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EXPERT WORKSHOP ON MARINE PROTECTED AREAS AND OTHER EFFECTIVE AREA-BASED CONSERVATION MEASURES FOR ACHIEVING AICHI BIODIVERSITY TARGET 11 IN MARINE AND COASTAL AREAS
Montreal, Canada, 6-9 February 2018

BACKGROUND DOCUMENT ON OTHER EFFECTIVE AREA-BASED CONSERVATION MEASURES USED IN MARINE FISHERIES

Note by the Executive Secretary

1. The Executive Secretary is circulating herewith, for the information of participants in the Expert Workshop on Marine Protected Areas and Other Effective Area-based Conservation Measures for Achieving Aichi Biodiversity Target 11 in Marine and Coastal Areas, a background document on other effective area-based conservation measures used in marine fisheries. The document was prepared by the Fisheries Experts Group of the IUCN Commission of Ecosystem Management (IUCN/CEM/FEG), as commissioned by the Secretariat, in support of its preparation for the above-mentioned workshop, with the financial support from the Government of Norway.

2. The document is being circulated in the form and language in which it was received by the Secretariat.

Other Effective Area-Based Conservation Measures (OEABCMs) Used in Marine Fisheries: A Working Paper

Background Information Document for the

CBD Expert Workshop on Marine Protected Areas and Other Effective Area-based Conservation Measures for Achieving Aichi Biodiversity Target 11 in Marine and Coastal Areas

(6 - 9 February 2018 - Montreal, Canada)

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Commissioned by: the Secretariat of the Convention on Biological Diversity

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1. Introduction – Context of the Workshop

In 2020 the CBD COP will assess progress in the achievement of the 20 Aichi Biodiversity Targets adopted at CBD COP 10 in 2010. Although, operationally, the pursuit of each target must take into account the different ecological, economic and social circumstances of each Party, the intent of the Targets should be interpreted consistently. The language used in each target is an important guide to the intent of COP 10, when the targets were adopted. Target 11 is among the longest – "*By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes*."

In the case of the longer Targets, the complexity of language has two causes: the inherent complexity of the conservation challenges being addressed, and the need for consensus at the COP. In the case of Aichi Target 11, key complexities included first the need to address the different starting conditions for coverage of terrestrial and marine conservation areas. A second complexity is that, whereas on land (in most of the world) the ownership of a tract of land greatly influences how it can be used and conserved, in the ocean and coasts, specific areas are rarely "owned" in the same way, so different types of measures may be needed to achieve the same regulation of uses and conservation of ecosystem features. The phrase "*other effective area-based conservation measures*" allowed both terrestrial areas such as indigenous lands under traditional agroforestry practices, and marine spatial measures other than formal Marine Protected Areas to be included in the target. However, for this phrase to be applied consistently, there needs to be consistent interpretation of which area-based measures (other than MPAs) may be "conservation measures" and how such measures can be considered "effective".

In this Working Paper, we review the different types of area-based measures used in fisheries management, with regard to how "effective" they are at conservation. In this context "effectiveness" at conservation must consider both how much of the biodiversity characteristic of an area is being conserved, and how well protected it is. The intent is to inform a policy discussion of where a measure needs to lie along the continua of "effectiveness" in each in each of these two considerations, a before it is appropriate to include it in reporting on Target 11.

The Target also includes other terms that are important to Target 11 reporting, such as "equitably managed", "ecologically representative", and "well connected". However, these terms are applied both to the collection of protected areas and to areas considered to be "OEABCMs" and are considered to be out of scope for the Expert Workshop and this Working Paper.

Structure of the document

Section 2 clarifies the terminology used in the working.

Section 3 provides a review of area-based fishery management measures (ABFMs), their objectives and intended outcomes of sustainable use and biodiversity conservation, the factors of performance, a typology of ABFMs, and specific examples, with a summary of their track record in delivering their intended outcome and the factors enabling or limiting their effectiveness.

Section 4 reviews published evidence on broader biodiversity conservation effects of the ABFMs listed in Section3, describing the approach used for the review, the empirical and model-based evidence available regarding impacts on non-targeted species, seabed integrity, and ecosystem structure and function, summarizing the potential contributions of the ABFMs reviewed in Section 3.

Section 5 proposes draft criteria for identifying fishery OEABCMs, with short guidelines on the conduct of their evaluation.

Section 6 contains a short synthesis.

2. TERMINOLOGY

Article 2 of the Convention provides several helpful definitions.

2.1 In-situ conservation

"In-situ conservation *means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties*." This definition makes clear that for areas to be included in reporting on Target 11, area-based measures have to be developed in an ecosystem context, and they must promote both natural features of the habitat and viable populations of species characteristic of those habitats. This definition does not necessarily require pristine habitats and populations at completely un-impacted states. It does require that the habitats have all "natural" features and are not undergoing degradation, and that the populations of the characteristic species either be viable or if they are depleted, they should be recovering.

The properties of ecosystems and natural habitats that need to be conserved can in turn be taken from the properties included in the Voluntary guidelines on biodiversity-inclusive impact assessment that were endorsed by the 8th meeting of the Conference of the Parties to the CBD in Curitiba, Brazil (20-31 March 2006) (CBD, 2006) and it foundation documents (CBD Decision VI/7-A, the Ramsar Convention on Wetlands Resolution VIII.9) and the Convention on Migratory Species Resolution 7.2) which refer to "biodiversity composition, structure and processes".

2.2 Protected area (PA)

The second important definition in the Convention (Article 2) is that, in a CBD context, "*Protected area' means a geographically defined area which is designated or regulated and* *managed to achieve specific conservation objectives*". The definition specifies that the two criteria required for an area to be a PA are that the area must be geographically defined and it must have specific conservation objectives. Target 11 specifically refers *to protected areas* but adds *other effective area-based conservation measures.* This reflects the Parties consensual intent of going beyond solely the areas that meet those two PA criteria. Since "area-based" is explicitly included in the language of Target 11, consequently these "other areas" do not necessarily have to have explicit conservation objectives. Rather the conservation intent can be implicit, as long as the measures applied therein are effective at delivering the in-situ conservation outcomes.

2.3 Effective conservation

The term *"Effective"* is not defined in the Convention or in the Target itself, and is a major focus of this Working Paper.

Consistent with the definition of "in situ conservation", "Effectiveness" is viewed as a gradient of how probable a conservation outcome is, and not a binary (succeed or fail) term. Building on the Convention text and previous CBD COP decisions, "effectiveness" could be evaluated as the extent to which the area, with its measures, contributes to the central three objectives of the CBD: (i) *The conservation of biological diversity*, maintaining ecosystems, species and genetic diversity for human present and future well-being; (ii) *The sustainable use of its components,* i.e. *providing livelihoods to people, without jeopardizing future options*); and (3) *The fair and equitable sharing of benefits arising from the use of genetic resources.* In addition, CBD (2006) highlights that priority be given to the protection of: *threatened, declining or endemic ecosystems; ecosystem services; habitats that are unique or play a vital role in supporting seasonal or migrant species; endemic, threatened or declining species; species of known use or cultural value to society; irreplaceable biodiversity which cannot be found anywhere else.* CBD (2006) *also highlights that* priority is also given to *opportunities to enhance biodiversity through restoring, re-creating or rehabilitating natural habitat are used to optimum benefit* and to full compensation *of unavoidable negative impacts on biodiversity (no Net Loss*).

This CBD guidance means that using ecosystem considerations in choosing the area-based measure and tailoring its implementation can have three important positive consequences. Such measures can promote: (i) keeping habitats in the "natural" condition; and (ii) maintaining viable populations of the species characteristic of those habitats, and their recovery when depleted. As a result, area-based measures that are developed in an Ecosystem Approach context may be more "effective" relative to the first CBD objective. In addition, areas successfully managed for sustainable use with spatial measures not compromising the first objective (conservation of biological diversity) could also be part of the other areas effectively managed under the intent of Target 11, if they are developed within an Ecosystem Approach.

Many area-based measures are used in fisheries management, for many purposes. Most can be implemented in a variety of ways, depending on the specific intent of the fisheries policy-makers and managers. Some measures may be implemented in ways intended to resolve an operational issue like conflicts between gear sectors or communities about opportunities to fish. In such cases biodiversity benefits beyond the obvious benefit for the target may receive little consideration. In other cases, area-based measures may be chosen specifically because they offer protection to either a wide range of biodiversity, or key biodiversity features of special concern (e.g. areas dedicated to limit/reduce/eliminate bycatch, or avoid disturbance of a protected species). Many area-based measures are likely to have intermediate consequences – enhancing the conservation potential of some species or ecosystem features, leaving other features unprotected or possibly exposed to even greater pressure through factors such as displaced effort.

In practice, each of these types of situations warrants review. For example, measures to specifically restrict fisheries on forage species in the proximity of seabird breeding colonies may not be effective for seabird conservation unless, overall, the exploitation of the forage species was developed in an appropriately ecosystem-based framework. On the other hand, measures intended only to resolve gear conflicts between competing fisheries may, in fact, result in broad biodiversity benefits, if the individual fisheries then use their respective gears in more responsible manners and comply more fully with limits on catches, effort and bycatch. It is the case-specific context and outcomes –whether planned or emerging as collateral effects– that really reflect the "effectiveness" of each area-based measure in delivering conservation outcomes.

2.4 Area-based fishery management measure

An area-based fisheries management measure (ABFM) is a formally established, spatially-defined fishery management and/or conservation measure, implemented to achieve one or more intended fishery outcomes.

These outcomes are commonly related to sustainable use of the target species of the fishery, such as the protection of vulnerable life-stages or critical habitats or to allocation of space and resources among fishing communities or sub-sectors. However, increasingly the intended outcomes can include protection or reduction of impact on biodiversity components, habitats, or ecosystem structure and function, such as closures of Vulnerable Marine Ecosystem (VMEs) or exclusion of small-mesh fisheries within the foraging range of seabird colonies. Moreover, many of the measures that are intended primarily to deliver outcomes related to the target species also deliver additional biodiversity conservation outcomes relevant to Target 11. These area-based measures have an implicit or explicit time dimension (from permanent, to temporary, seasonal or real time).

Some area-based fisheries measures may be considered as OEABCMs if they fulfill the intent of Target 11 regarding in-situ conservation objectives and the goals of the CBD. However, there is not yet clear guidance on how to identify which area-based fisheries measures are appropriate for Target 11 reporting. Fisheries management agencies are increasingly specifying the objectives of their management plans explicitly (Mardle et al 2004, Hilborn 2007), but the practice is far from universal. Moreover, specific objectives are rarely matched to the individual measures in large management plans. Even when there are objectives for individual measures, these may not cover the outcomes of the measures comprehensively, and specified objectives of long-established measures are not retrospectively augmented to cover all the additional contributions the measure may be making to conservation of biodiversity and sustainable use.

Consequently, the objectives alone are an incomplete guide to determine which sites where area-based fisheries management measures are in place could be included in Target 11 reporting. This Working Paper explores the relationship of area-based fisheries management measures to Target 11 reporting in more depth.

2.5 Other Effective Area-Based Conservation Measures (OEABCMs)

As implied by their name, the Other Effective Area-based Conservation Measures (OEABCMs) could be defined as *area-based measures, other than designated protected areas (PAs), used in various economic activities and which outcomes make an effective contribution to broad in-situ conservation of biodiversity composition, structure and function*.

The IUCN (2018) draft guidelines on Other Effective Conservation Measures (OECM) (Part B, Section 2) propose that: OECMs are "*a geographically defined space, not recognised as a protected area, which is governed and managed over the long-term in ways that deliver the effective in-situ conservation of biodiversity, with associated ecosystem services and cultural and spiritual value*". Consistent with the arguments above, this IUCN definition notes that the difference between MPAs and OECMs is that the latter do not have conservation as primary objective but should deliver [as an outcome] effective in-situ conservation of biodiversity, regardless of their objectives.

From a fishery point of view, it may be important to stress that an OEABCM is a cross sectoral concept. Any proposal to include an area managed by fisheries *with effective contribution to broader conservation* will also be reviewed relative to other pressures either present or likely in the same area. The consequences of those other pressures will also be a consideration in Target 11 reporting.

3. Inventory of fishery closures

The spatial dimension is an essential aspect of fisheries, albeit often only implicit. Fish resources are distributed in space, and knowledge about the marine space, its resources and hazards is vital for fishers' performance and survival. With experience, fishers establish their individual fishing territories and seasonal trajectories between their fishing spots. The fishing mortality (F) they apply to the resource is proportional to the effort (f) deployed per unit area (F=q.f/A) with q as the catchability coefficient. Conventional fishery management measures such as input and output controls and gear regulations apply to specific fisheries and their resources in management units, hence within a space corresponding to the area of distribution of the stock, the fishing ground, or, for large distribution areas, a statistical division. In modern fisheries management, the regulation of the amount and types of fishing pressures is increasingly space-based even though the precise stock structure (in terms of genetic sub-populations) may not yet be sufficiently identified to be fully effective in terms of maintaining biodiversity.

Contrary to common belief, fisheries are not free to roam the marine space, but rather face numerous constraints stemming from the specific designation of areas more formally allocated to other economic activities such as: extraction of oil, gas, diamonds, sand and gravel; aquaculture; renewable energy production, e.g. tidal power, aeolians and turbines;

communication and electric cables; navigation channels; garbage dumping areas (where still practiced); and Navy firing range areas. There is very little fishery literature on the otherwise obvious impact of these non-fishery spatial constraints on fisheries operations and management.

In addition, No-Take-Zones, established as fully protected areas, are often established within fishery territories with nature conservation as prime objective (as for all MPAs) and sometimes with fisheries enhancement as secondary objective. Their positive impact on biodiversity inside the protected area has been well described. Their impact outside the MPAs on resources and fisheries is often difficult to measure and depends heavily on the ambient fishery management. Moreover, some *bona fide* MPAs are multiple-use MPAs (IUCN Category VI) that allow sustainable economic activities within them. The Australian Great Barrier Reef Marine Park is an iconic example. Large national marine parks have similar characteristics. All these areas, which are considered MPAs, are not examined in this document.

In the following sub-sections, we will provide a review of ABFMs, their objectives, performance and typology, summarizing the ways in which they are typically used and their <u>intended</u> outcomes regarding the sustainable use of the fishery target species and the mitigation of impact on the other components of biodiversity such as bycatch species and seabed habitats that might alter ecosystem structure and function. It will also give illustrative examples of fisheries and geographic locations where the types of closures have been used. This section also includes a summary of the general track record of the measures for delivering their intended outcomes, identifying also enabling and limiting factors which, make such measures likely to be either: (i) effective in delivering ecologically and socioeconomically sustainable fisheries; or (ii) ineffective or unnecessarily costly or disruptive of fishery operations.

3.1 Objectives of ABFMs

In order of priority, ABFMs usually aim at (based on Hall, 2009):

a. <u>Optimizing the exploitation of the target species</u>, as a complement to other fishery management measures controlling input and output, and economic incentives. They aim at protecting: (i) specific life stages (eggs, larvae, juveniles, spawners); (ii) depleted stocks or parts of stocks during rebuilding programmes; (iii) genetic reservoirs; (iv) habitats critical to fishery sustainability; and (v) reserves of food, particularly is small island countries communities (food security insurance). ABFMs have also been sometimes used to restrain fleet capacity and optimize catch composition and value, with mixed results.

b. <u>Allocating space and resources,</u> e.g. between small-scale fisheries (SSFs), large scale fisheries (LSFs), foreign fleets, and aquaculture, ensuring equitable distribution of access to space and resources, reducing conflict between socio-economic groups or gears as well as risk of collision between small and large fishing vessels.

c. <u>Broader conservation</u>, e.g. providing additional protection to species that are depleted, threatened, or emblematic, limiting bycatch and protecting vulnerable living habitats that are critical to fishery sustainability and ecosystem services needed for it.

Areas may also be closed to fishing for (i) sea food safety, when there is a risk of localized contamination of seafood; (ii) operational safety of fisheries and other economic activity such as in navigation channels, oil and gas fields, protection of submarine communication cables, tidal energy production installations, aeolians or turbines. The latter affect fisheries but are not ABFMs and are most often established by non-fishery authorities other Ministries than fisheries.

3.2 Performance factors of ABFMs

ABFMs are used in lieu or as a complement to more conventional fishery management measures such as input/output controls and economic incentives. The possible advantages of ABFMs include: (i) conceptual simplicity: they can be easily understood; (ii) easier implementation in remote multi-gear, multi-species, small-scale fisheries; (iii) effectiveness and efficiency in protecting species of concern from bycatch; (iv) effective protection of benthic habitats from bottom-gear damage; (iv) easier monitoring of fishing impact. However, all ABFMs do not necessarily provide all these advantages all the time and are often adopted based on only a subset of them.

Some disadvantages of ABFMs may be that: (i) only the fishing activity can be controlled; (ii) their economic performance may be lower than that of more conventional measures or economic incentives and voluntary measures (Squires and Garcia, 2015, 2018); (iii) enforcement cost—Controlling entry into, and exit from, a closed area may be complicated and costly if Vessel Monitoring Systems (VMS) or on-board observers are not available.

ABFMs' performance is also affected by contextual factors such as the type of governance (e.g. top-down vs co-managed), the management performance (e.g. in control and surveillance) and the complexity of the jurisdiction (national, shared, straddling, High Sea)

ABFMs' performance may be assessed in relation to their contribution to fisheries' sustainability (their conventional primary objective) as well as to broader conservation. A significant difficulty, however, is in measuring precisely their impact, as they are generally implemented alongside a mix of other methods (such as gear selectivity, effort and catch controls, minimum landing sizes, etc.) and in the context of changes in broader environmental and socio-economic factors which complicates the identification of individual cause-effect relationships. In general terms, ABFMs' performance depends on:

- The overall state of the environment and its intrinsic oscillations, including climate change (that may affect the distribution or survival of the life cycle to be protected;
- The adequacy of its parameters (e.g. size, location, history, state, and general environment);
- Their intended purpose(s) when adopted (i.e. their objectives, whether explicit or implicit), and what fishery issues they are intended to address;
- Fishery governance, particularly community involvement, access rules, additional management measures, inside and outside it, and enforcement; and

- Overall fishing pressure (excess capacity will reduce the efficiency of most measures that do not directly reduce pressure, including those that are area-based).

3.3 Typology of ABFMs

ABFMs have three main dimensions of constraint: (1) Time: areas are closed to fishing permanently (reserves) or temporarily (seasonal, rotational, in real-time); (2) Space: closing the entire EEZ or all or part of a fishing ground within the EEZ; (3) Fishing activities: limitations may apply to all fishing or only to some gears, or some socio-economic categories. Measures affecting dimensions 1, 2 and 3, together with additional technical measures within the areas, can be used to achieve the purposes listed **Section 3.2**. The realm of possible ABFMs is illustrated in a 3-D diagram on **Error! Reference source not found.** and examples are given in **Table 1**.

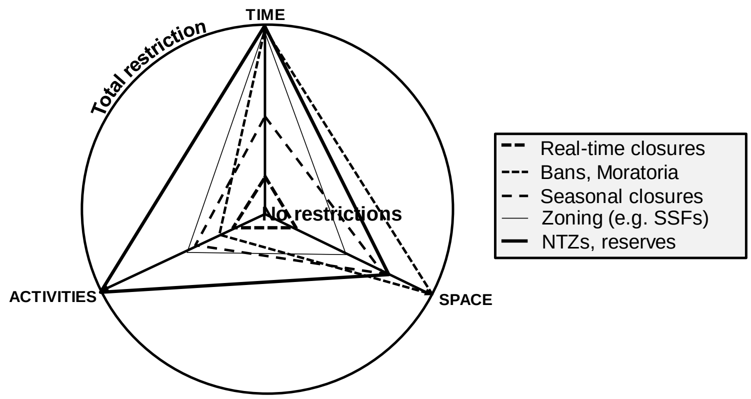

Figure 1: Different types of area-based fishery management measures (ABFM) according to the degree of restriction of time, space and types of activities (Redrawn from Garcia et al., 2013). The three axes range from zero restriction (at the center) to total restriction (on the circle). All these types may be implemented for different purposes (see text)

Table 1. Constraints in space, time and fishing activities in various ABFMs. BPA: Benthic protected area; CCA: Community Conserved Areas; FRA: Fishery Restricted Area; LMMA: Locally Managed Marine Areas; RTIs: Real-Time Incentives; RTSM: Real-Time Spatial Management; TURF: Territorial Use Rights in Fisheries. The characteristics of these and other areas is clarified below.

	DIMENSIONS CONSTRAINED									
	TIME				SPACE CLOSED				ACTIVITIES	
	Permanent	Temporary	Seasonal	Real time	High Sea	EEZ	Fishing ground	Partial	Total closure	Partial closure
Total gear ban										
Zoning										

Reserve, Sanctuary										
TURF										
VME; BPA										
FRA										
Ring fencing										
Moratorium										
MMA										
LMMA; CCA										
Rotational										
Closed season										
RTI, RTSM										
Move-on rule										

The degree of restriction in the three main dimensions leads to a large range of ABFMs when combined with the different potential purposes and contextual parameters related, for example, to the oceanographic characteristics (e.g., depth rage; inshore, coastal, or offshore; neritic or oceanic; benthic or pelagic[1]), jurisdiction (e.g., national jurisdiction, shared with neighboring States, straddling between jurisdictions, or in the High Sea), types of governance, etc.

Because of their multiple dimensions, ABFMs cannot be easily "boxed" into simple homogenous categories. Therefore, in the following sections, we will describe some main types of ABFMs along the "activities" dimension of Figure 1 and Table 1 (total and partial prohibition of fishing), identifying various examples that vary considerably (i) in the degree to which the other dimensions, in time and space, as restrained, and (ii) in their wide range of purposes.

3.4 "Total" closures to fishing

These ABFMs may ban: (i) all fishing activities, year-round and until the measure is revoked, e.g. in a reserve or sanctuary or (ii) to only a specific fishery, e.g. for the duration of a moratorium on a collapsed resource. The ban may apply to: (i) a very large area in the high Seas as in the Fishery Restricted Areas (FRAs) adopted by GFCM; (ii) to the entire EEZ (e.g. for dynamite or poison fishing); or (iii) to smaller areas (e.g. in reserves, Vulnerable Marine Ecosystems (VMEs) and Benthic Protected areas (BPAs). The total ban may also apply only to some problematic gear on specific habitats (e.g. trawls in deep-sea or coastal coral reefs) or to protect well-delimited and stable nursery areas or old spawners' refugia. Some examples are detailed below.

3.4.1 Total closure for food safety or security reasons

"No-Fishing" Areas

"No-fishing" areas can be instituted in a "zoning"[2] process of fishing and other economic activities in an EEZ, for different reasons. All fishing may be prohibited in areas so highly

[1] Eventually sub-divided in epipelagic or mesopelagic)

[2] The term "zoning" is generically used for the process of designating different "zones" with different characteristics for different purposes (such as core reserves, buffer zones, sustainable fishing zones, protected nursery areas, etc.).

contaminated that eating seafood from them poses significant health risks (e.g. fishing for bivalves in contaminated lagoons and coastal areas or close to sewage effluents). Other closures might be instituted where there are operational security concerns due to other human activities in the same area (such as in major shipping lanes or around offshore windfarms or hydrocarbon facilities). These measures may apply to only some fisheries/gears in an area or to all fishing depending on the nature of the risk. The areas are usually established for the long-term. They might be re-opened to fishing if the risk disappears, e.g. if contamination is eliminated or oil operations ceased.

Fishing Zones

Fishing zones could fit in that group. They are often also established inside an EEZ to allocate the available space, and the resources therein, exclusively to types of fishing or fleets or to socio-economic groups, excluding all others. The purpose is to improve equity, allocate de facto some resources to some target groups, avoid conflict between fisheries using incompatible gears, and reduce the risk of dangerous collisions. For example, SSFs may be given exclusive access to the first 6 miles from the coast, while large scale national fisheries may be given access only beyond 6 miles, and foreign fleets operating under an access agreement authorized only beyond 12 miles. These distances may vary depending on national policy and the shelf width. They may also vary between regions in an EEZ, depending on the geography and habitats. Fishing "zones" of this kind are usually established for the long-term but might be modified, e.g. to account for the evolution of the sub-sectors (e.g. mariculture; foreign fishing). They are important for the orderly development of the sectors but have little direct impact on sustainability or conservation.

3.4.2 Total closures for fisheries management reasons

Total closures of fishing activities are rarely used in fishery management strategies, for obvious political and economic reasons. Therefore, such measures are usually adopted only when key target species are badly depleted or collapsed and other measures have not succeeded in limiting catches and rebuilding biomass, and hence the total range of the fishery is closed. Depending on circumstances, the area might be closed *sine die* or until the conditions that led to the closure disappear (e.g. in a rebuilding moratorium).

Total closures tend to be temporary. They may be established with a given duration, or with strict criteria for their closing and eventual re-opening (e.g. moratoria and other stock rebuilding closures). They are also primarily used when quotas for a season or fishing year have been exhausted for the target species (or for a quota-protected bycatch species) and the fishery is closed for the entire fleet for the rest of the year. Such closures commonly reopen when the next fishing season or year commences, and quota becomes available for sufficient stocks to support the fishery again.

If compliance is high, such closures can be very effective. However, to have high compliance, it is necessary to either have the tools for full surveillance and enforcement in the area that is closed, or high voluntary cooperation from the industry. Such cooperation requires that the industry have a shared understanding of the need for protecting the stocks from all harvest and that alternative, more selective measures are not available or unlikely to be effective at protected the key stocks. Alternative livelihoods for the fishers denied access to the fishing grounds also can contribute to improved compliance with such total closures. Conversely, poor buy-in by the fishing industry to the need for a total closure, limited capacity of management to enforce a total closure, and lack of alternatives for food or income are all factors that limit the effectiveness of total closures.

3.4.3 Total closures for ecosystem management reasons

Closures of large areas to all fishing can also be implemented by fishing authorities for broader ecosystem reasons, often for protection of some spatial ecosystem feature. These fishery "reserves" are thus often similar, in their intent, to MPAs (which, however, are cross-sectoral) about which there is a much literature. These "ecosystem" closures will be considered in **Section 4.** Their effects on affected fisheries and target species depend on where and how extensive the alternative fishing options are elsewhere, the fate of the fishing pressure excluded from the closed area, and the status of the targets species of those fisheries before the closure.

Vulnerable Marine Ecosystems (VMEs)

Closures of areas because of the risks incurred by Vulnerable Marine Ecosystems (VMEs) are probably the example best known to the broad CBD community, and are cases where both the identification and management frameworks have attracted more attention from the United Nations General Assembly (UNGA) since 2002, are specified most explicitly, and have drawn much media attention in the last decade**.** The UNGA Resolutions have called on States to apply a precautionary approach to management of bottom-contacting gear with significant adverse impacts on VMEs, identifying the vulnerable areas based on transparent criteria (similar to EBSAs criteria) and adopting protection measures (including move-on rules and exclusion of impacting gear). Guidance has been elaborated by FAO, (2008, 2009, Thompson et al., 2016) to qualify the significance of adverse impacts and is available on the FAO and other VME-dedicated websites[3]. Vulnerability has been defined as *the likelihood that a population, community, or habitat will experience substantial alteration from short-term or chronic disturbance, and the likelihood that it would recover and in what time frame (*FAO, 2008, Article 14). The actions expected from States, RFMO/As and fishers in case of encounter with a VME have been specified and a VME database has been developed (See Annex 1 for more detailed information). Performance assessment of deep-sea fisheries is systematically required (UNGA Resolution 61/105 (§83a); FAO Deep-Sea Fisheries Guidelines (§ 47, 49, 51, 52, and 83); CCAMLR, 2012; Thompson et al., 2016).

Benthic Protected Areas (BPAs)

In 2006, the Southern Indian Ocean Deepwater Fishers Association (SIODFA) members who have been fishing in the Indian Ocean since 1996, announced the voluntary closure to fishing to

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[3] Accessible at: http://www.fao.org/in-action/vulnerable-marine-ecosystems/vme-database/en/vme.html
http://www.fao.org/in-action/vulnerable-marine-ecosystems/en/
http://www.ices.dk/marine-data/data-portals/Pages/vulnerable-marine-ecosystems.aspx
https://www.nafo.int/Fisheries/VME
https://www.ccamlr.org/en/science/vulnerable-marine-ecosystems-vmes

their own vessels of 11 high-seas Benthic Protected Areas (BPAs) representing 309 000 km2. Two more areas were announced in 2013. These BPAs include deep-sea benthic habitats representative of a wide zone across the Southern Indian Ocean and offer protection from SIODFA fishing vessels for the conservation of globally significant biodiversity such as deepwater corals and sponges as well as sharks, tuna, marine mammals and commercially important deep-sea fish species. The compliance of SIODFA vessels with the measure is deemed very good. The overall impact of this voluntary measure will depend on the behaviour of other fleets operating eventually in the same area in the future and the agreement is only binding on SIODFA vessels and on self-enforcement. A process of formalization and recognition of BPAs at international level has started in the Southern Indian Ocean Fisheries Agreement (SIOFA, http://www.siofa.org).

Ring-Fencing

This term was created apparently in South Africa (Augustyn et al., 2018). In its approach, this type of closure is the opposite of all other closed areas. Instead of closing some areas of the ecosystem to fisheries, it encloses a fishery in a delimited boundary beyond which it will not expand, limiting and containing the impact on biodiversity outside the boundary (within which other conventional ABFMs might also apply). The measure, that could be voluntary or imposed by States, delimits implicitly or explicitly the extent of the areas historically and currently exploited by (certain) fisheries and prohibits further development in all areas beyond that limit. Instead of protecting an area inside the fishing ground, it intends to limit expansion outside it.

Ring Fencing has been voluntarily adopted in South Africa by the hake trawl industry in 2008 (Augustyn et al., 2018). The fishing grounds historically used (since 1970) by the Hake industrial trawl fishery were delimited and the voluntary agreement of the Industry was to operate in the future only within these limits, without any further extension, *de facto* stopping the historical increase of the fishery's impact on the bottom and benthic habitat. The ring-fenced area is integrated with the Vessel Monitoring Systems (VMS) and Compliance is controlled by the South African Deep-Sea Trawling Industry Association (SADSTIA) and is now part of the permit conditions

At intergovernmental level a striking example of "ring-fencing" is given by the General Fisheries Commission of the Mediterranean (GFCM) which, in 2005, prohibited the use of towed dredges and trawls at depths below 1000 meters –i.e. beyond the presently exploited areas– in the entire Mediterranean Sea[4], with the view to protect little known deep-sea sensitive habitats such as VMEs from fisheries expansion (Thompson et al., 2016: 107, 111). In 2016, the whole area was declared a Fishery Restricted Area (FRA) (sea below).

A similar, but unilateral, regulation (EU 2016/2336) adopted in 2016 by the European Parliament and Council after lengthy negotiations with the sector, prohibits trawling for deep-sea stocks, at depths greater than 800 meters[5] to (i) the Union fishing vessels and third-country fishing vessels in Union waters of the North Sea, north-western and south-western European

[4] http://www.fao.org/gfcm/data/map-fisheries-restricted-areas/en/

[5] Article 8.4 states that *No fishing authorisation shall be issued for the purpose of fishing with bottom trawls at a depth below 800 metres.*

waters as well as Union waters of ICES zone IIa; and (ii) by Union fishing vessels in international waters of CECAF areas 34.1.1, 34.1.2 and 34.2.

Fishery Restricted Areas (FRAs)

Since 2006, seven Fishery Restricted Areas (FRAs) have been adopted by the GFCM as multi-purpose spatial management tool to protect any kind of marine resource and habitat (e.g. aggregations of vulnerable sponges, seamount areas, coral reef building formations, seagrass meadows, spawning grounds and reproduction sites for fish resources, etc.) from relevant fishing activities, in EEZs or the High Sea, therefore following criteria in accordance to (but broader in scope than) those established for VMEs in the FAO deep-sea fisheries guidelines.

Enabling and limiting factors

Enabling factors for areas closed to fisheries for ecological reasons include: (i) explicit expansion of the mandate of Fisheries Management authorities to apply the Ecosystem Approach and protect marine habitats and ecosystems as part of managing fisheries under their authority (ii) efficient monitoring control and Surveillance (VMS, observers) (iii) sufficient data on spatial ecosystem features to identify areas of higher vulnerability (scientific surveys; exploratory and encounter) and agreed measures to protect biodiversity features that would be considered vulnerable, when they are encountered by a fishery in areas left open (encounter protocols; thresholds and move-on rules, etc.). And, as with all area-based management, the size of the area may be important to its effectiveness.

Limiting factors for the effectiveness of such closures include: (i) adoption of incomplete criteria for justifying these closures, such that fisheries are allowed to continue in vulnerable areas[6] (ii) Difficulties inherent to MCS, (iii) The limited "best evidence" available to assess significant adverse impacts in a VME; (iv) the long recovery-times of some species and habitats when an area meeting the vulnerability criteria is encountered in an area open for fishing.

These actions limit the continued spread of fisheries to new areas of the High Sea and protect biodiversity in those areas by either preventing fishing or placing the burden on the industry to demonstrate its operations are sustainable and do not cause serious adverse impacts on key ecosystem features. The increased emphasis on the need to minimize risk has also led to the development of fishing gear modifications, and the development of fishing technology to increase selectivity for targeted catch as well as adaptive fishing practices (e.g. aimed trawling), which increases both protection of biodiversity in areas let open to fishing and the sustainability of those fisheries.

Consequently, these area-based approaches simultaneously require fisheries management jurisdictions to be proactive in identifying areas that require enhanced conservation measures for a wide range of ecological reasons, while allowing fisheries that can demonstrate their sustainability on an ecosystem scale to continue to operate. They also provide incentives for

[6] This would be a weakness in any area-based measure, including MPAs. They are not effective where they are not applied, but where they are not applied this type of areas cannot be included in Target 11 reporting. This is of special relevance here because of the possibility that jurisdictions may adopt criteria to identify appropriate spatial areas for ecosystem closures but fail to a apply them in appropriate areas.

fisheries to adopt gears and fishing measures that reduce impacts on habitats and non-target species, reducing the area closed to protect biodiversity considered to be vulnerable to fishing activities, and improving the overall fishery performance. To varying degrees, these ABFMs initially developed in the High Sea have been taken up by many States within their national jurisdictions (See **Section 4)**

3.5 Partial closures to fishing

In this group of ABFMs, some areas, with specific vulnerable characteristics are closed to specific fishing gear while fishing may continue with other less or non-impacting gears. Gear-specific closures are a common fisheries management tool (**Table 1**). They are commonly invoked to protect some ecosystem feature such as a vulnerable stage of the life-cycle of a species (e.g. a nursery, or spawning concentrations), or vulnerable (living) habitats like corals or seagrass beds which are particularly vulnerable to some specific gears and are critical for stocks productivity.

Moving along the time dimension, partial closures of fishing activities could be rotational (usually multi-year), seasonal (annual), or real-time.

3.5.1 Rotational closures

Rotational closures are also “Partial” closures as only part of the fishing territory (or ground) is closed at any time. They involve temporary inter-annual and usually recurrent closures and re-opening of areas to specific fisheries or gears. In the long-term, all areas are fished on some pre-established multi-year schedule. They are often used, for example in some fisheries for sedentary benthic species such as bivalves or precious corals, when efficient harvesting can take most of the stock in a local area (and the local depletion rate cannot be really controlled), and renewal of the stock takes several years. Such fishing often has large impacts on the seabed as well, such as with Northeast Pacific geoduck, where the individual geoducks are dug out of sand as much as a meter below the seafloor. The length of the closed and open periods and the relative size of the open and closed areas depend on the re-growth capacity of the stock, and the depletion capacity of the fleet. As a compromise to allow efficient harvesting and localize habitat impacts, only a small fraction of the total range of the stock is open for fishing in a single year, with the expectation that the small open area will be nearly fully depleted, but with ample opportunity for subsequent recruitment from the large closed area.

In terms or enabling and limiting factors, substantial information on the life history and spatial distribution of the target species is needed to balance the depletion and rebuilding processes in the rotation design. Enforcement is also highly dependent on the nature of the stock and on the market because the incentive to poach in closed areas increases as the stock biomass and market value rebuild. Maintaining full closures in much of the range of stock is difficult if fishing gears and activities are easy to disguise, and with some area open for fishing each year there is a need for strong chain-of-custody of product from location of harvest to market to allow the full potential sustainable harvest to be taken.

3.5.2 Seasonal gear-specific closure

Seasonal closed areas are common in fisheries management. They are partial in that fishing is restricted only part of the year and often in part of the fishing area. These ABFMs close areas to a specific fishery or fishing gear for a period of time. The area and the time are usually the same every year, based on average time-space distribution of the element to be protected (e.g. juveniles or spawners of the target species; concentration of protected species). With short-lived animals, however, as in tropical penaeid shrimp fisheries, the closures might cover the entire EEZ (becoming a "closed season" more than a "closed area") and the exact dates might be fixed every year, based on pre-recruitment surveys.

They may be established to either prevent fishing on a target stock during a specific period of its annual life history cycle or prevent fishing during a period when a dependent or associated species vulnerable to disturbance by the fishery (through bycatch, trophodynamic dependence, other types of disturbance) is especially exposed to fishing pressure. The latter cases will be addressed in **Section 4**. When seasonal closures are used to manage fishing pressure on the target species, they may apply to the total stock range, so no directed fishing (and sometimes indirect fishing as bycatch) can occur or may apply to a specific part of the species range where the life-history actions are centred (e.g. concentration of spawners or juveniles). In either case, the full range of the stock would be open to fishing at other seasons of the year, although the actual overall spatial distribution of the fishing effort would depend on the seasonal pattern of distribution of the stock. In general, seasonal closures based on life history vulnerability apply to one or a few related stocks or species, while fisheries for other species is allowed to continue in the same area, if the likelihood of incidental catches of the stocks protected by the closures is acceptably low. When seasonal closures are established for economic reasons (e.g., on periods of exceptional abundance or catchability to avoid gluts and decreased prices) or for social reasons (e.g., to reduce conflicts), the number of species or stocks included in the closures will depend on the features of the markets and the social characteristics of the fishing communities.

Seasonal closures can be very effective for the target species, in redirecting fishing effort to seasons when the stock (or some component of it) is less vulnerable to exploitation. However, there are several different aspects of "vulnerability" that may be the rationale for seasonal closures, e.g.: (i) to minimize disturbance of a species during spawning, especially of the eggs themselves are vulnerable to harm by the fishing gear; (ii) because the quality of the fish is low during or just after spawning; (iii) or sometimes, to spread fishing opportunities, for example when the stock (or the recruiting cohort) is exceptionally densely aggregated during the spawning (or recruitment) period, to avoid landing glut and market disruptions (or recruitment overfishing).

<u>Key enabling factors</u> are: (i) a clearly defined seasonal life history of the target species, so that the periods when life stages are most vulnerable to fishing pressure are concentrated in specific and predictable places; (ii) concentrated and less costly enforcement as closures are necessarily localized in space and time. If the fishery is able to take the full quota in seasons and places not closed, the impact on it (and on fishing mortality) is not serious. Although fishing may be prohibited at a time when catch rates are particularly high, fishing costs of seasonal closures can be particularly low if fishing in other seasons is economically viable. If fishing really does

disrupt spawning (e.g. through disturbance of mating concentrations, or damage to eggs or spawning grounds) the seasonal closures can pay off significantly with subsequently improved recruitment.

Limiting factors, if the vulnerability of the stock to fishery impacts has little seasonal variation, the seasonal closures are unlikely to convey substantial conservation benefits for the stock, although seasonal closures might still have good justifications if the markets showed strong seasonality or if safety at sea varied seasonally. In addition, if the core problem with a fishery is overcapacity, seasonal closures are likely to simply shift the problems of overfishing or market inefficiencies of "glut and drought" to the period following the seasonal closure.

3.5.3 Real-Time Closures (RTCs)

RTCs are area-based measures that have been recently advocated in Dynamic Fishery Management (DFM). This term refers to a type of fishery management that *changes in space and time in response to the shifting nature of the ocean and its users based on the integration of new biological, oceanographic, social and/or economic data in near real-time* (Maxwell et al., 2015). DFM is in contrast with the conventional spatiotemporal management characterized by the use of historical data with low spatial resolution, slow acquisition of new data, delayed analyses and weakly responsive management decisions, usually associated with the use of static closed areas/seasons. DFM uses current, near real-time data, operates at much higher spatial resolution, undertakes near real-time assessments (often by third Parties) and allows high responsiveness to change, ensuring better and faster matching of fishing operations with the current state of Nature (the stock and the environment). The approach suits better to mobile and variable resources, the distribution and structure of which is too weakly predictable for the establishment of static closures.

Fishers are essential participants, in data collection, assessment and implementation, incentivized by systems of payments/credits and reduction of risk, to more fully use their knowledge and innovation capacity to optimize their operations (e.g. reducing opportunity costs and risk of premature closure of target fisheries because of bycatch) and reduce collateral impact on biodiversity (reducing bycatch or habitat degradation, the cost of which is internalized in the process).

The consequence is a dynamic area-based management system, resulting in mobile, continuously adapting closed/open areas, with interesting area-based outcomes for fisheries and conservation, without the need for, or as complement to, regulatory closed areas. As such, RTCs might not be among the expected "good candidates" to be considered under Target 11 Reporting (because of the difficulty in measuring conservation areas), particularly for 2020. However, the potential conservation benefits of this type of system are large, even if they do not exactly fit within an area-based framework as typically envisioned.

DFM has focused on three types of RTCs: grid-based closures, move-on rules and oceanographic closures (Dunn et al., 2016):

- Grid-based closures involve the overlaying of a grid on an area of interest and closing fishing in individual grid cells where bycatch has exceeded a threshold level. They have been implemented on a daily or weekly basis with cell sizes as small as ~50 km2.
- Move-on rules are also triggered by a threshold, but rather than moving out of a grid cell, fishermen must move a set distance away from the point of significant encounter of a species or habitat of concern. The result is a sort of real-time closure. Move-on rules have been widely implemented with real-time closures lasting days to weeks over distances as short as 2–10 km in radius (12-300 km2), with the potential to be implemented on temporal scales of days or hours if higher-resolution catch data are incorporated. Such closures have been used in the Eastern Australia pelagic longline tuna fishery to reduce bycatch of southern bluefin tuna (*Thunnus maccoyii*). In addition, as in the case of VMEs, move-on rules may trigger the establishment of long-term static VME closures.
- Oceanographic closures are mobile closed fishing areas defined by combining information on habitats requirements and conditions environmental conditions (e.g., sea surface temperature) to predict moving areas of concentration of biodiversity elements of concern (life stages or protected species) that fishers can voluntarily avoid catching. They have been implemented on a daily and biweekly basis.

Examples of Real-Time Closures (RTCs) have been proposed, or de facto result from different schemes such as: Real-Time Incentives (RTIs, Kraak et al., 2012); Real-Time Spatial Management (RTSM, Hobday et al., 2014) or Real-Time Ocean Management (RTOM, Dunn et al.,2016), differing in the degree to which the systems are "real-time" and the extent to which fishers are involved in designing and operating the management tools (Little et al., 2015). The response of the fishers to the information they generate and exchange on the biodiversity elements to protect (i.e. the movement away from problematic areas) may be based on space-based bycatch cap triggers activated by the central management system or on economic incentives (e.g. bycatch credits in RTIs).

Real-Time Spatial Management (RTSM)

This short section is a compilation of information elaborated in (Hobday et al., 2014; Lewison et al., 2015; Maxwell et al., 2015; Little et al., 2015; Dunn et al., 2016; Eliasen and Bichel 2016; Squires and Garcia, Forthcoming). RTSM proponents argue that permanent/static fishing closures are often poorly implemented, unresponsive to short-term stock dynamics, have significant opportunity costs in foregone catches and profits, and do not allow fine-tuning of management and fishers' behavior on the smaller time and space scales at which they would best achieve management and conservation objectives at least cost. However, RTSM has also a risk of free-riding on the voluntary management costs and may be more applicable in small homogenous and cohesive groups of operators (to reduce transaction costs) and in "high tech" fishery systems (to get and process the high-density data).

RTSM has been described mainly in the USA and Europe but also in Australia in a dozen of large-scale modern fisheries (Squires and Garcia, forthcoming). The distribution of fishing effort and catches in space and time is obtained influencing fishers' behaviour through economic incentives, increasing their collaboration, information sharing and innovation. High-density spatial information on resources and vessels, vessels monitoring systems (VMS) and/or on-board observers, and complex fishery models are needed. Third Party companies may be involved in collecting rapidly, processing, and re-distributing the information which allows fishers to adjust their fishing to avoid bycatch species. Fishers' fishing opportunities are then adjusted up or down depending on their performance in avoiding bycatch

In the USA, RTFM, operating at high resolution, closing much smaller areas for much less time, has shown to be three times more efficient than large static closed area, at lower cost to the sector. It also reduced better the risk to reach the bycatch quota, prematurely closing the target fishery (Dunn et al., 2016).

Move-on Rules for fishing (real-time exclusion)

Move-on rules are mobile spatial tools that have limited roles as fisheries management tools for managing exploitation of the target species, but more extensive roles in managing ecosystem effects of fishing, as will be explained in **Section 4**. In general move-on rules require set by set (individual tows, deployments of a long-line, etc.) monitoring of a fishery, with a specific trigger for action specified in advance. If the monitoring finds the catch of a specific set exceeds the trigger, the fishing in that immediate area stops and the vessel must move a specified distance before trying another fishing event. This continues until the monitoring shows that the trigger is no longer exceeded. The area is immediately signaled to the management authority and fishing is excluded in the area for all vessels. The exclusion may be temporary, e.g. when the trigger is about temporary coastal concentrations of juveniles or of a vulnerable bycatch species. It can be permanent, e.g. when the trigger refers to a permanent ecosystem element such as a coral or sponge reef (as for VMEs).

In target species fishery management, a common trigger for a move-on rule is the high proportion or number of undersized / immature fish of the target species present in the catch, or the high abundance of vulnerable protected bycatch species moving across a wide foraging range. Such strategies are considered a more effective option than conventional fishery management measures when the feature of the target species used as the trigger is aggregated in space, but the location of such aggregations is hard to predict, either because of limited knowledge of its spatial distribution, and/or because the feature itself is mobile, as in the examples provided above. Although those are a specialized set of conditions, they occur commonly enough that move-on rules are encountered in many jurisdictions (**Table 1**). Move-on rules can be a favoured management measure for both the industry and managers, if properly implemented, because they can allow substantial fishing to occur while maintaining a low fishery impact on some vulnerable property of the target or protected species. To be effective, they do require set-by-set monitoring on all vessels, and that fisheries management jurisdictions be organized so that information can be shared in real time among the full fishing fleet and the fleet can respond in near real-time to management directives.

The move-on rules, *de facto* require one impacting fishing operation (to detect the problem) and hence one occurrence of the undesirable fishery impact before the move-on action is triggered, which makes them suboptimal as a tool for avoiding extremely high-risk events. This short-coming can be mitigated by making the move-on trigger event (proportion of juveniles, or amount of bycatch species) set at a level well below that at which serious harm occurs, or requiring that the first tow with a mobile gear in a new area to be very short, e.g. to see if any corals or other vulnerable benthos are present in the small catch. Such highly precautionary triggers increase the possibility that fishing opportunities will be restricted, and costs of operations increased by frequent enforced moves while providing little incremental benefit to the resource. Their effectiveness for broader ecosystem properties is highly variable, but sometimes excellent, and will be discussed in **Section 4**.

In vulnerable habitats protection, move-on rules may also be the first step in designing more long-term closures like Vulnerable Marine Ecosystems (VMEs).

Real-time incentives (RTIs)

With these economic instruments, fishers are not formally excluded from operating in specific areas, but they pay for access to the areas they aim at, proportionally to the risk they create for the target or non-target resources. The payment is made with “impact credits” allocated to them which they can spend as they wish, selecting the areas in which they want to fish balancing costs (in credits) and benefits. Fishing opportunities for the vessel are terminated when its credits are exhausted. The conventional problem of top-down control of capped catches is transformed into a problem of self-optimization by each vessel operator, of the bycatch credits allocated him (Kraak et al., 2012).

The expected result is that a complex grid of small areas, precisely located (but not a priori closed and needing enforcement) remain lowly fished or unfished, offering protection to vulnerable ecological elements, without need for costly top-down prohibitions. To our knowledge, this system has only been tested in simulations and not yet in reality. It is mentioned here only for completeness of the inventory of ABMs in fisheries and because of its possible application in market-based fishery management frameworks in the future.

Therefore, no empirical experience is yet available for its overall performance and costs. The spatial measure can only be used in cases where the management authority has a great deal of information about the spatial distribution of the properties of interest for conservation, and there the science-management-industry capacities and communications are well developed. The basic logic is that on a fine-scale grid of the full fishing area, probabilities of being able to fish without significant negative impacts on the target species (or ecosystem features) can be estimated for each grid cell. Based on these probabilities, fishing fees (tariffs) are assigned to each grid cell, for the target species and for the species of concern, with lowest fees for fishing in the areas where probabilities of negative impacts are lowest. The expectation then is that the economic aspects of fishing would provide incentives for the industry both to concentrate its fishing activities in areas where catches can be optimized to the lower environmental cost possible. The system would also incentivize fishers to innovate to reduce the gear impact in order to reduce the access cost to rich but problematic areas and to develop methods of fishing which minimized the likelihood of the consequences (such as bycatch of a prohibited species) on which the access price was based. In addition, where fisheries did choose to fish in higher risk grid cells because of the higher expected catches, the revenues from access payments could be used to fund additional conservation measures. With enough information, the system may be quite dynamic, adjusting the fishing pattern to eventual changes in abundance and risks due to climatic oscillations and change.

Success of this spatial measure would depend on the quality of information available for setting up the cost grid, and require a fishery with catch value high enough that individual fishers would be able to pay for the right to fish in any places. Hence it is likely to be used primarily in larger-scale commercial fisheries for high value species, in jurisdictions with high capacities in science and management. But for these fisheries, the spatial approach offers a potentially powerful way for economic concerns to be harnessed for conservation purposes. Potential opportunities to assess fishing costs on the basis of ecosystem properties other than parameters of the target stock will be discussed in **Section 4**.

3.5.4 Community-based fishing closures

Community-based closures are “partial” closures in that only part of the fishable territory is closed, and not always to all fishing activities and, usually not permanently. Community-based ABFMs are usually established in the long-term but may be opened and closed either regularly or in exceptional conditions. The term “community” is taken here in a broad sense including traditional communities, but also municipalities or other competent associative institutions (e.g. cooperatives, unions)

As fisheries management becomes decentralized in many jurisdictions, cases are occurring where traditional fishing areas are formally recognized or newly allocated to individual fishery “communities” who then have substantial flexibility to manage them, within the overarching regulatory framework of the government. Hence, the effectiveness at conserving the fishery target species, biodiversity and habitats within these areas depends on the measures the community chooses to apply and the type of governance. .

Non-centralized governance may be: (i) Delegated, i.e. transferred to peripheral institutions of the central administrations such as in national territories or regions; (ii) Decentralised, i.e. transferred to local communities; (iii) Sectoral, i.e. transferred to cooperatives or other associations; or (iv) Autochthonous, i.e. community-based, self-managed, usually by concession of the State (Garcia et al., 2013). Terminology varies between countries, between Federal States within countries, and even between the Ministries of fisheries and of environment, and hybrid governance solutions exist complicating classification and comparisons.

The underlying rationale for decentralization or devolution of management responsibilities is the expectation that the behaviours of fishers will be managed more effectively by community-scale social dynamics than by top-down regulation imposed by a governmental agency. It is also expected that the clear and equitable attribution or recognition of rights of access and management will increase the long-term perspective of the community and its stewardship and compliance, decreasing enforcement costs. For these expectations to be met, however, the social structure and processes in the “communities”, needed for common decision-making, self-enforcement, etc., should be fully functional.

Some examples of community-based ABFMs, used usually for both fishery management and broader biodiversity conservation are described below.

Marine Managed Areas (MMAs) and Locally-Managed Marine Areas (LMMAs)

MMAs and LMMAs are abundantly referred to in the Pacific Ocean. While differing in their governance approach, they are both managed for a set of objectives covering sustainable use and conservation of marine resources (Govan et al., 2009).

Marine Managed Areas have been defined in various ways. In general, they aim at protection or management of marine resources (FGDC, undated). Other definitions may come closer to the definition of MPAs but differ significantly from it in that they MMAs may not be permanent but "*must provide the same protection, for any duration within a year, at the same location on the same dates each year, for at least two consecutive years,* even though they are expected to have continuity and the potential of permanence[7]. In that sense, they are close to ABFMs. In the Pacific Ocean they are typically considered as *areas of marine, estuarine, and adjacent terrestrial areas designated using federal, state, territorial, tribal, or local laws or regulations intended to protect, conserve, or otherwise manage a variety of resources and uses.* This indicates clearly that their governance may be centralized as well as partially or totally decentralized.

LMMAs[8] are defined as *areas of nearshore waters and coastal resources that are largely or wholly managed at a local level by the coastal communities, land-owning groups, partner organizations, and/or collaborative government representative who reside or are based in the immediate area* (Govan et al., 2008). Their objective, in addition to transferring management competence to local authorities, is to rebuild and maintain resources through strong community-based adaptive management, combining fishery management and biodiversity conservation.

MMAs have tended to be managed from the capital and through the local mediation of ENGOs. LMMAs, in reaction, have been more squarely managed locally and in cooperation between communities and local administrations (co-management) (Govan et al., 2008). The main driver for their creation, in most cases, is a community desire to maintain or improve livelihoods in front of perceived threats (including from NTZs) to local food security or economic revenue, in a traditional institutional context in which conservation and sustainable use are often seen as inseparable as part of the surviving concepts of traditional environmental stewardship (Govan et al., 2008; 2009).

Marine areas for responsible fishing (MARF)

Marine Areas for Responsible Fishing (MARFs) have been established in Costa Rica. They are "*Areas with important biological and sociocultural characteristics, delimited by geographical coordinates and any other mechanisms identifying their limits, within which fisheries are*

[7] From: Marine Managed Area. marineprotectedareas.noaa.gov. *Marine Protected Areas Glossary*. NOAA National Marine Protected Areas Center. http://www.expertglossary.com/definition/marine-managed-area (accessed: January 28, 2018).

[8] LMMAs have local names (e.g.: ra'hui; tabu area; kapu zone; sasizen, bau zone, tambu zone) and may also be referred to as traditional reserves, community-protected areas, traditional or community-based MPAs, cultural marine conservation districts, no-take areas, multiple use MPAs, customary areas, marine sanctuaries; village-managed reserves etc. (Parks and Salaski, 2001).

regulated to ensure particularly the use of fishery resources in the long term, and for the conservation, use and management of which the Costa-Rica Institute of Fisheries and Agriculture (INCOPESCA) can count on the support of coastal communities and/or other institutions"[9]. In the decree establishing them, "responsible fishing", and hence the MARF objective is defined *as the use of fishery resources in harmony with the environment; The use of fishing and aquaculture practices that are not noxious for the ecosystems, the resources, and their quality*.

Fishery management (and specific zoning of the areas) is undertaken with the local communities and is materialized in a management plan approved by INCOPESCA, complete with objectives, measures, enforcement, monitoring and evaluation. Enforcement is jointly undertaken by the communities and coast guards. There is an Oversight Commission. Tourism is not impeded unless specified in the Plan.

Refugia

A refugia is generally defined in dictionaries as "*An area inhabited by one or more relict species"*[10] *or "*An *area where conditions have enabled a species or a community of species to survive after extinction in surrounding areas*[11]. In fisheries, they have been defined in the South China Sea as "*spatially and geographically defined, marine or coastal areas in which specific management measures are applied to sustain important species [fisheries resources] during critical stages of their life cycle, for their sustainable use*" (Paterson et al., 2013). Broader conservation objectives are not explicitly mentioned. In Mexico "*zonas de refugio*" have been defined as *delimited areas established in waters under federal jurisdiction, with the primary objective to conserve and contribute, naturally or artificially, to the development of fisheries resources, their reproduction, growth or recruitment, and to preserve and protect the surrounding environment*[12]. Conservation objectives are explicitly included.

Considered as potentially useful in intensive small-scale fishery management systems in which typical effort and catch controls were not easy to implement, they have been re-promoted in the South China Sea (Pernetta et al., 2007; Paterson et al., 2013) as a management instrument, and a regional system integrating fisheries management and biodiversity conservation implemented by or in cooperation with empowered coastal and fishing communities.

AS described in southeast Asia, e.g. in Paterson et al. (2013) they: (i) are not NTZs; (ii) aim at sustainable use; (iii) protect areas of critical importance to the life cycle of a species or group of species, including spawning and nursery grounds, or areas of habitat required for the maintenance of brood stock; (iv) have different characteristics according to their purposes and target species or species groups, and various management measures may apply within them

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[9] Translated from Decree N° 35502-MAG of 2008, from the President of the Republic and the Minister of Agriculture and Cattle-raising of Costa Rica.

[10] American Heritage® Dictionary of the English Language, Fifth Edition. Copyright © 2016

[11] Random House Kernerman Webster's College Dictionary, © 2010

[12] http://www.dof.gob.mx/nota_detalle.php?codigo=5442227&fecha=23/06/2016&print=true
http://www.dof.gob.mx/nota_detalle_popup.php?codigo=5313972
http://dof.gob.mx/nota_detalle.php?codigo=5280841&fecha=30/11/2012

including access rules and vessels and gear exclusions or regulation. While apparently initially promoted and developed centrally with participation of relevant stakeholders and strong collaboration of NGOs, steps were considered for delegating their management to local authorities under co-management arrangements.

Territorial Use Rights in Fisheries (TURFs)

This section is built on Christy (1982) seminal analysis of TURFs. There is no generally agreed definition for TURFs. A TURF intends to remove the condition of common property of the resources in a territory, allocating use and management rights explicitly to its owner, which can be an individual, a private enterprise (Costello and Kaffine, 2017), a cooperative, association or community. While the definition could apply to an EEZ, we will consider here only TURFS owned by communities. A TURF may relate to the surface, the bottom, or to the entire water column within an area. Its size depends on local conditions and its performance depends on its size relative to the distribution area of the resources to be managed. A TURF may enclose only part of the resource implying that its performance depends on management in neighbouring TURFs or open access areas. The rights allocated to the TURF owner include the rights to use and manage (including a right of exclusion) but may be differently defined in different countries and depending on the resource(s) concerned. The length of tenure may vary but should at least be sufficient to allow the owner to capture a satisfactory return on any capital investments he has made. In the case of a community-owned TURF, the tenure may be in perpetuity and this has clear advantages in terms of habitats management.

Generally, a TURF may be effective if: (i) it covers a relatively small and clearly distinguishable territory; (ii) provides rights of exclusion and determination of kind and amount of use and rights to extract benefits; (iii) is relatively specific in its ownership; (iv) is not much affected by other uses outside the TURF; and (vi) resources are resident (with little movement out of the TURF).The effectiveness of a TURF in generating broad biodiversity conservation outcomes Intended or not) would depend on its objectives, measures, management effectiveness.

Advantages of a TURF include: (i) locally determined objectives; (ii) a more economically efficient use of the resources; (iii) welfare opportunities for small-scale fishing communities; (iv) increased management capacity; (v) development of stewardship (including in relation to broader ecological considerations) and community empowerment; (vi) buy-in and self-enforcement.

The main issue may be the initial allocation of coastal resources among potential TURF's holders, the definition of the resources includes in the TURF, the size of the TURFs (equity issue), and the agreement on national management and conservation overarching norms.

TURFS are used abundantly in Chile since 1991 (Gonzalez et al., 2006; Gelcich and Donlan, 2015). Locally called "Áreas de Manejo y Explotación de Recursos bentónicos" (AMERBs) or Management and Exploitation Areas for Benthic Resources (MEABR, in English) they were established primarily as a response to increasing conflicts between mobile harvesters roaming in the coastal area, exploiting resources traditionally supporting resident communities. Presently, TURFs are being developed combining harvest and management rights and NTZs (reserves) within TURFs, with the full involvement of the communities concerned, to enhance the broad biodiversity benefits of the TURFs in addition to fishery ones (Aflerbach et al.; 2014; Gelcich and Donlan, 2015).

Fishery community-based MPAs

These "Fishery MPAs" are very widespread in Japan. Voluntary, autonomous and self-managed, they are small areas managed by local fishing communities for both nature protection and fisheries sustainability. These are defined as a "*clearly identified marine area, which is managed through law or other effective means while giving consideration to the utilization form, with the aim of conserving the biodiversity that supports the healthy structure and function of marine ecosystems and/or ensuring sustainable use of ecosystem services*". The definition explicitly inspired from the IUCN MPA definition, indicates its clear conservation purpose but also sustainable use ones, in line with most community-based closed areas. Over 1100 community-based MPAs exist in Japan and 30% of them have been self-imposed by fishing cooperatives within a State-guaranteed tenure system. They are autonomously managed by them, using conventional fishery management measures, no-take-zones, stock enhancement, and habitat restoration (e.g. for eel-grass or corals). Self-enforced management and restoration costs are paid by fishing communities. The effectiveness is not always known and future evaluation standard for conservation activities are expected to cover institutions, monitoring, participation mechanism, and outcome on both stock rebuilding and ecosystems rehabilitation (Yagi, 2010). These ABMs provide flexibility in protecting migratory species and, for example, in the sand eel fishery in Ise bay, the area protected area coverage changes weekly to allow timely escapement of moving fish stocks (Matsuda et al, 2010).

Conclusions on community-based fishing closures

Generalizations are always dangerous. Nonetheless, in most cases, in establishing community-based closures, the local communities wanted more ownership of the local resources on which they depended, and greater flexibility in regulating how the resources would be use. In these areas, they set implicit or explicit objectives for providing livelihoods and restoring and securing food sources as a major priority. Conservation purposes are expressed in some cases, but the degree to which these constitute prime or sufficient community motivation or reflect priorities of international NGOs and donors it is rarely clear, particularly for externally-driven initiatives such as MMAs (Govan, 2009: 48).

Key implicit or explicit objectives of communities in MMAs may include: (i) prevention of access from neighboring village; (ii) restriction of access to immigrants; (iii) protecting the source of income for custom owners; and (iv) establish property rights to reef/land areas. However, surveys indicate that in many areas, beyond the focus on livelihoods, community members assign a relatively high value to preserving the ecosystem for use by future generations, independent of their own use of the ecosystem (bequest value), reflecting a community sense of "duty of care" and conservation ethic (Govan, 2009: 49; See also Jupiter et al, 2014; Cohen et al., 2014).

The management measures applied to deliver these objectives on local scales include permanent, seasonal or temporary (rotational) spatial closures that can be total or gear-specific, and refugia (*sensu-stricto* MPAs) as well as conventional fishery management instruments such as effort and size limits, landing controls, and ecological measures including habitat rehabilitation, predator control, and restocking. Access and enforcement are socially-controlled. (Govan, 2009).

The outcomes of such community-based management initiatives is easier to evaluate if the harvested resource is relatively sedentary, because more sedentary local populations will reflect the consequences of locally applied management measures more than more migratory species or stock will. More mobile populations are likely to be exposed to the harvesting activities of multiple communities, each functioning in its own space. Without some mechanisms to coordinate the activities of all the community spatial allocations impacting single target stocks or other ecosystem properties, the sustainability of the aggregate outcomes is not assured for the stocks or whole ecosystem features, even if each community individually is acting sustainably within their spatial allocation. Consequently, the effectiveness of this set of spatial management measures cannot be evaluated separately from the management measures used within the individual allocations and the formal or informal measures used to coordinate management of fisheries across allocations.

The enabling factors are like those for total closures: a sufficient capacity for surveillance and enforcement of the gear closures, and incentives for the excluded fisheries to comply with the exclusions, including alternative fishing opportunities elsewhere. Limiting factors, related to poor governance, include the lack of transparency in the exclusion decisions, leading to perceptions of favouritism and inequity among types of fishers (métiers).

Properly implemented, however, gear-specific closures can be an effective tool for making the use of the target species more sustainable in all dimensions (stock status, economic returns, social coherence), but the broader biodiversity consequences (including on benthic habitats) will be considered in **Section 4**.

4 LITERATURE REVIEW OF BROADER BIODIVERSITY CONSEQUENCES OF SPACE-BASED FISHERIES MANAGEMENT MEASURES

Spalding at al. (2016) review the performance of space-based measures for delivering biodiversity outcomes. Although their review focused on marine reserves, it provides a systematic analysis of why space-based management measures may fail to be effective. Key causes of poor performance are: (i) inadequacy of design and (ii) failure of implementation and particularly governance process, and enforcement. It was useful in identifying properties to look for while reviewing the literature specifically on area-based fisheries measures, rather than marine reserves.

4.1 Approach - Evidence sought in the literature

A full evidence-based assessment of effectiveness of area-based measures would use an empirical meta-analysis of an extensive literature of case histories. This has been done to some extent with systematic reviews of specific types of outcomes from use pf specific measures, such as responses of fish populations to full and partial closures (Sciberras et al. 2015). However, such meta-analyses have not been undertaken comprehensively for the range of possible biodiversity outcomes of area-based fisheries measures in general. For such a meta-analysis the biodiversity outcomes expected in the 3-dimensional space shown in **Figure 1** would need to be examined systematically along all three axes. For a full grid of locations in the 3-D space, the literature would be used to document:

a) what aspects of biodiversity are affected by the type of spatial measure being applied

b) what is the nature and magnitude of the response of the aspects in a) to the measure

c) how reliable are the responses in b).

These documented outcomes would be evaluated against standards for "effective conservation" which would also have to be developed. When the same type of spatial measure, corresponding to a position in the 3-D space, would have been implemented in different fisheries, the comparison of the outcomes would allow inferences to be drawn about the expected outcomes of such a measure and their variability. The inferences could be presented in terms of what aspects of biodiversity received conservation benefits, and what factors would potentially enhance or compromise the reliability or magnitude of those benefits. These inferences could become benchmarks and guidance for decisions on whether a spatial fisheries management measure was an OEABCM.

Unfortunately, the nature of the literature available did not allow such a systematic evaluation of all possible spatial fisheries management measures. Most of the relevant information is scattered in primary papers and government and organization reports not directly examining the question of what constitutes an OEABCM; and very few studies examine the broader biodiversity impacts of various types of fisheries measures, particularly beyond the specific area where the measure is applied. These challenges with the literature are likely to persist for some time because of (i) a lack of mandate for agencies to conduct such larger studies even under and Ecosystem Approach to Fisheries (FAO 2003), (ii) the inherent complexity of quantifying the full range of possible biodiversity outcomes of any measure., and (iii) the difficulties of attributing causality of documented changes in biodiversity properties to any single management measure (Rochet et al. 2010)

4.2 Approach – Information available from the literature

For the reasons mentioned above, it is necessary to take a more opportunistic approach to use the scattered and incomplete literature. A general approach could be developed starting with established knowledge of marine ecology, marine community dynamics, etc. and results from increasingly powerful models contrasting baseline and scenario projections (e.g. Fulton et al.) Similar approaches have been taken recently by other expert teams, in particular Wells et al. (2016) and Spalding et al (2016) both developing frameworks for considering the future of MPAs. These reviews correctly highlight that there need to be operational standards for differentiating which subsets of areas with spatial conservation measures in place would be appropriate for Target 11 reporting, and that these standards should be based on performance.

To use an inferential approach to the literature review, based on ecological knowledge, it is necessary to specify the types of biodiversity outcomes that would be indicative of improved conservation. Spalding et al (2016) and Wells et al. (2016) have considered this issue with regard to MPAs. Both reviews call attention to the seven criteria[13] that the CBD has already adopted for assessing marine areas as Ecologically or Biologically Significant Areas (EBSAs) (CBD Decision IX/20, Annex I). These criteria could be used to prioritize the types of ecological properties that would indicate that a measure is contributing to conservation. In both this evaluation and in the identification of EBSAs in the CBD regional workshops (COP IX/29), the criteria are not used as present/absent properties, but as gradients of ecological significance, derived from an expert process to assess how much a given area stands out from the background setting, and how important an area is to ecosystem processes.

The sustainable use objective of the CBD also brings in the importance of areas for the conservation of the ecosystem services (ES) on which such uses are based. Spatial measures that are shown to enhance a range of ESs –including but not limited to food provisioning, a central concern for fisheries–may contribute to Target 11 and could therefore be considered as OEABCM candidates. However, there are many competing definitions and classifications of ecosystem services (Potts et al. 2014), making it harder to identify a single set of ES-based criteria against which to evaluate the broader conservation outcomes of the uses of spatial measures in fisheries.

In the review, 67 papers (listed in **Annex 1**) were examined primarily published since 2010, when adoption of Target 11 may have provided a greater incentive to report biodiversity outcomes of fisheries measures. This reflected a concern about publication biases in the literature - both a positive bias towards reporting successes more often than failures, and a negative bias if fisheries researchers focus on stock or ecosystem features intended to receive conservation benefits and not evaluate a wider range of possible consequences. Several older papers were also included, where they brought together important overviews of potential consequences of area-based fisheries measures. All reported on one or more of the following:

- Outcomes of spatial management measures used in managing fisheries;
- Patterns and trends in biodiversity features in areas where fisheries pressures and potential impacts were a direct or indirect consideration;
- Model results from analysis of expected outcomes of use of spatial measures to manage the activities of fisheries (and sometimes other sectoral activities as well).

For each paper/area there we made an attempt to tabulate the following information:

- Geographic area and jurisdiction;
- Target-species (one or multiple) and gears affected by the measure(s);
- Time, space and sectoral scale of the measure(s);
- Intended purpose/objective of the measure(s), whether explicit or inferred form the rationale for its choice;

[13] These are: 1. Uniqueness or Rarity. 2. Special importance for life history stages of species. 3. Importance for threatened, endangered or declining species and/or habitats. 4. Vulnerability, Fragility, Sensitivity, or Slow recovery. 5. Biological Productivity. 6. Biological Diversity. 7. Naturalness

- Impacts on fishery performance;
- Biodiversity features that changed and in what ways (whether attributed as impacts of the measure or not);
- Factors that were considered by the authors to have influenced effectiveness in producing the fishery and biodiversity consequences noted in the two above bullets; and
- Whether social and economic consequences of the measures were explicitly considered in design and/or evaluation of the measure(s).

Almost none of the papers had all the above information, and many required substantial breadth of interpretation of the information in the manuscript. Combined with the unquantifiable effects of the reporting biases noted above, this would make quantitative tabulations of results of the literature review of very low rigour and possibly misleading. Consequently, the best that could be done was to summarise observations extracted from the review, as a basis for generalizations about effectiveness of the types of area-based fisheries measures and the factors that influence their effectiveness.

4.3 Inferences from publications on modelling studies

Modelling studies were more prevalent than actual field studies of the consequences of spatial measures. This was the case both for uses of MPAs to reduce fisheries impacts on biodiversity and for assessing the effectiveness of fisheries measures and is consistent with the frequent observations that marine biodiversity is under-sampled on all scales (MIloslavitch et al., 2016: Chapter 33) and there is inadequate attention to validation of the effectiveness of management actions.

The expression “modelling studies” includes a vast range of scientific efforts. For biodiversity conservation spatial planning tools such as MarxAn (Ball and Possingham, 2000; Smith et al., 2009) are in wide use. It is sometimes possible to draw inferences between the nature of the closures being optimized or otherwise explored in these models and the outcomes for fisheries and those biodiversity aspects included in the models. Fisheries assessment and management models with spatial structure are still uncommon (Berger et al., 2017) and rarely address biodiversity features, but the few relevant publications provide some partial insights into biodiversity consequences of fisheries measures. On the other hand, Management Strategy Evaluations (MSEs) are becoming increasingly used as a basis for selecting fisheries management strategies, using results from complex end-to end models (e.g. in Fulton et al., 2014). These models often allow fairly extensive (but model-based) explorations of biodiversity outcomes expected by various spatial fisheries management measures.

4.3.1 MSE and end-to-end fishery models[14]

End-to-end models (such as Atlantis) have been used to explore ecological responses to spatial measures, including no-take-reserves, in a few areas. The most thorough modelling studies are of the continental shelf and slope off New South Wales (Australia), combining bio-physical and fishery models. These studies are reviewed in Fulton et al (2014, 2015). Key conclusions of these and other simulation studies (e.g. Buxton et al., 2006; Savina et al., 2013) include:

- Spatial closures have mostly direct positive effects on most biodiversity measures in scenarios when fishing pressure had been very high before the closure;
- Spatial closures have mixed effects when the fishing pressure had been modest before the closure. There are direct positive effects on top predators such as sharks and rays and significant indirect negative effects on preys, through trophic cascades that affect both commercial and non-commercial species;
- Whether fishing pressure was high or moderate before the closure, there was a weak but consistent indication that larger reserves might have greater consequences than smaller ones;
- Trade-offs may exist not only between fisheries and conservation objectives, but also among conservation objectives;
- Static fishery closure designs were unlikely to achieve desired conservation objectives when applied to mobile species or when challenged by climate-related ecosystem restructuring and range shifts;
- High coverage of closed areas would result in four-fold increases in CPUE for key target, but also to significant industry and human cost, and high levels of competition among fishers on open fishing grounds, High conservation performance with areas closed for fishing required integrated management to deal with issues not well addressed by the closures alone;

4.3.2 Uses of other spatial models in fisheries management

Studies have used spatial fisheries models to assess effort displacement from areas closed seasonally or wholly to fishing, and to design fishery closed areas for optimal balance of protection of benthic biodiversity or specific features such as spawning grounds, while minimizing impacts of economic performance of the fishery (Bode et al., 2015; Emery et al., 2016; Eno et al., 2001; Costello and Kaffine, 2017; Kerr et al., 2016; Neumann et al., 2017; Hiddink et al. 2006) Conclusions emerging from these studies generally include those from the larger-scale end-to-end models. Their narrower scope showed additional more specific patterns, including:

- Assumptions about fishers' responses to many types of closures had large, often dominant, effects on the type and magnitude of both fishery and biodiversity outcomes.

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[14] In all three types of models described below, individual inferences are not tied to specific papers. Rather, in all cases, efforts were made to find synthetic conclusions consistent with all papers reviewed and explicit in at least a few of them.

It is necessary to include estimates of patterns of fishing effort displacement in any analysis of the consequences of fishery closures;

- Similar sized closures located in different fishing grounds might have either net positive or net negative outcomes depending on the pattern of displaced fishing effort, assuming no reduction in fishing capacity was implemented;
- Dynamic adaptive management could provide substantially greater benefits to fisheries performance than static closed areas, particularly when the closed areas are sub-optimally located. Dynamic adaptive management also could provide greater benefits to mobile biodiversity components than static closed areas because they result in full harvest of the quotas with substantially less total fishing effort. However, the incremental biodiversity benefits were much smaller than the benefits for fisheries yields;
- For a wide range of types of fishery closures, biodiversity conservation benefits could be high for sessile benthic species but were rarely large for mobile species;
- Rotational closures on longer time scales produced better fishery and biodiversity outcomes than seasonal closures for most biodiversity components except for very long-lived and sedentary species
- For longer-lived species taken as target species or bycatch, population recovery would be possible but limited with only the use of no-take reserves as a management measure. Without improved management outside the reserves, the incremental benefit from the reserves would be small and transitory

4.3.3 Uses of models in biodiversity conservation

Modelling approaches for design of reserves and networks of closed areas often require substantial quantitative work outside the model itself. These tasks commonly include both (i) setting the weighting vectors to be used for competing management objectives and priority of spatial features, and then (ii) assigning qualitative or quantitative values for those features to the grids being optimized. If this supporting work included parameters relevant to fisheries management and the biodiversity features affected by fisheries, then inferences can be drawn of how different configurations of closed areas would affect both fishery performance and biodiversity conservation. Such studies are common in the conservation biology literature. However, the realism of the treatment of fisheries activities in the presence of the closures is challenged in some cases. Illustrations from the literature include: Schmiing et a. 2015; Young and Carr, 2015; Yates et al., 2015; Sutcliffe et al., 2015; Gurney et al., 2015; Nenadovik et al. 2012; and Tulloch et al., 2017; Richardson et al. 2006). Typical emergent conclusions include:

- Extensive consultation and inclusive design processes greatly improve performance of these models, as measured by coherence of final designs with users' expectations;
- Data on fine scales allows the design models to produce outputs with much higher spatial precision, but greatly increase costs. Moreover, as such spatial planning models are run at increasing fine spatial scales, it becomes increasingly necessary to interpolate

data from coarse field sampling to the finer spatial grids of the model. Errors of inaccurate interpolation compound much faster than the likelihood of missing areas important to biodiversity is reduced;

- Performance of these approaches requires all objectives to be made explicit at the outset of the initiative, with the addition of new objectives late in the process sometimes being disruptive;
- When there are multiple objectives, there even have to be trade-offs among conservation outcomes, as well as between conservation and fishery outcomes;
- When models are used to design spatial management approaches, very good biotic data are necessary before model performance (in terms of amount of biodiversity protected) is improved over using physical habitat surrogates for biodiversity features;
- Inclusion of biodiversity and socio-economic data can lead to very different modelled network designs that achieve conservation objectives and that minimise cost to resources users;

These general findings from the network or MPA design models generally highlight the importance of data quality and resolution for effective modelling, the importance of community engagement in the objective setting and model development processes, and the increasing necessity to confront trade-offs as the diversity of objectives increases. All these general insights have come to fisheries management over the decades as well, as has the difficulties in going from awareness of these issues to incorporating them into practice.

4.4 Inferences from publications on empirical / field studies

4.4.1 Structured empirical performance assessments

With a structured meta-analysis of the literature made difficult by the reporting and interpretation challenge explained in **Section 4.3**, an inferential approach was necessary. To provide some benchmark for such an approach, we first present the major findings of other empirical meta-analysis of spatial measures, including MPAs, experimental gear closures, and habitat-species exclusions of fisheries. These narrower but more structured reviews show evaluations of effectiveness focused on specific area-based management measures usually applied in specific conditions, against which the inferential results found in the results that follow can be contrasted.

Sciberras et al. (2015) undertook a systematic review and meta-analysis of the response of marine communities to either full or partial protection from fishing activities. The response to protection was examined in relation to MPA parameters and the exploitation status of fish. While partially protected areas significantly enhance density and biomass of fish relative to Open areas, no-take reserves yielded significantly higher biomass of fish within their boundaries relative to partially protected areas. The positive response to protection was primarily driven by target species. There was a large degree of variability in the magnitude of response to protection, although the size of the partially protected area explained some of this variability. The findings in this paper are similar to those reported by Lester and Halpern (2008). A key problem with all these assessments is that the majority tend to focus on fish species, especially target species of fisheries, with very little systematic reporting of the responses of other fish, invertebrates, plants and algae very much in the minority (Stewart et al. 2009).

Blyth-Skyrme et al. (2006) assessed empirically the impact of gear restrictions in temperate closed areas, comparing trends in sportfishing catches of nine fish species in an area influenced by a large (500-km2) towed-fishing-gear restriction zone and in adjacent areas under conventional fishery management controls. Over three decades (1973-2002) the analysis showed that: (i) In the areas most influenced by the gear restriction area, the mean reported weight of trophy fish of early-maturing species with limited home-range was highest, and declined less and more slowly, than in other areas; (ii) The mean reported weight of trophy fish of late-maturing species with extended home-rang declined at the same rate in all areas, indicating that these species would require protected areas over 500 km^2 for effective protection; (iii) fish species with a localized distribution or high site fidelity may require additional protection from sport fishing (other than just the closed area) to prevent declines in the number or size of fish within the local population. In a related study of the same management system, the same authors found that diversity and biomass of benthic invertebrates were significantly higher (compared with open access areas) in areas from which towed bottom fishing gear were prohibited (although the areas were subject to static trap fishing on the seabed). Areas that were subject to a six-month rotation between towed and static bottom fishing gear, had a higher diversity of species relative to open access areas, but the biomass of these species showed no sign of recovery. This is a good example where the rotational frequency is too frequent to enable community recovery (biomass) (Blyth et al. 2004).

Cinner et al, (2005) reported on performance of periodically re-opened reef areas under community-based management. They found that: periodic closures (and hence re-openings) had positive effects on reef resources and found that both the biomass and the average size of both long lived and short-lives species of fishes commonly caught in Indo-Pacific subsistence fisheries were 17-37% greater inside areas subject to periodic closures compared to sites with year-round open access. No significant differences in abundance of target species and on biodiversity (hard and soft corals, sponges, sea grasses, gorgonians, zooanthids, anemones, ascidians, bryozoans, fleshy algae, turf algae, encrusting red algae, coralline algae, etc.) or species richness were detected between managed and control sites. The reasons are not fully understood and may relate to lower fishing mortality in periodically open areas than permanently open ones as well as behavioural change in fish (less elusive behaviour after a closure) or even attracting power of closed areas, especially of large, longer-lived predators. The overall impact of this management system on the resources overall, at ecosystem level, is not known either. This work indicates, however, that, in such socio-ecological contexts (tropical reef ecosystems, with modest fishing pressure on species with limited home-range), periodically closing and re-opening of fishing areas (as practiced in many community-based management areas and in rotationally closed areas) yield some localized positive results for fisheries and food security but no clear impact on broader biodiversity.

4.4.2 Inferential findings from a review of the broader literature

In addition to studies based on modelling results, a number of the papers we reviewed report results of empirical studies of the outcome of area-based fisheries measures. The papers were less numerous than studies based primarily on modelling results, and also likely to be highly selective in terms of outcomes reported. Moreover, the division between the empirical studies and modelling studies is not rigid, since many empirical studies use models as a framework to develop the predicted values against which field data are compared. Nevertheless, these field-based reports present real-world sampling results and thus are less dependent on assumptions underlying the model construction, as compared to completely model-based analyses, where the outputs of the models are presented as the results of the studies.

Empirical studies are not immune to assumptions like those in all modelling studies, however. , The expectations of the researchers will influence what is measured in the field, and the expectations can be based on non-validated or incomplete theory, preconceptions and advocacy goals, or both. These issues are also not immune to the publication biases mentioned above (**Section 4.2**), favouring studies that show major differences over studies showing little effect of treatments like management measures. This is particularly an issue when reporting changes in biomass rather than abundance, as biomass tends to inflate the size of response effects more than measures of abundance (Stewart et al. 2009). In addition, all these types of studies must confront the challenges noted in **Section 4.1** about attributing causality in a fisheries management regime where many policy, social, economic and environmental circumstances are changing at the same time, and with the standard problems of lack of ideal statistical baselines in these BACI (Before-After-Control-Impact) study designs. All these concerns need to be considered when interpreting these summaries of findings, just as they must be when interpreting the findings in **Section 4.3**.

Empirical studies have looked at the issue of biodiversity outcomes of fishery area-based measures from both fisheries and conservation perspectives. On one hand, there are studies of how a particular fisheries management measure, applied under a fisheries management jurisdiction, has actually affected some aspects of biodiversity or ecosystem structure and function. In many cases these studies were guided by some expected outcome of the measure, (often the measure was implemented with the intent of delivering that specific outcome), and only those specific biodiversity features were investigated. Studies which investigate possible biodiversity outcomes of area-based measures implemented by fishery management agencies just to manage fisheries, are far less common, but are reported separately below.

On the other hand, another set of studies focus on a particular biodiversity property, examine how it is changing, and then may attribute the pattern of changes to some specific fishery area-based measure. Such studies are particularly vulnerable to the BACI and attribution-of-causality challenges. However, the studies do focus their examination of the conservation or sustainable use on biodiversity or ecosystem properties of priority concern. Still, though, such individual studies tend not to look at biodiversity and sustainable use comprehensively, so general inferences must be built-up over the suite of studies examined.

A. From empirical studies of intended biodiversity impacts of ABFMs

The studies of the intended effects of spatial fishery management measures on broad biodiversity conservation almost always focused on specific biodiversity features, directly expected to benefit from the measures being applied. Therefore, they may underestimate the full range of outcomes of these spatial measures, by looking preferentially for outcomes of the specific biodiversity expected to benefit from the measure, and potentially missing other benefits. It is rare that fisheries management measures are implemented to intentionally have negative effects on biodiversity or ecosystem structure and function. Such measures are not unknown, such as the efforts that have been made to deter marine mammal predation on both target and non-target fish stocks (Brandt et al. 2013, Goetz & Janik 2013). General inferences emerge from studies (such as Kaiser et al., 2018; Lancaster et al. 2015; Daley et al. 2015; Becker et al. 2016; Armstrong et al. 2013; van der Lee et al., 2013; Miethe et al.2017; Kaplan et al., 2012; Oliver et al., 2015; McAllister et al., 2015; Sys et al. 2017; Mangubhai et al. 2015; Richardson et al., 2006; Kerr et al. 2016; Galaiduk et al. 2017; Smolowicz et al. 2016. Claudet et al., 2008; Mangano et al., 2013**)** include:

- Spatial measures can greatly improve population status of the target species and other species being affected by fisheries, if fishing pressure is high and the spatial measures are appropriately located;
- The use of inclusive and consultative decision-making processes during the design of spatial fisheries measures can greatly improve both their design and compliance of fishers with the measures. Either types of improvement can increase their effectiveness;
- The impacts of spatial measures on fishery performance ranges from negligible to very large, depending on some obvious factors such as size of the area and scope (duration and gears) of the exclusions of fishing, and some less obvious factors such as dominant oceanographic conditions, proximity to alternate landing sites for catches etc.;
- Implementation and compliance is higher when all gears taking a particular stock are affected by a spatial measure than when only selected gears are covered by a spatial measure. This can be a serious challenge when the concern prompting the measure is an impact of a specific single type of gear;
- If the species intended to benefit from spatial protection are moderately mobile or migratory, only very large areas of protection, or use of spatial measures in combination with other measures, is likely to produce measurable benefits to the population;
- The location of boundaries of spatial measures may be better based on habitat variables than on species distribution data, unless the population distribution data are very good;
- The redistribution of fishing effort after a spatial measure is implemented is often hard to predict, even if spatial data on the target species distribution are available. However, such redistribution of effort can reduce and sometimes completely negate any expected benefits for biodiversity or sustainable use;

- Ontogenetic niche and habitat shifts may reduce or negate the expected benefits of a spatial measure applied in fisheries, whether the measure is intended for the target species or other species affected by the fishery;
- Even when spatial measures are carefully designed before implementation, time and spatial boundaries need to be reviewed and adjusted, as appropriate, on decadal scales, to respond to the many changes that are occurring in coastal marine ecosystems.

B. From empirical studies of unintended biodiversity impacts of ABFMs

Fewer studies of broader biodiversity effects of ABFMs when such effects were not an explicit objective of their implementation (unintended effect) were found in the review. However relevant incidental information could also be extracted from many of the studies reported under **Section 4.4.2.A.** In such cases researchers conducting field studies to evaluate expected biodiversity consequences of an area-based measure had to have observed and reported on a broad range of biodiversity features or patterns in the data that had changed when the measure was implemented. Such reports usually came from studies with fairly comprehensive monitoring of areas however, rather than field programs focused solely on the specific biodiversity benefits expected from an area-based measure. Some studies did look directly or indirectly for aspects of these “unintended consequences”, including some or all the results of Frank et al. (2000), Kenchington et al. (2006), (Gruss et al.2014), Clark et al. (2015), Kaplan et al. (2012) and McAllister et al. (2015) **,** but many of the inferences are drawn from material in the studies listed in the section above. Some of these effects were at least moderately large and reliable.

Moreover, because in many cases these were not just “un-designed” outcomes but also unplanned ones, it is likely that the literature review underestimates the frequency and, possibly, the magnitude of these consequences of area-based fisheries management measures. Both underestimations are possible because with the multiple possible causes of changes in marine ecosystems and populations, other possible causes of the observed changes might get priority. In addition, if biodiversity benefits are found without the spatial tool being specifically designed or optimized to provide them, it is possible that with greater attention to possible biodiversity benefits when the measure is designed, the benefits could be even larger. In contrast, overestimates of benefits of spatial fisheries measures are less likely to occur unless evaluations of ecosystem dynamics show a rush to attribute all observed positive changes to such measures, a pattern not observed in the literature.

Most of the inferences in **Section 4.4.2.A** also seem to apply to the more limited information about the “un-designed effects” of fisheries, particularly with regard to:

- The importance of the linkages between exact location of the spatial measures and the places where the benefits are observed;
- The importance of consultation with fishers, communities and biodiversity conservation experts in the design of spatial measures, who may think of ways to include a greater number of biodiversity considerations in a management tool designed primarily for a specific fishery outcome;

- The importance of effort redistribution after a spatial measure is implemented;
- A greater likelihood of un-planned and unexpected biodiversity benefits from larger spatial measures; and
- In addition, it is important to consider unplanned negative effects of spatial measures (such as spatial gear restrictions) on biodiversity components such as seabirds, which may forage extensively on discards and face reduced foraging success when discards are reduced.

C. From empirical studies of biodiversity and sustainable use of ecosystem features exposed to spatial fisheries management measures.

Many studies of changes in biodiversity or resources being extracted in delineated spaces are available, and a fair proportion of them at least discuss the impacts of fisheries. A subset of those go on to discuss the role of fisheries management measures, including spatial measures, in managing – or not managing – those impacts. Only a small proportion of those studies actually match the scales of the biodiversity / resource concerned and those of the spatial fisheries measures being applied. Consequently, most of these studies face the joint challenges of attributing causality for any observed biodiversity pattern to any particular management measure when these scales do not match, and multiple changes may be occurring in the fishery and in other uses of the same area. The number of such reports is large enough that when specific patterns and relationships among measures and trends in biodiversity or resources appear repeatedly, inferences can be drawn cautiously about at least the likelihood of these trends being linked to the measures.

Carefully designed experiments to test the effectiveness of particular area-based measures for producing particular outcomes, would be the most appropriate approach to obtain results that would be unambiguous to interpret. However, many spatial fisheries management policies are implemented across a fishery, or across an entire area of special conservation concern. In most cases this allows only opportunistic monitoring and before-after comparisons without parallel monitoring of control areas. In such cases, reported consequences of the measure on the protection of biodiversity features reflects the core interests of the research team, and the full range of biodiversity consequences of the measure may be reported incompletely.

In the body of literature reviewed, studies such as Girardin et al. 2015, Samy-Kamal et al.2015, Farmer et al. (2016), Tancel et al. (2016), Vincent et al. (2016), Cabral et al. (2017), Magris et al. (2017), Canessa et al. 2017, Fidler et al. (2017), Sciberras et al. (2013) all lend themselves to be viewed from the biodiversity-to-measure perspective. Inferences from those studies, in combination with relevant information from the studies that were the basis for **Section 4.4.2.A** include most of the same inferences listed for **4.4.2.B,** particularly with regard to inclusiveness of processes for designing the measures, plus:

- The behaviour of fishers is resistant to change yet also is opportunistic. Fishers are reluctant to change grounds or behaviours without strong incentives to do so, but can be quick to take advantage of new fishing opportunities when they are presented;

- Few benefits accrue to benthic biodiversity from short (<3 months) seasonal fishery closures, but substantial benefits can accrue to mobile fish, seabirds or mammals that are particularly aggregated during the periods of closures;
- Seasonal closures in areas of the seabed exposed to high energy environmental perturbations (e.g. strong wave or current activity) that exceed the magnitude of fishing disturbance may yield positive responses in the target species but not in biodiversity attributes, given most fauna resident in high-energy environments are resilient to background levels of natural disturbance.
- Seasonal spatial measures intended to protect mobile species from bycatch (including entanglements) can improve conservation performance if timing can be adjusted to match interannual variation in ocean conditions. However, these types of adjustments can be disruptive to fishery performance if not made with care and in consultation with fishers;
- For highly mobile species, any spatial measures, including those applied by fishery agencies, need to be coordinated across multiple jurisdictions if strong conservation outcomes are to be realized;
- Broadly-inclusive consultative processes can develop integrated multiuse areas where conservation is enhanced compared to areas outside the planning zone, with each sector, including the fishery sector, using spatial measures it designed to deliver the common objectives. However, when conservation objectives are not met, attribution of responsibility for errors of planning or implementation is difficult to resolve;
- Sometimes, unexpected environmental events (e.g. storms), or unexpected impacts of populations growing quickly due to high protection, generate feed-back that diminish or negate some benefits expected from implementation of spatial measures;
- Suites of area-based fisheries measures focused on increasing protection of priority species and habitats do not necessarily improve resilience or connectivity at larger network scales. However, fisheries increasingly acknowledge the importance of protecting the priority species or places. Many fisheries are increasingly willing to accept additional spatial restrictions on their activities to deliver these higher-level outcomes, and to design them in cooperation with other area-based measures developed by conservation agencies
- Where overfishing has been difficult to manage, a stepwise process implementing, first, spatial measures that result in spill-over or improved recruitment of targeted species with direct benefits to fish harvesters and, subsequently, measures aimed at broader biodiversity benefits may gain support.

4.5 Messages emerging from overview or synthesis papers

Although this literature review intentionally focused on publications presenting field or model-based evidence for consequences of spatial fisheries measures, there are many overview and synthesis papers on spatial measures in general. The ones mentioned above by Spalding et al.

(2016) and Wells et al. (2016) are current, well focused, and provided the basis for much of the framework adopted here. Many of the synthesis messages on those reviews echo the results of the review conducted here. Where they raise other points, these sometimes may reflect the particular intent for the review –just as the present review focuses specifically on spatial measures used in fisheries management. In other cases, the additional points may be emergent considerations that individual studies might not report.

Drawing from Spalding, Wells, Clark, Agardy, Devilliers and others, it is important simply to reinforce that any quantitative target for coverage of protected-areas is not, in itself, an assurance that full biodiversity conservation and sustainable use are achieved if the target is met, nor that conservation is compromised and uses are unsustainable if the target is not met. The location, nature and size of the closure as well as the management in and around the area, and the socio-economic context have more relevance that the percent coverage. A primary goal of the CBD, and of sectoral agencies as well, is that uses of ocean resources are sustainable everywhere. In addition, almost all fisheries management agencies endorse and have mechanisms to deliver enhanced protection and conservation to priority places and species, and use tools, including area based fisheries management measures to deliver both sustainable use and, where appropriate, enhanced protection (see **Section 3**). There are varying perspectives in the publications regarding whether all areas managed to contribute to those joint outcomes should be called "Protected Areas" of some classification status or another (Wells et al 2016, and Spalding et al 2016). However, the "other effective area-based conservation measures" combined with whatever range of areas are considered as "Protected Areas" by the reporting authority, should cover all the areas that receive some degree of enhanced protection compared to a background of global sustainable use of marine natural resources.

4.6 Summary: potential contributions of fishery ABFMs to OEABCMs and performance factors

Section Error! Reference source not found. provided a typology of spatial management measures used in managing fisheries and ecosystem effects of fishing in a three-dimensional system of restrictions of space, time and fishing activities in an area. We will look here at some of the combinations of types and degrees of restrictions that are frequently encountered. These do not correspond to discrete categories of areas, as many intermediate combinations of degrees of restriction on each dimension can be implemented by a fisheries management authority. In addition, in their various implementations in different fisheries of the world, they are accompanied by and surrounded by different sets of measures that affect their performance. Nonetheless, their potential consequences and enabling and limiting factors give a workable view of the panorama of area-based measures used by fisheries that might be considered as candidates for inclusion in Target 11 reporting as OEABCMs.

For each spatial measure (defined in space, time and activities restricted) presented below this section tries to summarize:

a. The nature and relative magnitude of the benefits to conservation of biodiversity or enhanced sustainable use that could arise if the type of measure were applied; and

b. The enabling factors that could increase the likelihood of more effective measures and greater benefits, as well as any limiting factors that could diminish the likelihood or extent of the benefits.

Enabling and limiting factors may often be symmetrical, depending on whether the factors are present or absent; high or low. For example: (i) Closed areas often are effective if fishing pressure has been very high before their establishment, and often have little effect (aside from displacing effort) in the opposite case; (ii). Similarly, good governance and effective enforcement are enabling factors if present but limiting ones if missing. However, these factors are often thought of from one direction or the other. A very common property of an ecosystem or social-economic setting will often be noted as limiting if absent, whereas its presence is merely assumed to be the "norm". On the contrary, a property that is not widespread in such settings may be unnoticed if absent but considered enabling when present.

4.6.1 Total closures to fishing

As noted in **Section 3.4**, total closures of an area to fishing can occur for several reasons, and the reason can influence the likelihood of biodiversity conservation benefits or increases in the sustainability of resource utilisation. Closures due to food safety reasons are likely to be centered on areas of serious and persistent contamination and be unlikely to be preferred candidates for biodiversity conservation. Short term closures to all fishing due to factors like red tides or domoic acid might still have some enhanced biodiversity value, but if the closures only last as long as the episodic outbreak of the causal factor (usually lasting weeks to months), it would not last long enough to count towards a decadal-scale conservation target.

Total fishery closures for safety reasons are usually to avoid conflict with some other use of the ocean space that is incompatible with fishing, such as requiring fisheries to avoid shipping lanes or avoidance of energy-generating platforms. Within these areas, fishery impacts on biodiversity and ecosystem structure and function are negligible, so they could be candidates for OEABCMs *solely* from the perspective of fisheries measures. However, all biodiversity and ecosystem properties in these areas would be fully exposed to whatever other activities are permitted in the area closed to fishing. Only if those activities were also managed in ways that greatly reduced aggregate pressure on the biodiversity and ecosystem structure and functions, would the area be suitable to consider as *effectively managed* for conservation. If other activities are also effectively managed, then consideration could proceed, accounting for the factors as described in **Section** Error! Reference source not found..

For areas closed to fishing on ecological considerations (as fishery reserves, VMEs, BPAs, FRAs, etc.), most or all could be considered for inclusion as OEABCMs if not subject to any other negative impact. The "ecological considerations" used in selecting the area for closure would be a factor in the case-specific evaluations. However **Section** Error! Reference source not found. documents that the ecological considerations used in such fishery closures are generally very similar to the considerations used by other authorities, including conservation agencies, to select areas for use of their own spatial measures; for example presence of fragile or uncommon habitats, importance to a species of high conservation priority, or importance to the life history of a species where alternative areas for the life history function are uncommon or less suitable. In the subsequent evaluation, it may be found that other anthropogenic activities pose risks of unsustainable pressure on the ecosystem features of the area, and the area would not be considered an OEABCM. However, where fishing is the major pressure on biodiversity or ecosystem structure and functions, these areas could be candidates for OEABCM, if the factors referred to in **Section** Error! Reference source not found. are adequate.

In terms of enabling and limiting factors in these areas, above all, compliance with the total closure would have to be high. As noted in the conclusions of **Section 3.5.4**, to have high compliance it is necessary to either have the tools for full surveillance and enforcement in the area that is closed, or else high voluntary cooperation from the industry. Such cooperation requires that the industry has a shared understanding of the need for protecting the area from all harvest and that alternative, cost-effective, conventional measures are not available or are unlikely to be effective at protecting the key features of concern (e.g. effort reduction measures). Alternative livelihoods for the fishers denied access to the closed part of the fishing grounds also can contribute to improved compliance with such total closures. Conversely, poor buy-in by the fishing industry to the need for a total closure, limited capacity of management to enforce a total closure, and lack of alternatives opportunities to obtain food or income are all factors that limit the effectiveness of total closures. As with any spatial measure, to provide effective conservation, such closed areas also should be large enough that: (i) the habitat protected or catch prevented is large enough to be considered a meaningful contribution to conservation or population viability; and (ii) the species or life history function is spatially stable enough that protecting an area contributes to the function.

4.6.2 Gear specific closures

These measures are widely used in fisheries management with the intent to protect specific habitat, species, or biotic community features. Many RMFO closures of Vulnerable Marine Ecosystems to bottom-contacting gears, required under UNGA Resolution 61/105, may allow fishing the areas with static or midwater gears. Reviews have found effectiveness of VME closures to vary (Thompson et al., 2016) with the completeness of implementation of the closures. However, when VME identification has been undertaken carefully, and compliance with the closures is high, the measures are very effective. They may provide the possibility for recovery from damage to habitats of fish populations done by fisheries before the gear-specific closures were implemented, but cannot, in themselves, undo such damage. However, that is true for any type of spatial measure, including Protected Areas.

The VME experience is reflected as well in the other literature reviewed above in **Sections 4.3 and 4.4**. There have been both successes and failures for using gear-specific closures to increase protection of priority habitats such as corals and seamounts, and priority species including marine mammals and seabirds. Moreover, in some cases investigations have found the conservation benefits do extend to species associated with the protected habitat or species, and not just the ecosystem feature that was the focus of the management measure. This includes cases such as juvenile fish closures to mobile gears, where the benthos showed increases in abundance, biomass or diversity.

Potential for gear substitutions also need to be considered with gear-specific closures. If the gear exclusions are to reduce pressure on a target species of the fishery, increasing use of other gears that are allowed can reduce or negate the expected benefits or be compatible with the desired reduction in fishing pressure. Outcomes depend on whether the new gears take a different size, age or sex distribution in their catches, and on any changes in effort needed to take the catch allowed from the area. In addition, changes from one type of gear to another will change the nature of the potential ecosystem impacts that may occur. For example, mobile bottom-contacting gears may be excluded to remove their impacts on benthic communities but replacing them with static gears may increase in risks of entanglements of seabirds and marine mammals, changing but not eliminating biodiversity impacts from fisheries. These types of considerations are necessarily case-specific and may be mitigated or eliminated with foresight in planning for gear-specific exclusions.

It appears that three conditions need to be met for the gear-specific closures to be effective.

- The gears excluded must be those linked to the unsustainable pressure on the ecosystem feature(s) to be protected. Excluding some gears that have unsustainable impacts of ecosystem features while allowing other gears may be ineffective in avoiding or mitigating harm to the ecosystem feature(s), if the other gears still impact those features directly or indirectly.
- The areas of the gear exclusions must coincide well with the features that are intended to receive benefit from not being exposed to the gear. If the gear closure zones are too small or poorly placed, the ecosystem features may still be exposed to unsustainable pressure from areas where the gear can still be used. If the areas are too large the negative impacts on fishery performance will increase, new ecosystem/biodiversity risks from displaced effort may arise, and compliance may be undermined, with little incremental benefit to the ecosystem features of concern.
- Compliance with the closures must be high. Poor compliance will mean the pressure from the gear impacts will not be reduced to the amount expected, and possibly not at all.

Some enabling factors are similar to those for total closures – capacity for surveillance and enforcement of the gear closures and incentives for the excluded fisheries to comply with the exclusions, including alternative fishing opportunities elsewhere. Fine resolution data of the features intended to benefit from gear specific closures can also improve performance, for two reasons. The first reason is because it is important that the ecosystem feature to be protected is adequately covered by the closure, and the second is that since the management interventions will target specific gears and fishers, the rationale for exclusion needs to strong if the fishers are to consider the exclusion fair and work to comply with it. Similarly, implementation is improved with good ability to document how the specific gears to be excluded are linked to specific negative impacts on the stock or ecosystem features. Both of those considerations are consistent with the general negative factor of resistance or low compliance by fishers when there is a lack of transparency in decision-making, so different gear sectors may feel favouritism is being shown. Another limiting factor would be little capacity for the excluded gears to relocate outside the area from which they are excluded. If relocation is difficult because of management regulations, increased costs of fishing elsewhere (including longer travel times or lower catch rates), or lack of suitable places to fish elsewhere, the gear-specific spatial measure is actually a measure to reduce the use of the gear overall in the fishery and should be approached as such.

4.6.3 Gear and season-specific closures

These area-based measures have many similarities with the circumstances and outcomes associated with gear-specific closures (**Section 4.6.2**), except that they are in place for only part of each calendar year. This means that their effectiveness is low with regard to avoiding or mitigating impacts on static ecosystem features, including structural habitat features and sessile species. However, their effectiveness can be high when the stock or ecosystem features intended for protection are aggregated in particular places and times of the year. This has been shown for both target species of fisheries, such as spawning closures when a stock is densely aggregated and especially vulnerable to fishing effort, and for ecosystem features, such as excluding small-mesh trawling near seabird colonies during their breeding season, when their foraging range is limited while food demands are high, so the seabirds are particularly vulnerable to depletion of their prey.

Even though seasonal closures are is usually justified by a small number of stock or ecological reasons, all species and ecosystem properties impacted by the fishing gears that are excluded experience reduced pressure during the period of the closure. There are many documented cases where dense aggregations of fish, for seasonal spawning, foraging or other life history functions, either aggregate to take advantage of seasonally aggregated prey –such as “spring bloom” effects (Grebmeier et al., 2006; Stock et al. 2014)– or themselves attract high concentrations of predators, or both. The seasonal gear closures reduce pressure on all the ecosystem features particularly aggregated in the place and times of the closures, and these potential consequences need to be considered in evaluating the effectiveness of seasonal closures.

The same three general considerations in 4.6.2 also apply to seasonal closures, whether for all gears or for just some, and additional considerations are typically important as well, including:

- The stock or ecosystem features to be protected by these seasonal spatial measures need to actually have times of the year when they are particularly vulnerable to the gear or gears being prohibited. Otherwise the benefits that may accrue during the period of closure are dissipated as soon as the closure is over. This increased vulnerability is usually caused by either a life history activity that requires atypical aggregation or exposure to the fishing gear(s), or an environmental condition that increases vulnerability, such as water temperatures becoming unfavourable for large areas and concentrating the stock or ecosystem feature in only part of its typical range.
- Because these fishery measures are seasonal and area-based, it is important consider potential patterns of effort redistribution in both space and time. If the exclusions are in a period of typically high catch rates for the target species, in fisheries with output

controls (e.g. quotas) they will usually result in more fishing effort being necessary to take the full allowed catch. If the catches are maintained within the season (desirable for supply to steady markets), there will be more fishing outside the exclusion zone, and disproportionately increasing pressure in other places. On the other hand, if effort is displaced to other seasons, different impacts of the same fishery may arise, if other features of the ecosystem also vary seasonally. Both types of effects have been reported at least incidentally.

The most important enabling factor is that the features intended to benefit from the reduction in fishing pressure have a clearly defined seasonal pattern of occurrence and/or aggregation, and that these periods are predictable in time and space. This requires substantial knowledge of the ecology of those features intended to benefit from the measures. The use of local community knowledge has been shown to often improve conservation outcomes of such measures – both through better design of the places and times to exclude the relevant fisheries, and through higher compliance due to the fishers' better understanding of the reasons for the closures. A key limiting factor is when there is substantial interannual and/or spatial variation in when and where the aggregations or periods of high vulnerability will occur. Trying to address low predictability by large and long duration seasonal closures has been shown to increase the risk that fishers' responses in redistributing effort in space and time will result in increased risk of other unstainable pressures being imposed on the stocks and ecosystems. In such circumstances of low predictability of the time or place of higher aggregation or risk, several cases have found real-time "seasonal" closures with pre-agreed triggers for closing and opening are more effective at delivering the desired conservation outcomes with fewer negative impacts on both other ecosystem features and fishery performance.

4.6.4 Rotational closures

From a broad biodiversity and sustainable use perspective multiyear rotational closures have both a potential great advantage and a corresponding limitation. The potential is that in any single year of a multiyear rotational schedule, all the fishery is restricted to only a limited portion of the total potential area in which the fishery could operate, and that proportion is smaller the longer the rotational cycle is. Thus, in each year most of the total area for which the fishing plan is implemented is not exposed to any fishing activity, so the population and all ecosystem features in the majority of the total area is not impacted by the fishery. This allows for the population and ecosystem features to be on a trajectory of recovery from any impacts of past openings. The corresponding limitation is that every place in the total management area is open for fishing at some point in the rotational schedule and is exposed to the concentrated impact of the entire fishery. For such rotational harvesting systems to confer a conservation benefit, there needs to be an adequate understanding of the recovery time for the biodiversity components of the system, not just the target species, as the latter may recover considerably more quickly than many biodiversity features (Kaiser et al. 2018).

Such rotational closures are usually implemented for fisheries on sedentary target species. If they are implemented in fisheries on species that move widely around their total range, it is usually to spread fishing opportunities among communities where the fishers themselves may have limited mobility for social, technological or management-imposed reasons. Incremental biological benefits to the mobile stocks are not expected, as long as each area in the rotational cycle presents relatively equal catch opportunities when opened (usually a necessary precondition for such rotational plans). Comparably, biodiversity features – populations, species and communities - that are mobile would not be expected to gain substantial benefits from rotational closures. Each year the likelihood that the mobile population or community would encounter the open area in some part of the year is equal (assuming that the rotationally open areas are generally comparable). When the mobile population or community enters an area that the rotational schedule has allowed to be open, the total fishing effort sustainable for the target stock would be concentrated in that area, so the full impact of the fishery could be imposed in a short time.

For sedentary ecosystem features, however, all areas would be ensured long periods with minimal disturbance from the fishery. The amount of recovery that could occur during this period of "protection" would be strongly dependent on the life histories of the sedentary species (e.g. Sciberras et al. 2013; Kaiser et al. 2018). If the intervals of openings in the rotational schedule are scheduled far enough apart in time to allow recovery of the exploited target stock to a highly productive state (so overall yield from the resource is kept high), then all sedentary species in the area with comparable or "faster" recovery times would also reach their carrying capacity. Longer-lived sedentary species, however, would continually be knocked back by re-exposure to fishing pressure during each opening, such that over time the community would come to be dominated by the more disturbance-tolerated species. In addition, in all cases the "recovery benefits" of the longer periods of closure between openings would only occur if recruits could colonize readily from outside the area at the end of its rotational opening, when the fishery was again excluded from the area for a longer period. However, for many sedentary marine species recruitment products disperse widely so this is rarely a constraint in practice (but see Kaiser et al. 2018).

Thus, for mobile species and many sedentary species, rotational closures would frequently not be good candidates for Target 11 reporting. The exception would be when a sedentary species with a "faster" life history than the target species of the fishery being managed with the rotational closures is also a priority species for conservation. This may occur, but many authors have highlighted that it is the long-lived, later-maturing species that are more often of priority for conservation. Such species would be the least likely to benefit from rotational closures *unless* the rotational schedule was timed for the life history of the species or ecosystem feature of conservation importance rather that for the target species of a fishery. Such an approach would be possible in practice and may be attractive by ensuring most of the population of the priority species was undisturbed by the fishery for long periods. However, this would restrict the fishery itself to very small areas of operation each year or to an infrequent periodicity of fishing. The fishery would have to be able to harvest the target species very efficiently with the limited areas of opening and have markets able to accept volatile supplies (as the target species came and went in the small areas where fishing was allowed) for this to be a viable management approach from the perspective of the fishery.

The conditions are met for relatively few stocks. In some jurisdictions rotational spatial openings in an otherwise closed stock range may be one of few options available to fisheries managers to regulate harvesting, particularly when enforcement capacity is limited or when harvesting requires substantial habitat impacts. However, if the knowledge of stock life history and/or spatial densities by location is weak, then the harvesting protocols must be highly precautionary to ensure sustainability of the target stock, and such protocols are likely to be inefficient at allowing the full potential sustainable harvest from the stock to be taken. In addition, the attractiveness of the closed area for illegal fishers increases with the period during which the areas has been closed for rebuilding. Thus, if surveillance and enforcement are not highly effective, any biodiversity benefits accumulating during the closure would be a risk of dissipation faster than the rotational schedule might imply.

4.6.5 Community allocations of space

The nature of community-based fisheries management areas are so diverse that only broad generalizations about effectives for conservation and sustainable use can be made. Moreover, community conservation initiatives are increasingly common within the conservation biology community, and they are equally diverse. Both are inherently area-based approaches to management, and both assume that the behaviours of all community members, including fishers, will be managed more effectively by community-scale social dynamics than by top-down regulation imposed by a governmental agency.

To the authors' knowledge there have been no efforts to systematically differentiate properties between community-based fisheries management regimes and community-based biodiversity and sustainable use regimes. However, reports of community-based fisheries management initiatives and community-based conservation initiatives both general emphasis that these initiatives start with a process for identification of community objectives. In both cases most reports also say the resultant objectives include both minimizing impacts on some ecosystem properties of interest to the community and ensuring sustainable livelihoods from the resources in the area. For both community-based conservation areas and community-based fisheries management areas many publications focus primarily or exclusively on their processes of establishment and implementation. Most follow-up studies that report outcomes of the community fisheries management regimes do report some form of "improved" status for aspects of the marine or coastal ecosystem as well as for the performance of the fishery. Similarly, most studies of the community conservation initiatives do not just report "improved" status for key ecosystem features like seabed habitat, aquatic vegetation and fish populations, but also improve livelihoods for communities that are dependent on the marine and coastal resources.

Thus, there is no evidence that would indicate a need to evaluate the appropriateness of community-based fishery initiatives for inclusion under Target 11 reporting using standards of evaluation fundamentally different from those used to evaluate community-based conservation initiatives. In both cases, necessary standards and quality of evidence for "success" of these initiatives is highly variable among jurisdictions and should be accounted for on a case-by-case basis. However, there are several studies that report that if the fundamental social structure of the communities is being undermined either by immigration to the coastal areas by people not assimilated into the community, or by external influences of money or attention (whether from commercial markets for harvest or influxes of “donor funding for conservation projects), then the social dynamics making these community-based conservation or fisheries management initiatives effective are likely to be undermined. As has been learned in cases like the Chilean TURFs, areas where communities show success in improved stock and ecosystem status within the space that they manage become increasingly attractive to poachers and intruders who do not respect the community standards of behaviour (Gelcich et al. 2004).

4.6.6 Move-on Rules

Areas that fishers leave because of move on rules would rarely be candidates for inclusion under Target 11 reporting. If the trigger for relocation of the fishing effort is a fixed feature of the seabed or benthic ecosystem, the move on rule itself does not prevent the initial impact between the fishing gear and the ecosystem feature of concern. Consequently, there is no a priori improved conservation outcome produced by simply adopting move on rules. Once the first encounter with a fixed habitat or benthic feature has occurred, the response of the fisheries management authority or the fishers themselves determines the appropriateness of the area for inclusion in Target 11 reporting.

If nothing further is done by the fisheries authority or fishery itself, then the likelihood of future encounters is not changed and there is no conservation benefit. However, if a measure is then implemented in the area that greatly reduces the likelihood of any further encounters with the feature, then it would be appropriate to evaluate for target 11 reporting. However, that evaluation would be based on the properties of the measure then implemented, and not in the fact that the adoption of the measure was the result of a move-on rule having been triggered.

Not all move-on rules are triggered by impacts with sedentary benthic or seabed features. Move-on rules can be triggered by bycatch amount or type being recorded in a fishing event. These can be very effective at reducing bycatch of priority species when the bycatch species of concern is highly aggregated, but the locations of the aggregations are unpredictable. One fishing event in an area provides evidence of the presence of the species of concern, and if all effort relocates away from the area in real time, there is evidence that substantial reductions in bycatches can be achieved. The distance necessary to relocate and time before the fishery would be allowed to return are both case-specific, and, for effective design, requires good information on the temporal patterns of distribution of the species of concern. However, even with the necessary information, these cases still might not be appropriate for Target 11 reporting. The size, their number and the time they would be in place would all be changing in any fishery, the long-term effectiveness of the strategy for keeping bycatch low for the priority would have to be demonstrated, and the benefits would only be accruing to the trigger species and species very closely associated with it, so the conservation benefits would be limited. The species would have to be of very high conservation priority before the reduction in bycatch mortality would be considered an important conservation outcome.

5 Potential criteria and guidelines

From **Sections 3, 4 and 5** three key conclusions emerge that set the overall conceptual boundaries within which areas where area-based fisheries management measures are in place could be evaluated for inclusion in national reporting on Target 11. First, the range of variation in types of spatial fisheries management measures means the measures are not readily sorted into a small number of internally homogenous categories. Rather there is a complex typology of implementation of spatial measures for fisheries management, with continua of variation in size of area, duration of application, and extent of activities excluded or carefully regulated by the measure(s). Second, measures characterized by any single combination of size, duration, and degree of restriction of fisheries can vary widely in performance for promoting protection of biodiversity and sustainability of the uses of resources in the area. Third, multiple internal and external factors may contribute to the variability on performance, and therefore potentially their "effectiveness", including type of governance (top-down, co-managed, community-based), socio-economics of the fishery (export markets, local consumption, large or small-scale, etc.) the environmental and oceanographic characteristics (coastal or offshore, pelagic / demersal / benthic), and the jurisdiction and legal frames (national, shared, straddling, high seas). All these dimensions may affect to varying extents the performances of fishery spatial measures, and therefore their "effectiveness".

Taken together, these three conclusions mean that a simple set of typological categories of area-based fisheries measures cannot provide a sound basis for robust general conclusions about their performance with regard to broad biodiversity conservation, or even fisheries management. They also mean that evaluations of any specific areas for inclusion in Target 11 reporting should be case-specific, and not just be inferred from a few characteristics that would result in an area being placed in a particular category. Such a case-by-case approach would nevertheless have to be systematic (i.e. following agreed criteria of evaluation) if a consistent reporting standard is to be maintained. As with other such systematic evaluations, such as the description of areas that meet the EBSA criteria, the exact standards that need to be attained are policy choices, but the relevant factors that should be considered should have a strong foundation in science and knowledge systems. Some of the factors that should be considered may function better as criteria to be evaluated directly in terms of whether or not an area is relevant to furthering the objectives of the CBD and intent of Target 11. The others might better be used as contextual considerations that influence the effectiveness of the measures but not necessarily their relevance to Target 11 reporting.

5.1 Potential criteria for OEABCMs identification

It is the prerogative of States to decide what areas within their national jurisdictions they wish to evaluate as OEABCMs. However if the intended rationale is that the area has conservation and sustainable use benefits due to application of a spatial fisheries measure, consistent evaluation criteria would be useful, as would guidance on how to take into account factors affecting effectiveness of implementation As noted in Section 1 and 2 of this Working Paper the language of Target 11 and the Definitions in the Convention itself provide starting points for developing criteria for evaluating whether an area subject to an area-based fisheries management measure could qualify for inclusion in Target 11 reporting. The focus should be on how well the area contributes to the core CBD objectives. There can be a primary focus on direct conservation of biodiversity, but contributions to sustainable use could also be considered as long as biodiversity was not being degraded and "in situ conservation" was being supported.

Potential criteria for describing areas as being OEABCMs might include:

1. **For species that have been detrimentally impacted** by natural or anthropogenic pressures (including but not exclusively fisheries) there is evidence or an ecological basis to expect that area-based fisheries management **measures have or will contribute to increases in abundance and biomass (including SSB) of populations, species and recovery** of age/size composition, recruitment, and other relevant population or community parameters;

2. **For species or populations considered to be healthy**, there is evidence or an ecological basis to expect the area-based fisheries management measures **have or will increase the likelihood of maintaining or safe-guarding the healthy state** of the populations or species, including their genetic diversity.

3. **For marine habitats** – particularly but not exclusively the seafloor and substrate - there is evidence or an ecological basis to expect the area-based fisheries management **measures have or will protect habitat features from degradation and allow previously disturbed biotic or biogenic features to recover** in ecologically appropriate time frames.

4. **For natural communities that have been disturbed** by natural or anthropogenic pressures (including but not exclusively fisheries) there is evidence or an ecological basis to expect the area-based fisheries management **measures have or will contribute to improvements in community structure and increases in function** (including food webs, size spectra, etc.), or reduce fishing pressure that could cause further degradation, until more complete recovery programs are in place.

5. **For critical or preferred habitats** of target species of fisheries, the area-based fisheries management **measures make an important contribution to protecting the features of the habitat that are important** for specific life history functions, do not interfere with the suitability of the habitat for other species expected to use such habitats, and contribute to the conservation of ecosystems and natural habitats

6. **For priority species or habitats for conservation** the area-based fishery management **measures substantially reduced pressure of the fishery on the species or habitat,** whether by reducing likelihood of bycatch, reducing likelihood of depleting a key prey species or type, reducing likelihood of vessel strikes or gear entanglements, or protecting essential habitat for the priority species or features of the priority habitat.

For measures that focus on the target species of a fishery, it is likely that any area-based fisheries management measure for a target stock would be intended to contribute to conservation and sustainable use of that particular species. For many involved in negotiating the language of Target 11, those consequences alone would fall short of the expected outcomes of the Target.

Here, the Convention definition of "in situ conservation" provides valuable context, in particular the explicit inclusion of "*conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings*". Thus, the justification for inclusion of areas solely on the first two criteria is weak unless there if there is evidence or an ecological basis to expect that: (i) Many other species or stocks characteristic of the general area would also benefit from the area-based fisheries measure, particularly priority species for conservation; and (ii) Implementation of the measure itself was unlikely to render the area unsuitable for biodiversity components for which the area would be considered "natural surroundings".

It is neither necessary nor likely that application of any single area-based fisheries management measure would meet all six criteria, just as most MPAs would not, and just as few or no areas would be expected to meet all EBSA criteria.

5.2 Context for applying the criteria

Evaluation of the criteria for OEABCMs should be context specific. The information in this Working Paper, particularly regarding the enabling and limiting factors of the possible measures, highlights many of the relevant contextual features. These contextual features may be useful in both pre-screening areas for more in-depth evaluation and should be used in the inevitable judgements that have to be made about effectiveness of a measure. They include:

1. EAF-basis. Does the area-based fisheries management measure and its implementation fit within an Ecosystem Approach to fisheries management and conservation? The more this is the case, the more likely the area will contribute to "conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings"
2. Best scientific evidence. Is selection of the measure and planning of its implementation the based on the best scientific evidence available (including social sciences), and make full use of available indigenous and local knowledge? The more this is the case, the greater the likelihood that the measures will deliver the outcomes intended.
3. Integration. Does implementation of the measure integrate explicitly fisheries management and biodiversity conservation? The more the implementation of the measure brings these two streams together the greater the likelihood there can be synergies between the fisheries policies and management actions and the policies and actions intended for biodiversity conservation.
4. Precautionary approach. Is the area-based fisheries management measures and its implementation consistent with the Precautionary Principle/Approach, explicitly considering the sources and magnitudes of uncertainties and the risks and consequences of both errors of inaction (ecological "misses") and errors of unnecessary restriction of fully sustainable ocean uses (ecological "false alarms")?

5. Degree of protection. How fully or partially do the area-based fisheries management measures offer the protections intended by the relevant criteria, including (i) area covered by the area-based fisheries measure relative to the size of the population or ecosystem features to be protected, (ii) the timing of the protection offered by the area-based fisheries management measures (seasonal, year-round) relative to the presence of the pressure(s) being managed with the measure and vulnerability of the feature(s) being protected, and (iii) expected duration of protection (likely to be temporary, rotational, or not expected to change without substantial performance evaluation and consultation)?

6. Degree of consultation with the full range of interested stakeholders. This includes fishers likely to be affected by the measure (so they understand the reasons for and goals of the measure and are more likely to comply with it), with conservation biology interests (so they have confidence that the measures will protect and where necessary improve the status of species and habitats of priority for conservation), and local communities, particularly indigenous peoples, who may have concerns about their rights being respected by the measures.

7. Capacity for monitoring, surveillance and enforcement, including community-based approaches. This would affect the likelihood that the area-based fishery measures would actually produce the intended results, by encouraging high compliance by fishers and rapid identification of and response to violations.

8. Management within and around the area and compatibility between the area-based fisheries management measures and the measures used in conventional fisheries management outside the area. The more compatible the measures are inside and outside the area the more likely that the resources and ecosystem as a whole will benefit from the measures.

5.3 Conducting the evaluations

Evidence-based evaluations of areas under these criteria and taking the additional factors into account can require time and expert effort in complex fisheries and marine systems, where impacts of specific measures may be hard to disentangle. Guidance for some degree of pre-screening areas for more thorough evaluation could be helpful but must weighed against two major findings from our literature review:

1 The typology of area-based measures used in fisheries is too complex for the determination of a few typical categories that would be meaningful and facilitate robust and rapid evaluations. Although we describe some general types of measures heuristically in the Working Paper, the intent is illustrative to keep the points being made from being too abstract.

2 Even where similar area-based measures may be adopted in different EEZs or fishing grounds, differences in the context factors (Section 5.2) can dominate strongly over any similarities in what is written in a management plan about a measure adopted.

Given these two conclusions, we advise against trying to create categories of spatial fisheries management measures that would be used as a basis for deciding that all members of some categories would be eligible for inclusion in Target 11 reporting, and all members of other categories would be ineligible. Nevertheless, the literature review indicated that for many combinations in the typology, some of these measures were likely able to provide conservation benefits if properly implemented, even though we also found but no spatial measures were so predictably effective as to that they produced substantial benefits in every application.

We also observed in the literature review that some enabling and limiting factors for effectiveness of area-based fishery measures seemed to be influential very frequently. This allows two broad generalizations, with exceptions: First certain types of area-based fisheries measures seem to be easier to implement successfully than others. Second, certain enabling factors, if present, are more likely than others to broadly increase effectiveness of a measure whereas certain limiting factors, if present, are likely to reduce or negate effectiveness. These general patterns can help guide choices of which area-based fishery measures, implemented in which contexts, are good candidates for further evaluation as potential OEABCMs. They can also assist in the planning process for increasing the chances of success if an authority wants to implement a type of area-based measure to address a particular type of fisheries management challenge. For example

- The more exclusionary a measure is, the more likely it is to provide desired broader biodiversity benefits, but the more disruptive it is likely to be to fisheries performance;
- The more consultative the process for selecting measures and designing their implementation, the more likely there will be compliance with the measure subsequently;
- If serious structural problems exist in a fishery, such as substantial over-capacity and excessive fleet size and effort, few spatial measures can perform to their full potential, and many will have limited or no effectiveness until the structural problems are addressed;
- Inability to provide some form of effective monitoring, surveillance and enforcement of area-based measures (including community-based for small scale fisheries), is likely to weaken or negate the effectiveness of any area-based fisheries measure;
- Spill-over benefits to fisheries from areas where the fisheries are excluded depend greatly on the status of the target stocks before the closures, with substantial benefit possible for depleted target species that do well within the closed area, but limited or no potential benefits for stocks that were maintained in a healthy condition (say, near Bmsy) throughout their range before the closure (although the closures to protect particular life history functions of the target species may still be effective)

These types of considerations can be used as subjective pre-screening criteria, to pick more likely candidates for more thorough evaluation.

5.4 Information needed for applying criteria and addressing context

These potential evaluation criteria and considerations suggest some information that would be appropriate for proposals for evaluation and for justifications of areas for inclusion in Target 11 reporting. To the fullest extent possible, the material in the proposals and rationales should be evidence-based and documented, and the material peer reviewed by appropriate experts (usually both natural and social scientists and holders and/or experts in indigenous and local knowledge).

Proposals should probably include:

1. The location and the description of the area and its geographical coordinates and extent;
2. A review of its specified fishery and conservation objectives (if any) and broader biodiversity conservation outcomes that are desired;
3. An assessment of current/foreseen threats to the general area, with particular attention to any specified objectives and outcomes (see 2, above);
4. The relative coverage (in %) provided by the measure, relative to the total relevant area of the ecological feature, where an area-based measure is intended to protect only a portion of a larger feature (such as part of a nursery or spawning ground);
5. The typical migration or movement patterns of the species (particularly priority species for conservation) the spatial measure is intended to protect, and the justification for expecting the spatial measure to contribute to the conservation of that species.
6. A management plan for the area-based measures or the management plan within which they operate, containing (i) The objectives of the plan; (ii) The measures adopted to counter/mitigate these threats within the OEABCM; and (iiI) The expected outcomes of these measures (extent, probability, timing) in relation to the sustainable use objective of the target species and in relation to additional conservation outcomes, whether explicit or implicit.

6 Synthesis of Key Points

The findings in this working paper can provide the elements of a framework for evaluating the effectiveness of areas where area-based fisheries management measures are in place. The framework can be used from two different perspectives:

- There is interest in using a particular spatial measure in managing a fishery, initially for reasons of delivering outcomes about the fishery and the target stock(s). However, there is also an interest in understanding what other biodiversity outcomes may be achieved or expected.
- There is a specific biodiversity concern associated with a specific fishery – usually an ecosystem impact that should be reduced or eliminated. There is an interest in knowing

how well various spatial measures both might address the biodiversity concern and might affect the fishery.

Key Messages

- The typology of how area-based measures are used in managing fisheries is multi-dimensional, with key axes of area, time, and degree of restriction. Fisheries measures include so many combinations along these axes that establishing “categories” of measures would not adequately reflect practice. Rather, for any specific area, the combination of features of the closure should be considered
- For any specific type of area-based fisheries measure (area, duration and degree of restriction), performance in terms of protecting biodiversity and allowing sustainable fisheries is highly variable. The variation is due to both the ecological, socio-economic, and governance context of the area, and the nature of implementation of the measure.
- Although as a broad generalization, as the area, duration, and degree of restriction increase, the protection of many biodiversity components also increases. However, the ecosystem impacts of the fisheries activities displaced by the exclusions also increase in the areas where the fisheries continue to operate. Effective overall conservation planning needs to include all these considerations.
- Well-designed and implemented measures can be effective even if the areas are not large and with permanent severe restrictions, and poorly designed or implemented measures can be ineffective, regardless of their scale.
- The four points above underscore that evaluation of effectiveness of area-based fisheries management measures must be done on a case-by-case basis. The evaluation should take into account the characteristics of the measure(s) being implemented, the context in which it is implemented, and the likely responses of the fisheries affected by the measure.
- The key features of the area to consider in the evaluation of specific applications of an area-based fisheries management measure include:
    - The ecological components of special conservation concern in both the specific area and the larger region, and how the measure could contribute to their conservation;
    - The size, duration, extent of restrictions and placement of the area;
    - The ability of the management authority to implement the measure if adopted, and monitor and provide enforcement in area while the measure is in place;
    - The structure of the fisheries that would be excluded by the measure, including how their likely responses to the measure could impact the effectiveness of the measure at providing biodiversity outcomes;
    - The potential contributions the measure could make to overall performance of the fishery.

- Important attributes of the context in which the measure would be applied, that also should be taken into account in the case-by-case evaluations, include:
    - The extent to which the measure(s) were developed within Ecosystem Approaches to both fisheries management and conservation of biodiversity, and are well integrated with the other measures being used to manage the fisheries and achieve the biodiversity conservation outcomes;
    - The extent to which the measure(s) were developed using the best scientific information and indigenous and local knowledge available, and an appropriate application of precaution;
    - The degree of protection that the measure(s) offers to the biodiversity components of high priority, taking into account other imminent or plausible threats in the same area, and, when relevant, outside the area;.
    - The governance processes leading to development and adoption of the measure, and their implications for compliance and cooperation with the measure(s).
- The two lists immediately above are not proposed as pass/fail criteria. Rather they provide a basis for the case-by-case evaluations of individual areas where area-based fisheries management measures are in place. They can guide both the gathering of the necessary information to evaluate and the drafting of rationales for the conclusions reached about "effectiveness" of the measures.

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ANNEX 1. LIST OF THE REFERENCES USED AS THE INFORMATION BASE FOR THE INFERENCES PRESENTED IN SECTION 4 OF THE REPORT.

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