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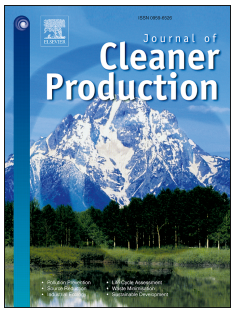

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Author contributions

EG conceived and structured the research, coordinated all the activities, the assessment and the sub-teams work; EG and FM curated the ABMT review; EG, FM, SU co-chaired the 2 workshops for the internal expert assessment; EG, ZK, FM, ARF, SU co-lead the sub-teams; EG, CFZ, ZK, FM, BN, ARF, AQ, SU prepared, curated and edited the ABMTs assessment and related tables for the sub-teams activities; all the authors contributed to the assessment and produced the evidence of the ABMTs contribution towards the SDGs; EG prepared the first draft of the manuscript and the figures; all the authors contributed to the assessment and revised the manuscript.

Contributions of marine area-based management tools to the UN Sustainable Development Goals

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Abstract

Area-Based Management Tools (ABMTs) are spatial instruments for conservation and managing different forms of ocean use. A multitude of ABMTs exists in marine areas within and beyond national jurisdiction, ranging from tools for the regulation of specific human activities (e.g. fisheries, shipping, or mining) to cross-sectoral tools (e.g. such as marine protected areas, MPAs, and marine spatial planning, MSP). By applying expert elicitation and reviewing scientific and grey literature we evaluate the contribution of ABMTs to

sustainable development goals (SDGs) as set out under the United Nations 2030 Agenda for Sustainable Development, including for SDG 14 that directly addresses the conservation and sustainable use of oceans, seas, and marine resources. We find that fisheries-related and conservation-related ABMTs, and MSP offer the greatest potential contributions to SDG 14 and to SDGs in general. Moreover, there is high complementarity and synergy among different ABMTs for most SDG 14 targets and other SDGs, with the exception of SDG target 14.6 *Prohibit fisheries subsidies* and SDG 7 *Affordable and clean energy*. We find that some ABMTs contribute directly to goal attainment, while others contribute in more nuanced or even unexpected ways. Furthermore, context-specific factors that relate to political and legal factors, enforceability, transparency, governance, and inclusivity are crucial for unlocking the full potential of ABMTs of attaining multiple SDGs, as shown through examples. The major challenge to face in the next decade is ensuring durable and equitable outcomes from ABMT implementation by coordinating ABMT initiatives established by different organisations and responsible authorities. It is also critical that outcomes are monitored and evaluated across environmental, social, economic, governance, and health dimensions, with indicators addressing management effectiveness and not only ABMT area coverage.

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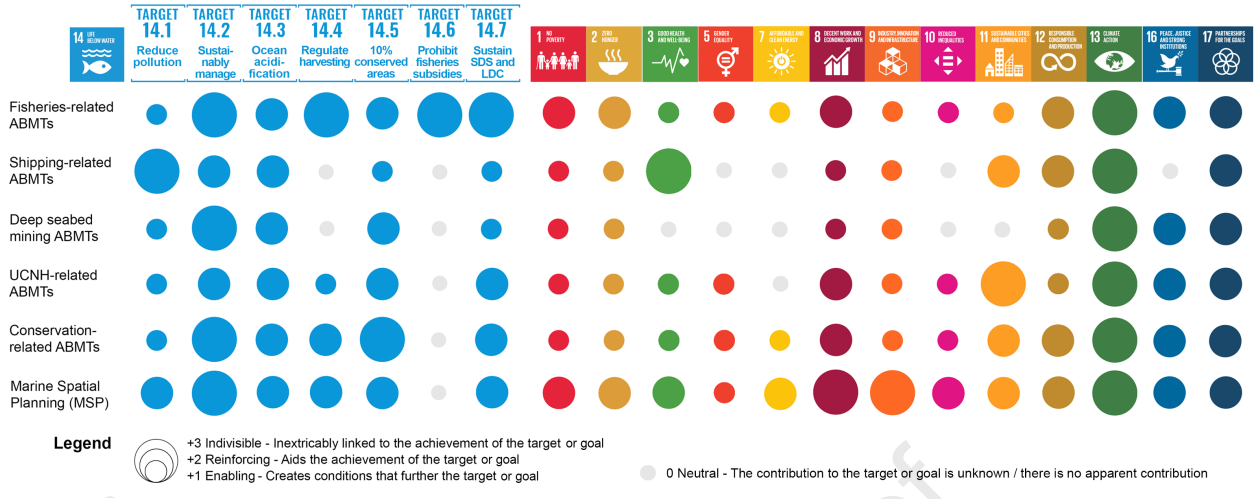

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Abstract

Area-Based Management Tools (ABMTs) are spatial instruments for conservation and managing different forms of ocean use. A multitude of ABMTs exists in marine areas within and beyond national jurisdiction, ranging from tools for the regulation of specific human activities (e.g. fisheries, shipping, or mining) to cross-sectoral tools (e.g. such as marine protected areas, MPAs, and marine spatial planning, MSP). By applying expert elicitation and reviewing scientific and grey literature we evaluate the contribution of ABMTs to

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Keywords: area-based management, marine/maritime spatial planning, ocean governance, cooperation mechanisms, areas beyond national jurisdiction, biodiversity, conservation, sustainable development.

1. Introduction

The United Nations (UN) 2030 Agenda for Sustainable Development (United Nations, 2015), henceforth the 2030 Agenda, is a holistic, inclusive and coherent strategy encompassing a set of 17 "integrated and indivisible" Sustainable Development Goals (SDGs). One of these goals, SDG 14 *Life below water*, focuses specifically on the conservation and sustainable use of the ocean and its resources. It builds on commitments and requirements as set out in different, yet related legal instruments or international declarations. For example, the target to conserve at least 10% of coastal and marine areas by 2020 (SDG 14.5) was based on the UN Convention on Biological Diversity (CBD) Aichi Target 11 (Convention on Biological Diversity, 2010). The

82 'zero draft' proposal for the CBD post-2020 global biodiversity framework now recommends the protection
83 of at least 30% of the ocean by 2030 (UNEP, 2020). Achieving conservation outcomes in the ocean while
84 supporting other SDGs is critical, especially in light of the recent and rapid "blue" acceleration in marine
85 resource exploitation (Jouffray et al., 2020), and major challenges in achieving sustainable blue growth
86 (Laffoley et al., 2020; Rilov et al., 2020a; Winther et al., 2020). Furthermore, the ocean is a continuum, with
87 currents and species moving across multiple zones (Popova et al., 2019) and ecosystems being affected by
88 transboundary anthropogenic pressures that cannot be controlled through protected zones alone (Menegon et
89 al., 2018; Reusch et al., 2018). Whilst there is a growing body of literature on the nature of interlinkages
90 between sustainability goals and targets in the ocean (Nash et al., 2020; Nilsson et al., 2016; Obura, 2020; S.
91 Schmidt et al., 2017; Singh et al., 2018), there is limited comprehensive evaluation of the contribution of
92 specific management tools to attaining SDGs.

93 Area-based management tools (ABMTs) are globally applied, purpose-orientated instruments used in the
94 planning and management of marine and coastal areas. By definition, ABMTs entail the implementation of a
95 system of rights and duties in a particular management area, under the responsibility of a designated authority,
96 and tend to afford high levels of protection (Roberts et al., 2010; UNGA, 2007). Taking into account the legal
97 status of the different maritime zones under the UN Convention on the Law of the Sea (UNCLOS), ABMTs
98 range from sectoral spatial instruments designed to manage a particular human activity (e.g., fisheries,
99 shipping, or mining) to cross-sectoral tools for managing multiple uses, such as marine protected areas
100 (MPAs), and marine/maritime spatial planning (MSP) (Muraki Gottlieb et al., 2018).

101 These tools reached particular global resonance in recent years, as part of biodiversity conservation targets and
102 the negotiation of an international legally binding instrument (under UNCLOS) for the conservation and
103 sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ) (General Assembly
104 resolution 72/249, United Nations, 2018). In addition to being discussed as a potential measure to achieve
105 BBNJ-related objectives, ABMTs have been identified as a key mechanism for delivering global biodiversity
106 goals and SDG 14 (Reimer et al., 2021). However, due to the great variety of ABMTs, there is a need for a
107 clear understanding of how these tools can contribute – separately and/or combined – to the implementation
108 of the 2030 Agenda as a whole. Given the indivisible and interlinked nature of SDGs delivering on a broad

range of objectives, it is vital that implementation considers synergies and trade-offs between different SDGs. Understanding the broad and interconnected nature of SDGs is key to supporting decision-makers, managers and communities in applying ABMTs to maximize policy effectiveness for environmental and societal benefits, as well as addressing challenges and potential trade-offs among goals.

Here, we review existing types of ABMTs as stipulated by different international and regional agreements (Fig. 1) and their contribution to achieving SDG 14 and other SDGs. Drawing on expert opinion, we first assessed the potential range of ABMTs' contributions to achieving the different targets of SDG 14, together with several other interlinked SDGs with strong implications for ocean-related transformations towards sustainability, i.e., SDGs 1, 2, 5, 7-13, 16, and 17 (see section 2.2 below). We then explored constraining and enabling factors of ABMTs implementation through existing cases and evidence from literature. Finally, we discussed the potential multiple contributions of ABMTs to sustainable development in both areas beyond national jurisdiction (ABNJ) and areas under national jurisdiction, and we outlined pathways towards more effective SDGs achievement – acknowledging the multiplicity of social, environmental, economic, political, and institutional challenges, as well as opportunities that come with ABMTs implementation.

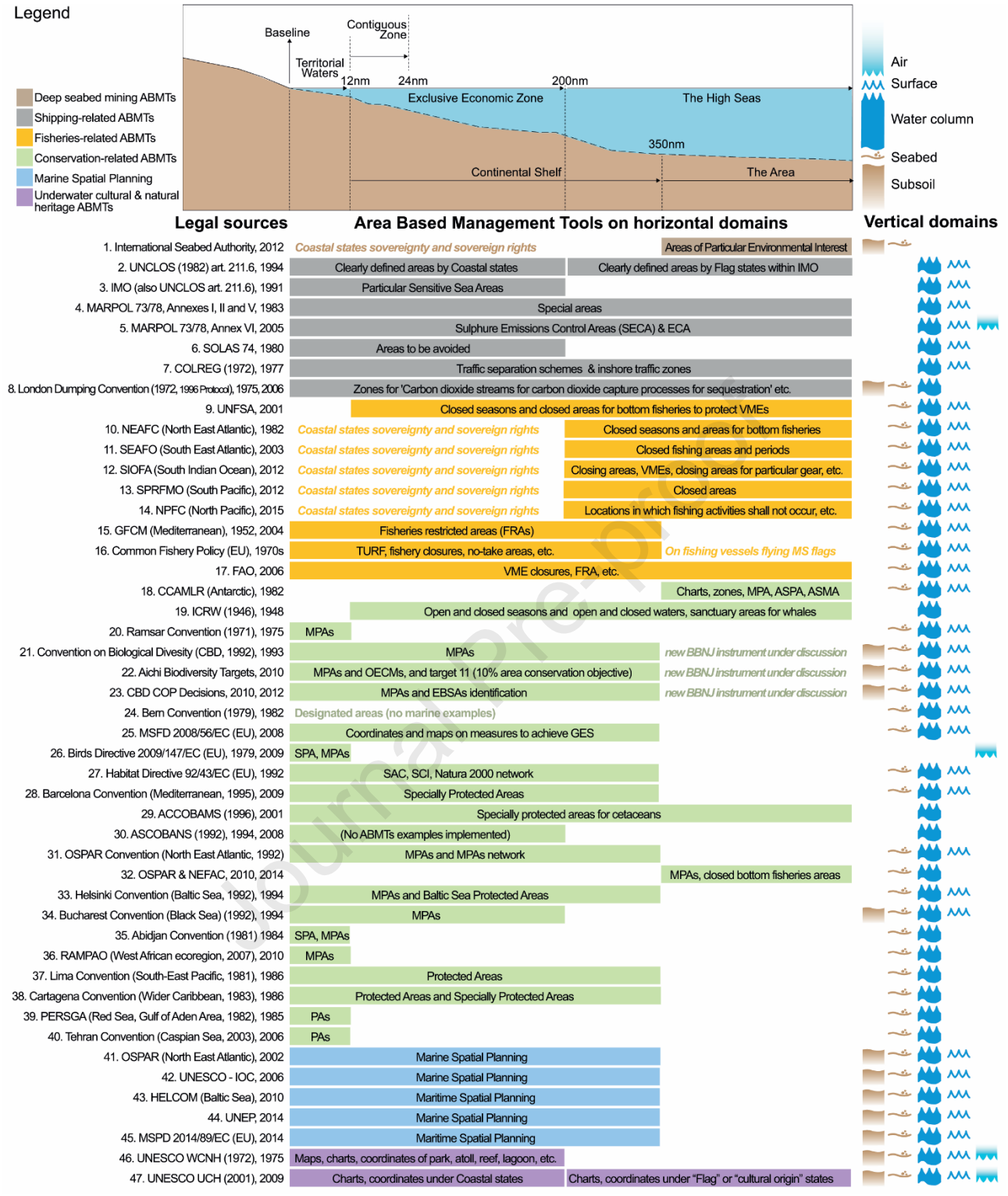


Figure 1: Area-based management tools (ABMTs) identified in international and regional conventions and agreements. ABMTs are grouped according to the specific sector/purpose they target (expressed by the colors of the horizontal bars). Legal sources are reported, with the region/area of application and the year of adoption into brackets, while the year of entry into force is reported outside brackets. Maritime zones are split in areas under national jurisdiction (including the Exclusive Economic Zone) and areas beyond national

jurisdiction (ABNJ), indicating in which maritime zone the ABMTs classified by the colored rectangles can or could apply. “High Seas” is just the water column in ABNJ. The sea floor is the “Area” (International Seabed Authority ABMTs apply there). Both can be taken together as ABNJ. The colors of the rectangles represent the sector or cross-sectorial group to which the ABMTs belong. The vertical marine domain subdivisions indicate the scope of the ABMTs, such as air, water, seabed, and are shown by different icons. For detailed descriptions of each ABMT see Table A.3; APEI=Areas of Particular Environmental Interest, ASMA=Antarctic Specially Managed Area, ASPA=Antarctic Specially Protected Area, BBNJ=Biodiversity Beyond National Jurisdictions, EBSA=Ecologically and Biologically Significant Area, ECA=Emissions Control Areas, FRA=Fisheries Restricted Areas, GES=Good Environmental Status, MPA=Marine Protected Area, MSP=Marine/Maritime Spatial Planning, OECM=Other Effective area-based Conservation Measure, PA=Protected Areas, PSSA=Particular Sensitive Sea Areas, SAC=Special Areas of Conservation, SCI=Site of Community Importance, SECA=Sulphur Emissions Control Areas, SPA=Specially Protected Areas, TURF=Territorial Use Rights in Fisheries, VME=Vulnerable Marine Ecosystems; for the acronyms of the International and Regional Agreements see Table C.1.

2. Material and methods

The assessment conducted in this study is structured around two main steps: i) the descriptive analysis of a vast set of ABMTs with respect to their scope, mandate, responsibilities, spatial extent, and single/multiple sector-based objectives; and ii) the qualitative assessment of the potential contribution of selected ABMTs to ocean-related SDGs of the 2030 Agenda.

2.1. Descriptive analysis of ABMTs (Step 1)

An initial list of 47 ocean-related international agreements (at global and regional levels) was compiled, with respect to shipping, fisheries management, deep seabed mining in the Area, underwater natural and cultural heritage, environmental conservation, and marine spatial planning (Step 1). We screened them and compiled a list of ABMTs mentioned by the respective legal sources and related tools. ABMTs were selected along two

criteria: i) implementation in practice; and ii) existing specific, identifiable geographical scope for zoning. We recorded how legal sources at the international level have shaped ABMTs with regard to spatial scope, mandate and responsibilities, and single/multiple sector-based objectives (protocol in Table A.1). ABMTs were analyzed (Table A.2) with respect to: i) their objectives; ii) authorities responsible for delivering such objectives; iii) the system of management and planning entailed in the ABMT forms; and iv) the specific spatial domain ABMTs refer to (both vertical depth and horizontal).

We grouped ABMTs according to the focus/sector of each tool into six categories based on Muraki Gottlieb et al. (2018) (Table A.3): i) fishery-related ABMTs; ii) shipping-related ABMTs; iii) ABMTs related to deep seabed mining in the Area; iv) ABMTs related to underwater cultural and natural heritage (UCNH); v) conservation-related ABMTs; vi) MSP initiatives. These categories were further used to perform a qualitative assessment of ABMTs as described below (Step 2). The full list of ABMTs and the analysis from the related legal sources is reported in a database attached to this study.

2.2 Contribution of ABMTs towards SDGs (Step 2)

After identifying, analyzing, and grouping ABMTs (Step 1), we selected the SDGs on which to focus the analysis (the SDGs selection procedure is described in the Supplementary methods A.4. We then assessed the contribution of the previously identified ABMTs towards the selected SDGs through expert elicitation. Subsequently, we added elements of existing ABMTs implementation, based on evidence from the literature.

We focused on SDG 14 *Life below water* (United Nations, 2020) and its main targets (14.1 to 14.7), as well as on other ocean-related SDGs, at the goal level. These were SDG 1 *No poverty*, 2 *Zero hunger*, 3 *Good Health and Well-being*, 5 *Gender equality*, 7 *Affordable and clean energy*, 8 *Decent work and economic growth*, 9 *Industry, innovation and infrastructure*, 10 *Reduce inequalities*, 11 *Sustainable cities and communities*, 12 R*esponsible consumption*, 13 *Climate action*, 16 *Peace, justice and strong institutions*, and 17 *Partnerships for the goals*. Accounting for a broader spectrum of SDGs in this analysis is important not only because of the integrated and indivisible character of the 2030 Agenda and SDGs. Also, previous research focused exclusively on SDG 14 with limited attention to the social and economic dimensions (Reimer et al.

2020), which we aim to expand here. With respect to SDG 14, we focused the analysis on the seven outcome-oriented targets (targets 1-7). We did not address the three targets (targets a-c) that represent "means of implementation" (namely, science and technology, knowledge-sharing and capacity building, and implementation of international law) as the latter were recognized to be inconsistently formulated and mainly qualitative (Bartram et al., 2018).

The assessment of the contribution of each ABMT to the SDGs took place according to the protocol reported in Table 1. The scoring framework developed by Nilsson et al. (2016) and applied by Nilsson et al. (2017), by McCollum et al. (2018), and by Schmidt et al. (2017) specifically on the case of SDG 14, was applied to assess the contributions of ABMTs to SDG 14 at the target level, and for the other selected SDGs at the goal level. The framework (Table 2) employed a seven-point rating scale to identify benefits and trade-offs between ABMTs and SDGs. It allowed a rapid assessment of relationships among them and highlights priorities for integrated policy. As the potential contribution of ABMTs towards SDGs is independent from its application in a specific maritime domain, the assessment of these contribution was conducted jointly for areas under national jurisdictions and ABNJ.

Table 1: Research questions and criteria for the assessment of the contribution of ABMTs towards the achievement of SDG 14 targets and other ocean related SDGs.

Research question	Field code	Field name	Description	Sources
SDG 14 target or SDG assessed	Q5.1	No. of SDG 14 target or SDG	Number of the SDG 14 target or of the SDG goal for which the assessment was made.	(United Nations, 2015)
	Q5.2	SDG 14 target or SDG	Text of the SDG 14 target or SDG for which the assessment is produced.	(United Nations, 2015)
What is the potential contribution of the ABMT towards the achievement of the respective SDG?	Q5.3	Score	Qualitative scoring that represents the potential contribution of the ABMT to the respective SDG target or SDG goal; the scoring is described in Table 3.	(Nilsson et al., 2017, 2016; Singh et al., 2018)
	Q5.4	Contribution to the SDG	Textual description of the potential contribution of the ABMTs group to the SDG studied.	
What is the level of confidence on which the assessment is based?	Q5.5	Confidence	Qualitative scoring indicating the confidence level of the experts in assessing the potential contribution of ABMTs towards the SDG (summary terms: 'low,' 'medium,' 'high').	(Mastrandrea et al., 2011; McCollum et al., 2018)

Are there any enabling factors or barriers that can enhance or inhibit the contribution of ABMTs towards the assessed SDG?	Q5.6	Enabling factors and/or barriers	Text describing factors and barriers that can enable or inhibit the contribution of ABMTs towards the achievement of the SDG from literature and cases; enabling factors and barriers are drawn from expert knowledge, literature, and implemented ABMTs.	(United Nations, 2015) (Nilsson et al., 2017, 2016; Singh et al., 2018)
Are there any examples of ABMT implementation and related contribution towards the assessed SDG?	Q5.7	Examples	Text describing cases reported as examples of ABMTs implementation that did or did not contribute towards the achievement of the SDG.	
What is the level of evidence on enabling factors and barriers from the various sources on ABMTs applications?	Q5.8	Evidence	Qualitative scoring to indicate the type, amount, quality, and consistency of evidence on which enabling factors and barriers were elaborated (summary terms: 'low,' 'medium,' or 'high').	(Mastrandrea et al., 2011; McCollum et al., 2018)

198

199 **Table 2**: Qualitative scoring system to assess the contribution of the ABMT to the achievement of the SDGs,
200 elaborated from Nilsson et al. (2017, 2016) and Singh et al. (2018).

Score	Name of the criterion	Explanation expanded from Nilsson et. al (2016) for the purpose of this study	Example of assessed relationships between ABMTs and SDG goals for illustration (this study)
Benefits (potential positive contribution of the ABMT to the achievement of the target or goal)			
+3	Indivisible	Goal achievement is **inextricably linked** with the designation and implementation of the ABMT.	The achievement of SDG target 14.5 which aims to conserve at least 10% of coastal and marine areas is inextricably linked to the implementation of MPAs.
+2	Reinforcing	Goal achievement is **reinforced by** the designation and implementation of the ABMT (direct support).	MSP is a reinforcing condition to SDG target 14.2, i.e. the sustainable management and protection of marine and coastal ecosystems.
+1	Enabling	The designation and implementation of the ABMT **creates conditions** that further the goal (indirect support).	The designation and implementation of shipping-related ABMTs can reduce potential harm from international shipping to marine and coastal ecosystems providing multiple benefits and natural resources (ie ecosystem services) to coastal communities, indeed enabling SDG 1 *No poverty* achievement.
Neutral contribution of the ABMT to the target or goal			
0	Neutral	No significant positive or negative interactions towards goal achievement.	The designation of an APEI by the International Seabed Authority or the development of environmental management plans for defined areas such as the Clarion Clipperton Zone have no apparent positive or negative interaction with SDG target 14.6 which is related to the prohibition of certain fisheries subsidies.
Trade-offs (potential negative contribution of the ABMT to the achievement of the target or goal)			
–1	Constraining	The designation and implementation of the ABMT **limits** options on the goal.	(No potential contributions of ABMTs going in this direction were found in this study)

–2	Counteracting	The designation and implementation of the ABMT **clashes** with the goal.	(No potential contributions of ABMTs going in this direction were found in this study)
–3	Cancelling	The designation and implementation of the ABMT makes it **impossible to reach** the goal.	(No potential contributions of ABMTs going in this direction were found in this study)

The assessment of the potential contribution of ABMTs to SDGs was based on internal expert elicitation, in line with the method applied by McCollum et al. (2018). Experts involved were part of the Working Group on "Area Based Management" of the European COST Action CA 15217 OceanGov "Ocean Governance for Sustainability: Challenges, Options and the Role of Science". We leveraged the diverse and in-depth knowledge of the experts – as the authors of this study – on the different ABMT groups (conservation, shipping, fisheries, deep seabed mining, UCNH, MSP) to conduct and produce the assessment. Sub-teams were formed during the first expert workshop (Ghent, 20-21 February 2019), where they were trained on the assessment method. The sub-teams were composed of at least three researchers coordinated by the lead author. They worked through small-group discussions to reach agreement on each score, first in person during the workshop, and remotely afterwards. The sub-teams were also asked to assess the confidence (Table 1) with which they collectively judged the different potential contributions of ABMTs towards the achievement of SDGs. Confidence scores were assigned considering the level of expert knowledge on the different ABMTs.

Once the scoring was defined, the sub-teams also analyzed the actual implementation of ABMTs, reporting evidence on potential enabling factors and barriers that enhance or inhibit ABMTs contribution towards specific SDGs. The sub-teams leveraged evidence from their own knowledge, as well as scientific and grey literature on the implementation of ABMTs. They compiled empirical examples and cases of ABMT implementation that have contributed towards (or hindered) the achievement of the targeted SDG. Finally, the sub-teams assessed the level of evidence of implemented cases, and related enabling or constraining factors, in order to identify potential knowledge gaps in our assessment.

When preliminary versions of the assessment for all ABMTs were finalized, they were circulated among the entire group of authors with two goals: i) provide elements of agreement or disagreement with the initial assessment; ii) comment and add potentially relevant knowledge and cases on the implementation of ABMTs. The sub-teams were then asked to collect feedback and to elaborate on potential points of disagreement in the assessments.

Finally, revised versions of the assessment were circulated among the entire expert group again, and further discussed in a second expert workshop (Potsdam, 10-11 December 2019). Here, there was a special focus on points of disagreement regarding the scoring through verbal discussions in parallel and plenary sessions. The final version of the assessment was jointly consolidated into 20 SDG-ABMT tables (see Tables B.1-20).

3. Results

3.1. ABMTs contributions to ocean sustainability goals

ABMTs have the potential to generate multiple benefits necessary for achieving SDG 14 and other ocean-related SDGs (Figs. 2 and 3; for a detailed description see Tables B.1-20). For SDG 14, Figure 2 indicates that fisheries- and conservation-related ABMTs, and MSP have the greatest potential contributions overall. Also, looking at the columns, there is high complementarity and synergy among different ABMTs for most targets, with the exception of SDG 14.6 *Prohibit fisheries subsidies*. These patterns are also evident in Figure 3 for the other SDGs, for which fishery- and conservation-related ABMTs, and MSP have the greatest potential contributions overall, with high complementarity for most goals, and the lowest in SDG 7 *Affordable and clean energy*.

While some of these contributions are straightforward, others are nuanced or unexpected. Indeed, some ABMTs are inextricably linked to the achievement of specific SDG 14 targets, being "indivisible" from them (Fig. 2 and 3). For instance, SDG target 14.5 relates to the conservation of at least 10% of coastal and marine areas and is thus inextricably linked to the current global coverage of MPAs (United Nations, 2015). Similarly, fishery-related ABMTs aim to regulate harvesting to avoid overfishing, eliminate illegal unregulated and unreported fishing, and conserve living marine resources (Haas et al., 2021), thus contributing substantially to the achievement of SDG target 14.4 (Fig. 2).

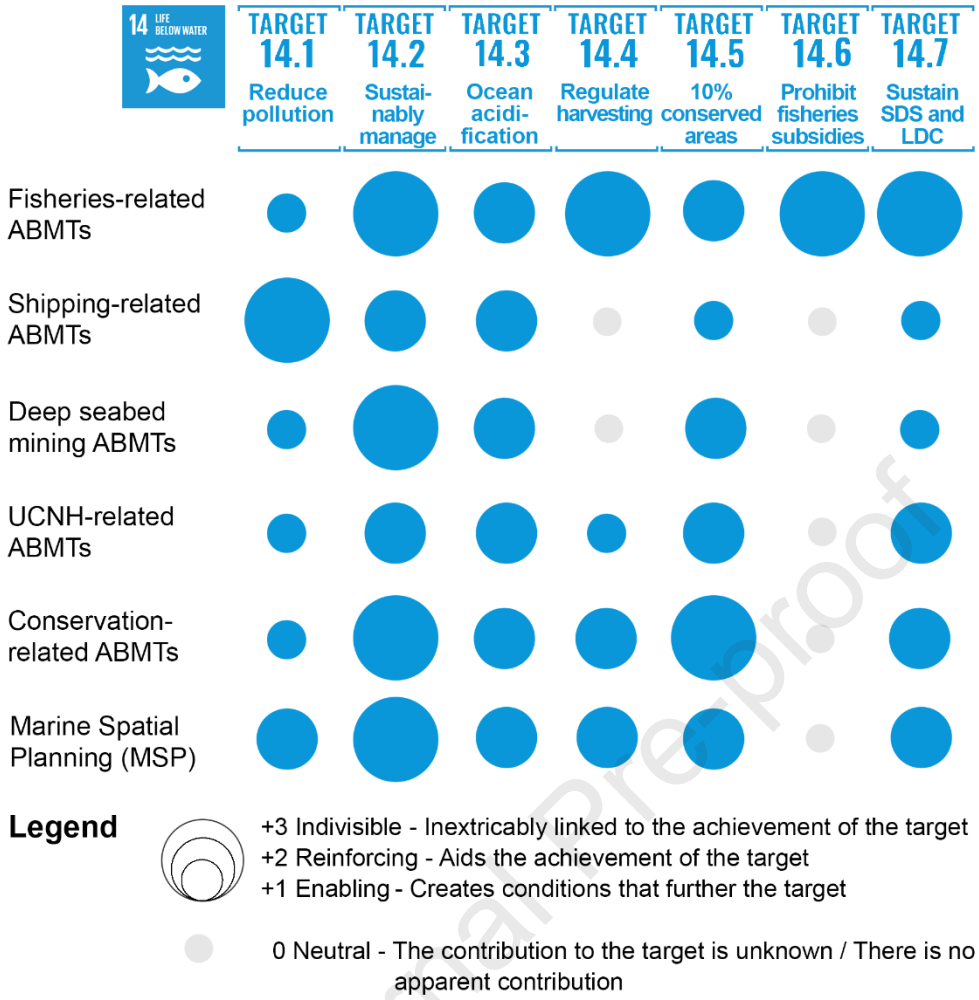
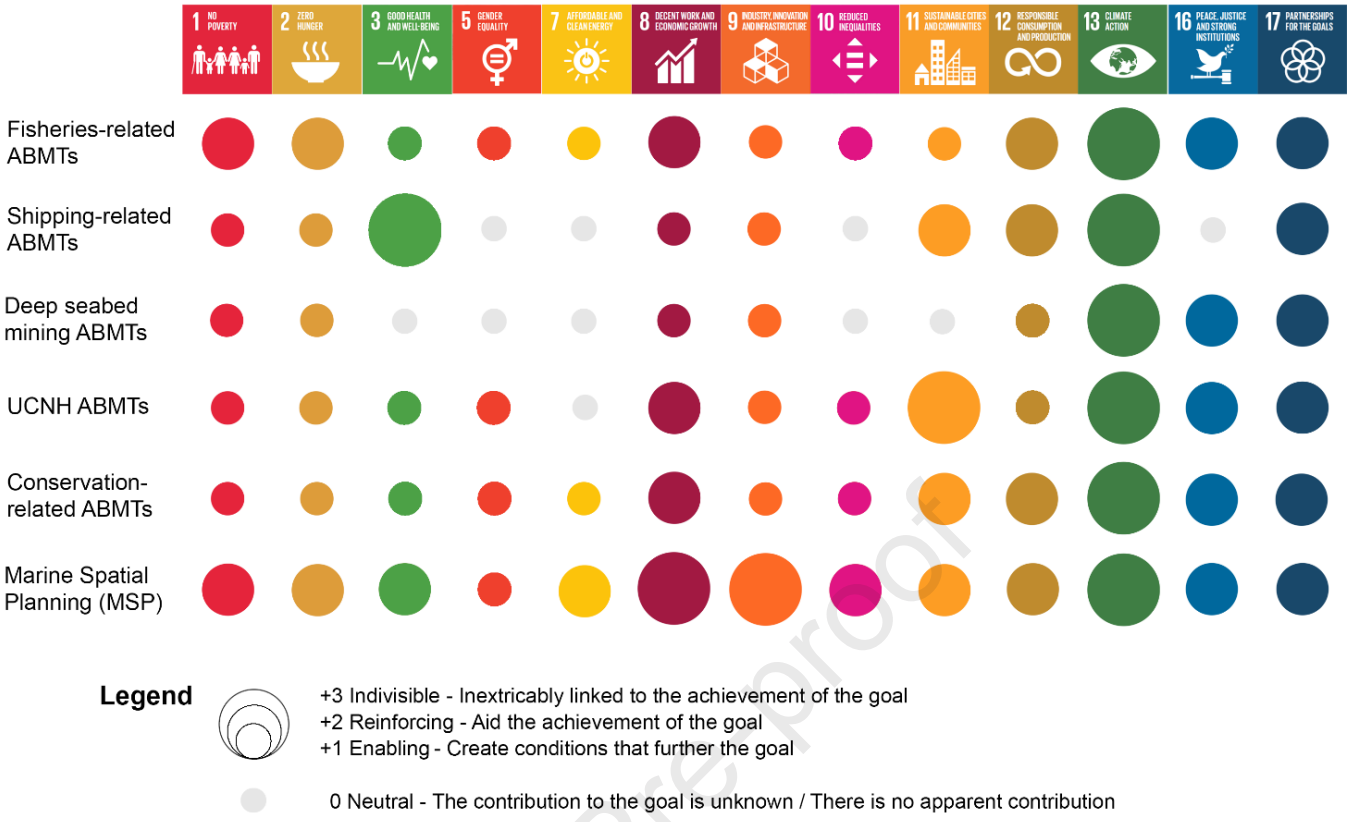


Figure 2: **Potential contribution of existing Area Based Management Tools (ABMTs) stipulated in international and regional agreements towards the achievement of the seven SDG 14 targets.** UCNH = Underwater Cultural and Natural Heritage. For details see Tables B.1-20.



253

254 **Figure 3: Potential contribution of existing Area Based Management Tools (ABMTs) stipulated in**
255 **international and regional agreements towards the achievement of selected ocean-related SDGs at goal**
256 **level**. UCNH = Underwater Natural and Cultural Heritage. For details see Tables B.1-20.

257

258 At the same time, there are cases where ABMTs can still create the conditions to further such goals, i.e.
259 "enabling" or even aiding ("reinforcing") in their achievement, although they are not inextricably linked to the
260 respective SDGs (Figs. 2 and 3). For example, integrating women's needs and actions in the establishment of
261 fishery-related ABMTs can increase women empowerment and provide social and economic benefits to their
262 families and the broader community (Di Ciommo and Schiavetti, 2012; Rohe et al., 2018), simultaneously
263 supporting SDG 14.4 *Regulating harvesting*, SDG 5 *Gender equality* and SDG 1 *Reduce poverty*. Another
264 example can be found with respect to SDG 9 *Build resilient infrastructure, promote inclusive and sustainable*
265 *industrialization and foster innovation*, where the adoption of MARPOL Special Areas (Annexes I, II, IV, V)
266 in the Baltic Sea has led to the creation of reception facilities in Baltic ports (Klopott, 2018), followed by other
267 EU ports in a Special Area. To meet the new environmental regulations targets, shipping industry and port

facilities responded through fleet renewals and retrofitting (Klopott, 2018). Also, the designation of shipping-related ABMTs (e.g., Particularly Sensitive Sea Areas - PSSAs, special areas, or routing measures) contributes to sustainable tourism (SDG 8 *Decent work and economic growth*) by reducing safety risks and significant negative impacts of shipping, as in the Malaysia PSSA case (Marine Environment Protection Committee, 2017). Finally, transboundary protected areas, some particularly connotated peace parks, have been designated to simultaneously protect and maintain biological diversity and natural and cultural resources, and to promote peace and cooperation between countries, as in the case of the Red Sea Marine Peace Park (Portman and Teff-Seker, 2016); these clearly contribute to SDG 14 and SDG 16 *Promote peaceful and inclusive societies for sustainable development*.

In general, ABMTs have the overarching potential to contribute to SDG 17 *Strengthen the means of implementation and revitalize the global partnership for sustainable development*, as their designation and implementation is usually the outcome of negotiations and coordination between multiple stakeholders including private actors, non-governmental organizations and States.

Importantly, several ABMTs can significantly contribute towards SDG 13 *Taking urgent action to combat climate change and its impacts*, and to minimize and address the impacts of ocean acidification (SDG target 14.3). For instance, the adaptive management of fishery closures and spatially-based rights towards climate-induced shifts of fish stocks can promote long-term resource stewardship (Ojea et al., 2017; Pinsky and Byler, 2015). Targeting climate refugia to identify new MPAs is also a promising action to improve ecosystem resilience and to adapt to the effects of climate change (Rilov et al., 2020b). Another example is the proposed 10% speed reduction across the global shipping fleet to be implemented throughout shipping-related ABMTs by the International Maritime Organization (IMO), which is estimated to reduce overall greenhouse gas emissions (GHG) by around 13% (Faber et al., 2017; Psaraftis, 2019), and therefore improves the probability of meeting GHG reduction targets by 23% (Comer et al., 2018). The OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic Ocean and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) emphasize the importance of marine research on ocean acidification to ensure effective management of their MPA networks (Johnson et al., 2018), in line with the

294 indications of SDG target 14.3 on minimizing and address the impacts of ocean acidification, including through
295 enhanced scientific cooperation at all levels.

296 For several SDGs, limited evidence was found on the potential contributions of ABMTs towards their
297 achievement. This is the case, for example, of SDG 14.6 *Prohibit certain forms of fisheries subsidies which*
298 *contribute to overcapacity and overfishing*, where no clear contribution was detected for any ABMTs, except
299 for fishery-related ones. This is most likely due to the limited spatial nature of the target for which the other
300 ABMTs are not suitable instruments. Negative influences of ABMTs on SDG 14 targets and other goals were
301 not identified.

302

303 **3.2 Enabling factors and impediments to progress towards SDGs**

304 Although it is clear that ABMTs have the potential to contribute substantially to the achievement of SDGs,
305 there are important factors that could reduce or potentially even hinder the realization of such contributions.
306 To unlock the full potential of ABMTs for SDG achievement, it is therefore crucial to consider a range of
307 context-specific, positive and negative factors (see examples in Table 3, and full description in Tables B.1-
308 20). Though the evidence is still limited for several ABMTs (Figs. 4 and 5), overall enabling factors and
309 impediments were found to be largely related to questions of governance (e.g., in conservation-oriented
310 ABMTs (Ban et al., 2017; Sciberras et al., 2015)), institutional capacity in ABMTs enforcement (e.g., in
311 fishery-related ABMTs in ABNJ (Haas et al., 2020)), societal challenges (e.g. raising awareness amongst
312 multiple actor groups, such as on cultural and natural heritage along with UCNH sites implementation (Calado
313 et al., 2019)), or environmental factors (e.g. with regard to the effectiveness of fishery closures both in areas
314 under national jurisdiction (Beare et al., 2013) and ABNJ (Davies et al., 2017)).

315 For instance, a complex picture emerged on whether or not MPA designation and implementation increases
316 people's overall food security (SDG 2), as the enabling factors for implementing MPAs towards food security
317 are unclear (Charles et al., 2016; Kumar, 2014). Moreover, the impact of MPAs on food security and health of
318 local populations is complicated by a range of mediating, historical, political, socioeconomic, ecological,
319 seasonal, cultural, and contextual factors (Kamat and Woo Kinshella, 2018). Similarly, the likelihood of

320 reducing impacts from deep sea trawling on seabed habitats and biota by fisheries spatial measures is
321 influenced by several factors. These range from legal barriers, to the characteristics of the fishery and the
322 ecosystem, to local, regional or national priorities and resources (McConnaughey et al., 2019), thus affecting
323 the contribution of fishery-related ABMTs towards SDG targets 14.2, 14.4, and 14.5. Enforcement capacity of
324 ABMTs also determines the contribution towards SDGs. Adequate human and financial resources to
325 implement ABMTs have proven critical for MPAs within national jurisdiction and in ABNJ (Gill et al., 2017),
326 as well as for fishery closures (Haas et al., 2020) and UCNH zones (Calado et al., 2019). For example,
327 mobilizing private investments by setting up innovative financing mechanisms is critical in supporting
328 enforcement capacity (Thiele and Gerber, 2017).

329

330 **Table 3**: Examples of enabling and constraining factors of the contribution of ABMTs to attaining SDGs. For
331 details see Tables B.1-20.

Categories of enabling and constraining factors	Examples
Political factors/political will	Fishery-related ABMTs and SDG 2: Suarez de Vivero et al. (Suárez-de Vivero et al., 2019) found that, with the exception of the African Union and its 2050 Africa's Integrated Maritime Strategy, the notion of food security can be said to lack relevance and visibility in newest visions of marine strategy. This will influence the way the concept is formally reflected in technical and political documents (Suárez-de Vivero et al., 2019) and related ABMTs.
Legal factors	MSP and SDG 7: By supporting the allocation of space to renewable energy developments, MSP can substantially increase the share of renewable energy in the global energy mix by 2030 (European Commission, 2019). The overall legal framework for wind energy projects in ABNJ can however pose challenges. Flag states will play a central regulatory role for high seas wind energy developments. However, there is the risk that flags of convenience might unduly undercut environmental and safety standards (in place for projects at territorial sea and EEZs). Such abuse of high seas freedom could compromise the UNCLOS principle of 'due regard'. MSP approaches and the establishment of cooperative mechanisms, led by the IMO, could safeguard against such potential misappropriation (Elsner and Suarez, 2019).
Enforceability	UCNH ABMTs and SDG 9: The 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage is slowly but peremptorily becoming a standard reference tool for underwater archaeology and underwater cultural heritage management. The many provisions included within the Convention touch on many aspects that are key to an effective protection and promotion of the underwater cultural heritage. Within the web of these provisions many aspects are gaining consideration and driving research in underwater archaeology worldwide. These provisions, when seen within a wider frame of social, economic and technological dynamics, pinpoint many aspects requiring further scrutiny from the disciplinary circle (Secci, 2017). Shipping-related ABMTs and SDG 11: The designation of PSSA and the adoption of routeing measures (ATBA and TSS) in relevant areas for cultural and natural heritage contribute to their safeguard (Target 11.4) by reducing significant negative impacts of shipping. However, TSS speed reduction is not mandatory (Faber et al., 2017), hampering the contribution of PSSA towards safeguarding UCNH. Fishery-related ABMTs and SDG 12: With respect to sustainable consumption, already in 2007, Jacquet and Pauly (2007) documented several limitations in the relationships between seafood awareness campaigns and sustainable consumption, due, for instance, to the lack of traceability of the products, and, consequently, the

	capacity to relate to fishery-related ABMT. Still, the proliferation of eco-labelling practices makes the assessment and evaluation of their effectiveness complex (Alfnes et al., 2018).
Transparency	Conservation-related ABMTs and SDG 2: In five MPAs of South Africa, the loss of tenure rights and access to resources amongst already marginalized communities contributed to food insecurity, less exchange of food and less household income (Sowman and Sunde, 2018). Nevertheless, MPAs may represent a viable strategy for enhancing food security, but current MPA practices in many places can negatively affect some fishers (Mascia et al., 2010). If food security of local communities is envisaged as one of the objectives to design an MPA, this has to be clearly addressed in the MPA management and governance (Kamat and Woo Kinshella, 2018).
Governance structure	Conservation-related ABMTs and SDG 10: When setting a MPA, the conservation targets, the established objectives, and the type of governance structures in place will partly determine the benefits for coastal communities and their equal distribution across social groups, actors, and communities (Bennett et al., 2020).
Inclusivity	MSP and SDG 2: In Canada, MSP supports priority use of marine resources for First Nations traditional use (subject to conservation needs), including food, social and ceremonial requirements. It also supports maintenance of natural resource systems that deliver marine goods and services at multiple scales (Pacific North Coast Integrated Management Area (PNCIMA) Initiative, 2017) Fishery-related ABMTs and SDG 8: Fishery-related ABMTs such as fishery closures have the capacity to provide both economic benefits (e.g., revenues, incomes) and conservation benefits. These benefits, however, depend on several factors (Goetze et al., 2018) such as the duration of the closing period; the extension of the closing area (the larger the better), compliance to the closure, which should be encouraged via community engagement and enforcement; and strict deadlines/goals for harvesting to prevent overfishing.

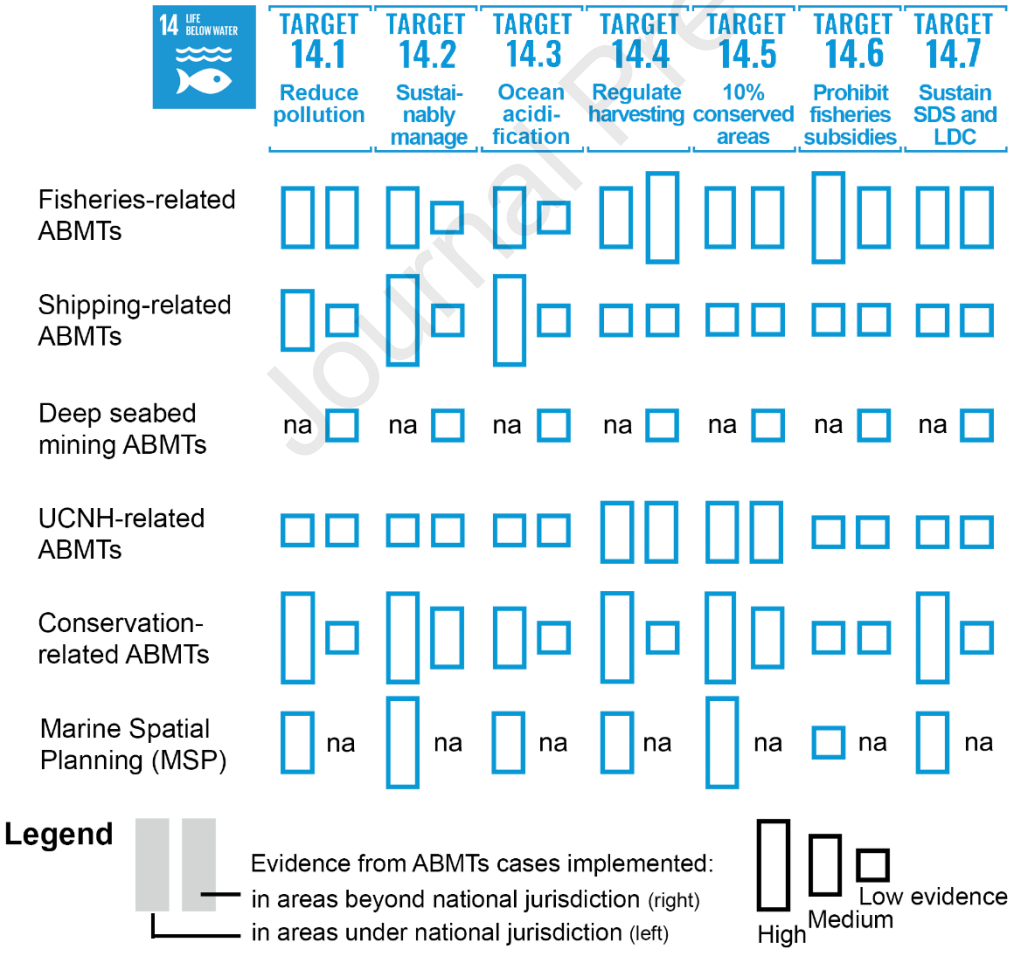


Figure 4: Evidence from experts' knowledge, scientific and grey literature on enabling factors and barriers for ABMTs to contribute to the seven SDG 14 targets. Evidence is leveraged from ABMTs cases

implemented in areas under national jurisdiction and in ABNJ; boxes provide a summary estimate of evidence for both enabling factors and barriers. UCNH = Underwater Cultural and Natural Heritage. For details see Tables B.1-20.

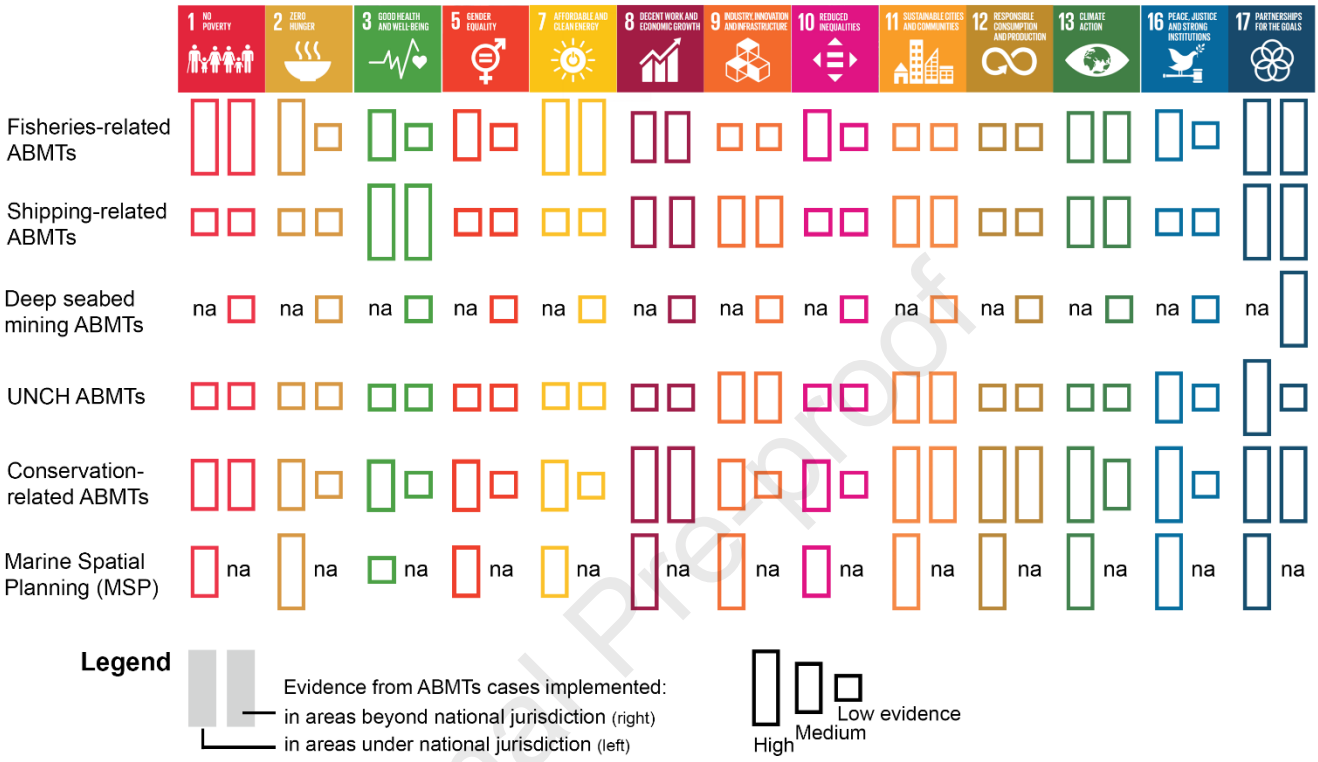


Figure 5: Evidence from experts' knowledge, scientific and grey literature on enabling factors and barriers for ABMTs to contribute to the selected ocean-related SDGs at goal level. Evidence is leveraged from ABMTs cases implemented in areas under national jurisdiction and in ABNJ; boxes provide a summary estimate of evidence for both enabling factors and barriers. UCNH = Underwater Cultural and Natural Heritage. For details see Tables B.1-20.

A general hindering factor pertains to power relationships and equity in ABMTs designation and implementation, both within and between countries, with respect to the use of marine resources (SDG targets 14.2, 14.5, and 14.7). This is of special concern to Small Island Developing States and Least Developed Countries, many of which can be affected by activities occurring beyond their national boundaries (Popova et al., 2019). Concerns for equity in designating ABMTs are particularly relevant in marine areas under national jurisdiction, for instance with respect to equal access to natural resources for multiple economic actors and

local communities (Stead, 2018). Concerns on equity and power relationships have also been raised on ABNJ for deep seabed mining, e.g., with regard to Areas of Particular Environmental Interest (APEIs), and on fishery closures. For these areas, transparency and inclusiveness are at stake for decision-making mechanisms of the International Seabed Authority (Ardron et al., 2018) and some of the Regional Fishery Management Organizations (RFMOs) (Haas et al., 2020).

4. Discussion

This study showed that ABMTs can significantly contribute to SDGs attainment, with fisheries- and conservation-related ABMTs, and MSP having the greatest potential contributions overall. We also depicted various ways in which ABMTs can complement the attainment of various SDGs in parallel, showing high complementarity and synergy among different ABMTs for most SDGs.

Importantly, we did not find trade-offs between ABMTs and SDGs. This might be partially attributed to the methodological approach taken in this research, which focused on potential contributions of ABMTs for achieving SDGs under ideal circumstances. Further in-depth analysis of existing cases that accounts for different context-related factors would be valuable to show how the contribution of ABMTs to achieving SDGs is dependent on case-based implementation. This is also valid for the ABMTs for which we did not find any apparent contribution towards some SDGs, such as for shipping-related ABMTs towards SDG 5 on *Gender equity*. In these cases, the authors were not aware of any case of ABMT implemented for the purpose of achieving other SDGs in addition to their primary purpose. This consideration opens for a vast field of investigation. For instance, intersectional research could provide valuable insights on the contributions of ABMTs towards the achievement of SDGs 3 *Good health and well-being*, 5 *Gender equity*, 10 *Reduce inequalities*, and on the role of multiple interacting factors shaping marine and coastal social-ecological systems, such as socio-economics, gendered division of labour, ethnicity, education level. This would help to unveil the potential contribution of ABMTs to the achievement of all the SDGs, including for those that appear not strictly related to ABMTs designation and implementation.

Another point to be raised pertains to the questions how the contributions of ABMTs towards the SDGs could be determined and monitored for best possible outcomes. The current SDG framework addresses ABMTs and their potential to achieve the SDGs in a generic way, with only two targets directly referencing ABMTs: SDG targets 14.2 and 14.5 refer respectively to "sustainably manage[ing] and protect[ing] marine and coastal ecosystems (…)", and "conserve[ing] at least 10 per cent of coastal and marine areas (…)" (United Nations, 2015); the latter target will likely be overpassed by the CBD's new post-2020 global biodiversity target which is set at the 30% (UNEP, 2020). The indicators defined by the Inter-agency and Expert Group of the UN Statistical Commission to monitor these SDG 14 targets only count for the area coverage of ABMTs, with indicator 14.2.1 referring to the "Proportion of national exclusive economic zones managed using ecosystem-based approaches", and indicator 14.5.1 to the "Coverage of protected areas in relation to marine areas". However, counting the area managed with ABMTs does not allow for a sound reporting about the actual effectiveness of implementing ABMTs towards any SDG attainment.

Thus, a next step should be to define quantitative and qualitative indicators to monitor the contribution of ABMT implementation to achieving the SDGs. These indicators need to be relevant and straightforward (Cai et al., 2021; Hák et al., 2016) in reflecting on the management quality towards SDG attainment, and go beyond monitoring managed areas by quantity or area coverage (De Santo, 2013; Grorud-Colvert et al., 2021). The vast experience and knowledge on assessing MPA effectiveness towards environmental, social, and economic outcomes (e.g., Grorud-Colvert et al., 2021; Meehan et al., 2020; Picone et al., 2020) could be utilized to develop such indicators for assessing the contribution and effectiveness of ABMTs towards SDG achievements. A meaningful assessment framework that brings together these indicators could help to align policies and ABMT initiatives, monitor goal attainment and identify gaps, and so help making progress towards the 2030 Agenda while ensuring durable and equitable outcomes from ABMT implementation.

To make progress towards multiple SDGs at once, it is crucial to ensure coordination between initiatives established by different organisations and responsible authorities. At present, different ABMT initiatives can potentially be developed in parallel and independently from one another in the same geographical area by the respective responsible authorities, and without any coordination between the competent management bodies. The lack of coordination between ABMTs can potentially undermine the achievement of their objectives,

404 because of potentially conflicting visions and agendas between institutions (Singh et al., 2018). Without
405 coordination, the co-occurrence of multiple interests and responsible authorities over the same areas can
406 significantly hinder a holistic approach to ecosystem-based decision-making and transformation towards
407 sustainability (Gjerde and Wright, 2019; Saunders et al., 2019; Vince and Day, 2020) – and hence, towards
408 SDGs achievement. Eventually, the implementation of ABMTs can provide nuanced contributions to SDGs
409 while responding directly to the specifics of problems they were set up to address, e.g., related to a single
410 sector, a single area, or a single management problem.

411 Whereas sectoral ABMTs have the potential to directly support the implementation of specific SDG 14 targets,
412 the analysis has shown that ABMTs taking a cross- or multi-sectoral approach tend to simultaneously enable
413 a broader range of benefits for different SDG 14 targets, as well as for other SDGs (Fig. 1, 2). Cross-sectoral
414 ABMTs, such as MSP, are those managed to coordinate multiple uses at sea towards the common overarching
415 objective of sustainable development (Ehler and Douvere, 2009; IOC-UNESCO and DG MARE, 2017). They
416 usually work by harmonizing sectoral management and related ABMTs through the cooperation of respective
417 responsible authorities (e.g., fisheries agencies and conservation agencies). Especially in Africa, initiatives to
418 foster a blue economy are seen as a way to alleviate poverty (SDG 1) and to support sustainable economic
419 development (SDG 8, e.g., World Bank and UNDESA, 2017). In addition to MSP, other ABMTs can adopt
420 cross-sectoral management approaches, as it is the case of MPAs (Muraki Gottlieb et al., 2018). However,
421 MSP can provide several benefits for both conservation and the sustainable use of marine resources (Agardy
422 et al., 2011; Fraschetti et al., 2018; Rilov et al., 2020b). MSP is usually applied to large areas under the
423 responsibility of coastal States, i.e. territorial seas and EEZs, and so MSP can support the achievement of
424 multiple SDGs on large areas. In some cases, national MSP initiatives fully or partially coincide with the
425 management of large MPAs, such as in Palau with the Palau National Marine Sanctuary (PICRC and COS,
426 2019), and in the 30 year-long MSP process of managing the long-term protection and ecologically sustainable
427 use of Australia's Great Barrier Reef Marine Park (Day et al., 2019).

428 The need for coordination of multiple ABMT initiatives for the purpose of achieving multiple SDGs is
429 especially urgent in ABNJ, where ABMTs are generally far less developed compared to those in national
430 waters that are subject to the rights and obligations of single coastal States, and where the coexistence of many

different sectorial organizations can undermine each other. The need for MSP in international waters has long been advocated (Ardron et al., 2008; Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel and —GEF, 2012; The Aspen Institute, 2011), and is increasingly argued for as part of a more comprehensive approach to ocean sustainability (Ehler, 2020; Wright et al., 2019). However, there are no formal MSP initiatives in ABNJ, nor is there a specific policy context for it. The ongoing negotiation of a legally-binding instrument for the conservation and sustainable use of marine biological diversity beyond national jurisdiction provides the opportunity to address the shortcomings of predominantly sectoral approaches for ABMT in ABNJ and facilitate the development of cross-sectoral approaches with a greater potential to deliver the overall 2030 Agenda. As UN Resolution 69/292 (UN, 2015) on the development of such a new legal instrument included a provision that it should "not undermine" relevant existing legal instruments and frameworks and relevant global, regional, and sectoral bodies in ABNJ, it will be important that a "narrow" interpretation of this provision will be avoided in the negotiation process (Clark, 2020; Scanlon, 2018). Instead, sectoral organisations with mandates in ABNJ, such as the ISA or RFMOs, need to adopt coordinated and collaborative approaches that contribute towards the overall objective of the new legal instrument. In ABNJ, there are pioneering cases of ABMT applications that have successfully provided multiple benefits towards the achievement of SDGs. An example of cross-sectoral cooperation is the development of a regional network of MPAs in ABNJ in the North-East Atlantic. This world's first MPA network in ABNJ was established by the OSPAR Commission and largely corresponds to fisheries closure in the same area established by the North-East Atlantic Fisheries Commission (Smith and Jabour, 2018). A collective arrangement between both organisation helps further cooperation across institutional and sectoral barriers and addresses some of the weaknesses of the fragmented governance approach (Kvalvik, 2012; NEAFC and OSPAR, 2015).

4. Conclusions

This study demonstrates the benefits of ABMTs for the implementation of the 2030 Agenda and achieving SDG 14 and other related SDGs. However, without much needed transformations in the governance of ABMTs, the largely fragmented governance of ABMTs might hamper the implementation of the holistic 2030

Agenda with its indivisible set of SDGs. Here, the 2030 Agenda might not only serve as goal-based governance framework within which ABMTs are implemented, it could also drive change that serves the development of novel holistic ocean governance approaches needed, e.g., in the context of the proposed post-2020 Global Biodiversity Framework putting forward new global targets to ensure all sea areas are under integrated biodiversity-inclusive spatial planning and at least 30 per cent globally of all sea areas are conserved through protected areas and other effective area-based conservation measures (CBD, 2021).

To increase the opportunities to achieve the 2030 Agenda and associated SDGs, coastal states should address relevant contextual factors and strengthen the coordinated, equitable and inclusive applications of ABMTs. There is an urgent need to move beyond the current sectoral approach in ABMTs, and to advance strategies and governance arrangements for coordinated actions between multiple types of ABMTs. In contrast to a sectoral ABMT approach, the adoption of a holistic perspective that promotes the coordinated and coherent implementation of ABMTs will amplify associated co-benefits for multiple SDGs, both within and beyond national jurisdiction.

Overcoming potential conflicts and competing interests that hinder the achievement of the SDGs requires not only consistent coordination and cooperation between ABMT initiatives, but also the identification of overarching goals to be achieved and towards which the different ABMT initiatives can converge through multilevel governance agreements over multi-administrative boundaries and responsibilities. SDGs in itself are an attempt to provide such overarching goals to reduce potential conflicts between multiple policy objectives. Integrated ABMTs can become a key tool to operationalize and implement SDGs in the ocean. Future research needs to establish an indicator framework for assessing and monitoring implementation and effectiveness of ABMTs and their support of SDG attainment.

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Highlights

1. Qualitative assessment of Area-Based Management Tools (ABMT) contribution to SDGs
2. Expert and literature review provided assessment with evidence from existing cases
3. We found high complementarity and synergy among different ABMTs for most SDGs
4. Fishery ABMTs, MPAs and MSP contribute mostly to SDG 14 *Life Below Water*
5. All ABMTs can significantly contribute towards SDG 13 *Climate action*

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: