ASSESSING PROGRESS TOWARDS AICHI BIODIVERSITY TARGET 6 ON SUSTAINABLE FISHERIES[1]

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Executive Summary

Reporting framework

In 2010, the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) adopted Aichi Biodiversity Target 6 as part of the twenty Aichi Biodiversity Targets and the CBD Strategic Plan for Biodiversity 2011-2020. Aichi Biodiversity Target 6 reads as follows:

> "By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits."

Reporting on Aichi Target 6 requires information on its various components, in particular: A) All targeted stocks; B) Depleted target and non-target species; C) Threatened species and vulnerable ecosystems; and D) Ecosystem structure and function. This report examines the key elements for coherent and credible reporting.

The report discusses approaches for realistic and coherent reporting on the elements of Target 6, including through the use of various indicators and internationally agreed reference points. The connection between Aichi Target 6 and the Sustainable Development Goals (particularly SDG 14) is briefly described.

The relevance of some existing sources of information for reporting and assessing Target 6 is discussed, including from global scientific reviews of the state of fisheries and information submitted by FAO Member States to the questionnaire on the implementation of the Code of Conduct for Responsible Fisheries (CCRF).

Progress on legal and policy frameworks

The report focuses on three aspects of sustainable fisheries: (1) the fight against illegal, unreported and unregulated (IUU) fishing; (ii) the implementation of the ecosystem approach; and (3) the performance of regional fishery management organizations (RFMOs).

Regarding IUU fishing, the report provides: the definition of IUU fishing; a rough assessment of the extent of IUU fishing and of the action taken to combat it, including national and international plans of action as well as the adoption of the international Port States Measures Agreement (PSMA) and voluntary FAO Guidelines for Port States Performance.

The ecosystem approach to fisheries has been progressively mainstreamed in many fisheries management frameworks and is the de facto implementation framework for Target 6. Nonetheless, the requirement to avoid significant adverse impacts and maintain ecosystem structure and function within safe ecological limits may be difficult to report by all Parties in a coherent manner, as neither of these concepts has internationally agreed definitions, indicators and reference values.

This report analyses Aichi Target 6 by delineating it into specific components as follows:

Target 6A – Sustainably harvested species

This component addresses target stocks and envisages that "*by 2020 <u>all</u> fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided….*" This report identifies, clarifies and interprets the key concepts of this element that may require indicators.

Available information indicates that a large majority of States and regional fishery bodies (RFBs) have taken action to address this element, even though enforcement needs to be improved in many areas. The trends in fishing pressure and state of stocks vary between regions, States and stocks, making it difficult to draw general conclusions at the global level. Assessments indicate that, globally, around 50 per cent of stocks are fished around their maximum sustainable yield (MSY) and 30 per cent are overfished. The outlook to 2020 and beyond depends on the action taken regarding underfished, overfished and collapsed stocks and the population dynamics of stocks concerned.

Target 6B – Depleted target and non-target species

Target 6B requires that "recovery plans and measures are in place for all depleted species" building on Target 6A. Formal recovery (or rebuilding) plans for depleted target species are getting more traction in fisheries management, though the use of formally agreed rebuilding targets (and reference points), strategy, explicit or mandatory time frames, control rules and measures. They are also becoming more prevalent for non-target species recognized as depleted. However, for these species, the scarcity of regularly collected fishery-dependent information calls for the use of rough benchmarks. The key lesson from available experience is that rebuilding requires, inter alia*,* significant reduction in fishing pressure and the outcome depends on the extent of depletion and climatic conditions.

Target 6C - Threatened species and vulnerable ecosystems

Target 6C requires that "fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems". "Threatened species" is interpreted to include all species (and population below the species level) identified by a competent authority as being at risk of biological extinction comparable to the IUCN Red List category "Threatened" or higher. Different parts of the world show a wide range of variation in the priority given to identifying threatened marine species. However, 91 per cent of the respondents to the CCRF questionnaire have measures providing a high level of protection to species identified as threatened, and 74 per cent have established mechanisms for monitoring and evaluation of performance. Implementation has often been challenging, with both challenges to the robustness of some of the IUCN criteria for risk of extinction, particularly the decline criterion, when applied to marine fish species, and the creation of problematic "choke species" when very stringent bycatch limits are enforced. However, there is also progress in implementing many modifications to fishing gears and practices that have reduced bycatch mortality on many seabird and marine turtle populations.

The term "vulnerable ecosystems" was intentionally used so that Target 6 would correspond with UNGA Resolution 61/105, calling for fisheries to have "no serious adverse impacts" (SAIs) on "vulnerable marine ecosystems" (VMEs). Criteria for identifying VMEs have been developed by FAO, approved by the United Nations, and found closely comparable to the CBD criteria for ecologically or biologically significant areas (EBSAs). A review for the United Nations General Assembly in 2016 reported "considerable progress … has been made at global., regional and national levels on implementation of resolution 61/105", but that "gaps remain", and "it was noted that implementation remained uneven and that further efforts to strengthen it were needed". Particular attention has been given by many jurisdictions to protect special and highly vulnerable systems, such a coral reefs, and mangroves from damage by fishing.

Target 6D—Safe ecological limits

Target 6D requires that "the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits" (SEL). The concept of SEL has never been precisely defined operationally; nor are there clear units for its quantification. Various experts have proposed links with the concepts of ecosystem health, ecosystem integrity, resistance to perturbation, persistence, resilience, variability and multiple locally stable equilibria. However, none of these concepts bring with them explicit normative goals or operational implementation frameworks of evaluation. Thus, the actual implementation of this aspect of Target 6 requires much more framework development and interpretation before guidance on reporting can be developed. The term "safe ecological limits" derives from the "Planetary Boundaries" concept, and lessons for implementation are emerging from other fields, including climate change, mining and agriculture, although there are few efforts to examine the applicability of these lessons to fisheries.

For stocks and species, meeting the standards contained in 6A, 6B, and 6C is considered to also be sufficient to keep fisheries within SEL. However, for ecosystems, benchmarks comparable to the limit reference points used for single populations would need to be identified and implemented for robust metrics of ecosystem structure and function. There is not yet professional consensus even on what metrics would be most appropriate and robust for measuring and managing fishery impacts on marine ecosystem structure and function, nor on where, according to such metrics, a benchmark for an ecological limit to perturbation should be placed. Moreover, the concept of planetary boundaries also addresses the social and economic dimensions of an "ecosystem" and as such could have to include adequate provision of all necessary ecosystem services to human communities associated with the marine system.

Discussion and conclusions

This edition of the Technical Series does not draw any firm conclusions regarding the potential achievements of fisheries in relation to Target 6 by 2020. It offers a perspective on a possible reporting framework, based on a 2016 expert workshop, and follow-up work called for at that workshop. As a generalization, the full implementation of the existing FAO CCRF and UNGA resolution 61/105 would also meet the standards of 6A and 6B, and most of 6C, particularly if the assessment of risk of extinction of marine species was complete, so jurisdictions would know which species and stocks required sufficiently stringent protection. For 6D, fully delivering 6A-6C would achieve the necessary standards for all stocks and species. However, substantial further development of criteria for choosing robust indicators sensitive to fishery impacts of ecosystem structure and function and for setting limits on those indicators would be necessary to evaluate achievement of 6D at the ecosystem scale.

Unfortunately, even implementation of the FAO CCRF is incomplete; a 2016 questionnaire found key weaknesses were due to budget limitations (69 per cent of countries responding), insufficient human resources, inadequate data (32 per cent), institutional weaknesses (28 per cent) and incomplete legal or policy frameworks (23 per cent). Resource mobilization to expand implementation of policies and measures already accepted as necessary for sustainable use of fishery resources appears to be a more urgent priority than development of additional policies. More focus on selecting indicator frameworks for integrated assessments of marine systems, particularly the exploited stocks and directly impacted ecosystem components will also aid reporting on achievement of Target 6. Nevertheless this report summarizes the substantial progress made to date on mainstreaming biodiversity concerns within "conventional fisheries management", and identifies several drivers, all consistent with Target 6, that make continued progress on such mainstreaming highly likely.

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ACRONYMS AND ABBREVIATIONS

AHTEG	Ad-Hoc Technical Expert Group
B_{lim}	Level of biomass below which reproduction might be threatened
B_{MSY}	Level of biomass at which the long-term maximum sustainable yield (MSY) may be produced
CBD	Convention on Biological Diversity
CCRF	Code of Conduct on Responsible Fisheries
CECAF	Commission for Eastern Central Atlantic Fisheries
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
COFI	Committee on Fisheries
COP	Conference of the Parties
CPUE	Catch per unit effort
EAF	Ecosystem Approach to Fisheries
EAFM	Ecosystem Approach to Fisheries Management
EBSA	Ecologically or biologically significant marine area
EIA	Environmental impact assessment
ERA	Ecological risk assessment
EEZ	Exclusive Economic Zone
ESF	Ecosystem structure and function
FAO	Food and Agriculture Organization of the United Nations
FIRMS	Fisheries and resources monitoring system
F_{MSY}	Fishing mortality consistent with achieving Maximum Sustainable Yield (MSY),
GBO	Global Biodiversity Outlook
GFCM	General Fisheries Commission for the Mediterranean
HCRs	Harvest control rules
IPOA	International Plan of Action
IPHC	International Pacific Halibut Commission
IUCN	International Union for Conservation of Nature
IUCN-CEM-FEG	Fisheries Experts Group of the IUCN Commission of Ecosystem Management
IUU	Illegal, unreported and unregulated (fishing)
LRP	Limit reference point
MCS	Monitoring, control and surveillance
MSE	Management strategy evaluation
MSY	Maximum sustainable yield
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-governmental organization
NPOA	National plan of action
PSMA	Port States Measures Agreement (2009)
RFB	Regional fishery body
RFMO/A	Regional fishery management organization or arrangement
RSN	Regional Fishery Body Secretariats' Network
SAI	Significant adverse impact

SBL	Sustainable biological level
SCBD	Secretariat of the Convention on Biological Diversity
SDG	Sustainable Development Goal
SEL	Safe ecological limits
SSF	Small-scale fishery
TRP	Target reference point
UNCED	United Nations Conference on Environment and Development (1992)
UNCLOS	United Nations Convention on the Law of the Sea
UNDS	United Nations Development Summit (1995)
UNEP	United Nations Environment Programme
UNFSA	United Nations Fish Stock Agreement (1995)
UNGA	United Nations General Assembly
VME	Vulnerable Marine Ecosystem
WCPFC	Western and Central Pacific Fisheries Commission
WSSD	World Summit on Sustainable Development (2002)

Introduction

In 2010, the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) addressed the question of fisheries sustainability in its Strategic Plan for Biodiversity 2011-2020 and its 20 Aichi Biodiversity Targets. Aichi Biodiversity Target 6 sets out a broad agenda for fisheries and the ecosystem within which it operates. It reads as follows:

> "By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits."

Because of the unavoidable lag times between an action and its outcomes, the results achieved during the current decade (2010-2020) depend not only on actions taken during that decade, but also before it. Moreover, the achievement of Target 6 also depends in part on actions toward the achievement of other Aichi Targets, such as Target 4 (focused on sustainable production and consumption as well as governance systems able to keep the impacts of use of natural resources well within safe ecological limits), Target 7 (focused on sustainable management of agriculture, of which fisheries is a sub-sector, and aquaculture), Target 10 (focused on minimizing the multiple anthropogenic pressures on coral reefs and other vulnerable ecosystems impacted by climate change or ocean acidification), Target 11, focused on area-based conservation), Target 12 (focused on the protection of threatened species) and Target 14 (focused on restoration and safeguarding of ecosystems and their services).

In February 2016, the Expert Meeting on Improving Progress Reporting and Working towards Implementation of Aichi Biodiversity Target 6 (hereafter referred to as the 2016 Expert Meeting), jointly organized by the Food and Agriculture Organization of the United Nations (FAO), the Secretariat of the Convention on Biological Diversity (SCBD) and the Fisheries Experts Group of the IUCN Commission of Ecosystem Management (IUCN-CEM-FEG) in Rome, Italy, developed a draft conceptual framework that could be used as guidance by CBD Parties in reporting on Aichi Target 6 (FAO et al., 2016). The meeting identified a set of actions and potential indicators, and discussed ways to improve coordination among CBD, FAO and regional fishery bodies with regards to reporting.

In decision XIII/28, the COP welcomed the report of the 2016 Expert Meeting, its framework of actions and indicators, and invited CBD Parties, other Governments, the FAO and regional fishery bodies to further develop it, in collaboration with the Executive Secretary. In the same decision, with regards to indicators for the Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets, the COP also noted: (i) the properties that were required for the indicators (paragraphs 4 and 5); (ii) the potential use of the indicators (paragraph 6); (iii) the variety of approaches available for CBD Parties to use in conducting their national-level assessments (paragraph 7); (iv) the advantages of aligning the indicators for the Strategic Plan for Biodiversity 2011-2020 and those of the Sustainable Development Goals (paragraph 9); and (v) the potential role of the FAO questionnaire on Implementation of the Code of Conduct for Responsible Fisheries (CCRF) in assessing progress towards Target 6 (paragraph 11).

This volume in the CBD Technical Series offers additional reflections in these respects, with examples of relevant current situations and trends, mostly at the global level, taken from the scientific or grey literature and websites. It is not a comprehensive assessment of the achievement of Target 6.

In section 1, a possible reporting framework is examined by breaking down Target 6 into four main "elements", for which different actions, measures, outcomes, indicators and criteria for evaluation may be required. In sections 2 through 6, each element is examined, clarifying its content, the concepts involved, the potential indicators and eventual reporting challenges, with examples of current situations, trends and outlook (when possible) as illustrations of possible outcomes. Section 7 provides some conclusions regarding the present situation, trends, main challenges and outlook to 2020 and beyond.

1. The reporting framework

To facilitate guidance and reporting, the 2016 Expert Meeting broke down Target 6 into elements for which the target implicitly or explicitly sets different evaluation standards (cf. elements 6A to 6D in Table 1). Element A defines the overall scope and expectation of Target 6 (sustainable harvest of all species and taxa, avoiding overfishing) and serves as a chapeau for the Target. Elements B and C address some specific vulnerable or threatened components of biodiversity (i.e., depleted, bycatch and endangered species as well as vulnerable habitats) that need special attention to match the overarching requirement. Element D wraps all preceding elements together in an ecosystem-wide limit of fisheries impacts within a safe ecological limit. These elements are examined in more detail in sections 2 through 6.

The 2016 Expert Meeting suggested that reporting should refer not only to the outcomes expected in Target 6, but also to the actions taken—from legislation to policy development and management plans—towards these outcomes even though the outcomes might not yet be delivered in 2020. A challenge is that in complex systems, with changing environments and various measures continuously implemented, there is no guarantee that actions will always produce the expected outcome, that more action produces more outcomes or that the causal links between the two are linear or easily identified (Garcia and Charles, 2007; Anderson et al., 2015). In addition, outcomes emerging or strengthened during the current decade (2010-2020) may also be the result of action taken prior to the adoption of Target 6[2]. Nonetheless, there should always be a logical link between the action reported and its expected outcome.

Table 1. Elements of Target 6, including examples of intermediate and final outcomes (based on FAO et al., 2016: Fig. 1)

<table>
<tr><th colspan="2" rowspan="2">Target 6 elements</th><th colspan="3">Types of Actions (intermediate outcomes)</th><th rowspan="2">Expected final states and outcomes</th></tr>
<tr><th>Laws</th><th>Policies</th><th>Plans</th></tr>
<tr><td>A</td><td>All target stocks Fish, invertebrates, plants</td><td rowspan="4">Fishery Act; Adoption of international agreements (UNFSA, PSMA); Rebuilding and conservation laws</td><td rowspan="4">Rebuilding and protection goals and strategies; Capacity-building;</td><td rowspan="4">Approach; Measures; Roles; MCS deadlines; Benchmarks ; Evaluation</td><td>Sustainably harvested; Legally harvested; Overfishing is avoided;</td></tr>
<tr><td>B</td><td>Depleted target and non-target species</td><td>Recovery plans and measures in place for depleted stocks; Non-target species not being depleted or else have recovery plans</td></tr>
<tr><td>C</td><td>Threatened species; Vulnerable ecosystems</td><td>No significant adverse impacts (SAIs)</td></tr>
<tr><td>D</td><td>Ecosystem structure and function</td><td>Within safe ecological limits (SEL)</td></tr>
</table>

[2] For example: the 1982 United Nations Convention on the Law of the Sea; the 1995 UNFSA; the 2003 Compliance Agreement; the 2009 PSMA; the 1992 UNCED Agenda 21; The 2002 WSSD Plan of Implementation, the 2012 UNSCD (Rio+20) Agenda (The Future We Want); and the 2015 Sustainable Development Goals (SDGs) of the 2030 Agenda of the UN High Level Political Forum on Sustainable Development.

It should be noted that, in

Table 1, the actions (laws, policies and plans) contribute to achieving multiple elements of the Target. For that reason, legal and policy frameworks will be addressed together, first (in section 2) and additional element-specific legal and policy actions might be referred to in sections 3 through 6, as appropriate.

1.1 Relationship between Target 6 and fishery concepts

Although Target 6 refers to species, fisheries assessment and management focus on stocks as proxies for populations, which is a finer degree of resolution. Therefore, this document refers to species whenever referring to Target 6, to maintain the original language and to stocks when referring to fishery matters.

1.1.1 International standards for fisheries

The reference points used to indicate the status of fisheries stocks are often model-based. Despite the recognized limitations of models when considering multi-species relationships and uncertainties (e.g., natural variability, measurement errors, management uncertainties and climate change), the biomass (B) or fishing mortality (F) of individual stocks at maximum sustainable yield (MSY) (e.g., B/B_{MSY} and F/F_{MSY}) are still used to define the state of fisheries stocks. When data on B and F are not available, catch trends analyses may provide an assessment of the state of fisheries (e.g., as "developing" (sometimes subdivided into "undeveloped" and "developing"), "mature" and "senescent" (Figure 1A)). If catches have not been constrained by management, socioeconomic drivers or climate, these classifications of the state of fisheries may be considered proxies for the state of the underlying resources as "underfished" (sometimes subdivided into "underfished" and "moderately fished"), "fully fished" and "overfished"[3]. If the required data (i.e., catch, effort, catch structure, population parameters) is available, conventional synthetic or analytical assessment models and simulations are used to directly assess the state of stocks (see Figure 1, B and C).

In theory, stocks can be sustainably harvested (i.e., maintaining some catch level in the long term) at various levels of fishing mortality, including under fishing pressure above F_{MSY}, as illustrated by the parabola[4] in (Figure 1B). In practice, however, the risk of collapse (e.g. when strong natural oscillations occur) increases with fishing pressure, and the United Nations Convention on the Law of the Sea (UNCLOS) and the United Nations Fish Stocks Agreement (UNFSA) require maintaining stocks of harvested (target) species at their MSY biomass level (or above), with a fishing mortality equal to F_{MSY} (or below). B_{MSY} and F_{MSY} are therefore the references used for fishery management and form the basis for the standard that will be used to report on sustainable fisheries harvest in line with Target 6 (see Table 2).

[3] The use of catch trends alone to assess fish stocks (usually when more complete data on the fishery and the stock are not available to make a conventional stock assessment) has been controversial (e.g., Pauly et al., 2013), but reliable estimates can be obtained by combining catch trends and additional population and fishery parameters (Branch et al., 2010; Costello et al., 2012)

[4] Many other non-symmetric versions of the model exist.

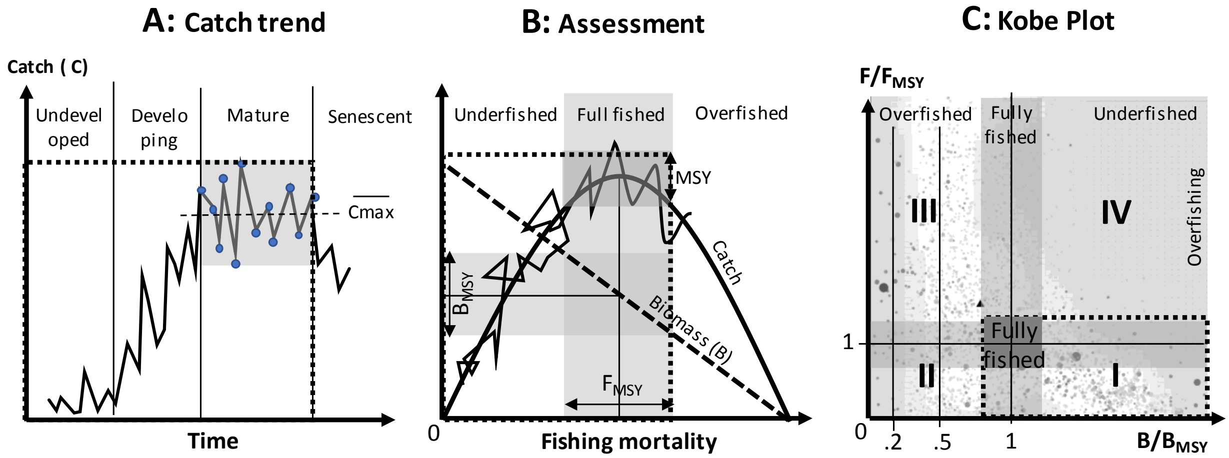

Figure 1. Different ways to assess and represent sustainability in fisheries.
A—using catch trends; B—using conventional Schaefer model; C—"Kobe plot" used to track the state of a stock across time or to display the state of many different stocks on a standardized plot (modified from Costello et al., 2016). In a deterministic frame, B/B_{MSY}=1 and F/F_{MSY}=1 are sustainability reference values below which stocks are considered overfished. Shaded bands around these reference values have been added (at +/- 20%) to reflect some level of natural variability. Below $B/B_{MS}Y$=0.5 stocks are often considered depleted. Below B/B_{MSY}=0.2 stocks are often considered collapsed. Lightly shaded bands (on all panels) indicate potential variability in the MSY-related reference values. On Panel C the confidence limits (grey bands) have been set at B_{MSY} and F_{MSY} +/20% (from 0.8 to 1.2) following FAO (2011; 2016) (see text). The darker shaded area on Panel C indicates the locus of fully fished stocks when uncertainties are taken into account. The dotted rectangle in all panels indicates the minimal area in which stocks meet Target 6A requirements (see text).

The system most frequently used to graphically represent stock status is a "precautionary plot" (e.g. Garcia and De Leiva Moreno, 2000; 2005), now referred to as a "Kobe plot"[5] (Figure 1C). On such a plot, the state of one or many stocks at a given time (stock status), or at different times (stock trajectory), may be represented on a standardized set of F/F_{MSY} and B/B_{MSY} coordinates to illustrate their situation in relation to MSY-related reference values for biomass and fishing mortality reference values. All things being perfectly known and stable, stocks would be strictly exploited at MSY level when their F/F_{MSY} and B/B_{MSY} are equal to 1. In relation to these two reference lines, four quadrants can be identified:

- F/F_{MSY} <1 and B/B_{MSY} >1: the stock is underfished. It is sustainably harvested but could produce more food if fishing effort were increased, and still be sustainably harvested.
- F/F_{MSY} <1 and B/B_{MSY} <1: the stock has been overfished in the past, but fishing pressure has been reduced, so overfishing is presently being avoided but biomass is still lower than the standard. As long as F/FMSY is kept at or below 1, this aspect of Target 6 will continue to be met. However, B must be allowed to increase until B/BMSY >1, either through natural recovery as removals are reduced or through a formal rebuilding plan with stock enhancement measures, which are required if B is depleted (See section 1.1.2).
- F/F_{MSY} >1 and B/B_{MSY} <1: the stock is currently being overfished and requires an immediate reduction of fishing pressure. Depending on how far below 1 the value of B/B_{msy} is, a rebuilding plan may also be required (see section 1.1.2).
- F/F_{MSY} >1 and B/B_{MSY} >1: Fishing pressure is excessive, but stocks are not (yet) depleted. This situation is unstable in the long term and results from: (i) the fact that fishing has recently increased, and the

[5] Probably in reference to the first meeting of tuna RFMOs in Kobe, Japan (2007), where this plot was used for common reporting.

stock has not yet adjusted to its final and lower size; (ii) natural variability; and/or (iii) assessment errors.

When $B/B_{MSY} < 0.5$, stocks are often conventionally considered as being below safe biological limits[6] (B_{lim}). These are the stocks which, in the overfished category, tend to be referred to as “depleted” and may formally require special rebuilding plans (cf. section 4). Below B/B_{MSY}=0.2, depleted stocks are referred to as “collapsed” and in this case, rebuilding plans are mandatory and require even more restrictive measures than depleted stocks.

It should be noted that the reference values used in catch-based classifications (C_{max}) and assessment-based classifications (B, B_{MSY}, F and F_{MSY}), as well as a stock’s position relative to these reference values, are affected by natural variability (e.g., in stock productivity, fleet efficiency) as well as reporting and measurement errors[7]. They should therefore ideally be presented with their confidence limits. The “fully fished” stocks category used historically in FAO assessments and the “maximally fully fished” stocks presently used in the FAO State of Fisheries and Aquaculture report[8] are the stocks that fall within these confidence limits (as in Figure 1). If such limits are not calculated or represented (as in many Kobe Plots), the stocks that are indeed exploited on average “at MSY”, in line with the UNCLOS requirement, cannot be identified and are “lost” within the two categories, above or below the reference points. The same considerations can be made for all reference points used to define stock status categories.

However, confidence limits of reference points and stock status are not consistently available. Simulations of the management of a wide range of stock-types provided by Thorson et al., (2015) indicate that, even for stocks with reasonably good data, and management systems aiming at B/B_{MSY} =1, the biomass ratio achieved could range between 0.5 and 1.5. Moreover, the range would depend on the species and would be larger in species with high natural mortality under strongly variable climates (e.g., small pelagic species in upwelling areas) and smaller for species with lower natural mortality under more stable climatic conditions (e.g., North Sea plaice). The proportion of stocks in the different status categories will depend on their confidence limits and there is not yet international agreement on such limits. The use of different limits in different places complicates coherent communication and compilation of responses at the regional or global level. Branch et al., (2010) used +/-50% confidence limits. The same approach is used in New Zealand (Ministry of Primary Industries, 2017), Australia and the United States of America (Hilborn, personal communication). In the 2016 FAO State of World Fisheries and Aquaculture (SOFIA) report, more precautionary confidence limits of +/- 20% (e.g., B/B_{MSY} ranging from 0.8 to 1.2) have been adopted for “fully fished” stocks to reflect this problem (as shown in Figure 1C), and this is the approach used in the present volume (cf. Table 2).

1.1.2 Correspondence between the elements of Target 6 and fishery concepts

Figure 1 and Table 2 contain the elements needed to connect the elements of Target 6 to fisheries and stocks state categories and reference values as they are used today, relating their current biomass (B) to their biomass at MSY (B_{MSY}), accounting for confidence limits (see also Garcia et al., 2018 for a review).

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[6] In the present volume, it is important to be aware of the distinction between “safe *biological* limit” — a well-established single-population term — and “safe *ecological* limit” — a newer term explored in section 6.

[7] It has been demonstrated, for example, by simulation and fossil records, that stocks may even collapse under continuous no-fishing conditions (Laurec et al., 1980; Baumgartner et al., 1992; Thorson et al., 2015; McClatchie et al., 2017).

[8] E.g. in SOFIA 2018 available at www.fao.org/3/I9540EN/i9540en.pdf

Table 2: Categories of the state of stocks and fisheries, B/B_{MSY} reference values (top rows) and corresponding Target 6 elements (bottom rows) and criteria.

<table>
<tr><th colspan="8">SPECIES/STOCKS</th><th colspan="2">ECOSYSTEM</th></tr>
<tr><th colspan="4">Target</th><th colspan="3">Target/non-target</th><th rowspan="2">Threatened Protected spp</th><th rowspan="2">VMEs</th><th rowspan="2">Ecosystems</th></tr>
<tr><th>Categories</th><th>Under fished</th><th>Develo-ping</th><th>Fully fished</th><th>Overfished</th><th>Depleted</th><th>Collapsed</th></tr>
<tr><td>Metric (B/B_{MSY})</td><td>>2.0</td><td>2.0-1.2</td><td>1.2-0.8</td><td>0.8-0.5</td><td>0.5-02
<Blim</td><td>< 0.2</td><td>Jurisdictional designation <0.2</td><td>Density of vulnerable spp.</td><td>Structure and function</td></tr>
<tr><td rowspan="2">Goal</td><td colspan="3">Maintain at target level</td><td colspan="4">Rebuild to target level</td><td colspan="2">Protect/maintain/restore</td></tr>
<tr><td colspan="8">No SAI</td><td>Within SEL</td></tr>
<tr><td rowspan="2">Main measures</td><td colspan="3">Conventional controls of fishing mortality level and distribution (fishing pattern)</td><td colspan="2">More stringent reduction of fishing pressure and protection of recruitment</td><td colspan="2">Strict protection; Fishing moratoria and stock enhancement measures</td><td>Move-on rules; Protected areas</td><td>Meet 6A-6C. Maintain structure and function</td></tr>
<tr><td colspan="3">Management plan</td><td colspan="2">Rebuilding plans (RP)</td><td colspan="2">RP may be mandatory</td><td colspan="2">Restoration plans may be established</td></tr>
<tr><th>T6 Element</th><th colspan="3">6A -Sustainably harvested</th><th colspan="3">6B-Depleted</th><th colspan="2">6C-Threatened spp. and vulnerable ecosystems</th><th>6D-Safe ecological limits</th></tr>
</table>

*Using the confidence limits of the fully-fished category adopted in FAO reports (FAO, 2011, 2016)

Target 6,

Table 1 and Table 2 contain terms that may need some clarification. The terms “target species” and “non-target species” are used neither in UNCLOS nor in the CBD. However, they are solidly established in fishery science and management and cannot be avoided when reporting on fisheries. The concepts of “significant adverse impact” (SAI) and “safe ecological limit” (SEL) are relatively new, both in biodiversity conservation and fishery management, and tend to be used in ecosystem contexts, whereas the concept of “biologically safe limit” is commonly used in fisheries and usually applied to individual stocks. It is important to understand the relationship between these terms for a consistent interpretation and consolidation of the information provided in reports of the status and trends of fisheries (Figure 2**)**.

UNCLOS refers to harvested species, noting that they must be maintained or restored to the level at which they can produce MSY (UNCLOS article 61.3), and to species associated with and, dependent upon, harvested species, which should be maintained or restored above the level at which their reproduction becomes seriously threatened (article 61.4). Fisheries science and management usually refer to these two categories as “target species” and “non-target species”.

“Target species” (elements 6A and 6B) are species that are specifically sought by fishing. The degree to which they are monitored, assessed and managed depends on the commercial importance and size of the resource, the type of fishery and the country’s capacity. Generally, small-scale fisheries are formally monitored and assessed less frequently than commercial ones. By 2020, target species may be “sustainably fished” (element 6A), “overfished” and not yet depleted (element 6A) but may still require a reduction in fishing pressure, “depleted” (element 6B) and require a specific rebuilding programme, or possibly designated as “threatened” by a jurisdiction and require even more stringent protection measures (element 6C).

In natural resource conservation, the term “depleted” is used for a resource that has been consumed faster than it can be replenished for long enough that its abundance has been stably reduced –although there is no standard for how great a reduction constitutes a “depleted” state. From that angle, the progressive increase of removals from a target stock, in order to extract more food, which necessarily reduces the stocks abundance, should be a well-controlled “depletion” process, stopping at or before the level corresponding to the MSY. Fisheries management aims to regulate it in ways that take advantage of density-dependent processes that allow productivity to increase at low to moderate levels of reduction in abundance. This is embodied in the goal to maintain stocks at or above their highest level of productivity (MSY) (as provided for in UNCLOS), but not at their unexploited level of biomass (B_0).

“Non-target species” are species with no current commercial interest. They include bycatch species (accidentally taken) and other species that may be impacted indirectly by fisheries (e.g., through the food chain). Target 6 does not set benchmarks for all non-target species, as 6A explicitly applies to “all fish and invertebrate stocks”. However, 6B equally explicitly refers to “all species”. Consequently, if bycatches have caused any non-target species to reach a level considered depleted, Target 6B requires a plan and measures for its recovery. Should a non-target species be designated as “threatened” by a competent jurisdiction, 6C would also apply, and the species should be protected from SAI.

Ecosystem-level conservation is dealt with in elements 6C and 6D. Element 6C specifically addresses vulnerable ecosystems (including VMEs), which should be protected from serious adverse impacts, and 6D addresses all ecosystems more generally, specifying that they should be maintained within SEL. In fisheries, the term VME initially referred primarily to living (biogenic) habitats, like cold-water corals and sponge reefs in the deep-sea threatened by bottom-impacting fishing gear. In Target 6, and increasingly within national fisheries management, the term refers more generally to all ecosystems with a similar degree of vulnerability to fishing, such as coastal coral reefs, algal or seagrass beds and kelp forests. Element 6D is the overarching standard for fisheries, calling for impacts of fishing (on species, stocks and ecosystems) to be kept within SEL.

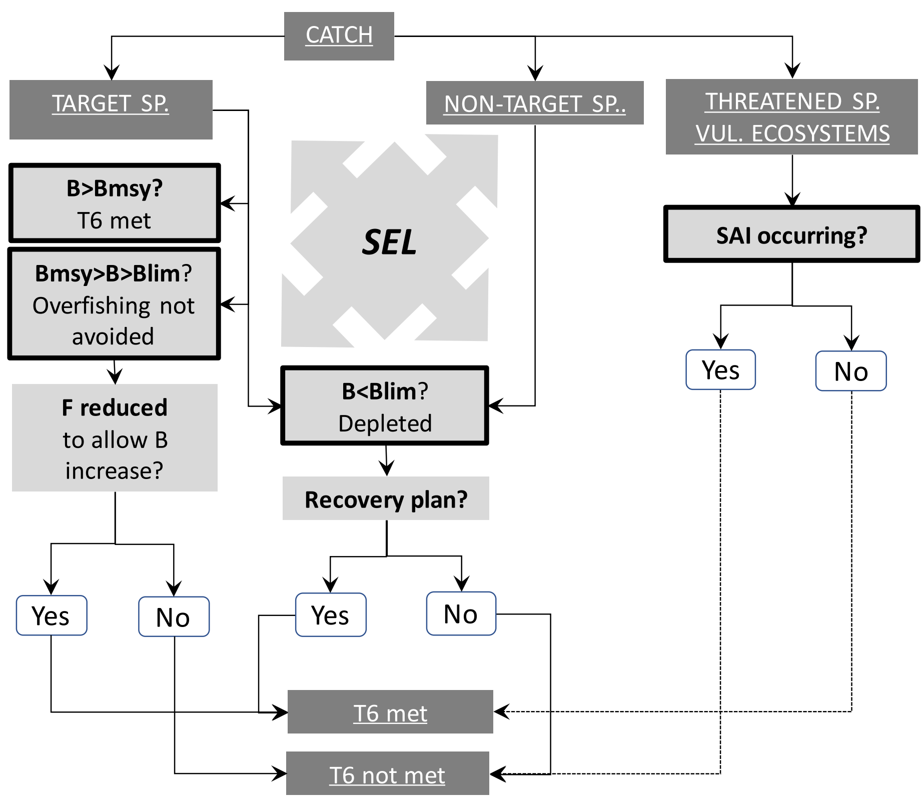

Figure 2. Relations between the terms used in fisheries management and biodiversity conservation. BMSY is the level of biomass corresponding to the maximum sustainable yield (MSY) and B_{lim}, the level below which reproduction may be threatened.

It has been argued that the concepts of sustainability, SAI and SEL have ambiguous meanings and lack universal agreement on measurement methods and indicators, complicating consistent reporting and meaningful aggregation of Parties' responses at the regional or global level (Donohue et al., 2016)[9]. Sustainability has several dimensions (i.e., ecological, social, economic and governance) and may refer to stocks, species, multispecies assemblages and the social-ecological system. For fisheries, avoiding SAI requires ensuring that threatened species and vulnerable ecosystems are accorded a high degree of protection to prevent further harm from fishing and allow recovery. However, this protection has no effect on factors other than fishing that may be contributing to the degraded status of the stock, species or ecosystem, thereby potentially limiting recovery. Maintaining the ecosystem within SEL might be interpreted as requiring the persistence of overall structure and functions (e.g., maintaining impacts below some thresholds and balancing all other requirements). Reporting, therefore, implies translating the undefined terms in Target 6 into measurable elements, such as those mentioned above.

Figure 2 also illustrates the important fact that the distinct elements identified within Target 6 to facilitate analysis and reporting are inter-dependent and functionally linked. Species may move between elements. A species classified as "other species" (not directly affected by fishing) may become a bycatch species if fishing strategies or areas change, and even a target species if demand arises. It might then be sustainably harvested, depleted and even threatened if poorly managed. Moreover, all species are inter-connected in multispecies assemblages that may use vulnerable ecosystems in their life cycle and require an ecosystem within SEL to thrive.

The important implication is that, while the elements might be examined separately, the challenge will be to combine information on all elements into one overall sustainability performance assessment. Combining assessments on these elements into one composite indicator that would communicate in a meaningful way the degree to which all the fisheries in a reporting jurisdiction are sustainable is a difficult task. This volume does not attempt to address how this should or could be done, but rather aims to inform discussions of possible approaches that might be feasible and meaningful.

1.2 Suggested indicators

CBD Parties have the responsibility to report on progress made on all Aichi Targets and implementation of their National Biodiversity Strategy and Action Plans (NBSAPs).

Ideally, indicators used to report on Target 6 should be: (i) clearly connected to elements of Target 6 as shown in

Table 1; (ii) actionable and achievable with the means available; (iii) based on science and local knowledge; (iv) robust to uncertainty (precautionary); (v) meaningful and understandable (communicable) to users and actors concerned; (vi) ideally, developed with key stakeholders and (vii) available as soon as possible to allow for timely action. The last point is a real challenge for the 2020 reporting. Indicators should also be accompanied by information on their scope (species, fishery, sector, EEZ, region, global), the methodology used for calculation, and a key to interpretation of their variations (when not obvious).

[9] The argument is a double-edged sword. It is therefore advisable to have both conceptual goals and measurable targets.

Two important considerations are specific to the Target 6 reporting process: (1) Considering the number of Aichi Targets to be reported on, only a small number of indicators would be manageable for each target; (2) Considering that 2020 is almost upon us, the indicators of interest need to be already available or in the process of being elaborated. Indicators that are used for reporting in 2020 might be expanded for subsequent reporting/assessment exercises.

The CBD Ad Hoc Technical Expert Group on Indicators for the Strategic Plan for Biodiversity 2011-2020 identified the following indicators for Target 6, each of which presents substantial problems of interpretation: (i) marine trophic index (although its changes, when referring to catches, cannot be easily interpreted because of both the multiple possible causes of any change, and because improvements in fisheries management can cause the index to either increase or decrease, depending on the nature of the fisheries); (ii) proportion of fishery products derived from sustainable sources (which might be confusing when catches are reduced to increase biological sustainability or socio-economic performance); (iii) trends in abundance and distribution of selected species (that may be affected by fishing but also by climatic factors and cannot be extrapolated to non-target and other species), and (iv) proportion of overexploited or collapsed stocks/species (only reliable for well-assessed species). Catch trends might be used in data-limited situations, but variations may be due to management or climate as well as fishing. Additional information may often be useful for a correct interpretation of trends.

The 2016 Expert Meeting agreed that (i) the indicators to be collected within available means should be prioritized using at least a qualitative risk-based framework, (ii) effective reporting on such a complex target requires capacity-building in many parts of the world, (iii) shared, straddling and high seas stocks present specific challenges, and (iv) a disciplinary consensus was needed on how ecosystem benchmarks should be defined and calculated (e.g., in relation to SAI and SEL). It also agreed that it was necessary to report on actions taken, stressing the logical link between legal, policy and management actions and expected outcomes (with the caveats mentioned in the introduction of section 1.)

The complete lists of indicators addressed respectively by the 2016 Expert Meeting and in COP decision XIII/28 are provided in annex 1 and 2, respectively, for ease of reference. Values and trends in some of them are reported in sections on Target 6 elements, below.

It may not be possible for some of the indicators above to be collected continuously worldwide, and some may be correctly interpreted only with significant additional contextual information. In terms of fisheries management effectiveness, three attributes generally influence success: (i) the quality and coverage of stock assessment; (ii) the extent to which fishing pressure is effectively limited; and (ii) the comprehensiveness and deterrence of enforcement programmes (Melnychuk et al., 2017). These elements are notably absent from the list of indicators above even though they may intervene indirectly in some of them.

Quantitative indicators with reference values facilitate monitoring, reporting and communication. However, because of the lack of quantitative information on many indicators, CBD Parties' reporting also includes narrative descriptions. With serious limitations of reporting based solely on quantitative indicators, advice may be needed regarding the aggregation of narratives into a meaningful global-level picture. The development of global indicators will largely depend on the data collected by or submitted to intergovernmental organizations like CBD, FAO, IUCN, CITES, as well as analyses by academics and NGOs. Regular data collection and reporting systems on the state of fisheries and stocks exist in FAO. RFMOs have their own mandatory reporting systems. Tuna RFMOs have a common reporting system developed by the International Seafood Sustainability Foundation (ISSF)[10]. Market information is also available through the FISH

[10] Accessible at https://iss-foundation.org/about-tuna/status-of-the-stocks/interactive-stock-status-tool/

INFOnetwork[11], coordinated by GLOBEFISH at FAO. This economic information is important for development and management and may contribute to assessing sustainability but is not (or rarely) used to monitor the state of stocks.

1.3 International collaboration on reporting

While the main source of information to assess the achievement of Aichi Target 6 remains the national reports submitted by CBD Parties, international collaboration with specialized agencies and conventions with a central role in fisheries and biodiversity conservation is essential in the process of producing global, regional or species-specific assessments. Collaboration among IUCN, CITES, CMS, UNEP and environmental NGOs sharing concerns on conservation and sustainable use of biodiversity has developed during the last 20 to 30 years (Friedman et al., 2018b).

The long-standing and growing collaboration between the CBD Secretariat and FAO with regards to fishery-related biodiversity issues allowed, inter alia, the development of joint considerations on Target 6 reporting at the 2016 Expert Meeting. These considerations included the interpretation of Target 6, potential indicators and their availability, additional efforts needed and the potential use of the CCRF questionnaire. There is substantial overlap between FAO Member Nations and CBD Parties, and Target 6 requirements overlap very closely with CCRF requirements on target and non-target resources and habitats. Consequently, responses to the CCRF questionnaire (by fishery authorities) may complement CBD Parties' reporting on their implementation of Target 6. To enhance this opportunity, complementary questions have been added to the CCRF questionnaire, as a result of collaboration between FAO, CBD and IUCN-CEM-FEG. Summaries of responses to these new questions were presented at COFI (FAO, 2018c), available at http://www.fao.org/3/CA0465EN/ca0465en.pdf. It should be noted that supplementary questions have also been added to the CCRF questionnaire to better contribute to the analysis of progress made on SDG indicator 14.6.1 on combatting IUU-fishing (Camilleri, FAO, pers. comm.). Since 2013, there have been versions of the questionnaire for RFBs and NGOs, with 26 RFMOs and 10 NGOs responding in 2015. The 2015 responses to the CCRF questionnaire (as compiled in FAO, 2016, 2016a) have been analyzed and distributed below on the pertinent sections related to Target 6 elements A to D. Although the responses are mainly declarative, they provide a "panoramic" perspective on Parties' buy-in, intentions, actions, claimed achievements, problems and solutions, even though detailed data on performance may not (yet) be available.

1.4 Connections between Aichi Biodiversity Target 6 and Targets of the Sustainable Development Goals

SDG 14 aims to conserve and sustainably use the oceans, seas and marine resources for sustainable development. As such, it is clearly the most relevant and comprehensive SDG for marine fisheries. This section examines the correlation between Aichi Biodiversity Target 6 and the targets and indicators of SDG 14 (see annex 3 of the present volume for the relevant original texts pertaining to SDG 14). It is important to note that SDG 14 addresses a much broader set of issues and priorities than Target 6.

SDG Target 14.4 aims, by 2020, to effectively regulate harvesting and end overfishing, IUU-fishing and destructive fishing practices and to implement science-based management plans to restore fish stocks in the shortest time feasible, at least to levels that can produce MSY. The indicator (14.4.1) is the proportion of fish

[11] INFOPESCA in Latin America and the Caribbean, INFOFISH in Asia and the Pacific Region, INFOPECHE in Africa, INFOSAMAK in the Arab Region, EASTFISH/EUROFISH in East and Central Europe and INFOYU in China (http://www.fao.org/fishery/topic/16133/en).

stocks within biologically sustainable levels. This target is very similar to Aichi Target 6, and the indicator is identical to one of those selected for Aichi Target 6A and 6B on sustainable harvest of target species (sustainably harvested or depleted).

SDG Target 14.6 aims, by 2020, to eliminate the fisheries subsidies that drive overcapacity, overfishing and IUU fishing, and to refrain from introducing new subsidies. The indicator (14.6.1) focuses on progress by countries in the degree of implementation of international instruments aiming to combat IUU-fishing. As such, this SDG target may be related to the action implicitly needed under Aichi Targets 6A and 6B to achieve sustainable harvests and rebuild depleted stocks. Its broad drafting, however, relates it to the legal actions needed across all Target 6 elements to maintain sustainable fisheries.

SDG Target 14.7 aims, by 2030, to increase the economic benefits to small island developing States (SIDS) and least developed countries (LDCs) from the sustainable use of marine resources, including through sustainable fisheries. The indicator (14.7.1) is the relative contribution of sustainable fisheries to the gross domestic product of these countries. There is no echo of this socio-economic concern in Target 6.

SDG Target 14b aims to provide access for small-scale artisanal fishers to marine resources and markets. The indicator (14.b.1) is the progress in the degree of application of a legal, regulatory, policy or institutional framework that recognizes and protects access rights for small-scale fisheries. Target 6 has no reference to small-scale fisheries or access to resources and markets. SDG Target 14b could be very indirectly related to Aichi Target 6 through its legal thrust, but with a socio-economic rationale that is missing in Target 6.

SDG Target 14c aims to ensure the full implementation of international law for the conservation and sustainable use of oceans and their resources by their parties. The indicator (14.c.1) is the number of countries making progress in ratifying, accepting and implementing ocean-related instruments that implement international law, as reflected in UNCLOS. This SDG Target also refers to law but, contrary to the preceding, with an environmental rationale directly related to Aichi Target 6, particularly 6A.

The SDG 14 targets above are closely related, therefore, to Aichi Target elements 6A and 6B on sustainably harvested stocks or overfished (depleted) stocks, in terms of requiring legal fishing operations (complying with UNCLOS and related regimes), ending overfishing, requiring management plans and rebuilding of depleted stocks to MSY. The SDGs also address subsidies, access rights of small-scale fishers to resources and markets, SIDS and LDCs, which are not explicitly mentioned in Target 6.

For fisheries, Aichi Target 6 and the targets of SDG 14 are complementary. Target 6 is more explicitly concerned than SDG 14 by the broader impact of fishing on the ecosystem and on biodiversity. SDG 14 addresses more explicitly the socioeconomic and equity issues in fisheries. Clearly, however, the healthy ecosystems for which Target 6 aims are needed for several SDGs to be reached (Schultz et al., 2016). Similarly, achieving Aichi Target 6 requires the buy-in of local communities and hence the provision of food security and livelihoods needs, as expressed in SDG14. However, the lack of explicit recognition of these trade-offs may also reflect the fact that some core goals of Aichi Target 6 (the mitigation of fishing impact on biodiversity) could be considered a constraint in the SDG 14 framework (on sustainable development) and vice-versa

2. Progress on legal and policy frameworks

Element 6A refers to legal, policy and planning frameworks, and requires that “all fish and invertebrate stocks and aquatic plants [be] managed and harvested (i) sustainably, (ii) legally and (iii) applying ecosystem-based approaches”. The adequacy of these frameworks is fundamental for enabling action and the achievement of all Target 6 elements.

For sustainable harvesting, a complex set of actions is needed in legal and policy frameworks (and governance) to translate international instruments into a national enabling environment of legislation, regulations and policies, e.g.,: (i) Adoption of a fishery act and effective processes of governance—a long-term process, which, in many cases, started long before 2010 and continues to evolve at different paces in different countries. The most strategic, structural elements have been already adopted in most countries but improvements are always necessary; (ii) Formal adoption of the criteria and related benchmarks of UNCLOS (e.g., MSY) and CBD (e.g., SAIs; SELs); (iii) Formal adoption of the precautionary approach to fisheries and of a risk-based approach to assessment and management (e.g., using precautionary reference points, harvest control rules, and management strategies evaluation); (iv) Development of capacity in governance, science and management; (v) Explicitly addressing socioeconomic dimensions (including profitability and equity); and (vi) Increasing cooperation across data collection, scientific assessment and information exchange to improve reporting. Reporting in these areas may often take the form of narratives, which could be turned into quantitative or qualitative regional and global indicators.

Progress in the development and implementation of legal and policy frameworks is examined below only in relation to the fight against IUU-fishing and the application of the ecosystem approach to fisheries (EAF) in relation to IUU.

2.1 The fight against IUU-fishing

IUU-fishing is seen as one of the most serious impediments to sustainable fishing and hence the achievement of Target 6. In the following sections, we look at its definition, how it is assessed, action taken against it and outcomes.

2.1.1 Definition of IUU-fishing

There is no simple agreed definition of IUU-fishing. The FAO International Plan of Action to Prevent, Deter, and Eliminate Illegal, Unreported, and Unregulated Fishing (IPOA-IUU) adopted in 2001 (FAO, 2001, 2002), indicates that IUU-fishing is characterized by overlapping violations at national (EEZ), regional (RFMOs) or international levels (see also FAO, 2015):

- *Illegal fishing*: fishing activities in conscious contravention with national, RFMO or international legislation concerning access (e.g., pirate fishing) and fishing practices (poaching);
- *Unreported fishing*: non-reporting, under-reporting or misreporting, of catch, bycatch, discards, fishing location, and other information formally required, eventually including transshipment and transport of fish;
- *Unregulated fishing*: activities not covered by the governance system in place, which violate international laws or agreed principles of resources and biodiversity conservation, e.g., fishing with vessels that (i) are stateless, (ii) belong to non-cooperating Parties to a RFMO, or (iii) are not properly controlled by their flag States.

According to Tsamenyi et al., (2015), States have the sovereign right to regulate activities in their EEZ (presumably subject to UNCLOS, article 61.3, requiring the maintenance of stocks at least at their MSY level), and certain unregulated fishing (e.g., in many small-scale or subsistence fisheries) may not violate any applicable international law and hence not require the application of “anti-IUU” measures. A lack of direct jurisdictional regulation of small-scale and subsistence fisheries was not explicitly discussed when Target 6 was negotiated. However, as long as such fisheries were prosecuted with the knowledge of the central jurisdiction and “regulated” by community standards and practices (FAO 2015c), they should be consistent with the spirit of “legally”, as used in Target 6.

2.1.2 Assessment of IUU-fishing

Considering its complex components and their obvious opacity, IUU-fishing cannot be easily reduced to a simple indicator and measured. Nonetheless, illegal and unreported catches (not unregulated ones) were globally estimated on a regional basis for the period 1980-2003 (Agnew et al., 2009). In 2000-2003, they were estimated to represent 11-26 million tonnes per year (13-31 per cent of the reported harvest) with a value of USD 10-23.5 billion. Trends from 1980-1984 to 2000-2003 varied between regions and, overall, show an average decline of illegal and unreported catches from 21 per cent to 18 per cent of the reported landings, which might not be statistically significant. The most severely affected area appears to be West Africa, where total catches were estimated to be 40 per cent higher than reported ones. The worst period seemed to have been the mid-1990s, and, as expected, the relative impact was higher on high-value resources and in weak governance areas (Agnew et al, 2009: 5). These values are "best educated guesses" and would need to be updated from time to time in a consistent manner to detect trends. The FAO Expert Workshop to Estimate the Magnitude of Illegal, Unreported and Unregulated Fishing Globally (FAO, 2015) was organized for this purpose. As a follow-up, international guidelines for IUU-fishing assessments were drafted at FAO and presented to COFI 33 (FAO, 2018 b). Some IUU-fishing assessments have been undertaken in various countries and regions, such as North East Atlantic Fisheries Commission, Bay of Bengal and South Pacific Island countries (FAO, 2015) but, to the authors' knowledge, no synthesis has been published yet.

2.1.3 Action taken against IUU-fishing

Illegal fishing has been a long-standing concern, leading to the development of binding legal instruments and numerous efforts to strengthen monitoring, control and surveillance (MCS) well before the adoption of Target 6. The 1993 FAO Compliance Agreement[12], the 1995 UN Fish Stock Agreement (UNFSA)[13], the 1995 FAO Code of Conduct for Responsible Fisheries (CCRF), the 2001 FAO IPOA-IUU, the 2002 International MCS Network[14] (2002), and the 2009 Port States Measures Agreement (PSMA) strengthened the arm of flag States and RFMOs, developing their capacity to curb IUU-fishing. They did not, however, stop it.

The range of measures that would be useful to report for 2020 is large and may be different when specifically addressing each of the illegal, unregulated or unreported components of IUU. For example, States and RFMOs were expected to adopt IUU-related plans of action at national (NPOAs-IUU) and regional (RPOAs-IUU) levels to, inter alia, (i) enhance MCS, (ii) reduce overcapacity, (iii) impede the access of IUU catches to markets, (iv) enhance port State and flag State controls and (v) strengthen regional cooperation and effectiveness of RFMOs (Agnew at al., 2009; Bray, 2000).

The following paragraphs provide some guidance on the elements to be tracked and reported by States and RFMOs in order to assess progress towards Target 6, and examples of possible achievements are found in the responses of FAO Parties to the CCRF questionnaire, given below.

a) *National action*

Numerous examples of national action have been reported through various channels.

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[12] FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (2003)

[13] Agreement for the Implementation of the Provisions of the United Nations Conventions on the Law of the Sea of 10 December 1982 Relating to the Conservation and the Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (1995)

[14] International Monitoring, Control and Surveillance Network (http://www.imcsnet.org (2002). It now includes 62 States, the European Union and two RFMOs.

The 2010 Illegal Fishing Regulation of the European Union, for example, encourages countries willing to export fish to the EU to address illegal fishing in their waters and by their fleets and asks EU member States to request certificates of the legality of imported seafood products. In addition, by requesting minimum MCS standards in the exporting countries, the EU has encouraged many countries to entirely reform their fisheries policies and laws and introduce more sophisticated vessel monitoring systems and sanctioning tools ("yellow cards") to combat IUU-fishing effectively at home. Similar results are expected from action taken by port States in the framework of the Port State Measures Agreement (PSMA).

b) International collaboration

International collaboration against IUU-fishing is essential to achieve significant global results. This collaboration has been intense during the last decade. Several international organizations are working together in various forms, including (i) the Joint FAO/IMO Ad Hoc Working Group on IUU-fishing (FAO/IMO, 2016), (ii) the International Monitoring, Control and Surveillance (IMCS)[15] network, which connects enforcement agencies around the world, (iii) The Tuna Compliance Network (TCN), supported by the IMCS network, which was established in 2017 and promotes communication and cooperation between authorities and staff, sharing information on best anti-IUU practices in tuna fisheries[16], (iv) FISH-i Africa[17] between eight countries in the western Indian Ocean operating in a regional inter-governmental task force to tackle IUU fishing, (v) INTERPOL's Fisheries Crime Working Group[18], (vi) the United Nations Review Conference on the Fish Stocks Agreement and the Sustainable Fisheries sub-agenda of the General Assembly, (vii) The UNGA process to develop an international legally binding instrument under UNCLOS for the conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction (known as the BBNJ process) and (viii) Thailand-Indonesia Working Group on Labour and IUU.

Numerous private institutions and NGOs have developed information, advisory and advocacy services, including (i) Transnational Alliance to Combat Illicit Trade[19], (ii) Center for Strategic and International studies[20], (iii) Chatham House Forum on IUU-fishing[21], (iv) The Pew Charitable Trust[22] in its International Fisheries News, (v) International Seafood Sustainability Foundation (ISSF) and (vi) The CBD Sustainable Ocean Initiative (SOI).

2.1.4 Outcomes related to IUU-fishing

a) Publication of IUU-fishing vessels lists

Many RFMOs have agreed to cooperate in publishing "positive lists" of vessels known to fish legally (e.g., at http://tuna-org.org/vesselpos.htm) as well as "black list" of vessels known to have been involved in IUU-fishing (e.g., in http://tuna-org.org/vesselneg.htm).

b) Adoption of IUU-fishing Plans of Action (POAs)

Information on IPOA-IUUs (adopted in 2001) at national and regional levels is available on the FAO website (http://www.fao.org/fishery/ipoa-iuu/npoa/en). Thus far, national plans of action (NPOA-IUU) have been adopted in 10 States (Antigua and Barbuda, Australia, Belize, Canada, Fiji, Ghana, Korea, Sri Lanka, St Kitts and

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[15] imcsnet.org
[16] http://www.fao.org/3/a-i8146e.pdf
[17] https://fish-i-africa.org
[18] https://www.interpol.int/Crime-areas/Environmental-crime/Committee-and-Working-Groups/Fisheries-Crime-Working-Group
[19] https://www.tracit.org/fisheries.html
[20] https://www.csis.org/events/report-launch-illegal-unreported-and-unregulated-fishing-national-security-threat
[21] https://www.chathamhouse.org/search/site/Forum%20on%20illegal%20unreported%20unregulated%20fishing
[22] outreach@pewtrusts.org

Nevis, and the United States of America) and in the European Union. Regional plans of action (RPOAs) were also adopted before 2010. The Regional Plan of Action to Promote Responsible Fishing Practices including Combating IUU Fishing in the South China Sea, Sulu-Sulawesi Seas (Celebes Sea) and the Arafura-Timor Seas was established in 2007[23]. More recently, in 2014, a Regional Working Group on IUU-Fishing (RWG-IUU) was established in Trinidad and Tobago under the aegis of the Western Central Atlantic Fishery Commission (WECAFC). The responses of the RFBs to the CCRF questionnaire of 2015 indicate that several of them contributed to implementation of the IPOA-IUU, mainly through initiatives to strengthen and develop new ways to prevent, deter and eliminate IUU-fishing (71 per cent of RFBs), enhancing the exchange of information on vessels involved in IUU-fishing (63 per cent of RFBs), and assisting in the implementation of other activities prescribed by the IPOA-IUU (63 per cent of RFBs).

c) *Port States Measures Agreement (PSMA)*

At the global level, the focus of States' action against IUU-fishing is the implementation of the PSMA and complementary instruments. The PSMA was adopted in 2009 just before the Aichi Targets. It entered into force in 2016 and there are now 55 Parties to the Agreement. The first meeting of the Parties to the PSMA, held in 2017, focussed on exchange of data and information (FAO, 2017; 2017a). Recognizing also that the effectiveness of the PSMA relates strongly to national capacity to exert the control required, the Agreement has established a fund to assist developing States in their implementation of the Agreement (FAO, 2017). In addition, in 2014 COFI endorsed a set of Voluntary Guidelines for Flag State Performance, intended to help strengthen compliance by flag States with their international duties and obligations regarding the flagging and control of fishing vessels. The FAO Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels (Global Record), the Voluntary Guidelines on Catch Documentation Schemes and other tools developed by RFMOs are complementary instruments facilitating implementation of the PSMA. The measures taken by States within the framework of the PSMA can be found in the FAO database at http://www.fao.org/fishery/psm/search/en.

d) *The FAO Voluntary Guidelines for Flag State Performance*

These guidelines were adopted by COFI in 2014. They are voluntary but based on UNCLOS, the CCRF and the IPOA-IUU. Their objective is to prevent, deter and eliminate IUU-fishing or fishing-related activities through the effective implementation of flag-State responsibilities to ensure the long-term conservation of living marine resources and marine ecosystems (FAO, 2015a) and in particular to: (i) combat IUU-fishing; (ii) control fishing vessels flying its flag; (iii) ensure that they do not engage in IUU-fishing; (iv) ensure conservation of living resources; and (v) discharge its duty to cooperate (e.g., in RFMOs).

The performance assessment criteria relate, *inter alia,* to: (i) translation of international rules in domestic legislation; (ii) adoption of the necessary measures or implementation of those taken in a RFMO; (iii) contribution to effective functioning of RFMOs; (iv) control of vessels flying the national flag; and (v) cooperation in management (effort and catch controls). In addition, the performance is measured by the extent to which the State complies with international standards regarding: (i) fishery management organizations, institutions, laws and regulations, and implementation; (ii) information registration and formal records; (iii) delivery and recording of authorizations to fish; (iv) monitoring, control and surveillance, and enforcement; (v) cooperation with other flag States and coastal States; and (vi) the conduct of the performance assessments, which may be self-assessments or independent assessments undertaken by third parties.

[23] With Republic of Indonesia, Australia, Brunei Darussalam, Cambodia, Malaysia, Papua New Guinea, The Philippines, Singapore, Thailand, Timor-Leste and Viet Nam.

e) Clarification of Flag-States' duties

Flag-States' duties in relation to IUU-fishing—including that of due diligence—have been further clarified by the 2015 Advisory Decision that the International Tribunal for the Law of the Sea (ITLOS) delivered on request of the West African Sub-Regional Fishery Commission (Rajesh Babu, 2015; Schatz, 2016) regarding the direct responsibility and liability of the Flag State for IUU fishing of their vessels beyond due diligence in ensuring lawful behaviour. These developments, as emerging analysis of the jurisprudence established by fishing access agreements (FAAs) has shown, have the potential to strengthen international norms on IUU-fishing and sustainable fisheries resources management but many issues remain regarding the liability and responsibility of the flag States regarding IUU-fishing by vessels flying their flag in other States' EEZs (Rajesh Babu, 2017; Schatz, 2017). Some have noted that this responsibility may not be well enough established and a new legally binding agreement might be needed to resolve the issue (Schatz 2016a).

f) National-level measures

The responses of FAO Parties to the CCRF questionnaire in 2015 (FAO, 2016) provide some information about the action of States, 79 per cent of which still perceived IUU-fishing as a problem. National plans of action (NPOA-IUU) were being drafted by 54 per cent of them, while 46 per cent already had such a plan in place. In order of importance, measures taken relate to improvement of: (i) MCS, (ii) legal framework, (iii) bilateral and international cooperation and (iv) port State controls. In addition, 75per cent of the respondents were implementing vessel monitoring systems, and 93 per cent were taking measures against trade of IUU-fishing products, such as enhanced controls and inspections on fisheries (60 per cent) and customs/borders (45 per cent); implementation of the NPOA-IUU and NPOA-Sharks (38 per cent); introduction of tougher sanctions (26 per cent) and implementation of catch traceability practices or controls (25 per cent). Finally, 61 per cent of the respondents responded that they were formally authorizing vessels bearing their flag to fish on the High Sea, monitor and obtain reports on their activities (85 per cent), and report such authorizations to FAO (69 per cent)

g) Outcomes

The results of these actions "on the ground" since 2010 should be reflected in indicators of state and trends. Being an illegal activity, IUU is obviously not officially reported anywhere and is hard to measure. Its components are very difficult to assess with any degree of confidence, and available values are tentative.

Updating the study of Agnew et al., (2009), referred to in section 2.1.2, is therefore a major challenge. May (2017) extrapolated that estimate to more recent times, using FAO landings data for 2011-2014, and assuming the regional ratios of IUU to legal activities calculated from Agnew et al., data in 2000-2003 were still valid, the author concludes that marine IUU-fishing generated annually a catch of 12-28 million tonnes, or 14-33 per cent of the officially reported landings, worth USD 16-36 billion in value (and not "profits" as stated in the original publication). As the total landings reported to FAO changed little between the two periods (100.10^6 t versus 93.10^6 t) and the IUU occurrence was assumed constant, the extrapolation does not show much of a difference after a decade (Table 3). Moreover, considering the quality and variability in the data available to Agnew et al., both within and between years, the confidence in the extrapolation can only be low[24].

Agnew at al. (2009) indicated that, during the period 1982-2003, IUU-fishing was only well correlated with the governance quality index. In many aspects, governance has improved since 2010, on paper, and the information on rebuilding of target species (in Garcia et al., 2018) indicates that, in well-managed areas it has also improved on the ground. Therefore, IUU-fishing may have decreased in those countries (and RFMOs) that

[24] A conclusion checked with D. Agnew, pers. com. March 2018.

have taken effective measures, but possibly also increased in areas under weak governance, and no conclusion is available yet on the overall outcome.

Table 3: Estimates of IUU catch and value in absolute values and in percentage of reported harvest in 2000-2003 (Agnew at al., 2009) and in 2011-2014 (May, 2017)

	IUU-catch			
	10^6 t.	%	10^9 USD	%
2000-2003	11-26	13-31	12-28	15-35
2011-2014	12-28		16-36	

2.2 The Ecosystem Approach framework

The ecosystem approach (EA) is formally required by the CBD as a condition to sustainable use and better defined in the Malawi Principles (UNEP/CBD, 1998) at COP 7 (decision VII/11) as “a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way” (SCBD, 2004).

In fisheries, the EA was implicit in UNCLOS through reference to associated and dependent species and became more explicit in 1995 with the adoption of the UNFSA and FAO CCRF. The EA was formally translated in an Ecosystem Approach to Fisheries (EAF) and Ecosystem-based Fisheries Management (EBFM) in the early 2000s (FAO, 2001, 2003; Brodziak and Link, 2002; Molenaar, 2002; Pikitch et al., 2004; Scandol et al., 2005). The EAF, which includes the precautionary approach, was more clearly elaborated in the FAO EAF guidelines (FAO, 2003) and other guidelines and plans of action aimed at reducing biodiversity impact: e.g., on marine protected areas (MPAs) and fisheries; protection of sharks, seabirds, turtles, and vulnerable marine ecosystems (VMEs). The EAF has been integrated, at least in principle, in the fishery policies of most advanced nations and the work of RFMOs (if not always in their basic texts) in the decade preceding the adoption of the Aichi Biodiversity Targets (Bianchi and Skjoldai, 2008), and has since largely penetrated regional and national legal and policy frameworks (Skonhoft, 2011; Fisher et al., 2015; FAO, 2016c), including the SDGs.

In practice, EAF implementation may be gauged by action taken to address: (i) Species interactions in stock assessment and management; (ii) Unwanted bycatch (and discards) and their impact on threatened or protected species; (iii) Fishing gear impact on bottom habitats and vulnerable ecosystems; (iv) Ghost fishing, reducing gear loss or abandonment; (v) Further integration of the precautionary approach to fisheries and adoption of risk-based fishery management approaches; and, although less specific guidance is available, (vi) Impact of –and adaptation to– climate change.

Although Target 6 is delineated into four main elements in this document (Table 1) to facilitate the understanding of concepts, indicators and related reporting issues, its drafting implicitly reflects an integrated ecosystem assessment approach, recognizing the dependence of key ecosystem functions on sufficient availability of structural features potentially impacted by fishing and the interconnections between the impacts (see section 6). The ecosystem approach brought in the requirement to maintain ecosystem structure and function (ESF). Target 6 has built on this foundation, specifying the requirement to avoid SAIs and to ensure impacts do not exceed SELs for ecosystem structure and function. The CBD Strategic Plan for Biodiversity 2011-2020 brought in the concept of ecosystem services and the requirement to maintain them. These elements and their relations are represented in Figure 3.

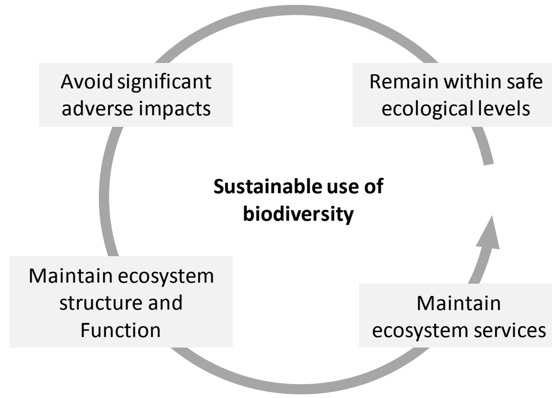

Figure 3. Interconnected ecosystem-related concepts and requirements

A major difficulty for implementation and reporting on progress in that area, however, is that none of the ESF, SAI and SEL concepts have agreed indicators[25] or standards and, as argued in sections 5 and 6, may not be amenable to fitting into reporting frameworks relying solely on a small number of indicators and rigid performance benchmarks. Consequently, it may not be possible to report this part of Target 6 consistently in quantitative terms, and qualitative reporting in the form of narratives and integrated assessment may not be robustly summed-up in any single format. This is exactly the situation faced generally as fisheries embrace an ecosystem approach to management.

The ecosystem approach required by the CBD, with its broad (comprehensive) translation in the FAO EAF, has the potential to generate indicators for all sets of fisheries interacting within ecosystems, feeding not only into Target 6 but also into many other complementary targets (Figure 4). Its generalization to all Parties, however, represents a major additional investment in research (data collection and assessments) as well as increasing costs associated with more complex interactions between fishing and coastal communities and between stakeholders when more participative and adaptive governance is established.

In terms of implementation of an ecosystem approach, the responses to the CCRF questionnaire 2015 (in FAO, 2016) indicate that:

- EAF: 78 per cent of the 93 respondents indicate that they have started implementing it. Of these, 99 per cent have identified ecological and socio-economic objectives of management, 95 per cent have identified the issues that need to be addressed;
- Destructive fishing practices: 98 per cent of the 67 respondents prohibit explicitly the use of destructive fishing methods and practices;
- Ecosystem indicators: 42 per cent of the 33 respondents indicated that they use ecosystem indicators in fisheries management and Protection of biodiversity:
- 86 per cent of the 66 respondents indicated that they address issues related to biodiversity, essential habitats and ecosystems,

[25] This was recognized in the report of the Expert Meeting, which took place in Rome in 2016 (FAO, CBD and IUCN-CEM-FEG, 2016)

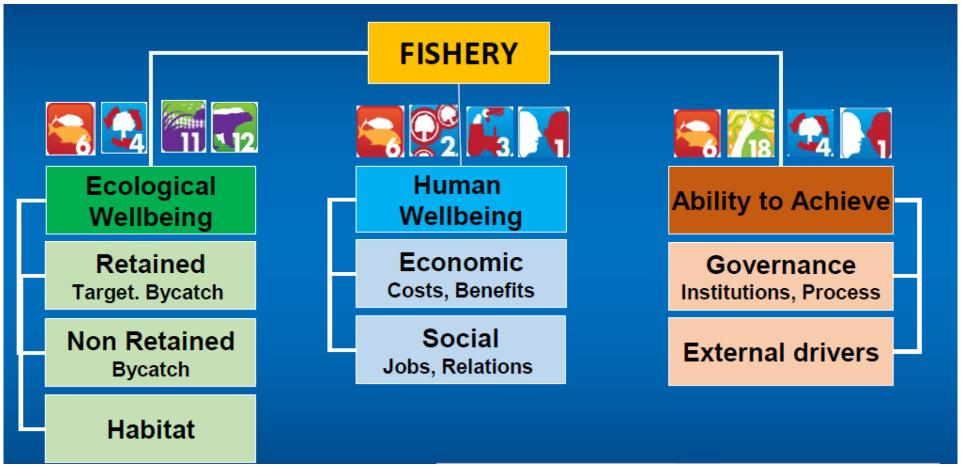

Figure 4. Elements identified in the FAO Ecosystem Approach to Fisheries and connections to the Aichi Biodiversity Targets

2.3 Performance of Regional Fishery Bodies (RFBs)

RFBs play an important role in conservation and management of the resources in their jurisdiction and as such are expected to contribute to the achievement of Target 6. The information provided on their websites, through the Regional Fishery Body Secretariats' Network (RSN, fao.org/fishery/rsn/en; FAO, 2016b) and the CCRFQ, provides useful accounts of their activities and outcomes.

This section refers briefly to the general role of RFBs as regional frameworks for management. A more detailed review of their contributions to Target 6 will be made in the relevant areas of sections 3 through 6, below.

The mixed results of RFMOs regarding the state of stocks as well as the collateral impact of fishing (e.g., on bycatch, discards and impact on the habitat) has been a subject of concern and study (Cullis-Suzuki and Pauly, 2010; Lutgen, 2010; Rice, 2011; Gilman et al., 2012), leading to efforts to review more systematically their role and suggest best practices (FAO, 1999; Lodge et al., 2007; Ceo et al., 2012; FAO 2012, 2015b, 2016b). The International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO, 2009) have been widely adopted and translated into action (Rice, 2010), but the outcome in terms of stabilization or reduction of the impact biodiversity has yet to be assessed (see sections 5 and 6).

During the last decade, RFBs—particularly RFMOs—have been encouraged to undertake self-performance reviews either as self-assessments or independent assessments by third parties. The criteria for these assessments (usually referred to as the “Kobe Criteria”) are not very different from those that would be used for review of States’ performance in relation to implementation of Target 6:

- On conservation and management: (i) the status and trends of target and non-target (associated and dependent) species; (ii) the extent of EAF incorporation; (iii) the scientific basis of the advice; (iv) the extent to which effective measure are taken; (v) the use of the precautionary approach; (vi) compliance with the “compatibility principle for straddling stocks”; (vii) a clear system of allocation of shares; (viii) attention paid to unregulated, new fisheries; (ix) reduction of harmful impacts (including through bycatch, discards, ghost fishing) on associated and dependent species and biodiversity; (x) the use environmentally safe fishing techniques; (xi) the implementation of effective rebuilding plans for depleted stocks; (xii) effective detection and management of excess capacity.
- On control and enforcement: (i) the degree of compliance with Flag States’ duties; (ii) the application of Port States Measures (minimum standards) by the RFMO parties, including strengthening of MCS

through use of vessel monitoring systems; catch documentation and trade tracking schemes; restrictions on transshipment; follow-up on infringements; International cooperation to monitor, detect and report on non-compliance; and market measures. The indicator should account for the extent to which such measures are applied, the measurement of which is not always straightforward.

The principle of undertaking recurrent and publicly available performance reviews in relation to these indicators is now well established, and reports are made to the governing bodies and exchanged across the RSNs (FAO, 2016b). The performance reviews are usually publicly available on the RFB's websites, as well as in summary publications (Ceo et al., 2012; FAO, 2015b) and at www.tuna-org.org, in the case of tuna RFMOs.

To the authors' knowledge, no updated global assessment of RFBs' performance is formally available yet. An unpublished comparative analysis (Fuller et al., 2017) on biodiversity measures used by RFMOs/As in 2006—when the UNGA Resolution 61/105 on Sustainable Fisheries and the UNFSA was adopted—and in 2017 indicates significant progress in addressing the provisions of that resolution, and others that have been adopted since. Existing RFMO/As have strengthened and expanded their measures to include more biodiversity-related components, and in regions where no RFMO/As existed, three new bodies have entered into force since 2012. The newcomers benefitted from the experience of the others, existing models and the existence of the RSN, to progress faster and adopt the relevant measures. The analysis also reveals the relative homogeneity of the biodiversity measures taken by these RFMO/As in bottom fisheries (including exploratory fisheries, encounter protocols, VME indicator species and thresholds) and close alignment with the UNGA resolution 61/105 and the FAO Deep-sea Fisheries Guidelines.

Nonetheless, in general, most RFMOs have updated their basic texts to account for the adoption of the UNFSA, the International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO 2009) and the Port States Measures Agreement (www.fao.org/port-state-measures/en/). Most also adopted the ecosystem approach and precautionary approach a decade or more ago. Detection of IUU has improved as States improved their performance as flag and port States following the Voluntary Guidelines for Flag State Performance (FAO, 2015a), and the use of target reference points (TRPs) and harvest control rules (HCRs) is slowly being generalized. The use of management strategy evaluation (MSE) is also spreading in leading RFMOs, but more slowly in others. Identification of threatened species in bycatch and vulnerable habitats is progressing very slowly, limited sometimes by the need to amend basic texts to broaden the RFMO mandate, and often constrained by limited budgets and national capacity. Overall, the international standards are up-to-date (although they could be improved), their political acceptance has been affirmed and formal steps to implement them have effectively started, to a different degree in different RFBs, reflecting operational constraints, as well as insufficient political will. The elaboration and update of RFMOs' performance reviews and their public availability, together with exchange of experience between RFBs through the RSN, are elements likely to increase performance in the future.

The detailed responses provided by RFBs to the FAO CCRF questionnaire in 2015 are available (FAO 2016) and mentioned below in the relevant areas of sections 3 through 6 (on Target 6 elements A to D).

3. Target 6A – Sustainably harvested species

3.1 Rationale

Target 6A envisages that "by 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided…". The key concepts that may require indicators have been underlined.

As suggested in section 1, element 6A is the overarching element of Target 6, while the following elements indicate what is expected when the overarching requirements are violated and species are depleted (6B) and considered threatened with risk of extinction (6C) (Table 2). Element 6A indicates that for species to be considered sustainably harvested, their fisheries need to be actively managed by a mandated authority, based on sustainability principles and legal foundations and within an ecosystem context. This element refers specifically to species targeted for harvesting, that are neither overfished nor depleted or collapsed and need to be maintained as such, remembering, as stressed in section 1.1.2, that in multi-gear-multispecies fisheries, non-target species incidentally caught (e.g., bycatch species) may often, with time, become *bona fide* target species as demands evolve.

3.2 Key concepts and indicators

The interconnected concepts to understand in order to report properly are underlined in element 6A above: (i) sustainable harvest and overfishing; (ii) legal harvest; and (iii) ecosystem-based approach. These concepts are clarified below.

3.2.1 Sustainable harvest and overfishing

"Sustainability" is defined in CBD (Art. 2) as "the use of components of biodiversity in a way and at a rate that does not lead to long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations". It requires a balance between its ecological, economic, social and governance dimensions. Target 6 refers only to the ecological (biodiversity) dimension (e.g., stocks, species, habitats, ecosystems).

UNCLOS uses the term "sustainable" but requires that the maintenance of the living resources is not endangered by overexploitation (article 61.2) and that "measures should maintain or restore populations of harvested species at levels which *can* produce the maximum sustainable yield, as qualified by relevant environmental and economic factors…taking into account… the interdependence of stocks" (article 61.3, emphasis added). The related UNFSA specified more explicitly that the MSY level of exploitation should be considered as a limit (to remain above) and not as a target (to reach). The ecological and economic factors, respectively, are recognized in the references to referred environmental factors and interdependence of stocks, on the one hand, and economic factors on the other, without specifications.

Overfishing is a synonym of overexploiting, to which UNCLOS (article 61.2) refers as driving a stock below the level at which it could produce MSY. Overfished stocks may be depleted or collapsed and are dealt with in section 4. Clearly, in Target 6, species are considered sustainably harvested when their overfishing is avoided, connecting the two antinomic concepts.

The clear implication for reporting on Target 6 is that sustainably harvested stocks include fully fished stocks (with $B=B_{MSY}$ and $F=F_{MSY}$ on average) and underfished stocks (with $B>B_{MSY}$ and $F<F_{MSY}$, on average), as described in section 1.1.1. In some countries (e.g., the United States of America), a distinction is made between (i) a stock that has been reduced below B_{MSY}, considered overfished whether the fishing pressure is still excessive or not, and (ii) a stock subject to excessive fishing pressure, considered actively overfished, whether the biomass is already below B_{MSY} or not. Target 6 does not explicitly delineate the boundary between 6A (fished sustainably) and 6B (depleted). However, it does explicitly link "depleted species" with the requirement for a recovery plan and measures. Fisheries management rarely requires the development of recovery plans for stocks with slightly less than B_{MSY}, but it definitely does so when stocks have fallen near or below biologically based limits, below which productivity may start to be impaired (B_{lim}). Between B_{MSY} and B_{lim}, conventional fisheries management is expected to reduce fishing pressure and with the productivity of the stock not yet impaired, natural stock dynamics should return the stock to or above B_{MSY}. This is typically supported by

precautionary buffers (B_{pa} values) intended to ensure the exploitation rate on declining stocks is reduced well before the risk of impaired productivity starts to increase. It is assumed that this practice will be maintained in Target 6 reporting. Stocks can be considered “sustainably managed” if biomass is above B_{MSY} or an appropriate surrogate or fluctuating around B_{MSY} with appropriate precautionary management in place to ensure that the exploitation rate decreases well before risk of impaired productivity increases.

3.2.2 Legal harvest

The legal harvesting of stocks implies that fisheries operate under the rule of law (e.g., abiding to regulations contained in a fisheries act, effectively enforced by a mandated authority). In theory, all countries have some legal framework regulating commercial fishing activities. In practice, however subsistence, small-scale and sometimes recreational fisheries tend to be weakly regulated or unregulated.(cf. section 2.1.1). Ideally, national laws regulating fisheries should: (i) cover all the biodiversity elements (target and non-target species, overfished and threatened species, vulnerable habitats, etc.), including elements that might not also be covered by environmental conservation legislation; and (ii) aim to reduce non-compliance as much as possible through low-tolerance enforcement, fast and effective judicial processes, and deterrent penalties.

The complexity of reporting on this Target 6 requirement is discussed under IUU-fishing (section 2.1.1)

3.2.3 The ecosystem approach

The EAF/EBFM framework was addressed in section 2.2. For target species, the approach is intended to account for interactions between individual species in assessments and management. The practice has been increasing but is far from being the general rule. Related reporting aspects will be discussed in sections 5 and 6.

3.3 Example of outcomes on Target 6A

In this section, we look first at the actions taken by FAO member States and RFBs, as reported to COFI in 2016 (half-way through the current decade), based on their responses to the CCRF (FAO, 2016, 2016a) questionnaire. Percentages refer to the proportion of the 66 to 112 Parties that responded to some or all of the questions (sections 3.3.1 and 3.3.2). Examples of available information on the outcomes of these actions, aggregated at global level, are provided in sections 3.3.3 to 3.3.5

3.3.1 Responses of States to the CCRF questionnaire of 2015

- *Legislation*: 93 per cent of the responding members have legislation which conform fully (54 per cent) or partially (40 per cent) with the CCRF. Of the 7 per cent that do not conform, 74 per cent are planning to align their legislation with the CCRF. On average, 11 per cent of the respondents enacted their fishery legislation after 2010.
- *Policies*: 94 per cent of the respondents have a fishery policy aligned either fully (64 per cent) or partially (34 per cent) with the CCRF. Of the 6 per cent of the respondents that are not aligned, 80 per cent intend to have their policy aligned with the CCRF.
- *Governance*: 97 per cent of the respondents provide for stakeholder participation in determining decisions, and 98 per cent address the interests and rights of small-scale fisheries.
- *Stock assessment*: 83 per cent of respondents indicate that (in total) they assess 1627 stocks and that 41 to 50 per cent of key national stocks are addressed by reliable assessments.

- *Management plans*: About 82 per cent of the respondents have such plans in place. They are an important step towards implementation of legal obligations and policy decisions. More than 700 plans have been developed in total in the marine area (and 200 in inland waters), 90 per cent of which are effectively being implemented.

- *Control of fishing pressure*: 81 per cent of the respondents declared that they address fishing capacity issues and economic conditions of fishing operations. About 52 per cent of the respondents launched a programme to assess fishing capacity; 93 per cent ensure compliance with licensing systems; 90 per cent aim to ensure that the level of fishing is commensurate with the state of fisheries resources; 62 per cent claim to take steps to prevent further capacity build-up, but only 27 per cent implement a NPOA on Capacity.

A summary conclusion on these points is that the very large majority of countries seem to have taken steps in the right direction to enable sustainable fisheries, both in the legal, policy and management frameworks. Those who have not yet done so, expressed their willingness to proceed. The international instruments and guidance have, therefore, percolated down to the national fishery sector level and, to regulations for the fisheries themselves, at least those in which regulations are effectively enforced.

3.3.2 Responses of RFBs to the CCRF questionnaire of 2015

- *Stock assessment*: 20 out of 24 RFBs reported that reliable estimates of the status of a cumulative total of 273 stocks had been obtained within the last three years. Nine RFBs covered more than 80 per cent of their key stocks; six covered 40-60 per cent of key stocks; and two covered less than 40 per cent of them.

- *Target Reference Points (TRP)*: 15 RFBs (60 per cent of the respondents) have developed TRPs for a total of 109 stocks. Eleven of them report having reached TRPs for some stocks, and nine have exceeded them. Measures taken in this case were: Limiting fishing (most commonly); increased research; strengthening MCS; and continuously adjusting fishing capacity (least common). Also, catch and effort indicators were by far the most popular alternatives to the use of TRPs (applied by 78 per cent of RFBs not using TRPs).

- *Management plans*: 24 RFBs indicated that they had management plans with the following goals: (i) to control fishing pressure and protect endangered species (common); (ii) to allow depleted stocks to recover, prohibit destructive fishing methods and practices, and address selectivity (less common); and (iii) to address fishing capacity and the interests and rights of small-scale fishers (least common, and obviously more complicated to address or less relevant on the high seas). In inland fisheries the focus was on destructive fishing methods, biodiversity of aquatic habitats and ecosystems, and the rights of small-scale fishers.

- *Control and surveillance*: 68 per cent of the respondents reported that they ensured that fishing operations were in line with their management plans

- *Vessel monitoring systems (VMS)*: 22 per cent of responding RFBs implemented VMS for the entire fleet, and 48 per cent for only a portion of the fishing fleet. None reported implementation problems, and compliance was high (91 per cent of members in line with standards).

- *Other measures taken*: assessment of fishing capacity (38 per cent); publication of information material (33 per cent); and capacity building (33 per cent).

As with FAO member States, above, the conclusion is that the very large majority of RFBs consider that they have taken the expected action (within their different mandates)[26] for the management of their target species. It should be stressed that within RFBs, some organizations have a formal management mandate and can make binding decisions (the RFMOs) while the role of others is purely advisory and relates to capacity-building in terms of data collection, fishery science, stock assessment and management.

3.3.3 Trends in fishing pressure

Fishing pressure is a key driver of stock status and a useful indicator for the whole of Target 6, even though it is meaningful only when related to the pressure corresponding to MSY. The relationship of fishing pressure and stock status is not linear, however, and its relationship with the broader environmental impacts of fishing (the fishery “footprint”) is even more indirect and non-linear. For almost all fisheries, changes in fishing pressure can change the many different aspects of the fishery’s footprint on the ecosystem at different rates.

The global fleet is composed of a very large range of vessel types, from a one-person, non-motorized canoe using simple gear, to very large industrial factory ships, using very large-scale fishing gear, advanced positioning and detection devices (sonars, sounders, helicopters, planes and satellites) and on-board fish-processing facilities. The amount and efficiency of the technology available to these fishing units has very significantly increased with time. Moreover, any unit of fishing capacity (e.g., of gross tonnage, horsepower or kilowatts) or fishing effort (e.g., days-at-sea, trawling time, soaking time of gill nets or long lines) may result in a wide range of actual fishing mortality depending on species and areas. To make matters more complicated, the fishing mortality generated, on average, by each unit of fishing capacity or effort—the “catchability coefficient” tends to change with fish abundance, increasing as abundance decreases. Consequently, calculating global trends in actual fishing pressure since World War II and any change since 2010 is a challenge.

Nonetheless, it is very clear that global nominal fishing power increased very significantly from 1950 to the mid-1990s (Garcia and Newton, 1997). Just before the adoption of Target 6, it was estimated (combining various incomplete data series) that world fishing capacity was twice the amount necessary to take the present world catch (World Bank, 2009), and this capacity continued to increase until around 2010 (Bell, Watson and Ye, 2016).

[26] Many RFBs are not RFMOs, and their management competence is mainly advisory.

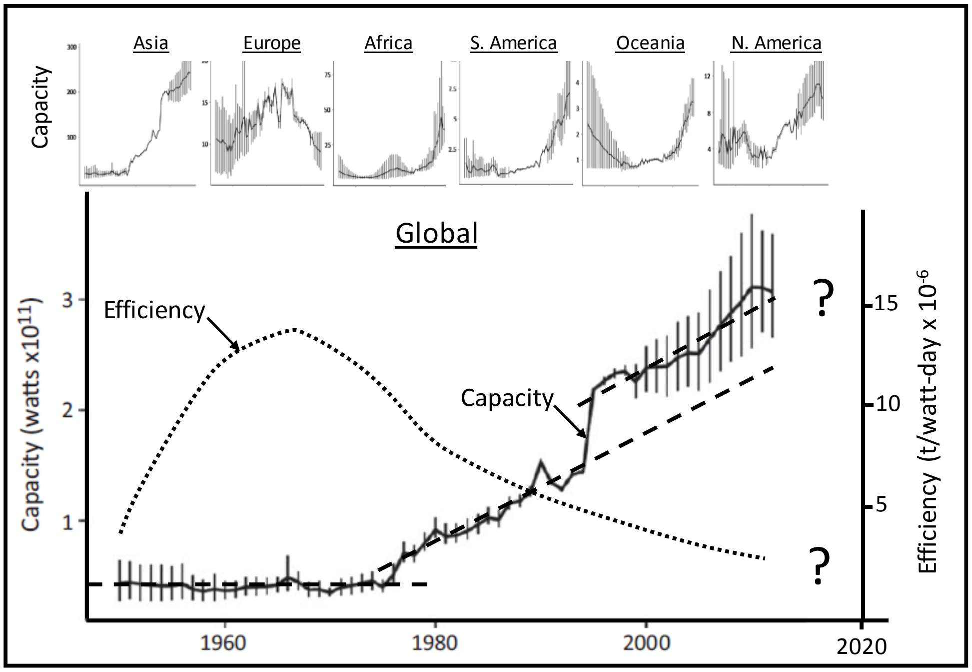

Figure 5. Global fishing capacity from 1950 to 2012.
The grey shading illustrates the 95 per cent confidence intervals. The capacity scales of the regional inserts are all very different and intended only to illustrate relative trends. The "jump" in capacity before 2000 is odd (see text). Constructed from Bell, Watson and Ye (2016).

The sharp "jump" in capacity around 1995, shown in Figure 5, if real, would represent a massive "instant" investment (for a global capacity increase of more than 50 per cent in two years) for which there is no supporting evidence. This means that the jump may be an artifact that reflects a change in the information content of the indicators used in the compilation, the methodology applied to construct them, or the national reporting practices**.** The global pattern, including this "anomaly", is imposed by the evolution in Asia, which has, by far, the largest fleet capacity and effort (and extends its impact worldwide). Fishing capacity has been increasing everywhere, except in Europe, where it has been decreasing since the mid-1990s, and the faint hints of decrease in some regions after 2010 (e.g., in North America and Oceania) may not be significant considering the variance observed in the indicators (cf. Figure 5). The evolution of global fishing effort (in watt-days of fishing) shows a similar pattern (Bell, Watson and Ye, 2016, Figure 2).

The average fishing efficiency of the global fleet (watt-days[27] of effort spent per tonne of fish officially landed) has also decreased since the late 1960s and was, in 2012, below what it was in 1950, reflecting the global decrease in catch per unit of effort that one should expect as fishing pressure increases up to (and sometimes beyond) the level corresponding to MSY. One interpretation of this trend is that efficiency increased during the fisheries expansion period as the accessible biomass increased faster through "discovery" of new stocks than it was depleted—until the stock's discovery phase was over.

Regardless of how approximate these data may be, they indicate a pervasive and increasing trend in fishing capacity. Updating this analysis after 2020 will provide a better assessment of achievements in managing capacity. Pending this, extrapolation of the 2000-2012 trends to 2020 would lead to concern as it would

[27] Multiplying the fishing capacity (measured by KW rating of the main engine) by the number of days fished

indicate that, globally, countries would likely fail to reduce the world overcapacity well described during the last three decades, despite success in areas that have made aggressive efforts to reduce over-capacity.

The worry is likely justified because reversing the trends of fishing capacity in developing countries to align it to stock productivity is likely to be challenging, with significant social, economic and hence political consequences, requiring national and/or international investments in stock rebuilding for compensation, support to vulnerable communities, creation of alternative livelihoods, etc. (Garcia et al., 2018).

3.3.4 Trends in certified fisheries

The number and proportion of world fisheries that are certified by the Marine Stewardship Council (MSC) are indicators of sustainable harvest. Almost 300 fisheries have been certified, representing about 12 per cent of world landings in 2017. However, the trends shown in Figure 6 need to be interpreted carefully. They do not indicate that fisheries are improving globally but that sustainability is an increasingly attractive argument for traders and probably consumers, hence, providing a growing incentive to improve the way they operate and to make this known to consumers through labelling. Many, if not most, of these fisheries have had to improve their practices to obtain the label and must work to keep it. According to the MSC, more than 1200 improvements have been made in certified fisheries since 2000, including reducing their impact on habitats, and over 20 per cent of the certified fisheries have made at least one improvement to their habitat management measures. Independent assessment has shown that MSC-certified stocks had stable high biomass levels as expected and that biomass levels had increased following certification (MSC, 2017).

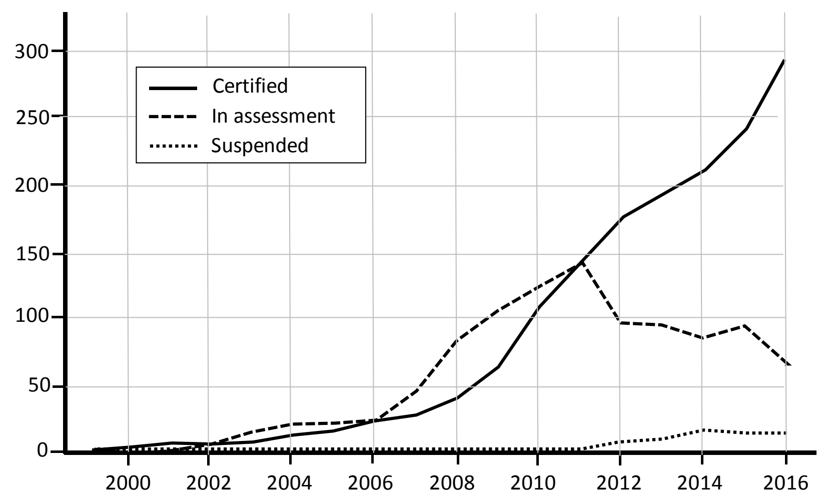

Figure 6: Number of fisheries certified, being assessed, or suspended by the Marine Stewardship Council 2000-2016 (Source: www.msc.org)

The MSC Principle 1 for all certified stocks is that they have a biomass target reference point equivalent to maximum sustainable yield (B_{MSY}) and strive to ensure stocks stay above or fluctuate around this target (due to natural variability). The Principle also requires that each certified stock has an identified biomass level below which the probability of impaired productivity may increase (e.g., B_{lim}), and that the stock is being maintained above that level with very high likelihood, similar to the boundary considered appropriate for the application of 6A or 6B. While assessments are as much as possible based on quantitative indicators, the MSC has also developed and, since 2009, applied a set of precautionary risk-based indicators for the assessment of datadeficient fisheries – the risk-based framework (RBF); 67 fisheries have been certified using the RBF to evaluate fishery impacts on either target or bycatch. Since 2008, with Principle 2, the MSC has been promoting ecosystem-based fishery management with a view to reduce the collateral impact of fishing (with special efforts on bycatch and VMEs) and to better account for the role of low-trophic-level species in the ecosystem. Certified fisheries are also required to ensure their impacts on marine habitats are sustainable, to have a strategy in place to manage these impacts, and to have sufficient understanding of the relevant habitats to underpin such management (MSC, 2017).

3.3.5 Status and trends in sustainably harvested stocks

a) *Global assessments*

Both conventional assessments (covering a small part of the world's resources) and analyses of catch trends (with much broader coverage) indicate a progressive increase in the number of overfished stocks and a parallel decrease in underfished stocks between 1950 and 2010 (Grainger and Garcia, 2005; Froese and Kesner-Reyes, 2002; Pauly et al., 2008; Worm et al., 2009; FAO, 2009; Garcia, 2009; Anderson et al., 2012). The global patterns were confirmed up to 2006 at the regional level for the Mediterranean, with earlier and sharper declines in the northern and western countries of that region, whose fisheries developed earlier and more intensively, and in higher-value demersal species compared to small pelagics (Garcia, 2011; Vasilakopoulos et al., 2014). Since 2010, assessment coverage has been improved by a series of comprehensive analyses using a combination of catch trends, population parameters and conventional fishery stock assessment approaches, while raising controversies as to the biases in these methodologies[28] (Costello, 2012; 2016; Thorson et al., 2012; Anderson et al., 2012; Martell and Froese, 2013; Rosenberg et al., 2014, 2016; Hilborn, 2017; Froese et al., 2018). While these assessments diverge (sometimes significantly, at stock or regional level), they tend to agree on general trends and indicate that the proportion of overfished stocks has continued to increase since 2010 (Figure 7), albeit at a slower rate since the 1990s, despite successful management and recovery in several leading nations (Costello et al., 2016; Hilborn, 2017). The state of global stocks in 2013 estimated respectively in FAO (2016) and Rosenberg et al., (2018), using FAO delimitation between stock categories (shown in Table 2), are similar (Table 4; Figure 8).

Table 4. Percentages of world stocks assessed as underfished (U), fully fished (F) and overfished (O) in 2013 according to FAO (2016) and Rosenberg et al., (2018)

	% of stocks by category				
Reference	U	F	O	<B_{MSY}	>B_{MSY}
FAO (2016)	11	58	31	-	-
Rosenberg et al., (2017)	17	53	30	53	47

Should depleted stocks be rebuilt and underfished ones be fished more intensively, it is estimated that 18 million more tonnes of food fish could be produced and perhaps 25 million more tonnes if IUU were eliminated, assuming that no IUU catch is in fact already reported[29] and that predator-prey interactions are sufficiently accounted for in calculations (Costello et al., 2016).

[28] Particularly between conventional stock assessment methods and catch-only methods, which allow some assessment to be made for poorly informed stocks.

[29] E.g., misreported as national catch in the flag State ports, transhipped at sea on a non IUU vessel, etc.

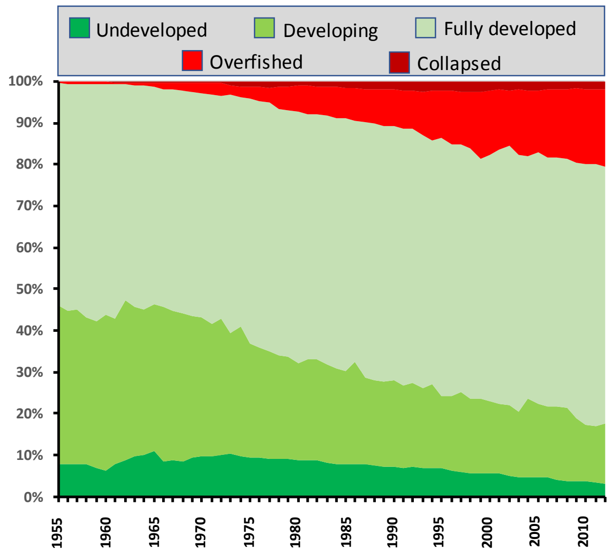

Figure 7: State of assessed stocks 1950-2012. Data by courtesy of Ray Hilborn (University of Washington) The stock status categories are defined as undeveloped (B/B_{MSY}>2.0); developing (B/B_{MSY} = 1.5 - 2.0); fully developed (B/B_{MSY} = 0.5 - 1.5); overfished (B/B_{MSY} = 0.2 - 0.5) and collapsed (B/B_{MSY}<0.2)

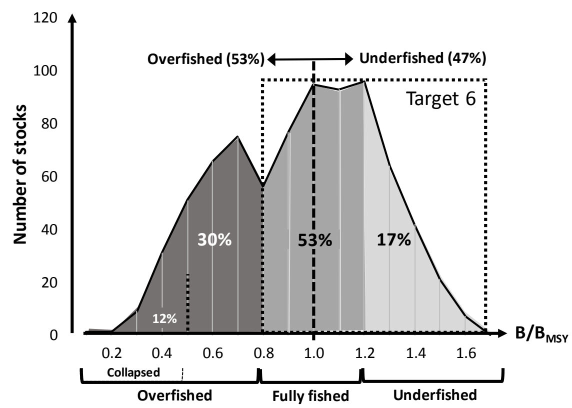

Figure 8. Global distribution of state of stocks in 2013.
The 12 per cent of collapsed stocks are included in the 30 per cent of overfished stocks. The stocks in the dotted rectangle are in line with Target 6. Modified from Garcia et al., (2018), based on data from Rosenberg et al., (2018).

The diagnosis on the state of stocks varies somewhat between authors according to data, assessment methods and reference values used to determine the stock status categories even though the overall situation and trends remain similar. Altogether, the state of the world stocks in 2013 was distributed around the international MSY standard (Hilborn, 2017; Rosenberg et al, 2018). However, the spread of values seen around B/B_{MSY} = 1 (e.g., Figure 8) reflects, in part, the variability inherent in the various assessments but also real differences in fishing pressure and management between stocks and regions.

For Target 6 reporting purposes, 69-70 per cent of the stocks appeared to be fully fished or underfished (i.e. sustainably harvested, at the beginning of the current decade (2010-2020)). However, Target 6 does not require that all stocks be above B_{MSY} level by 2020 but that management has reduced fishing pressure to allow increases of all stocks below B_{msy} and has implemented effective rebuilding plans for stocks that are depleted (below B_{lim}), possibly accounting for the fact that rebuilding may take some time to occur for many longer-lived species (See section 4). Consequently, it would be necessary to account for cases where all stocks are below B_{msy} but above B_{lim}, and with some form of harvest control ensuring a reduced exploitation rate, and for overfished stocks below B_{lim} that are under a formal rebuilding plan. These are not very numerous yet, and their accounting might not change this global figure (or any equivalent figure) very much, but particularly the former (use of harvest control rules for fluctuating stocks) is being adopted by many jurisdictions. Hence these reviews could be used as a baseline when measuring performance in relation to 6A, particularly if they can be augmented with national or regional information on harvest management rules for stocks below B_{msy}.

A strong concern is that the proportion of overfished stocks at the beginning of the current decade had been growing slowly but steadily. A note of caution is needed, as the number of stocks included in the annual assessments has increased continuously since 1974. The stocks being added were, in many cases, unassessed previously for lack of data, and their state tends to be worse than that of assessed stocks (Costello et al., 2012; Rosenberg et al., 2018). The continuous increase in the proportion of overfished stocks may be due, at least in part, to a progressively better accounting of previously unassessed stocks. This sampling bias would not reduce the value of the latest assessments as "best available estimates" but would imply that past levels of overfishing might have been underestimated.

The information on depleted and collapsed stocks is addressed in section 4.

b) *Regional assessments*

Global average statements about state and trends of stocks hide the large disparity between stocks (Figure 8) and regions (Figure 9) as well as socio-economic groupings[30] (Hilborn and Costello, 2018), and hence the case-specific implications for the actions needed to improve performance. The spread of values around the MSY reference indicates that more food might be extracted from the underfished stocks (with due regard to forage fish) and that significant efforts are needed to bring overfished stocks in line with international legal standards and policy commitments. On Figure 9, panels are organized in order of decreasing state of stocks as measured by the median value of their regional frequency distribution of B/B_{MSY} and hence of harvest sustainability (from top left to bottom right). Indian Ocean and Northwest Atlantic stocks appear as the least and most impacted, respectively. Slightly different classifications might emerge from different analyses[31] but the point is that regions differ, and global assessments are not particularly informative for regional, national and single-stock management.

[30] Costello et al., (2012) have shown that since the mid-1990s, well-assessed stocks in technologically advanced States have stopped declining on average and are slowly recovering, while the opposite is true for unassessed (and hence probably weakly managed) stocks, largely but not only in developing countries.

[31] For example, stocks have been declining in the Mediterranean over the past several decades as a result of excessive fishing and capture of immature fish (Vasilakopoulos et al., 2014). Historically, declines started in the North and are now observed also in the South (Smith and Garcia, 2014).

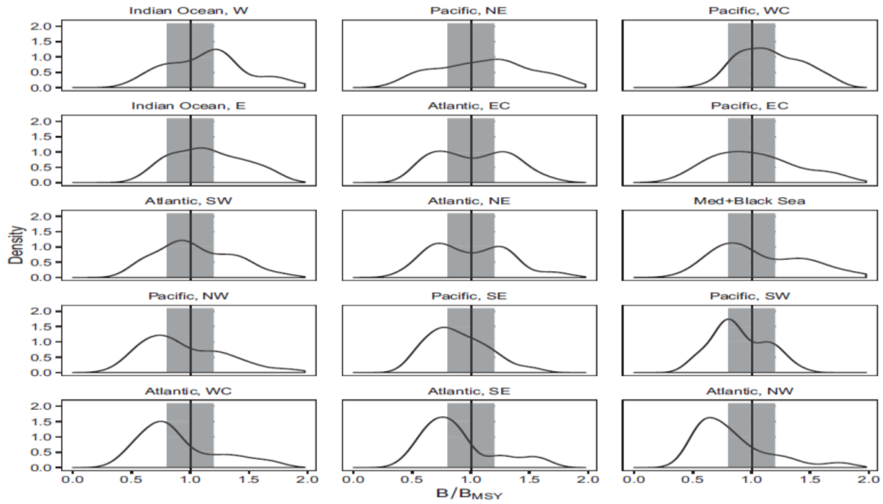

Figure 9. Regional distribution of *B*/*B*$_{MSY}$ status in 2013.
Black vertical lines indicate *B*/*B*$_{MSY}$ = 1. Shaded areas indicate ±20% around this point. The panels are organized in order of decreasing median *B*/*B*$_{MSY}$ and hence of harvest sustainability (from top left to bottom right). From Rosenberg et al., (2018). Courtesy of Conservation Letters.

Nonetheless, regional trends are also important to report, particularly where a large proportion of stocks are shared, as for example in the Northeast Atlantic, where stocks seem to have finally started to recover (Fernandez and Cook, 2013; Smith, 2013) or in the Mediterranean, where they have not (Vasilakopoulos et al., 2014). Of particular interest would be a comprehensive assessment of the state of stocks in marine areas beyond national jurisdiction (ABNJ), in particular deep-sea, tuna and tuna-like stocks. The most recent comprehensive review of highly migratory, straddling and other high seas stocks was conducted by Maguire et al., (2006) and needs substantial updating.

c) Tuna resources

Regarding tuna resources, which are regularly monitored by tuna RFMOs in charge of the different ocean areas and species, the International Sustainable Seafood Foundation (ISSF) has compiled global information that can be disaggregated by species and region since 2011[32] and is therefore directly relevant to Target 6. The state of tuna stocks is referred to as (1) healthy (B>B_{MSY} and F<F_{MSY}); (2) intermediate (B<B_{MSY} but stable or improving and F>F_{MSY} but adequately managed) and (3) needing improvement (B<BSMY, decreasing; F>FMSY, not properly managed). The trends during the current decade (2011-2018) are provided in Figure 10.

[32] Accessible at https://iss-foundation.org/about-tuna/status-of-the-stocks/interactive-stock-status-tool/.

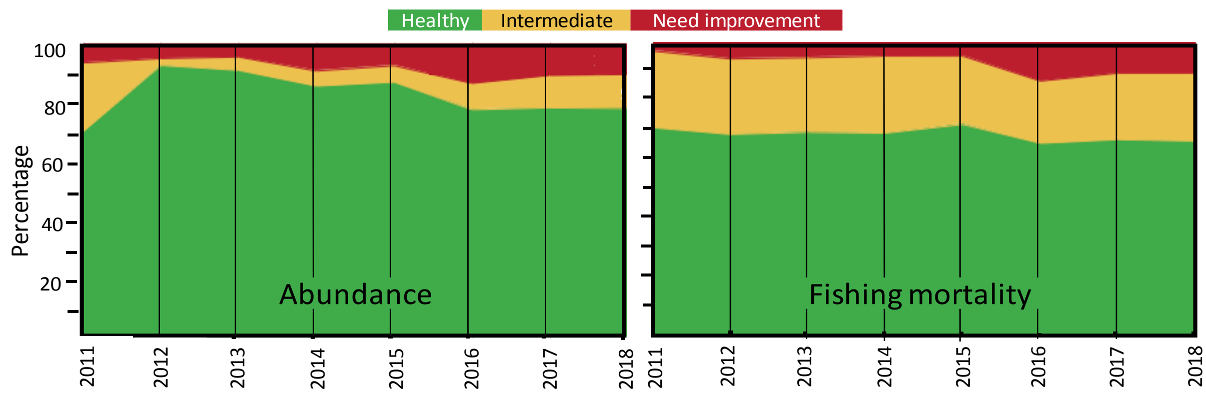

Figure 10. State of world tuna stocks 2011-2018.
Source: ISSF website interactive stock status tool, accessed 12/04/2018 at https://iss-foundation.org/about-tuna/status-of-the-stocks/interactive-stock-status-tool/

Figure 10 indicates a decrease in healthy tuna stocks, an increase of stocks in intermediate state and a stable proportion of stocks in need of improvement. In 2016, 57 per cent of the stocks were considered healthy, 30 per cent at intermediate level, and 13 per cent actively overfished ($B<B_{MSY}$, not improving). In terms of fishing pressure, 65 per cent of the stocks are experiencing a low fishing mortality rate ($F<F_{MSY}$), 22 per cent have a high fishing mortality ($F>F_{MSY}$) that is being managed adequately and 13 per cent are experiencing active overfishing ($F>F_{MSY)}$, not properly managed (ISSF, 2018). According to the international standards identified in section 1.1.1**,** these categories correspond to stocks that are (1) underfished, (2) overfished but rebuilding and (3) under active and worsening overfishing.

In terms of Target 6, the stocks considered to be sustainably fished are the healthy ones and the portion of the intermediate ones that are equipped with an effectively implemented rebuilding plan. As this assessment is the timeliest available, it is unlikely to change much in the near term, and it would be very urgent to demonstrate that such rebuilding plans are in place.

d) *Outlook*

Most of the data above refer, at best, to 2013, near the beginning of the Target 6 period. It is clear that there are significant delays between changes in the fisheries and the assessments of their consequences. The only international institution producing regular comprehensive reports on the state of stocks at the global level is FAO, whose report on the State of World Fisheries and Aquaculture, issued every two years, contains data with time lags of about two-to-three years. For example, the 2018 version will cover data available up to 2015, and the 2020 version will cover data up to 2017. The International Council for the Exploration of the Sea (ICES) advises its constituencies every year, but the last synthesis (e.g., the 2018 advice for the Greater North Sea Region)[33] only contains data until 2015. The delay has to do with the collection of statistics at national level, the stock assessment process, the transfer of information, control and compilation at global level and the analysis of this compilation. The implication is that the global community may have to wait until 2023 to find out, in quantitative terms, to what degree Target 6 was reached.

The problem might be mitigated, accepting some risk, by projections based on available data and a few assumptions about the future, recognizing that they need to be taken "with a grain of salt" and are not

[33] Available at http://www.ices.dk/community/advisory-process/Pages/fisheries-overviews.aspx

predictions. Figure 11 indicates the trend in state of stocks according to FAO data from 1974 to 2013 and using FAO categories.

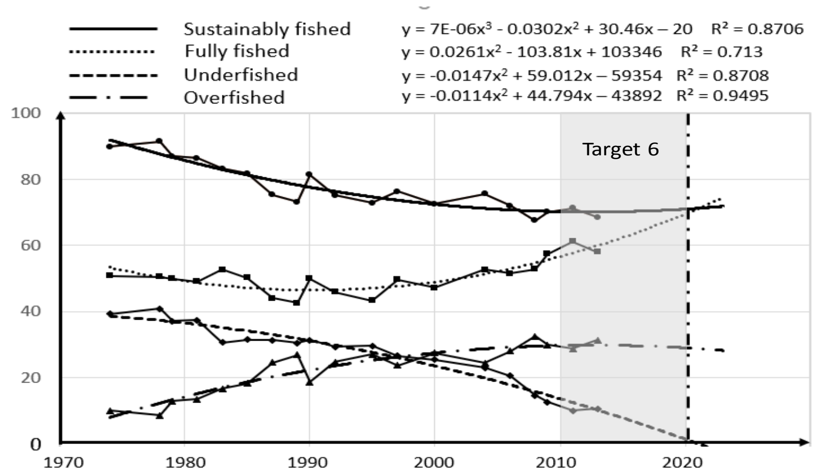

Figure 11. Proportion of sustainably fished stocks (= fully fished + underfished) from 1974 to 2013 and trend extrapolation to 2020. The current Target 6 decade is shaded. Data 1974-2013 courtesy of FAO.

The trend (order 2 or 3 polynomial function) is extrapolated to 2020 as an educated approximation for a possible situation at the end of the current Target 6 decade, if global fisheries continue to evolve in the same way as in the past. In this scenario, no more underfished stocks exist, and fully fished stocks increase to about 70 per cent. In terms of Target 6, sustainably harvested stocks would stabilize at least at 70 per cent, and fully fished and underfished stocks but would also need to include stocks with formal rebuilding plans in place. Overfished stocks would remain at about 30 per cent.

Figure 12 presents a set of projections (Costello et al., ,2016) from 2013 onwards according to three different management policies regarding rebuilding: (1) RBFM: a rights-based fisheries management in which economic efficiency (rent extraction) is maximized in all stocks; (2) F_{MSY}: a strategy in which all overfished stocks and those currently well managed are maintained around their individual MSY level to maximize catch, probably optimizing fishery employment and livelihoods at the same time; and (3) BAU: A business-as-usual strategy in which currently well managed stocks continue to be managed in the same way, and poorly managed stocks (in which fishing pressure is not limited) decline significantly following past trends.

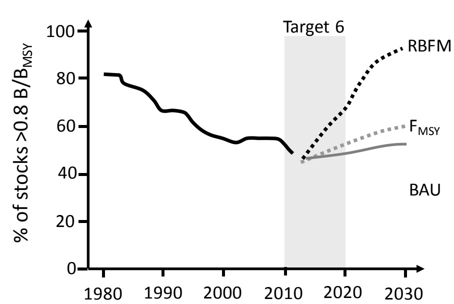

Figure 12: Projected trajectories of the global proportion of sustainably fished stocks ($B>0.8B/B_{MSY}$) according to different policy scenarios. RBFM = Economic optimization policy. F_{MSY} = Biological optimization policy. BAU = business-as-usual with presently well maintained fisheries maintained as such, and other fisheries declining under poor or no management. Modified and redrawn from Costello et al., (2016). The Target 6 decade is indicated to signal that large uncertainties still exist about the likely situation in 2020.

The business-as-usual scenario in Figure 12 is more pessimistic than our simple extrapolation in Figure 11. However, a homogenous global evolution is most unlikely, and differences in policies and strategies between different socioeconomic systems are to be expected. It is unlikely that States in which fisheries are declining will remain inactive, however. If advocacy for improved management continues and assistance is provided, some progress towards Target 6 elements can be expected, particularly if governance improves and the private sector gets more involved in management decision-making. This progress will not happen immediately, and current political instability, low research capacity and weak governance might not be resolved by 2020, if the past is of any use to predict the future.

4 Target 6B – Depleted target and non-target species

4.1 Rationale

Element 6B indicates that "recovery plans and measures are in place for all depleted species". Extending element 6A, it also deals with target stocks but focuses on those stocks that management failed to harvest sustainably. Although element 6A refers specifically to fish and invertebrate stocks (and aquatic plants), reflecting the focus on targeted stocks, element 6B applies to all species impacted directly by fishing. Recognizing implicitly that effective recovery takes time, element 6B requires that rebuilding plans be in place and not that the species be already fully recovered by 2020. However, elements of that can signify progress to full recovery (e.g., intermediate milestones) would be useful, and the rebuilding strategy may indicate a mandatory maximum allowable time within which the species should be rebuilt (Garcia et al., 2018).

The term "recovery plans" is not defined. In fisheries, the term "rebuilding plan" refers to a management plan elaborated to rebuild a stock when the measure of its status (e.g., its biomass) is below the (biomass) limit reference point (i.e., it is assessed as overfished) and which specifies rebuilding targets, time horizons and control rules (https://iphc.int/the-commission/glossary-of-terms-and-abbreviations). Rarely have these requirements been generalized to non-target species, however, and the authors found no widely used standards for rebuilding or recovery plans of depleted non-target species that have not been designated as "threatened" (6C).

The important scope of this element cannot be over-emphasized. While a core purpose of fishery management is to avoid overfishing (as per Target 6A), its performance in that respect has been mixed, and about 30 per cent of stocks were overfished in 2013 (Figure 8; FAO, 2016d; Costello et al, 2016). Results tend to appear worse in regions where poorly informed data and catch-only assessment, as well as weak governance, are prevalent (Froese et al., 2018). Following the standards and correspondence described in sections 1.1.1 and 1.1.2, the term "depleted" covers both targeted stocks that have been seriously overfished in the past ($B<B_{lim}$) and now still experience some fishing pressure through bycatch or active directed fishing, and any non-target species that, through excessive mortality (whether largely from fisheries bycatch or not), whose abundance has been reduced to a level where productivity may be impaired, and is currently exposed to fishing mortality. Maintaining and restoring resources that have been inadvertently (or intentionally) overfished/depleted and may have collapsed is an obligation under UNCLOS, for all resources, target or non-target, and under the CBD for biodiversity in general. This obligation has usually been implicit in normal fishery management plans that formally aim to avoid overfishing of target species and has become more and more explicit in States' commitments and actions as fishing pressure and the proportion of poorly managed resources have increased, and the need for an ecosystem approach has become more widely recognized.

The specific focus on mandatory rebuilding plans for severely depleted target stocks started to increase in the 1990s and increased more rapidly in the 2000s (Garcia et al., 2018), although the rebuilding of depleted non-target species (other than highly charismatic megafauna) has received far less attention—even less than vulnerable habitats (section 5) or impacted ecosystems (section 6). When stocks are lightly overfished, stock increases may be undertaken under the "ordinary" management plan (e.g., using a harvest control rule to semi-automatically correct fishing pressure to return to the target management level). These cases are not considered “depleted”.

When targeted stocks are depleted, a special management regime should be put in place that formally indicates: (i) the minimum level of biomass (e.g., B_{lim}) below which the rebuilding plan is in force; (ii) the level of biomass (and other considerations of structure) at which the rebuilding phase will be formally considered completed and the ordinary management plan resumes; (iii) the measures being put in place, in addition to, or replacement of, the ordinary management regime; (iv) the trajectory expected for fishing pressure and resource parameters during the rebuilding process (i.e., the trajectory); and (v) the maximum time allowed for rebuilding (depending on the species concerned) with an acceptable level of probability. Under Target 6B, such measures should be supported by legislation and regulations, and ideally become mandatory. Importantly, since 6B explicitly applies to all species, 6B also requires that non-target species taken as bycatch be evaluated at appropriate intervals (see section 5) and, if found to be depleted relative to reference levels comparable to B_{lim} for target species, also be covered by such special regimes.

4.2 Key concepts and indicators

4.2.1 <u>Concepts</u>

Following the framework described in sections 1.1.1 and 1.1.2 and in Table 2, we consider here that in the case of targeted species, the term “depleted species” refers to stocks with $B < B_{lim}$, or stocks with $B/B_{MSY} < 1$ and either a lack of provisions in their management plan for reducing F or a lack of evidence that such a reduction is occurring. Stocks below B_{msy} require effective measures to increase biomass, either integrated in the “ordinary” management plan, or part of a special rebuilding plan and regime. Stocks with B/B_{MSY} below 0.5 (below B_{lim}), and particularly below 0.2 (collapsed), may require mandatory rebuilding plans. “Collapsed″ stocks are not distinguished from “depleted″ species in Target 6 but they may require different, more drastic, measures than less depleted species.

For non-target species, it is rare that values of B_{msy}, B_{lim} or other fisheries reference points will have been estimated, and not even common that their status is assessed regularly. One of the new challenges to fisheries in Target 6 was that they were directly accountable for depletion of non-target species, even though that was implicit with the provisions in UNCLOS, with the inclusion of “associated and dependent species”, and in the adoption of the ecosystem approach (Garcia et al., 2003). Where no efforts are made to monitor and assess the status of non-target species taken as bycatch, it will difficult or not possible to report positive outcomes on this aspect of Target 6.

An exception to that generalization is for some groups of megafauna with particularly vulnerable life histories, such as seabirds, marine reptiles and elasmobranchs. For these groups, FAO has led efforts to develop International and National Plans of Action (IPOAs and NPOAs) for the larger species groups (FAO 2002). Because these were developed out of concern for multiple species in those taxa that were considered threatened, the IPOAs/NPOAs are dealt with in section 5. However, in cases where effective IPOAs or NPOAs are in place, *depleted* non-target species in these taxa should be covered by appropriate provisions. Because the IPOA guidance is for plans sufficient to protect and allow recovery of species that are considered threatened, they should be sufficient for all depleted species to which they are applied as well, provided they are designed and implemented effectively.

For other non-target species, some rough benchmarks could be of assistance. Simulations have indicated that for a wide range of life histories, reductions of a population below 30 per cent of unexploited biomass (0.3 B_0) begin to increase the risk of impaired productivity (Restrepo et al., 1998), although for particularly highly productive species (maturation by the age of two, possibility to produce strong recruitments under favourable environmental conditions) this can be as low as 20 per cent. However, this robust but general benchmark of 0.3 B_0 for a depleted non-target species still requires that (i) the species composition and amount of bycatch be monitored, (ii) some estimate of unexploited biomass of the species has been developed, and (iii) either bycatch limits to keep fisheries impact from reducing the population to below $0.3B_0$ or that status of the major non-target bycatch species is assessed periodically against this benchmark. Target 6 element 6B also requires that recovery plans are developed and implemented for non-target species if they are depleted.

4.2.2 Indicators

The indicators could provide evidence of rebuilding efforts, such as adoption of specific laws, policies, goals, plans and measures. Such efforts may not always be easily distinguished from general reforms of the fishery system. There are relatively few countries in which such special efforts are made to deal explicitly with excessive depletion, requiring mandatory rebuilding plans with reinforced conservation measures (e.g., United States of America, Australia, New Zealand). In the European Union, the mandatory multi-annual plans have similar characteristics when they: (i) provide a detailed and tailor-made roadmap for achieving their objective; (ii) include fishing effort restrictions in addition to total allowable catches and specific control rules; (iii) set the target of fishing at maximum sustainable yield and a deadline for achieving this target; and (iv) safeguards for remedial action and review clauses[34]. Evidence of rebuilding efforts and plans is probably less often available for non-target than target depleted species but, when available, would be similar. Recovery plans for non-target species might be separate from those for target species or might take the form of extra provisions in the management plans of fisheries that contributed to the depletion.

Evidence of rebuilding outcomes tends to refer to trends in fishing mortality and stock biomass. Evidence of improvements in other dimensions – such as stock size, age structure, spawning biomass, spatial distribution and migration – is still rarely mentioned despite the importance of these factors. Moreover, evidence of rebuilding outcomes is likely to be part of the regular stock-assessment reporting for target species, but, in the case of non-target species, would require special assessment and reporting. Rebuilding programmes usually need a strong socio-economic component to assist communities in facing the added cost of rebuilding, but these aspects are not foreseen explicitly in Target 6, despite the fact that these are not only necessary conditions of success but also, often, explicit expected outcomes.

Global indicators for depleted target species may include:

- The number of States that have adopted specific rebuilding laws, policies and plans or are in the process of doing so. This would show progress in interest and intentions;
- The number of stocks identified as currently depleted. Trends in that indicator may reflect a trend in the state of the resource complex but also a trend in the capacity of the local research to detect such stocks in that resource complex;
- The percentage of stocks identified as currently depleted that are covered by a rebuilding plan. Ideally 100 per cent of the stocks identified as depleted should be covered by a plan, or be under pressure to develop one a specified time frame (e.g., within two years of their identification as depleted); and
- The number or percentage of depleted stocks that have recovered. A high percentage may reflect good recovery or poor detection performance.

[34] https://ec.europa.eu/fisheries/cfp/fishing_rules/multi_annual_plans

For depleted non-target species, all these global indicators would also be relevant if available, although they are often not available. For the groups of vulnerable species covered with IPOAs and NPOAs, reporting guidance is presented in 5.3.1. Otherwise, reporting should include at least the extent to which bycatch is being monitored with sufficient accuracy and precision to detect trends in catch of non-target species. This information is assessed periodically against depletion benchmarks in order to indicate progress on this aspect of Target 6. Reporting on cases when recovery plans are developed and implemented for depleted non-target species would be particularly noteworthy when such plans exist.

4.3 Examples of outcomes on Target 6B

Some outcomes on responses to the CCRF questionnaire for Target 6A are also relevant here as they would help to maintain stocks in a sustainably harvested category but would also help with recovery of depleted resources. Indeed, measures to continuously adjust fishing effort and removals to the state of stocks, which are central to Target 6A, are also useful in reducing the probability of having depleted or collapsed stocks. The same can be said of efforts to improve MCS systems and combat IUU-fishing (section 2.1), which are relevant even if not repeated below. The fact that some stocks are depleted indicates, however, that the existing measures of the ordinary management plan are not always sufficient. In such cases, it may be necessary to (i) raise the level of control and the quality of enforcement (thereby usually increasing the related costs) on depleted stocks and/or (ii) introduce new measures, affecting research (e.g., introduction of management strategy evaluation, MSE), management (e.g., real-time closures to protect recruitment), landings (e.g., checking the scales used to control landed weight) and trade. This is true and more often necessary for depleted non-target species than for target species, in cases when fisheries are contributing to their depletion.

4.3.1 <u>Responses from Parties to the CCRF questionnaire of 2015 regarding target species</u>

- Recovery plans: 87 per cent of the respondents have plans to allow depleted stocks to recover.
- Use of TRPs: 72 per cent of the respondents use stock-specific TRPs.
- Response to depletion: When TRPs are exceeded, 95 per cent of the 85 respondents limit fishing effort; 95 per cent increase research effort; 80 per cent strengthen MCS; 68 per cent adjust fishing capacity; and 68 per cent close affected fisheries.

4.3.2 <u>Responses from RFBs to the CCRF questionnaire of 2015 regarding target species</u>

- According to the 24 respondents to the CCRF questionnaire section concerning marine capture fisheries, most management plans include measures to maintain a level of fishing commensurate with the state of fisheries resources and, to a lesser degree, measures to allow depleted stocks to recover.

The wording seems to indicate that specific rebuilding plans (that specify not only a rebuilding target but also a deadline for rebuilding with a given probability) are not widely used. The questionnaire results indicate that most RFBs use target and limit reference points (TRPs and LRPs) and many use HCRs as part of their “ordinary management”. Indeed, many RFMOs (e.g., some tuna RFMOs, the International Pacific Halibut Commission – IPHC) use management procedures or HCRs that specify limit and TRPs in an attempt to avoid overfishing or rebuild overfished stocks. Typically, these are extended, and measures made even more stringent when the targeted species reach levels considered “depleted”, consistent with the intent of Target 6B. For example:

- The Commission for the Conservation of Southern Bluefin Tuna uses a management procedure that fixes a level of rebuilding and a time frame for it (2011 Bali procedure) for the southern bluefin tuna. Management aims to ensure a 70 per cent probability of rebuilding the stock to the interim rebuilding

TRP of 20 per cent of the original spawning stock biomass by 2035 (https://www.ccsbt.org/en/content/management-procedure).

- The Inter-American Tropical Tuna Commission (IATTC) uses Harvest Control Rules (HCRs) and Target Reference Points (TRPs), and avoids the Limit Reference Points (LRPs) for yellowfin, bigeye and skipjack tuna, but no specific action is designed to rebuild the stock in case of depletion well below the LRP (https://www.iattc.org/ResolutionsActiveENG.htm).
- The International Commission for the Conservation of Atlantic Tunas has been considering adopting HCRs for its main tuna species. A 15-year (2017-2031) recovery plan was adopted for the swordfish (*Xyphias gladius*) in the Mediterranean, with the goal of achieving B_{MSY} with at least 60 per cent probability. For the western bluefin tuna (*Thunnus Thynnus*) the rebuilding plan specifies the annual total allowable catch, the MSY target, and the 20-year rebuilding period that may be on the advice of the scientific committee (ICCAT, 2017).
- The Western and Central Pacific Fisheries Commission (WCPFC) decided in 2015 to develop or refine harvest strategies and reference points for skipjack, bigeye, yellowfin, South Pacific albacore and Pacific bluefin, including TRPs corresponding to appropriate levels of risk, a monitoring strategy, harvest control rules and recurrent evaluation of the strategies. Action seems to be ongoing (https://www.wcpfc.int/doc/supplcmm-2015-04/updated-workplan-harvest-strategies-2016-2019-and-record-outcomes-wcpfc13).
- The Northwest Atlantic Fisheries Organization (NAFO) has established recovery plans for cod (in the 3N and 3O Divisions) and American plaice (in Divisions 3L, 3N and 3O) (https://www.nafo.int/About-us), which call for rebuilding at B_{MSY}, with interim milestones, TRPs, LRPs for fishing mortality, rules for re-opening the direct fishery, and HCRs (NAFO, 2018). None of these RFMOs have recovery plans for depleted non-target species or processes that ensure that the status of non-target species is evaluated against relevant reference points, suggesting that the "species" aspect of Target 6B is treated incompletely.

When species straddle the geographical jurisdiction of different RFBs, there may be significant problems of coordination to ensure the application of the compatibility principle of the UNFSA. An example is the management of bluefin tuna in the Pacific between IATTC and WCPFC.

4.3.3 Status, trends and outlook in overfished target stocks

Some global information was offered in section 3. Table 4 and Figure 8 indicate that in 2013, about 30 per cent of world stocks were overfished, 12 per cent of which were collapsed stocks, most of the latter likely to be depleted, as intended by Target 6. Figure 10 indicates that 43 per cent of tuna stocks appeared overfished in 2018, and although the proportion of those overfished stocks that are depleted is not indicated separately, overall three-quarters of them of them are under management deemed adequate for recovery (often without defined time frame).

In terms of outlook, the lack of globally consistent use of LRPs for stocks means that many of the information sources do not differentiate stocks that are overfished from stocks that would be considered depleted. Consequently, inferences about outlook for depleted target species must be drawn from the information on overfished stocks. Figure 11 illustrated the growing trend in the proportion of overfished stocks status from 1974 to 2013 according to FAO data (FAO 2016e). For all overfished stocks, this figure shows the slowing of that increase since the 1990s and the potential stabilization from 2013 to 2020 in a simple statistical extrapolation (see Figure 13). With depleted stocks usually already having been overfished for some years, the stabilization and possible decrease in proportion of overfished stocks suggests the proportion of depleted stocks has also stabilized and possibly decreased even more. To the extent this is the case, the provisions in these fishery management plans must be sufficient to promote stabilization and commence recovery of the stocks, meeting the expectation of Target 6B.

More detailed projections (Costello et al., 2016) indicate a continuous degradation of stocks in the case of a business-as-usual scenario, in which some States and fleets continue to overexploit stocks, or a stock improvement if fisheries are reformed, to an extent depending on the objectives (higher if aiming at maximum economic rent, and lower if aiming at optimal production and livelihoods).

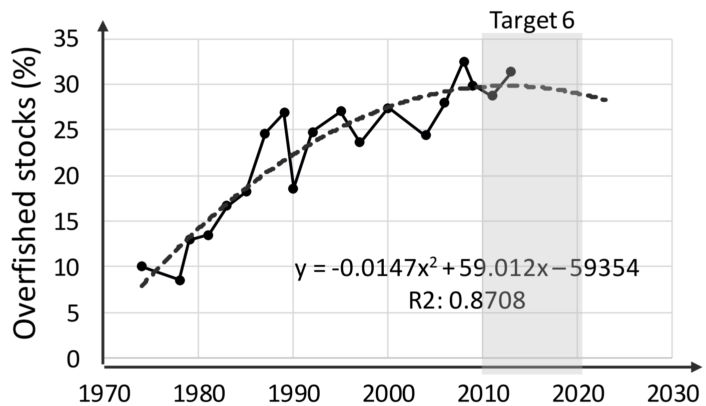

Figure 13. Trends in the proportion of overfished stocks (B/B_{MSY} <0.8) from 1974 to 2013. Data from FAO (2016e) with trend extrapolated to 2020.

4.3.4 <u>Status and trends in collapsed stocks (threatened by fishing)</u>

Collapsed stocks are the most likely to be considered depleted stocks in the sense of Target 6B. In fisheries, they are conventionally estimated to have B/B_{MSY} ratio below 0.2 and therefore likely to be below the generic 30 per cent B_0 benchmark for depletion. There is little information on global trends in the proportion of collapsed stocks. Collapses have been part of the natural history of many ocean populations, particularly of small pelagic species, even in the absence of fishing. Modern fisheries have both suffered as a result of, and certainly contributed to, many collapses. The frequency of stock collapses has been estimated at different times in different ways, varying from 9 to 36 per cent, depending on data, methods and reference level used to define the category (Garcia et al., 2018). The highest values, obtained from catch-only assessments, have been considered overestimated when compared to values obtained for the same stocks with more comprehensive assessments (Branch et al., 2011; Costello et al., 2012). More comprehensive assessments, combining catch and population data, indicated that the proportion of collapsed stocks increased from close to zero in the 1950s (following the interruption of fishing during World War II) to about 5 per cent from the 1960s to the 1980s and increased rapidly after 1990 to almost 15 per cent in 2007 (Worm et al., 2009; Branch et al., 2011). Analysing catch data, Mullon et al., (2005) describe an increase in the number of collapses from 1950 to the mid-1990s and a decrease afterwards. A similar trend is described by Hilborn (2018) using stock assessment data (Figure 714) showing a decrease after 2000. This timing would be consistent with, but not direct evidence of, fisheries management plans adopting adequate measures for stock recovery, as expected for plans consistent with the CCRF and required under Target 6B. However, in the latter analysis, the overall proportion of collapsed stocks is very much lower than in any other analysis, at all times, and should be considered with caution. The data from well-assessed stocks contained in the RAM Legacy Stock Assessment Database (http://ramlegacy.org/) (Figure 14) show an increase from the 1960s to the 1990s, to more than 8 per cent and a decline after 1995, possibly reflecting the trends in management quality in States with high-management capacity and the impact of the CCRF guidance mentioned above. The abrupt, deep decline in the 2010s would indicate a positive trend at the beginning of the current decade, which would need to be confirmed with a longer time series. In addition, the proportions are likely to be higher and trends less positive in regions with weaker governance and poorly assessed stocks.

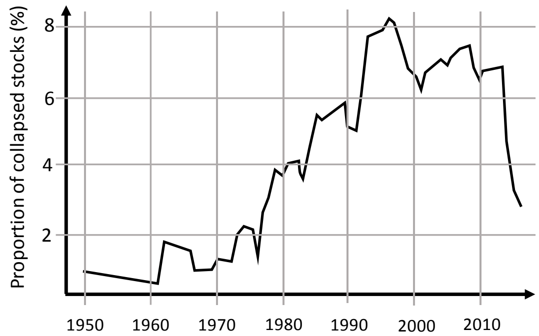

Figure 14. Proportion of collapsed stocks in the assessed stocks of the RAM Legacy database (data courtesy of R. Hilborn). The decline in the proportion of collapsed stocks starts in the mid-1990s. The very sharp decrease in the 2010s would need to be confirmed with a longer data series.

4.3.5 <u>Status and trends in stocks rebuilding</u>

The proportion of overfished and depleted stocks (section 4.3.3) is related to the increase in fishing pressure but also to the proportion of stocks that are (being) effectively rebuilt. Trends in formal rebuilding would also be useful information in relation to Target 6, both in terms of action and outcomes. Actions are easily seen, including by evaluating the terms of any existing formal rebuilding plans. Interim outcomes, such as reduced fleet size and fishing effort, are also easily quantifiable. Measuring outcomes of actions on the water, however, may be more problematic for various reasons.

- Data may be missing if the fishery has been legally closed during the rebuilding process or is commercially extinct;
- Trends in fishery-dependent abundance data (CPUEs) may be biased by changes in catchability as stocks increase;
- Increases in biomass indices may be a poor measure of rebuilding of the stock reproduction potential as the age structure, geographical distribution, and migration processes may still be impaired, and
- The relation between the management action and the observed stock reaction may be complex, with distortions due external drivers (e.g., climate);
- The stocks in quadrant II of Figure 1C are overfished, and even if they are no longer being actively overfished (and possibly slowly “self-rebuilding”) they may not be covered by a formal recovery plan.

The authors have not found any comprehensive global statistic on rebuilding of depleted target stocks and only isolated cases of the rebuilding of depleted non-target species other than those covered by IPOAs and NPOAs and presented in section 5. Nonetheless, after several years of debate on whether or not it is possible to rebuild depleted stocks, it is now established that rebuilding of depleted stocks for which decisive rebuilding measures—particularly those intended to reduce significantly fishing pressure—had been taken and effectively enforced, has indeed occurred, over a period of time and at a rate that might not have been easily predicted at the onset of the process. It is also clear that the more severe the depletion, the less predictable these two parameters (Costello et al., 2016; Garcia et al., 2018).

a) *Regional assessments*

At regional level, rebuilding policies are complicated by jurisdictional issues. Regional issues were examined under section 4.3.2, in the context of actions taken by RFBs.

Improvements in European waters started becoming obvious at the beginning of the 2010s, following reductions of up to 50 per cent in fishing mortality (Fernandes and Cook, 2013; Cardinale, et al., 2013; Gascuel et al., 2016). Biomass started to improve in 77 per cent of the stocks assessed, the majority of which were considered to be fished sustainably (i.e., at an appropriate level of fishing pressure) despite the low level of biomass. Biomass levels remained low, in part because recruitment decreased during the period concerned for unknown reasons, and because the decrease in fishing mortality might not have been sufficient—or was still too recent—to show a clear rebuilding in terms of recruitment, species composition and trophic biodiversity (Fernandes and Cook, 2013; Collie et al., 2013; Gascuel et al., 2016). The recent catch-only assessments (from 2000 to 2017) are more negative in parts of the Atlantic Ocean and the Mediterranean (Froese et al., 2018).

The rebuilding efforts for North Atlantic salmon is an example of rebuilding failure, despite the very stringent measures taken at sea and in riverine fisheries. In the southern parts of the North Atlantic, most populations are at low level of biomass, declining at intermediate latitudes and stable in the North. While the declines could be attributed to the construction of dams, pollution (including acid rain), drying up of freshwater streams, along with overfishing, and recently, changing ocean conditions and intensive aquaculture, they cannot be fully explained (ICES, 2014: Table 10.1.8.3).

Another high-profile example of rebuilding "failure" is that of the Southern Bluefin Tuna (SBT) in the Southern Ocean. The stock is at an extremely low level and the present rebuilding strategy has a 70 per cent probability of reaching the interim rebuilding TRP of 0.2 B_0 by 2035.

In 2010, NAFO developed a special Working Group of Fishery Managers and Scientists on Conservation Plans and Rebuilding Strategies with the aim of reviewing and updating such plans and strategies and considering risk management approaches. The Southern Grand Bank cod is still in a state of weak initial rebuilding (still under moratorium since 2014). The Grand Bank and Flemish cap American plaice stocks, under moratorium since 1995 but still taken as bycatch, have slightly improved in recent years. In 2016, the Grand Bank stock was recovering slowly but was still well below its precautionary reference level. The witch flounder was recovering slowly in 2016 under reduced fishing pressure, but not enough to resume direct fishing. However, the redfish stock on the northern Grand Bank has recovered significantly from depletion and is now considered to be well above the level that can produce maximum sustainable yield.

b) *National assessments*

There are still very few analyses (and time series) on national rebuilding efforts and their outcomes. Case studies have become available since 2010 on single fisheries (Holland, 2010; Khwaja and Cox, 2010; OECD, 2012; Garcia and Ye, 2018), and a few States (e.g., United States of America[35], Australia[36]) dedicate sections of their websites to their rebuilding efforts. However, annual publication of the state of national stocks is not yet common practice. Some examples follow.

In Australia, 14 out of the 20 stocks identified as overfished were still in need of recovery in recent years, and two had recovered. Between 2005 and 2010, the proportion of overfished stocks was reduced from 40 per cent to 10 per cent, and the proportion of non-overfished stocks grew from 60 to 84 per cent, illustrating the fact that with good management stocks can and do rebuild (OECD, 2012; Kearney et al., 2013).

In the USA, in 2006, the Congress passed amendments to the Magnuson-Stevens Fishery Act, which required fishery managers to rebuild depleted populations of marine fish to mandatory levels. At that time, 63 stocks required rebuilding, 52 were under formal rebuilding plans and 14 had recovered since the beginning of the

[35] http://www.fisheries.noaa.gov/sfa/fisheries_eco/status_of_fisheries/index.html

[36] http://www.afma.gov.au/sustainability-environment/protected-species-management-strategies/

rebuilding programme (Wakeford et al., 2007). Most recent data from the National Oceanic and Atmospheric Administration (NOAA)[37] indicate that of the 474 stocks and stocks complexes monitored by the fishery authority, 91 per cent are not subject to active overfishing ($F<F_{MSY}$). Forty-two stocks (9 per cent) are currently under formal rebuilding plans, and 41 stocks have been rebuilt since 2000)[38] (Figure 15).

Successful cases of active rebuilding programmes are also described in Garcia and Ye (2018) in the Mediterranean bluefin tuna (Fromentin and Rouyer, 2018), Norwegian herring and cod (Gullestad et al., 2018), Japanese mackerel (Makino, 2018), West Australian snapper and scallop (Fletcher et al., 2018), and South African deep-sea hake and sardine fisheries (Augustyn et al., 2018). The same set of analyses also illustrates the difficulties met by rebuilding programmes in: (i) complex multispecies, multigear fisheries in southeastern Australia (Smith et al., 2018) and Western Australia (Fletcher et al., 2018); in the presence of strong environmental drivers of pelagic assemblages (Makino, 2018); under weak or corrupted systems of governance of small-scale fisheries (Augustyn et al., 2018); and under a combination of overfishing and climatic pressure, high socio-economic stakes and conflicting research advice (Rice, 2018).

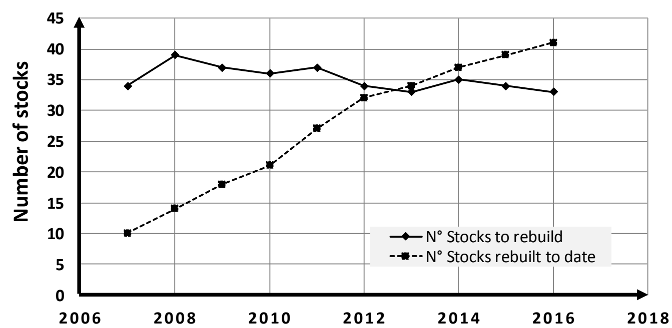

Figure 15. Number of stocks in need of rebuilding and total number of stocks rebuilt in the USA (2007-2016)

c) Multispecies considerations

Target 6 does not refer to multispecies fisheries challenges. It is practically impossible to fish all target species of an ecosystem at their individual MSY level because of their numerous interactions, resulting in a multispecies MSY (mMSY). Their sustainable harvest implies fishing some at MSY and others above or below that level and hence modification of the structure of the assemblage (in terms of relative abundances and demographic structure of its components). As long as no species were harvested to levels resulting in their biomasses falling below their respective B_{lim} values, such multispecies harvest strategies would be consistent with Target 6, although not necessarily with a narrow interpretation of UNCLOS standard to maintain all stocks about their individual B_{msy} levels. Harvesting a species assemblage while maintaining a structure (i.e., species composition and relative abundances) and system productivity close to the unexploited state is theoretically possible through balanced harvest, distributing fishing pressure across species and sizes proportionally to their production rate. However, the concept is still being discussed and has not been applied formally (Garcia et al., 2010, 2012; Kolding et al., 2016).

Rebuilding species assemblages that have been significantly disturbed by fishing is a complex endeavour on which there is still very limited information. The example below (Figure 16) illustrates the decline and rebuilding of a species community in the overfished Newfoundland shelf, off the east coast of Canada.

[37] http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/archive/2017/first/q1-2017-final-rebuilt-map.png
[38] http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/trends_analysis.html).

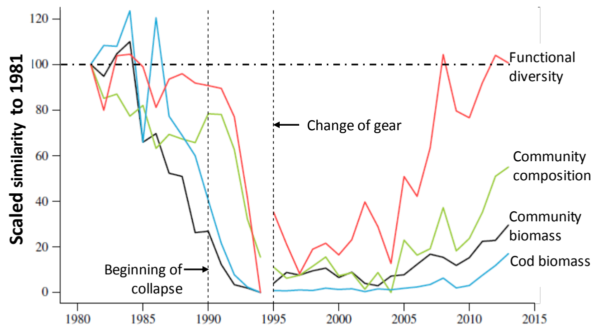

Figure 16: Relative change of different community metrics over time, scaled between 0 and 100, the reference value in 1981. 1990 is considered the start of the cod collapse, and an important change of gear occurred in 1995. Redrawn from Pedersen et al., 2017. © Creative Commons

This example proves that rebuilding is possible and illustrates the hysteresis and delays than can be expected in rebuilding complex species assemblages and the uncertainties about re-establishing biomass and species dominance patterns.

d) Depleted non-target species

Our review found that all well documented cases of efforts to rebuild depleted non-target species focused on species considered threatened or near-threatened by the competent authority. These will be presented in section 5.4.2. Examples of at least partial and on-going recovery of threatened species suggest that it should be feasible to recover non-target species that are depleted but not yet threatened. However, the general lack of attention this review has found to monitoring non-target bycatches and periodically checking the status of non-target species that experience substantial bycatches (relative to their productivities) against biologically based reference points underscores that this aspect of Target 6B still receives little attention in fisheries. Addressing the issue would demand a substantial increase in resources for bycatch quantification and assessment of the status of non-target species in exploited ecosystems, and it can be argued that these may not be the most effective uses of additional resources for fisheries management. On the other hand, it can be a costly alternative to pay little attention to non-target species exposed to relatively high bycatch rates until some of these species are assessed as threatened, and then bear the burden of draconian management measures usually necessary to protect and recover threatened species. Initiatives like the FAO plans of action (section 4.2.1) for groups of species vulnerable to bycatch mortality may be a practical compromise.

5. Target 6C - Threatened species and vulnerable ecosystems

5.1 Rationale

In element 6C, threatened species and vulnerable ecosystems have been combined in a requirement that sustainable fisheries have no SAIs on threatened species and vulnerable ecosystems.

This element can be associated with the UNCLOS provision that, in taking conservation and management measures, States should "take into consideration the effects on species associated with or dependent upon harvested species" (i.e., target species) with a view to maintaining or restoring populations of such species "above levels at which their reproduction may become seriously threatened" (article 61.4). The association gives a clue for the concept of SAI, which, in the case of populations, is the impact that seriously threatens their reproduction. This level is similar to the levels used in fishery management as reference values for minimum or safe biological levels (B_{lim}, B_{pa})[39] in Harvest Control Rules (HCRs) and for rebuilding strategies. In the general case, this standard is fully covered by sections 3 and 4 of this publication, in that target species and bycatches are to be kept at levels where population productivity is not impaired.

However, element 6C adds two additional aspects to Target 6: (i) a standard for impacts on habitats that may be especially vulnerable to the impacts of fishing (vulnerable ecosystems) and (ii) a separate and very stringent standard for the impact of fisheries on stocks and species that for any reason have already been reduced to a level where their productivity may already be impaired (threatened species). More specifically:

- Vulnerable ecosystems are ecosystems in which some types or intensity of fishing may cause significant disruptions that may have widespread ecological consequences and/or from which recovery may be particularly difficult. The use of the expression “vulnerable ecosystems” intentionally uses the concept of vulnerable marine ecosystems (VMEs), earlier used in the 2007 UNGA Resolution 61/105 and the International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO, 2008a). In the UNGA resolution, the scope of VMEs was limited to deep-sea fisheries on the high seas using gear in contact with the bottom. Element 6C does not carry those explicit restrictions and, as part of an Aichi Biodiversity Target, it covers the full range of marine ecosystems considered vulnerable at other depths, under other jurisdictions and possibly vulnerable to other pressures than just bottom-contacting fishing gears, consistent with FAO et al., (2016).
- Threatened species are species threatened with a risk of extinction for any reason. The drivers of the poor status may be fishing, through excessive targeted depletion, possibly augmented by international trade demands[40] (McClenachan et al., 2012; Davies and Baum, 2012; Purcell et al., 2014) or possibly through other natural or human-induced factors, but depleted to a level where any pressure, including fishing as target or bycatch, may further jeopardize survival or recovery of the species. The use of the term “threatened” was intentional, to link this element to processes that assess the state of species against risk of extinction, either from intrinsic biological vulnerability (e.g., on the IUCN Red List; IUCN, 2016) or from international trade (CITES Appendices). At the level of a State’s jurisdiction, many countries have legislation or other binding legal arrangements to identify species at a relatively high risk of extinction and usually also to offer them a higher level of protection than the norm for biodiversity not designated as “threatened” (e.g., the EU Species and Habitats Directive[41] ; the US Endangered Species Act[42], the Canadian Species at Risk Act [43] and the Australian Endangered Populations and Biodiversity Act[44]).

For threatened species and vulnerable ecosystems, the standard to be met is no SAIs, which was chosen to closely align Target 6C with the guidance in UNGA Resolution 61/105 and the International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO, 2008a).

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[39] B_{pa} is used here to refer to any of the triggers in harvest control rules that manage the risk of biomass falling below a biologically defined limit reference point (B_{lim}). The exact name given to such reference points differ among jurisdictions, and for this report, the interpretation in ICES (2002, 2003) is used for such reference points.
[40] Eventually calling for an intervention of CITES
[41] http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/nat2000/en.pdf
[42] https://www.fws.gov/endangered/laws-policies/
[43] http://laws-lois.justice.gc.ca/eng/acts/s-15.3/
[44] http://www.environment.gov.au/biodiversity/threatened/species

5.2 Key concepts

5.2.1 Vulnerable ecosystems

The term "vulnerable (marine) ecosystems" was not included in the language of the Convention on Biological Diversity. However, it had recently gained prominence in fisheries management though its use in paragraphs 80-87 of UNGA Resolution 61/105 in 2007, although it had appeared much earlier in UNGA Resolution 58/240, which "Reaffirms the efforts of States to develop and facilitate the use of diverse approaches and tools for conserving and managing vulnerable marine ecosystems" (paragraph 54). These paragraphs do not have a definition or criteria for what types of marine ecosystems were "vulnerable", but the language of Resolution 61/105 clearly focused on vulnerability specifically to impacts from mobile, bottom-contacting fishing gears. The need for a definition and criteria was quickly filled by the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO, 2008a), based on a set of expert consultations (FAO 2006; 2008b, c).

The FAO Guidelines do not contain a definition of VMEs but note in paragraph 42 that a marine ecosystem should be classified as "vulnerable" based on the following characteristics/criteria:

i. Uniqueness or rarity of species and habitats;
ii. Functional significance of the habitat for the survival, productivity and reproduction of stocks;
iii. Fragility and susceptibility to anthropogenic degradation;
iv. Life-history traits of component species that make recovery difficult; and
v. Structural complexity, e.g., in biogenic structures supporting essential ecosystem processes.

The guidelines and criteria they included were available at the time the Aichi Biodiversity Targets were being negotiated, although the CBD was focused on ecologically or biologically significant marine areas (EBSAs) as their preferred phrase for habitats in need of more risk-averse management (COP decision IX/20). However, this CBD language was intentionally not used for a target on fisheries (J. Rice, Convener of the Friends of the Chair Group, pers. comm.), as the COP has emphasized that there should be no direct link between identifying an area as meeting the EBSA criteria and any specific management actions. During the same meeting of the COP where the Aichi Targets were adopted, decision X/29 reaffirmed the need to avoid linking EBSAs to specific management actions but also explicitly acknowledged the FAO VME criteria as "relevant, compatible and complementary nationally and inter-governmentally agreed scientific criteria" to the EBSA criteria in decision IX/20. COP decision X/29 (paragraph 54) specifically encourages Parties and other Governments to fully and effectively implement paragraphs 113 through 130 of UNGA Resolution 64/72 on responsible fisheries in the marine ecosystem calling on States and/or regional fisheries management organizations (RFMOs), to conduct impact assessments, identify VMEs, and adopt conservation and management measures to prevent known or potential SAIs and ensure long-term sustainability of deep-sea stocks, consistent with the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas. VMEs and EBSAs are different instruments developed for different purposes and geographical and ecological scopes. However, the similarity of their identification criteria and of their long-term goal (i.e., to maintain essential ecosystems) suggests that both could be reported by States as a contribution to implementation of the vulnerable ecosystems aspects of Target 6C. The intent of the CBD decisions would be maintained, because Target 6 highlights only the desired outcome—no SAIs on these areas—and not the measures that should deliver it. However, the language makes clear the outcome desired from all fisheries is similar to the outcome already agreed to by the UNGA as necessary for high seas fisheries, but unlike UNGA 61/105, without specifying any specific fisheries, gears, or management measures.

5.2.2 Threatened Species

The term "threatened species" was the aspect of element 6C best-established in the CBD discussions at the time the target was negotiated but has not proven simple to implement in fisheries. Within the CBD operations there has been widespread acceptance of the IUCN Criteria for "red-listing" species (IUCN, 2016). Element 4 of Target 6 was intended to deal in general with non-target species on which fisheries have a collateral impact and to set for them a general standard of impact comparable to that set for target species (i.e., a standard comparable to B_{lim}; see section 4). The biomass of species or populations designated as threatened ought to be well below any biologically based LRP (B_{lim}) used in fisheries, because such fisheries limits are supposed to be set at levels of biomass below which productivity may be impaired but well above the level below which the risk of extinction is unacceptable (Powles et al., 2000). How far below an LRP used in fisheries is appropriate for considering a population as threatened has been debated for some decades (Mace et al., 2014).

This logical relationship between healthy marine stocks and species, depleted marine stocks and species in need of rebuilding, and marine species threatened with extinction has proven challenging to delineate, particularly when fishing has either played a role in the population decline or when catch (intended or not) is deterring population increase. Some of the challenge arises from the multiple criteria recommended by the IUCN for assessing risk of extinction, where the robustness of the decline criterion used to assess extinction risk in general has been questioned when applied to fished marine fish populations (Mahon et al., 2000; Mace et al., 2014). Although this debate has been resolved operationally with a formal agreement between FAO and CITES for how marine fish are assessed and listed in CITES Appendices[45] (Friedman et al., 2018a), the substantive differences of view have not been fully resolved, and CITES is still called on to take an important role on protection of threatened species from fishing impacts (Vincent et al., 2014).

Notwithstanding any differences in points of view regarding application of the threatened species criteria, fisheries can take bycatches of species with highly vulnerable life histories or that are severely depleted, such that levels of mortality from a given amount of fishing effort that are sustainable for healthy target species may be excessive for these other species. These concerns may apply widely but have centred on groups of species that are intrinsically particularly vulnerable (Musick, 1999), such as sharks and other elasmobranchs (Worm et al., 2013; Croll et al., 2016; Dulvy et al., 2017; Stein et al., 2018), seabirds (Anderson et al., 2011; Zydelis et al., 2013; Gilman et al., 2016) and sea turtles (Lewison and Crowder, 2007; Wallace et al., 2013).

Bycatch limits are a common tool of fisheries management (e.g. Abbot, J.K. and Wilen, J.E. 2009; Gilman et al., 2010; Gjertsen, H. et al., 2010) but their application has posed special challenges when used to reduce bycatch mortality on potentially threatened species, sometimes referred to as "choke species"[46]. Fishery control rules that are sufficiently precautionary to effectively protect highly vulnerable species have asymmetric consequences for the fisheries and the bycatch species. When very low bycatch quotas on vulnerable species are applied to fisheries operating on healthy species, the bycatch limits may greatly reduce fishing opportunities (i.e., leading to closure of the fishery before the sustainable quota is caught), with high cost to the industry. However, if a bycatch event already has low probability because the bycatch species is severely depleted, the restrictive bycatch quota might not actually increase protection of that species very much. This can occur particularly in the case of vulnerable species that school, where bycatch events, although rare, are clustered such that a few accidental "hits" can close the fishery long before the quota of the target species is taken, with severe economic impacts (Rice and Legacè, 2007; Auge et al., 2012).

[45] https://www.cites.org/sites/default/files/eng/disc/sec/FAO-CITES-e.pdf

[46] "Choke species" is a term used in mixed fisheries, when one species (typically with a lower quota or higher market value than other species in the mixed catches) has its quota fully taken, and the fishery must close even though substantial quota is left from other species in the mix.

Target 6 does not specify the listing authority for "threatened species". Since reporting is done at the national level, each Party may choose to use whatever standards are applied at the national level for listing threatened species, consistent with national legislation for designating species at risk (DeMaster et al., 2004; Dorey and Walker, 2018). Such choices could be contested by some who consider such listing criteria as too permissive or too constraining, or that the listing and revision processes is too slow or strongly influenced by special interests (Mooers et al., 2007; Mace et al., 2014). However, all CBD decisions on marine and coastal biodiversity fully acknowledge national sovereignty over their jurisdictional waters, so it is consistent with CBD process to use whatever official processes CBD Parties have for designating species as "threatened" in reporting on progress on Target 6.

Applying internationally agreed criteria may help if this target is applied in areas beyond national jurisdiction, for example the FAO-CITES memorandum of understanding (Friedman, 2018a). For RFMOs and high seas fisheries that might be reviewed or reported during the evaluation of the Aichi Targets, the listings of marine species in CITES Appendices might be an appropriate starting place for evaluations.

5.2.3 Significant adverse impacts (SAIs)

The standard of no SAIs also taken directly from UNGA Resolution 61/105 and, in Target 6C, is applied both to vulnerable ecosystems and to threatened species with implications examined below.

a) *SAIs on vulnerable ecosystems*

Referring to vulnerable ecosystems, the UNGA resolution, again, did not contain a definition or standards for what adverse impacts were "significant", nor even technically for which impacts of fishing gears would be "adverse". This void was also filled by the International Guidelines for the Management of Deep-sea Fisheries in the High Seas, which states "Significant Adverse Impacts are those that compromise ecosystem integrity (i.e., ecosystem structure or function) in a manner that: (i) impairs the ability of affected populations to replace themselves; (ii) degrades the long-term natural productivity of habitats; or (iii) causes, on more than a temporary basis, significant loss of species richness, habitat or community types. Impacts should be evaluated individually, in combination and cumulatively" (paragraph 17). Points (i) and (iii) of this understanding suggest a connection between SAIs and threatened species (see next section).

The Guidelines also indicate that the following factors should be considered: (i) the intensity or severity of the impact at the specific site being affected; (ii) the spatial extent of the impact relative to the availability of the type of habitat being affected; (iii) the sensitivity/vulnerability of the ecosystem to the impact; (iv) the ability of an ecosystem to recover from harm, and the rate of such recovery; (v) the extent to which ecosystem functions may be altered by the impact; and (vi) the timing and duration of the impact relative to the period in which a species needs the habitat during one or more life-history stages "(paragraph 18).

The acknowledgement of the FAO Guidelines in CBD decision X/29 (paragraph 54) provides a basis for harmonizing standards for what constitutes SAIs between the CBD and FAO guidance for applying UNGA Resolution 61/105 (http://www.fao.org/in-action/vulnerable-marine-ecosystems/en/). Although the CBD has not tested the robustness of these standards for delivering the intended outcomes of Target 6 for threatened species and vulnerable marine ecosystems, it has neither proposed any alternative standards nor explicitly questioned their appropriateness. Moreover, there have been two UNGA reviews of progress on the effectiveness of FAO guidance for protecting vulnerable marine ecosystems (findings summarized below), illustrating a level of rigour that exceeds the rigour of testing many of the reporting standards for Aichi Targets, at least when applied to vulnerable marine ecosystems.

b) SAIs on threatened species

The application of SAI as a standard for threatened species would allow some not significantly adverse impacts from fisheries on such species, so the Target does not offer full protection. However, it is possible to transpose directly to threatened species the understanding about SAIs and vulnerable ecosystems contained in the FAO guidance that the CBD has explicitly recognized. Full harmonization of CBD standards for SAIs with the accepted standards for SAIs under UNGA Resolution 61/105, would mean “significant adverse impacts” on threatened populations would include impacts that (i) impair the ability of affected populations to replace themselves; (ii) degrade their long-term natural productivity; or (iii) cause, on more than a temporary basis, significant loss of intra-specific diversity. Impacts should be evaluated at both species and multispecies levels, accounting for interactions and cumulative effects. When determining the scale and significance of an impact, the following factors should be considered: (i) the intensity or severity of the impact on the threatened species; (ii) the relative extent of the fishing impact (on the population age and genetic structures); (iii) the intrinsic sensitivity/vulnerability of the population to the impact; (iv) the ability of the population to recover from harm and the potential rate of such recovery; and (v) the extent to which population functions (productivity and reproduction) may be altered by the impact.

When dealing with target species, these criteria have some similarities to those used in stock assessment to define situations of overfishing, depletion and collapse. However, precautionary reference points are used in HCR and MSE to define upper boundaries on such stock conditions (i.e., overfished, depleted, collapsed) and to calibrate rebuilding strategies.

Because threatened species are, by definition, in a much poorer state than most species in an ecosystem and have already been identified as being in need of rapid and secure rebuilding to a status where the threat of extinction is no longer imminent or likely (i.e., to a status considered consistent with IUCN Category of “Special Concern” or higher), the appropriate benchmark for an SAI must allow even less impact than the LRPs (e.g., F_{lim} or B_{lim}) used in fisheries harvest control rules for rebuilding (see sections 3 and 4). Even in fisheries rebuilding plans, a clear distinction in the urgency and the level of action to be taken is made between “overfished” or “depleted” stocks ($B_{MSY}>B>0.5B_{MSY}$) and “collapsed stocks ($B<0.2B_{MSY}$). For a population that is considered “threatened” the adverse impact of fishing that is not “significant” must therefore be lower than the impact allowed for a collapsed stock.

At the extreme, setting F=0 as the tolerance for fishing mortality on threatened species would consist of instating a moratorium for target species and a zero bycatch for non-target species. Such measures would certainly meet the intent of 6C and have been shown to be effective, but expensive, means to rebuild collapsed resources. However, such a measure could be more restrictive than agreed to in the adoption of Target 6. Target 6 does not require “no impact on threatened species” but rather no significant adverse impact, strongly suggesting that adverse impacts could be accepted as long as they were not “significant”. Judging what non-zero level of fishing impact is consistent with 6C requires information about the particular species and fishery. For some highly endangered species, a standard of zero impact (moratorium or zero bycatch) may actually be necessary for species survival (e.g., Phillips et al., 2016; Thiebot et al., 2016). For other species, however, appropriate science-based standards are still debated (Dulvy et al., 2008; Phillips et al., 2015; Cooke et al., 2016; Williams et al., 2016; Garcia et al., 2018).

A possible option for guiding the determination of a species/fishery-specific level of impact as the standard for “significant” is to focus on the recovery plans and/or measures adopted by States or RFMOs for threatened target species within their jurisdictions (Taylor et al., 1993; NMFS, 2010). Typically, fisheries recovery plans specify explicit targets for recovery of population numbers (or appropriate surrogate) and timetables for the achievement (Foin et al., 1998; Clark et al., 2002) based on comprehensive science input and consultation (Clark et al., 2002; Lundquist, 2002). Impacts of fisheries large enough to reduce the planned likelihood of achieving these targets of stock status and time to recovery (assuming all other components of the recovery plan were operating within their respective parameters), would be *de facto* impeding recovery of the threatened species, and hence considered significant and adverse. Such an approach would be consistent with that taken by a number of jurisdictions that require assessments of "allowable harm" as part of developing recovery plans[47]. Such an approach would allow SAIs to have a consistent interpretation across all threatened species in a jurisdiction, taking into account both existing scientific knowledge and public consultation processes, and linking the standard directly to the recovery of the threatened species, rather than to a status quo that would maintain it in a threatened state.

5.3 Indicators and alternative reporting approaches

5.3.1 Vulnerable ecosystems

Given the definition of SAI, and particularly the set of considerations necessary in its evaluation, simple numerical indicators based on widely available data sets are both impractical and inappropriate. However, alternatives (such as narratives and more integrated assessments) are both feasible and informative, even for data-moderate cases. In relation to vulnerable ecosystems, such progress reporting could be: (i) the steps taken for their formal identification and (ii) the measures taken for their conservation.

a) *Identification of potential fishery impacts on vulnerable ecosystems*

For the VME aspects of element 6C, the FAO criteria for identifying VMEs were developed only for deep-sea areas beyond national jurisdiction (even though nothing impedes sovereign States from identifying VMEs in their EEZ) and only relative to mobile, bottom-contacting gears. This is a serious limitation on their generality. However, synchronous with the development of VME criteria and implementation processes in RFMOs, the CBD and other conservation biology interests were developing criteria for describing EBSAs and processes for their application. EBSA criteria were intended to be globally applicable in areas within and beyond national jurisdiction, possibly under different jurisdictional authorities, and from the surface to the bottom of the oceans. In addition, the CBD COP has been careful to not to link the EBSA description process to any specific pressure (natural or anthropogenic) on biodiversity or to any specific regulatory action. The intent was to identify areas where management should be more risk-averse than in the adjacent "background" areas (COP decision X/29), but the actions by which the greater risk aversion would be achieved were left to the discretion of the management authority. This gave EBSA criteria the global applicability that VME descriptions lack.

There have been several comparisons of the FAO's VME criteria and the CBD's EBSA criteria, including both by the FAO (FAO, 2010) and the CBD (CBD, 2009) and other researchers (Ardron et al., 2014; Rice et al., 2014). These authors conclude that the two sets of criteria—which are very similar—would be expected to perform very similarly with the same information and identify the same areas as in need of more risk-averse management, although Rice et al., (2014) note that no formal test of similarity of their outcomes in terms of identification of bottom vulnerable ecosystems has been performed.

The EBSA and VME criteria give States the tools for identifying vulnerable ecosystems. This identification of relevant areas, by applying the VME, EBSA or comparable national criteria (e.g., DFO, 2006), is the first element of reporting on implementation of the vulnerable ecosystem element of Target 6. The FAO Guidelines (e.g., paragraph 47vi) then state explicitly that a risk assessment of some sort should be conducted, to evaluate the fishing activities, if any, that could bring about SAIs to the areas, unless those fishing activities are appropriately managed or excluded from the VME. This serves a function comparable to the practice of identifying the "feature condition and future outlook" in many EBSA descriptions.

[47] http://www.gazette.gc.ca/rp-pr/p2/2013/2013-03-27/html/sor-dors34-eng.html

b) *Measures taken*

The next step is to evaluate the degree to which the appropriate fishery measures are being taken, including closures in areas where gear impacts cannot possibly be managed (FAO, 2008a). As a consequence, this aspect of Target 6 could be considered fully achieved if: (i) all the waters under a given jurisdiction have been assessed in terms of significance and vulnerability, using EBSA, VME or comparable criteria-based evaluations; (ii) qualitative risk assessments have been conducted and (iii) appropriate fisheries management measures have been implemented. If this agenda is only partially implemented, achievements will be proportionally less but States may report on transitional or interim results and possibly specify the intended scope, timeline and outcomes of their further implementation.

5.3.2 <u>Threatened Species</u>

a) Identification of Impacts on Threatened Species

Reporting on the direct impact of fisheries on threatened species requires obtaining reliable information on the level of mortality imposed on such species and evaluating that information relative to the level of mortality consistent with its survival and recovery. There are also indirect ways that fisheries can impact threatened species, primarily through depleting essential prey. Measuring and reporting on these indirect effects requires looking at fisheries within an ecosystem-based framework, with reliable ecosystem models (section 2.2).

The direct effects themselves pose many challenges for assessing and reporting. Clear guidance in both measuring and reducing bycatches in fisheries have been available since Target 6 was adopted (FAO, 2011), and many papers have reviewed the effectiveness of bycatch monitoring for quantifying take or harm to rare species (see section 5.4.2). Some of these challenges are present in all efforts to quantify bycatch amount and species composition, as described in section 4, but special attention must be devoted to threatened species. Guidance on assessing impacts from fishing on potentially threatened species has been developed most thoroughly for species that are rare or have particularly vulnerable life histories. Across sharks, seabirds, other fish and marine mammals, the messages are generally the same. Indirect methods of quantifying the take of rare species are likely to be inaccurate and often biased low (Brothers et al., 2010; Phillips et al., 2015). Direct methods are often expensive to implement, hence are usually preferred and sometimes the only feasible option (Gilman et al., 2017; Pilcher et al., 2017). Technologies are being developed to improve monitoring but are not yet well tested and widely available (Bartholomew et al., 2018). Fairly accurate direct estimates of magnitude of take may be made if there is adequate investment in monitoring; otherwise much more uncertain estimates can be obtained indirectly, with a greater risk of underestimating than over-estimating bycatch rates for rare species.

This element of Target 6C also requires that estimates of bycatch levels for threatened species are compared to benchmark levels to assess the significance of impact on the species. Again, there has been substantial research on estimates of appropriate reference points for very uncommon or threatened species (Forrest and Walthers, 2009; Clarke and Hoyle, 2014; Courtney et al., 2016; Jaiteh et al., 2017). In addition, many of the methods developed for estimating reference points for data-poor fisheries can be explored for threatened species, since many of the features of the data needed in both cases are similar (Carruthers et al., 2014; Newman et al., 2015) although the uncertainties in the bycatch information can have substantial impacts on these estimates (Tsai et al., 2011; Wetzel and Punt., 2011; Moore et al., 2013; Wiedenmann et al., 2013). Again, reference points are obtainable for many kinds of threatened species, and they can be developed with little more than general life history information. However, the weaker the species-specific information available to identify the level at which the impact becomes significant and adverse, the more uncertain and therefore the more restrictive the reference points are likely to be (assuming the application of precaution in setting the benchmarks).

b) Measures taken

With the many challenges in obtaining the necessary information to directly assess if impacts of a fishery on threatened species are sustainable, there has been substantial interest in at least measuring the effectiveness of measures to avoid or mitigate bycatches. Spatial closures are a potential tool for protecting threatened species from fisheries. The topic was explored in depth 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, which took place from 6 to 9 February 2018, [48] and will not be revisited here. However, for mobile protected species, that workshop report noted the residual risk to the species from fisheries outside the closed area. This risk is sometimes multiplied by the relocation of fishing effort from the closed area to areas remaining open where the threatened species also occurs (Rice et al., 2018). Many non-spatial tools have also been developed to mitigate or avoid bycatch mortality, with a particular focus on threatened or vulnerable species. Many of these methods for gear modification can be highly effective or ineffective, depending on how they are deployed and how the fishing gear is retrieved (Rice et al., 2012). The use of financial instruments as incentives is also being intensively studied and tested (Squires and Garcia, 2016; Squires et al., 2018; Milner-Gulland et al., 2018), and their presence could also be included in reporting on this aspect of element T6.

These issues are primarily considered relative to element 6B of Target 6 (section 3), but there are particularly detailed studies of their effectiveness for sharks (Favaro and Côté, 2013; Gilman et al., 2016), seabirds (NMFS, 2005; Gilman et al., 2005, 2014; Yokota et al., 2011; Clarke et al., 2014, Melvin et al., 2014) and turtles (Luchetti et al., 2016; Gilman & Huang, 2017). Multiple performance reviews of these mitigation measures highlight the variable effectiveness of all bycatch mitigation measures for reducing fishery impacts on threatened species depending on the particular circumstances of the fishery, the degree of involvement of the fishers in measure design, and the ability to evaluate the actual implementation of the measures. As a generalization with many exceptions, gear modifications that can be implemented for full fisheries are more effective than spatial measures or temporary or set-by-set gear modifications (Wakefield et al., 2017; Senko et al., 2014). In well managed industrial fisheries, economic incentives result in much more effective economic efficiency in protecting megafauna (Squires et al., 2018).

The diversity of measures available for mitigating the impacts of fisheries on threatened species represents opportunities as well as challenges. There are many opportunities to use combinations of gear modifications, spatial and temporal measures, economic incentives and even multispecies measures to manage these impacts. The potential of these opportunities and the need to act on them was recognized early in the adoption of the Ecosystem Approach to Fisheries (section 2.2). Of particular relevance to minimizing the impact of fisheries on threatened species have been efforts in FAO to develop IPOAs for both sharks[49] and seabirds[50]. The generic frameworks for the IPOAs lay out the principles and general approach for each particularly vulnerable species group, with guidance on how the general framework can be adapted to individual fisheries at national (NPOA) or regional (RPOA) levels.

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[48] https://www.cbd.int/doc/c/36f1/d6e8/90a68e516b0c5e8aa3f5a0eb/sbstta-22-06-en.pdf

[49] The FAO International Plan of Action for the Conservation and Management of Sharks includes all species of sharks, skates, rays, and chimaeras (Class Chondrichthyes). http://www.fao.org/ipoa-sharks/background/about-ipoa-sharks/en/

[50] http://www.fao.org/fishery/ipoa-seabirds/about/en

5.4 Examples of outcomes on Target 6C

5.4.1 <u>Examples of outcomes on vulnerable ecosystems</u>

Information on implementation of the proposed approaches is not speculative. Rather, because of the importance of its resolution 61/105, the UNGA has requested regular reviews of progress and effectiveness of efforts to achieve the commitments it contains. An expert workshop held in 2011 concluded that there were substantial differences among RFMOs with regard to progress made on implementing the provisions of the resolution. The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) appeared to have made the most progress but most of the RFMOs in the Atlantic were taking partial actions, with additional actions being planned. However, few RFMOs were collecting all the types of environmental data needed for full implementation of the FAO Guidelines and corresponding intent of UNGA resolutions 61/105 and 64/72. Likewise, where VME identification was incomplete, management measures to protect VMEs either were not in place, or only move-on rules of questionable effectiveness were being used (Weaver et al., 2011). These general findings were in accord with the UNGA conclusions. However, it was noteworthy that where VMEs were identified and measures implemented, no shortcomings with the outcomes were identified, although weak data for their evaluation was a concern.

A second UNGA review, just five years later, found the situation substantially improved. The letter about the review sent by the workshop moderator to the President of the General Assembly indicated that: (i) the application of the VME framework has been acknowledged as also covering the long-term sustainability of deep-sea fish stocks, an important aspect of 6C from a biodiversity conservation perspective; (ii) "considerable progress … had been made at the global, regional and national levels since the adoption of resolution 61/105.[51] However, it was noted that implementation remained uneven and that further efforts to strengthen it were needed" (paragraph 6); and (iii) although there are "still gaps in the coverage of regional fisheries management organizations and arrangements for bottom fisheries, bottom fishing was not taking place in most areas lacking those organizations and arrangements competent to regulate such activities (paragraph 11); (iv) the shortcomings are in the information available to support implementation of the Resolutions and Guidelines, and the United Nations General Assembly review "noted that a comprehensive evaluation of the scale of impacts on benthic ecosystems was not feasible owing to the relative lack of data" (paragraph 8) that "more needed to be known about the status and characteristics of many deep-sea fish stock (paragraph 9), and with "regard to the assessments of cumulative impacts, seabed mapping, threshold-level determination, encounter protocols, footprint determination and an understanding of the nature of vulnerable marine ecosystems" (paragraph 10).

Importantly, at the national level, the review found clear evidence of progress in implementing many types of measures to deliver the objectives of the United Nations General Assembly resolutions, and correspondingly of element 6C, including "… the imposition of gear restrictions, the establishment of protected areas and ecologically and biologically significant areas, capacity-control measures, data-collection measures, the management of shark fisheries, awareness-raising programmes, the application of the precautionary and ecosystem approaches and monitoring, control and surveillance mechanisms, including logbook reporting" (paragraph 24). Similar measures were being expanded at the regional level (paragraph 29). Despite the incomplete implementation of all the provisions in the resolutions and guidelines, whether due to limitations in data or in capacity, all workshop participants "commended the good progress made in implementing the

[51] Letter dated 9 September 2016 from the moderator of the workshop to discuss the implementation of paragraphs 113, 117 and 119 to 124 of resolution 64/72 and paragraphs 121, 126, 129, 130 and 132 to 134 of resolution 66/68 on sustainable fisheries, addressing the impacts of bottom fishing on vulnerable marine ecosystems and the long-term sustainability of deep-sea fish stocks addressed to the President of the General Assembly

relevant General Assembly resolutions at the regional and national levels" (paragraph 35) and many participants "expressed the view that the full implementation of the resolutions would be sufficient to protect vulnerable marine ecosystems and the long-term sustainability of fisheries resources" (paragraph 37).

The conclusions of these reviews are both encouraging in terms of the progress made to date in describing VMEs in areas beyond national jurisdiction and closing them to bottom trawling, and informative about the areas where more work is needed for identification of VMEs and expanding the protection measures to apply additional tools for reducing risk and broadening the range of fishing gears considered. The greater consideration of EBSAs in fishing plans at national and subnational scales that is also occurring in some jurisdictions (Kenchington et al., 2014; Dunstan et al., 2016) also offers scope for greater progress on the vulnerable ecosystems' aspects of Target 6.

More recent information on actions taken has been obtained in the responses from RFMOs/As to the 2015 CCRF questionnaire (FAO, 2016):

- All RFMOs/As appear to have taken actions to assess the presence of VMEs and protect them from SAIs.
- Almost all the efforts of RFMOs/As have focused on identifying areas with "significant concentrations" of corals and sponges, and in a few cases seamounts. Very little work has been done with other VME criteria.
- In almost all cases, RFMOs/As have noted that the absence of clear standards for how to interpret "significant concentrations" has impeded progress on identification of VMEs based on presence of corals and sponges.
- Incomplete information on distribution, abundance and species composition of corals and sponges specifically, but more generally of all the ecosystem features that may meet the VME criteria, also impedes progress of RFMOs/As to implement the FAO Guidelines. However, in all cases the RFMOs/As have been able to assemble enough information to make at least partial progress on identification of areas where corals and sponges are present.
- Management measures used to protect VMEs have almost exclusively consisted of closures of areas considered to have significant concentrations of corals and sponges (and in a few cases, seamounts). There is some exploratory work with other mitigation measures, but such work is in early stages.
- There are numerous gaps remaining in the implementation of the International Guidelines, many arising from either the focus on corals and sponges at the expense of attention to other VME criteria and from the lack of operational guidance on how to interpret "significant concentrations".
- There are also numerous opportunities for activities to increase progress. Most of these involve collaborative efforts among RFMOs/As, usually with FAO playing a major role in facilitating the collaborations. Development of a global database on known VMEs (and the criteria they meet), and sponsoring expert meetings for provision of "best practice" guidance would be roles that should return particularly high benefits.

The examples of outcomes reflect strong support for the adequacy of this general framework for delivering the vulnerable ecosystem aspects of element 6C and evidence that substantial progress can be made even with very incomplete information on marine ecosystems. Although the conclusions presented here are from discussions among science and policy experts at the UNGA workshop, substantial evidence supporting these conclusions was consolidated and communicated in FAO (2016f). The details in that document can provide more case- and situation-specific information needed by individual States to undertake the type of evaluation of progress outlined above, updating the assessment for the 2020 timeline.

5.4.2 Examples of outcomes on threatened species

Progress on threatened species can be appreciated by, *inter alia*, looking at the implementation records of the FAO IPOA-Sharks and IPOA-Seabirds for which there is available information.

A comprehensive review of the implementation of the FAO IPOA-Sharks, undertaken in 2012, in 26 top shark-fishing nations and 10 RFMOs (representing about 84 per cent of the global shark catches from 2000 to 2009) showed that more than two thirds (18) of the top shark-fishing countries had a NPOA-Sharks in place and that five more were in the process of developing one. The main problems hindering successful implementation are linked to problems with fisheries management in general, such as institutional weaknesses, lack of trained personnel, and deficits in fisheries research and in MCS.

In addition, there existed at that time a number of Regional Plans of Action for the conservation and management of sharks (RPOA-Sharks) by: the European Union (2009); UNEP/IUCN in the Mediterranean Sea (2003); Permanent Commission for the South Pacific (CPPS) (2010); Central American Integration System (SICA) (2012); Central American Fisheries and Aquaculture Organization (OSPESCA) (2011); Pacific Islands Forum Fisheries Agency (FFA), Secretariat of the Pacific Regional Environment Programme (SPREP) and WCPFC (2009) and the Commission Sous-Régionale des Pêches (CSRP) and International Foundation for the Banc d'Arguin in West Africa (http://www.fao.org/ipoa-sharks/national-and-regional-plans-of-action/en/). The IPOA-Seabirds was adopted in 1999. National Plans of Action for reducing incidental catch of seabirds in longline fisheries were adopted in the United States of America (2001, 2003), Australia (2003), South Africa and New-Zealand (2004), Brazil (2004, 2006), Uruguay (2006, 2015), Canada (2007), Japan (2009) and Argentina (2010).

Most of the progress on development of IPOAs and NPOAs was "on paper" and had been made before the adoption of Target 6. However, the increasing collaboration between FAO and CBD on all the Aichi Targets, and particularly the workshops that addressed aspects of Target 6C (cf. section 5.4.1) has helped to advance their shared interest in more sustainable fisheries and better conservation of marine biodiversity. These shared interests were reflected in a number of questions added to the questionnaire that FAO sends to all its Parties and RFBs, to monitor progress on implementation of the CCRF. Several questions were intentionally framed to provide information also relevant to reviewing progress on Target 6. The responses of both individual States and RFBs underscore the increasing attention to these biodiversity concerns.

The responses of the FAO members to the CCRF questionnaire of 2015 indicate:

- Protection of endangered species: 91 per cent of the 65 respondents have measures providing such protection addressed by management plans in relation to these objectives, and 74 per cent have established mechanisms for monitoring and evaluation of performance.
- Precautionary approach: 89 per cent of the 65 respondents use the precautionary approaches to ensure conservative safety margins in decision-making.
- Bycatch management: 94 per cent of the 67 respondents address selectivity in their regulations; 63 per cent of the 92 respondents recognized having the problem; and 58 per cent monitored bycatch and discards. Of these, 74 per cent find their bycatch and discards unsustainable, 92 per cent put in place corrective measures which aim, *inter alia*, at protecting juveniles (in 97 per cent of the cases) and reducing ghost fishing (67 per cent of the cases).
- Protection of sharks: 49 of the 90 respondents recognized having sharks as target or bycatch species, 39 have conducted shark assessments, 36 concluded that a NPOA-Sharks was needed, and 27 have such a plan in place. However, the recent assessment of national capacity in Asia, Africa and Latin America (FAO, 2018) revealed that very few countries (particularly in Africa) meet all the minimum conditions to implement the CITES requirements to export Appendix II species of sharks and rays.

Several countries already have a management framework in place that could support the regulation of shark fisheries and provide the basis for meeting the CITES requirements. However, implementation is hampered by the limited information available to support the making of non-detriment findings (NDFs), which is compounded by limitations in the ability to identify the listed species in the catch and trade, and the weak enforcement capacity in fisheries.

- Protection of seabirds: 77 of the 89 respondents indicated that longline fishing was conducted in their area; 36 of them assessed such fisheries for the need of an NPOA-Seabirds, 23 recognized the need for such a plan and 15 had it currently in place.

In addition, the review of responses from RFMOs/As to the CCRF questionnaire of 2015 (FAO, 2016) indicates that:

- Bycatch and discards: 96 per cent of the RFBs have taken or strengthened measures to limit bycatch and discards.
- IPOA-Sharks: Assessments of the status of shark stocks were the most common activity (58 per cent of RFBs) followed by publishing documents and guidance (50 per cent of RFBs).
- IPOA-Seabirds: The most common activity was assessing the incidental catch of seabirds in longline fisheries (50 per cent of RFBs) and the publication of related documents (42 per cent of RFBs).

The uptake indicates that, before the adoption of Target 6, many fishing nations were already taking seriously the impacts of fishing on remarkable ecosystem components (particularly megafauna). However, the real impact on the ground, in terms of bycatch amounts and on abundance of the species concerned, would be a better reflection of the efficiency of the IPOA/NPOA initiatives and the responses of Parties to this element of Target 6.

Unfortunately, measuring the degree to which SAIs of fisheries on threatened species have been avoided is not a simple matter. None of the generic indicators suggested by the AHTEG could be expected to provide relevant information on this element for Target 6. Reliable reporting on this aspect of Target 6 would require, as a minimum, three practices to be in place:

- Some form of bycatch monitoring, of known accuracy and precision, that would reliably detect and report mortalities of rare or threatened species;
- Some method for estimating the maximum allowable bycatch and indirect mortality that can be imposed by the fishery on the threatened species, taking into account the recovery goals in population status and time-to-recover, the other sources of mortality on those species, and the desired probability of achieving the goals.
- A process for periodic evaluation of the bycatch estimates relative to the bounds on fishery impacts on the species, with feedback on management actions if the fishery impacts are not within those bounds.

Only if the three practices were in place would it be possible to report directly on the performance of a fishery relative to Target 6C. These are demanding standards even for data-rich fisheries with significant science capacity. Consequently, at least relative progress could be reported in terms of the extent to which: (i) bycatch of threatened species is actually being monitored accurately in fisheries; (ii) biologically based allowable harm or bycatch limits for threatened species are established and used in evaluation of fisheries performance; and (iii) when progress on (i) and (ii) are not available, bycatch mitigation measures are used (e.g., gear modifications, spatial and temporal limits on fishing opportunities, economic incentives). The latter may be the weakest option when conducted and reported in an ad hoc manner, but it could be an informative option if the reporting is on the extent of development and implementation of comprehensive IPOAs for fisheries of concern. Presenting the information in the context of implementing the FAO Guidelines on Bycatch Management and Discard Reduction (2011) would also give some consistency to narrative reporting on the Target, when information is insufficient for quantitative reporting.

5.4.3 Common conclusions

Most of the examples of progress listed above can be regarded as "progress on paper" with agreements being made to do things, without necessarily changing fishing practices on the water. The "acid proof" of improvements would be given by direct assessment of trends in the status of stocks of threatened species and vulnerable ecosystems. However, because of the nature of these biodiversity components, often characterized by very long recovery times from disturbances (Musick, 1999; Mahon et al., 2000; Van Allen et al., 2012), it may take decades for threatened species and even longer for vulnerable ecosystems to accumulate the evidence that they have recovered to acceptable baselines. There are at least encouraging signs of reduced pressure on vulnerable seafloor ecosystems and expanded identification of those systems (according to the UNGA review of 2016). However, trends in exploitation of sharks and threatened marine fish, and bycatches of seabirds suggest progress on reducing fisheries pressure on threatened species needs to accelerate (Clarke et al., 2014; Torres-Irineo et al., 2014; McDevitt-Irwin et al., 2015; Baretto et al., 2016; Phillips et al., 2016; Stein et al., 2018).

These examples of progress on actual conservation and protection of threatened species and vulnerable ecosystems may reflect a more general pattern of better collaboration between fisheries management and conservation biology interests (Garcia et al., 2014), where the need for enhanced protection of VMEs from fishery impacts provide a set of priorities common to both perspectives. Conservation-focused initiatives have begun to provide greater recognition of, and substantive support for "sustainable use" of commercially exploited fish species through closer cooperation with FAO, fishers and fishery management agencies. For example, FAO, RFBs, CITES and IUCN (especially through its species specialist groups) now work more collaboratively to promote and support capacity-building in fisheries management to support CITES provisions (regarding legality and sustainability of the fish trade). According to Friedman et al., (2018a), this cooperation includes: (i) decision support and shared programme planning or management of species listed on CITES Appendices, such as the development of NPOAs for CITES-listed species that can guide fisheries management (e.g., Sadovy et al., 2007; Gillett, 2010;) as well as for sharks and rays (Fischer et al., 2012, Friedman et al., 2018a); and (ii) assessment of responses to threatened species listing under CITES, such as a jointly funded web-based portal that documents management responses in relation to fisheries for cartilaginous fish (Chondrichthyes), a database of measures put in place to conserve and manage sharks and rays, and a questionnaire framework to assess expert opinion on the delivery and impact of CITES provisions.

At the most basic reporting level, trends in fishing effort alone, in the relevant fisheries, would provide information on the potential pressure exerted on threatened species and vulnerable marine ecosystems. Less fishing overall would reduce the opportunities for fisheries to encounter them. However, unless planned otherwise, it is likely that the remaining amount of effort would be disproportionately concentrated in area of maximum abundance of the target species. Consequently, the degree to which the reduced effort actually reduces impact on the threatened bycatch species and vulnerable ecosystems depends on its new spatial distribution of effort relative to the distribution of these components. If the distributions were similar (i.e., areas of high abundance of the stocks targeted by the fishery and of the vulnerable ecosystem or threatened species largely overlap) the reductions in pressure on the vulnerable ecosystems and threatened species might be much less than the total reduction in effort on the target species. Clearly, if effort reduction is a major tool for reducing the impact of fisheries on vulnerable ecosystems or threatened species, spatial allocation of the reductions, taking the distribution of the vulnerable ecosystems and threatened species into account, would usually be more effective than just reducing overall effort but allowing fisheries to fish where and when they choose within the effort limits. In addition, as VMEs on the high seas are normally closed to trawling as soon as they are discovered, a recognition of already exploited (and impacted) areas followed by an immediate freeze (or reduction) of fishery footprint in such areas would be a measure stabilizing (or reducing) the impact.

6. Target 6D—Safe ecological limits

6.1 Rationale

Target 6 ends with the commitment that "…the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits".

This element (6D) refers to stocks, all species (implicitly target, non-target) and ecosystems in general (not only vulnerable ones) and can function to integrate all the preceding elements. By drawing them together, it implicitly acknowledges the interactions among the parts and allows consideration of both the aggregate and cumulative impacts of fishing on ecosystems[52] and extends the conservation commitments to multispecies communities, food chains, all habitats (including non-vulnerable ones) and, ultimately, the ecosystem structure and functions. Considerations of this element, therefore, necessarily overlap with those in the preceding ones.

However, the concept of SEL, also referred to in Aichi Targets 4 and 5, has never been precisely defined (and agreed) in operational terms, e.g., with clear units for its quantification (Donohue et al., 2016). Links with the concepts of ecosystem health and integrity may be assumed but these are also controversial and not better operationally described. These concepts often assume ecosystem stability although it is becoming widely accepted that ecosystems are variable, may alternate among different locally stable states, and may show directional trends over time (Frank et al., 2007; Shackell et al., 2012). Against this ecological background, the SEL concept, when used in a policy objective such as Target 6, implies a normative goal reflecting mainly "resistance to perturbation" and relates to the concepts of persistence, resilience, variability and multiple locally stable equilibria (Donohue et al., 2016), which are not easily defined in measurable terms. It may also relate to conservation of ecosystem services.

Thus, the actual implementation of this aspect of Target 6 requires much more framework development and interpretation, before guidance on reporting can be developed.

6.2 Key concepts

The notion of the variability of ecosystems was well recognized in 2010, when the target was adopted (Ives et al., 2007; Cardoso et al., 2010), so the roots of the commitment to maintain not just stocks and species but full ecosystems within SEL requires detailed consideration. The expression has not been used by the science advisory bodies of Western Europe, Canada, or the United States of America (pers. comm., ICES, Canadian Science Advisory Secretariat and the Center for Independent Experts, respectively), three of the fisheries jurisdictions with formal and structured science advisory processes for fisheries management, nor by any RFMOs (pers. comm., FAO). Rather, the term has its roots in the concept of "planetary boundaries" that was

[52] By <u>aggregate impact</u>, we refer to the ways that a single fishing action can alter multiple parts of an ecosystem, such that interactions among populations or between populations and habitats may make impacts of fishing different from what would be expected from the individual initial impacts; by <u>cumulative impacts</u>, we mean both the accumulated impacts of multiple fisheries in the same area and the accumulated impacts of a fishery operating over longer time periods. Both are addressed in the general ecosystem approach to fisheries (Garcia et al., 2003)

gaining currency at the time of COP 10. The summary paper by Rockström et al., (2009) provided a basis for arguing that across all the pressures that humans put on ecosystems, the aggregate and cumulative impacts need to all remain with a "safe operating space". This space had boundaries on many environmental dimensions, including air and water quality (Gertsen et al., 2013; Sala et al., 2013), land degradation (de Vries et al., 2013) and biodiversity (Mace et al., 2014). Initially proposed as a global-scale concept, it was recognized from the outset that to be operational, downscaling to more jurisdictional scales would be necessary. Proposals for applying the concepts and approaches at regional (Dearing et al., 2014; Nykvist et al., 2013), national (Dao et al., 2013; Fang et al., 2015; Häyhä et al., 2016; Fauré et al., 2016) and local (Kahiluoto et al., 2015) levels have been explored.

Importantly, the planetary boundaries framework also acknowledges legitimate dimensions of a safe operating space for humanity, including social and economic opportunities and social justice (Rockström et al., 2009, Raworth, 2012; Steffan and Stafford Smith, 2013), as well as for nature. This notion has placed the framework in the center of much of the conceptual debate about how to harmonize the Sustainable Development Goals in ways that serve both humanity and nature (Griggs et al., 2013; Hajer et al., 2015).

Thus, the concept of SEL is clearly about how to use the ecosystem in ways that are sustainable, but do not push it beyond its boundaries and tolerances. This focus on defining boundaries of ecosystem tolerances as a precondition for discussing how to share human pressures within those boundaries has taken many forms in the discussion of sustainable development since the framework emerged (Sandin et al., 2015; Depledge 2009; Mace et al., 2013) The discussion has quickly centered on the location of "critical transitions" or the "adaptation frontier" (Bruckner et al., 2003; Preston et al., 2013) as the defining property of these property-specific safe boundaries, as reflected in approaches like the "hockey stick" relationship between many ecosystem structural properties and functional properties (Rockström and Karlberg, 2010). Although the concept has elicited strong criticism as well as support (e.g., Montoya et al., 2018) it appears to be the original source of the phrase in the target, and the role of critical transitions or tipping points is not the major basis for the professional criticisms.

Although the concept of planetary boundaries is now a central, if disputed (Montoya et al., 2018), concept in many discussions of the sustainability of human development initiatives terrestrially, the comparatively slow uptake of the concept in marine policy, planning and development has been noted (Steffan et al., 2015; Nash et al., 2017). However, this convergence of research within the planetary boundary framework on tipping points, regime limits and shifts (Hughes et al., 2013; Baum and Handoh, 2014) provides a direct link to work within more established and less disputed frameworks for evaluating human impacts on marine systems. In particular, as explored in depth in section 3, the identification of limits for stock status and fishery parameters, such as spawning biomass (state) and fishing mortality (pressure), are the foundation for contemporary single-species fisheries management, used both in designing harvest strategies and setting annual sustainable fisheries quotas, and assessing the status of exploited stocks to ensure removals have been within "safe limits" for individual stocks.

Although that well-established fisheries management and conservation framework was developed for use in single-stock management, it has several features that facilitate its extrapolation to other uses in fisheries. One feature is that the placement of the limit along the stock spawning biomass axis is determined largely by a function that spawning biomass serves for the stock—provision of recruits to the stock in future. Although the stock-recruit relationship is weakly determined overall for most stocks, with substantial variation in recruitment at any given spawning biomass, many methods have been used to identify the spawning biomass below which the probability of poor recruitment begins to increase markedly (ICES 2001, 2002). The function (recruitment) served by the state (spawning biomass) has an inflection point below which the specific state variable is a dominant factor in further degradation of the function, and above which many other factors can strongly influence the function. This pattern, with a critical inflection point defining a limit for a state variable relative to a function it supports, has been developed as a general formulation of the relationships between environmental states and the related functions (Rice, 2009). So, on a feature-by-feature basis for the ecosystem, the “critical transition” or “adaptive frontier” aspect of the “safe limits” is compatible with the common framework already in place for single-species fisheries management. Moreover, the methods used in fisheries, including details like the aforementioned “hockey stick” relationship (Barrowman and Myers, 2000) and more general non-parametric methods (Cadigan, 2013) for locating the inflection point or safe limit (ICES, 2001; 2002), are well known and do not require an understanding of the full functional relationship between the ecosystem state property and the functions it serves.

A second feature of the fisheries framework for reference points is that methods are well established for including uncertainty in both the status assessment and harvest advisory roles of the framework (Cadrin and Dickey-Collas, 2015). There are many possible ways it can be done, depending on the nature of the uncertainty (ICES, 2012) but the diversity of methods is a positive feature of the framework, allowing a wide range of causes of uncertainty to be accommodated and both data-rich and data-poor stocks to be assessed and managed within the same conceptual framework (Canales et al., 2017, Fulton et al., 2016.).

By including both biologically based limits and uncertainty, the stock assessment framework can provide information about the degree of precaution needed to manage the risk of falling below the safe limit. This is the third feature that nests the established single-species reference-point–based framework within the broad planetary boundaries framework. Ecological risk assessments (ERA) are becoming established as a part of fitting fisheries into the broader ecosystem, with well-developed methods for both assessing risk relative to ecosystem structure and function (Hobday et al., 2011) and for individual ecosystem features, such as seabird bycatches (Small et al.,2013). These risk-assessment and management approaches effectively complement the general risk-based approaches used in the broader planetary boundaries framework (Rockström et al., 2009; Mace et al., 2015; Dearing et al., 2014).

This review of the planetary boundaries concept and the precautionary approach to single-species assessment and management provides two points about how the SEL concept could be interpreted in its application in Target 6, in a way consistent with the original intent of this aspect of Target 6. First, SEL might be interpreted as identifying *limits* for ecosystem perturbations, just as it is being interpreted in fields like climate change (Preston et al., 2013), pollution (Diamond et al., 2015, Sandin et al., 2015.; Griggs et al., 2013) and agriculture (Campbell et al., 2017). Second, these limits are to accommodate human uses and societal values to as large an extent as possible, because of the human dependencies on activities that require impacts on natural systems (e.g., Robert et al., 2013; Heestermann, 2017) and the diversity of values used to judge those impacts (e.g., Mee et al., 2008; Gilbert et al., 2015).

Within the concepts and framework comprising the planetary boundaries concept, the basis for interpreting and applying the concept of SEL for fisheries can be developed. The steps are not easy, but they are at least clear. The notions of “safety” and “risk” will need to be operationally defined, and the definitions will have to be flexible enough to accommodate societal goals and preferences that are likely to differ culturally and economically. Once defined, the characteristics of appropriate indicators would have to be delineated, as would the properties of the “safe limits” on such indicators. Finally, assessment approaches that could operate in a range of data-poor as well as data-rich situations and inform about the risk of not being within SEL would also need to be described.

6.3 Indicators and alternative reporting approaches

Given this background for the derivation of the term within SEL, what are the implications for measurement of progress towards the aspect of Target 6? Four considerations emerge from section 6.2:

- Being within SEL is concerned with avoiding limits, where structural or functional properties critical to an ecosystem are degraded to a state where ecosystem processes cannot be supported, and further degradation is likely. It is not about being at or near some targets defined on a range of socio-ecological factors and trade-offs.
- The key properties that should not be driven below their safe limits are well-identified functional properties of ecosystems.
- The structural properties of ecosystems (and species and stocks) are far more readily quantified than ecosystem functions, so the relationships between the level of key ecosystem functions and structural properties that produce or strongly influence them are usually the basis for defining operational limits
- The “safe limits” that should be avoided with high probability are inflection points in the structure – function relationship. Below the inflection point the likelihood that the function is being adequately supported in the ecosystem begins to decrease rapidly with further decrease in the structural property (Figure 17, Panel 1). Above the inflection point, the function may increase further with increases in the structural property, but other factors are likely to have increasing influence on the function (as, for example, oceanographic conditions increase their influence on recruitment to a fish stock, as long as spawning biomass is sufficiently large to allow good recruitment under “normal” environmental conditions).

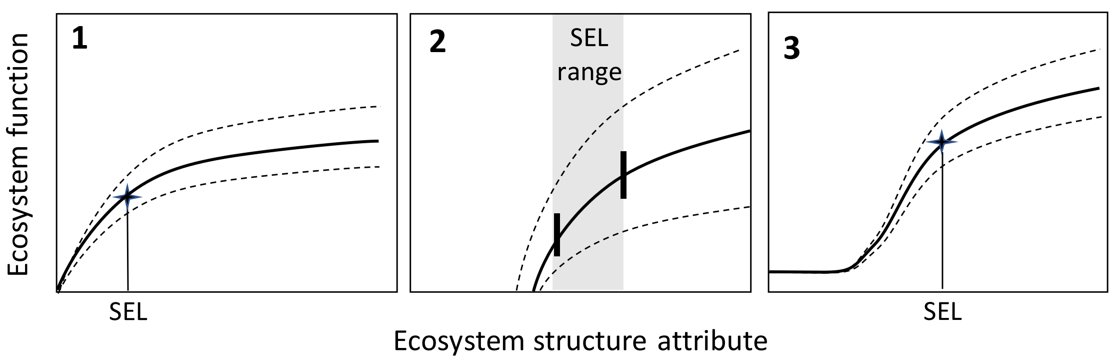

Figure 17. Schematic diagram illustrating the relation between an ecosystem function to protect and a functionally related ecosystem structure indicator. The SEL—designated by a cross (+) in the figure—corresponds to the point of inflection of a relationship, the exact shape of which may not be (completely) known. Panel 1 – A typical structure function relationship, with greatest adverse impact on the function at low availability of the structural attribute. Panel 2 – a less sensitive relationship, where at best an interval for the SEL boundary (a) can be identified. Panel 3 – a case where, at low levels of the structural attribute, the function can be partially supported by other ecosystem features.

These considerations help in evaluating the properties of indicators needed to measure achievement of this aspect of Target 6. Following from these considerations, several practical approaches to identifying indicators emerge:

- If indicators of ecosystem functions are available, they can be used directly to measure the state of the ecosystem being impacted by fishing. However, it is necessary to know how much of the function is needed to maintain the ecosystem processes in order to set a limit on the level of the function that must be avoided with high likelihood.

- If functional indicators are not directly available, or critical levels of the function to maintain ecosystem processes are not known, then indicators of ecosystem structure can be used. However, the structural features should be ones known to be (or plausibly) linked to key ecosystem functions.
- Such structural features do not have to be the only features of the ecosystem linked to the functions of concern, as long as there is sufficient information to identify a region of the structural indicator below which the function is highly likely to decline, even if other factors influencing the function are in their typical range[53]. If the function supported by the structural property is highly likely to continue to decline as long as the structural property is not improved (or the function is otherwise actively enhanced) then the SEL can be the limit on the structural feature, since if that structural limit is not avoided, the dependent function will be on a degradation pathway that will eventually also reach a level of serious or irreversible harm (vertical lines on Figure 17).
- Importantly, though, the shape of the full functional relationship between the structure and function does not have to be quantified, so issues like degree of density dependence or saturation at excessive levels of the structural feature (asymptotes in Figure 17) are of secondary importance to identifying the lower inflection point in the structure – function relationship (localized at crosses [+] in Figure 17).

Because important ecosystem functions, such as productivity (Brown et al., 2002; Peck et al., 2018), resilience (Ieno et al., 2006; Saint-Béat et al., 2015) and energy flows (Pinniger et al., 2005, Blanchard et al., 2011) are the consequence of many contributing species and populations, aggregate indicators of ecosystem state (Loomis et al., 2014) may sometimes be more tractable for identifying the location of the inflection points representing the SEL. However, aggregate indicators may make it more difficult to isolate the exact causes of the decline in the function, and to direct management interventions most effectively. Unfortunately, the alternative of using a large suite of indicators including every individual population or habitat feature (in the water column or on the seafloor) in an ecosystem related to the function of concern poses other challenges. The alternative of using suites of indicators to collectively evaluate ecosystem status, (whether relative to targets or limits) is both data demanding and requires some additional assessment-like process to interpret their collective information and choose the approach management interventions (Rice, 2003; Link, 2005), a topic returned to in section 6.4.

This conclusion about the need for indicators that track at least moderately integrated ecosystem structural properties that are linked to important ecosystem functions reinforces a conclusion from the 2016 Expert Meeting. This meeting concluded that, because the indicators discussed by the Ad Hoc Technical Expert Group on Indicators for the Strategic Plan for Biodiversity 2011-2020 (14 - 17 September 2015, Geneva) were chosen within constraints of accessibility and global coverage of data needed, the resultant indicators “focused largely on fishing pressure, with a notable absence of indicators of fishing impacts at the ecosystem scale”. To address the “safe ecological limits of … ecosystems” that workshop called for additional indicators of fishing *impacts* on ecosystem properties, structure and functions. Such indicators would allow use of national assessments and reports on ecosystem status, even if the same data were not available globally. Types of indicators specific to ecosystem impacts that were suggested included:

- Size-based indicators such as the Large Fish Indicator (proportion of large fish in the species community) used in the EU (Graham et al., 2005, Greenstreet and Rogers, 2006; Modica et al., 2014);

[53] In the language of the precautionary approach, this is the region of the structural property where the likelihood of *serious or irreversible harm* begins to increase markedly.

- Food-web indicators: e.g., trophic level in the community, biomass of functional groups (Bourdaud et al., 2016; Reed et al., 2016);
- Species-based indicators: e.g., abundance or biomass of sensitive species or keystone species (for example, habitat-building species, nodal species in wasp-waist food-webs, herbivore species in coral reefs) (Foch et al., 2014; Coll et al., 2016);
- Trophic level of the community as a fishing impact indicator; trophic level of the catch as a fishing pressure indicator (Gascuel et al., 2005; Branch et al., 2010).

In addition, direct indicators of habitat structure and integrity (Rice et al., 2012; Lederhouse and Link, 2016) have also been used to evaluate ecosystem impacts of fishing.

All these indicators, and others, have been used to measure at least qualitatively and usually quantitatively how fishing has impacted ecosystem structure—size, food web linkages, species composition, or trophic structure. However, this does not mean that they have been used to quantify (in absolute or relative terms) the ecosystem functions affected by fishing, such as energy flow, productivity and stability or resilience. In addition, many of these applications have been used to determine whether targets, such as those specified in the EU Marine Strategy Framework Directive (e.g., Rice at al., 2012; Greenstreet and Rogers, 2006) or the US Magnusson–Stevens Act (Lederhouse and Link, 2016) have been achieved. This is quite a different role in decision-making than determining the likelihood that limits have been avoided.

The planetary boundaries framework for interpreting SEL highlights that setting targets is a complex interaction of social, economic and ecological considerations, including factors such as justice and equity, for which universal empirically determined targets are unlikely to be possible (Diaz et al., 2018). On the other hand, the inflection points in the structure–function relationship do give a consistent basis for determining the general position of a limit on any appropriate indicator (Rice, 2009). These inflection points may not be easy to locate, but for applications to single stocks and species the diverse methods have been developed (section 6.2) and results have been shown to be robust in tests (Piet and Rice, 2004).

The infrequency with which limits rather than targets have been set for marine ecosystem indicators is not the only challenge with making this aspect of Target 6 operational. Even when used either to assess progress towards a target or simply to track the trajectory of the impacted ecosystem, interpretation of the indicator values is not straightforward relative to broad ecosystem status. Challenges include that:

- Details of formulations of the analyses streams or models that produce the community indicator values can either make the model hypersensitive or overly buffered to ecosystem changes (Pinnigar et al., 2005; Robinson et al., 2011; Rombouts et al., 2013);
- Even when trends are found in the indicator, attributing the trend to specific causes is difficult and not possible without excellent data (Jennings et al., 2008; Seebacher et al., 2012; Sugihara et al., 2012; Gislason et al., 2017);
- Specific changes to ecosystem structure may have widespread impacts on ecosystem functions, so single structure-function relationships may appear to be capturing the ecosystem impact of a structural change, but not detect other functional impacts that may be more serious (Myers et al., 2007; Baum and Worm, 2009; Cianelli et al., 2013), or a key function may be being driven simultaneously by multiple changes in ecosystem structure (Mueter et al., 2006; Fonseca et al., 2015).

Together, these factors paint a pessimistic picture of the ability to actually apply the SEL standard for at least the ecosystem impacts of fishing using solely an indicator approach, even with suites of indicators. However, if efforts are taken to go beyond narrow indicator-based approaches, more promising pathways are available.

6.4 Integrated Approaches

Although the evaluation of ecosystem impacts relative to SEL differs from the task of evaluating ecosystems relative to achievement of targets (such as multispecies MSY), key lessons have been learned from the efforts to assess ecosystem status relative to policy targets. In both the US and EU, such assessments have gained priority since the Millennium Ecosystem Assessment, and a variety of approaches were explored.

One thought was to develop systematic guidance for selection of the most effective indicators for each evaluation. Such guidance could be provided readily enough (e.g., Rice and Rochet, 2005; Greenstreet and Rogers, 2006) but, when the outcomes were tested, "effectiveness" was found to be judged differently by different potential users of the ecosystem indicators (Rochet and Rice, 2005). In addition, when suites of indicators of the single property of benthic community status were tested, no single indicator was found to be sensitive to pressures and impacts across the range of nutrient enrichment pressures and flow regimes planned to be assessed. Rather, different indicators would be informative in different flow regimes and at different stages of perturbation (Keeley el al., 2012). Efforts to conduct such largely indicator-based assessments of Good Environmental Status (GES) within the European Commission's Marine Strategy Framework Directive made substantial progress (e.g., Shepherd et al., 2014, 2015), frameworks for interpreting the results were proposed (e.g., Cardoso et al., 2010; Mee et al., 2008; Tett et al., 2013), and useful results were identified (Potts et al., 2015; Coll et al., 2016). Nevertheless, the actual assessment of GES was debated from the policy perspective (Gilbert et al., 2015), and lacked scientific consensus on many aspects of what such assessments should include and how they should be conducted (Borja et al., 2013, 2014).

These circumstances led to re-evaluating indicator-based approaches to assessing ecosystem status relative to properties like the GES called for in the EU Marine Strategy Framework Directive. A particularly thorough evaluation concluded that to assess whether just the pelagic component of an exploited ecosystem was in GES, three conditions would have to be met: "(i) all species present under current environmental conditions should be able to find the pelagic habitats essential to close their life cycles; (ii) biogeochemical regulation is maintained at normal levels; (iii) critical physical dynamics and movements of biota and water masses at multiple scales are not obstructed" (Dickey–Collas et al., 2017). Each of those three conditions would require multiple indicators for the life cycle of all species, the components of bio-geochemical regulation, and "physical dynamics and movements of biota and water masses at multiple scales ". The study also noted that "reference points for acceptable levels of each condition and how these may change over time" would require consultations and agreement among knowledge experts, stakeholders, and governance jurisdictions".

These conclusions are no longer calling for indicator-based assessments, but stress that some variant of integrated ecosystem assessments (IEAs) will be required to evaluate ecosystem status relative to specified targets. This same conclusion will apply to assessing ecosystem status relative to SEL. Even if the dependence of limits on ecosystem structure, function and their dynamic interactions (section 6.2) may make identifying the appropriate limits somewhat more objective rather than socially negotiated, they also make an integrated approach to setting the limits even more necessary. Whether standardized indicators are used alone or are augmented with a diverse and likely variable body of information from multiple knowledge systems, the integrated outcome across all the available information is necessary to draw qualitative or quantitative inferences regarding the likelihood that the ecosystem is within SEL.

IEAs are not new. Guidance was already available in the 1990s (Toth and Hizsnyik, 1998), and assessments have been conducted regularly in recent decades in HELCOM (2010), OSPAR (2010), UNEP Transboundary Diagnostic Assessments (TDAs), and for placing fisheries within its larger ecosystem context (Garcia et al., 2003). As the limitations of solely indicator-based evaluations of ecosystem status, relative to targets, and in some TDAs became more apparent, attention to IEAs as central to such evaluations has grown. A call for more ecosystem-based approaches to fisheries management in waters under the jurisdiction of the United States led to key guidance documents nearly a decade ago (Levin et al., 2009, 2013). The assessments arising from these initiatives underwent critical scrutiny (Link and Browman, 2014), with calls for even more expanded and inclusive assessments (Dickey-Collas, 2014; Walter and Mollman 2014). In the case of integrated assessments relative to the GES for the waters of the European Union, detailed guidance has been developed for conducting them (Walmsley et al., 2017) and interpreting their results (EC, 2017). Emerging from these integrated approaches is a recognition that they need to:

- Include as wide a collection of sound information and knowledge (and experts) on the ecosystem as feasible;
- Take into account the objectives and reference points (when they exist) of the jurisdictions that will use the IEAs to inform planning and decision-making; and
- Use flexible approaches and formats to allow the two previous priorities to be well served across a wide range of marine ecosystems, jurisdictions and cultures, and quantities and quality of information.

6.5 A possible way forward

If such an integrated assessment approach is taken to evaluate the impact of fisheries on stocks, species and ecosystems, what features would appropriate assessments have?

As a start, it would be reasonable to assume that if all impacts addressed under elements 6A, 6B and 6C (individual target stocks, other species, and vulnerable marine ecosystems) meet with agreed international standards and related national ones[54], the ecosystems supporting them are highly likely to be within SEL. Even if they do not meet the international and national standards for targets, where single species LRPs have been (or could be) determined using established methods (e.g., ICES 2002, 2003) that take account of factors like species interactions (e.g., B_{esc} for forage species[55]), as long as the respective stocks, populations or species have a low likelihood of being below their LRPs, then SEL are likely to be met for the individual populations. This does not guarantee that the habitat structure and all community interactions are also within safe limits, but if they were seriously degraded then the evidence should show in the status of at least some populations. On the other hand, if some of these individual populations have an unacceptable probability of being below their LRPs, it is necessary to consider the cumulative impacts of all pressures on these highly impacted populations at the ecosystem level. In addition, the role of non-fishery drivers on their status (such as climate and pollution) should be considered. Partitioning out the effects of drivers like climate and fishing is not straightforward (Boldt et al., 2012; Shackell et al., 2012) and already identifies the need for integrated assessment approaches (Sugihara et al., 2012).

It is when confronting the task of evaluating the status of ecosystems (VMEs or ecosystems in general) against SEL that the integrated approaches become essential. Based on sections 6.2 and 6.3, the operational objective would be to maintain ecosystem structure and function[56] above the state where serious or irreversible harm is likely, with "serious harm" being defined as ecosystem functions falling to levels where the relationships

[54] For example, all target stocks are around MSY, all non-target and other species are above the level at which reproduction is threatened and do not suffer any significant adverse impact, and all vulnerable ecosystems are protected),

[55] See http://www.ices.dk/community/Documents/Advice/Acronyms_and_terminology.pdf. B_{esc} refers to the escapement biomass required.

[56] As required in the 1998 CBD Ecosystem Approach, the Malawi Principles (decision V/6) and the 2004 Addis Ababa Principles for Sustainable Use (decision VII/12)

among species, or the rates of a key process, cannot support the biological community. These breakdowns can take countless forms, such as depletion of a key lower trophic level population (Sydeman et al., 2017), depletion of a top predator (Baum and Worm, 2009) or damage to habitat structure important for community members (Rice et al., 2012). Again, however, the very many kinds of structural features of habitats or ecosystems, and the many ways in which the functions served by these features may be at risk of serious or irreversible harm, call for comprehensive ecosystem assessment approaches. On a feature-by-feature basis, the inflection point associated with the structure—function relationship may serve as an LRP for the structural feature itself, relative to its safe biological limits, but such relationships have rarely been examined in relation to SEL for the ecosystem as a whole (Rice, 2012). In addition, developing case-specific LRPs takes time and expertise, even when the data and appropriate framework are both available (ICES, 2002, 2003). Consequently, this cannot be done quickly and readily by most states. As a fallback, the outcome of well conducted integrated ecosystem assessments can be expected to identify:

- Functional properties of the ecosystem that are at least outside typical bounds of variation and may be having serious adverse impacts on other functions or relationships in the ecosystem;
- Structural properties of the ecosystem that are being perturbed to the extent that functions dependent on the structures are being altered; and
- The roles of major drivers in the changes observed in the structural and functional properties above.

A conclusion on properties and drivers may be reached by many combinations of indicators, quantitative and qualitative information, and expert knowledge. Several outcomes are possible, all of which are informative for reporting on Target 6:

- <u>The ecosystem looks fine</u>: If the assessment concludes that the ecosystem is in a state consistent with the targets set for it, then as explained in section 6.4, it is also safe to conclude that the impacts of specific pressures, including fisheries, have all been within SEL.
- <u>The ecosystem is under growing pressure</u>: If the assessment notes that pressures from fisheries are escalating, its impacts may not yet be outside SEL but may be moving in that direction and require monitoring and regular examination.
- <u>The ecosystem has been impacted</u>: If the integrated assessment concludes that some functions are being affected in ways that could have serious adverse consequences, then the assessment's evaluation of the main drivers in the ecosystem should shed as much light as possible on the extent to which the impact of fisheries on structural components in the ecosystem is contributing to those trends. On a case-by-case basis, such assessment may provide direction for focused follow-up studies to identify the specific fisheries and ecosystem features involved in the trend, so that appropriate management measures can be implemented to mitigate the impact. But in terms of reporting on Target 6, the integrated assessment will provide the necessary information that some impacts of fishing are at risk of being outside SEL, how many, and how seriously. Even if this is a relative measure, it provides some context, which can be re-evaluated over time, with regard to whether the number of structural and functional properties that are being adversely affected and the level of risk of serious or irreversible harm are being reduced.

Even in cases where there is adequate information and expertise to evaluate specific individual ecosystem structure–function relationships relative to their inflection points and assess the state of the structural features relative to those inflection points, there would have to be a number of such individual evaluations to state generically if the impacts of fishing on the habitat and ecosystem are all within SEL. The integration step would still be necessary to combine the individual results into the message needed for reporting. Again, periodic repetition of these integrated assessments would also allow tracking of the trajectory of the aggregate likelihood that the fishery impacts are outside safe limits.

7. Discussion and conclusions

This paper does not draw any firm conclusions regarding the potential achievements of fisheries in relation to Target 6 by 2020. It offers a perspective on a possible reporting framework, elaborated by the Expert Meeting on Improving Progress Reporting and Working towards Implementation of Aichi Biodiversity Target 6, held in 2016, involving the breaking-down of Target 6 into its key elements, which differ in terms of the criteria and indicators to be used to measure or qualitatively gauge achievements.

An indicator framework?

In order to contribute to the measure of progress towards global sustainability, and to relate to the SDGs, the indicators of fisheries sustainability should address its ecological, economic and social dimensions—the so-called "triple bottom line". Although the Convention on Biological Diversity is focused on the biodiversity aspects of that triple bottom line, the commitment to both its conservation and its sustainable use makes all three dimensions relevant to the CBD goals. Although Target 6 does not have elements directly addressing economic or social outcomes of fishing, patterns and levels of fishing that deliver all the elements of Target 6 must be sustainable in terms of their social and economic dimensions as well for fishers and governments to support keeping fisheries in those conditions. This makes the "use" part of the "sustainable use" goal of the CBD an intrinsic part of Target 6.

The problem of assessment and representation of sustainability in fisheries using indicators was raised more than two decades ago in the wake of UNCED (cf. Garcia, 1997) and with the publication of the FAO Guidelines on the issue (Garcia et al., 1999). Although reporting on implementation of adopted international instruments has become common practice across the UN (e.g., with the FAO CCRF questionnaire), no international "tri-dimensional" sustainability dashboard has been established for fisheries, even when the ecological outcomes are not as comprehensively laid out. This perhaps indicates the low potential cost/benefit value of such an instrument.

Without aiming specifically at such a dashboard, the 2016 expert meeting referred to above outlined an ambitious framework for comprehensive reporting on sustainable fisheries along the key elements of Target 6. The commitment of fishing nations, against the UNCLOS, the UNFSA, the CCRF, EAF, etc. already covered most of what is required in Target 6, particularly with regard to target stocks and "associated and dependent species". The incremental expectations of Target 6 were greater focus on threatened species and ecosystem status, and the 2020 deadline for aligning, in the medium-term, laws, policies and plans with the long-term goal of sustainable harvesting and conservation. Progress on these previous fisheries commitments has been consistent but slow as recognized regularly in the biannual FAO SOFIA Reports (http://www.un.org/depts/los/general_assembly/general_assembly_resolutions.htm) and annual UNGA Sustainable Fisheries resolutions (http://www.un.org/depts/los/general_assembly/general_assembly_resolutions.htm. Moreover, the 2020 deadline implied a rate of change and a related implementation capacity (in institutions, knowledge, human resources and budgets) and change that were not explicitly assessed.

Some available statements on key indicators of state, and some trends, have been given as an illustration of the types of information that might become available by 2020 and more information than envisaged here may be forthcoming if States report comprehensively on their actions and on the results obtained. The coverage in time and space of the information available on each element (6A-6D) is very uneven. The available information tells us already that actions and responses are very case specific and that a wide range of responses needs to be expected depending on species, State, jurisdictional area, political and socio-economic conditions. Global generalizations, if possible, might not be very meaningful in terms of what to do after 2020 to enable further progress.

Global assessments?

Some analysis of the global "response landscape" might be found useful anyway for international agencies and as a support for international dialogue between fisheries and conservation stakeholders. Friedman et al., (2018a) provide an example of statistical analysis of response to questionnaires concerning the impact of CITES listings on conservation of sharks and rays. While much narrower than Target 6 in scope, the methodology might be useful. Something to be mindful of, perhaps, would be the impact of the questionnaire itself and the process of familiarization with the questions on the coherence and quality of the responses. A simpler approach might be used to map the response landscape and perhaps appreciate future changes if further target dates (e.g., in 2030, etc.) are set for the future. The present FAO CCRF questionnaire does not lend itself easily to collect quantitative responses. However, a possibility would be to use binary "metrics" (Yes/No; 0/1) and a system of grading the proportion of responses (e.g., 0-25%; 26-50% and >50%), associating them with a colour code (traffic light approach) to generate a representation that would reflect the degree of progress made on countries' responses, the areas lacking implementation, etc. (e.g. Table 5).

A comprehensive system of indicators (more than 60, with five grades each) was developed by Anderson et al (2015) for 64 case-studies (fisheries) covering the period 2010-2013 and the three dimensions of sustainability: ecological, economic, and social (community). The system is probably too complicated for use at global level (as only well-documented fisheries might be reported on), however the outcome of the analysis may already prefigure what we might expect from an analysis of Target 6 implementation, namely:

- A wide range of performance should be expected between fisheries, from very good to very bad, and the overall score is sensitive to weighting used between the three dimensions;
- The rankings of fisheries performance based respectively on ecological, economic, or community criteria performance are poorly correlated

Table 5. Example of traffic-light representation of actions claimed to have been taken by FAO Parties in the 2015 CCRF questionnaire (FAO, 2016). Shading density indicates relative levels of completion, based on the percentage of respondents giving a positive response. Sustainability: High, in green (>75%); Intermediate, in yellow (50-70%); Low, in red (<50%)

Target 6 elements		Actions			Outcomes
		Laws	Policies	Plans	
6A	Sustainably harvested	**>75%**			$B>_{BMSY}$
	Legally harvested				Compliance
	Overfishing is avoided				$B>B_{MSY}$
6B	Recovery plans in place	50-75%		<50%	
6C	Threatened species				
	Bycatch				
	Vulnerable ecosystems				

	Other species				
6D	Safe ecological limits				
	Ecosystem Structure/function				

Some challenges

The barriers that may slow down progress towards Target 6 can be related to the various dimensions of sustainability:

- Environmental: e.g., Ignorance or instability of the ecosystem's carrying capacity, species interactions at the ecosystem scale, and vulnerability to degradation; and the insufficient (too little, too late) protection of vulnerable species and habitats;
- Technological: e.g., excessive capacity leading to unsustainable use of goods and services; non-existent or unaffordable alternative technology; continual technological innovation even in many small-scale fisheries, making it difficult to control effort; insufficient focus of innovation on practices to protect or enhance the ecosystem productivity;
- Economic: e.g., primacy of short-term economic gains; inadequate incentives for and insufficient investment in conservation, or excessive costs of solutions (cost of compensation, transition and alternative livelihoods, see below); perverse subsidies;
- Social: e.g., poverty; low capacity to act; marginalization; cultural barriers; violations of traditional rights; and
- Governance: e.g., inadequate legal and institutional frameworks; unclear objectives; uncertain tenure and use rights; participation deficit; poor planning; lack of performance assessment; inadequate resolution of conflicts within fisheries and with other sectors.

In addition, information plays a central role overall, and many of the barriers relate to ignorance or uncertainty; inadequate data; lack of agreed indicators; poor communication; lack of transparency; insufficient science and disregard of informal knowledge (Grafton et al., 2008; 2010), as does a lack of capacity in many places to implement measures likely to resolve problems (see below).

The responses to the FAO CCRF questionnaire of 2015 indicated that constraints to implementation of the CCRF—and hence of Target 6—include, by order of importance, as measured by the percentage of respondents:

1. budget limitations (69 per cent);
2. insufficient human resources, partly related to item 1 (39 per cent);
3. inadequate data (32 per cent);
4. institutional weaknesses (28 per cent); and
5. incomplete legal or policy frameworks (23 per cent).

In addition, data gaps are identified to be mainly on stock status (52 per cent), ecosystem (37 per cent), IUU and MCS (36 per cent), catch (35 per cent), and effort (29 per cent).

In this respect, FAO has launched an Umbrella Programme entitled "Support for the Implementation of the 2019 Port States Measures Agreement and Complementary Instruments to Combat Illegal, Unreported and Unregulated (IUU) Fishing" (PGM/MUL/2016-2021/PSMA)aiming to: (i) strengthen national and regional policy, and (ii) reinforcement of MCS systems, enhancing States' capacity and performance in relation to the various related FAO Voluntary Guidelines, to perform inspections in port and to more effectively take action against persons and entities engaged in IUU-fishing and to implement market-access measures, such as catch documentation and traceability schemes. Up to 40 countries are expected to benefit from the Programme from 2018 to 2022 within a budget of about USD 15million (Camilleri, pers. comm.; see also http://www.fao.org/port-state-measures/capacity-development/ongoing-capacity-building-efforts/en/). At the beginning of 2019, 19 countries were already involved. This capacity-building Programme alone should contribute substantially to the intent of Target 6 and SDG 14.

Like the other Aichi Biodiversity Targets, Target 6 focuses on the desired biodiversity outcomes and not the costs of achieving them, and thus does not explicitly deal with trade-off. Remaining in the bio-ecological domain, its commitments are nonetheless coherent. All the elements identified overlap and sustain each other. The problem is that behind these elements, other social and economic objectives of sustainable use are at stake. The usual tensions are about: (i) Short- and long-term costs and benefits of the conservation measures required; (ii) The distribution of such conservations cost and benefits (and resulting equity issues); and (iii) The trade-offs between improved ecosystem, economy and provision of livelihoods. For example, in all countries where strong bio-economic reforms of the capture fishery sector have been implemented, employment in the sector has suffered the most (with a reduction of about 90 per cent in Norway, for example). Teh and Sumaila (2013) estimated that 260 ± 6 million people are involved in global marine fisheries, encompassing full-time and part-time jobs in the direct and indirect sectors, with 22 ± 0.45 million of those being small-scale fisheries, equivalent to 203 ± 34 million full-time equivalent jobs. Suppressing 80 per cent of that workforce to substantially improve financial and ecological performance is a challenge that not many politicians would like to face. Even if the necessary reductions in participation were proportionately less in small-scale fisheries, the livelihood dependencies on small-scale fisheries (FAO 2015c) would make even more modest reductions very challenging socially and politically.

The delays between fishery developments and analysis of status and trends indicate clearly that by 2020, the final conclusions on performance during the current decade (2010-2020) will not be fully available; there could be a three- to five-year delay, particularly for the quantitative assessments. Forward projections of historical trends, and their coherence or divergence with time and between sources may help fill some time-gaps. Being purely statistical, or based on simulation models, their conclusions need to be considered very carefully, using multiple sources of information and "forecasting" means. In addition to the extent that Target 6 was intended to change fisheries practices for the better (from a biodiversity perspective) such projections will have to include hypotheses of how new measures will perform, making them particularly vulnerable to confirmatory (or exculpable) bias. A good example of use of projection methods is provided in section 3.3.5.

The national reports from CBD Parties and the responses of the FAO Parties, RFMOs and NGOs to the enhanced CCRF implementation questionnaire are likely to be the most comprehensive and up-to-date information available by 2020. The responses will report on actions taken, mainly, and reflect the intentions of the Parties and their adherence to international instruments, pending confirmation by quantitative outcomes. The relation between actions and outcomes is usually not very good (as shown, *inter alia,* by Anderson et al., 2015). In addition, the balance needed between the three dimensions (e.g., the Pareto equilibrium and frontier) is case-specific, e.g., very different in a small-scale abalone fishery in Chile, a large-scale snow crab fishery in the North Pacific, or a tuna fishery in Solomon Islands.

Finally, measuring the "influence" of Target 6 on the evolution of the fishery sector at a global (if this was in the objectives of the Target) level would be a major challenge because of the impossibility of separating the impacts of actions taken towards improving fisheries sustainability by scores of institutions at all levels. The outcomes of these efforts are a result of complex interactions within the fishery's social-ecological system and between it and its environmental and socio-economic environment. Chances to demonstrate a cause-effect relation between actions and outcome are better at local fishery or sector level, but disentangling the conundrum of the climatic and socio-economic drivers operating at higher scales remains a challenge. Efforts to address fisheries impacts of target species, bycatches, threatened species and the vulnerable ecosystems aspects of Target 6 were all underway well before 2010, when the Aichi Targets were adopted, although a review requested by CBD and FAO in 2011 (Rice et al., 2011) concluded that substantial additional efforts would be needed by States, RFBs and the fishing industry to achieve the intent of Target 6. Hence it is not possible to attribute with any certainty the progress achieved during the current decade (2010-2020) specifically to the actions taken in fulfilment of Target 6 commitments. Nevertheless, the intent of all the Aichi Targets is to improve the status of biodiversity and reduce the adverse impacts of human activities on the ecosystem, so progress on all aspects of mainstreaming biodiversity into fisheries practices (as illustrated in Friedman et al 2018b) also contribute to progress towards Target 6.

In terms of trends, between the last quantitative data available (2013) and 2020, the analysis of Costello et al., (2012) shows, as expected, that the future is highly dependent on the policy choices (and particularly on the alternative of pursuing purely economic performance (in terms of rent extraction) or maintaining a sustainable level of employment. While the first is likely to be chosen by developed nations, the second is more likely to be the choice of developing nations. However, as stated by Anderson at al. (2015) there are probably notable exceptions to this “rule”.

Blanchard et al. (2017) emphasize how the alternative prospective analyses undertaken at regional and national levels, and thus progress towards meeting global goals (SDGs and hence also Target 6), will depend on developments in: (i) aquaculture and farming; (ii) differences in countries’ and sectors’ adaptive capacity (iii) climate change on land and sea, and (iv) changing patterns of wealth, demand and trade. This situation has existed for decades even though drivers have evolved and, despite some progress, has not changed fast enough to face modern globalization challenges. Change is very unlikely to occur before 2020, and a difference between national and regional reports, in quality and comprehensiveness, must be expected. Paradoxically, it is in the countries where fisheries are most in need of improvement that information on sustainability will be least available and reliable.

Outlook

Friedman et al., (2018b) argue that biodiversity mainstreaming, through a co-evolution of policy and programmes between the fishery and environment conservation governance stream, will continue to progress because of several enabling factors, including:

- Growing awareness of (i) Increasing human pressures on biodiversity, (ii) Human-biodiversity interactions in marine social-ecological systems, (iii) The risk of reduction or loss of the ecosystem services needed for economic development, food security and livelihoods, (iv) The fact that conservation without or against people is likely to fail and (v) the convergence of economic and ecological interest in the longer term;
- The existence of a corpus of international legally binding agreements (e.g., UNCLOS, UNFSA, CBD), policy commitments (e.g., UNCED, WSSD, , United Nations Conference on Sustainable Development, SDGs), and high-level guidance (e.g., CCRF, EAF, Plans of Action) that create the needed enabling environment;
- Growing political support for and experience in participatory adaptive management in converging streams of governance for improved mainstreaming of biodiversity in fisheries and improved balance of environmental, social and economic goals; and

- Growing consumer demand for certified sustainable fisheries, with lower collateral impact on biodiversity.

Regarding joint progress in conservation and management of marine habitats, there are a number of examples that illustrate large-scale processes of biodiversity mainstreaming on ecosystem scales. For example, the United Nations Development Programme and the Global Environment Fund have provided opportunities for inter-institution and cross-sectoral interactions across "large marine ecosystems" in Latin America and the Caribbean (Troya, 2017).

The growing collaboration between RFMOs and regional seas organizations (RSOs) (promoted by the CBD, through the Global Dialogues of the Sustainable Ocean Initiative, and FAO[57]) also has the potential to improve governance towards a more integrated approach to habitat conservation. For example, in 2014, the North-East Atlantic Fisheries Commission (NEAFC) and the OSPAR Commission adopted a Collective Arrangement (https://www.neafc.org/print/21475) including recommendations to protect and conserve jointly identified vulnerable marine habitats (NEAFC and OSPAR, 2015). This arrangement sees both organizations work within their mandates to mainstream biodiversity and aligns closely with other global initiatives that offer sustainable fisheries management and biodiversity conservation in areas beyond national jurisdiction (Friedman et al., 2018b).

However, these factors do not apply equally well everywhere. While the developed world and some advanced developing nations are progressing towards more sustainable fisheries, most developing nations and SIDS are struggling to develop implementation capacity and to obtain an equitable share on the returns from resources in their EEZs and the high sea.

Significant tensions remain, e.g., in: (i) the short-term trade-off in objectives regarding conservation, economic returns, food security and livelihood; (ii) the different perception of risk on the part of conservation and sectoral institutions and stakeholders, which translates into disparities in preferred actions and outcomes (Mace and Hudson, 1999; Rice and Legacè, 2007; Gehring and Rufing, 2008). The coherence between the Aichi Biodiversity Targets and the SDGs should facilitate collaboration and/or trigger constructive confrontation at global as well as regional and national levels.

[57] The Seoul Outcome, which emerged from the first meeting of the Sustainable Ocean Initiative Global Dialogue in the Republic of Korea in September 2016, sets out the vision and groundwork for this initiative to promote greater collaboration between RSOs and RFMOs in mainstreaming issues of biodiversity. https://www.cbd.int/doc/meetings/mar/soiom-2016-01/official/soiom-2016-01-outcome-en.pdf

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ANNEX 1: Actions and indicators referred to in the 2016 Expert Meeting[58]

Table 1: Actions and indicators relevant for target species and depleted species. Policies and Laws (1) aim at sustainable use. The state (3) of these species is described strictly in relation to possible fisheries impact. The impact of other factors is ignored. Outcomes (4) are as specified in Aichi Biodiversity Target 6..

		1: Policies and laws are in place	2: Management measures in use	3: State	4: Outcome
A: All target species	Actions	1. International agreements translated into national legislation. 2. National fisheries policy implemented 3. EBFM/EAF in policy documents	1. Capacity management plan. 2. EBFM/EAFM measures. 3. Proper incentives in place. Reliable data on fishing operations and catches with regular stock assessment 4. Controls on fishing capacity and catches	1. Stock status evaluated against relevant benchmarks. 2. Harvested sustainably, within safe (stock) limits	Overfishing avoided
	Indicators	1. Number and coverage of stocks with adaptive management systems / plans 2. Number and coverage of MCS systems in place (including IUU assessment	1. Number and coverage of stocks with effort or catch limits 2. Number and coverage of stocks with capacity to adjust effort or catch levels in relation to status	1. Coverage of stocks sustainably harvested based on assessments of B and F or surrogates, 2. Coverage of stocks within safe limits	1. Coverage of stocks with unknown status 2. Coverage of stocks under overfishing 3. Coverage of stocks that are overfished or depleted
B: Depleted target species	Actions	Policy goals, legislation and incentives in place for bycatch/discards	1. Recovery plans and measures in place for depleted species: closures; mandatory reporting or bans on discards. 2. Species status monitored. Discard levels assessed 3.	1. Depleted species are rebuilding towards safe biological limits. 2. Bycatch/discard species within SBL	Trajectory to recovery is secure
	Indicators	Presence of regulations requiring recovery of depleted species	Depleted species designated and with recovery plans developing or adopted	Number and coverage of depleted stocks with rebuilding plan in place	1. Number and coverage of depleted species with $F<F_{Lim}$ 2. Number and coverage of depleted species with increasing biomass

[58] Expert Meeting on Improving Progress Reporting and Working towards Implementation of Aichi Biodiversity Target 6, held in Rome, Italy, from 9 to 11 February 2016.

Table 2. Actions and indicators of relevance for threatened species and other species. *Threatened species* are species on which fisheries have a significant adverse impact. *Other species* are species not otherwise covered in Target 6A, B or C. The state (3) of these species is described strictly in relation to possible fisheries impact. The impact of other factors is ignored. Policies and Laws (1) aim at sustainable use. Outcomes (4) are as specified in Aichi Biodiversity Target 6.

		1: Policies and laws are in place	2: Management measures in use	3: State	4: Outcome
C: Threatened species	Actions	1. Policies make adequate provisions to minimize impacts of fisheries on threatened species. 2. Legal provisions in place.	Protection measures in place. Species status regularly monitored.	Direct and indirect impacts of fishing kept low. Populations are increasing. Conservation status is improved.	No significant[59] adverse impacts of fisheries on threatened species
C: Threatened species	Indicators[60,61]	1. Policies make adequate provisions to minimize impacts of fisheries on *threatened species*. 2. *Threatened species*	1. Percentage of fisheries for which impacts on threatened species have been assessed 2. Percentage of fisheries that require measures to minimize impacts on threatened species that have such measures. 2.b. Coverage of threatened species impacted by fisheries for which there are bycatch limits 3. Coverage of fisheries with regular monitoring and reporting of impacts on threatened specie*s*	Coverage (or range of coverage) of threatened species for which mortality rate due to fisheries is decreasing	Coverage of threatened species experiencing significant adverse impacts from fisheries
D: Other species[62]	Actions	1. Policies to ensure that fisheries are managed and harvested using ecosystem-based approaches 2. Policies to secure that mortalities and significant indirect adverse impacts on other species are accounted for	1. Requirements for reporting on other species are in place, including catches and discards 2. Management measures in place to ensure that impact of fisheries on other species is within safe ecological limits	Mortalities and significant indirect adverse impacts on other species reduced where they exceed sustainable levels	The impacts of fisheries on other species are within SEL
D: Other species[62]	Indicators	1. Policies to ensure that fisheries are managed and harvested using ecosystem-based approaches in place 2. Policies to secure that mortalities and significant indirect adverse impacts on other species are accounted for are in place	1. Coverage of fisheries with mandatory bycatch reporting (species not covered in Target 6A, B or C) 2. Coverage of fisheries with mandatory discards reporting (species not covered in A, B or C) 3. Coverage of fisheries with management measures to reduce bycatch and discards	Trends in population of other species not covered in A, B or C	Coverage of other species within SEL

[59] Further elaboration on the term may be required. The language in the FAO deep-sea guidelines may be used as a model.
[60] Trade-related policies and measures not included here as they are more directly addressed in Aichi Targets 3 or 4.
[61] Indirect impacts of fisheries on threatened species (e.g., on habitats) are not included here as they may be dealt with by Group 3 – Ecosystems.
[62] "Other species" includes all species that are directly or indirectly impacted by one or more fisheries apart from those that have been identified as "target species" (A and B) or "threatened species" (C). See text for further explanation

Table 3. Actions and indicators of relevance for ecosystems, including vulnerable marine ecosystems. Policies and Laws (1) aim at sustainable use. The state (3) is described strictly in relation to possible fisheries impact on ecosystems, not in the state of the ecosystems in general, which may result from other impacts. Outcomes (4) are as specified in Aichi Biodiversity Target 6.

		1: Policies and laws are in place	2: Management measures in use	3: State	4: Outcomes
E: Ecosystem properties	Actions	1. Inventory of potential impacts developed 2. Vulnerable ecosystems identified 3. Policies to manage the impacts in an EBFM/EAF perspective adopted. 4. Legal mandate to adopt, implement, and enforce measures preventing significant adverse impacts exists	1. Measures to monitor ecosystem impacts of fishing and the progress towards the goals below 2. Measures to avoid, minimize, or mitigate significant adverse impacts on structure and function, such as spatial and temporal management, gear management, mesh sizes and minimum landing sizes, aggregate catch limits, to: • Maintain extent, quality and integrity of habitats • Reduce significant adverse impacts of fishing with bottom-touching fishing gears • Reduce bycatch of unmarketable fish and invertebrates. • Reduce discarding. • Reduce incidental mortality on birds, turtles, and mammals and other vulnerable bycatch species • Keep aggregate catches of functional groups from depleting the aggregate units to levels where their function in the ecosystem may be compromised • Measures to minimize loss of gears (littering) and ghost fishing	1. Governance mechanisms in place (ex: management plans, MSP, CBM) 2. Assessment of potential SAIs. 3. Assessment of ecosystem state (structure, function, important components) 4. Assessment of fishing pressure. 5. Assessment of effectiveness of species management and governance measures	1. Ecosystem impacts reduced to a level within SEL. 2. Potential for recovery of ecosystem structure and function is enhanced and maintained

Indicators	1. Coverage of policies adopting ecosystem structure references 2. Coverage of management plans consistent with EAF 3. Presence of legislation allowing actions protection of vulnerable habitats (including VMEs), and addressing threats to ecosystem structure and function	1. Measures in place related to potential ecosystem impact reduction objectives 2. Existence of ecosystem impact monitoring and/or assessment programmes 3 Existence of governance arrangements that are effective in implementing measures	Governance indicators 1. Answers to COFI questionnaire (minimal) 2. Uptake of ecosystem management measures in the fisheries (desired) 3. Level of compliance with these measures (desired) Fishing impact indicators (desired): 1. Size-based 2. Food-web 3. Species-based Fishing pressure indicators 1. Amount (spatial extent, gear type, intensity) of fishing effort within vulnerable habitats (desired) 2. Total catch (minimal) relative to best estimate of production (desired) 3. Catch of vulnerable species (minimal)	1. Trends in ecosystem impacts 2. Improvements in the indicators in Col (3) 3. Habitat rebuilding 4. Vulnerable species rebuilding

ANNEX 2: List of indicators for Target 6 considered by COP XIII (Decision XIII/28)

Generic Indicator	Specific indicator (Metrics)
Trends in certified sustainable fisheries	Number of MSC-certified stock
Trends in proportion of depleted, target and bycatch species with recovery plans	N° of countries with regulations requiring recovery of depleted species Proportion of depleted stocks with rebuilding plans in place
Trends in population and extinction risk in target and bycatch species	Red List Index (Harvested aquatic species) Number of countries with policies that make adequate provisions to minimize impacts of fisheries on threatened species Proportion of countries with regular monitoring and reporting on impacts of threatened species Proportion of threatened species for which mortality rates from fisheries is decreasing Number of countries with policies to secure that mortalities are accounted for and kept within SBLs Trends in populations of non-target species affected by fisheries Red List index (impact of fisheries) Living Planet Index (trends in target and bycatch species
Trends in fishing practices	Global effort in bottom trawling Progress by countries in the degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing (indicator for SDG target 14.6) Amount (spatial extent, gear type, intensity) of fishing effort within vulnerable habitats Number of countries with ecosystem impact monitoring and/or assessment programmes Number of countries with legislation allowing for actions for the protection of vulnerable habitats (including VMEs), and addressing threats to ecosystem structure and function Coverage of fisheries with management measures to manage bycatch effectively and reduce discards Number and coverage of stocks with adaptive management systems / plans
Trends in proportion of fish stocks outside SBLs	Proportion of fish stocks within biologically sustainable levels (indicator for SDG target 14.4)
Trends in CPUE	Estimated fisheries catch and fishing effort
Small-scale fisheries	Progress by countries in the degree of application of a legal/regulatory/policy/institutional framework that recognizes and protects access rights for small-scale fisheries (indicator for SDG target 14.b)

ANNEX 3. Sustainable Development Goal 14: Targets and indicators relevant to fisheries

Target 14.4: By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated (IUU) fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics.

Indicator: 14.4.1- Proportion of fish stocks within biologically sustainable levels (related to Aichi Biodiversity Target 6A).

Target 14.6: By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation.

Indicator 14.6.1: Progress by countries in the degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing (related to Aichi Biodiversity Target 6A).

Target 14.7: By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism.

Indicator 14.7.1: Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries (no echo in Aichi Biodiversity Target 6).

Target 14.b: Provide access of small-scale artisanal fishers to marine resources and markets.

Indicator 14.b.1: Progress by countries in the degree of application of a legal/ regulatory/policy/institutional framework which recognizes and protects access rights for small-scale fisheries (indirectly related to A through the legal aspect, but Aichi Biodiversity Target 6 has no requirement regarding allocation or equity).

Target 14.c: Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want".

Indicator 14.c.1: Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United Nations Convention on the Law of the Sea, for the conservation and sustainable use of the oceans and their resources (related to Aichi Biodiversity Target 6A).

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