Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Moving Protection for Moving Biodiversity: Towards dynamic area-based management in areas beyond national jurisdiction

Christian Rischer

christian.rischer@kielinstitut.de

Kiel Institute

Sina Berends

Carl von Ossietzky University Oldenburg

Jan-Claas Dajka

Helmholtz Institute for Functional Marine Biodiversity at the University of Oldenburg (HIFMB)

Evgeniya Elkina

Ecologic Institute

Gregory Fuchs

Ecologic Institute

Fenja Kroos

Ecologic Institute

Torsten Grothmann

Carl von Ossietzky University Oldenburg

Carl Reddin

University of Bremen

Wilfried Rickels

Kiel Institute

Arne Riedel Escobar

Ecologic Institute

Bernd Siebenhüner

Carl von Ossietzky University Oldenburg

Article

Keywords:

Posted Date: November 24th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11676107/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Achieving the global commitment to conserve at least 30% of the ocean by 2030 requires area-based management approaches that remain effective under changing environmental conditions. However, climate change is increasingly shifting the distribution of marine species, habitats, and ecosystems, while existing area-based management tools (ABMTs) remain predominantly static. This mismatch is particularly challenging in areas beyond national jurisdiction (ABNJ), where marine biodiversity are becoming more mobile and conservation governance remains fragmented across regional and sectoral institutions. Dynamic ABMTs, which allow management measures to respond to changing ecological and environmental conditions, could help address these limitations. The recently adopted Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement) provides a new opportunity to strengthen area-based protection and explore more adaptive management approaches. A qualitative legal and policy analysis of existing governance arrangements and dynamic ocean management approaches identifies institutional fragmentation, lengthy decision-making procedures, and limited cooperation among sectoral organizations as key barriers to implementing dynamic conservation measures in ABNJ. These findings underscore the need to explicitly recognize dynamic ABMTs within the BBNJ framework, develop scientific and technical guidance incorporating predefined control rules, and strengthen cooperation among relevant regional and sectoral organizations. Together, these measures could enable stronger coordinated, and science-based management responses to changing ecological conditions.

Complementing static area-based conservation in a changing ocean

Climate change is accelerating the dynamics of marine ecosystems: oceanographic fronts move, habitats shift, species migrate, and novel ecosystems emerge[1,2]. These changes can, in turn, reshape the conditions under which marine human activities take place, altering where, when and how intensely activities including fishing, shipping and offshore resource extraction exert pressure. For example, marine heatwaves can redistribute pelagic fishing fleets[3]. While both ecological conditions and human pressures are changing rapidly in both intensity and distribution[4,5,6], area-based marine conservation and management remain predominantly static, in terms of spatial and regulatory approaches, such as static marine protected areas (MPAs) with fixed boundaries. This mismatch and associated costs are particularly pertinent in areas beyond national jurisdiction (ABNJ), where area-based approaches need to account for highly mobile species, pelagic ecosystems, transboundary ecological connectivity and processes that cross jurisdictional boundaries[7,8].

Area-based protection in ABNJ remains limited: less than 2% of the high seas are currently protected through area-based management tools (ABMTs)[9,10]. However, the recently ratified High Seas Treaty (also known as the BBNJ Agreement), with its Part III on ABMTs, now provides a regulatory framework and political window of opportunity for implementing more of these area-based protection measures in the high seas. Expanding effective area-based conservation in ABNJ will also be crucial for global efforts to

achieve Target 3 of the Kunming-Montreal Global Biodiversity Framework (KMGBF), commonly referred to as the “30 by 30” target. It aims to conserve and sustainably manage 30% of terrestrial and marine areas by 2030, with an emphasis on equitable management, ecological representativeness, and connectivity for a stronger area-based protection[11].

At the same time, increasing coverage alone may not be sufficient where the ecological features targeted for conservation shift spatially away from the equator over time mainly due to climate change[12] (Hodapp et al. 2023). Modelling the habitat shifts of high seas EBSAs under climate change until 2100 suggested that static protection would be effective for only a third of EBSAs[13] (Reddin et al., 2026). These findings point to a broader challenge for conservation in ABNJ: not only is the current extent of area-based management limited, but existing approaches may also be not well suited to respond to these ecological changes. This raises questions about whether the present state of area-based management tools is sufficient to maintain conservation effectiveness under these changing conditions.

Current ABMT implementation in ABNJ: fragmented and predominantly static

Area-based management in ABNJ has so far developed through a fragmented system of global, regional and sectoral governance. Understanding this fragmented governance landscape is important because the BBNJ Agreement establishes a new global and cross-sectoral legal framework for the designation and implementation of ABMTs, including MPAs, across ABNJ, thereby moving beyond the predominantly regional and sectoral pathways that have characterized area-based management to date[14]. While the United Nations Convention on the Law of the Sea (UNCLOS) provides the overarching legal framework for the protection and preservation of the marine environment, it does not provide a dedicated mechanism for the designation and implementation of ABMTs in ABNJ[15]. Prior to the BBNJ Agreement, ABMTs have been established primarily through regional conventions and sectoral organizations exercising mandates over particular regions or activities[16]. High seas MPAs, for example, have been established under the OSPAR Convention in the North-East Atlantic and the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) in the Southern Ocean, while sectoral bodies have adopted other forms of area-based measures, including fisheries closures and protection of marine ecosystems, for example, the North East Atlantic Fisheries Commission (NEAFC) protecting Vulnerable Marine Ecosystems (VMEs).

Existing ABMTs demonstrate that area-based conservation in ABNJ is possible but also exposes important limitations (Table 1). At the moment, a limited number of ABMTs in ABNJ at the regional and (cross-) sectoral level are established. Regional conventions can establish MPAs within their geographical mandates yet generally lack the authority to regulate all human activities occurring within them. Sectoral organizations, in turn, can regulate only the activities falling within their respective mandates, limiting their ability to address cumulative or cross-sectoral pressures[17,18]. These measures should not, however, be treated as equivalent forms of area-based protection. They range from scientific

descriptions to sector-specific measures and treaty-based MPAs, with substantial differences in legal effect, scope and capacity to address cumulative pressures. EBSAs (Ecologically or Biologically Significant Marine Areas) identify areas of ecological significance but do not themselves prescribe management measures; APEIs (Areas of Particular Environmental Interest) in the Clarion–Clipperton Zone, by contrast, are no-mining areas under the ISA (International Seabed Authority) framework, but their protection is directed primarily at seabed mining and does not extend to fisheries, shipping or other activities. VMEs and PSSAs (Particularly Sensitive Sea Areas) likewise operate within fisheries and shipping mandates, respectively. Table 1 should therefore be read as illustrating a fragmented and uneven landscape of ABMTs in ABNJ, rather than a set of equivalent conservation areas.

OSPAR illustrates this governance challenge particularly clearly. The OSPAR Commission can establish MPAs and define conservation objectives but is still limited in their sectoral competencies. Fisheries still fall primarily under the competence of the North-East Atlantic Fisheries Commission (NEAFC), while shipping and seabed activities fall under the International Maritime Organization (IMO) and ISA, respectively[18]. Cooperation and coordination between the relevant institutions are consequently central to effective implementation[19]. Cooperation between OSPAR and NEAFC developed comparatively successfully under the Collective Arrangement, demonstrating that regional and sectoral measures can be better aligned. Cooperation with other sectoral bodies has, however, been more limited. The IMO and ISA have historically been more hesitant to participate in the arrangement, although the ISA attended a meeting under it in 2023[20]. Despite significant regional and legal overlaps, this shows that no single institution exercises comprehensive cross-sectoral authority over these areas[15,18] neither have they established truly dynamic approaches to marine conservation.

Table 1

Existing area-based management tools (ABMTs) at the regional and sectoral level. This overview showcases the limited amount of ABMTs in ABNJ while also symbolising a certain level of fragmentation.

regional / sectoral framework	form of ABMT	implementation
International Seabed Authority (ISA)	Areas of Particular Environmental Interest (APEIs) Regional Environmental Management Plans (REMPs)	13 APEIs implemented
International Maritime Organization (IMO)	Particularly Sensitive Sea Areas (PSSAs) MARPOL special areas	no PSSAs in ABNJ; some in territorial waters overlapping with MPAs
Regional Fisheries Management Organizations (RFMOs)	Vulnerable Marine Ecosystems (VMEs) spatial/seasonal fishery closures	8 RFMOs have established VMEs
OSPAR and CAMLR Convention	MPAs	10 MPAs in ABNJ
International Whaling Commission (IWC)	Whale sanctuaries	2 sanctuaries

Sources

Table is compiled from various sources[15,18,20,21,22,23].

More broadly, the effectiveness of regional and sectoral measures remains dependent on implementation by their contracting parties, while decision-making can be lengthy (years to decades) where consensus requirements (e.g. CCAMLR), competing interests, geopolitical considerations and concerns over state sovereignty intersect[21,25,24]. Similar limitations apply to sectoral organizations such as RFMOs, whose mandates remain focused on fisheries and whose measures depend strongly on implementation and enforcement by states[15].

The existing governance landscape has therefore produced a regional- and sectoral pathway for ABMT implementation rather than a comprehensive cross-sectoral system. Conversely, the existing governance landscape appears better suited to supporting static area-based measures than to accommodating biodiversity that shifts across space and jurisdictional boundaries over time. This distinction becomes particularly important where conservation effectiveness depends on the ability of management measures to track ecological change rather than remain fixed in space. Importantly, the ABMTs established through these arrangements remain predominantly static; no dynamic ABMT is currently operational in ABNJ[26]. This raises the question of whether existing governance structures are sufficiently

flexible to accommodate management approaches that must respond more rapidly to changing ecological conditions.

The BBNJ Agreement: a global framework for ABMT implementation and coordination

The BBNJ Agreement creates a new governance framework for area-based management in ABNJ[14]. Most importantly, the Agreement establishes a global and cross-sectoral legal basis for the designation and implementation of ABMTs, including MPAs, across ABNJ, thereby moving beyond the predominantly regional and sectoral pathways described above[14]. Part III of the BBNJ provides a common process for the proposal, assessment, establishment, implementation, monitoring and review of ABMTs. In this way, the Agreement has the potential to provide greater coherence to area-based management and to facilitate and potentially accelerate ABMT implementation[15].

Meanwhile, the BBNJ Agreement does not replace the existing governance architecture. It is expressly required to be interpreted and applied in a manner that does not undermine relevant legal instruments and frameworks and relevant global, regional, subregional and sectoral bodies (IFBs) (Article 5(2)). This safeguard reflects concerns raised during the negotiations, particularly regarding the continued competence of sectoral organizations such as RFMOs[14,27]. Importantly, however, the obligation not to undermine existing IFBs is coupled with an explicit commitment to promote coherence and coordination. Cooperation and coordination are embedded throughout the ABMT process, and the Conference of the Parties (COP) is required to establish arrangements for regular consultations with and among relevant IFBs. Parties are likewise expected to promote the objectives of the BBNJ Agreement when participating in decision-making within those bodies. The Agreement can therefore provide a coordinating layer across existing regional and sectoral regimes without displacing their respective competences[26,28]. This coordinating role may help bring otherwise fragmented conservation objectives, sectoral measures and institutional processes closer together and has been described as allowing the Agreement to act as a potential “mechanism coordinator” and “gap filler” within the existing governance landscape[29].

The BBNJ Agreement therefore provides an opportunity not only to strengthen the implementation of existing forms of area-based management, but also to explore more responsive approaches that better reflect the dynamic character of marine ecosystems under global change. Dynamic area-based management and, more specifically, dynamic ABMTs, comprise one such option.

Policy option: Implementation of dynamic ABMTs under the BBNJ Agreement

One approach increasingly discussed in this context is dynamic ocean management (DOM), which seeks to align management more closely with the dynamic character of marine ecosystems[30,31,32]. Rather than applying management measures to the same area over long periods, dynamic ocean management can

respond to changing biological, environmental and human-use conditions, using near-real-time data, forecasting and modelling of species and habitat distributions, for example by closing areas for fishing for a limited time[33,34,35]. DOM builds on the concept of adaptive management (AM) that becomes particularly relevant during the implementation phase of the management process[33]. AM is generally characterized as a structured and iterative learning-by-doing process in which management actions are adapted according to data from continued monitoring, assessment, and new knowledge[33,36]. Within this process, repeated expert assessments are important to fine-tune management processes[37]. As suggested for the management and conservation of Antarctic Krill[38], DOM can accelerate this process based on pre-defined protocols/control rules – such as triggering management measures when a specified number of species is detected within an area – in combination with historical data on species movements or sea-surface temperature (near real-time data). These rules can trigger rapid and repeatable management responses when pre-determined thresholds are crossed, for example when dynamic models predict elevated bycatch risk[37,39]. DOM therefore retains AM's iterative structure while reducing the need for a new expert assessment for every decision and enabling spatial or temporal management measures to respond to changing ocean conditions, species distributions and pressure exposure[37].

DOM could also be based on future model-based projections, for example based on models of habitat shifts (as done by [13]) or based on joint species distribution models providing assessments of future spatial shifts of ecosystems or species due to climate change. Species-specific approaches may be most appropriate when conservation targets a limited subset of species, whereas habitat modelling may be more suitable when no specific species is targeted or when the aim is to protect the ecosystem as a whole. Here, the species' or habitat spatial shifts are assessed for the future (alongside for the present as with AM), which offers the advantage of providing decision-makers with greater planning precision regarding where protected areas need to be extended or relocated in order to continue effectively protecting shifting species and ecosystems, while reducing exposure to relevant pressures. However, projections of future species migration are characterized by considerable scientific uncertainties, particularly in ABNJ, where incomplete knowledge of current species distributions limits the reliability of models projecting future range shifts. A further source of uncertainty is extent and spatial distribution of ocean warming, as well as related species distributions and human-use patterns. Accordingly, it is impossible to predict exactly where protected areas should be relocated—for example, in 50 or 100 years —in order to effectively protect the species or habitat in question. Nevertheless, model-based future projections of species migration can identify a spatial corridor of likely species migration; however, they would need to be closely monitored and measured regarding the actual species or habitat migration (that is, with adaptive management procedures) and actual shifts in human pressures.

In suitable contexts, DOM approaches can better achieve conservation outcomes through more spatially and temporally targeted restrictions, thereby reducing the cumulative area and duration over which management measures apply[40,41,42]. This may reduce the costs borne by affected sectors—for example, lost fishing time, catch and revenue or additional steaming costs—relative to broader, static restrictions,

potentially easing implementation resistance[40,43]. Yet, dynamic ABMTs are currently not operational in ABNJ[26,44] and we currently observe only domestic applications within national jurisdictions of DOM[37]. We argue, however, that for management to remain effective and adaptive under a changing climate, dynamic approaches such as dynamic ABMTs will also need to be considered in ABNJ. Dynamic approaches would enable more responsive management actions effectively to pursue short-term and longer-term conservation objectives. Here, the BBNJ Agreement provides an opportunity to apply DOM and to give area-based conservation in ABNJ a dynamic and adaptive spina.

A range of overlapping concepts has emerged from the this literature strand to describe area-based conservation measures that respond to changing ocean conditions (preferably also in ABNJ): *mobile MPAs*, whose boundaries track an environmental feature or population[45], *climate-smart MPAs* [45] and *dynamic MPAs*, which represent a further evolution of this approach, with boundaries continuously adjusted across temporal, sectoral and institutional dimensions[34,26,48,47]. Others are named for what drives the change, as in *climate-responsive biodiversity approaches*, which encompass both the siting of new protection against projected distributions and the incorporation of adaptive elements into management of existing areas[49,50]. A further set is named for the legal instrument class, as in the emerging work on dynamic ABMTs under the BBNJ Agreement[48,26]. While their scope and design differ, these approaches share the underlying logic of dynamic ocean management: management should be matched more closely to the spatial and temporal scales at which ecological features, human activities and their interactions change. Permanent/static protection remains essential for relatively fixed features (e.g. seamounts, cold-water corals, sponge grounds, even some features of oceanographic currents) while dynamic layers add particular value where the conservation feature, exposure pathway or human activity is predictably variable.

Depending on the ecological feature and management objective, adjustments within dynamic ABMTs could occur on temporal scales ranging from days and weeks to seasons or longer-term climate-driven shifts over decades or centuries[51,13]. By targeting management more closely to where and when conservation needs occur, dynamic approaches can reduce the spatial and temporal extent of restrictions required to achieve a particular conservation outcome, while potentially reducing associated costs (by exceeding quota limits or expensive static closures) and allowing greater involvement of affected ocean users[33,52,53,40]. Evidence from existing dynamic applications (in territorial waters) demonstrates that more targeted closures can substantially reduce the total time-area subject to restrictions compared with coarser static measures. A key distinction from conventional adaptive management[33] is that the principal management decisions do not need to be reconsidered from the beginning each time conditions change. Instead, decision or control rules are agreed in advance, allowing incoming data to trigger predefined management responses. For example, a predefined ecological or management threshold could temporarily activate a fisheries closure once predicted bycatch risk or species occurrence exceeds an agreed level[37]. At the same time, future model-based projections of habitat or species shift due to climate change can offer the advantage of providing decision-makers with greater planning certainty regarding probable spatial corridors of where protected

areas need to be relocated to. For example, Reddin et al. 2026 provide distance and direction estimates for the movement of habitat conditions for each individual high seas EBSA under low, medium and high SSPs until 2100.

The BBNJ Agreement provides a particularly suitable framework for developing dynamic ABMTs[54]. Notably, the Agreement is the first international agreement to explicitly define ABMTs and MPAs, defining it as "a tool, including a marine protected area, for a geographically defined area through which one or several sectors or activities are managed with the aim of achieving particular conservation and sustainable use objectives in accordance with this Agreement"[14,54]. Compared with the more specific concept of an MPA, the ABMT definition provides greater flexibility in relation to the activities managed and the conservation and sustainable-use objectives pursued. De Lucia (2024) similarly highlights that the ABMT definition focuses on one or several human activities, whereas MPAs are specifically directed towards long-term biodiversity conservation objectives.[14] This distinction is particularly relevant to dynamic (ocean) management: a dynamic ABMT might target a specific activity, such as pelagic longline fishing or vessel transit, or operate within a particular sector, such as fisheries or shipping. Examples include a temporary fishing closure triggered by predicted bycatch risk or a dynamic shipping-routing measure around a sensitive area. Such measures would therefore remain embedded within the terminology and institutional architecture of the BBNJ Agreement. Hence, we propose a working definition of dynamic ABMTs that would align with the terminology and scope of the BBNJ Agreement and could be subsumed as part of the current ABMT definition[54].

Proposed working definition (dynamic ABMT) — *A dynamic area-based management tool is an ABMT whose spatial extent, the timing or duration of the measures in force within it, or the stringency of those measures, may change without a new designation decision. Changes follow pre-defined decision rules in response to observed, modelled or forecast ecological, oceanographic or human-use conditions. The rules specify which conditions or thresholds initiate a change, how and how regularly those conditions are assessed and verified, who implements changes, and how it is communicated and enforced form part of the tool itself. These rules are publicly stated, periodically reviewed and monitored.*

Dynamic ABMTs could operate in at least two ways. First, an overlapping dynamic ABMT with a static ABMT where the dynamic ABMT would be fluid within the static area and would target one species or ecosystem and provide sector-specific measures in cooperation with the respective sectoral organizations under the umbrella of the static ABMT ("nested dynamic ABMT"). Then, the dynamic ABMT would align with an established concept, i.e. a static ABMT, and be operating within this framework. An example for that is the implementation of Particularly Sensitive Sea Areas (PSSAs) under the IMO, for which an MPA was the basis. Second, following the notion of DOM, the operative boundary of the dynamic ABMT itself could change to follow the ecological feature, species distribution or habitat that the tool is intended to protect without being directly related to a static ABMT ("stand-alone dynamic ABMT"). This option would require the cooperation of the sectoral organizations, preferably within one regional management body, under the BBNJ Agreement to implement certain measures to protect

certain species (Fig. 1). It would also require a solid and credible science-based monitoring and reporting system ensured through a legitimised science-policy framework.

Both models retain a stable conservation objective while allowing the management response to change as conditions require. Klerk et al. (2024) similarly conceptualize dynamic ABMTs through spatial, normative and institutional dimensions of dynamism[48]. In this way, dynamic ABMTs could complement static ABMTs by combining long-term conservation objectives with shorter-term, more targeted and responsive management measures.

Obstacles for dynamic ABMT implementation

The principal challenge considered here is whether existing governance arrangements can adjust management measures on ecologically relevant timescales. We here focus specifically on the operational governance requirements of dynamic ABMTs and on the institutional capacity needed to translate that into practice. Three governance-related obstacles stand out.

First, dynamic ABMTs need a legal and procedural basis for changing boundaries or measures. The rules for change, i.e. thresholds, triggers, responses, must be agreed in advance, transparent and predictable and operate without excessive intermediate steps[37,56].

Second, ABNJ governance remains institutionally fragmented. Although the BBNJ definition of ABMTs introduces flexibility, the Agreement does not explicitly provide for dynamic ABMTs, and high seas MPAs remain few and of limited effectiveness[57,58]. Since the activities on which dynamic measures would be implemented fall to sectoral organizations, addressing multiple pressures requires cooperation among them; the BBNJ Agreement could fill the coordinating role[59,34,47,34].

Third, decision cycles measured in years cannot track species or habitats shifting seasonally or faster. Examples include migratory Arctic marine mammals[60,61], and highly dynamic pelagic systems such as the Costa Rica Thermal Dome[62]. These cases illustrate where dynamic ABMTs may be particularly relevant, especially where moving ecological features overlap with pressures such as shipping or fisheries (see [63]). Pre-agreed control rules and implementation procedures would let a scientifically-identified threshold trigger agreed responses without reopening the entire designation process, complementing long-term area-based conservation[45,64].

These are not exhaustive: broader political, technological constraints or costs incurred for the data analysis process may also affect implementation, but are beyond the immediate scope of this paper.

Actionable recommendations: The BBNJ Agreement can simplify and speed up the process of implementing dynamic ABMTs

The first BBNJ COP should actively ensure from the outset that the ABMT framework can accommodate dynamic approaches and support approaches that complement static management, allowing for

adaptation to the ocean's responses to anthropogenic pressures.

1. Recognize dynamic ABMTs as a legitimate form of ABMT implementation. This would signal that Part III is not limited to static measures and that proposals may incorporate temporal, spatial and regulatory dynamism where scientifically justified. If a process to establish high seas MPAs would include dynamic ABMTs, it would give countries the opportunity to submit such proposals and strengthen their implementation.
2. Initiate scientific and technical guidance for their development. Guidance should address when dynamic approaches are appropriate; ecological and management thresholds; data and uncertainty; adjustment procedures; monitoring and review; and communication. It should distinguish the political decision establishing the ABMT and its operating rules from subsequent implementation when predefined conditions are met. This would also mirror missing data in regions and general regional differences regarding dynamic ABMTs: these cannot be implemented in every region due to data availability, knowledge gaps, regional frameworks and structure.
3. Build cooperation mechanisms and encourage pilot applications. The BBNJ Agreement can provide an overarching biodiversity framework, but measures affecting fishing, shipping or seabed activities will often require cooperation with competent organizations. Pilot cases, including in rapidly changing environments such as the Arctic, could identify workable institutional models before broader application when local conditions indicate a need for such action and the relevant authorities are prepared to support its implementation. Article 22(3)[54] offers a complementary route towards more systematic cooperation. The COP could operationalise its obligation to establish regular consultations through standing arrangements with, for example, the IMO, regional fisheries management organizations and arrangements, the ISA, regional seas bodies and relevant species agreements. These arrangements could establish regular contact points, information-sharing and early notification of proposed or changing ABMTs, while providing a forum for coordinating compatible sectoral measures and monitoring. They would not transfer sectoral competences to the BBNJ COP, but could create a structured interface for aligning measures adopted under different mandates. Within this architecture, the OSPAR Commission could serve as a regional coordination platform in the North-East Atlantic.

In summary, the BBNJ Agreement creates an unprecedented framework for area-based biodiversity conservation in ABNJ. Its implementation and operation should not be restricted to static conservation approaches in those cases when the ecological conditions are better conserved by flexible approaches to achieve biodiversity targets (see [49]). Dynamic ABMTs can connect the Agreement’s area-based framework with the realities of a rapidly changing ocean. Hence, that possibility should be made explicit from the outset, with the BBNJ COP providing an opportunity to begin building the conditions needed to turn it from concept into an operational tool for effective conservation in the longer term.

Declarations

Competing interests

The authors declare no competing interest.

Author Contribution

Conceptualization and Analysis: C.R., S.B., J.-C.D., E.E., G.F., F.K., T.G., C.R., W.R., A.R.E., B.S.; Writing – original draft: C.R., S.B., J.-C.D., E.E., G.F., F.K., T.G., C.R., W.R., A.R.E., B.S.; Visualization: C.R.; Project administration: C.R. All authors have read and approved the manuscript.

Acknowledgement

C.R. and W.R. would like to thank Mira Schmidt for her support during the systematic collection and preparation of the current dynamic conservation approaches and figure creation.

Data availability

All data needed to evaluate the conclusions in the paper are present in the paper. There are no supplementary materials. Additional questions related to this paper may be requested from the corresponding author.

References

1. Pecl, G. T. et al. Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. *Science* 355, 6332(2017).
2. Caldeira, M., Teixeira, H. & Hilário, A. Negotiations to implement area-based management tools beyond national jurisdiction: the scientific community`s view. *Front. Mar. Sci.* 10, 1–16(2023).
3. Farchadi, N. et al. Marine heatwaves redistribute pelagic fishing fleets. *Fish. Fish.* 25, 602–618(2024).
4. Bao, S. et al. Ocean heat content in 2025. *Nat. Rev. Earth Environ*. 7, 206–208(2026).
5. von Schuckmann, K. et al. (2023). Heat stored in the Earth system 1960–2020: where does the energy go? *Earth System Science Data* 15(4), 1675–1709.
6. Cheng, L., et al. (2024). IAPv4 ocean temperature and ocean heat content gridded dataset. *Earth System Science Data* 16(8), 3517–3546.
7. Santos, B. S. et al. Beyond boundaries: governance considerations for climate-driven habitat shifts of highly migratory marine species across jurisdictions. *npj Ocean Sustain*. 3, 22(2024).
8. Lascelles, B. et al. Migratory marine species: their status, threats and conservation management needs. *Aquatic Conserv: Mar. Freshw. Ecosyst.* 24, 111–127(2014).

9. UNEP-WCMC. Marine Protected and Conserved Areas. Protected Planet. *Protected Planet* https://www.protectedplanet.net/en/thematic-areas/marine-protected-areas(2026).
10. IUCN. *IUCN* https://iucn.org/press-release/202604/world-reaches-milestone-nature-10-ocean-now-officially-protected(2026).
11. Fu, C., Steckbauer, A., Mann, H., & Duarte, C. M. Achieving the Kunming–Montreal global biodiversity targets for blue carbon ecosystems. *Nat. Rev. Earth Environ*. 5, 538–552(2024).
12. Hodapp, D. et al. Climate change disrupts core habitats of marine species. *Glob. Change Biol*. 29, 3304–3317(2023).
13. Reddin, C. *et al*. Climate change will displace habitats prioritised for marine protected areas in the high seas. Preprint at https://doi.org/10.21203/rs.3.rs-10333137/v1(2026).
14. De Lucia, V. After the Dust Settles: Selected Considerations about the New Treaty on Marine Biodiversity in Areas beyond National Jurisdiction with Respect to ABMTs and MPAs. *Ocean Dev. Int. Law.* 55, 115–136(2024).
15. Miao, X. Establishing a coherent ABMTs network: how the BBNJ Agreement can foster cooperation with existing mechanisms from the perspective of institutional complementarity. *Front. Mar. Sci.* 13, 1–14(2026).
16. Smith, D. & Jabour, J. MPAs in ABNJ: lessons from two high seas regimes. *ICES J. Mar. Sci.* 75, 417–425(2018).
17. Matz-Lück, N. & Al-Hajjaji, S. The International Legal Framework for Area-Based Marine Management Toolsin *Area-Based Management of Shipping*(eds. Chircop, A., Goerlandt, F., Pelot, R. & Aporta, C.) 69–90(Springer, 2024).
18. Wu, W. High seas marine protected areas under the BBNJ agreement: implementation gaps and governance pathways. *Front. Mar. Sci.* 13, 1860724 https://doi.org/10.3389/fmars.2026.1860724(2026).
19. Scott, K. N. MPAs in the Southern Ocean under CCAMLR: Implementing SDG 14.5. *Korean J.Int.Comp.L.* 9, 84–107(2021).
20. Klerk B. E. Ocean in Motion: Addressing Gaps in MPA Governance in Areas beyond National Jurisdiction. in *Non-use Measures for Global Goods and Commons in International Law*(eds. Guggsberg, S. & Blanchard, C.) 64–88 (Brill, 2025).
21. Jiang, X. & Wang, Z. Emergency Marine Protected Areas Under the BBNJ Agreement: A Feasible Solution for Emergencies in ABNJ? *Ocean Dev. Int. Law.* 55, 25–55(2024).
22. IMO. Special Areas under MARPOL. *International Maritime Organization* https://www.imo.org/en/ourwork/environment/pages/special-areas-marpol.aspx(2026).
23. IWC. Whale Sanctuaries. *International Whaling Commission* https://iwc.int/management-and-conservation/sanctuaries(2026).
24. Goldsworthy, L. Consensus decision-making in CCAMLR: Achilles' heel or fundamental to its success? *Int. Environ. Agreem.: Politics Law Econ.* 22, 411–437(2022).

25. Abuelenin, A. H. M. Strengthening marine biodiversity governance: a framework for enforceable compliance and equitable ocean management under the BBNJ agreement. *Biodivers. Conserv.* 35, 3 https://doi.org/10.1007/s10531-025-03206-7(2026).
26. Klerk, B. E. The Arctic marginal ice zone is well suited to dynamic area-based management tools but faces institutional constraints. *ICES J. Mar. Sci.* 83, 3(2026).
27. Antsygina, E. Interpreting the Non-Undermining Clause of the BBNJ Agreement: Restrictive or Complementary Roles for the COP within RFMO Competences?in *Max Planck Yearbook of United Nations Law Online*(eds. de Wet, E. & Scherr, K. M.) 46–73(Brill/Nijhof, 2025).
28. Karim, S. & Cheung, W. W. L. The new UN high seas marine biodiversity Agreement may also facilitate climate action: a cautiously optimistic view. *npj Clim. Action.* 3, 8 https://doi.org/10.1038/s44168-023-00088-9(2024).
29. Wang, W. & Xue, G. J. The BBNJ agreement and its potential to facilitate fisheries management in the ABNJ. *Mar. Policy* 186, 107043 https://doi.org/10.1016/j.marpol.2026.107043(2026).
30. Gjerde, K. M. et al. Getting beyond yes: fast-tracking implementation of the United Nations agreement for marine biodiversity beyond national jurisdiction. *npj Ocean Sustain*. 1, 6; https://doi.org/10.1038/s44183-022-00006-2(2022).
31. Hausner A., Samhouri J. F., Hazen E. L., Delgerjargal D. & Abrahms B. Dynamic strategies offer potential to reduce lethal ship collisions with large whales under changing climate conditions. *Mar. Policy* 130, 104565 https://doi.org/10.1016/j.marpol.2021.104565(2021).
32. Keith, D. M., Sameoto, J. A., Keyser, F. M. & Ward-Paige, C. A. Evaluating socio-economic and conservation impacts of management: A case study of time-area closures on Georges Bank. *PLoS ONE* 15(10), 1–25(2020).
33. Maxwell, S. M. et al. Dynamic ocean management: Defining and conceptualizing real-time management of the ocean. *Mar. Policy* 58, 42–50(2015).
34. Ortuño Crespo, G. et al. Beyond static spatial management: Scientific and legal considerations for dynamic management in the high seas. *Mar. Policy* 122, 1–10(2020).
35. Silva, T. L. et al. Exploring the Use of Seabirds as a Dynamic Ocean Management Tool to Mitigate Anthropogenic Risk to Large Whales. *Front. Mar. Sci.* 9, 837604 https://doi.org/10.3389/fmars.2022.837604(2022).
36. Ardron, J., Gjerde, K., Pullen, S. & Tilot, V. Marine spatial planning in the high seas. *Mar. Policy* 32(5), 832–839.
37. Hazen *et al*. Building the scientific and analytical framework for Dynamic Ocean Managementin *Navigating Our Way to Solutions in Marine Conservation*(ed. Crowder, L. B.) 203–217(Open Book Publishers, 2025).
38. Meyer, B. et al. Adjusting the management of the Antarctic krill fishery to meet the challenges of the 21st century. *PNAS* 122(37), e2412624122 https://doi.org/doi:10.1073/pnas.2412624122(2025).
39. Howell, E. A., Kobayashi, D., Parker, D., Balazs, G. H. & Polovina, J. J. TurtleWatch: a tool to aid in the bycatch reduction of loggerhead turtles Caretta caretta in the Hawaii-based pelagic longline fishery.

Endanger. Species Res. 5, 267–278.

40. Dunn, D. C., Maxwell, S. M., Boustany, A. M. & Halpin, P. N. Dynamic ocean management increases the efficiency and efficacy of fisheries management. *PNAS* 113(3), 668–673(2016).
41. Hazen, E. L. et al. A dynamic ocean management tool to reduce bycatch and support sustainable fisheries. *Sci. Adv.* 4, 5 https://doi.org/10.1126/sciadv.aar3001(2018).
42. Gilman, E., Kaiers, M. J. & Chaloupka, M. Do static and dynamic marine protected areas that restrict pelagic fishing achieve ecological objectives? *Ecosphere*10(12), e02968 (2019).
43. Welch, H. et al. Selection of planning unit size in dynamic management strategies to reduce human–wildlife conflict. *Conserv. Biol.* 38, 3(2024).
44. Hobday, A. J. et al. Dynamic Ocean Management: Integrating Scientific and Technological Capacity with Law, Policy, and Management. *Stan. Envtl. L.J.* 33(2), 125–165(2014).
45. Maxwell, S. M., Gjerde, K. M., Conners, M. G. & Crowder, L. B. Mobile protected areas for biodiversity on the high seas. *Science* 367, 252–254(2020).
46. Brito-Morales, I. et al. Towards climate-smart, three-dimensional protected areas for biodiversity conservation in the high seas. *Nat. Clim. Change* 12(4), 402–407(2022).
47. Westholm, A. & Argüello, G. Dynamic Ocean Management in Areas Beyond National Jurisdiction. *Ocean Dev. Int. Law.* 54, 4(2023).
48. Klerk, B. E., Heinrich, H. & Primicerio, R. Beyond equilibrium thinking: dynamic area-based management tools in a changing ocean. *Front. Mar. Sci.* 11 https://doi.org/10.3389/fmars.2024.1418435(2024).
49. Tittensor, D. P. et al. Integrating climate adaptation and biodiversity conservation in the global ocean. *Sci. Adv.* 5(11), aay9969(2019).
50. Fuchs, G. et al. Towards climate-ready marine protected areas: challenges and strategic pathways. *npj Ocean Sustain.* 5, 15(2026).
51. Hilborn, R. et al. Area-based management of blue water fisheries: Current knowledge and research needs. *Fish. Fish.* 23, 492–518(2022).
52. Little, A. S., Needle, C. L., Hilborn, R., Holland, D. S. & Marshall, C. T. (2015) Real-time spatial management approaches to reduce bycatch and discards: experiences from Europe and the United States. *Fish. Fish.*16, 576–602 (2015).
53. Briscoe, D. K. et al. Are we missing important areas in pelagic marine conservation? Redefining conservation hotspots in the ocean. *Endanger. Species Res.* 29, 229–237(2016).
54. UNCLOS. Agreement 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 Agreement* https://www.un.org/bbnjagreement/en(2023).
55. D'Aloia, C. C. et al. Coupled Networks of Permanent Protected Areas and Dynamic Conservation Areas for Biodiversity Conservation Under Climate Change. *Front. Ecol. Evol.* 7, 27 https://doi.org/10.3389/fevo.2019.00027(2019).

56. Humphries, F. & Harden-Davies, H. Practical policy solutions for the final stage of BBNJ treaty negotiations. *Mar. Pol.* 122, 104214 https://doi.org/10.1016/j.marpol.2020.104214(2020).
57. Roessger, J., Claudet, J. & Horta e Costa, B. Turning the tide on protection illusions: The underprotected MPAs of the 'OSPAR Regional Sea Convention'. *Mar. Policy* 142, 105109 https://doi.org/10.1016/j.marpol.2022.105109(2022).
58. Matz-Lück, N. & Fuchs, J. The impact of OSPAR on protected area management beyond national jurisdiction: Effective regional cooperation or a network of paper parks? *Mar. Policy* 49, 155–166(2014).
59. Heinrich, K. Fit-for-purpose ocean management in times of change - marine conservation and management examples from the polar regions. *Mar. Policy* 193, 107203(2026).
60. Shuert, C. R., Marcoux, M., Hussey, N. E. & Auger-Méthé, M. Decadal migration phenology of a long-lived Arctic icon keeps pace with climate change. *PNAS* 119(45), e2121092119 https://doi.org/10.1073/pnas.2121092119(2022).
61. Ferguson, S.H. et al. Killer whale range expansion and extended seasonal presence in the eastern Canadian Arctic, 2002–2023. *Front. Mar. Sci.* 12, 1595960 https://doi.org/10.3389/fmars.2025.1595960(2025).
62. Castillo Rodríguez, R., Jiménez, J., Arroyo Arce, K. & Thompson, K. R. An Analysis of Policy Options Available to the International Maritime Organization to Protect the Costa Rica Thermal Dome: Building the Case for a Particularly Sensitive Sea Area. *Mar. Policy* 148, 105375 https://doi.org/10.1016/j.marpol.2022.105375(2023).
63. Esteban-Cantillo, O. J. et al. Six key policy recommendations to advocate for marine conservation that matches the ocean's dynamism. *npj Ocean Sustain.* 4, 50 https://doi.org/10.1038/s44183-025-00151-4(2025).
64. Hyrenbach, D. Using Marine Reserves to Protect Highly Migratory Species: Scientists Discuss Potential Strategies, Including Mobile MPAs. *MPA News* 8, 1–6(2007).

Figures

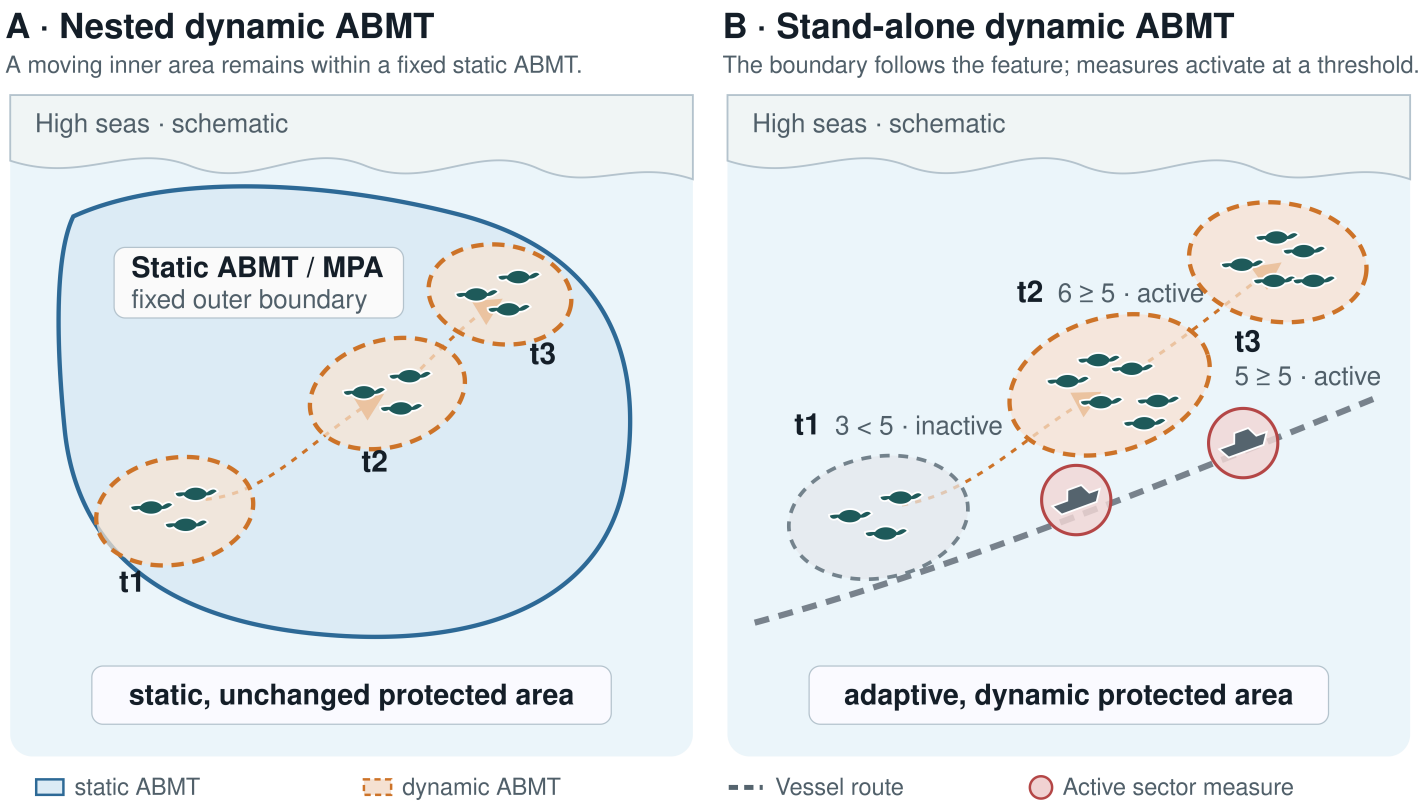


Figure 1

Visualization of nested and stand-alone dynamic ABMTs. (A) overlapping dynamic ABMT with a static ABMT; (B) one stand-alone dynamic ABMT with fluid boundaries and being dynamic in temporal scales without being directly attached to a static ABMT. Other ideas also lock dynamic ABMTs to a network of ABMTs/MPAs so that the dynamic ABMT becomes the connecting factor and the overall protected area would be larger[55].