set to increase the global coverage of marine protection. Aichi Target 11 of the CBD calls for 10% coverage by 2020, a figure set to be achieved for jurisdictional waters globally, but not for ABNJ (CBD 2018, Dinmore 2016). In 2016, a major International Union for Conservation of Nature (IUCN) conference called for 30% coverage of highly protected areas by 2030 (Dinmore 2016).

MPAs are best planned as networks that span the ocean and coastal areas. The idea of reserve networks originated in the SLOSS[8] debate of the 1970s and 1980s (Kingsland 2002, Neigel 2003), which later gave way to the more integrated concept of systematic conservation planning (Margules & Pressey 2000) and a series of systematic reserve network design principles that aim to achieve maximum conservation benefits at minimum societal cost (safeguarding space for nature and for use by people). These principles have been widely applied in MPA research, planning, and assessment (Allison et al. 2003, Ardron 2008, Ballantine & Langlois 2008, Ban et al. 2009, Ban et al. 2014, Ban & Klein 2009, Fernandes et al. 2005, Jantke et al. 2018, Klein et al. 2008, Lieberknecht et al. 2014, Natural England and JNCC 2010, Pressey et al. 1993, Pressey et al. 1994, Shafer 2001, Stewart et al. 2003, Stewart et al. 2006, Vane-Wright et al. 1991). They include:

Box 4. CBD Criteria for Ecologically or Biologically Significant Marine Areas

Uniqueness or rarity: Area contains either (i) unique ("the only one of its kind"), rare (occurs only in a 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.

Special importance for life-history stages of species: Areas that are required for a population to survive and thrive.

Importance for threatened, endangered or declining species and/or habitats: Area containing habitats for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species.

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.

Biological productivity: Area containing species, populations or communities with comparatively higher natural biological productivity.

Biological diversity: Area contains comparatively higher diversity of ecosystems, habitats, communities or species, or has higher genetic diversity.

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.

8 "Single Large or Several Small", a debate about whether single large reserves deliver more conservation benefits than several small reserves of the same combined size

- Representativity (reserve networks should protect the full range of biodiversity)
- Adequacy / Viability (individual sites as well as their combined footprint across the network should be large enough to safeguard ecosystem integrity)
- Replication (any given feature should be represented in more than one location)
- Connectivity (pathways for ecological linkages should be designed into a reserve network).

Not all MPAs are managed effectively (Rife et al. 2013, Solandt et al. 2020), but if they are, they restrict or eliminate environmentally damaging activities within their boundaries. MPA networks can thus be seen as a type of 'ocean use' that competes with others, potentially impacting on livelihoods or displacing users and exacerbating conflicts elsewhere (Bennett et al. 2015, Charles & Wilson 2008, Röckmann et al. 2015, Stevenson et al. 2013, Suuronen et al. 2010). However, MPAs can also be a tool for managing and preventing conflicts, for example, by creating space for activities with low environmental impacts (Cadiou et al. 2008) and maintaining ecosystem services that ocean users elsewhere depend upon in the long run (Arbo & Thủy 2016, Gell & Roberts 2003).

Systematic planning principles allow planners the flexibility to explore alternative spatial configurations of protected areas with different sets of trade-offs, thereby managing user-user conflicts and capitalizing on synergies where possible. Planners can also use these principles to complement existing protected areas efficiently and to build in requirements to protect any particularly valuable, vulnerable or threatened EBSAs in order to ensure their ecological value is safeguarded within the wider MPA network configuration. By planning across spatial scales that match those of ocean ecosystems, by explicitly focusing on ecosystem connections and on protecting all parts of the ecosystem, and by providing space for human well-being needs as well as nature conservation, systematically planned MPA networks align closely with the ecosystem approach.

3.3.3. Marine spatial planning

The Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO) defines MSP as "a public process of analyzing 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. Characteristics of MSP include ecosystem-based, area-based, integrated, adaptive, strategic and participatory"[9]. Thus, MSP allocates marine space to different uses (including conservation, through MPAs) and its outputs include a map of zones that certain activities are permitted in, excluded from, or regulated within (Arbo & Thủy 2016). The IOC-UNESCO MSP website[10] provides links to MSP guidance documents (e.g. Ehler & Douvere 2007, Ehler & Douvere 2009), as well as detailed information on MSP processes around the world.

The MSP concept originated essentially as a call to embed systematic MPA networks in wider spatial measures that simultaneously pursue environmental, social and economic objectives (Ban et al. 2012, Jay et al. 2012). Most MSP literature is therefore rooted in the ecosystem approach, with many MSP frameworks resembling generic EBM frameworks that all emphasize the need for an integrated, adaptive, multisectoral, and strategic approach that involves stakeholders and delivers social and economic benefits within ecosystem boundaries (Agardy et al. 2011, Ansong et al. 2017, Arbo & Thủy 2016, Crowder & Norse 2008, Domínguez-Tejo et al. 2016, Douvere 2008, Foley et al. 2010, Gilliland & Laffoley 2008, Katsanevakis et al. 2011, Noble et al. 2019a).

Viewed this way, MSP is central to EB-IOM, addressing the 'where' in 'who can do what, where, how and when at sea' in line with the ecosystem approach. Strategic cross-sectoral MSP should simultaneously plan MPA networks and multi-use zones that separate incompatible activities, co-locate compatible or mutually beneficial activities, help manage cumulative impacts, and provide enough space for nature and humans to thrive in.

MSP implementation in policy and practice, however, often lacks genuinely strategic cross-sectoral integration (Jones et al. 2016) and some recent MSP literature has started to frame MSP not as an instrument for EBM, but for supporting 'blue growth' by maximizing efficiencies in the economic use of marine space (Bonnevie et al. 2019, Depellegrin et al. 2019, Gimpel et al. 2015, Rodríguez-Rodríguez et al. 2016, Schupp et al. 2019, Stelzenmüller et al. 2017, Zanuttigh et al. 2016). This illustrates the tension between nature conservation and economic growth (discussed in section 2.4), which should be circumvented by re-framing the sustainable ocean economy as the blue doughnut: it isn't economic growth, but human needs and ecosystem boundaries that take centre stage in EB-IOM.

9 http://msp.ioc-unesco.org/about/

10 See http://msp.ioc-unesco.org/

3.3.4. Integrated coastal zone management

The idea of ICZM became established in the 1990s, when the ecosystem approach was also gaining significant traction (Clark 1992, Pernetta & Elder 1993, Post & Lundin 1996). In essence, ICZM applies EBM to human activities along coastlines, addressing impacts across the land-sea interface. EB-IOM, on the other hand, applies EBM to activities at sea. Simply put, ICZM is dry, EB-IOM is wet, but conceptually they are equivalent to (and extensions of) each other.

While ICZM technically falls beyond the scope of ocean management (as defined in this report), the ecosystem approach includes safeguarding the ocean from impacts of human activities that take place beyond it. Thus, EB-IOM needs to be complemented and supported not only by ICZM, but also by integrated watershed management, waste reduction and management in the terrestrial economy, and, of course, the control of global greenhouse gas emissions. Ocean managers may not be in a position to do all this, but they should do whatever is in their power to identify downstream impacts of human activities on the ocean and to address these at source (or to prompt others to do so).

3.4. A closer look at integration

3.4.1. The five categories of integration in Ecosystem-Based Integrated Ocean Management

To achieve the vision of the blue doughnut (section 2.4), multiple environmental, social and economic objectives need to be integrated strategically. Management measures must be designed that simultaneously address cumulative ecosystem-scale environmental impacts (safeguarding the ecological ceiling), minimize user-user conflicts and pursue human wellbeing (building the social foundation). Although the importance of strategic integration and 'holistic approaches' is often stressed, authors sometimes fail to define exactly what this means in practice (Kelly et al. 2019), although frameworks for analysing different forms of integration are being developed for ocean management (Saunders et al. 2019). For EB-IOM, strategic integration across sectors and objectives can be translated into five categories of integration that practitioners should embed in any new EB-IOM process or initiative (Figure 5):

1) **Integration of governance** institutions, organizations and processes, both vertical (through tiers of administration, from local to international), and horizontal (for example, across ministries)
2) **Integration of knowledge** through multi- or transdisciplinarity
3) **Integration of stakeholders** through participatory processes
4) **Transboundary integration** across administrative and biophysical boundaries
5) **Integration of system dynamics** (temporal ecological, economic and/or socio-ecological) into models used in EB-IOM research or to support planning and decision-making.

3.4.2. Governance integration

Figure 5 shows governance silos, represented by different administrative bodies with separate sectoral responsibilities at different scales. Governance integration means creating mechanisms to facilitate the cooperation between these bodies within each administrative tier (horizontal) and across administrative tiers (vertical). This could mean many different things in practice, including:

- the development of new legislation (or reforms of existing legislation) to clarify remits and mandates of the different bodies and how they operate in relation to one another, especially in areas where they may overlap or impact one another
- the creation of new permanent governance organizations (and underpinning legislation, as required) with a mandate to facilitate cooperation across existing bodies, or to take over multiple portfolios in relation to marine activities
- subsidiarity or decentralization (as anchored in the Malawi Principles, box 3) in support of vertical integration
- the creation of less formal governance structures and processes, either permanent or temporary (for the duration of a specific project or initiative), such as joint memorandums of understanding for sharing information relating to planning and development processes, data-sharing agreements for technical and scientific data, joint working groups for planning, decision-making or the long-term monitoring and management of particular issues

These integration mechanisms can complement rather than replace single-sector silos (for an example, see NEAFC & OSPAR 2015). The benefits of integration do not infinitely outweigh the efficiency benefits of specialization and sector-specific bodies are often best placed to manage specialized processes that have little or no cross-sectoral impacts. Furthermore, managing the institutional and organizational changes required to build functioning integration mechanisms is in itself a significant task. There are instances where wider government or legal reforms provide opportunities for fundamental restructuring of mandates and remits,

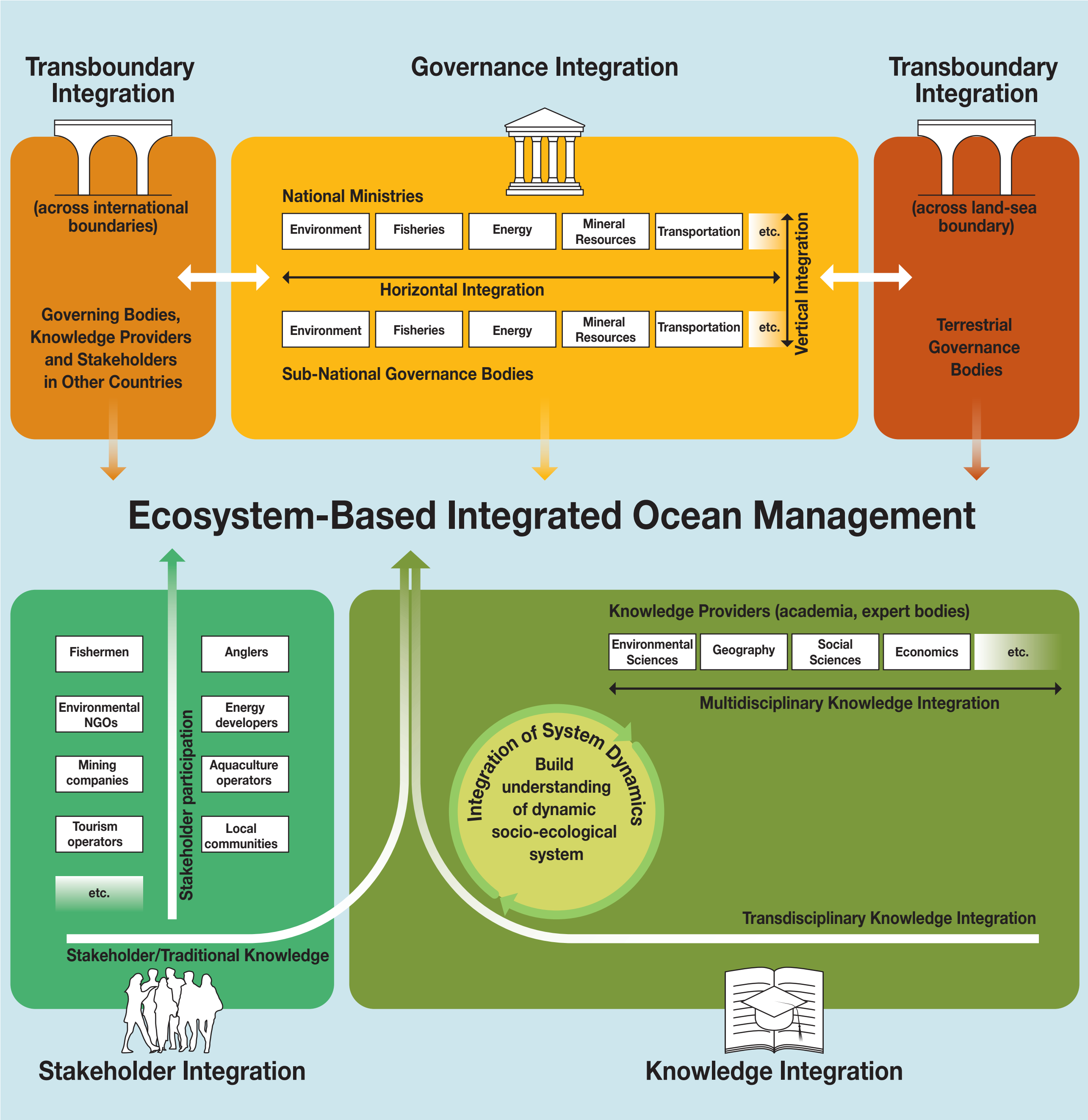


Figure 5. The five categories of integration in EB-IOM.

Governance integration *refers to mechanisms of communication, information exchange, coordination or collaboration between public sector organisations that have a remit to plan and manage activities taking place at sea. At the national level, different ministries often have responsibility for different maritime sectors. Similarly, there are often different sectoral management bodies that operate at a sub-national (e.g. province, state or municipal) level. Integration mechanisms are therefore needed both horizontally (to integrate management across sectors) and vertically (to integrate across scales of governance).* **Transboundary integration** *is needed to coordinate governance and information exchange across international boundaries (represented in the top right), and across the land-sea boundary (represented in the top left).* **Stakeholder integration** *refers to mechanisms that engage stakeholders in planning, decision-making, implementation, monitoring and evaluation of management measures.* **Knowledge integration** *refers to the need to draw knowledge from multiple fields of academic expertise (through multidisciplinary and interdisciplinary approaches) and from stakeholders who often hold valuable local or traditional knowledge of relevance. This means that stakeholder integration and knowledge integration mechanisms may need to be linked. The purpose of knowledge integration is to build a comprehensive understanding of the socio-ecological system of the planning region in question, creating the information base needed to underpin sound management measures. This requires* **integration of system dynamics** *to create an information base that reflects the natural dynamics of the systems that are being managed.*

and in such cases, the creation of new marine governance bodies with integrated, cross-sectoral remits can be beneficial. However, change processes of this scale can take many years and may be fraught with difficulties, and will usually be beyond the scope and power of new EB-IOM initiatives. In many cases, the most pragmatic way to make progress is to build on the existing governance landscape and create integration mechanisms where they are most needed.

3.4.3. Stakeholder integration

Successful stakeholder engagement needs to be thoughtfully planned and appropriately supported, though ocean management practice significantly lags behind academic knowledge in this regard (Bennet 2018). While stakeholder participation is almost universally stated as 'essential' for EBM and integrated ocean management (see box 2, box 3, Ehler 2014, Ehler & Douvere 2007, Ehler & Douvere 2009, UNEP-WCMC 2019), relevant literature usually does not elaborate even on very basic questions, such as: *Why* is participation important? *How* is participation best carried out? *When* should it be carried out (i.e. at what stage(s) in the process?) *What* role should stakeholders be given? *Who* are the stakeholders that need to be involved at different stages or in different roles? Furthermore, what are the risks and incentives to participate for stakeholders? What are the risks and costs of participation for the process and its outcomes?

Practitioners should articulate clear answers to each of these questions and ensure that all actors involved in any process share an understanding on these matters. A review of the vast literature on stakeholder participation is well beyond the scope of this report, but the next paragraphs provide some orientation. For further guidance, Morf et al. (2019) provide a comprehensive overview of participation in the ocean management context, and Link et al. (2017) complement this with a review of the role of participation in related research. In addition, the AA1000 Stakeholder Engagement Standard (AccountAbility 2015), although generic in scope, contains a very useful set of practical guidelines to help develop robust engagement processes.

The first question to clarify concerns the *why: Why involve stakeholders in EB-IOM?*

There are two common ways of framing answers. One is to regard participation as a way of improving the quality of a process, ensuring it is just, transparent, fair, accountable and inclusive. In many jurisdictions there is legislation that requires a minimum level of stakeholder participation in public environmental planning, such as the Aarhus Convention in the EU (Morgera et al. 2016). There can be good reasons to go beyond such basic legal requirements, including ethical considerations, compliance with local and cultural practices, achievement of SDGs that focus on equality and good governance, and efforts to safeguard against MPAs or MSP being perceived as 'ocean grabs' that marginalize coastal communities or serve agendas beyond ocean management (Bennet 2018, De Santo 2020).

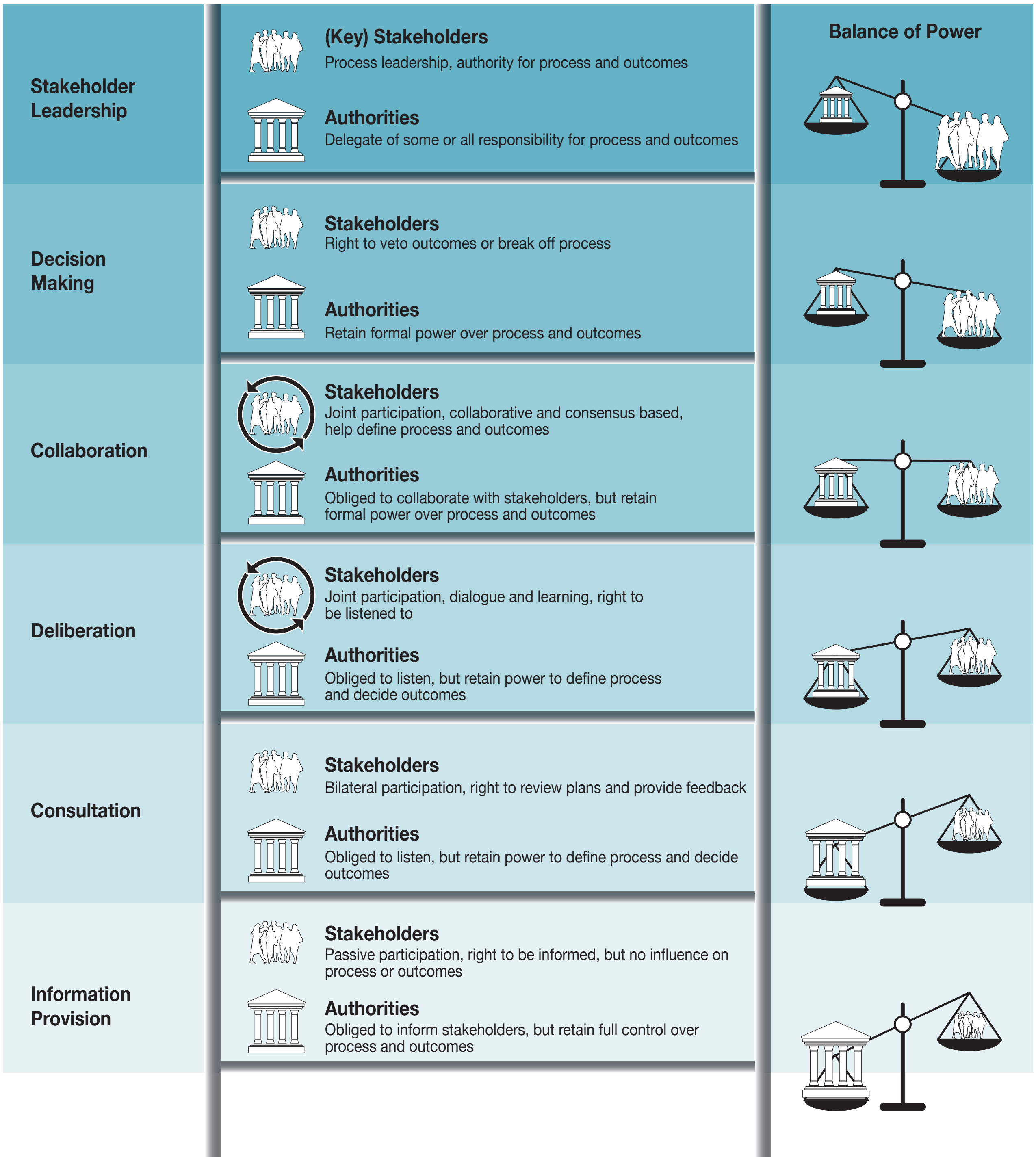
Another way to answer the question is to regard participation as a way of improving the quality and effectiveness of outcomes, for example, by generating goodwill and buy-in, and by bringing in a wide range of knowledge and perspectives to underpin robust decisions (Bennet 2018, Lockwood 2010).

The next question to consider is the *how: How is participation best carried out?*

Different levels of participation delegate different amounts of power to stakeholders, represented as a "ladder of participation" by Arnstein (1969). The most appropriate level depends on the type of problem being addressed and the purpose of participation, among other factors (Hurlbert & Gupta 2015). Although stakeholder participation is a core component of EB-IOM, each level of participation has a role to play, including the lowest level at which stakeholders have no power to influence decisions at all (for example, governance bodies with legitimate powers may need to implement emergency measures to protect fragile environmental features under immediate threat, or to stop activities that are unsafe or illegal).

Morf et al. (2019) developed a version of the ladder based on a review of stakeholder engagement in MSP processes in Europe (Figure 6). This has six levels of increasing power delegation, and two levels (deliberation and collaboration) at which stakeholders are supported to engage with each other across sectoral divides (indicated by circular arrows around the stakeholder group icon). Given its Eurocentric focus, this version of the ladder doesn't comprehensively represent every form of stakeholder engagement that has proven effective in EB-IOM around the world (for example, it doesn't include collaborative, cross-sectoral forms of community-level co-management of MPAs or coastal fisheries). However, it provides an empirically founded starting point for practitioners new to the topic.

There are two important benchmarks on the ladder in Figure 6 that mark two common but very distinct types of engagement: 'consultation' and 'deliberation'. In consultation, plans for new developments or measures are published so that stakeholders can comment on them, but with no guarantee that their views will have any substantive impact



Source: adapted from Morf et al. (2019).

Figure 6. The Ladder of Participation.

The ladder represents different levels of power delegation from authorities to stakeholders. Higher levels of power delegation can ease burdens on authorities and improve management effectiveness, if the power delegation is genuine. Two levels represented in this figure, deliberation and collaboration, require different stakeholders to engage with each other and work together across sectoral divides (indicated by the black circular arrows around the stakeholder group icon). This cross-sectoral element is absent in the two highest levels on this particular version of the ladder, which is based on a geographically limited sample of MSP case studies (all in Europe). However, in EB-IOM it is also possible to maintain the cross-sectoral collaborative aspect while fully delegating power to stakeholders (for example, there are successful examples of collaborative, community-based co-management of coastal fisheries and MPAs in other parts of the world). Cross-sectoral engagement can bring significant benefits, if there is sufficient capacity to support mechanisms that bring stakeholders together and facilitate their joint work. The most appropriate and effective form of engagement depends on a wide range of case-specific considerations (including the cultural, political, and legislative context, established engagement practices, and the resources and capacities available). There is no single type of engagement that is inherently superior: every type of engagement represented here can be an effective element of EB-IOM in the right circumstances, and different types of engagement might be needed at different stages of the same process.

on the final decision. Consultation is usually bilateral, which means that each interested party provides their own comments separately, with few (if any) opportunities for different stakeholder groups to communicate with each other to develop any kind of joint position. Consultation is very common in public planning, including as a requirement of EIAs. This means that there can be well-established consultation processes in ocean management that have become institutionalized and that stakeholders are familiar with.

Deliberation, in contrast, brings different stakeholder groups together to jointly inform a process. They may not have power to *make* decisions, but the deliberative space provides an opportunity to exchange knowledge, views and perspectives, bring conflicts to light, address them, and develop well-informed solutions that no single party may have been able to find on their own. Deliberation (like collaboration, the next level up in Figure 6) can be a vehicle for transdisciplinary knowledge integration (section 3.4.4) and for integration across governance silos (section 3.4.2). It can also have intangible benefits by developing social capital and relationships of trust which can subsequently facilitate integration in other processes.

Where bilateral consultation is already standard practice, however, the associated institutional inertia can make it challenging to move up the participation ladder in a new EB-IOM initiative. It is therefore essential to secure genuine commitment for higher levels of participation from existing governance bodies, including the necessary delegation of power and control. Failure to do so can lead to participation becoming tokenistic, ultimately reducing rather than creating social capital when expectations are dashed (Bennett 2018, Gaymer et al. 2014, Jones et al. 2016, Lieberknecht & Jones 2016).

To be effective, deliberation and collaboration also require dedicated and skilled support in the form of process design and facilitation, workshop preparation, communication, knowledge and information provision, feedback, etc. (Sayce et al. 2013). Thus, while well-managed deliberative and collaborative participation can yield great benefits, there are situations when bilateral consultation is the preferable option.

The next question to address is the _when_*: At what stage(s) should stakeholders be included?*

At each stage of EB-IOM, a different form of participation may be appropriate. What these levels should be is entirely dependent on the scope and context of a given initiative. For example, in some instances, collaborative formulation of goals and objectives at the very earliest stage of the cycle may be a necessary foundation for effective buy-in and support from stakeholders. In other instances – for example, if there are strong governance institutions that are well-trusted in a society – it may be most efficient for overarching goals to be formulated in a top-down, expert-driven process, with higher levels of participation in the planning and implementation stages so that stakeholders can help shape the way in which the overarching goals are achieved. Similarly, monitoring and evaluation of management measures may be best carried out by expert institutions with relevant mandates or may be delegated entirely to local communities.

The adaptive management cycle in section 4.2 can serve as an orientation when planning stakeholder participation. Asking the why, how, what and who questions for every individual stage in the cycle can help find the most appropriate balance between top-down and bottom-up approaches for any given process.

This ties in with the next question, which concerns the _what_*: What role should stakeholders be given?*

Stakeholders may take on many different roles in EB-IOM, such as information recipient, information/knowledge provider, collaborator in developing potential management options or solutions to a given problem, representative of sectoral perspectives or interests in conflict resolution, adviser to decision makers, or decision maker (in co-management).

These roles closely tie in with the level of participation previously discussed, so the most appropriate roles at each stage in the planning cycle will depend on the scope and context of a given initiative. The adaptive management cycle in section 4.2 can help determine what these are. Irrespective of the specific roles that stakeholders take on, all actors in a process should have a shared understanding of these roles and what they entail. Ocean managers should map out roles and levels of participation through each stage of any given initiative, manage expectations accordingly, and provide appropriate levels of support and capacity-building to stakeholders.

The subsequent question focuses on _who_: *Who are the stakeholders that need to be involved?*

The _who_ can depend on the _when_ and the _what_, because different constellations of stakeholders may take on different roles at different stages. In every event, ocean managers should carry out a thorough and competent stakeholder analysis to identify stakeholders and map their main interests, relative power and influence, as well as their relationships with one another. Particular emphasis should be placed on identifying those whose voices are at risk of not being heard, and those who may require specific support or incentives to engage constructively. Ocean management is an inherently political arena (Bennett 2019b) and stakeholder integration in itself will not make power imbalances between stakeholders disappear (Adjei and Overå 2019) or automatically solve conflicts (Kelly et al. 2019). Practitioners are advised to seek advice from social scientists on further tools and approaches that can address these issues (Bennet 2018, Kenter 2018).

Once the <u>*why*</u>, <u>*how*</u>, <u>*when*</u>, <u>*what*</u> and <u>*who*</u> have been established, there are two final questions:

- What are the risks and incentives to participate for stakeholders?
- What are the risks and costs of participation for the process and its outcomes?

Some of the costs and risks of participation to ocean managers have already been covered under the <u>*how*</u>. But there are also costs to stakeholders: the dedication, goodwill, time and effort that participative processes can demand should not be underestimated (Portman et al. 2016). Stakeholders may literally lose money (lost work time, travel costs to attend meetings, etc.); the higher up the ladder a process is located, the higher those costs. To ensure that access to participation is fair and equitable, at a minimum, processes should cover monetary costs for those who cannot attend stakeholder workshops as part of their day job. If different people ask the same set of stakeholders to participate in multiple processes, this can rapidly lead to 'stakeholder fatigue', especially if there are no clear incentives for participation.

There are also social risks for stakeholders. Being seen to constructively engage with 'the enemy' in a process that might restrict stakeholder activities can elicit hostile reactions from colleagues and communities. Thus, the higher the level of participation requested from stakeholders, the stronger the payoff should be for them. This payoff could be the chance to have a genuine influence on decisions or the benefits of social capital generated. It is the responsibility of ocean managers to deliver well-run engagement processes where these benefits will genuinely materialize as promised, and to manage stakeholder expectations appropriately.

3.4.4. Knowledge integration

Key to the ecosystem approach is that management decisions should be underpinned by the best available information base. As articulated in the Malawi Principles (box 3), this means using best available science, drawing from a range of scientific disciplines to ensure a comprehensive understanding of ecosystems and their interlinkages with social and economic systems (Alexander et al. 2019, Markus et al. 2018), as well as using relevant traditional and local knowledge.

Effective EB-IOM thus requires the integration of expertise from multiple academic disciplines (from natural science to social science, economics and law), as well as relevant traditional and local knowledge held by a variety of stakeholders. Box 5 provides terminology that can help ocean managers plan and define different types of knowledge integration needed in a given initiative.

The definitions in box 5 highlight that, just as there are different levels of stakeholder participation, there are also different levels of knowledge integration. While increased levels can bring significant benefits and indeed be necessary for truly sustainable outcomes (Bennet 2019a, Link et al. 2017), inter- and transdisciplinarity are not achieved simply by bringing relevant people together. Almost three decades ago, Stember (1991) highlighted the challenges of overcoming epistemic barriers, a task that requires goodwill, supportive structures, and sufficient resources. Furthermore, academics can face risks from engaging in interdisciplinary work, such as reduced success in funding applications and slower career progression (Rhoten & Parker 2004, Bromham et al. 2016).

A lot of the considerations that apply to stakeholder integration (section 3.4.3) therefore also apply to knowledge integration, and there is likely to be overlap in the constituencies of people and institutions that have to be engaged with for both. Wisely selecting the right stakeholder engagement mechanism at the right time can greatly facilitate effective knowledge integration. Ocean managers should therefore ideally plan the two at the same time; the *why, what, who, when* and *how* questions discussed previously for stakeholder engagement can serve as an orientation for both.

Ocean managers can also draw from established and tested frameworks to support knowledge integration in EBM, such as the integrated ecosystem assessment (IEA) framework developed by the National Oceanic and Atmospheric Administration (NOAA) of the United States of America specifically to support EBM in ocean management (Levin et al. 2009, Samhouri et al. 2014). The IEA framework is a version of the adaptive management framework presented in section 4.2 that focuses on bringing together academic experts and other stakeholders with different knowledge and expertise to build a shared understanding of socio-ecological systems, environmental risks and their drivers in order to help them develop management scenarios to address risks. The IEA approach has been used successfully

Box 5. Knowledge integration: useful terminology

When working in EB-IOM, it helps to use precise vocabulary. Various authors have put forward definitions of important terminology that can help define different types and levels of knowledge integration, including Alexander et al. (2019), Schultz-Zehden & Weil (2019), Stember (1991) and Tress et al. (2005). The following definitions, proposed by Tress et al. (2005), can be directly applied to EB-IOM:

1. Disciplinarity: Work that takes place within the boundaries of currently recognized academic disciplines, oriented towards one specific goal or one specific question.
2. Multidisciplinarity: Work in different academic disciplines that shares an overarching goal, but has multiple disciplinary objectives, in which participants exchange knowledge without aiming to cross subject boundaries or create integrative knowledge and theory.
3. Interdisciplinarity: Work that integrates knowledge and theory from several academic disciplines towards a common goal, creating new knowledge and theory that cannot be broken down into its disciplinary ingredients and would not have emerged through either disciplinary or multidisciplinary efforts.
4. Transdisciplinary: Work that combines interdisciplinarity with a participatory approach, involving academics from different disciplines as well as non-academic participants, such as resource managers, user groups and the general public, to create new knowledge and theory and address a common question.

Inter- and transdisciplinarity are truly integrative, generating entirely new types of knowledge. Interdisciplinary integration is a precondition for generating the systems-level knowledge that is needed to model socio-ecological dynamics (Frusher et al. 2014). Transdisciplinarity further brings in non-academic knowledge held by a diverse range of stakeholder communities, reflecting different values as well as different ways of knowing (Bennett, 2019a). Multidisciplinarity simply consists of illuminating the same central question from several different disciplinary perspectives. While this does not generate new types of knowledge, in some situations it can be sufficient for supporting decision-making. Thus, all three approaches to knowledge integration (multi-, inter- and transdisciplinarity) have potential application in EB-IOM.

to build a shared multidisciplinary understanding of complex ecosystems spanning the land-sea interface and to transfer science to policymakers effectively in Florida (Fletcher et al. 2014) and California (Harvey et al. 2016), as well as other large marine ecosystems. Guidance on using the IEA approach can be found on the NOAA website[11].

3.4.5. Transboundary integration

EBM requires planning across geophysical and jurisdictional boundaries because ecosystems span across both. Transboundary integration across jurisdictional boundaries goes hand in hand with horizontal governance integration, as it requires knowledge-sharing, cooperation and collaboration across institutions responsible for different jurisdictions. At the international scale, regional marine cooperation mechanisms already exist, such as the Regional Seas Programmes and Large Marine Ecosystem projects (UNEP 2011, UNEP 2016). Portman (2011) argues that the crossing of traditional geographic boundaries in MSP processes will catalyse other forms of integration, as it will automatically require different management bodies to work together and consider ecological interdependencies in ways they would not necessarily do within their own geographic remits.

Transboundary integration across ecosystem boundaries is a key aspect of EBM. Section 3.3.4 has already highlighted the importance of planning across the land-sea interface, for example, with ICZM, integrated watershed management and wider terrestrial conservation and waste management mechanisms vital in protecting the ocean from downstream impacts of human activity on land. This has been widely recognized (UNEP GPA 2006) and put into practice in some parts of the world, such as in Switzerland (a landlocked nation) for example, which as a Contracting Party to the OSPAR Commission[12] commits to protecting north-east Atlantic marine environments from river-borne pollutants.

3.4.6. Integration of system dynamics

The interlinkages of socio-ecological systems are dynamic, with systems changing over time in many ways. Policy measures or economic changes can drive changes in human behaviour that have knock-on effects that reverberate around ecosystems, and ecosystem changes can drive changes to human behaviour that have economic and social ramifications.

11 See https://www.integratedecosystemassessment.noaa.gov/

12 See https://www.ospar.org/

Simple frameworks to help understand these system dynamics have existed for decades, a prominent one in ocean management being the DPSIR framework (Patrício et al. 2016). This is an analytical and management framework designed to break down **drivers** of human behaviour, the **pressures** that human behaviours cause on ecosystem components, the changed **state** of system components that result from those pressures, the ecological and (in more recent versions of the framework) human wellbeing **impacts** of those changes in state, followed by the formulation of an appropriate management **response**. This response can target the drivers, mitigate the pressures or mitigate the system changes and impacts that result from them.

There are also well-established tools to help model ecosystem dynamics, such as Ecopath with Ecosim and Ecospace[13], which started as a tool to model a static snapshot of a system, before being expanded to include modules for modelling dynamic changes within the ecosystem, along with impacts of spatial management measures of human activities. Such tools can be used to evaluate ecosystem effects of human activities, such as fishing, as well as to explore the potential ecosystem impacts of management options, but they are not yet routinely used as decision-support tools in ocean management.

A key challenge for research is to develop tools and approaches that not only enable better futures to be envisioned, but that also help make those visions a reality through improved understanding of complex systems (Bai et al. 2016). Interdisciplinary research is now starting to develop a wider range of socio-ecological models that have the potential to predict complex systems dynamics (Elsawah et al. 2017, Schlüter et al. 2019) and new technologies have created opportunities for dynamic approaches in management by implementing measures in response to real-time remote monitoring of ecosystems, for example (Dunn et al. 2016, Maxwell et al. 2015, Rose et al. 2015). With continued advances in interdisciplinary modelling, computer technology and remote-sensing technology, such tools may soon become part of ocean mangers' standard repertoire.

13 See https://ecopath.org/

4. How is Ecosystem-Based Integrated Ocean Management implemented?

4.1. About this section

This section focuses entirely on the practical implementation of EB-IOM, presenting the adaptive management cycle as an overarching approach and discussing a range of tools that can support ocean managers at different steps of the cycle. It builds on the previous section, which in its deconstruction of the five different forms of integration already started to shift focus to the 'how'. The five types of integration cut across the entire adaptive management cycle presented in this section; each type should therefore be considered at each stage.

4.2. The adaptive management cycle

4.2.1. Overview

Adaptive management – the environmental management equivalent of the continuous improvement cycle in business management – was developed in the 1970s to optimize the management of dynamic systems with large uncertainties (Walters & Hilborn 1978). It is seen as a central component of EBM (Long et al. 2015, Waylen et al. 2014). The adaptive management cycle comprises an iterative process in which ecological, social and economic goals are set, the status quo is assessed, shortfalls in relation to the goals are identified and solutions for achieving the goals are planned and decided upon. Relevant measures are then implemented, monitored and evaluated. The outcome of the monitoring and evaluation allows managers to assess whether the measures taken have been effective at achieving the initial goals, at which point another iteration of the cycle is started.

The importance of adaptive ocean management is often stressed in related literature (Arbo & Thủy 2016, Forst 2009, Schupp et al. 2019), and many variations on the adaptive management cycle exist, for example, for participative multi-criteria decision-making (Estévez & Gelcich 2015), for MSP implementation (Ehler & Douvere 2009, UNEP-WCMC 2019), for EBM implementation (ELI 2009, Stelzenmüller et al. 2013), for ecosystem-based fisheries management (FAO 2019) and for ICZM implementation and coastal watershed management (AIDEnvironment et al. 2004, UNEP GPA 2006). The IEA, introduced in section 3.4.4 as a practical approach to support knowledge integration, is in essence a version of the adaptive management cycle, and is represented as such on the NOAA website[14]. Even the DPSIR framework (section 3.4.6), which is primarily an analytical framework to help break down and understand drivers, pressures and impacts on socio-ecological systems in order to help formulate appropriate management responses, is commonly represented as a closed cycle in which the assessment is repeated after measures are implemented, so they can be adapted if needed (Patrício et al. 2016).

Figure 7 shows a representation of an adaptive management cycle for EB-IOM, based on an illustration created by UNEP-WCMC (2019) to represent adaptive management for MSP. While this figure is very high-level, it provides a balanced overview of the 'big picture' of adaptive management and includes vital contextual elements that other illustrations sometimes lack. It is separated into two phases: pre-planning and the planning cycle itself. Both are embedded within a set of enabling conditions, including financing, capacity and the legal and governance context.

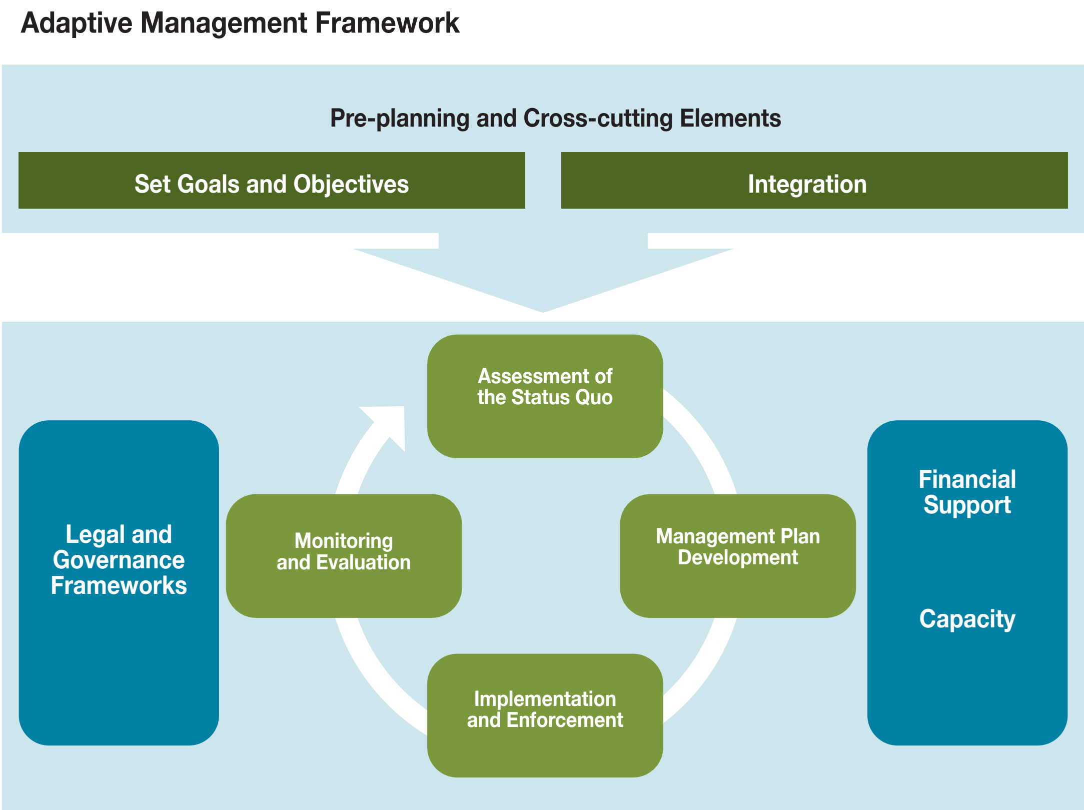
4.2.2. Pre-planning and cross-cutting elements

Figure 7 includes 'integration' as an important cross-cutting element, relevant at each stage in the planning cycle. Since the five categories of integration are covered comprehensively in section 3.4, integration isn't discussed further in the present section, which instead focuses on the other element represented in Figure 7: setting goals and objectives.

EB-IOM should be guided by clearly articulated overarching goals, in line with the vision of the blue doughnut (section 2.4). These broad goals should be used as a framework for articulating more specific objectives that guide specific actions or should serve as benchmarks for monitoring and evaluating success. This is sometimes represented as a one-off action to be completed at the start of the cycle, with the SMART acronym (box 6, Ehler 2014) commonly cited as a gold standard for objectives that each link to at least one management action and one indicator[15].

14 See https://www.integratedecosystemassessment.noaa.gov/

15 Belfiore et al. (2006), Link et al. (2017) and Pomeroy et al. (2004) are entry points to the literature on indicators. A lot of work is currently being done to develop indicator suites for reporting on the SDGs as well as on the performance of Large Marine Ecosystem projects and Regional Seas Programmes, which can easily be researched online for practical guidance.



Source: adapted from UNEP-WCMC (2019).

Figure 7. Adaptive management framework for EB-IOM.

This figure illustrates the main elements of the adaptive management cycle in EB-IOM. The top part of the figure indicates pre-planning and cross-cutting elements, the most important of which are to set clear goals and objectives, and the five forms of integration discussed previously (governance integration, stakeholder integration, knowledge integration, transboundary integration, and integration of system dynamics). The management cycle itself has four stages. The first is to assess the status quo of the socio-ecological system in the planning region, to identify shortfalls in wellbeing and overshoots over local or planetary ecosystem boundaries, and to compare the status quo to the desired goals and objectives. The second is to develop a management plan that details the measures needed to achieve the goals and objectives of the process, safeguarding the social foundation and ecological ceiling of the socio-ecological system in question. The third is to implement and enforce these measures, and the fourth is to monitor and evaluate their effectiveness, and adapt them as needed in an ongoing and iterative process. These four stages of adaptive management are embedded in enabling conditions that underpin the actions of each stage, with the legal and governance framework represented on one side, and the resources needed for effective management on the other. These include adequate financial support (which needs to be sustained over the long term to allow continuous adaptation through ongoing iterations of the cycle), and capacity. The latter refers to the capacity of individuals, organisations, and networks of organisations to act strategically and effectively, and covers aspects ranging from technical skills and competencies to appropriate materials, equipment, and infrastructure for each actor to fulfil their role.

However, EB-IOM actions are embedded in dynamic and complex socio-ecological systems, which can make it difficult to formulate SMART outcome objectives, since the knock-on effects of management measures cannot always be predicted. Such highly specific objectives are also not a suitable way to accurately measure or assess system-level outcomes, because attempting to develop SMART objectives for an entire ecosystem quickly becomes unwieldy. The attempt to manage MPAs in Europe against many specific ecological targets, for example, has generated a lot of scientific and administrative work that adds little value in terms of tangible ecosystem benefits (Solandt et al. 2020), and a recent attempt to evaluate the ecological status of the Mediterranean Sea against specific indicators generated a report over 500 pages in length (UNEP MAP 2017).

Ocean managers should therefore differentiate between a more diverse range of objectives that serve different purposes. One well-established approach that can be drawn from is results-based management (Global Affairs Canada 2016), in which objectives, goals and targets of different degrees of specificity and measurability are formulated for different steps along a results chain (box 7 illustrates what this might look like for an ocean management

Box 6. SMART objectives

1. Specific: objectives should be concrete, detailed, focused, and well defined in terms of defining desirable outcomes of the MSP process (have you specified what you want to achieve?);
2. Measurable: objectives should allow measurement of the outcomes and progress toward their achievement—preferable in quantitative terms (can you measure what you want to achieve?);
3. Achievable: objectives should be attainable within a reasonable amount of effort and resources (are the resources required to achieve the objective available?);
4. Relevant: objectives should lead to a desired goal, either on its own or in combination with other objectives; and
5. Time-bound: objectives should indicate a start and finish date in relation to what is to be accomplished (when to you want to achieve the specific objective or objectives?).

process). The early steps in the chain are fully controllable, meaning that SMART objectives can be effective in ensuring processes are accountable to donors, measuring progress, and evaluating the immediate outcomes of specific actions. Later steps require more broadly formulated longer-term goals that are increasingly impacted by system dynamics and become harder to measure, though these are the goals that matter the most. Progress against these should be assessed using a combination of SMART indicators for key system components complemented by qualitative assessments to capture different human values and perspectives, including through narratives and storytelling (Bennet 2018, Bennet & Satterfield 2018). Working towards the vision of the blue doughnut is a human value-based endeavour in which "not everything that can be counted counts, and not everything that counts can be counted"[16].

4.2.3. Assessment of the status quo

To map out a pathway towards the overarching goals, ocean managers must understand their starting point, meaning they must analyse the status quo of the socio-ecological system they are dealing with, including the governance context as well as the social, economic, and environmental characteristics, issues and trends within the planning region. This social, economic, and environmental baseline can be established using scientific

Box 7. Steps of a results chain for results-based management in EB-IOM

1. Inputs: for example, funding, staff, resources, etc. Inputs are easy to control and quantify.
2. Activities: such as planning workshops, technical work to support planning, communication and information dissemination, or any activities related to implementation, monitoring and evaluation. Fully controllable, describable and quantifiable.
3. Outputs: for example, reports, maps and data analysis results. Fully controllable, describable and quantifiable.
4. Immediate outcomes: for example, a given number of people with improved skills or knowledge following a training event, or an area of sea where damaging activities no longer occur. While less tangible than outputs, immediate outcomes are still relatively controllable, and can often be quantified and measured.
5. Intermediate outcomes: trust and social capital, cultural and institutional changes needed to make integration mechanisms sustainable, and behavioural changes in stakeholders. Generally hard to quantify and measure.
6. Ultimate outcomes: the blue doughnut.

methods, as well as through expert- and stakeholder-driven processes, which can draw from established practices within IEAs (section 3.4.4) or the expert elicitation approach developed for State of the Marine Environment (SOME) reporting (Harris et al. 2017). At a minimum, this stage should aim to identify the marine activities in the region (including past, current and future operations), their social and cultural context, and assess the status and trends of the marine ecosystem within this area. In the vast majority of cases, this will include collating spatial datasets, (for example on EBSAs), spatial footprints of marine activities, and economic and cultural values linked to different areas, with data sources ranging from satellite data to stakeholder knowledge captured through participative mapping (Appolloni et al. 2018, Vespe et al. 2016).

16 This quote is commonly attributed to Albert Einstein, although there is no documentary evidence that he said or wrote it (see https://quoteinvestigator.com/2010/05/26/everything-counts-einstein/#note-455-1)

4.2.4. Management plan development

This is the main planning stage of the adaptive management cycle, during which plans are developed for safeguarding the social foundation and ecological ceiling of the system, and for addressing the main shortfalls in the status quo compared with the overarching objectives. A common approach is scenario development to explore multiple alternative options for solving the main problems identified and to evaluate their relative strengths and weaknesses from multiple perspectives.

One key approach for this (and the previous) step is the SEA process, which has been codified in legislation and policy in some jurisdictions, including the EU through the SEA Directive. UNEP (2015) describes SEAs as a systematic process that assesses the impacts of proposed strategic actions (policies, programmes and plans) in order to provide early warnings of cumulative effects, transboundary effects and large-scale changes. SEAs should not be confused with EIAs. The SEA process applies to strategic policies, programmes and large-scale public planning approaches that cut across sectors and activities, while EIAs focus on the impacts of (and potential alternatives to) a specific new project or development. EIAs are routinely required in many countries for new infrastructure developments, such as offshore energy installations, port developments, dredging and mining activities, and aquaculture installations.

4.2.5. Implementation and enforcement

This stage of the cycle begins with a decision on which measures to implement. It should be clear to all participants involved in an EB-IOM initiative where this decision-making power lies. A decision-making process can be top-down, bottom-up, or a combination of both.

Once a decision has been made, there are many aspects to consider regarding implementation and enforcement, including:

- Communication of management measures taken to all relevant stakeholders
- Development of incentives for compliance, for example, legal measures, participative or knowledge incentives, cultural incentives, or economic incentives and alternative livelihoods (Jones 2014, Jones et al. 2013)
- Surveillance (through both remote and direct means), monitoring and enforcement of compliance.

More than other elements of the cycle, implementation and enforcement refers to a set of ongoing activities that should never stop. Whichever management measures are in place at any given time need to be implemented and enforced, even while they are monitored, their outcomes are evaluated, and plans are underway for revising them or replacing them with an improved set of more strategic and integrated measures.

4.2.6. Monitoring and evaluation

The monitoring and evaluation stage is commonly depicted as the part of the cycle that closes the loop and drives the cyclical iterations of adaptive management. However, similar to implementation and enforcement, it is best seen as an ongoing set of activities rather than as a discrete step on a cycle. Monitoring and evaluation should encompass two main aspects: firstly, process (to assess the internal workings of a given initiative) and secondly, outcomes (to assess the social and environmental changes achieved by a given initiative, from compliance with measures to environmental and human wellbeing impacts). The results-based management approach introduced in section 4.2.2 covers both of these aspects.

An additional purpose of ongoing monitoring of the human and natural environment should be to scan for risks and opportunities related to new developments or changes in the environment, which EB-IOM processes may need to adapt and respond to. Unlike process and outcome monitoring and evaluation, this is unrelated to any pre-formulated objectives, but should be considered an important aspect of risk management within EB-IOM.

4.2.7. Enabling conditions

The enabling conditions represented in Figure 7 include the legal and governance framework on one side, and resources needed for effective management (financial resources and capacity) on the other side.

With respect to the former, many countries have taken concrete steps towards cross-cutting and integrated national ocean policy through legislative frameworks (Cicin-Sain, Vander Zwaag & Balgos 2008). Although not a necessary precondition for successful EB-IOM initiatives, such legal frameworks can serve as a great catalyst for progress. This is especially true in strong governance contexts, in other words, where there are already well-established, well-resourced and functioning existing management bodies with official sectoral mandates. In these situations, it is difficult for strategic and integrated initiatives to flourish from the bottom up, as they are likely to clash with the established remits of existing governance bodies.

In weak governance contexts, on the other hand, where there is a lack of effective existing sectoral management or management bodies with relevant remits, it may be easier to establish strategic EB-IOM initiatives from the bottom up, at least at smaller scales and in coastal areas where there is a strong sense of ownership by local communities and other stakeholders.

The resources needed for effective EB-IOM include adequate financing that must be sustained over the long term to enable ongoing iterations of the adaptive management cycles to be completed. In addition, there is a need for a range of capacities at the level of individuals, organisations, and networks of actors, including skills, knowledge, and (organizational) culture.

Often, new capacities need to be developed. The institution of new integration mechanisms and new strategic planning processes requires existing institutions and individuals to change, adapt, learn, and acquire new skills, for example. These changes can be very difficult to achieve (Kelly et al. 2019), but there is a significant amount of literature and guidance on organizational change management that can help practitioners (for example, Kotter 2014), with effective capacity-building known to be vital for success.

Capacity-building for EB-IOM can be participative, thereby constituting a mechanism for integration in its own right. A full review of capacity-building approaches that can be used in the context of EB-IOM is beyond the scope of this report, but excellent resources exist to help practitioners get started. These include general resources on participatory training methods (UNITAR 2016), online training resources (such as the SessionLab library)[17], dedicated training resources for EB-IOM (for example, those developed by the Blue Solutions project)[18] and training courses related to specific tools, methods and approaches such as those discussed in the following sections.

4.2.8. How to use adaptive management frameworks

The 'stages' of the cycle in Figure 7 represent different elements of ocean management which should inform each other, but the adaptive management cycle should not be regarded as a strict 'how-to' manual with a prescribed sequence of discrete actions that must be carried out for every new project or initiative. As previously mentioned, there are several parts of the cycle that are best viewed as ongoing activities that should continue at the same time as other parts of the cycle. For example, the implementation and monitoring of existing measures should not stop while they are being revised or when new measures are being planned.

If every new initiative starts at the 'beginning', there is a risk of work continuously becoming stuck in the first half of the cycle and never delivering real-world impacts, especially when initiatives are projects with time-limited funding. The technical tasks needed in the first part of the cycle (data gathering and analysis to establish the status quo, development of future management scenarios) can take a lot of time and effort, use up a lot of resources, and generate a lot of outputs. Ocean managers have the sense of making progress, funders see deliverables in the form of maps, reports and recommendations, and politicians can point towards the effort made as evidence of their green credentials. However, if the outputs generated are not carried forward into management practice, there will be no tangible effects on ecosystems or human well-being: the blue doughnut will remain no more than a vision.

Ocean managers should instead review their current context to consider which elements of the cycle are already in place and decide which of those elements would most benefit from improvements using EB-IOM tools and approaches. In some instances, it may be necessary to begin by formulating a new set of goals and objectives. In others, the most benefit might be achieved by improving knowledge integration in the monitoring and evaluation of existing management measures or by developing governance integration mechanisms to support the efficient and effective enforcement of existing measures.

4.3. Tools

4.3.2. Types of tools for Ecosystem-Based Integrated Ocean Management

Defining what is or is not an EB-IOM tool is a matter of perspective. Any approach, method, technique, software, or physical instrument used to facilitate the implementation of any of the steps of the adaptive management cycle could arguably be counted, including tools to:

- Gather and analyse scientific data on the marine environment, society and economy
- Carry out integrated baseline environmental, social and economic assessments
- Develop and compare good or optimized potential future management scenarios
- Assess environmental, social and economic impacts of alternative management options

17 See https://sessionlab.com/library

18 See https://bluesolutions.info/capacity-development/

- Incentivize behaviours that comply with management measures
- Monitor and enforce compliance
- Monitor and evaluate outcomes of management actions
- Incentivize and facilitate constructive engagement of stakeholders at different stages of the management cycle
- Analyse, monitor and evaluate the effectiveness of existing governance processes
- Integrate different forms of relevant knowledge
- Analyse and manage multiple forms of uncertainty
- Capture, understand and integrate plural values and epistemologies

Technical tools that are designed specifically for EBM are continuously being developed and updated, so online expert communities (such as the EBM Tools Network[19]) can be a vital resource for practitioners. However, most tools that are used in EB-IOM are, in fact, methods and techniques that have a much broader application, many of which have their own extensive literature and related fields of expertise. This report does not aim to provide a comprehensive list or authoritative classification of all possible EB-IOM tools, but instead provides some particularly relevant examples, loosely grouped into four types: decision support tools, tools for analysing and modelling conflicts and interactions, tools for governance analysis, and ecosystem services valuation.

4.3.2. Decision support tools

'Decision support tool' (DST) is a broad term applied to analytical tools that process and integrate multiple datasets into value layers, future planning scenarios, or models. Such tools can cut through layers of information and generate solutions and insights that would be beyond the capabilities of the human eye and brain, thus helping managers and stakeholders to develop and evaluate planning options.

The Nature Conservancy[20] provides an overview of some commonly used DSTs in MSP. An empirical review by Pınarbaşı et al. (2017) found that DSTs are mainly used for planning, despite their potential to also support other stages of the EB-IOM cycle. Janßen et al. (2019) further highlight that their use remains overwhelmingly confined to the research context, which means that DSTs are not yet routinely embedded in real-world processes. Thus, there is untapped potential for DSTs to improve planning outcomes across environmental and social spheres (Kockel et al. 2019).

DSTs can be very powerful in some situations, but their use is not a necessary precondition for success. Using them effectively requires time and technical expertise, and the added value they provide is data dependent; if the available input data are sparse and/or unreliable, DST outputs will represent only a limited perspective on complex realities (Ardron et al. 2008, Weig & Schultz-Zehden 2019). In very data-poor situations, it can be preferable to use expert-based approaches to support decision-making.

To add value to real-world planning, DSTs also need to be integrated with the design of the wider IOM process. At a minimum, this means ensuring effective communication at the appropriate level of detail between technical analysts and other process participants. In some cases it may mean adapting entire process elements around a DST, particularly the mechanisms of stakeholder engagement (for example, Adem Esmail & Geneletti 2018, Bonnevie et al. 2019, Estévez & Gelcich 2015, Jumin et al. 2018, Weig & Schultz-Zehden 2019). DSTs can be used by experts to provide stakeholders with visual outputs that spark interest and provide a starting point for discussions and learning processes. Stakeholders can in turn help analysts shape DST input parameters through deliberative processes, though this requires appropriate incentives, support, and training. If it is not possible to provide these to stakeholders, then less technically demanding approaches of integrating stakeholder knowledge and perspectives might be more appropriate (Pope et al. 2019, Portman et al. 2016).

In every instance, the potential benefits and drawbacks of different DSTs should be explored and evaluated, so that the most appropriate approaches and tools can be selected for any given situation. The review by Janßen et al. (2019) provides useful guidance, and that by Noble et al. (2019a) examines scientific publications describing GIS-based DSTs that integrate social and ecological spatial data to inform MSP.

One commonly used DST is multi-criteria analysis (MCA), which has a range of applications in EB-IOM. Adem Esmail & Geneletti (2018) describe the three stages of MCA as follows:

1) Establish a shared understanding of the structure and context of the problem to be solved, including through defining objectives, developing alternative solutions, and

19 See http://www.octogroup.org/EBMTools.html

20 See https://marineplanning.org/tools/software/

defining criteria against which to evaluate each solution.
2) Analyse the potential solutions against the criteria, including weighting and/or aggregating criteria and carrying out sensitivity analysis.
3) Ranking or clustering of solutions depending on their performance against the criteria and taking a decision on the preferred option.

There are many approaches to MCA (Noble et al. 2019a). In the context of IOM, GIS-based MCA techniques are very common and have been used to:

- Analyse visual impacts of offshore wind energy developments in order to support siting decisions (Depellegrin et al. 2014)
- Analyse the global space potentially suitable for aquaculture developments (Dapueto et al. 2015, Gentry et al. 2017)
- Select sites suitable for offshore renewable/multi-use platforms combining renewables and aquaculture (Gimpel et al. 2015, Zanuttigh et al. 2016)
- Support artificial reef site selection (Barber et al. 2009, Mousavi et al. 2015)
- Zone activities in MPAs (Portman et al. 2016, Villa et al. 2002), including in combination with stakeholder input, either post-hoc (Habtemariam & Fang 2016) or eliciting input from stakeholders into the weighting of factors within the MCA (Martínez-López et al. 2019, Portman et al. 2016)
- Inform ecosystem-based fisheries management (Rossetto et al. 2015)
- Incorporate ecosystem service evaluations into site suitability analyses (Portman et al. 2016)

Adem Esmail & Geneletti (2018) provide relevant and useful guidance on engaging stakeholders in MCA, and Estévez & Gelcich (2015) propose an outline of a participative multi-criteria decision analysis (MCDA) that is in itself a variation of the adaptive management cycle presented in section 4.2. Research is now focusing on integrating spatial MCA with social network analysis used to comprehend and understand stakeholder conflicts and dynamics of interaction (Noble et al. 2019b).

Another type of DST that has a lot of relevance in EB-IOM is spatial optimisation software, a well-known example being Marxan[21], a suite of free software tools developed at the University of Queensland, Australia (Ardron et al. 2008, Ball & Possingham 2000, Ball et al. 2009, Watts et al. 2009, Watts et al. 2017a, Watts et al. 2017b). Marxan has been used to support the planning and evaluation of efficient, coherent and representative MPA networks (Airamé et al. 2013, Klein et al. 2009, Ruiz-Frau et al. 2015, Schill et al. 2015), explore trade-offs in ocean multi-use planning (Yates et al. 2015) and support the efficient zoning of marine uses in order to meet multiple sectoral objectives (Agostini et al. 2010, Jumin et al. 2018, Mazor et al. 2014).

Marxan uses an algorithm that finds multiple efficient solutions to spatial optimization problems based on systematic conservation planning principles (see section 3.3.2). It was initially developed to help design spatial reserve network configurations that protect multiple conservation features at a minimum cost (in money or other value parameters; for example, see Carwardine et al. 2008, Carwardine et al. 2010).

Its current version (Marxan with Zones) is a multi-objective spatial planning tool that identifies optimal spatial configurations for multiple zones, each of which protect different values. For example, if simultaneously planning MPAs, fishery zones, and recreational areas, the analyst can set targets for specified amounts of conservation features to be protected in MPAs, specified amounts of high-value fishing grounds to be represented in a separate fishery zone, and specified amounts of high-value recreation areas in the recreation zone. By allowing different relative weightings of targets within and between zones, Marxan with Zones can help explore trade-offs where no 'perfect' solutions exist that meet 100% of the targets for each zone.

4.3.3. Tools for analysing and modelling conflicts and interactions

User-environment interactions are at the core of EB-IOM and are primarily characterized and assessed through EIAs and SEAs (section 4.2.2). In addition, EB-IOM must also address user-user interactions, including those generated by MPAs restricting or displacing activities. There are different approaches and frameworks that can help ocean managers understand and analyse user-user interactions. Klinger et al. (2018) differentiate between neutrally compatible, positive, and negative (conflicting) interactions, with five basic categories:

- Competition (mutually negative impacts)
- Antagonism (impacts are neutral in one direction and negative in the other)
- Amensalism (impacts are neutral in both directions)
- Commensalism (impacts are neutral in one direction and positive in the other)
- Mutualism (mutually positive impacts)

21 See http://marxan.org/.

These categories can be further subdivided, recognizing that the nature of an interaction can depend on context (intensity of use, likelihood of spatial overlap, etc.), change over time, or be mediated by different types of linkage (spatial/temporal overlap, downstream impacts, or competition over shared infrastructure) (Bonnevie et al. 2019).

Identifying positive interactions (rather than just conflicts) allows EB-IOM practitioners to actively pursue opportunities for synergetic ocean multi-use (Depellegrin et al. 2019, Schupp et al. 2019), though this should happen only within environmental limits (identified through EIAs, SEAs and IEAs). Mapping out positive, neutral and negative interactions in a compatibility matrix (Bonnevie et al. 2019) can help underpin the development of spatial management zones in MSP, and for Marxan with Zones analyses aimed at finding optimal spatial management scenarios that co-locate compatible activities (amensal, commensal and mutualistic) and separate conflicting activities (antagonistic, competing), providing space for protection and recovery of ecosystems in MPAs.

Röckmann et al. (2015) highlight that user-user interactions are not adequately represented in a two-dimensional compatibility matrix because of 'conflict triangles', in which one conflict between two users drives another conflict with a third user. In fact, user-user interactions are embedded not just in triangles, but in complex networks. Social network analysis (SNA) is a tool that can be used to map and understand the networks of social relationships in which stakeholders in their planning region are embedded, generating network graphs with nodes representing individuals or other entities (such as organizations) within a social network, and links between nodes representing the relationships between them.

SNA often focuses most on positive relationships, though systematic ways exist to integrate conflicts (Everett & Borgatti 2014). This is increasingly being used by natural resource managers to map and assess their social and environmental connections to understand how they impact on each other through multiple nodes (Groce et al. 2019). This has been done to illuminate how stakeholders interact, collaborate and exchange information in MPA planning and governance (Cárcamo et al. 2014), analyse the evolution of local governance structures in sustainable coastal tourism development (Partelow & Nelson 2018), understand differences in perception between stakeholder groups about their relative power (Glaser et al. 2018), analyse what attributes of a local social network are supportive of effective co-management in a marine reserve (Alexander et al. 2015), analyse information flows in co-development of knowledge for MPA planning (Markantonatou et al. 2016) and analyse institutional integration and networking in MSP (Smythe 2017). Alexander and Armitage (2015) suggest an extensive list of further potential theoretical and empirical applications for SNA in MPA planning and governance.

4.3.4. Tools for governance analysis

Governance refers to the power, responsibilities and mandates of organizations and individuals, whereas management encompasses the resources, plans and actions that result from those powers, mandates and responsibilities being actively exercised (Lockwood 2010). The governance context in which ocean managers operate varies significantly across the world, affecting how stakeholder interactions play out on the one hand and what management approaches prove effective on the other hand (FAO 2016).

The academic literature on environmental governance contains many concepts that evaluate the quality and effectiveness of governance (Bennett & Satterfield 2018, Lockwood 2010). Lockwood (2010) lists seven key principles of good governance: legitimacy, transparency, accountability, inclusiveness, fairness, coherence and connectivity across multiple governance institutions, and resilience.

The governance analysis framework in Figure 8 (by Bennett & Satterfield 2018) was specifically designed to support practitioners in deconstructing, understanding, analysing, evaluating, designing and planning environmental governance. It differentiates between:

- Governance institutions that affect human behaviour and relationships (laws, policies, cultural context, social norms, etc.)
- Government structures that perform different functions (organizations, informal stakeholder networks, formalized bodies, etc.)
- Governance processes through which the functions of governance are performed (negotiation, law-making, policy formation, communication, conflict resolution, enforcement, etc.)

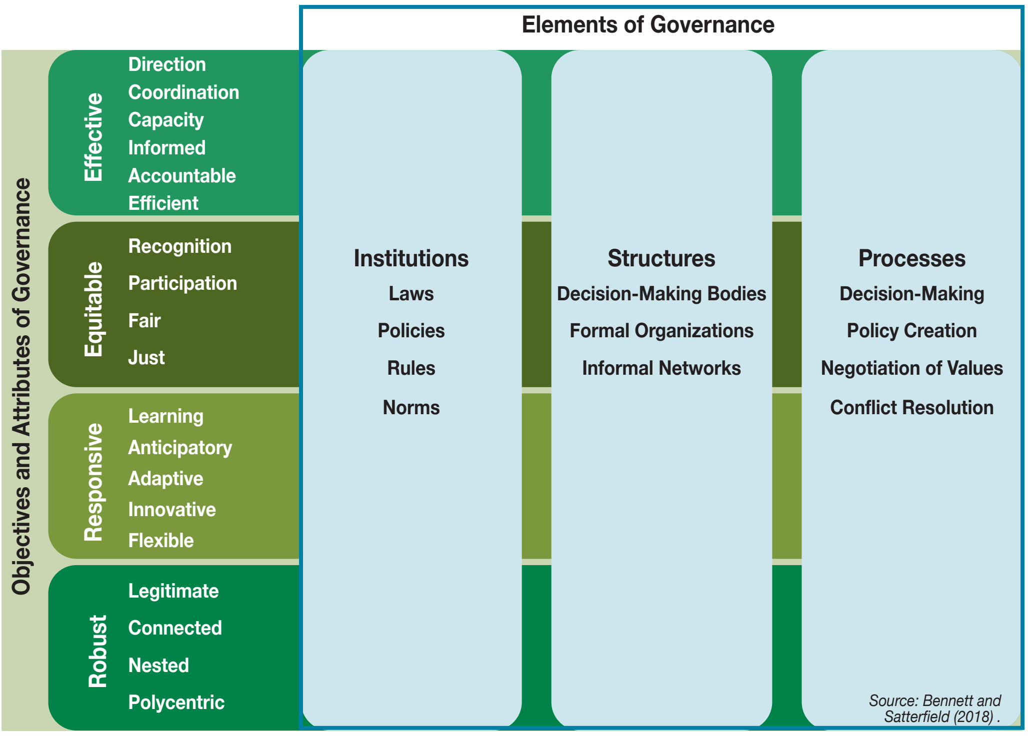


Figure 8. Governance analysis framework.

Another approach is to develop governance frameworks based entirely on empirical analysis of EB-IOM in the real world, for example, the framework used by Jones (2014) and Jones et al. (2016), which provides a much simpler but very practical orientation for EB-IOM practitioners aiming to gain a better understanding of their governance context.

4.3.5. Ecosystem services valuation

Ecosystem services valuation puts a monetary value on the goods and services that ecosystems provide to humans, from the food we eat and the oxygen we breathe to spiritual, cultural and wellbeing benefits associated with spending time in the natural environment (de Groot et al. 2002). Ecosystem services are commonly divided into four categories (Fisher & Turner 2008, Klinger et al. 2018, Lillebø et al. 2017, Wallace 2007):

1) **Provisioning services:** the direct products obtained from ecosystems, such as food, water, wood and genetic resources.
2) **Cultural services:** the intangible benefits nature provides to humans, for example, aesthetic and recreational values, spiritual and religious values, physical and mental wellbeing, and educational opportunities.
3) **Regulating services:** ecosystem processes that regulate the environment, for example, climate regulation, water purification and waste management, pollination and protection from natural hazards.
4) **Supporting services:** basic planetary life support services, such as primary production, photosynthesis, nutrient cycling and water cycling.

Ecosystem services valuation has become a keystone concept in conservation policy. It provides a common currency for integration of the economic, social and environmental spheres in SEAs and EIAs, and for the integration of market and non-market values into cost-benefit analyses that inform decision makers when weighing up whether a plan, project or development in the marine environment should receive planning approval (Klinger et al. 2018).

However, ecosystem services valuation also attracts criticism. On the practical level, there are methodological challenges. For example, depending on the valuation methodology used, there can be vast discrepancies in the results obtained for the same ecosystem service in the same time and geographical space (Hattam et al. 2015, Kenter et al. 2018). When aggregating results for multiple services and across multiple scales, variability associated with methodological differences becomes amplified. The more global an estimate, the larger its error bars.

On a philosophical level, there is concern that putting a monetary value on nature and associated human wellbeing is a vehicle for legitimizing and entrenching economic decision-making models that, by design, marginalize nature and human wellbeing (Hirons et al. 2016, Raworth 2017). Kenter et al. (2018) argue that the concept of ecosystem services in itself facilitates the commodification and privatization of nature and operationalising the sort of trade-offs critiqued along with the weak sustainability paradigm in section 2.4.

Ocean managers should question, communicate and interpret the meaning of marine ecosystem services evaluation with appropriate circumspection. There are situations in which resources may be better spent on alternative approaches for knowledge integration and for the reflection of plural values in decision-making (Bennett 2018, Bennett 2019a, Kenter et al. 2018). However, in established decision-making processes that are swayed heavily by economic cost-benefit calculations, ecosystem services valuation provides a useful and pragmatic way of accounting for non-market values in a 'language' that is understandable to decision makers (Hirons et al. 2016).

5. Ecosystem-Based Integrated Ocean Management in practice

5.1. Addressing challenges

Any EB-IOM initiative in the real world will face challenges. One technical challenge that is often raised is information gaps, especially in geospatial data. If DSTs are used, uneven data distribution, data gaps and data quality issues will skew analytical outputs and reduce how meaningful they are to planners and decision makers. St Martin & Hall-Arber (2008) highlight that geophysical and biological GIS data layers tend to be more often available than socio-economic data layers, a 'cartographic silence' that, in their view, inherently structures decision-making processes in a way that under-represents the needs of communities. One way to address this is through participatory mapping, in other words, capturing stakeholder knowledge in a GIS. Participatory mapping has been used to map the value of different sea areas to specific stakeholders, communities and sea users and the cultural value of areas to communities, as well as local and traditional knowledge about the environment.

Furthermore, as previously highlighted, the adaptive management approach was designed precisely for planning in the face of uncertainty, so data gaps should not stall the implementation of new measures to safeguard the environment and keep within safe ecological limits, in line with the precautionary approach. There is no option to take a 'neutral' position while waiting for the perfect evidence base to become available. Delaying environmental protection measures because of uncertainties is effectively making a conscious decision to continue with the status quo, allowing known conflicts and environmental impacts to remain unaddressed.

In practice, governance and institutional barriers pose much bigger impediments to progress than technical challenges (Depellegrin et al. 2019, Link et al. 2017). While it should be science-based, EB-IOM is not primarily a scientific or technical endeavour, but one of political, economic, institutional and governance transformation. This requires political will and support, including the provision of adequate financial resources to ocean management bodies, so that EBM implementation can be supported in the long term (one of the biggest obstacles to progress in ICZM in Europe, for example, has been its dependence on short-term, project based funding – see Shipman & Stojanovic 2007).

Ocean management is essentially a political arena (Bennett 2019b), in which institutional challenges are rooted in the complexities, dynamics and uncertainties of governance systems, which can be driven by economic upturns and downturns, political crises and other factors well beyond the scope of ocean management (Link et al. 2017). The sustainability transformations that ocean managers face are "wicked problems", defined almost half a century ago by Rittel and Webber (1973). Value conflicts abound in EB-IOM (de Juan et al. 2017, Forst 2009, Kenter 2018, Pope et al. 2019) and power relationships between different stakeholders can be highly asymmetrical (Adjei & Overå 2019), creating situations in which value conflicts, vested interests, and power imbalances can drive stakeholder dynamics, policy, legislation and planning decisions in ways that run counter to the publicly stated goals of sustainability.

Managing transformations in such complex systems is far from a trivial task (Kelly et al. 2019, Schuitmaker 2012). Some authors even question whether the concept of integrated ocean management itself is naïve (Kelly et al. 2019, Link et al. 2017), but this argument is fallacious. *Of course* implementing EB-IOM is hard, not because it is a flawed approach, but because it is addressing the hardest challenge we face as humans in the twenty-first century: transforming our economies and societies so that they provide for the needs of all within the ecosystem boundaries of our planet. It is the most important task that humans face today, and the concepts, frameworks and practical tools of EB-IOM that have been covered in this report leave ocean managers amply prepared to play their part.

5.2. Successes

5.2.1. Case studies

The ecosystem approach, integrated ocean management, and MSP have become anchored in policy and legislation in many parts of the world, resulting in a growing amount of empirical literature that examines real-world case studies of processes that have implemented elements of EB-IOM (WWF 2018). Throughout this report, reference has been made to a number of sources that draw from real-world case studies and experiences to illustrate key points (for example, Agostini et al. 2010, Airamé et al. 2003, Depellegrin et al. 2019, FAO 2016, Jones 2014, Kelly et al. 2016, Röckmann et al. 2015).

Empirical case studies can provide valuable lessons to learn from, but above all, they demonstrate that despite the existing challenges, the concepts, approaches and tools discussed throughout this report have already had a genuine impact in the real world, and will continue to do so as lessons are learned and planning cycles begin to go through multiple adaptive iterations. The following sections present some examples of real-world EB-IOM initiatives.

5.2.2. Belize Integrated Coastal Zone Management Plan, Belize

Belize has the second longest unbroken tropical coral reef system in the world and its coastal zone contains a rich diversity of habitats and attractions. Over 40% of the Belizean population live and work in the coastal zone, which supports thriving fisheries, aquaculture and tourism industries. As a result of multiple uses and increasing demand for coastal lands, the Government of Belize passed the Coastal Zone Management Act in 1998 to address issues such as rapid development, overfishing, and population growth. This legislation provides the Coastal Zone Management Authority and Institute (CZMAI) with the mandate to act as the entity responsible for integrated marine planning. The Belize Integrated Coastal Zone Management Plan was finalized in 2016 (CZMAI 2016). Despite its name, it covers the entire exclusive economic zone (EEZ) of Belize, so it is fully maritime in scope.

The ecosystem approach is embedded in the plan, which recommends actions that aim to achieve conservation goals at the same time as addressing the urgent economic and social needs of the country. The plan builds upon earlier efforts at the local level to develop sustainable regional guidelines for coastal zones (the coast of the mainland as well as offshore cays). The finalized plan includes a zoning scheme, which spatially designates zones for permissible activities and uses. It is, therefore, a case study of cross-sectoral MSP.

The approach taken by the CZMAI for the development of the Belize ICZM Plan involved four key steps, all of which fall into the first part of the adaptive management cycle: 1. literature review, 2. data acquisition, 3. stakeholder engagement and 4. ecosystem-based coastal and marine spatial planning. The CZMAI collaborated with the Natural Capital Project in this process, initially spending several months gathering existing data about biodiversity, habitats, and marine and coastal uses. This information was comprehensively mapped and shared with the public for review and feedback. Marine and coastal uses were then grouped into zoning categories, co-locating compatible uses, with three alternative draft zoning schemes developed at the local and countrywide scales, one prioritizing conservation, one prioritizing development and one that combined both.

The Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) modelling tool was then used to create value maps that effectively modelled the spatial distribution of several ecosystem services. These value maps were used to support an impact assessment of each of the three alternative draft zoning schemes.

The results of this analysis using the InVEST tool indicated that the 'development' scenario would have led to increased risks of habitat degradation, decreasing the delivery of ecosystem services. The 'conservation' future, in contrast, would have improved the health of ecosystems but allowed little room for human activities, especially in coastal areas of key importance for tourism. The third scenario was the one ultimately selected for implementation, as it embraces a combination of development and conservation priorities, minimizing impacts on coastal and marine ecosystems.

This case study provides an example of a process that successfully applied the ecosystem services valuation approach (through the InVEST tool) as a way to connect ecosystems, users and uses in a strategic analysis that evaluated trade-offs between alternative planning scenarios, allocating space to different uses. It is also an example of how extensive subnational consultations were successfully used to communicate plans, elicit feedback, and build support and shared understanding of the process outcomes. This demonstrates that stakeholder engagement in strategic marine planning can be successful without ascending to the deliberative or collaborative rungs on the ladder of participation. Finally, this case study is a good example of scientific knowledge integration into decision-making, building a shared understanding of science-based scenarios by decision makers, policymakers, direct stakeholders in the process and the general public.

5.2.3. Barents Sea Integrated Ocean Management Plan, Norway

Norway's seas span more than 3,000 km, from temperate waters in the North Sea at the southern tip of the country to the polar waters of the Svalbard archipelago in the North. The climate of the Norwegian coast is influenced by the North Atlantic Current which brings warm waters from the south-western Atlantic, hereby warming coastal Norway to 5–8°C more than other areas at the same latitude. In general, the marine environment is healthy but influenced by climate variability and long-range pollution. There are important designated shipping lanes from north-west Russia through the Barents Sea and along the northern

Norwegian coast. These were approved by the IMO in 2006.

The offshore petroleum industry accounts for about one quarter of Norway's GDP and one third of the State's income. Norway is a globally significant exporter of both petroleum and fish, and fisheries and aquaculture are two of the country's major economic sectors.

Historically, different uses of the oceans have coexisted with relatively low levels of conflict, due to the long coastline, vast oceans and low population densities. As is the case elsewhere, its ocean management was built on sector-based legislation and institutions. Over the past decades, this sectoral approach has been reinforced with new legislation, as well as the introduction of management plans for the oceans, and the establishment of an interministerial committee for oversight and interagency coordination.

The process for developing integrated and ecosystem-based management for the Norwegian portion of the Barents Sea (in the far north of the country) is documented by Hoel (2010) and Hoel and Olsen (2012). Early steps were taken in 2002, with a government white paper outlining a more integrated and ecosystem oriented marine policy: *Protecting the Riches of the Seas* (Report No. 12 to the Storting, the Norwegian Parliament). Following this, the development of an integrated management plan for the Norwegian part of the Barents Sea and the offshore waters south of the Lofoten Islands was initiated under the oversight of an Interministerial Steering Committee. This was led by the Ministry of the Environment, with representatives from other relevant ministries with a marine portfolio. This created an overarching mechanism for horizontal governance integration that facilitated work across institutional barriers at both ministry and agency levels. The actual work on the plan was carried out by several government agencies and research institutions.

The process involved the following key steps: 1. initial scoping phase (economic sectors, socio-economic aspects and environment), 2. assessments of potential impact of economic activities and external forces (including consultation), 3. aggregating activities (assessing the cumulative impact, identifying valuable areas, defining gaps in knowledge, and setting management objectives for the marine environment, including stakeholder consultation) and 4. ecosystem-based coastal and marine spatial planning.

The management plan developed through this multi-agency expert-led approach was adopted by the Parliament in March 2006. It is essentially a plan for area-based management, which aims to prevent cumulative impacts of various pressures on the marine environment.

The implementation and further development of the plan since its adoption in 2006 has been overseen by three permanent working groups: an advisory group on monitoring, a forum on environmental risk management and a forum for the coordination of the scientific aspects of EBM. The three groups have representatives from relevant agencies and research institutions, and they operate under a coordinating Interministerial Steering Committee, led by the Ministry of Environment, also including the ministries of Energy and Petroleum, Fisheries and Coastal Affairs, and Foreign Affairs. Stakeholder integration happens through a reference group that meets once a year.

This case study provides a successful example of the establishment of a new interministerial body as a mechanism for horizontal governance integration at a national scale during the planning phase. It also demonstrates how horizontal governance and knowledge integration mechanisms can be established on an ongoing basis to support the implementation and monitoring phases of the adaptive management cycle. The case study represents a successful transition from planning to implementation, in a clear, stepwise process, delivering a spatial management plan without getting 'stuck'. A clear process was established to carry forward the plan into the implementation phase, with permanent working groups established to cover monitoring, the ongoing integration of scientific knowledge, and a pragmatic, risk-based management approach.

5.2.4. Great Barrier Reef Marine Park Zoning Plan, Australia

The Great Barrier Reef is the world's largest coral reef ecosystem. In 1975, the Government of Australia passed legislation to establish the Great Barrier Reef Marine Park (GBRMP), which encompasses 344,400 km^2 of this large marine ecosystem. It is managed by a single body, the Great Barrier Reef Marine Park Authority (GBRMPA), which has the mandate to deny or impose limiting conditions on use of or entry to all or part of the marine commons within the Marine Park (except the passage of ships and aircraft). The legislation includes a specific section requiring GBRMPA to prepare a zoning plan that has regard to five objectives:

- the conservation of the Great Barrier Reef
- the regulation of the use of the Marine Park so as to protect the Great Barrier Reef while allowing the reasonable use of the Great Barrier Reef Region

- the regulation of activities that exploit the resources of the Great Barrier Reef Region so as to minimize the effect of those activities on the Great Barrier Reef
- the reservation of some areas of the Great Barrier Reef for its appreciation and enjoyment by the public
- the preservation of some areas of the Great Barrier Reef in its natural state undisturbed by human beings except for the purposes of scientific research.

The first zoning plan for the GBRMP was put in place in 1981. In the early 2000s, it was fundamentally reviewed, with the spatial coverage of highly protected zones increased significantly as part of a comprehensive zoning plan that covers the entire GBRMP in zones ranging from strict no-take zones to multiple-use areas. This revised zoning plan has been in place since 2004 and is described on the GBRMPA website[22].

The rezoning process was expert-led, driven by GBRMPA, and based on best available science about the natural state and the interconnections of the different ecosystems that make up the park. It is one of the earliest examples of systematic protected area planning principles being applied across large spatial scales in the marine environment, to create a representative and ecologically connected network of highly protected MPAs embedded in wider spatial measures, as well as non-spatial measures that range from public education to codes of environmental best practice, industry partnerships and economic instruments (Kenchington & Day 2011).

The legislation that established the park can be seen as an early example of some of the central tenets of EBM being adopted into marine institutional, legal and policy frameworks, and it has undergone amendments over time. In the most recent amendments, the provisions relating to zoning have been extended, providing a strong legal and institutional framework for integrated, multiple-use MSP. The establishment of an original zoning plan followed by its comprehensive revision, and the continued amendments to the legislation over time, can both be viewed as adaptive management in action.

Although the rezoning process was primarily top-down and expert-led, it included a comprehensive bilateral stakeholder consultation process, which was successfully combined with the use of a DST. Marxan was used to develop spatially optimal configurations of the most highly protected zone, based on a set of clearly articulated and published ecological reserve network design guidelines based on systematic MPA planning principles. Recognizing that the spatial data available at the time did not fully reflect the knowledge and perspectives of all the stakeholders in the region (an example of the 'cartographic silence' discussed in section 5.1), initial Marxan outputs were communicated to stakeholders and used as a way to elicit constructive and spatially specific feedback. This feedback was subsequently used to significantly modify the spatial configuration of the reserve zones, yielding a final compromise solution that still met the ecological guidelines, but which impacted less on stakeholder uses and thus resulted in higher levels of support, as well as reducing negative social and economic impacts on marine users.

The GBRMP example also provides lessons for transboundary integration, in terms of its links with the management of Queensland's wider coastal waters and adjacent Australian EEZ. The State of Queensland 'mirrored' the federal zoning in virtually all the adjoining State waters, the result today being complementary zoning for virtually all State and Federal waters across the entire Great Barrier Reef from the high water mark out to a maximum distance of 250 km offshore.

However, despite being a success story in many ways, the management of the GBRMP can also be seen as a cautionary tale about the limitations of ocean management measures alone in terms of managing impacts across the land-sea interface and addressing global environmental impacts on the ocean, especially those of climate change. In recent years, the Great Barrier Reef has suffered repeated significant bleaching events linked with rising sea surface temperatures, and as a result, this large marine ecosystem continues to be seriously threatened.

5.2.5. Gulf of Maine Council, Canada and USA

The Gulf of Maine Council on the Marine Environment[23] was created in 1989 by the state and provincial governments of Maine, Massachusetts, New Brunswick, New Hampshire and Nova Scotia to foster environmental health and community wellbeing throughout the Gulf watershed, spanning across the national border between Canada and the USA. It constitutes an example of transboundary integration across an international jurisdictional boundary using an informal integration mechanism that functions across different legal regimes governing ocean management in the two nations. Furthermore, it constitutes a mechanism designed to specifically address community wellbeing, and

22 http://www.gbrmpa.gov.au

23 http://www.gulfofmaine.org

across the land-sea interface, taking a watershed approach.

The mission of the Gulf of Maine Council is to maintain and enhance environmental quality in the Gulf of Maine for sustainability. The Council is, in essence, a forum of knowledge integration, where the different members share and exchange scientific information to inform management decisions and to protect and enhance natural resources in support of local communities. Other activities of the Council have focused on developing joint ecosystem indicators, pollution studies, monitoring and habitat restoration programmes including climate concerns as well as coastal and marine spatial planning programmes. The work that is carried out in these areas is published in the form of grey literature that is disseminated to management bodies across the region, including through the website of the Council.

One interesting aspect of this case study is that research exists to assess the effectiveness of the dissemination of these reports and other outputs generated by the Council, and the degree to which they are being used by management authorities to influence planning and implementation of management measures (Chamberlain et al. 2018, Cossarini et al. 2014, Soomai et al. 2013). This can be regarded as a good example of outcome monitoring and evaluation.

Chamberlain et al. (2018) analysed the outcome effectiveness of the Gulfwatch programme to monitor toxic substances in the Gulf of Maine. While relevant management authorities and government departments were found to have regularly accessed the Gulfwatch reports on the Council's website, this has not translated into any impact on coastal policy or practices. The authors recommend improved communication strategies that address the needs of the management authorities more directly, including by highlighting the relevance of the information provided to management questions more explicitly, and by engaging with key government stakeholders more proactively and on a continuous basis. They also highlight that time-limited funding for some activities of the Gulfwatch programme hampers effective dissemination and uptake of the work into policy, because it prevents long-term communication strategies being implemented and reduces the institutional memory of the relevant working groups.

These findings by Chamberlain et al. (2018) echo those of Cossarini et al. (2014), who analysed the impact of a wider selection of grey literature produced by the Council. They identified a long list of enablers and barriers to distribution and uptake of these publications, with a key recommendation to improve the way that the needs of the intended audiences are considered, both in the way that information is presented in the reports and in the way that these audiences are communicated with on an ongoing basis. Soomai et al. (2013) had similar findings, adding a recommendation to supplement technical reports with less technical forms and formats of communication.

Thus, while the knowledge integration between expert groups involved in the Council's work programmes and meetings functions well, the findings of these studies illustrate that this is not translating into improved real-world management practice as effectively as it could. Apart from underlining the importance of outcome monitoring and evaluation, this illustrates that, as discussed in section 5.1, the main barriers to implementing EB-IOM are often not technical challenges, but those related to institutions and governance. In this instance, the challenge is spanning the science-policy interface effectively, highlighting the need for effective communication mechanisms in ocean management that take into consideration the needs of the intended audiences. Simply placing reports on a website will not lead to uptake and impacts on the real world, no matter how excellent the quality of the documents themselves.

5.2.6. Management of the Benguela Current Marine Ecoregion, Angola, Namibia, and South Africa

The Benguela Current Marine Ecoregion stretches along the coast of Angola, Namibia and South Africa. It is considered one of the world's most productive and biodiverse marine regions. In recognition of its unique natural capital, these three coastal states have committed themselves under the Benguela Current Convention to jointly protect this large marine ecosystem across the boundaries of their respective EEZs. This is overseen by the Benguela Current Commission[24] (BCC), a multilateral organization with representation from the three member countries of the convention. Its work focuses on developing coordinated strategies for ecosystem conservation and sustainable development. It forms part of the United Nations Large Marine Ecosystems programme, which focuses on EBM as a core approach, and promotes sharing of approaches, methods and best practices in transboundary ecosystem assessments and management (IOC & GEF 2017).

24 https://www.benguelacc.org/index.php/en/

At present (2014–2020), the work of the BCC is being supported by the Marine Spatial Management and Governance Programme (MARISMA)[25]. This is jointly funded by the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU), the BCC and its member states, and is being implemented by the German Development Cooperation in partnership with the BCC.

MARISMA has three workstreams: one focused on developing joint approaches and building capacities for multisectoral and ecosystem-based MSP, one focused on the collation of data and information and sharing it via a shared online data portal, and one focused on identifying and mapping EBSAs in the EEZs of the three countries.

Harris et al. (2019) describe the success that the project has had in supporting the identification and mapping of EBSAs across the region through a collaborative, expert-led approach and the subsequent iterative refinement of their boundaries, as well as the integration of this information in a systematic MPA planning process. The latter has resulted in new MPAs being designated in South Africa, making a significant contribution to Aichi Target 11.

The project has been taking a 'learning by doing' approach to build capacities that will be sustained within the region once the project has finished. This case study therefore illustrates an effective approach not only to transboundary integration, but also of international development collaboration focused on participative capacity-building to create a firm and sustainable foundation for the implementation of EB-IOM in the long run.

25 https://www.giz.de/en/worldwide/30903.html; https://www.benguelacc.org/index.php/en/marisma

6. Conclusion

There is a need for a clear vision of what a sustainable ocean economy should look like. This report proposes to visualize this as the blue doughnut of safe and just space that marine economic activities should occupy. This overarching vision is proposed as an alternative to the currently predominating discourse around sustainable ocean economy development, which is centred on the pursuit of 'sustainable blue growth', which balances economic demands against nature conservation. Focusing on sustainable blue growth in this way creates an automatic tension between increased demands on ocean space and resources by economic activities on the one hand, and the need to better protect the ocean ecosystem on the other.

The blue doughnut circumvents this tension by shifting focus away from growth as a central objective, and instead directly placing the goals that matter most centre stage: to deliver a diversity of human wellbeing needs within safe ecological limits, with economic growth being a potential by-product. An immediate priority task for ocean managers should be to flesh out this vision with ocean-centred boundaries and thresholds for the ecological ceiling and social foundations for ocean economies in different parts of the world. This task will require working in multidisciplinary teams of natural scientists, economists, social scientists, indigenous communities, and other stakeholders.

Fortunately, this report demonstrates that in EB-IOM, ocean managers have a wealth of well-established, thoroughly researched, and increasingly well-tested concepts, approaches, frameworks and tools that can help them in this task, as well as in the bigger challenge of achieving the sustainability transformations needed to make the vision of the blue doughnut a reality. This report provides a deconstruction and detailed orientation around the diverse toolbox of EB-IOM, to illustrate that for any of the wide range of challenges a practitioner will encounter, others will probably have already developed methods to help address and overcome it. This will help ocean managers identify relevant approaches developed within the confines of academia and improve their uptake into applied practice.

Not only is there a vast literature covering relevant tools and approaches, but there are also communities of professionals from a wide variety of subject backgrounds whose expertise can be drawn from, and an increasing amount of empirical case studies that lessons can be learned from. A research priority for ocean management should be to invest in the systematic deconstruction of such empirical case studies (for example, using the governance analysis frameworks referred to in this report), to build a better empirical information base on which approaches tend to work best in which social, economic, cultural, political, and environmental contexts.

The key message from this report, however, is that we have a wealth of understanding to draw from. We have the scientific understanding, the tools, the knowledge, the tested approaches, and the adaptive management frameworks to roll out EB-IOM around the global ocean, as a vehicle for making the blue doughnut a reality. The main obstacles to overcome are related to institutional inertia and political will. Sustainability transformations are inherently 'wicked problems' but building economies in which people and the planet can thrive is the most important task we face as humans entering the Anthropocene. The concepts, frameworks and practical tools of EB-IOM that have been covered in this report leave ocean managers amply prepared to play their part.

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