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Reaching Global Marine Biodiversity Conservation Goals With Area-Based Fisheries Management: A Typology-Based Evaluation

Amber Himes-Cornell[1], Juan Francisco Lechuga Sánchez[1], Caroline Potter[2], Clayton McKean[2], Jake Rice[3], Kim J. Friedman[1,4], Serge M. Garcia[5] and Dave L. Fluharty[2]*

[1] Fisheries and Aquaculture Division, Food and Agriculture Organization of the United Nations, Rome, Italy, [2] School of Marine and Environmental Affairs, University of Washington, Seattle, WA, United States, [3] Fisheries and Oceans Canada, Ottawa, ON, Canada, [4] Oceans Institute, University of Western Australia, Crawley, WA, Australia, [5] International Union for the Conservation of Nature, Commission on Ecosystem Management, Fisheries Expert Group, Fiumicino, Italy

In 2010, the Parties to the Convention on Biological Diversity (CBD) adopted the Aichi Biodiversity Target 11, calling for conserving 10% of the ocean through marine protected areas (MPAs) and "*other effective area-based conservation measures*" (OECMs), explicitly recognizing that other types of spatial conservation measures beyond areas designated as MPAs may also achieve biodiversity gains. Eight years later, CBD Parties adopted a definition and criteria for OECMs, and by early 2022, only a few OECMs had been reported. The OECM definition clearly requires that the measures be area-based and likely to contribute to conservation. However, conservation need not be their primary objective. Guidance on the extent and limits of what these "area measures" might include is needed. Clarity would assist countries in delivering on the CBD's Post-2020 Global Biodiversity Framework, with decadal goals incorporating an area-based conservation target, in which OECMs will play a crucial role. To achieve greater recognition of OECMs, countries require sector-specific guidance to guide recognition, listing, and ongoing implementation of OECMs. Here, we evaluate how well area-based fisheries management measures meet the OECM criteria as well as sustainable use principles, broader ecosystem management objectives, and more general biodiversity conservation goals. We systematically review case studies across a broad range of spatial management approaches to provide evidence of correspondence with the OECM criteria, arguing that many with primary objectives related to fisheries sustainability provide co-benefits for biodiversity, and hence biodiversity conservation and sustainable development. This review highlights how fisheries measures can help achieve a number of Sustainable Development Goals alongside the global targets for biodiversity of CBD.

Keywords: Convention on Biological Diversity, OECM, fisheries, area-based management, biodiversity conservation

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Edited by:
Leslie New,
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****Correspondence:***
Amber Himes-Cornell
Amber.HimesCornell@fao.org

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INTRODUCTION

Growing demands and pressures on marine and coastal environments are resulting in inequitable and unwelcome outcomes for social–environmental systems across low- and high-income countries (FAO, 2022). Noting this and the shortfall in capacity and resources for remedial action, the need for integration of effective marine management and conservation has never been greater (Contestabile,

2021; FAO, 2022). In particular, establishing and strengthening spatial management across sectors, including marine protected areas (MPAs) and use of other types of area-based management tools, offers an opportunity to drive positive outcomes for biodiversity and people (Grorud-Colvert et al., 2021).

Numerous global, regional and national initiatives have promoted the use of area-based management tools (ABMTs) in marine and coastal zones. Correspondingly, commitment to using them is prominent in both the United Nations 2030 Agenda for Sustainable Development[1] and decadal plans for the conservation of the Convention on Biological Diversity (CBD), in both their Strategic Plan 2010–2020[2] (CBD, 2010) and in the 2022 negotiations of the Post-2020 Global Biodiversity Framework (termed in this paper as the 'Post-2020 Framework'). Within the CBD's Post-2020 Framework, a draft target proposes increasing the coverage of protected areas and other effective area-based conservation measures (OECMs) from 10 to 30% of the ocean by 2030 (CBD, 2021). Although progress toward the global area-based management targets has accelerated, there remains skepticism regarding whether global aspirations for effective and equitable conservation of 'special' areas will recognize all efforts in the delivery of this target and whether it will be met.

Well-managed MPAs (particularly no-take MPAs) deliver effective conservation within their boundaries in many regions (e.g., Fenberg et al, 2012; Lester et al., 2009; Giakoumi et al., 2017; Topor et al., 2019), strengthening calls and advocacy for MPAs to be the principal method for conserving marine biodiversity (O'Leary et al., 2016). Yet, others have highlighted their shortcomings, with MPAs receiving criticism for frequent poor placement, design or management, and risks to vulnerable coastal populations reliant on the oceans for food and livelihoods (Agardy et al., 2011; Rife et al., 2013; Bennett and Dearden, 2014; Sowman & Sunde, 2018; Álvarez-Fernández et al., 2020). There are questions about an over reliance on the use of MPAs, one being the challenge of having adequate knowledge and capacity to deliver effective conservation in aquatic systems by environmentally focused authorities that in many cases have weaker connections to governance bodies with a mandate in aquatic systems. Second, there is an issue of finding adequate public funding for this form of biodiversity conservation when designated *de novo* and unlinked from community livelihood opportunities (Bohorquez et al., 2019).

In the case of MPAs, sustained and appropriate financial and human capacity for designation and effective long-term management often falls to the public purse. Reliance on this funding source can pose difficulties for robust and long-lasting investment (Emerton et al., 2006; Gill et al., 2017) and has contributed to numerous countries reporting coverage levels below the 10% target of the Sustainable Development Goal (SDG) 14.5 and CBD's Aichi Biodiversity Target 11 (herein referred to as Target 11), with coverage averaging below 6% (UNEP-WCMC IUCN, 2021).

The inclusion of OECMs in the targets of the CBD represents a new opportunity to recognize the delivery of biodiversity conservation in place by a wider range of spatial management practitioners (Alves-Pinto et al., 2021; Beazley et al., 2021; Gurney et al., 2021; Jonas et al., 2021; Rodríguez-Rodríguez et al., 2021; Shackell et al., 2021; Agung et al., 2022; Gissi et al., 2022). Many sectors with established management frameworks use area-based management measures that result in co-benefits for local biodiversity and could qualify as OECMs (Reimer et al., 2021), including in the fisheries sector. Many ABMTs used to manage fisheries (herein collectively referred to as fisheries ABMT) already aim to meet socio-cultural sustainability goals with biodiversity conservation as part of broader ecosystem management approaches, which may well qualify for designation as OECMs, either as is, or with minimal modification (Rice et al., 2018). Recognizing that fishery ABMTs are often intricately linked to food, livelihood, and governance models of people with oversight frameworks already in place, there is an opportunity to potentially incorporate social and cultural norms of local communities for biodiversity conservation as OECMs. This broadens the capture of multi-sectoral efforts to conserve biodiversity under the umbrella of the CBD Post-2020 Framework while lowering the financial burden of inception and ongoing management to national authorities. It also offers recognition of sectoral efforts to conserve biodiversity within a globally recognized framework.

It was not until 2018 that the Parties of the CBD adopted a definition, criteria, and recommendations for OECMs (CBD, 2018). The novelty of the OECM definition and criteria by CBD means that government authorities and the private sector are still setting up standardized processes for the identification, designation, and ongoing management of OECMs. The evolving policy dialog on the development of criteria for identifying OECMs and the subsequent attempts at applying the criteria have illuminated issues in reconciling ABMTs with the novel OECM criteria. Recognizing which area-based management approaches can meet the OECM criteria, with or without modifications, and what contextual factors affect their effectiveness, remains a work in progress. Some headway in exploring a path forward is being made (Rice et al., 2018; ICES, 2021), but more localized delivery of sectoral guidance beyond the OECM definition, criteria, and recommendations of CBD is needed to guide countries in

[1] The United Nations 2030 Agenda for Sustainable Development (UNGA, 2015) stimulates national and regional action towards sustainable development via 17 Sustainable Development Goals (SDGs) and 169 associated targets. Specifically, SDG 14 – life below water – is a call to "conserve and sustainably use the oceans, seas, and marine resources for sustainable development" by 2030. Target 14.2 calls on countries to "By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans" and Target 14.5 calls for countries to "By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information."

[2] The Convention on Biological Diversity's (CBD) Strategic Plan 2010-2020 includes 20 targets—the Aichi Biodiversity Targets—as a means to achieve the vision that "by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem wservices, sustaining a healthy planet and delivering benefits essential for all people." Similarly to the SDG 14.5, the Aichi Biodiversity Target 11 (Target 11)—part of the CBD's Strategic Plan 2010-2020—called for conserving "at least 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, through effectively and equitably managed, ecologically representative, and well-connected systems of protected areas and other effective area-based conservation measures" by 2020 (CBD, 2010).

identifying OECMs in the case of fisheries and spur progress in reporting on fishery efforts under the CBD targets.

As countries now face a likely even greater challenge to achieving the proposed increases in spatial management aspirations currently under negotiation in the Post-2020 Framework, they need support in bringing ABMTs into line with the OECM Decision of CBD. Here, we attempt to add value to fisheries actors by taking a critical look at an existing typology of ABMTs used in fisheries management (Rice et al., 2018) to see how well they align with the definition and criteria of CBD for OECMs. We do this by:

i) summarizing the OECM definition and criteria, and the status of OECM reporting in the marine environment;
ii) documenting the methodology used to undertake a systematic literature review aimed at identifying fisheries ABMTs that may meet some or all of the OECM criteria; and
iii) presenting the results of how the reviewed case studies provide evidence for meeting the OECM criteria for the case studies.

The paper concludes by suggesting a positive role that sustainable fisheries management and fishery OECMs can have in area-based biodiversity conservation.

OECM: Definition and Identification Criteria

Following the addition of OECMs to the CBD lexicon in 2010, in November 2018, the 14th Conference of Parties (COP) to the CBD formally adopted a definition, criteria, and recommendations for OECMs, all of which are intended to be applied flexibly and on a case-by-case basis (CBD, 2018). This Decision (CBD, 2018; herein referred to as Decision 14/8) defines OECMs by including reference to their biodiversity outcomes:

"a geographically defined area other than a Protected Area[3], which is governed and managed in ways that achieve positive and sustained long-term outcomes for the *in situ* conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio-economic, and other locally relevant values."

Furthermore, Decision 14/8 (Annex III) provides 13 Guiding Principles that describe characteristics that OECMs should have, including (1) biodiversity value; (2) contribute to conservation; (3) be in place long-term and *in situ*; (4) their conservation role is complementary with other roles; (5) a scientific foundation; (6) representativeness and connectivity; (7) consultation processes; (8) capacity-building; (9) empowerment; (10) cultural and spiritual values; (11) governance diversity; (12) knowledge diversity; and (13) transparency and evaluation. In addition, it outlines 4 criteria and 10 sub-criteria that area-based management measures should meet to be considered OECMs (**Table 1**).

The OECM guiding principles, definition, criteria, and advice on OECMs are quite specific (CBD/COP/14/L.19). Together, they advance international area-based conservation standards by stressing the central role of equitable governance, effective management, and the need to account for locally relevant values, in addition to lasting biodiversity outcomes. The focus of the OECM definition and criteria on effectiveness in the delivery of biodiversity outcomes and ecosystem services enhances their ability to support the delivery of global biodiversity targets and several SDGs, including poverty eradication (SDG 1), food security (SDG 2), and coastal resilience (SDG 14.2), generating enduring environmental and social benefits for the oceans and people.

To date, although many countries are preparing their responses, few have already applied the OECM concept and only one has officially reported fisheries ABMTs as OECMs (as of June 2022). The analysis presented in this paper is intended to assist the fisheries sector in additional countries and their government authorities in identifying the types of fisheries ABMT are more likely to meet the OECM criteria, thereby encouraging them to conduct assessments that could result in increased identification and reporting of fisheries OECMs.

TABLE 1 | Criteria included in Section B of Annex III to Decision 14/8 relevant for the identification of OECMs.

Criteria	Sub-criteria
Criterion A: Area is not currently recognized as a protected area	* Not a protected area
Criterion B: Area is governed and managed	* Geographically defined space * Legitimate governance authorities * Managed
Criterion C: Achieves sustained and effective contribution to *in situ* conservation of biodiversity	* Effective * Sustained over long term * *In situ* conservation of biological diversity * Information and monitoring
Criterion D: Associated ecosystem functions and services and cultural, spiritual, socio-economic and other locally relevant values	* Ecosystem functions and services * Cultural, spiritual, socio-economic and other locally relevant values

MATERIALS AND METHODS

Identifying Publications for the Literature Review

We conducted a systematic literature review with the aim of 1) identifying case studies of ABMTs used to manage fisheries for which positive biodiversity outcomes have been documented in the published literature; and 2) comparing what is documented for each case study relative to the OECM criteria. To develop the search criteria for the review, we began with the wide range of area-based fisheries management measures (ABFM) (Rice et al., 2018) that were considered during a CBD expert workshop tasked with providing input to the development of the OECM definition and criteria that were eventually adopted in Decision 14/8. Decision 14/8 defines ABFM as "formally established,

[3]A protected area is defined as "a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives" (CBD, 1992).

spatially defined fishery management and/or conservation measures, implemented to achieve one or more intended fishery outcomes" [Annex IV B.2(c)].

We used the ABFM categories described by Rice et al. (2018) except for zoning, given that the concept of zoning is frequently integrated into many of the other ABFM categories and is a widespread method for designating the general use of marine areas, often without associated management. We defined our search criteria by combining each of these types of ABFM identified with "AND fish* AND (biodiversity OR conservation)." The final list of ABFM in the search included: *benthic protected areas, closed seasons, community conserved areas, fisheries restricted areas, gear ban, locally managed marine areas (LMMAs), marine managed areas, moratorium, move on rule for fishing, real time closures, reserve, ring fencing, rotational closures, sanctuary, territorial use rights for fisheries (TURFs), and vulnerable marine ecosystems (VMEs)*. Note that using these ABFM in the search criteria ultimately resulted in the identification of literature describing additional types of area-based management being used to manage fishing activities (e.g., biosphere reserves, MPAs, and national parks). This is likely due to the common reference in the literature to such areas being used by states to support fisheries and which function as a *de facto* fishery-based closed area. For simplicity, throughout the rest of the paper, we refer to the list of ABFM in Rice et al. (2018) and these additional categories collectively as "fisheries ABMTs."

We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement as a guide for this review (Moher et al., 2010). For each search criterion, we conducted a literature review of the first 1000 publications identified in Google Scholar using Harzing's (2021)[4] scientific citation retrieval and analysis tool to capture a wide variety of publication types. We conducted the search in mid-April 2021 and included all publications that included the search criteria for all years before the search. While we recognize that there are likely additional publications on fisheries ABMT case studies that did not appear in this search (e.g., publications in languages other than English), it is not feasible to develop search criteria that will identify all possible case studies. We expect that the search criteria, however, did identify various case studies relevant to this analysis and are not biased toward any one type of fisheries ABMT.

We screened 8,972 publications in our first selection (**Figure 1**). We excluded all publications that were not in English and removed all duplicates. We reviewed the titles and abstracts for the remaining publications and only retained publications where the titles or abstracts gave some indication that the publication discusses a specific marine fishery or fisheries being managed with area-based measures or a group of such measures. This resulted in 1,071 publications (12.1% of all papers in the initial search) that warranted a full text review. Through this second selection, we reviewed the full text of each of these publications. We were unable to locate the full-text of 60 publications. For the remaining 1,011, we only included publications in the final selection if they reported on specific case studies where marine fisheries are being managed with ABMTs, resulting in 457 publications being included in the final selection. To limit the extent of the review to marine ecosystems, we excluded all publications focused on freshwater fisheries ABMTs (N = 76). We also excluded all publications for which the full text was not in English because of the language limitations of the review team.

[4]Harzing A. (2021). Publish or Perish. Retrieved 9 March 2022 from: https://harzing.com/resources/publish-or-perish.

Analysis of Case Study Texts

For each publication retained in the final selection, we collected the following data: demographic information (author affiliation type, type of literature); basic case study information (type of fisheries ABMT employed, region/country, FAO fishing area, fishery being addressed, stated management objectives, identified species/habitats/ecosystems for conservation, year established); and information documented in the paper related to each of the 4 OECM criteria, 10 sub-criteria and 26 indicators included in Annex III of Decision 14/8. For publications that reported on more than one case study (n = 59, or 12.7% of papers retained for the full assessment), data were collected for each individual ABMT separately where possible. In instances where a publication discussed a geographically connected network of fisheries ABMTs without separately reporting on the individual measures, we collected data about the network. The review resulted in information collected from 669 individual case studies in the database, including 306 individual fisheries ABMTs and 363 fisheries ABMT networks.

Of the 669 case studies for which data were collected, there were 446 unique fisheries ABMT case studies reported (**Figure 2**), 91 of which were documented by two or more publications. We combined the reported data for each individual case study for which more than one publication was identified in the literature review.

We first classified each case study by the fisheries ABMT category and the dimensions that constrain these tools, including time, space, and activities. The dimension of time refers to the period during which the ABMT is in place. We consider the time dimension as permanent, temporary, seasonal, real-time, or periodic. A fisheries ABMT is considered permanent when it is in effect year-round and without a particular end date. A fisheries ABMT is also considered "permanent" if, at the end of its duration period, it is subjected to a review with the intent that it will be renewed if specified conditions are met. For example, we considered a TURF concession that can be renewed after a set number of years to be *de facto* permanent unless the conditions for its renewal are not met. However, a temporary fisheries ABMT is in place for a set period. The expectation is that the measure will be terminated (lifted) after a given time unless conditions call for its renewal, such as a non-permanent closure to recover stocks. A seasonal fisheries ABMT, for example, closures during spawning seasons, goes into effect every year for a duration of less than one year and occurs during the same months/seasons every year (although beginning and end dates may be slightly adjusted every year). A seasonal fisheries ABMT is often nonetheless perennial if repeated every year indefinitely (the measure is seasonal but long-term). Some real-time fisheries ABMTs are triggered by a

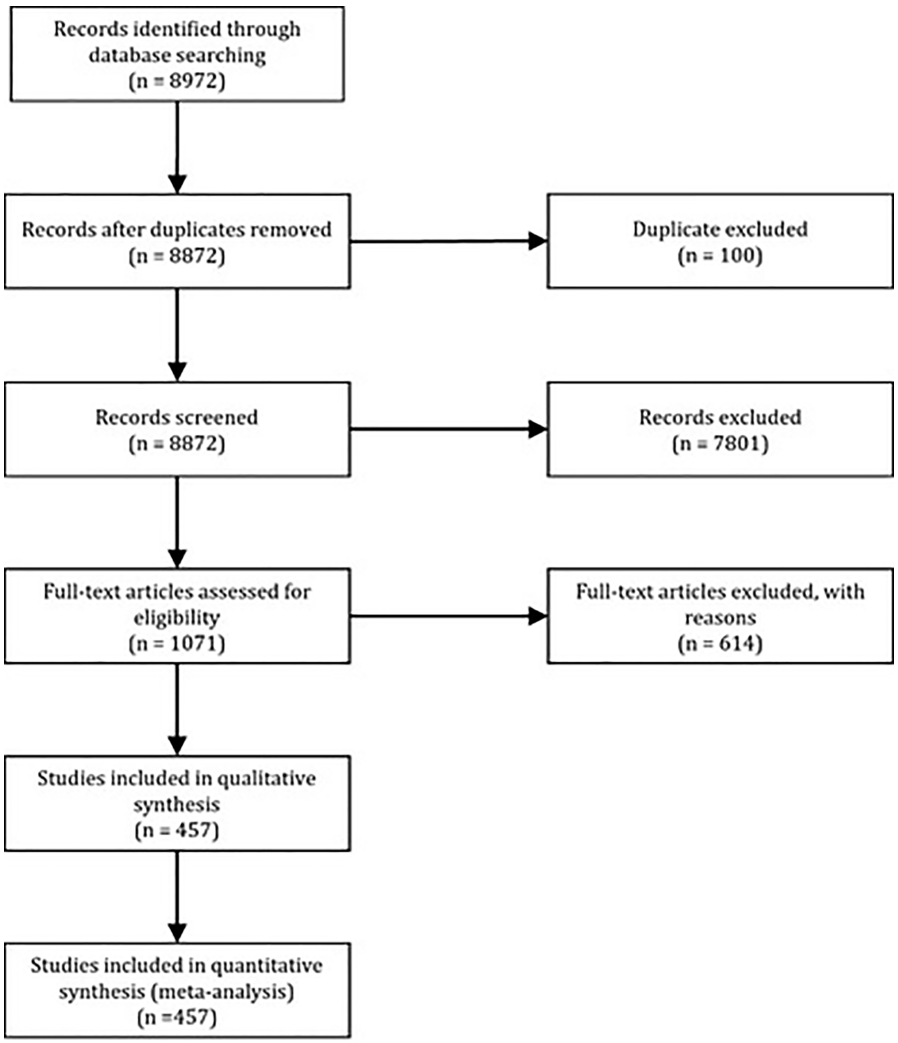

FIGURE 1 | Methodology and search criteria used in the systematic literature review following the PRISMA statement as a guide for this review (Moher et al., 2010).

specific rule, such as meeting a set threshold, and these may last for a variable amount of time. An example is a move-on rule, where a specific rule triggers the movement of the fishery away from a given area, thus creating a *de facto* closed area.

A rotational fisheries ABMT involves the successive closing and opening of parts of the fishing grounds to specific fisheries or gears. The rotation cycle may be repeated many times, possibly forever. The duration of the rotation cycle and of its opening and closing periods depend on the fishing impact and on the recovery time of the biodiversity attribute(s) being protected. Ultimately, the whole area may be fished, but each sub-area is fished only part of the time. Lastly, occasional fisheries ABMTs are implemented or relaxed when needed, but are not done so seasonally or only on a regularly recurring basis. There may still be rules during the "relaxed period." An example of such a measure is a taboo area inside an LMMA that may be lifted for exceptional ceremonies.

We refer to the dimension of space as the physical space that is regulated by a fisheries ABMT, including a) how the measure aligns with national jurisdictions (fully within national jurisdiction, fully in the high seas, straddling), and b) how the measure aligns with the distribution of the stock to which the measure is intended to apply (i.e., full or partial protection of the range of the stock). The first three categories depend on the geographical location of the measure, whereas the latter two are depend on the jurisdiction responsible for managing the stock that the measure is intended to conserve. High-seas fisheries ABMTs are located entirely in the high seas and outside of national jurisdiction. State fisheries ABMTs are located entirely shoreward of the EEZ outer boundary lines of one or multiple countries, including measures in more than one state jointly implemented. Straddling fisheries ABMTs are located in the high seas and within the outer boundary line of the EEZ of at least one country. Full fisheries ABMTs have fishing restrictions that apply to the entire geographical range of the stock the measure is intended to conserve, which may be located within the EEZ of a country, or shared between jurisdictions of multiple countries.

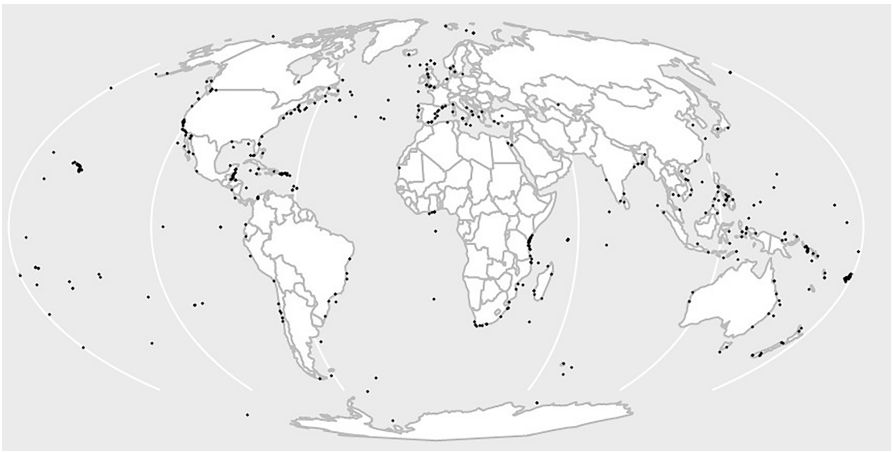

FIGURE 2 | Locations of the unique fisheries ABMT case studies included in this review.

Partial fisheries ABMTs have fishing restrictions that do *not* apply to the entire geographical range of the stock the measure is intended to conserve. Since the full and partial fisheries ABMT categories are concerned only with the range of a stock within the EEZs of the States, high sea measures are excluded from these categories.

The dimension of activities refers to where opportunities exist to place restrictions on the types of harvesting activities allowed in the fisheries ABMT. Here, we adopt the definition of "fishing" used in Article 1 of the Agreement on Port State Measures to Prevent, Deter, and Eliminate Illegal, Unreported, and Unregulated Fishing: "*searching for, attracting, locating, catching, taking or harvesting fish or any activity which can reasonably be expected to result in the attracting, locating, catching, taking or harvesting of fish*" (FAO, 2017). We characterized the activity dimension in two ways: total closure and partial closure. Total closure prohibits all harvesting of marine species. Partial closures restrict only certain harvesting activities. For example, they may limit certain gear, methods, target species, or socio-economic categories.

Comparing Fisheries ABMTs to the OECM Criteria

We then reviewed the information in the publication(s) relevant to each case study that could be related to each of the four OECM criteria. In evaluating the performance related to Criterion A—*the area is not currently recognized as a protected area*—we attempted to identify all individual case studies in our review that have been reported as MPAs to the World Database on Protected Areas (WDPA)[5] as of December 2021. Through this process, we searched for each case study name and identified any entries in the WDPA that matched the names used in the publications included in our review. In some cases, the names of the areas used in the case studies did not perfectly match those reported in the WDPA. In those cases, we compared the location of each case study as noted in the publication, with the protected areas mapped for each country in the WDPA. Additionally, we reviewed the case studies that countries have already reported to the World Database on OECMs[6] to identify them in this analysis as well.

For Criterion B—*the area is governed and managed*—we recorded whether authors reported geographic boundaries and a legitimate governance authority for each case study. We also recorded who oversees managing the ABMT, whether indigenous peoples and local communities are involved in management, what the management system consists of, and whether there is a management plan.

To evaluate performance against Criterion C—*achieves sustained and effective contribution to in situ conservation of biodiversity*—we analyzed the information reported in the publications regarding the perceived or measured consequences for biodiversity resulting from the fisheries ABMT. For fisheries ABMTs to be recognized as OECMs and to contribute toward the achievement of the global biodiversity conservation goals, it is imperative that they contribute to positive biodiversity outcomes. Although fisheries ABMTs are managed to support the sustainable use of fisheries resources, biodiversity conservation is not usually the primary objective of fisheries ABMTs and their contribution to biodiversity might be overlooked. Therefore, we deemed it necessary to explore in more detail the biodiversity conservation outcomes provided by the fisheries ABMTs identified in this literature review. To do so, we used emergent coding to record and group the documented biodiversity conservation outcomes for each individual case study. We categorized the outcomes based on

[5] The WDPA is the central database for protected areas that is reported to the CBD. Retrieved December 2021 https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA.

[6] The World Database on OECMs is the central database for OECMs that are reported to the CBD. Retrieved June 2022 from:https://www.protectedplanet.net/en/thematic-areas/oecms?tab=OECMs.

population/species, habitat, or ecosystem level. We note that the range of such reporting is varied in nature, and in data-limited situations, often narrative information collected from fishers is the best information available. It was not always known if controls in place were "likely to achieve (net) positive biodiversity conservation" in the presence of local pressures outside the control of area managers (e.g., human and natural pressures at larger spatial scales than the area, such as fishing pressures operational outside the area; unprecedented heat waves caused by climate change; or natural pressures, such as storms and cyclones). Therefore, as long as a positive biodiversity outcome was mentioned by the case study authors, the case study was scored positively.

Regarding Criterion D—*associated ecosystem functions and services and cultural, spiritual, socio-economic, and other locally relevant values*—we recorded whether the authors mentioned ecosystem functions and services as being associated with the area covered by the fisheries ABMT. These ecosystem functions and services include provisioning services (e.g., food, fiber, natural medicines, water, shells, decoration), regulating services (e.g., air quality, climate regulation, water quality, coastline protection, erosion reduction, natural hazards), supporting services (e.g., nursery habitats, nutrient cycling, water cycling, photosynthesis), and cultural services (e.g., coastal heritage, ethical values, existence value, aesthetic value, recreation, ecotourism, education).

We assessed how well the case studies corresponded to the OECM criteria. We calculated frequencies based on the fisheries management regime at the time the publication was written, even if management was expected to change. If the fisheries management approach at the time of writing was not provided, the management regime described by the author(s) is not included in the tables. Furthermore, there were seven cases in which an area had been designated but regulations had not yet been put in place. These areas are excluded from the time and activity dimension counts as there were no regulations at the time of writing, but they were included in the space dimension counts as they had defined boundaries. There were relatively few case studies that could be recorded as applying full or partial stock range protection. However, this is mainly because many authors did not specify what stock(s) the measure was intending to conserve. For the activity dimension, if a paper specified that fishing was prohibited, it was assumed that all harvesting of marine species was prohibited.

None of the identified publications is specifically aimed at assessing a case study against the OECM criteria. Therefore, if a publication did not present information allowing the evaluation of one or more of the criteria, we noted the assessment result as "not available" (N/A). An N/A evaluation does not indicate that the fisheries ABMT does not meet the OECM criteria. Rather, it means that, for case studies where the scoring indicated that some criteria were not met, the case study may actually meet the criteria, but that the information was not reported to allow an assessment to be made. Consequently, it means the counts and percentages are minimums, and the various measures could likely address each criterion more often than reported in this review.

RESULTS

Summary of the Literature Review

We identified 20 different categories of fisheries ABMTs used across all case studies identified in the review (**Table 2**). These categories include those originally identified in Rice et al. (2018) as well as other measures such as biosphere reserves, closed areas, marine reserves, marine sanctuaries, MPAs, and national parks that were identified in the case studies. Although most of the categories can be defined specifically as ABFM, we did identify some fisheries ABMT categories that are used to manage marine resources more broadly than fisheries (i.e., MPAs, biosphere reserves, marine reserves). It was not always clear how the terminology used was adopted or if the original authors respected conventional definitions. Through this review, we found that the most common fisheries ABMTs are referred to in the literature review as marine reserves (n = 88), closed areas (n = 78), and MPAs (n = 56) (**Table 2**). The types of fisheries ABMT being used employ various constraints and restrictions on human pressures relating to time, space, and types of activities.

In **Table 2**, the frequencies for each fisheries ABMT category indicate how many case studies met the constraint definition or for which we considered the constraint met based on the information provided by the author(s). If there was moderate uncertainty around whether the case study met a constraint definition, it is not included in the table. We could define at least one constraint for all case studies in the review. Some case studies met the definition of numerous constraint categories, as only the High Seas, State, and Straddling categories are mutually exclusive. Therefore, they were counted for each constraint that applied (meaning that the categories are not mutually exclusive). For example, an LMMA that contains a permanent closure and an area that is seasonally fished would meet both the permanent and seasonal constraint definitions. If the measure was no longer in place at the time of writing, it was not classified as temporary (n = 5) and was excluded from the frequency counts.

Comparing Fisheries ABMTs to the OECM Criteria

With regard to Criterion A *(not a protected area)*, we found that almost half of the case studies identified in this review (48.9% of all case studies) have been reported as MPAs to the WDPA (**Table 3**). One-third of the individual case studies in this review (34.8%) have not been reported to the WDPA, although three (e.g., Lophelia Coral Conservation Area, Hawke Box, and Northeast Channel Coral Conservation Area) have been reported as OECMs to the World Database on OECMs. For the remaining case studies (11.2%), it was impossible to determine whether they met Criterion A. This occurred for publications that referenced a network of fisheries ABMTs, where some measures in the network have been declared as MPAs and others have not, and it was impossible to separate the information reported, or when

TABLE 2 | Categories of fisheries ABMTs characterized by their constraints in time, space and allowed activities.

	DIMENSIONS CONSTRAINED												
	TIME						SPACE					ACTIVITIES	
Area Type	**Permanent**	**Temporary**	**Seasonal**	**Real Time**	**Rotational**	**Occasional**	**High Seas**	**State**	**Straddling**	**Full**	**Partial**	**Total Closure**	**Partial Closure**
Benthic protected area	9	–	–	1	–	–	1	8	–	–	2	–	7
Biosphere reserve	11	1	3	–	–	–	–	15	–	1	3	7	8
Closed area	78	2	18	1	3	2	2	83	1	4	19	59	62
Closed season	26	4	56	5	4	7	2	59	1	15	22	17	54
Community conserved area	25	2	7	–	2	4	–	39	–	1	1	13	20
Fisheries reserve	12	3	–	–	–	1	–	15	–	–	2	8	9
Fisheries restricted area	33	–	2	–	1	1	–	36	–	–	6	18	28
Fisheries sanctuary	6	–	3	–	–	–	–	7	–	–	1	5	6
Gear ban	15	1	1	1	1	–	–	16	–	3	5	4	15
Locally managed marine area	21	13	10	4	11	20	2	51	2	2	6	33	30
Marine reserve	88	–	9	–	–	–	1	98	1	–	7	64	59
Marine sanctuary	8	–	1	–	–	–	–	10	–	–	1	6	4
Moratorium	9	6	9	2	2	1	6	18	3	3	6	5	17
Move-on rule	3	1	–	5	–	–	3	1	1	–	–	2	3
Marine protected area	56	3	6	1	2	6	2	73	3	–	3	40	44
National Park	34	–	2	–	–	2	–	43	–	–	–	27	24
Real time closure	4	–	1	12	–	–	–	12	2	1	10	3	9
Ring fencing	1	–	–	1	–	–	–	1	–	1	–	–	1
Rotational closure	4	1	1	–	4	4	–	8	–	–	1	6	5
TURF	9	1	–	–	1	–	–	11	–	–	3	3	8
Managed VME	15	4	1	7	–	–	10	6	3	1	1	4	14

Each cell represents the number of individual case studies in the literature that are constrained in the respective dimensions. Note that any one case study may have more than one constraint in any of the three dimensions and may be categorized by more than one type of ABMT.

it was unclear whether the case study overlapped with an already reported MPA in the WDPA. The ABMT categories least likely to have been reported as MPAs, and therefore most likely to meet Criterion A, were benthic protected areas, closed seasons, gear ban moratoriums, move-on rules, real-time closures, managed VMEs, and ring fencing. In a minority of cases, references reviewed excluded a specific name and location of the ABMT. In such cases, we could not crosscheck with the WDPA. Given this, it is possible that some case studies included in our subsequent analysis may have already been reported in the WDPA.

With regard to Criterion B *(Area governed and managed)*, over two-thirds of the case studies reported geographically defined boundaries (74.9%) and a legitimate governance authority (76%). Over half (58.3%) of the case studies met both criteria, therefore likely meeting Criterion B. The only measures where less than 50% of case studies met this criterion were moratoria and rotational closures. Move-on rules, real-time closures, benthic protected areas, and managed VMEs performed best regarding this criterion.

With regard to Criterion C *(Achieves or is expected to achieve sustained biodiversity conservation)*, the authors of 36.1% of the case studies reported that the ABMT has a positive effect on biodiversity; 7% reported having both positive and negative effects on biodiversity; and 3.6% reported having a negative effect on biodiversity. More than half of the authors did not report explicit judgments about the impact of ABMT on biodiversity, and thus it could not be scored.

Of the case studies for which biodiversity outcomes were reported, only those reported as showing positive effects on biodiversity (including case studies showing both positive and negative effects) were considered to meet Criterion C (43.3%). Using the information reported in this literature review, this was the only individual criterion to be met by less than 50% of case studies. Overall, publications reporting on case studies in this review were less likely to provide adequate information related to Criterion C than for the other three criteria. In the review, publications describing rotational closures, LMMAs, gear bans, and closed areas were most likely to report information in support of Criterion C.

With regard to Criterion D *(Associated ecosystem functions and services and cultural, spiritual, socio-economic and other locally relevant values)*, we found that for 58.1% of the individual case studies, authors reported on management measures that explicitly support the relevant ecosystem services and functions of the area covered by the fisheries ABMT and therefore likely to meet Criterion D. Rotational closures, real-time closures,

gear bans, LMMAs, and TURFs performed best in this criterion. However, publications in this review rarely reported on locally relevant values associated with the area where the measures were applied.

Finally, we analyzed how many of the case studies could be argued as potentially meeting different combinations of the four criteria based solely on the information reported in the publications reviewed. A total of 36 fisheries ABMTs (8.1%) were evaluated as likely to meet all four criteria based on the information presented in this literature review (see **Appendix** A for the relevant publications). Managed VMEs (79%), fisheries sanctuaries (28.6%), and closed seasons (27.7%) are the most likely types of area-based management to meet all OECM criteria. Based on information reported in the publications identified in this review, the fisheries ABMTs that appear to most often meet all criteria include fisheries sanctuaries, closed seasons, benthic protected areas, and LMMAs (**Table 3**). Additionally, we scored 95 case studies (21.3%) as possibly meeting Criteria B, C, and D.

When looking only at the subset of case studies that meet Criterion A (i.e., they have not already been reported as MPAs), fisheries sanctuaries appear to perform best in meeting the rest of the OECM criteria (**Table 4**). This suggests that fisheries sanctuaries could be an important starting point for future work on identifying OECMs in the fisheries sector. Note also that 21.3% of the case studies meet Criteria B, C, and D but are characterized by publications in this literature review as MPAs (i.e., they do not meet Criterion A). In such cases, authorities should confirm that they are MPAs by internationally recognized provisions. If they are not formally recognized, states could go through a process to re-label them as either OECMs or internationally recognized MPAs to include them in accounting toward targets within the CBD (and 2030 Agenda) frameworks.

Typology of ABMT by Conservation Outcome

The most commonly reported indicators of positive species/population-level biodiversity outcomes included maintaining or enhancing species abundance or density; increases in the catch per unit effort; spillover; and increasing length, weight, biomass, and reproductive output of species in the case studies examined (**Table 5**). Additionally, indicators were reported for many other biodiversity outcomes (**Figure 3**). For example, at the habitat level, the most frequently reported outcome was the protection of a vulnerable or endangered habitat (**Figure 4**). Outcomes at the ecosystem level were much less frequently documented (**Figure 5**). Of the case studies included in this review, demersal and benthic communities were reported more frequently than pelagic communities. Additionally, several case studies reported improved ecological community cohesion, ecosystem structure and function, or conserving representative natural ecosystems. The limitations of this review were that biodiversity outcomes were not comprehensively reported for many case studies or the focus of the study was not on biodiversity outcomes. Given this, the percentage results presented here likely under-report potential biodiversity outcomes that are actually being achieved.

DISCUSSION

This review of fisheries ABMTs in the literature assessed the likely overlap of such areas with the OECM criteria and offered tangible insights into the scope of the fisheries sector to receive biodiversity conservation recognition within international conventions. The designation and implementation of OECMs as a new internationally recognized description of spatial measures supporting biodiversity conservation provides an opportunity to use knowledge of the linkages among fisheries

TABLE 3 | Percentage of case studies that meet each OECM criterion by ABMT type.

Area Type	Total # Case Studies	Meets A	Meets B	Meets C	Meets D	Meets All
Benthic protected area	9	77.8%	88.9%	44.4%	44.4%	22.2%
Biosphere reserve	15	6.7%	60.0%	33.3%	33.3%	0.0%
Closed area	86	41.9%	65.1%	60.5%	72.1%	10.5%
Closed season	65	86.2%	43.1%	52.3%	72.3%	27.7%
Community conserved area	39	51.3%	48.7%	43.6%	61.5%	10.3%
Fisheries reserve	15	46.7%	53.3%	60.0%	60.0%	6.7%
Fisheries restricted area	35	40.0%	74.3%	40.0%	57.1%	8.6%
Fisheries sanctuary	7	42.9%	57.1%	42.9%	57.1%	28.6%
Gear ban	15	80.0%	53.3%	66.7%	86.7%	13.3%
Locally-managed marine area	45	53.3%	44.4%	66.7%	82.2%	20.0%
Marine reserve	100	13.0%	66.0%	43.0%	59.0%	0.0%
Marine sanctuary	9	44.4%	66.7%	33.3%	66.7%	11.1%
Moratorium	23	87.0%	39.1%	52.2%	52.2%	8.7%
Move on rule	5	80.0%	100.0%	20.0%	40.0%	20.0%
MPA	79	25.3%	69.6%	40.5%	58.2%	7.6%
National Park	43	11.6%	62.8%	37.2%	58.1%	0.0%
Real time closure	15	100.0%	93.3%	13.3%	93.3%	13.3%
Ring Fencing	1	100.0%	0.0%	100.0%	0.0%	0.0%
Rotational closure	7	71.4%	42.9%	71.4%	100.0%	14.3%
TURF	11	72.7%	63.6%	54.6%	72.7%	18.2%
Managed VME	19	79.0%	79.0%	26.3%	36.8%	15.8%

TABLE 4 | Summary of how the subset of case studies that meet Criterion A (i.e., have not been reported to the WDPA) also meet each of the other OECM criteria by ABMT type.

Area Type	Total # Case Studies	Meets B	Meets C	Meets D	Meets All
Benthic protected area	7	85.7%	57.1%	42.9%	28.6%
Biosphere reserve	1	100.0%	0.0%	0.0%	0.0%
Closed area	36	55.6%	61.1%	66.7%	25.0%
Closed season	56	42.9%	51.8%	75.0%	32.1%
Community conserved area	20	25.0%	30.0%	45.0%	20.0%
Fisheries reserve	7	57.1%	42.9%	42.9%	14.3%
Fisheries restricted area	14	64.3%	42.9%	35.7%	21.4%
Fisheries sanctuary	3	100.0%	66.7%	66.7%	66.7%
Gear ban	12	41.7%	66.7%	83.3%	16.7%
Locally-managed marine area	24	58.3%	70.8%	79.1%	41.7%
Marine reserve	13	38.5%	38.5%	46.2%	0.0%
Marine sanctuary	4	50.0%	50.0%	75.0%	25.0%
Moratorium	20	35.0%	50.0%	50.0%	10.0%
Move-on rule	4	100.0%	25.0%	25.0%	25.0%
MPA	20	65.0%	45.0%	70.0%	30.0%
National Park	5	80.0%	20.0%	60.0%	0.0%
Real time closure	15	93.3%	13.3%	93.3%	13.3%
Ring fencing	1	0.0%	100.0	0.0%	0.0%
Rotational closure	5	20.0%	80.0%	100.0%	20.0%
TURF	8	50.0%	50.0%	75.0%	25.0%
Managed VME	14	80.0%	33.3%	40.0%	20.0%

TABLE 5 | Summary of case studies with documented positive biodiversity outcomes by category of fisheries ABMT.

Area Type	Total # of Case Studies	Biodiversity Outcomes	Population/Species Outcomes	Habitat Outcomes	Ecosystem Outcomes
Benthic protected area	9	100.0%	66.7%	77.8%	88.9%
Biosphere reserve	15	40.0%	26.7%	20.0%	33.3%
Closed area	86	75.6%	67.4%	30.2%	61.6%
Closed season	65	66.2%	64.6%	16.9%	41.5%
Community conserved area	39	43.6%	43.6%	25.6%	33.3%
Fisheries reserve	15	80.0%	80.0%	13.3%	66.7%
Fisheries restricted area	35	60.0%	54.3%	31.4%	57.1%
Fisheries sanctuary	7	71.4%	71.4%	14.3%	42.9%
Gear ban	15	66.7%	66.7%	13.3%	53.3%
Locally-managed marine area	46	65.2%	63.0%	43.5%	54.3%
Marine reserve	99	57.6%	50.5%	27.3%	47.5%
Marine sanctuary	9	77.8%	77.8%	22.2%	66.7%
Moratorium	23	65.2%	65.2%	21.7%	56.5%
Move-on rule	5	40.0%	40.0%	40.0%	40.0%
MPA	79	59.5%	51.9%	35.4%	46.8%
National Park	43	53.5%	46.5%	34.9%	44.2%
Real time closure	15	33.3%	26.7%	0.0%	26.7%
Ring fencing	1	100.0%	100.0%	0.0%	100.0%
Rotational closure	7	71.4%	71.4%	28.6%	71.4%
TURF	11	63.6%	63.6%	9.1%	63.6%
Managed VME	19	52.6%	42.1%	42.1%	47.4%

and other sectors to deliver coordinated strategies for biodiversity and people. This is welcome as fisheries ABMTs may offer both the fisheries sector and countries a greater opportunity to deliver on international conservation commitments.

OECMs provide an opportunity to use knowledge of the linkages among fisheries, biodiversity, and other sectors to design and implement concrete actions toward coordinated management strategies and policies. Given that the primary objectives of fisheries ABMTs are related to fisheries sustainability with improved biodiversity conservation as an additional objective, they are likely to generate multiple benefits for social, ecological, and economic development and provide a more flexible context for candid and transparent community dialog on alternative ways to balance conflicting interests. This makes OECMs recognized and managed by or for the fisheries sector particularly relevant to reconciling food security, biodiversity conservation, and sustainable development and to helping achieve several SDG targets alongside global biodiversity targets.

We found that although the case study ABMT literature did not hold a comprehensive overview on fisheries spatial

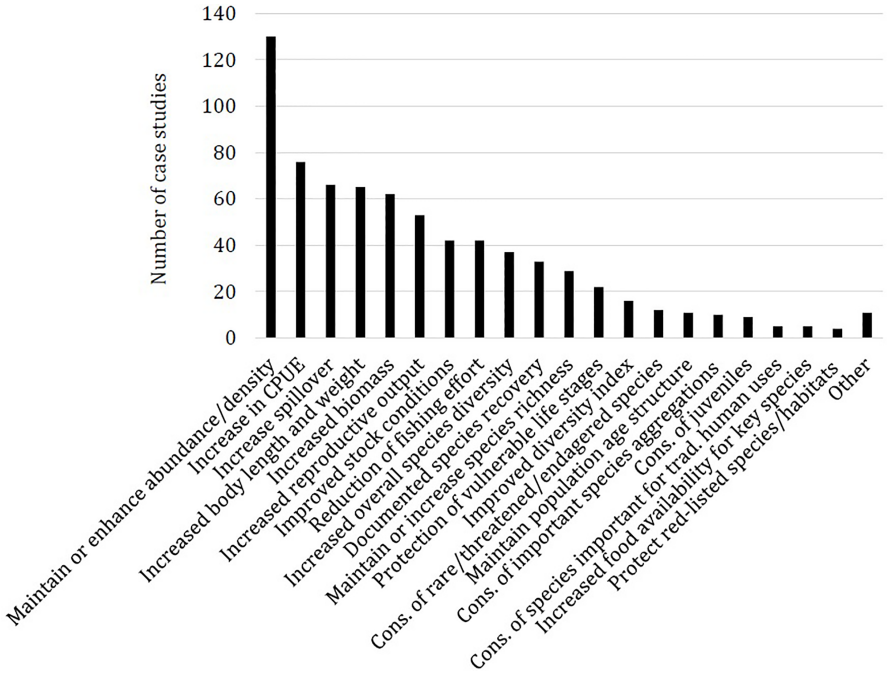

FIGURE 3 | Frequency of case studies for which population/species level biodiversity conservation outcomes were reported.

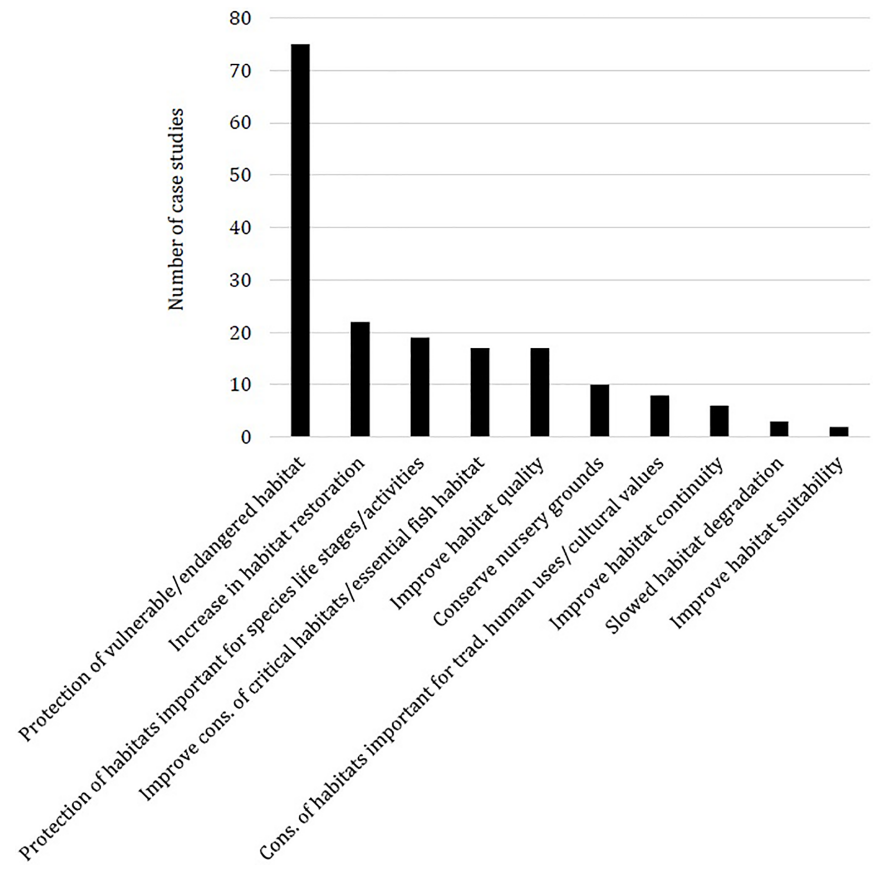

FIGURE 4 | Frequency of case studies for which habitat level biodiversity conservation outcomes were reported.

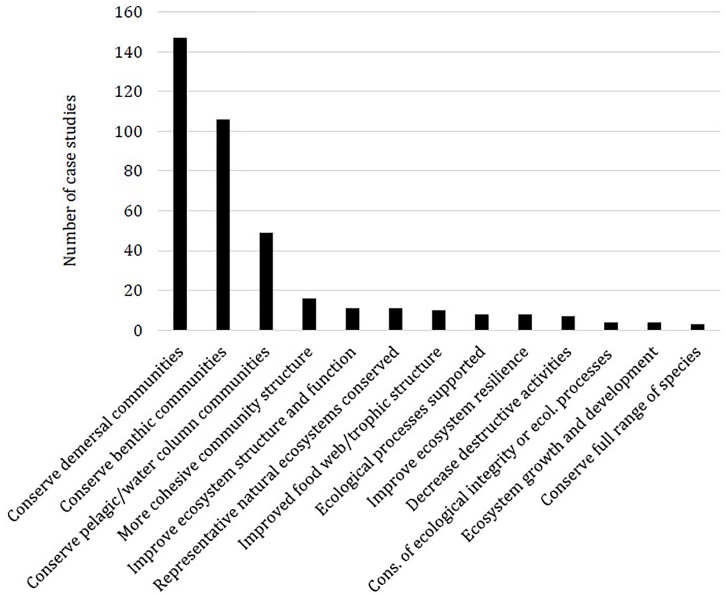

FIGURE 5 | Frequency of case studies for which ecosystem level biodiversity conservation outcomes were reported.

measures, it did reveal a continuum on what types of fisheries ABMTs might be most eligible for delivery against the area-based conservation targets of CBD. The development of a practical typology with unambiguous categories for information eligibility was difficult, as descriptions of fisheries ABMTs revealed overlapping dimensions in space, time, and human activities, or were missing definitive components of the required information to show direct congruence between the case studies and OECM criteria. However, the results showed that few fisheries ABMT categories are likely, by definition, to be accepted or rejected as OECMs solely based on their definition on paper, and the results reinforced the idea that recognizing a fisheries ABMT as an OECM will depend on its unique area characteristics. This will require access to context-specific information on a case-by-case basis—where, when, and how individual measures are governed and applied.

The results of this review highlight the ranked likelihood of which categories of fisheries ABMTs most consistently aligned to the criteria of OECMs, as well as where work would need to be invested to extract more information for such a task. In particular, information supporting OECM Criteria A (*not a protected area*), B (*area governed and managed*), and D (*associated ecosystem functions and services and cultural, spiritual, socio-economic, and other locally relevant values*) is frequently reported for well-managed fisheries ABMTs, whereas criterion C (*achieves or is expected to achieve sustained biodiversity conservation*) is the criterion for which comparative coherence with OECM criteria was most challenging to assess with the information reported in the literature. Since biodiversity conservation is usually not a primary objective of fisheries ABMTs, information required to support Criterion C was less well documented, including on secondary or ancillary biodiversity outcomes that such fisheries ABMTs achieve.

This review suggests a need to encourage authors to report information on biodiversity outcomes when publishing on cases where fisheries ABMTs are used and highlight where future efforts to build capacity are needed in the areas associated with those fisheries ABMTs. There are few well-recognized metrics for reporting such outcomes, which also highlight the need for building capacity and international agreement on how to measure progress, or likely opportunities for progress, on such issues. Additionally, the use of terminology in the literature is not necessarily standardized, and investment in standardizing terminology and not introducing unnecessary new terminology will help in cross-sectoral discussions and understanding.

Many of the requirements of fisheries management present in the internationally adopted Code of Conduct for Responsible Fishing (FAO, 1995) reflect well against the OECM criteria. Most fishing activities, if effectively managed, could be operated in ways, times, and places where impacts on mobile life forms, the seabed, and other biotic community features can be kept within safe ecological limits so that biodiversity can remain stable or improve. This means that most fisheries ABMTs should be able to permit a range of fishing activities while still delivering the outcomes expected of an OECM, if the fisheries can act in a way that reflects the OECM criteria while monitoring and reporting effectively. However, many fisheries ABMTs might not meet the OECM criteria as they currently exist. Additionally, the categorization of a given measure as a type of fisheries ABMT does not ensure eligibility as an OECM through control of fishery activity alone. Even a complete closure of an area to all direct and indirect fisheries impacts might not result in the measure being classified as an OECM if the reason for biodiversity depletion is

outside the control of the sector (e.g., long-term contamination of the area by pollution). Yet, even for categories that do not fare as well against the OECM criteria, there is the opportunity for relevant stakeholders to make practical changes in the governance, controls, monitoring, evaluation, and reporting to meet the OECM criteria.

Beyond the questions addressed in this study, other questions remain unanswered regarding how countries should move ahead in recognizing OECMs under fisheries governance and OECMs in general. For example, there is a lack of clarity regarding the issue of the duration of a fisheries ABMT with regard to the OECM criteria given there are varied descriptions of what "long-term" could mean in either the fisheries or the biodiversity context. Furthermore, the boundaries of OECMs will have to be dynamic to some extent, to account for climate change and the dynamic aquatic systems that marine systems represent. These issues will need to be addressed by the international community sooner rather than later if the fisheries sector is to embrace the concept of OECMs and be accepted as a valid contribution to CBD Post-2020 biodiversity conservation targets. Lastly, this review focused exclusively on fisheries ABMTs in the marine environment. However, area-based management is also commonly used to manage freshwater fisheries resources. Future work should include an analysis of freshwater ABMTs to highlight their contribution to biodiversity conservation.

CONCLUSION

Now that we have surpassed 2020, the CBD Strategic Plan for Biodiversity 2011–2020, including its Aichi Biodiversity Targets, gives way to new aspirations in the soon-to-be-finalized Post-2020 Global Biodiversity Framework, which is scheduled to be adopted in late 2022. This new framework will create new global targets, including a likely headline target to increase the percent coverage of marine spatial management, with the aim of achieving by 2030 a radical increase in coverage of MPAs and OECMs. However, given that most countries have not yet reached the 10% goal set by Target 11, and countries are only now beginning to promote the establishment of OECMs through cross-sectoral engagement, countries will be expected to expand their use of a range of recognized spatial management. This includes increasing the coverage of OECMs—including through recognition of fisheries ABMTs as OECMs—and tapping into the opportunities provided by sectoral-led spatial management approaches instead of being reliant solely on MPAs. This still requires the building of a common understanding and interpretation of the factors of importance that make fisheries ABMTs comply with OECM criteria, including which type of fisheries ABMT is used and, more importantly, how it is applied in a particular context. The extent to which ABMTs can support the achievement of the SDGs and CBD targets also depends on the effectiveness of the conservation benefits they can deliver (Geldmann et al., 2015; De Santo, 2018; Zafra-Calvo and Geldmann, 2020), which are enhanced by the active engagement of ocean users (Charles and Wilson, 2009; Christie et al., 2017; Reimer et al., 2021).

The evolution and growth of the discussion on OECMs provides an opportunity to take a more pluralistic and grounded approach to conserving and sustainably using the oceans. This study addresses some of the knowledge gaps by providing a scaled assessment of how reporting on fisheries ABMTs indicates which fisheries area-based approaches are most likely to comply with the OECM criteria, but also which information collation efforts need to be focused on to conduct such a task. This review and assessment shows that fisheries ABMTs produce a broad range of positive biodiversity outcomes related to the conservation of target species and other biodiversity features. This demonstrates that some fisheries ABMTs, as presently implemented or through minor adjustments, could be recognized as OECMs, allowing their contribution to biodiversity conservation goals to be internationally recognized and spurring further efforts by the fisheries sector to uptake conservation goals of relevance to the global Convention.

The results of this study highlight the value that recognizing fisheries ABMTs as OECMs could bring to achieving global coverage and progress on spatial conservation of marine biodiversity. Although there is already some guidance on OECMs (IUCN-WCPA, 2019), sector-specific guidance remains an outstanding requirement to support countries in evaluating fisheries ABMTs against the OECM criteria. If possible, the investment of the global community in the delivery of this guidance should recognize regional differences in management capacities, which have hindered the progress of CBD targets until now and action on the use of OECMs as well.

Finally, there is a need to look at the bigger picture regarding the achievement of biodiversity conservation goals. OECMs and MPAs should be part of the toolbox, along with sustainable use, using ecosystem approaches across 100% of the ocean, with measures of spatial protection included as just part of the strategy for improving people's relationship with the rest of nature. As such, highlighting the concept of effectiveness in achieving positive biodiversity conservation outcomes needs to be central to all management of social–environmental systems. Blending all approaches and ensuring each is implemented with effective monitoring systems in place—that respond adaptively to feedback on overall performance—can set us on a pathway to achieve the goal of 100% of the oceans being effectively managed.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**. Further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

AH-C oversaw the review, led the design of the search strategy, paper screening protocol, data collection and analysis and data interpretation, conducted thematic analysis and co-wrote the

manuscript. JLS assisted in the design of the search strategy, paper screening protocol, data collection and analysis and data interpretation, conducted thematic analysis and co-wrote the manuscript. CP and CM conducted the search, screened the papers, conducted the thematic analysis, and co-wrote the manuscript. JR, KF, SG, and DF reviewed the findings of the thematic analysis, verified scientific merit, and contributed to the discussion. All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2022.932283/full#supplementary-material

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