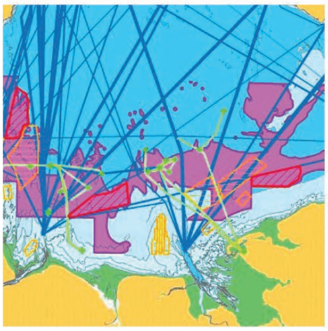
Defra

Applying the Ecosystem Approach to Fisheries Management

A global stock take and best practice review

September 2024

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Notice

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Executive Summary

The UN Convention on Biological Diversity (CBD) is an international forum dedicated to the conservation and sustainable use of the world's biodiversity. In 2022, the Kunming-Montreal Global Biodiversity Framework (GBF) was agreed by 196 countries at the 15th Conference of the Parties to the Convention (COP15). The new framework sets a global mission to halt and reverse biodiversity loss by 2030, to be delivered through four long-term goals (by 2050) and 23 targets (by 2030). Targets 5, 9 and 10 of the GBF all commit the adopted Parties to using and managing their biodiversity sustainably, and Target 5, in particular, requires the use of the ecosystem approach to management.

Traditional species-specific fisheries management is gradually shifting towards a more holistic approach that considers the wider impacts of fishing and interactions with other species, habitats and ecosystems. These aspects all fall within the ecosystem approach to fisheries management (EAFM). This report provides a review of the current understanding of EAFM and the extent to which it is being implemented globally, in line with Target 5 of the GBF. Through a global stock take of implementation, ten case studies were identified to demonstrating how the common principles of EAFM are being delivered using best practice methods and lessons that can be learnt from implementation so far. The intention is that these learnings will provide guidance to support countries in progressing towards the GBF targets by 2030.

A literature review of both academic and grey literature, on the application of ecosystem approaches to fisheries management, provided the definition and principles identified for what classifies as an ecosystem approach to fisheries management, how it is being measured/assessed, and whether there is sufficient information available to determine the extent of global progress towards EAFM, with specific consideration to achieving Target 5 of the GBF.

A survey on the use of EAFM in fisheries globally was distributed to CBD National Focal Points for Marine and Coastal Biodiversity, members of the Global Ocean Alliance (GOA) and Regional Fisheries Management Organisations (RFMO). This was designed to explore current definitions of EAFM, which aspects of EAFM (identified through the literature review) are addressed through fisheries management in each country, any barriers to implementation, and to identify examples of fisheries where EAFM is well developed.

For this report we use the CBD definition of the Ecosystem Approach (EA), and the Food and Agriculture Organization (FAO) definition of Ecosystem Approach to Fisheries (EAF), in considering EAFM. The literature review established the following key components of EAFM:

- Target species sustainability
- Non target species interactions
- Habitat interactions
- Ecosystem structure and function
- Cross cutting components

Progress towards implementation of EAFM was reviewed against each of these areas. Aspects of EAFM have been incorporated into international agreements and treaties since 1982 but implementation of management measures has been slower. The 2022 FAO questionnaire on the implementation of the Code of Conduct for Responsible Fisheries found that 82% of respondents had started implementing EAFM, although the extent of implementation varied.

Examples are given throughout the report to demonstrate how aspects of EAFM are being addressed. Literature indicates that implementation tends to take a staged approach, starting with single species management, moving to management of interactions with other fish species, bycatch and endangered, threatened and protected species (ETPs), and progressing to management of fisheries habitat and ecosystems and the social and-economic impacts of fisheries. All of this includes the overarching contributions of stakeholder participation and a precautionary approach to management. However, the case studies demonstrate that in practice, progress towards implementation depends on the priorities of each country and the type of fishery and gear that requires management.

Where there are already fishery management measures in place, these may be adapted to address wider ecosystem impacts. For example, the contribution of fishery-related closed areas may also contribute to habitat conservation (and be recognised as other effective area-based conservation measures or OECMs), and the use of bycatch reduction measures may also reduce discards or interactions with ETP species. There is less data available than needed to provide a comprehensive understanding of the level of implementation of EAFM globally, and the data that are available are skewed to more developed countries.

The FAO's EAF implementation monitoring tool provides a framework for monitoring the progress of implementation of EAFM, and has been used in fisheries in Africa, South America, the Mediterranean as well as Regional Fisheries Management Organisations (RFMOs). There are already training and capacity building materials available that could be more widely circulated to support fishery managers and other stakeholders to understand the requirements of EAFM.

EAFM offers significant potential to support the delivery of the GBF targets. The progress made so far in implementing EAFM demonstrates a wide range of management approaches that can be designed to contribute to the health of target species and the wider ecosystem. In fisheries that are early on in their journey towards EAFM, considering the examples already in place internationally along with frameworks and tools developed to guide implementation will provide a strong starting point.

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1 Introduction

1.1 Background

The UN Convention on Biological Diversity (CBD) is an international forum dedicated to the conservation and sustainable use of the world's biodiversity. In 2022, the Kunming-Montreal Global Biodiversity Framework (GBF) was agreed by 196 countries at the 15th Conference of the Parties to the Convention (COP15). The new framework sets a vison of living in harmony with nature by 2050 and aims to halt and reverse biodiversity loss by 2030, to be delivered through four long-term goals (by 2050) and 23 targets (by 2030). All Parties to the CBD must take domestic action to fully and effectively implement the GBF, by updating their national biodiversity strategy and actions plans, ensuring they are aligned to the GBF and its goals and targets, ahead of COP16[1] (Decision 15/6 CBD 2022).

The GBF commits Parties to using and managing their biodiversity sustainably. Since 1970, landings from marine fisheries have increased from approximately 60 million tonnes to 90 million tonnes. In 2021, the proportion of fish stocks within biologically sustainable levels was 62.3%, a decrease of 2.3 percentage points since 2019 (FAO 2024), and a significant decrease from 90% of stocks fished at sustainable levels in 1974. In contrast, the percentage of stocks fished at biologically unsustainable levels has been increasing since the late 1970s, from 10% in 1974 to 35.4% in 2019 (FAO 2022a). In 2021, the top seven fishing countries accounted for approximately 50% of total global capture production, while the top 20 countries accounted for over 72% (FAO 2022a). More information on the current status of world fisheries is provided in Appendix A.

GBF Target 5 (Ensure Sustainable, Safe and Legal Harvesting and Trade of Wild Species), Target 9 (managing wild caught species sustainability to benefit people) and Target 10 (Enhance biodiversity and sustainability in Agriculture, Aquaculture, Fisheries, and Forestry) all relate to sustainable fisheries. This report will focus on Target 5, which specifies the use of the ecosystem approach and sets out the proportion of fish stocks within biologically sustainable levels as its headline indicator. This aligns with indicator 14.4.1 of the UN Sustainable Development Goals (SDGs). This commitment to the ecosystem approach now underpins many fisheries policies around the world. For example:

- The EU Common Fisheries Policy states 'the CFP shall implement the ecosystem-based approach so as to ensure that negative impacts of fishing activities on the marine ecosystem are minimised, and shall endeavour to ensure that aquaculture and fisheries activities avoid the degradation of the marine environment'[2].
- The Australian Fisheries Management Act objectives state that '*ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development (which include the exercise of the precautionary principle), in particular the need to have regard to the impact of fishing activities on non-target species and the long term sustainability of the marine environment*'[3].
- The UK Fisheries Act contains an ecosystem objective that explicitly states that 'fish and aquaculture activities are managed using an ecosystem-based approach so as to ensure that their negative impacts on marine ecosystems are minimised and, where possible, reversed.[4]'

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1 Convention on Biological Diversity. 2022. 15/6. Mechanisms for planning, monitoring, reporting and review. cbd.int
2 Regulation (EU) No 1380/2013 of the European Parliament. 2013. europa.eu
3 Fisheries Management Act 1991. Australian Government. afma.gov.au
4 UK Fisheries Act 2020. legislation.gov.uk

- The South Africa Marine Living Resources Act requires '*the need to achieve optimum utilisation and ecologically sustainable development of marine living resources*' and '*the need to protect the ecosystem as a whole, including species which are not targeted for exploitation*[5]'.

Legislation is often complemented by specific policies focusing on the individual components of EAFM, such as bycatch, habitat protection, and the use of the precautionary approach.

Global Biodiversity Framework

Target 5 Ensure Sustainable, Safe and Legal Harvesting and Trade of Wild Species: Ensure that the use, harvesting and trade of wild species is sustainable, safe and legal, preventing overexploitation, minimizing impacts on non-target species and ecosystems, and reducing the risk of pathogen spill-over, applying the ecosystem approach, while respecting and protecting customary sustainable use by indigenous peoples and local communities.

Target 9 Manage Wild Species Sustainably to Benefit People: Ensure that the management and use of wild species are sustainable, thereby providing social, economic and environmental benefits for people, especially those in vulnerable situations and those most dependent on biodiversity, including through sustainable biodiversity-based activities, products and services that enhance biodiversity, and protecting and encouraging customary sustainable use by indigenous peoples and local communities.

Target 10 Enhance Biodiversity and Sustainability in Agriculture, Aquaculture, Fisheries, and Forestry: Ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably, in particular through the sustainable use of biodiversity, including through a substantial increase of the application of biodiversity friendly practices, such as sustainable intensification, agroecological and other innovative approaches contributing to the resilience and long-term efficiency and productivity of these production systems and to food security, conserving and restoring biodiversity and maintaining nature's contributions to people, including ecosystem functions and services.

1.2 Objectives of the study

ABPmer was commissioned by Defra to provide a high-level review of the current understanding and implementation of EAFM and determine what best practice could look like through the review of up to ten global case studies. Findings were used to provide high-level guidance on how progress could be made in delivering EAFM and suggestions for how successful progress could be measured.

The objectives of the study were to:

- Increase understanding of where and how ecosystem approaches are being utilised in fisheries management globally (focusing on commercial wild capture fisheries);
- Explore what has and has not worked, to produce best practice recommendations that could help to guide effective implementation of Targets 5, 9 and 10 of the Kunming-Montreal Global Biodiversity Framework (GBF).

5 Marine Living Resources Act 18 of 1998 | South African Government (www.gov.za)

This report provides a review of the current understanding of EAFM and the extent to which it is being implemented globally, in line with Target 5 of the GBF. The intention of this initial stock take is to identify a range of case studies that demonstrate how the common principles of EAFM are being delivered using best practice methods. These case studies are expanded on in Section 6 and Appendix B.

1.3 Structure of the report

The remainder of this report is structured as follows:

- Section 2 sets out the methodology for the study.
- Section 3 provides an overview of the ecosystem approach to fisheries management.
- Section 4 presents the progress made globally in implementing EAFM.
- Section 5 discusses progress made in each of the key components of EAFM.
- Section 6 outlines the case studies reviewed.
- Section 7 summarises lessons learnt and high-level recommendations.

2 Methodology

The approach to the study was split in two main phases:

- Literature review and stock take of ecosystem approaches to fisheries management.
- Case study review and best practice recommendations.

2.1 Literature review and stock take of ecosystem approaches to fisheries management

2.1.1 Literature review

A literature review of both academic and grey literature, using search engines such as Google Scholar, provided the definition and principles for what classifies as an ecosystem approach to fisheries management, key aspects of EAFM, how it is being measured/assessed, and whether there is sufficient information available to determine the extent of global progress towards EAFM, with specific consideration to achieving Target 5 of the GBF. A table was compiled to compare the components of EAFM most regularly occurring in the literature.

Where insufficient information was available to fully assess the proportion of global stocks managed through EAFM, the review focused on understanding progress towards the GBF Target 5 indicator of the proportion of fish stocks within biologically sustainable levels, based on information available through FAO. The review also explored the data gaps and barriers to assessing the proportion of stocks managed under EAFM and identified recommendations for moving towards being able to more fully assess progress.

2.1.2 Survey of national representatives

A survey on the implementation of EAFM in fisheries globally was developed and distributed to CBD National Focal Points for Marine and Coastal Biodiversity, members of the Global Ocean Alliance (GOA) and Regional Fisheries Management Organisations (RFMO). This was designed to explore definitions of EAFM in use, which aspects of EAFM (identified through the literature review) are addressed through fisheries management in each country, any barriers to implementation, and to identify examples of fisheries where EAFM is well developed. The survey circulated to GOA members and CBD Parties also asked for respondents to rank the extent to which different components of EAFM are being implemented through policy and in practice in their country. The survey was implemented using Survey Monkey, although a Word version was available upon request. The survey was sent to more than 500 contact points across the identified networks and responses for 31 countries and regions were received. Follow-up conversations with a selection of respondents provided additional context to the literature review, and helped identify options for case studies to be developed in Phase 2 of the project.

2.1.3 Research questions

The stock take considers several research areas:

- The common key principles of EAFM globally.
- Metrics currently used to measure the implementation of EAFM, including key indicators and proxies.

- An indication of the extent that EAFM is already being implemented nationally and internationally.
- An indication of how EAFM is contributing to the GBF Target 5 indicator of 'proportion of stocks fished at sustainable levels' and consideration of the extent to which this reflects the different aspects of EAFM. Where available information is limited, a proposed methodology for undertaking this assessment in the future is provided.
- Assessment of the percentage of survey respondents that indicated different aspects of EAFM are being implemented, as a stepping stone towards assessing proportion of stocks managed through EAFM in future research.
- Identification of data gaps and what information would be needed to apply the suggested methodology to calculate the proportion of stocks or fisheries considered managed through EAFM.
- Consideration of the extent to which climate change impact, mitigation and resilience is incorporated by those using EAFM or identification of data gaps required to determine this.
- Based on the above information, an indication of how far the requirement of GBF Target 5 to "apply the ecosystem approach" within the harvesting, trade, and use of wild species relevant to marine fisheries has been achieved, or identification of knowledge gaps to improve understanding of progress on this requirement.

2.2 Case studies

Through the literature review, ten case studies were identified for further investigation and the following research questions addressed:

- Where have ecosystem approaches to fisheries management been implemented successfully to deliver the outcomes specified in the GBF targets? Namely:
    - Ensuring that the use, harvesting and trade of wild species is sustainable, safe and legal, and that areas under fisheries are managed sustainably;
    - Preventing overexploitation (including overfishing);
    - Minimising impacts on non-target species and ecosystems (including bycatch);
    - Respecting and protecting customary sustainable use by indigenous peoples and local communities;
    - Providing social, economic and environmental benefits for people;
    - Contributing to the resilience and long-term efficiency and productivity of fisheries and to food security;
    - Conserving and restoring biodiversity;
    - Maintaining nature's contributions to people including ecosystem functions and services.
- What are the most successful examples of ecosystem approaches to fisheries management that have delivered these outcomes? What lessons can we learn regarding why they were successful?
- What available guidance and resources on the ecosystem approach to fisheries management are being utilised globally?
- What are the key recommendations for best practice in implementing the ecosystem approach to fisheries management? How could this inform the implementation of the GBF targets?

A matrix was developed to convey the types of management used in each case study to address each of the EAFM components. This matrix is provided as a separate Excel spreadsheet.

3 Overview of Ecosystem Approach to Fisheries Management

3.1 Definitions

The ecosystem approach to fisheries management (EAFM) is not a new concept (FAO, 2003) and has been present in international conventions in some form since 1982. The Global Biodiversity Framework uses the definition of Ecosystem Approach outlined in the CBD:

> *'The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.'*

The CBD also provides details on implementation of the ecosystem approach:

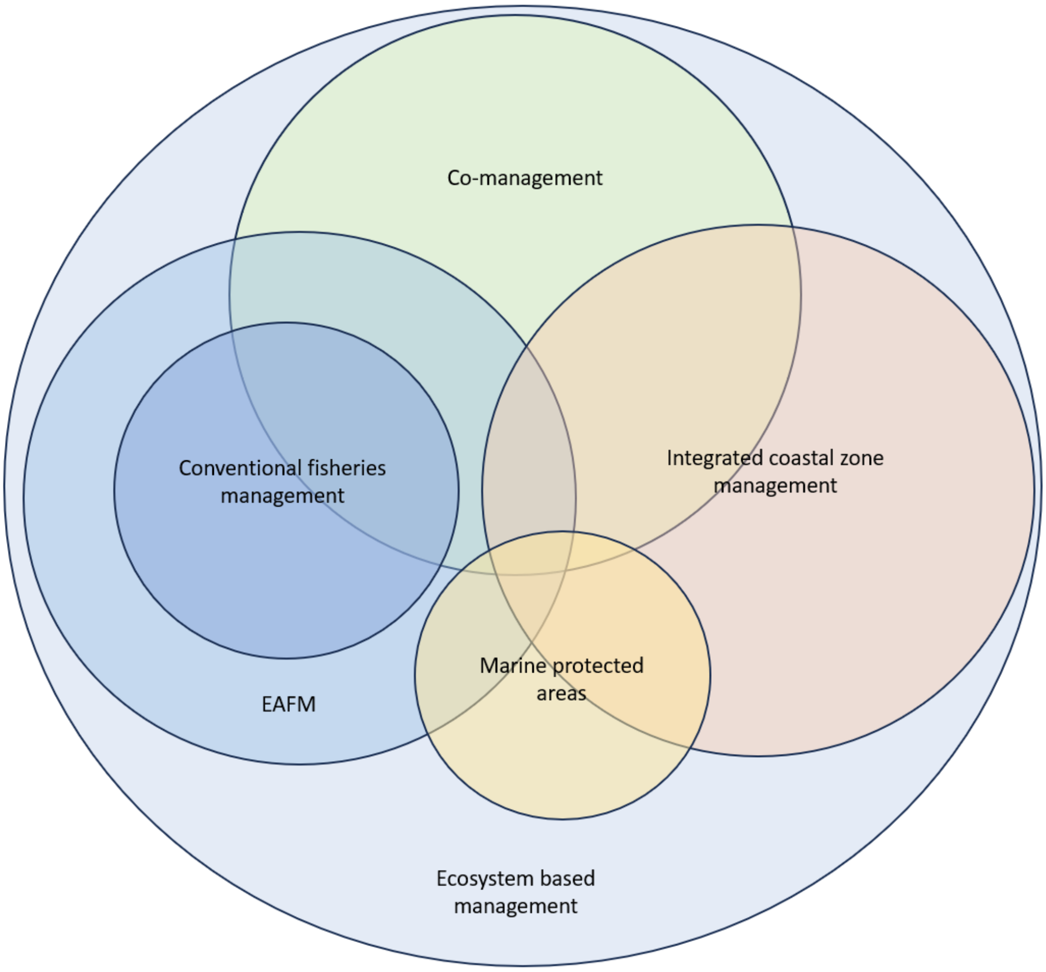
> *'Application of the ecosystem approach helps to reach a balance of the three objectives of the Convention. It is based on the application of appropriate scientific methodologies focused on levels of biological organization that encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems. The ecosystem approach is the primary framework for action under the Convention on Biological Diversity.'*

However, these definitions are broad and do not provide insight into how the Ecosystem Approach can be applied in practice in the marine environment. When considering how this explicitly applies to marine fisheries, the following bodies provide more focus:

- **Food and Agriculture Organization of the United Nations (FAO):** An ecosystem approach to fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries (FAO 2003). The FAO (2003) explains that the origins are in combining the approach to 'fisheries management' with 'ecosystem management' through two main pillars: (i) the elimination of overcapacity and overfishing, rebuilding of depleted stocks and protection of associated and dependent species; and (ii) the maintenance of ecosystem habitats, functional relations between components and productivity (FAO 2003).
- **OSPAR Convention:** the ecosystem approach is defined as "the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity".
- **International Council for the Exploration of the Sea (ICES):** The move toward an ecosystem approach to management implies that human activities should be managed such that the overall health of the marine ecosystem is not placed at risk. This means that fisheries management must consider not only the direct effects on fishery targets, but also the impacts on biodiversity, ecosystem structure, functioning, and marine habitats. The advice must also be based on the best available knowledge about the interactions between the fish populations and their environment, be it other fish populations, other organisms, or the physico-chemical environment (ICES 2012).

The Ecosystem Approach to Fisheries remains confusing to some stakeholders (Peterson *et al*., 2015), but ultimately is an acknowledgement that sustainable and productive fisheries and ecosystems require consideration of interactions between different species and other elements making up an ecosystem.

Other similar terms are in use, such as ecosystem-based fisheries management (EBFM), 'ecosystem management', 'ecosystem-based management', 'ecosystem approach to fisheries' (EAF), and 'integrated fisheries management'. While EBFM is common in the literature, the FAO guidelines (FAO 2003) explain that the term EBFM did not meet with consensus at the 2001 FAO Reykjavik Conference, possibly because some countries took it as implying that the "ecosystem" would become the new "foundation" of fisheries management. This may have been interpreted as giving environmental considerations pre-eminence over social and economic and cultural ones, raising concern about equity, political as well as social and economic costs and feasibility (FAO, 2003). The Coral Triangle Initiative provides a useful visualisation of how EAFM sits within other fisheries management approaches (Figure 1).



Source: Coral Triangle Initiative, CTI 2021

Figure 1. Visualisation of how EAFM sits within other fisheries management approaches

While there is significant debate regarding terminology and definitions, these approaches address similar or overlapping sets of objectives and there are some clear common themes regardless of the specifics of the definition or the name given to the approach (European Commission, 2022). Central to definitions is a holistic approach to management, that includes:

- impacts on the wider ecosystem;
- social, environmental, and economic aspects;
- the importance of stakeholders; and
- a precautionary approach when implementing management.

The most important point is that any progress made from single species fisheries management towards managing fisheries sustainably in the context of their wider ecosystem is positive, regardless of the terminology used. Figure 2 demonstrates how literature suggests implementation of EAFM is incremental (Fletcher and Bianchi 2014; Hilborn 2011) and usually progresses through a series of stages:

- Stage 1 consists of movement away from single species management towards the inclusion of reducing or eliminating bycatch of non-target species and mitigating impacts on ETP species.
- Stage 2 consists of considering Vulnerable Marine Ecosystems (VME) and habitat interactions, gear impacts and closed areas.
- Stage 3 considers the wider ecosystem including trophic interactions and ecosystem focussed reference points (Fletcher and Bianchi 2014).
- All stages are underpinned by social and economic considerations, participatory approach, use of best available science and the precautionary approach, and tackling illegal, unreported and unregulated fishing.

This aligns with the approach taken in reviewing fishery case studies in this report. Given the global variation in fishery type, species, size, gear and motivation, it is to be expected that not all aspects of EAFM may be addressed by any one fishery; and application of the approach to practical situations of fisheries management will also differ (Morishita 2008). Keon-Alonso *et al* (2019) discuss the use of a 'component approach' to EAFM, in which some components are being implemented while others are still being researched. FAO (2022) also acknowledge that EAFM may be possible in highly developed large-scale fisheries, but may be more challenging for data-poor, multispecies fisheries, or small-scale fisheries.

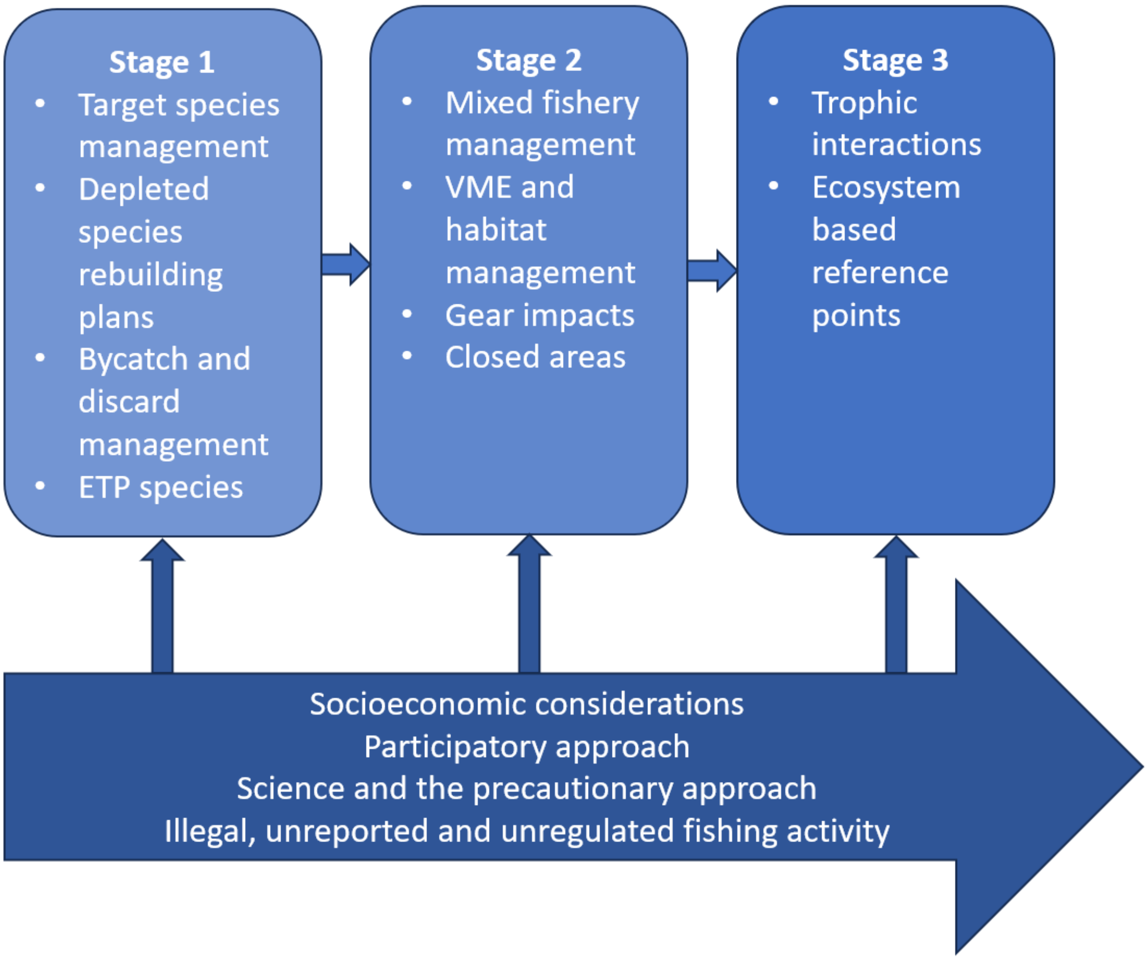


Figure 2. The stages of EAFM implementation based on findings from the literature review

FAO (2022) highlights the importance of implementing EAFM through a collaborative, co-management approach that empowers stakeholders to take responsibility for the sustainability of their fisheries in order to deliver the ecological, social and economic benefits possible through EAFM (FAO 2022). This inclusive process will help with the identification of fishery specific ecosystem interactions and appropriate management.

OECD (2022) stated the importance of agreeing a definition for EAFM in order to be able to measure progress towards it**. For this report we use the CBD definition of Ecosystem Approach (EA), and the FAO definition of Ecosystem Approach to Fisheries (EAF).** It should be noted that the use of the FAO definition was included as a survey question, and while 90% of respondents agreed that it was an appropriate definition, there were suggestions that the definition should also include reference to increased accuracy of science, setting of management goals, economic and social aspects, and clearer mention of sustainability. One respondent highlighted the importance of using the FAO definition in the context of many other international frameworks, such as the Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement).

3.2 Principles

Key principles and components of EAFM (Figure 3) have been identified from a review of papers and guidelines for EAFM, together with responses to a survey implemented by ABPmer for this project. These principles and components provided a structure which was used to consider progress in the implementation of EAFM in the context of GBF Target 5, which is discussed further in Section 5.

FAO (2003) and Staples and Funge-Smith (2009) summarised the key principles of EAFM into three overarching themes:

- ecological wellbeing;
- human wellbeing;
- ability to achieve/governance.

Garcia and Rice (2020) elaborate further that progress may be judged through action taken to address underlying components:

- Species interactions in stock assessment and management;
- Unwanted bycatch (and discards) and their impact on threatened or protected species;
- Fishing gear impact on bottom habitats and vulnerable ecosystems;
- Ghost fishing, reducing gear loss or abandonment;
- Further integration of the precautionary approach to fisheries and adoption of risk-based fishery management approaches; and
- Impact of – and adaptation to – climate change.

Figure 3 outlines the framework of EAFM principles and components based on the findings from the literature review.

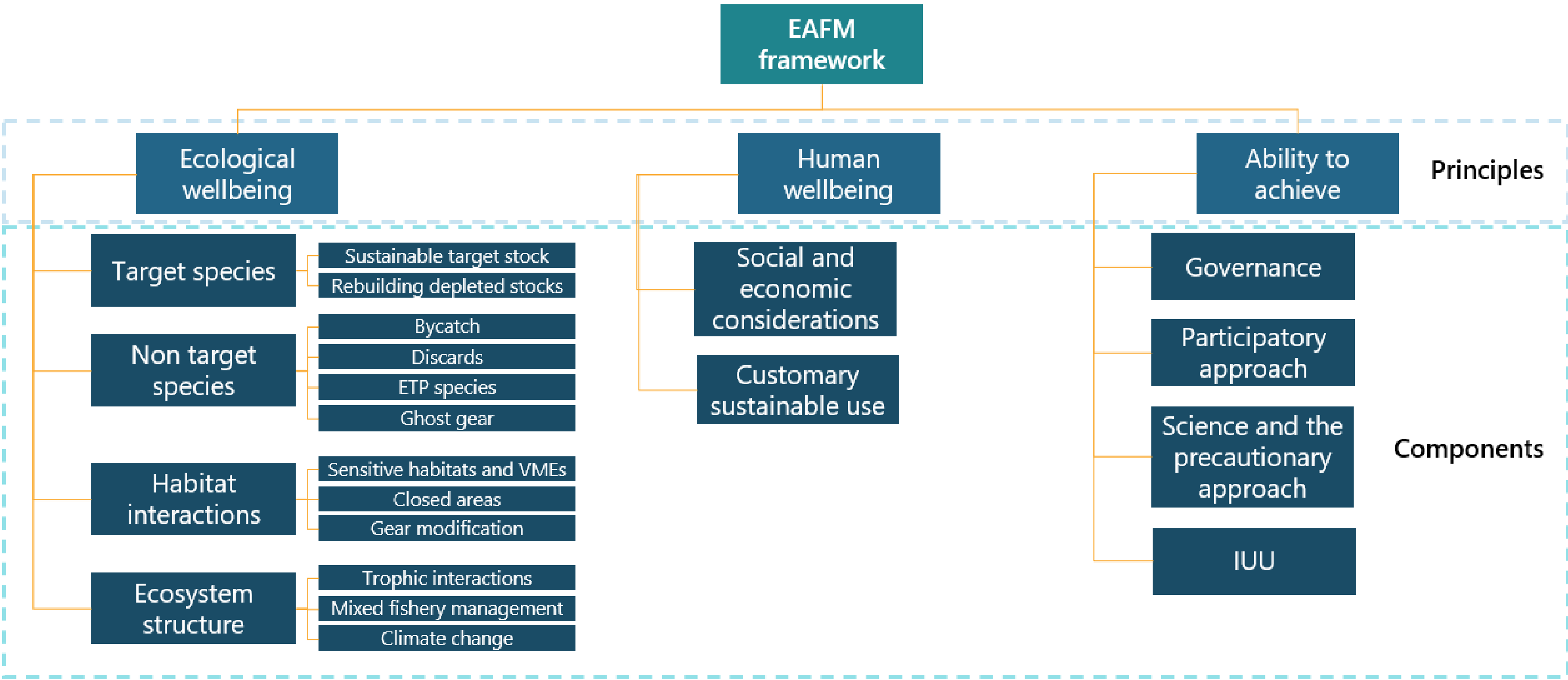


Figure 3. **EAFM principles and underlying components based on findings from the literature review**

3.3 Implementation process

The literature review revealed similarities in the implementation process recommended for EAFM. These range from a three-step to a twelve-step process, but all highlight the importance of:

- Co-management and a participatory process;
- Identifying and prioritising principles specific to the fishery in question;
- Establishing clear objectives and underlying metrics;
- Flexible and adaptive management; and
- Regular review against metrics to determine whether measures are successful.

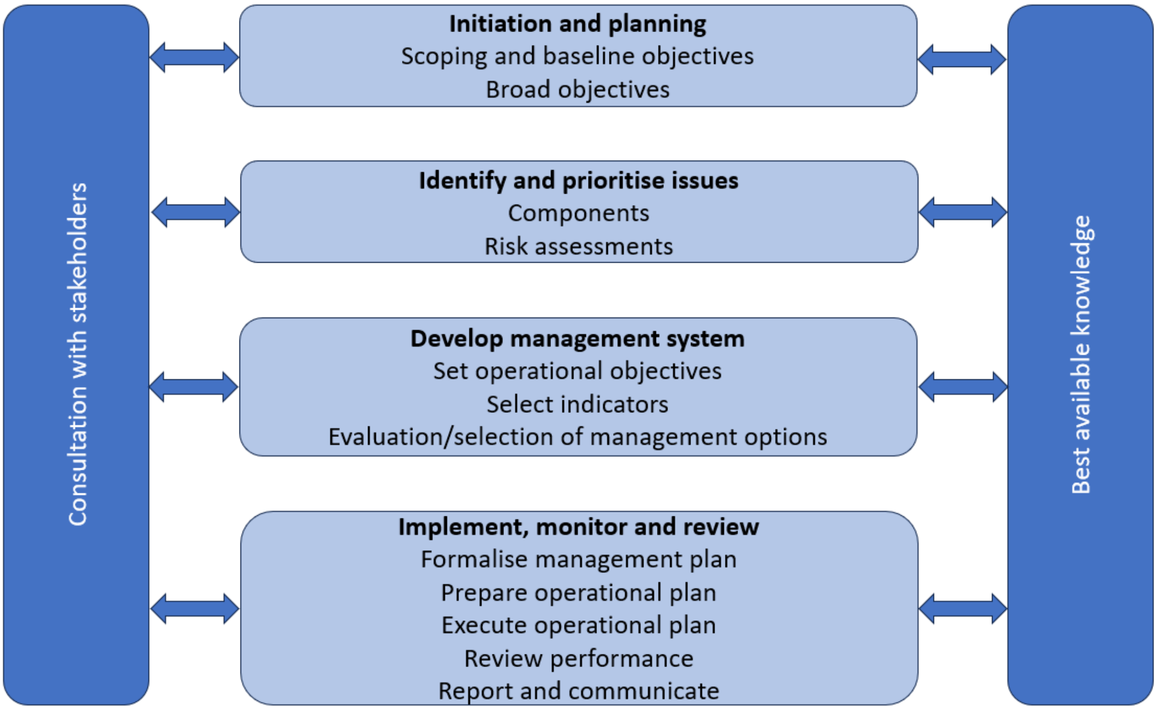
Garcia and Cochrane (2005) also highlight that the use of the participatory approach in EAFM should result in better communication between stakeholders, goals that arise through general consensus, and increased support for the management measures that are implemented. Reeves *et al* (2018) explained that since the implementation of EAFM is an incremental process, it should be viewed as a learning process and, through periodic review, can be continually developed. To aid in implementation, this process is further elaborated on by European Commission 2022; Dimech *et al* 2014; FAO 2005; Garcia and Cochrane 2005; and Brodziak and Link 2002. FAO (2021) provides a visual of the EAFM process based on the simple adaptive management cycle (Figure 4) using four steps:

Step 1. Initiation and scope: based on government and stakeholder input, generate an agreed and clear definition of the fishery (scale and type) plus a shared understanding of the social, economic and ecological objectives to be achieved.

Step 2. Identification of assets, issues and priorities: identify all relevant resource "assets", community outcomes and the issues affecting their management (generated either by the fishery or external factors) and determine priorities for direct action to best achieve objectives.

Step 3. Development of management system: develop a management system to cost-effectively and holistically deal with all high priority issues that includes clear operational objectives and the ability to monitor and assess performance.

Step 4. Implementation, monitoring and performance review: document the actions to implement the management system, monitor their completion, and evaluate and report on their performance in delivering acceptable community outcomes (FAO 2021a).



Adapted from FAO, 2021a

Figure 4. EAFM implementation process

There are multiple toolkits available to support fishery managers in setting up both the institutional framework for EAFM and delivering it in practice:

- FAO (2005) provides detailed guidelines on how to implement EAFM.
- The WWF implementation toolkit (Grieve and Short 2007) provides examples of how each of the stages have been adopted in global fishery case studies. This toolkit includes details on how to establish ecosystem values with stakeholders, how to determine the major influencing factors that could affect the ecosystem, how to establish targets and objectives, and how to design a monitoring system to assess the success of management.
- The FAO EAF Nansen project has a substantial toolkit for implementation (FAO 2021) and puts significant focus on the use of fishery management plans (FMPs) as an important mechanism for introducing EAFM into legislation through co-management and supporting translation of principles into on the ground fisheries management measures.

The intention of this report is not to overlap with the contents of these toolkits, but to provide a high-level review of the current level of EAFM implementation and assess the gaps in being able to determine progress. Only information available through literature and survey responses are used for this assessment. Future work would benefit from workshops and consultations with country representatives to create a baseline; and identify and agree appropriate progress indicators.

4 Progress Towards EAFM

4.1 Policy

The principles of EAFM have been incorporated into international agreements and treaties since the United Nations Convention on the Law of the Sea (UNCLOS) in 1982, which referenced the importance of managing associated species. The ecosystem approach is a principle of the 1992 Convention on Biological Diversity; and the 1995 FAO Code of Conduct for Responsible Fisheries (CCRF) provides a globally accepted operational framework for fisheries management that contains a significant number of EAFM principles (FAO 2003). The approach was endorsed by the FAO Committee on Fisheries (COFI) in 2003 as the appropriate and practical approach to deliver the sustainable management of fisheries (Fletcher and Bianchi 2014). Figure 5 summarises the timeline of key international agreements that contain aspects of EAFM.

To support countries to implement the requirements of the CCRF, the 2001 Reykjavik Conference (Reykjavik Declaration on Responsible Fisheries in Marine Ecosystems) proposed that an Ecosystem Approach to Fisheries (EAF) should be formally adopted by individual countries (FAO, 2002). EAFM has since been endorsed by World Conservation Congress (2012); United Nations General Assembly (2012); and the UN Conference on Sustainable Development (Rio +20) (2012). These agreements collectively require assessing all the impacts of fisheries on the ecosystem, along with consideration of the social, economic and governance components (Fletcher and Bianchi 2014). The FAO International Plans of Action for the conservation and management of sharks and a reduction of incidental catch of seabirds will also contribute to the implementation of an EAF (Garcia and Cochrane 2005).

Garcia and Rice (2020) state the importance of embedding EAFM in the legislative framework to support countries' delivery of commitment in global conventions such as the CBD. Of the seven countries responsible for the highest global landings (50%), six are party to the CBD, covering 46% of global landings (FAO 2022a). This provides a useful political framework to support the implementation of EAFM in practice.

EAFM has been integrated into regional and national fishery policies of most developed countries and the work of RFMOs, either explicitly or in its component parts (e.g., bycatch, MPAs, IUU) (Fletcher 2020).

Policy examples

In the EU, EAFM objectives are part of a range of policies and directives, including the Common Fisheries Policy (CFP), Marine Strategy Framework Directive (MSFD), Habitats Directive and Birds Directive (European Commission 2022). In Australia, the Fisheries Management Act required the use of Fishery Management Plans and Ecological Risk Assessments, as well as explicit policies to address bycatch, ghost gear and IUU. The United States Magnusson Stevens Act includes objectives for rebuilding stocks, increasing social and economic benefits and protecting habitats. Similar legislation is seen in New Zealand, South Africa, Canada and many other countries and regional management bodies. References to EAFM and its components can be seen to some extent in management policies from developing countries, although these tend to be less explicit and less likely to take the form of an overarching strategy. FAO (2021c) provides an appendix with examples of national legal and policy instruments that cover different components of EAFM.

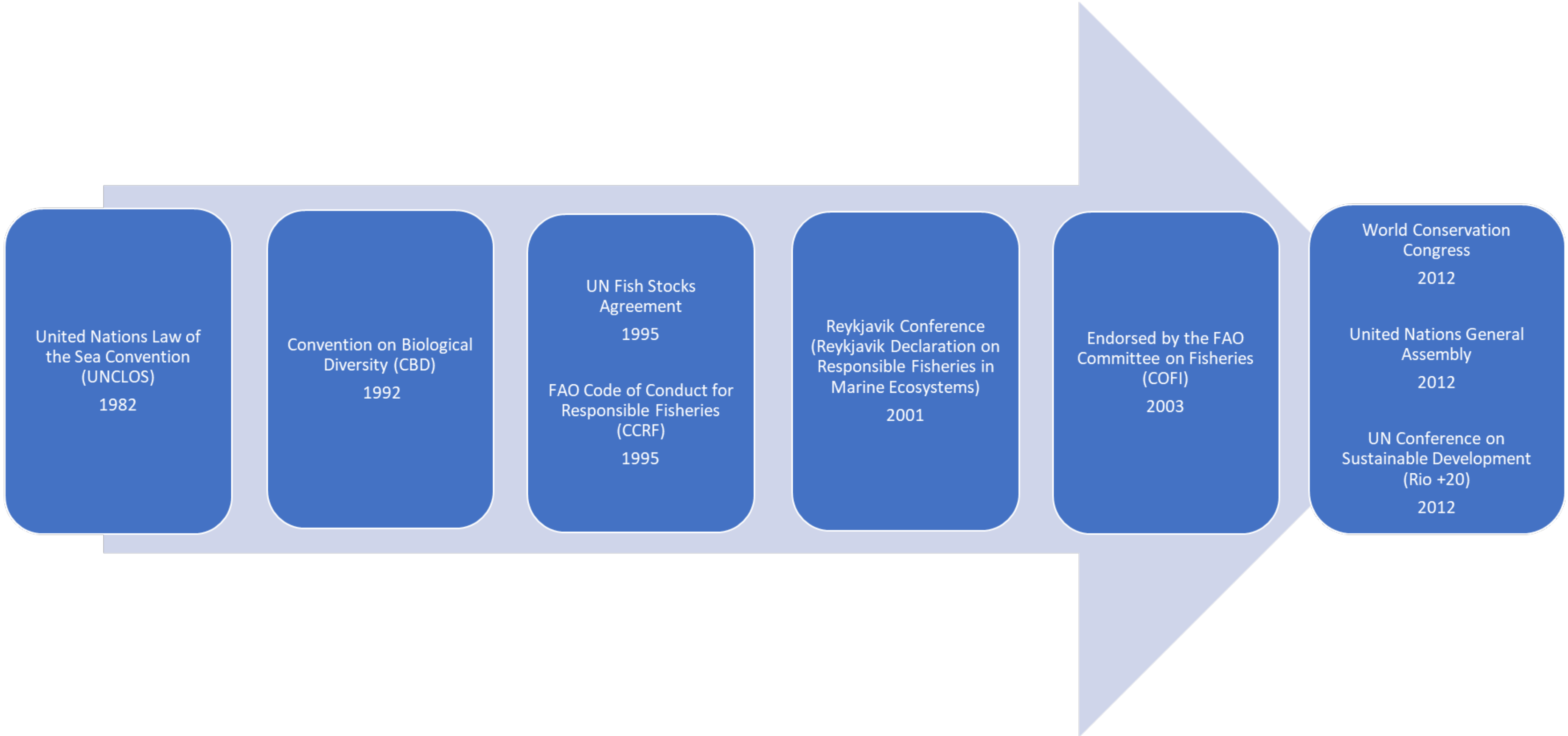


Figure 5. Timeline of key international agreements containing aspects of EAFM

4.2 Practice

The legislative structure is broadly in place for implementing EAFM (Section 4.1), but progress in implementation of management measures has been slow (FAO, 2014). 196 countries have ratified the CBD, which adopted the GBF, and commits them to the implementation of the ecosystem approach; but determining actual progress is difficult to measure given the range of challenges across different fisheries and regions leading to different EAFM components being prioritised. The FAO questionnaire on the implementation of the Code of Conduct for Responsible Fisheries (CCRF) and the ABPmer EAFM survey are discussed below and provide some indication of implementation progress globally.

4.2.1 FAO questionnaire on the implementation of the Code of Conduct for Responsible Fisheries

The FAO questionnaire on the implementation of the CCRF (henceforth, the 'FAO CCRF questionnaire'), has been circulated every two to three years since 2000, and covers a significant number of the components of EAFM, as well as explicitly asking members about their progress towards EAFM. The questionnaire relies on voluntary self-reporting by member country representatives and was most recently published in 2022 (FAO 2022). Responses have ranged from 49 members in 2004 to 128 members in 2018, indicating a growing awareness and engagement in fisheries management (FAO 2021). FAO continues to express concern that a number of countries have not responded to FAO questionnaires in recent years or report incomplete data. These countries include some large fishing nations such as Indonesia, Brazil, Mauritania and Cambodia (FAO 2022a).

The latest version of the questionnaire published in 2022 received 99 responses, which represents 50% of FAO members and 78% percent of global fisheries landings. In 2022, 82% of the respondents reported having started implementation of the ecosystem approach to fisheries (Figure 6). Based on the 2021 FAO landings data, representing 61% of total global landings (based on 2021 FAO landings data). Table 1 and Figure 7 show how this varies regionally.

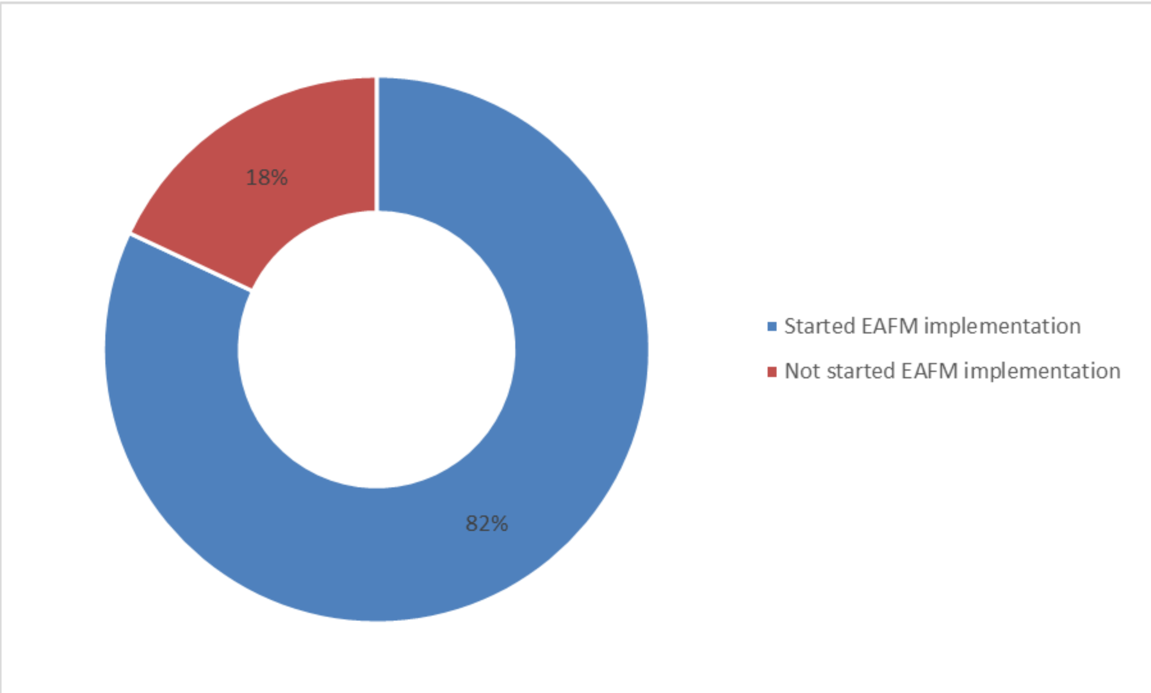


Figure 6. Percentage of respondents to the FAO CCRF questionnaire (2022) that have started implementing EAFM

Table 1. Percentage of regional landings under EAFM based on the responses to the FAO CCRF questionnaire 2022 and the FAO global landings data (2021)

Parameter	Europe	Asia	Africa	Latin America and Caribbean	North America	Near East	Southwest Pacific
Number of countries in FAO database	54	30	56	52	2	21	25
Number of FAO CCRF questionnaire responses (2022)	35	11	15	24	2	4	8
Total landings from countries responding to FAO CCRF questionnaire 2022 (million tonnes)	13.6	35.2	3	14.1	5	0.2	0.8
Percentage of total regional landings covered by responses to CCRF questionnaire (FAO 2021 data)	94%	79%	30%	98%	100%	8%	54%
Percentage of countries responding to FAO CCRF questionnaire (2022) that have started implementing EAFM	64%	73%	87%	92%	100%	50%	100%
Estimated percentage of total regional landings covered through implementation of EAFM	**60%**	**58%**	**26%**	**90%**	**100%**	**4%**	**54%**

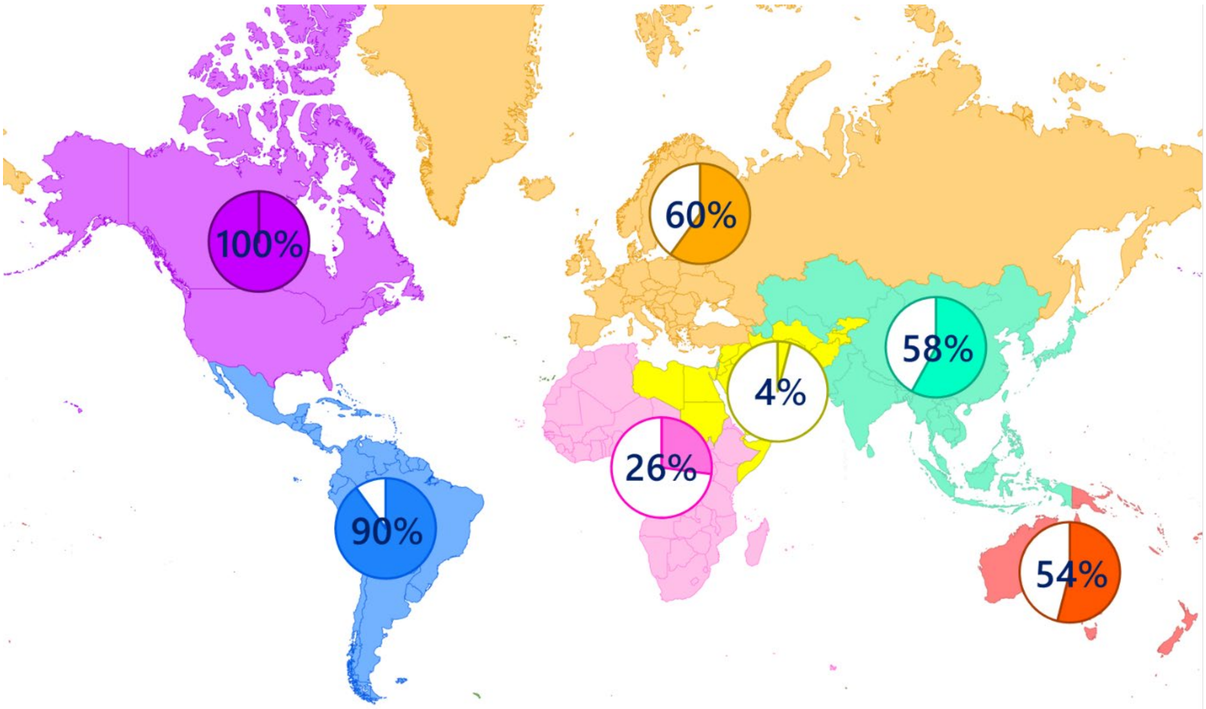


Figure 7. Percentage of regional landings under EAFM by region, based on the responses to the FAO CCRF questionnaire 2022 and the FAO global landings data (2021)

Of the respondents to the FAO CCRF questionnaire (2022) that have started implementing EAFM:

- 97% reported having established ecological, social and economic, and governance objectives;
- 97% reported having identified issues to be addressed by management actions;
- 84% reported having established monitoring and evaluation mechanisms.

Figure 8 shows implementation of EAFM at a regional level. While Asia, Northern America and Southwest Pacific are making progress on all these aspects, all other regions have made less progress towards establishing monitoring and evaluation mechanisms.

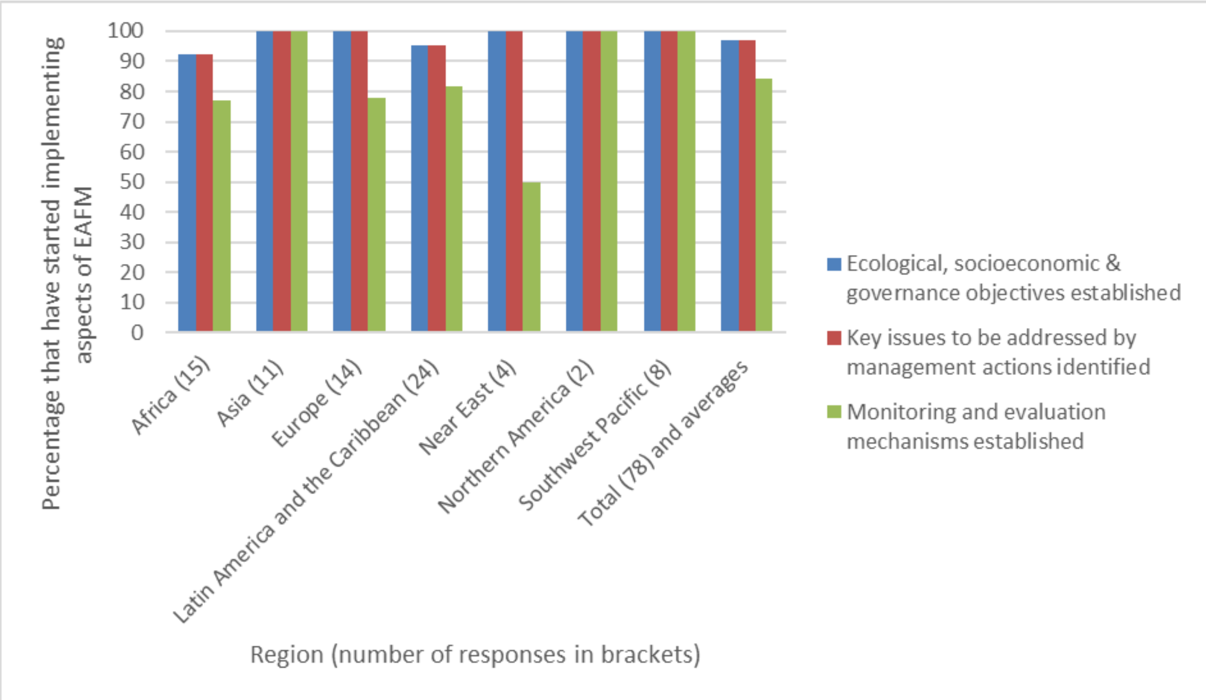


Figure 8. Percentage of respondents to the FAO CCRF questionnaire (2022) that have started implementing specific aspects of EAFM

Asia, Europe, North America and Southwest Pacific have highest reported levels of EAFM implementation. Africa, Latin America and Caribbean and Near East are at an earlier stage of implementation but do have some activities in place to address EAFM (Figure 9). Respondents indicated varying levels of activities to address EAFM components:

- 95% reported having management and institutional systems in place;
- 94% reported activities addressing retained species (target catch and bycatch);
- 92% reported activities addressing social and/or economic elements at the community and national levels;
- 87% reported activities addressing ecosystems, including fishing impacts of ecosystem structure; and
- 82% reported activities addressing discarded species (FAO 2021).

These percentages have all increased since the 2019 questionnaire, but this could be a result of different or fewer countries responding overall.

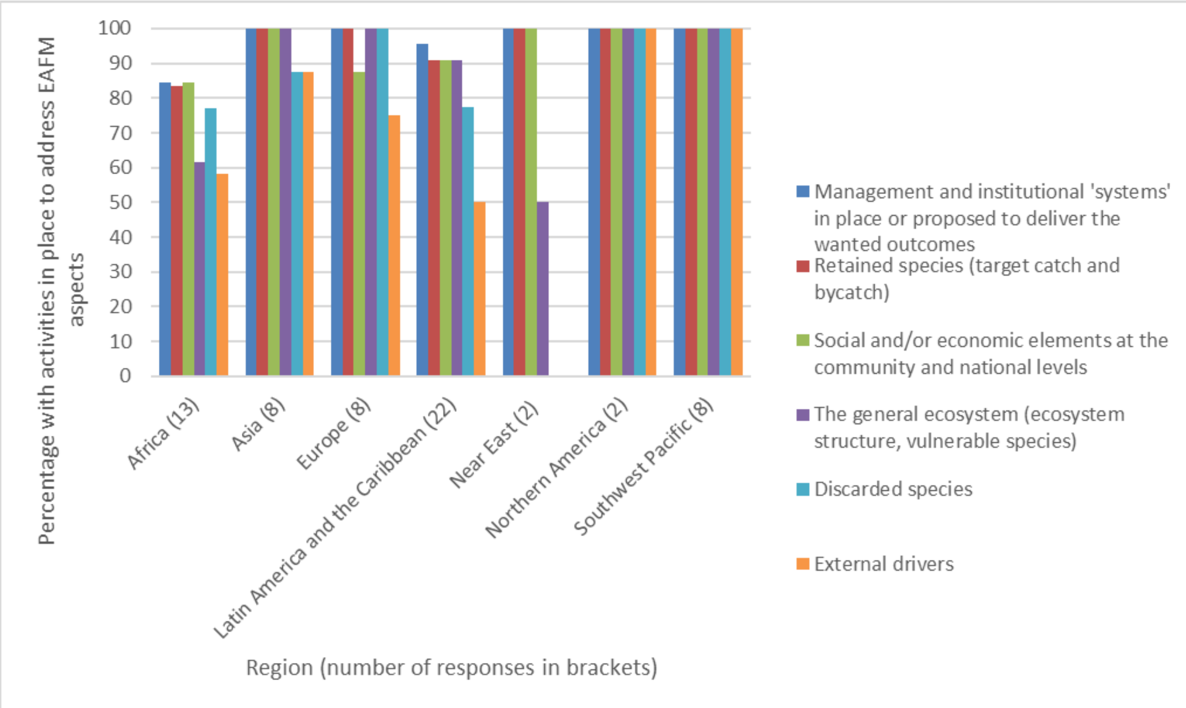


Figure 9. Percentage of respondents to the FAO CCRF questionnaire (2022) that have activities in place to address aspects of EAFM

4.2.2 ABPmer survey of national representatives on EAFM

In January 2024, ABPmer circulated a survey on EAFM to CBD National Focal Points and GOA members. This survey indicated that 55% of respondents' countries or regions were implementing EAFM in some fisheries, 26% were implementing EAFM in all fisheries, and 19% were not implementing it in any fisheries. The ABPmer survey received 31 responses and they reflect the responses to the FAO CCRF questionnaire (2022), which found 82% of respondents had started implementing EAFM.

The ABPmer survey on EAFM has provided further information on the level of implementation of EAFM measures internationally. Figure 10 shows the average extent to which respondents to the ABPmer survey thought EAFM was being implemented in policy and practice in their countries or regions. Based on the literature on the implementation process reviewed in Section 3.3, it would be expected that legislative policies supporting EAFM are in place first and then the issues are addressed in practice. In general, this seems to be the case from the survey results, with the exception of bycatch which was ranked marginally higher for progress in practice than in policy.

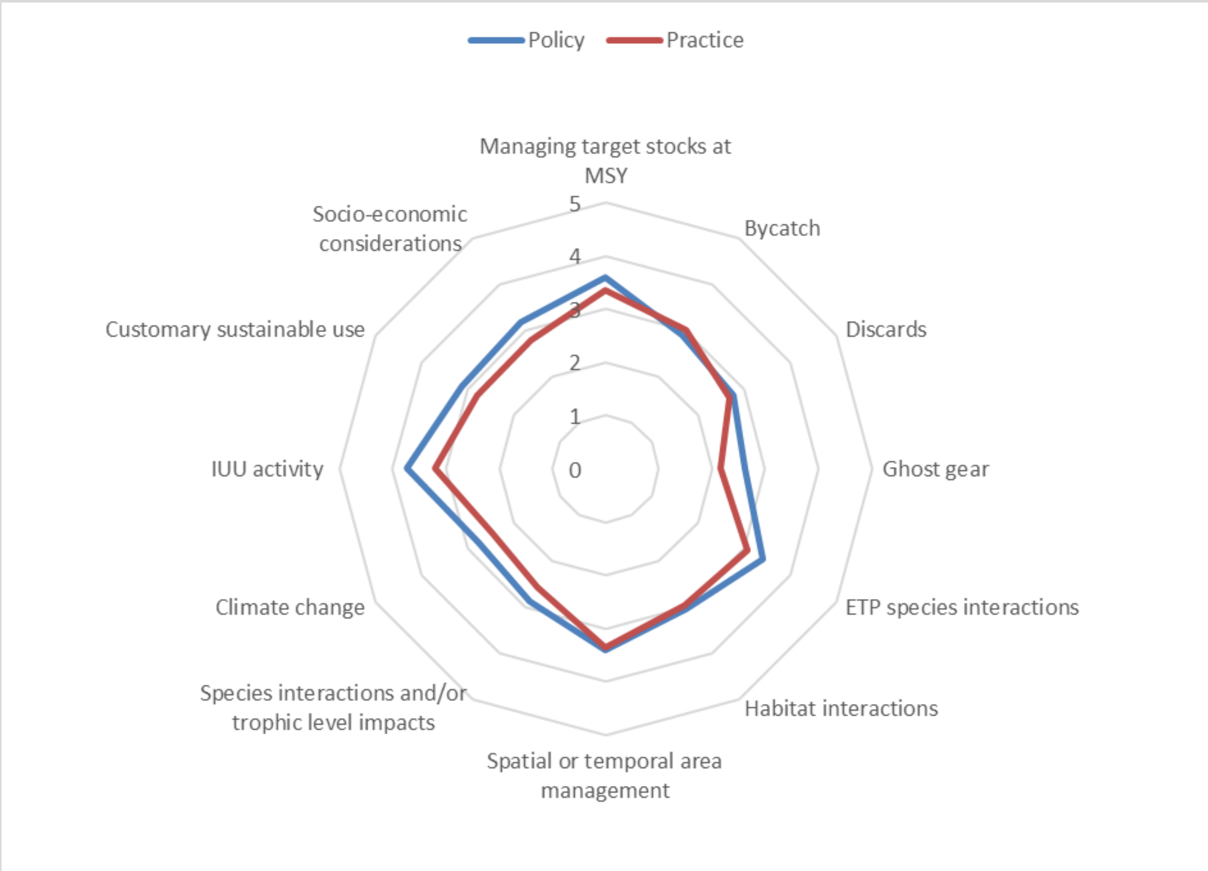


Figure 10. The extent to which respondents to the ABPmer survey reported EAFM was being implemented in policy and practice in their country or region (average based on 1 = low and 5 = high)

4.2.3 Fishery management plans

FMPs are a key delivery mechanism for EAFM. Implementation of EAFM should lead to the development of a comprehensive fishery management system that ensures the sustainable use of all ecological, social and economic systems related to the fishery (EAF toolbox, FAO 2021c), underpinned by a fisheries management plan (FAO guidelines 2005).

Fishery management plans (FMPs) are considered by the FAO (2005) to act as a tool to bring together all aspects of management to outline how implementation will be achieved for a specific fishery. They are now widely in use in developed countries such as USA, Canada and Australia, and the Marine Stewardship Council considers the presence of an overarching management plan good practice in demonstrating sustainable fisheries management (MSC 2023). The FAO's EAF Nansen project has been working with developing countries to further the delivery of the EAFM through the development and implementation of Fisheries Management Plans (FMPs) (EAF Nansen 2024).

Explicitly setting out fishery management objectives that cover EAFM principles provides the underlying direction for management measures and an FMP can help draw these together, including bycatch, habitats, social and economics, multispecies interactions, and climate change (MSC 2023). FAO (2002) also provides guidance on how to draft an FMP and what it should include, specifically referring to bycatch and other marine species, habitats, and the broader ecosystem. However, often the impacts of fishing on other species and marine habitats are poorly understood and potential management measures to mitigate these impacts may result in negative social and economic impacts. Where there is no information available, FAO (2002), suggests that FMPs should set out how this data will be obtained.

The FAO CCRF questionnaire (2022) asked country representatives about the development and implementation of FMPs. 94% of respondents stated they had developed FMPs, and of those, 92% had implemented them. When broken down by region for those who complete the questionnaire, Asia, North America and the Near East had developed FMPs for 100% of their fisheries, and in Europe 89% of fisheries had FMPs. These percentages have changed since the 2019 survey, with some regions that previously had 100% of management plans developed no longer reaching that level, potentially because different countries have responded, or respondents having included more species in the baseline calculations (e.g. now including non-TAC managed stocks).

In 2022, the FAO Committee on Fisheries (COFI) reported that the FMPs covered in the questionnaire addressed many aspects of EAFM. Of those countries with FMPs:

- 97% included measures for prohibiting destructive fishing methods and practices;
- 94% included measures to ensure the level of fishing is commensurate with the state of fishing resources;
- 94% included measures for stakeholder participation in determining management decisions;
- 92% included use of precautionary approaches which provide for conservative safety margins in decision making;
- 92% addressed selectivity of fishing gear;
- 91% addressed biodiversity of aquatic habitats and ecosystems including the identification of essential fish habitats;
- 89% addressed the interests and rights of small-scale fishers;
- 89% provided for the protection of endangered species;
- 88% contained additional measures for the protection of species with status marking them as being of concern should they be encountered by fisheries;
- 88% allowed for depleted stocks to recover;
- 86% recognised a process for identifying vulnerable habitats and other types of significant / sensitive / vulnerable areas;
- 86% addressed fishing capacity including economic considerations under which the industry operates;
- 70% make use of stock-specific target reference points; and
- 67% target or address Abandoned, Lost or Discarded Fishing Gear (ALDFG) / ghost gear.

There is regional variation in the implementation of each of these aspects, and the information is limited by how many countries responded to the survey (Figure 11).

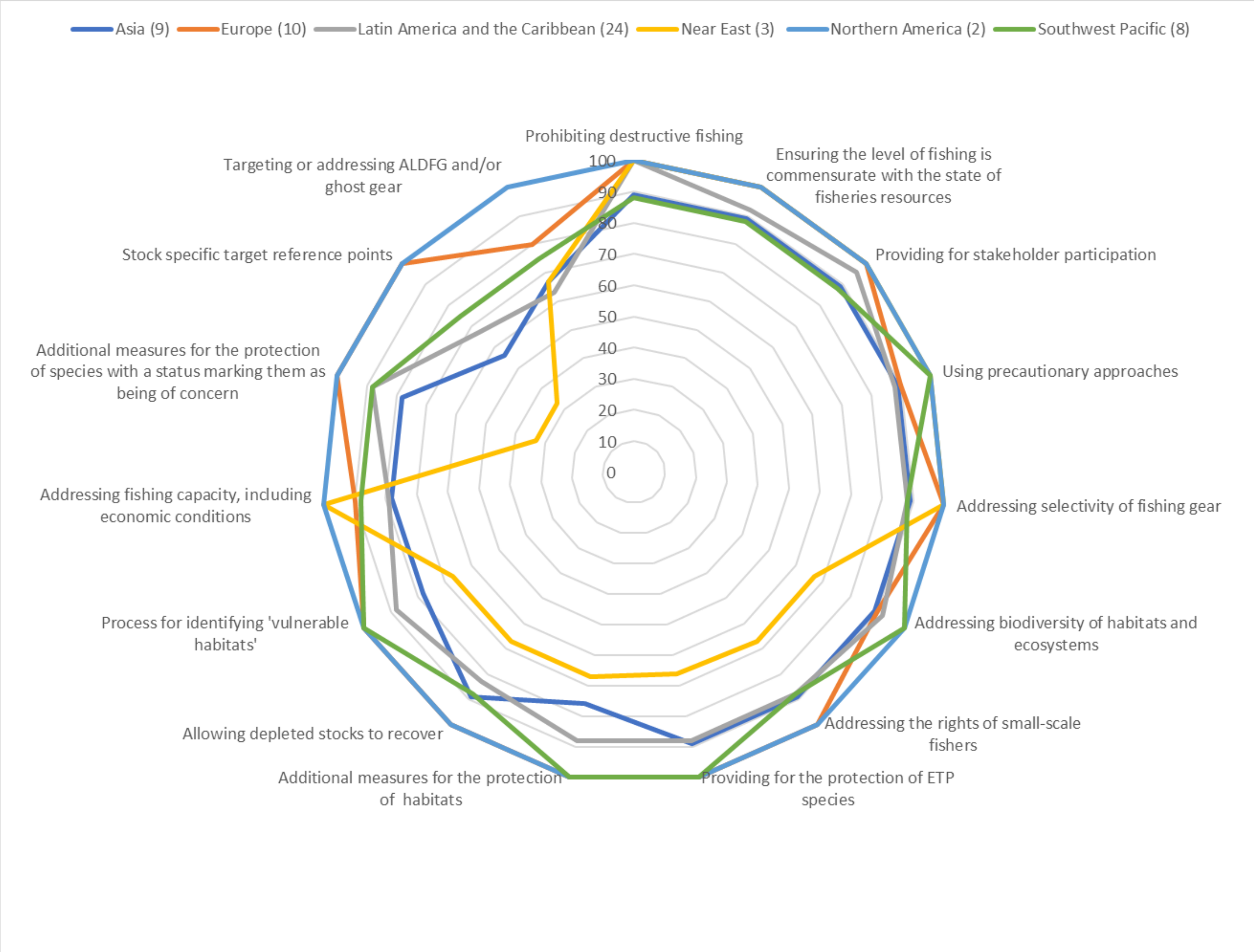


Figure 11. **Percentage of respondents to the FAO CCRF questionnaire (2022) that reported EAFM-related measures implemented through FMPs**

4.2.4 Other studies on the implementation of EAFM

There have already been many studies on the implementation of EAFM globally, including indicators to measure the degree of implementation. FAO (Defeo and Vasconcellos 2020) reviewed the implementation of EAFM in South America, and determined that progress was seen in all four pillars that underpin fisheries sustainability (ecological, social, economic and institutional capacity). There were measures in place to maintain target species within sustainable exploitation levels and to minimise impacts on habitats, as well as attempts to minimise bycatch in non-selective fisheries. However, there was less evidence of the consideration of the impacts of fishing on ecosystem function, and limited social and economic data available to evaluate achievements in relation to human wellbeing (FAO 2021). Vasconcellos and Unal (2022) used the FAO implementation monitoring toolkit to undertake a similar review of ten fisheries in the Mediterranean, and reviews are underway for Africa and Asia. Fletcher (2020) used this same toolkit to review the implementation of EAFM in cross-boundary and high seas collaborations through various international management bodies, including Regional Fisheries Management Organisations (RFMOs) and the Convention on Conservation of Antarctic Marine Living Resources (CCAMLR), which manage high seas and, in particular, migratory fish stocks using EAFM (Fletcher 2020).

A study by Pitcher *et al*. (2009) reviewed progress towards EAFM made in 33 countries, and found that more progress had been made in developing policies for EAFM, rather than in implementing management measure in practice. However, several developing countries (e.g., Malaysia, Peru, Mexico, Ecuador and South Africa), scored better than developed countries, which was attributed to progressive fishery legislators and managers in these countries and the more community-based nature of local fisheries management (Pitcher *et al* 2009).

Anderson *et al*. (2015) also considered the rate of progress towards social, economic and environmental objectives for 61 countries and found that social indicators did not necessarily correlate with the scores for environmental indicators, suggesting that using ecological indicators as a proxy for other aspects of fisheries management would lead to inaccurate conclusions on the level of progress (Anderson *et al* 2015).

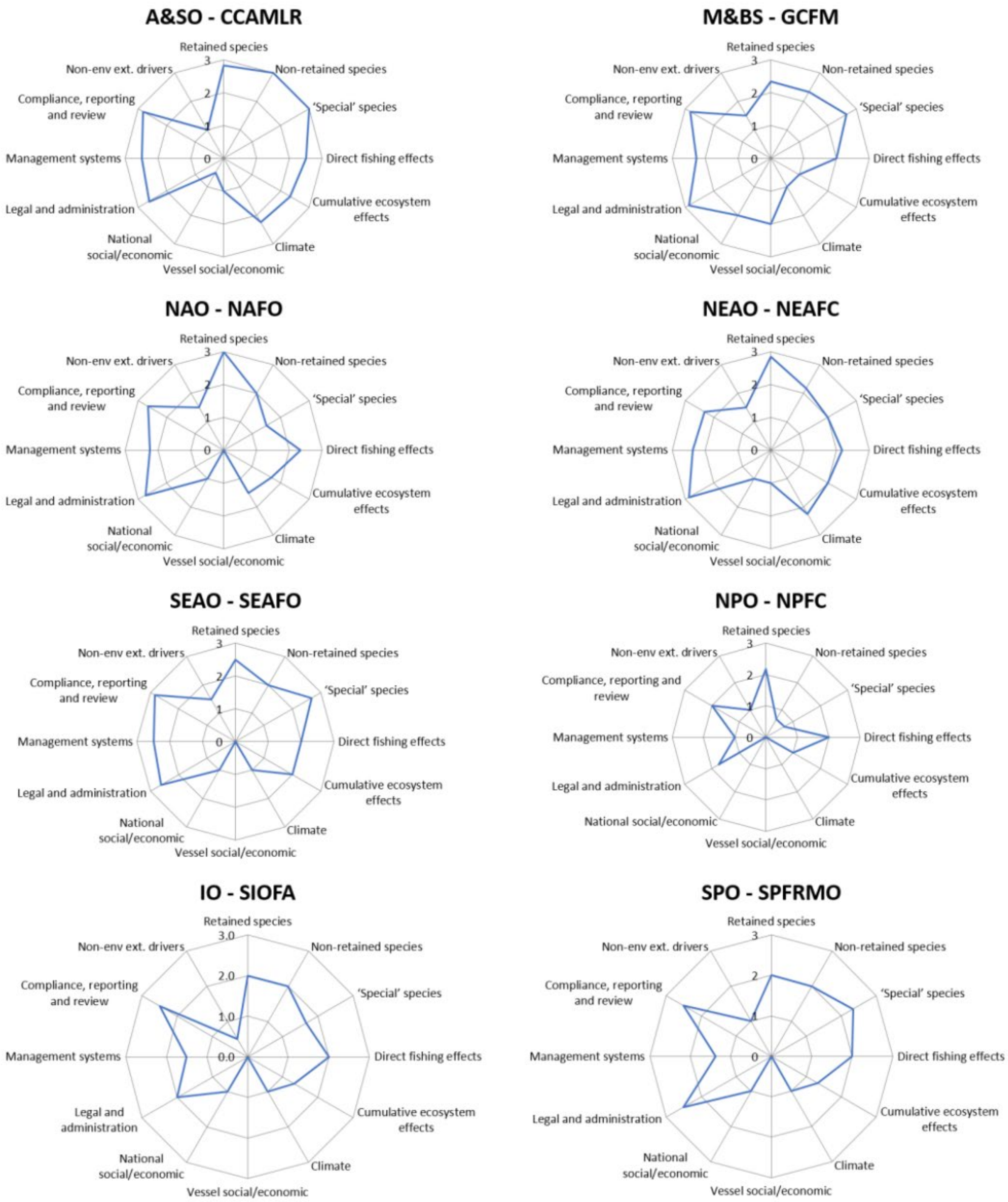
These studies demonstrate the scope of research available on the implementation of EAFM. In most cases, there is no ‘one size fits all’ approach to EAFM, as the measures used depend on the fishery and the priorities of the stakeholders. This is important to consider when trying to estimate global progress towards implementing EAFM and what best practice might look like.

4.2.5 Areas beyond national jurisdiction and RFMOs

Regional Fisheries Management Organisations (RFMOs) are international organisations establishing binding measures for conservation and sustainable management of highly migratory or straddling fish species (European Commission 2024). As these fisheries are not tied to a particular country it is harder to use the overarching metrics to document progress in implementation, however, Fletcher (2020) used the EAF implementation monitoring tool to review the implementation of EAFM in eight international management bodies (including seven RFMOs and CCAMLR, which is focused on conserving marine life but has some attributes of an RFMO). The study found varying levels of prioritisation of components and levels of implementation across RFMOs and attributed this to the time duration since they were set up and the relative value of their catches (Figure 12).

In general, the highest levels of implementation of EAFM activities were for retained species, bycatch species and benthic impacts. All RFMOs demonstrated the legal and administration structures to address the ecological components of EAFM, and seven out of the eight RFMOs had developed compliance systems. Of the EAFM aspects that had not been fully implemented, gaps have been identified and plans are in place to address these. Lower scores were seen for social and economic aspects and non-environmental external drivers (e.g., markets, fuel costs), which were attributed to there being no formal objectives for these components within most RFMOs' policies (Fletcher 2020).

The study by Fletcher (2020) found that no RFMO has completed a full EAFM assessment to examine the risk of each EAFM component and reiterated that this should be one of the first steps in the development and implementation of an EAFM system. None of the RFMOs had a fishery management plan that dealt with all EAFM components comprehensively and holistically. However, Fletcher (2020) suggested that the progress made so far by RFMOs can easily be integrated into an overarching EAFM strategy.



Taken from: Fletcher, 2020

Figure 12. Summaries of the average level of EAFM implementation within each RFMO and the CCAMLR Convention

Acronyms:
CCAMLR Conservation of Antarctic Marine Living Resources;
NAFO Northwest Atlantic Fisheries Organization;
NPFC North Pacific Fisheries Commission;
SIOFA Southern Indian Ocean Fisheries Agreement;
GFCM General Fisheries Commission for the Mediterranean;
NEAFC North East Atlantic Fisheries Commission;
SEAFO South East Atlantic Fisheries Organization;
SPRFMO South Pacific Regional Fisheries Management Organization.

Similar studies into RFMO progress towards implemented EAFM have shown that for tuna fisheries in particular there is a focus on the management of the target species and while there is reference to EAFM and/or its components in their management policies, there is less progress in practice on the interactions with other species and habitats (Juan-Jorda *et al* 2017).

4.3 Metrics to measure progress

Since the design of the EAF implementation monitoring tool by FAO in 2012 (updated in 2021 (FAO 2021d)), several studies have used it to determine the progress in implementation of EAFM. These studies demonstrate that the holistic nature of EAFM means there are a wide range of metrics that could be used to measure progress globally, however the difficulty is that different metrics apply in different fisheries and multiple metrics will generally be needed to account for the diversity of EAFM measures (Brodziak and Link, 2002). In general, the metrics are all reliant on consistent data collection and monitoring to determine current status and trends in progress (Halpern *et al*, 2015).

Table 2 highlights GBF indicators that can be used to measure progress in implementing different components of EAFM. CBD Parties are requested to use headline indicators and binary questions, as set out in the monitoring framework of the GBF adopted in CBD COP Decision 15/5, in their national reports, and supplement these, as appropriate, with optional component and complementary indicators (also included in the monitoring framework), as well as other national indicators. Target 5 has one relevant headline indicator (5.1 proportion of fish stocks within biologically sustainable levels) and discussions are underway to determine if there are other appropriate indicators. Indicators can be supplemented with EAFM toolkits designed to guide implementation and measure progress. Developing EAFM objectives through stakeholder participation should also provide an opportunity to agree appropriate metrics and indicators to demonstrate progress. Many of these components, and sustainable fisheries management in general, are also covered by FAO in their biannual questionnaire on the implementation of the Code of Conduct for Responsible Fisheries (CCRF).

Table 2. Key components of EAFM and metrics to measure progress towards implementation

Component	GBF Monitoring Framework	Other Indicators and Information Sources (Hyperlinks)
Target species sustainability · Managing target stocks at sustainable levels (MSY) · Stock rebuilding/recovery	**Headline Target 5 indicator:** 5.1 Proportion of fish stocks within biologically sustainable levels[6] **Component Target 5 indicators:** Red List Index for used species[7] **Complementary Target 5 indicators:** Marine Stewardship Council Fish catch[8]	· Sea Around Us[9] · FAO SOFIA report[10] · RAM legacy stock assessment database[11] · Global fishing index[12]
Non-target species sustainability · Bycatch · Discards · Ghost gear · ETP species interactions	**Component Target 5 indicators:** Red List Index for used species[7]; Living Planet Index for used species[13] **Complementary Target 5 indicators:** Bycatch of vulnerable and non-target species; Total catch of cetaceans under International Convention for the Regulation of Whaling[14]	· Sea Around Us[9] · Sustainable use of wild species[15]
Habitat interactions · Spatial or temporal area management · Protection of sensitive habitats/VMEs · Gear modification	**Component Target 5 indicators:** Red List Index for used species[7] **Complementary Target 5 indicators:** Proportion of terrestrial, freshwater and marine ecological regions that are conserved by protected areas or other effective area-based conservation measures	· Sea Around Us[9] · Ocean Health Index (Biodiversity)[16] · Protected Planet[17] · Vulnerable Marine Ecosystems Database[18]
Ecosystem interactions · Species interactions and/or trophic level impacts · Mixed fishery management · Climate change	No ecosystem specific indicators under Target 5	· Sea Around Us[9] · Marine Trophic Index[19]
Social and economic considerations	**Complementary Target 5 indicators:** Marine Stewardship	· Sea Around Us[9]

6 https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/1441-fish-stocks-sustainability/en
7 www.iucnredlist.org
8 www.fisheries.msc.org
9 www.seaaroundus.org
10 https://openknowledge.fao.org/items/ef79a6ba-d8df-41b9-9e87-2b6edd811511
11 www.ramlegacy.org
12 www.minderoo.org
13 www.livingplanetindex.org
14 www.iwc.int
15 https://www.unep.org/resources/report/assessment-report-sustainable-use-wild-species
16 https://oceanhealthindex.org/
17 www.protectedplanet.net
18 https://www.fao.org/in-action/vulnerable-marine-ecosystems/vme-database/en/vme.html
19 https://epi.yale.edu/epi-results/2020/component/rms

Component	GBF Monitoring Framework	Other Indicators and Information Sources (Hyperlinks)
· Customary sustainable use · Participatory approach	Council Fish catch[8]; Number of MSC Chain of Custody Certification holders by distribution country[20]	· SDG indicators[21]
Governance and policy · Science and the precautionary approach · Legal framework · Regular review with adaptive management · Risk assessments (social, economic, environmental) · monitoring control and enforcement systems · Regional collaboration across appropriate geographical scale and legislative bodies · Illegal, Unreported and Unregulated fishing (IUU)	**Complementary Target 5 indicators:** Degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing[22]	· Extent of use of FMPs[23] · IUU Fishing Risk Index[24] · Global Fishing Watch[25]

Several global metrics can be used to provide an indication of progress made in implementing EAFM. However, these are high level and should be supplemented by specific indicators such as percentage of closed areas, or population trends in ETP species, to provide a more detailed understanding, as well as fishery-specific indicators. However, Halpern *et al*. (2015), highlighted the importance of adopting indicators that provide information on the potential interactions among all components of the ecosystem because indicators that concentrate on a single component of an ecosystem cannot represent the 'health' of the system as a whole because they may miss important interactions among components. Any metrics considered must be easy to interpret, allow comparisons across countries, and be adaptable to different national contexts (OECD 2022).

20 https://cert.msc.org/supplierdirectory/
21 https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/14b1-access-rights-for-small-scale-fisheries/en
22 https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/1461-illegal-unreported-unregulated-fishing/
23 COFI. 2022. Regional statistical analysis of responses by FAO Members to the 2021-2022 questionnaire on the implementation of the Code of Conduct for Responsible Fisheries and related instruments.
24 www.iuufishingindex.net
25 www.globalfishingwatch.org

High level metrics that are already available and can be applied regionally and, in some cases nationally, include:

EAF Implementation Monitoring Tool[26] has been designed by FAO to help countries monitor progress and achievement in the implementation of the ecosystem approach to fisheries (EAF) as well as identify gaps and challenges where greater efforts are required to improve the country´s national fisheries management (FAO 2022). The EAF Nansen programme has used this tool globally, focusing on the development and delivery of Fishery Management Plans that meet EAFM criteria.

Sustainable Development Goals global database[27] provides data and analysis of 17 SDG goals using more than 200 indicators to assess more than 200 countries, areas and regions. The global indicator framework includes 231 unique indicators, including those covered by Target 14 (Life Below Water).

Fisheries Management Index[28] integrates research, management, enforcement, social and economic factors to determine the effectiveness of management systems. Countries with high Fishery Management Index (FMI) values include the United States, Iceland, Norway, Russia, New Zealand, South Africa, and Canada. Myanmar, Thailand, Brazil, China, and Bangladesh had the lowest FMI values among countries (Melnychuk *et al*. 2016).

Environmental Performance Index[29] The 2022 Environmental Performance Index (EPI) provides a data-driven summary of the state of sustainability around the world. Using 40 performance indicators across 11 issue categories, the EPI ranks 180 countries on climate change performance, environmental health, and ecosystem vitality. These indicators provide a gauge at a national scale of how close countries are to established environmental policy targets.

Ocean Health Index[30] is a measure of ocean health for 220 countries. A country's Index score is the average of 10 "goal" scores which represent the ecological, social, and economic benefits that people expect from healthy oceans.

Global Fishing Index[31] provides a comprehensive assessment of the state of 1,439 fish stocks across 142 countries, including a review of governance and an indication of progress towards SDG 14.4 (Proportion of fish stocks within biologically sustainable levels). While this is a useful summary from an Non-Governmental Organisation (NGO) perspective, it receives mixed reviews from the scientific community which should be considered when interpreting its' results (Hilborn 2021).

FAO CCRF questionnaire[32] is a biannual questionnaire circulated to FAO members to determine the level of implementation of the CCRF and contains explicit questions regarding progress implementing EAFM as well as questions on aspects of EAFM such as bycatch, discards, social and economic factors and IUU (see Section 4.2.1).

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26 FAO. 2021. Ecosystem approach to fisheries implementation monitoring tool – A tool to monitor implementation of the ecosystem approach to fisheries (EAF) management. User manual. Rome. https://doi.org/10.4060/cb3669en

27 https://unstats.un.org/sdgs/dataportal

28 Melnychuk *et al*. 2016.

29 Environmental Performance Index https://epi.yale.edu/

30 Ocean Health Index. https://oceanhealthindex.org/

31 Global Fishing Index. 2022. Minderoo Foundation Annual Report 2022. www.minderoo.org

32 COFI. 2022. Regional statistical analysis of responses by FAO Members to the 2021-2022 questionnaire on the implementation of the Code of Conduct for Responsible Fisheries and related instruments.

These metrics cover a range of aspects associated with EAFM implementation and are already in place with established reporting protocols. Most provide both global and country level analysis, and if used together may provide a useful indicator of progress towards EAFM implementation. Appendix D provides a list of potential indicators at EAFM component level, which could be used once management priorities with the fishery have been determined.

4.3.1 Marine Stewardship Council

The Marine Stewardship Council (MSC) fisheries standard is a certification scheme that awards fisheries through recognition of their performance in demonstrating sustainable fishing. The fisheries standard covers many of the core components of EAFM, including sustainable management of the target species, mitigation of environmental impacts such as bycatch, ETP species and habitats, as well as the use of robust management to underpin fishing activity. In 2023, 66 countries were engaged in the MSC programme, representing 19% of marine wild catch (either certified, in assessment or working towards assessment) (Figure 13). This has decreased since a significant volume of pelagic species had their certifications suspended as a result of a lack of mechanisms to ensure that catches were kept within scientific advice.

The MSC programme requires that fisheries continue to develop and improve their sustainable performance and management, and this is delivered through the use of 'conditions' of certification, for example undertaking further research to determine the impact of gear on habitats or implementing ETP mitigation tools. In 2023, 2,225 improvements to MSC certified fisheries had been made since its inception through the completion of conditions (MSC, 2023). Since 2020, 166 improvements have been made to benefit ETP species and reduce bycatch, 117 improvements have benefited stock status and harvest strategies, 74 improvements benefited fishery management governance and policy, and 80 improvements benefited habitats and ecosystems.

MSC also operates a chain of custody certification programme, which enabled the sale of 20,838 different fish products sold globally in 2022-23 through 47,858 sites worldwide selling sustainable seafood including supermarkets, restaurants, fishmongers and hotels. While the MSC is not immune to criticism, especially over the cost of certification being prohibitive to small scale or developing world fisheries, it sets out a useful framework to guide fisheries in the right direction to improve their performance and deliver long-term sustainability. As a third party verified standard, the intention is that there is auditable evidence of a fishery striving for best practice which is reviewed annually to ensure progress towards further improvements are being demonstrated. The process also provides a significant volume of knowledge and examples of how fisheries have overcome various challenges in order to demonstrate sustainable performance and could be a useful tool in helping fisheries to demonstrate progress towards Target 5.

Fisheries certified to the MSC standard cover a wide range of species, regions and gear types. For example, there are currently 19 dredge fisheries and 44 bottom trawl fisheries certified to the MSC standard. Fisheries using these gear type generally face opposition due to concerns over the impact they have on the habitats the gear fishes over. For these fisheries to be certified they must have demonstrated appropriate understanding of the level of impact on habitats and have a suitable mitigation system in place to limit the level of impact. Examples of these are included in Section 5.3.

Source: fisheries.msc.org

Figure 13. Location of MSC certified fisheries in 2023

5 GBF Target 5 and EAFM

The overarching objective of GBF Target 5 is to: Ensure Sustainable, Safe and Legal Harvesting and Trade of Wild Species, comprising the following:


Sustainable


Legal


Preventing overexploitation


Minimising impacts on non-target species and ecosystems


Applying the ecosystem approach


Customary sustainable use

To determine how progress towards the implementation of EAFM contributes to GBF Target 5, the EAFM components identified in the literature review (Table 3) are discussed along with the GBF outcomes agreed under Target 5. Best practice EAFM would be to design and implement a holistic strategy to address all components cohesively, but as many countries already have policies in place that contribute to implementing EAFM, this report reviews them independently and then draws conclusions about how they can be considered together to determine the level of progress.

Table 3. Components of EAFM and the requirements of GBF Target 5

EAFM component		GBF Target 5: Sustainable	GBF Target 5: Legal	GBF Target 5: Preventing overexploitation	GBF Target 5: Minimising Impacts on non-target species and ecosystems	GBF Target 5: Applying the ecosystem approach	GBF Target 5: Customary sustainable use
Target species	Target species management	✓	✓	✓		✓	
	Rebuilding depleted stocks	✓		✓		✓	
Non-target species	Bycatch	✓		✓	✓	✓	
	Discards	✓	✓	✓	✓	✓	
	Ghost gear	✓			✓	✓	
	ETP species	✓	✓	✓	✓	✓	
	IUU	✓	✓	✓		✓	
Habitat interactions	Closed areas	✓		✓	✓	✓	
	Gear modification	✓		✓	✓	✓	
Ecosystem structure and function	Trophic level impacts	✓		✓	✓	✓	
	Mixed fishery management	✓		✓	✓	✓	
	Climate change	✓			✓	✓	✓
Cross cutting	Social and economic considerations	✓	✓			✓	✓
	Customary sustainable use	✓	✓			✓	✓
	Participatory approach		✓			✓	✓
	Science and the precautionary approach	✓		✓	✓	✓	
	Governance and policy	✓	✓	✓	✓	✓	✓

Within the following review of implementation of the components of EAFM, scores are given globally for:

- Policy: the extent to which the literature review determined the component has been addressed in policy and/or legislation.
- Implementation: the extent to which the literature review determined the component has been addressed in practice.
- Data availability: the amount of information available about the component and the ease of access.
- Data reliability: how accurate the information is considered to be and whether there are significant knowledge gaps identified.

Scores are determined using a scale adapted from Fletcher (2020):

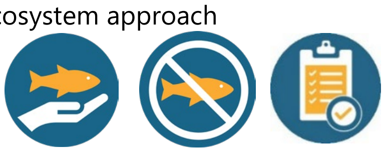
1 = None/no evidence.
2 = Few/partly/developing: some aspects covered or just beginning to be considered.
3 = Partly/some: many aspects covered but clear gaps remain.
4 = Mostly: main concerns are being addressed.
5 = All/fully: all aspects are identified and addressed.

Potential indicators of implementation are provided that could be adopted through stakeholder consultation, once appropriate fishery priorities and objectives have been identified. These are listed in full in Appendix D.

5.1 Target species

The headline indicator for GBF Target 5 is the proportion of fish stocks within biologically sustainable limits. The first step towards ecological wellbeing through the implementation of EAFM is to ensure that any target species are managed sustainably. The SDG progress indicator for indicator 14.4.1 (proportion of fish stocks within biologically sustainable levels) currently assesses global progress as 'Moderate distance from target', with trends considered to be deteriorating/moving away from target[33].

5.1.1 Managing target stocks at sustainable levels (MSY)

EAFM stage (Figure 2)	1
GBF Target 5	Sustainable; Preventing overexploitation; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	3
Data reliability (1-5)	3

[33] 14.4.1 Fish stocks sustainability | SDG Indicators Data Portal | Food and Agriculture Organization of the United Nations (fao.org)

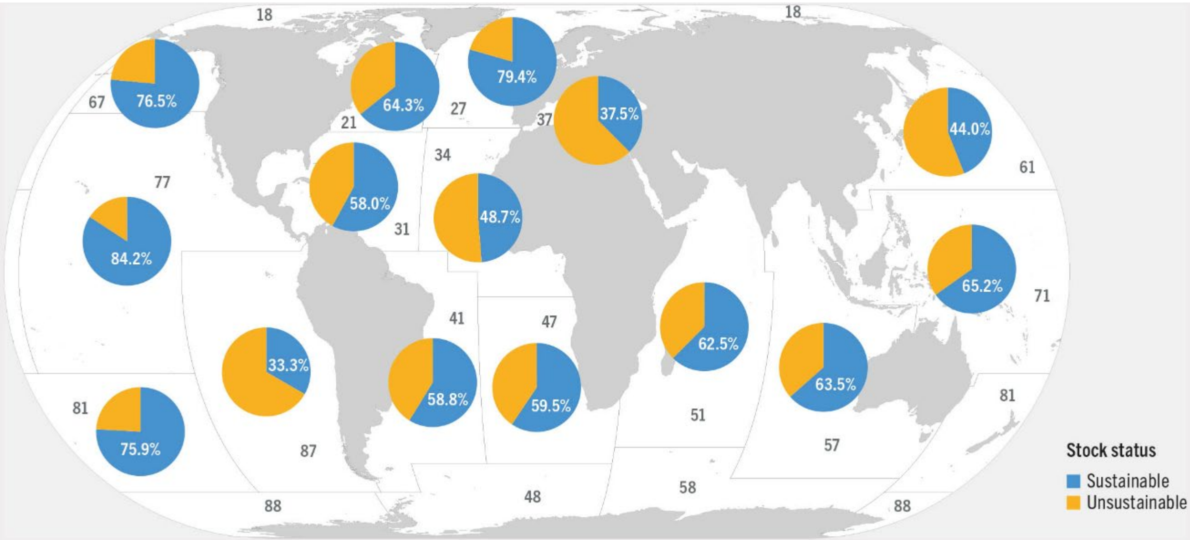
Stock assessments

FAO (2024) data indicates that 62.3% of global fish stocks are fished at a biologically sustainable level. Most studies conclude that approximately 50% of global stocks have some form of stock assessment that enables an understanding of whether the fishery has a sustainable biomass, which leaves a significant knowledge gap for species that have not been scientifically assessed. To determine the proportion of stocks fished at sustainable levels, most reviews consider the use of biological reference points, or similar proxies, as the most widely accessible metrics. Fisheries certified to the MSC Standard must demonstrate with a high degree of certainty that the stock is at or fluctuating around a level consistent with maximum sustainable yield (MSY), and where, possible biological and fishing reference points or proxies must be developed to track performance.

Maximum Sustainable Yield: In fisheries, MSY is defined as the maximum catch (in numbers or mass) that can be removed from a population over an indefinite period. The concept of MSY relies on the surplus production generated by a population that is depleted below its environmental carrying capacity (Maunder 2008).

Stock assessments are more common for large, commercially important stocks; data gaps remain for smaller stocks and for fisheries across Asia, Africa (except South Africa) and much of Latin America (Hilborn *et al* 2020). Even in Europe, one of the most developed regions of the world, the International Council for the Exploration of the Sea (ICES) assesses more than 250 stocks of fish and shellfish, but more than 60% of these are considered data-limited (ICES 2024b). This lack of knowledge means it is not possible to accurately determine the sustainability status of a significant proportion of global stocks (Kleisner *et al*, 2012). Proxies have been used to determine potential stock status in the absence of stock assessments, but these should be used with caution as it can be difficult to attribute a change in catch to a corresponding increase or decrease in biomass, owing to changes in markets, social factors or management actions (Liu *et al* 2024).

In 2021, FAO data indicated that the Eastern Central Pacific had the highest percentage (84.5%) of stocks fished at sustainable levels, followed by the Northeast Atlantic (79.4%), the Northeast Pacific (76.5) and the Southwest Pacific (75.9%) (FAO 2024) (Figure 14). The lowest percentages of stocks from sustainable sources were seen in the Southeast Pacific (33.3%), the Mediterranean and Black Sea (37.5%), and the Northwest Pacific (44%).



Source: FAO, 2024

Figure 14. FAO percentages of biologically sustainable and unsustainable fishery stocks by major fishing area, 2021

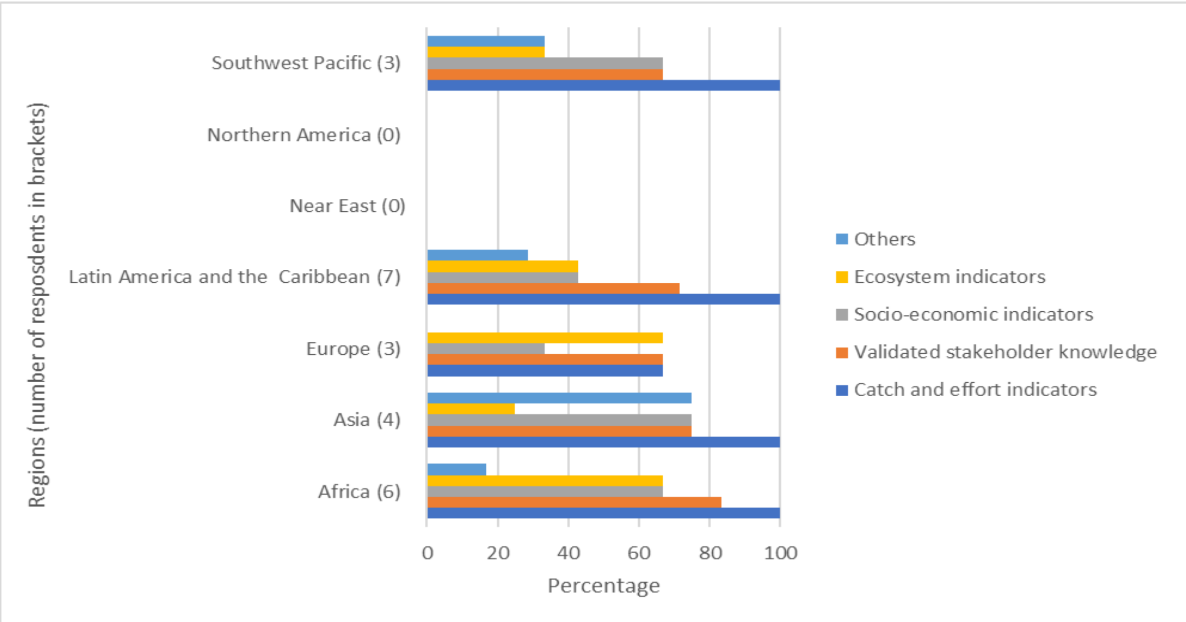
Reference points

Reference points can be used to determine whether stocks are being managed at MSY. In 2022, 69% of respondents to the FAO CCRF questionnaire stated that they had developed target reference points, covering a total of 1,489 stocks. The highest number of stocks with reference points in place is in the Southwest Pacific (Table 4). This may be a result of overlap between reporting countries and stocks that cross multiple management jurisdictions. For those countries that had not developed target reference points for fisheries management, some were using other stock management indicators, including catch and effort indicators, social and economic indicators, validated stakeholder knowledge, and ecosystem indicators (Figure 15).

Table 4. The use of stock-specific target reference points (TRPs) by respondents to the FAO CCRF questionnaire

Region (Number of respondents in brackets)	Members having developed TRPs (%)	Number of stocks/resources/ multispecies for which TRPs have been developed*	For those Members that have developed TRPs: TRPs are being approached/have been exceeded(%)
Africa (13)	54	55	86
Asia (11)	64	137	57
Europe (13)	77	399	80
Latin America and the Caribbean (24)	71	145	59
Near East (4)	100	27	50
Northern America (1)	100	79	100
Southwest Pacific (8)	63	647	80
* Number of stocks does not account for possible overlaps between different members			

Source: FAO, 2022



Source: FAO, 2022

Figure 15. The use of alternatives to target reference points by respondents to the FAO (2022) questionnaire on the implementation of the CCRF

However, when considering management of the target stock from an EAFM perspective, it is important to reflect on the significant proportion of stocks that are found in mixed fisheries. Fishing at a level consistent with MSY for one species in a mixed fishery does not necessarily mean that this correlates with advice for MSY on other species. For example, in the UK, cod and haddock are often caught together, but the two species do not necessarily have the same status in relation to MSY and this can lead to over exploitation of cod in order to fully utilise haddock (Sun *et al*. 2023). This is discussed further in Section 5.4. Reeves *et al*. (2018) stated that collectively managing multiple stocks at a sustainable level requires an extensive understanding of how each stock interacts with all other stocks and its environment and how the gears used for each fishery impact each stock and the marine environment. As most unassessed fisheries are in tropical and subtropical regions dominated by highly diverse mixed fisheries, the single-stock assessment and management practices used in temperate countries are considered to be impractical (Hilborn *et al*, 2020).

Fisheries management

Common measures used to keep a fishery fluctuating around MSY include input controls (effort), output controls (Total Allowable Catch, TAC) and technical measures (gear restrictions). Adapting current fisheries management measures for wider ecosystem benefits are discussed throughout Section 5 and elaborated on further in the case studies. While historically fisheries management measures are used to regulate the pressure on the target stock, there is potential to modify them to address wider ecosystem impacts identified through EAFM. For example, a closed area to protect target stock spawning areas could also be designed to protect vulnerable marine ecosystems (VMEs); or gear modifications designed to allow juveniles below minimum conservation reference size (MCRS) to escape could also be designed to allow ETP species to also escape. The use of TACs to regulate the amount of fish removed from a population can take into account the needs of other species e.g. for food by birds and other predators, in particular for low trophic level species such as krill. The use of a pre-agreed management approach (i.e., harvest strategy and harvest control rules) has been shown to support adaptive, flexible management decisions that can respond to fluctuations in the stock with predetermined measures to reduce the level of fishing pressure (Gutteridge 2024). The presence of a robust fisheries management system has been shown to correlate with healthier stock biomass (Costello *et al* 2012).

Around two thirds of the most valuable fish stocks are managed by TACs (OECD, 2022). By controlling the amount of fish that can be harvested, TACs are an important tool for ensuring the health of fish stocks where there is strong science, assessment and monitoring of landings. In 2020, species covered by TACs accounted to $9.2 billion in landings and 61% of the value of landing for all species in the OECD data set. This data covers 40 countries and economies, accounting for 90% of world landings (OECD 2022). These management tools should be considered the baseline for good single species fisheries management, but more is required to demonstrate that the wider ecosystem has been considered through EAFM (Hilborn *et al* 2020).

New Zealand hoki: The New Zealand government introduced a Quota Management System (QMS) designed to ensure sustainable use of the fisheries resources while allowing economic efficiency in the industry by directly limiting the total quantity of fish taken. The major focus is on the amount taken by the commercial fishing industry so that there are sufficient fish available for non-commercial uses and for the conservation of the resource. The needs of recreational fishers and Maori interests are provided for before commercial quota levels are set. Within the commercial catch limit, access is determined by ownership of quota and ownership of Annual Catch Entitlement (ACE). The QMS is also being used in dealing with Maori claims to commercial fisheries. The Government has purchased quota and transferred it to the Te Ohu Kai Moana (TOKM, Treaty of Waitangi Fisheries Commission) in recognition of Maori rights to the commercial fishery. TOKM distributes quota to iwi (Maori tribes). When the initial species were introduced into the QMS, 10% was given to Maori, and 20% of commercial quotas of all new species now brought into the QMS are given to the TOKM to distribute (Akroyd *et al* 2012).

Fishing limits are calculated from the stock assessment and set well above sustainable thresholds. The fishery is split into eastern and western populations, and when one population is more depleted than the other, effort is shifted. In 2001, there was an informal agreement with the Minister of Fisheries that 65% of the hoki catch should be taken from the western stock to reduce pressure on the eastern stock. This agreement was removed following the 2003 hoki assessment, which indicated that the eastern hoki stock was less depleted than the western stock, and effort was shifted back into eastern areas (Akroyd *et al* 2012).

5.1.2 Rebuilding of depleted stocks

EAFM stage (Figure 2)	1
GBF Target 5	Sustainable; Preventing overexploitation; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	3
Data reliability (1-5)	3

FAO (2024) data indicated that 37.7% of stocks are fished at biologically unsustainable levels. Kleisner *et al* (2012) used data from the Sea Around Us project to calculate that 10% of fish stocks globally should be classified as 'rebuilding' (where the stock biomass is depleted but management has been put in place to support its recovery). The recovery of fish stocks has been slow and most depleted stocks are still below target biomass levels (Neubauer *et al* 2013). The rebuilding of overexploited fish stocks would be beneficial for both fisheries and ecosystems, easing pressure on fish populations while supporting a more resilient ecosystem (Costello *et al* 2012). Hilborn *et al* (2020) found that most stocks subjected to low fishing pressure are rebuilding, and Naubauer (2013) found that it usually takes at least 10 years of low fishing pressure for a stock to recover.

Anderson *et al* (2018) found that after decades of overfishing, many global fish stocks have recovered through the implementation of effective management including: regulating catch and fishing mortality, regulating effort and regulating spatial access. Where countries have responded to exceedances of target reference points, FAO CCRF questionnaire (2022) found the measures taken included carrying out more research, limiting fishing effort, strengthening monitoring control and surveillance systems, closing the fishery and effecting capacity adjustments.

Management measures have been introduced in fisheries globally as a reaction to stock depletion. This includes legislation for rebuilding plans and reduced fishing pressure in the United States, Canada, Europe, Japan, Chile and New Zealand. Worm *et al*. (2009) reviewed the tools required for stock rebuilding and found that a combination of diverse tools, such as catch restrictions, gear modifications, and closed areas, are typically required to meet both fisheries and conservation objectives. They found that good local governance, enforcement, and compliance form the basis for conservation and rebuilding efforts. Worm *et al*. (2009) provided a useful overview of the types of management that have been used to rebuild fisheries. In most cases, more than one measure was required, and while gear restrictions and closed areas were used in all fisheries considered in the study, it was the use of TAC reductions that was considered to be the most essential tool. If implemented through EAFM, these management tools could contribute not just to stock health but also wider ecosystem health through the consideration of impacts on other species and habitats.

Successful rebuilding plans cap the effort in the fishery while also controlling the level of extraction and monitoring the stock biomass closely. Examples of rebuilding strategies that have improved the stock biomass are provided below. Previously, closing the fishery was the first step in rebuilding the stock, but more recently the need for balancing social and economic impacts has generated alternative approaches to fisheries management and rebuilding plans.

Namibian hake: After a decline in biomass in 1990s, there has been a recovery in the most recent years and the biomass is estimated to be approximately double the 1990 level. During the years 1991 to 1996, hake TAC recommendations were based on the biomass estimated by annual combined swept area/acoustic research surveys. It was assumed that these surveys estimated the absolute abundance of Namibian hake and a recommended TAC was calculated as 20 % of the fishable biomass. Between 1997 and 2000, as a result of uncertainty about the status of the stocks, TAC recommendations were based on an Interim Management Procedure (IMP); this adjusted the recommended TAC up or down depending on trends in the research survey and the commercial Catch per Unit Effort (CPUE) data. Recent TACs have been based on a decision rule that estimates the catch equivalent to 80 % of the value required for replacement of the biomass. An analysis of potential stock rebuilding has estimated that this rule will rebuild to 55 % of biomass with high probability in the next eight years (Jones *et al*., 2020). This fishery has been MSC certified since 2020.

Georges Bank scallop fishery: In 1998, a 10-year rebuilding programme was implemented using Days at Sea effort limitation (DAS) and TACs to control fishing pressure. The fishery has a pre-agreed harvest control rule (HCR) that sets DAS based on the available annual exploitable biomass. The fishery is divided into fishing zones, and HCRs are applied to each zone based on reference points for stock levels in each area, with rules for 'healthy', 'cautious' and 'critical' stocks. The Northern Gulf of Maine is managed separately from the rest of the Georges Bank Atlantic Sea scallop stock, by creating a separate limited entry programme for fishing in the area. The area is managed under an annual TAC and a daily possession limit of 90.7 kg. Other measures include:

- Permits issued to vessels with a history in the fishery and no new permits have been issued.
- A rotational area strategy to increase the size of scallops caught (a system for closing and opening areas to improve yield per recruit, using open areas, closed areas, areas temporarily closed and access areas). Areas re-open for fishing when the scallops are larger, boosting meat yield and yield-per-recruit, and include separate DAS or TACs for reopened area.
- Gear restrictions on minimum ring size (102mm), minimum size of the twine top mesh (10 inches) and crew limits (7).
- Minimum shell height (8.9 cm).
- Possession and trip limits.
- 100% dockside monitoring.
- Recording every 6 hours: catch, location and effort of fleet.

Industry fund dropdown camera surveys to count the number of individual scallops on the seabed rather than weight of scallops. The approach gives an absolute measure of density that can be used to inform management immediately, unlike timeseries where 7-8 years of data is required. Biomass has increased significantly since 1998 and is currently comfortably above MSY. This fishery is now MSC certified.

5.2 Non-target species interactions

Single species management focuses on the target stock (see Section 5.1). Moving towards EAFM implementation requires broadening this to include the impact of fishing on non-target species, trophic interactions, and habitat impacts. Management of non-target species is considered part of the first stage of EAFM implementation, and directly contributes to GBF Target 5 through the requirement of 'minimising impacts on non-target species and ecosystems'.

5.2.1 Bycatch

EAFM stage (Figure 2)	1
GBF Target 5	Sustainable; Preventing over exploitation; Minimising impacts on non-target species and ecosystems; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	2
Data reliability (1-5)	2

The FAO describes bycatch as '*catch that is incidental to the target species*'. Bycatch species may be landed or discarded at sea and can also sometimes be sold if they are marketable and they have quota. In some cases, they may be commercial species that are too small to land, or that the vessel does not have a licence or quota for. In other cases, they may be endangered, threatened or protected species that fishing vessels should not be interacting with. The management of bycatch in commercial fisheries is becoming more common, and there are a wealth of examples and technologies to support this (Suuronen 2022). EAFM requires fishery managers to consider the impacts of fishing on other species, including bycatch of fish and other species, especially where discarding or illegal, unreported or unregulated activity could occur (Shen and Song 2023). Monitoring bycatch in fisheries has become an integral part of fisheries management with regards to sustaining healthy ecosystems and the fisheries they support (Bellido *et al*., 2011).

The FAO CCRF questionnaire (2022) found that 70% of respondents reported that bycatch and discards occur in major fisheries in their country. While 70% reported having formal bycatch and discard monitoring schemes in place, these did not align with the countries that had identified bycatch and discards as a concern. This indicates that some countries are undertaking monitoring even when bycatch and discards were not considered significant, while others have not yet implemented formal schemes despite having concerns about the presence of bycatch and discards.

Of those formally monitoring bycatch and discards, 70% consider that bycatch and discards contribute to unsustainability and almost all (94%) had management measures in place to minimise bycatch and discards. Of respondents who have management measures for bycatch and discards, 97% also have measures to address the protection of juveniles and 83% for ghost fishing, respectively (FAO, 2022) (Table 5).

Table 5. Responses to the management of bycatch and discards in the FAO CCRF questionnaire

Region (Number of respondents in brackets)*	Members where bycatches and discards occur in major fisheries (%)	Formally monitor bycatch and discards (%)	Bycatch and discards are found to be unsustainable (%) *	Management measures to minimise bycatch and discards are in place (%) *	These measures also address the following:*	
					Protection of juveniles (%)	Ghost fishing (%)
Africa (15)	53	47	71	100	100	80
Asia (11)	64	73	100	100	88	75
Europe (13)	77	92	58	100	100	100
Latin America and the Caribbean (24)	79	71	65	82	100	67
Near East (4)	50	0	-	-	-	-
Northern America (2)	100	100	100	100	100	100
Southwest Pacific (8)	75	100	63	100	100	100
Total (77) and averages	**70.13**	**70.13**	**70.37**	**94.74**	**97.22**	**83.33**

* *Only refers to Members responding positively in the previous column.*

Source: FAO, 2022

When asked about the implementation of elements of EAFM, 89% of respondents stated that they had activities in place to address target catch and bycatch. Regionally, this varied from 100% of responses from North America and Southwest Pacific to 75% in the Near East. Africa, Europe, Asia and Latin America all considered it in more than 85% of responses (FAO 2022) (see Figure 11). The FAO CCRF questionnaire does not indicate whether these activities and policies are effective.

FAO (2022) also asked about the most effective measures taken by government to promote the improved use of bycatch in fish processing, distribution and marketing. 87% of respondents felt this was relevant to their country, and effective measures included:

- Awareness raising and training/dialogue with processors (50%);
- Mandatory landing of bycatch in given fisheries (40%);
- Fostering adoption of new processing techniques and technology (31%);
- Strengthening relationships between producers, processors and distributors (36%);
- Improvement of handling infrastructure and conversation facilities (31%); and
- Other (assisting processors to access new markets, funding research, development or pilot projects, providing financial incentives for bycatch related commercial activity, forcing operators to sell all bycatch locally).

If fish or other species are regularly fished, but a fishery does not have effective management plans in place, the stock may not be at a healthy level and overfishing could quickly occur (MSC 2024). This poor management could also disrupt the food web by inadvertently taking fish that other species rely on as food (MSC 2024). This is considered further in Section 5.4.

As demonstrated by the responses to the FAO CCRF questionnaire (2022), there are a range of approaches to reduce and avoid bycatch, including the use of real-time closures, reporting apps, and gear modifications. The types of innovation seen in fisheries addressing gear catch are often most successful when measures have been developed with stakeholder participation and engagement.

Realtime reporting App: Based on success stories in Alaska and the Pacific Northwest, Scottish skippers, producer organisations and scientists have collaborated to develop and deploy 'BATmap' (Bycatch Avoidance Tool using mapping), a state-of-the-art technology to avoid unwanted catches. BATmap enables fishing vessels to share bycatch observations in 'real-time', identify areas having high probability of bycatch, and alert other skippers so they can avoid these areas. A similar system has been used on fisheries in Alaska and Pacific Northwest for over 20 years to successfully reduce bycatch (Marshall *et al* 2021).

In Alaska, the North Pacific Fisheries Management Council allowed the fishing industry to develop their own approaches to reducing salmon bycatch, and the use of rolling hotspots enabled skippers to report a haul with a high bycatch rate, which triggers an alert to all vessels in the cooperative with a link to a map showing the geographic coordinates of the haul and basic information about the bycatch. This information is used by skippers to make decisions about where and when to fish and saw a reduction in the rate of chinook bycatch and the frequency of high-volume bycatch incidents, indicating that vessels are exhibiting accountability for avoiding bycatch hotspots (Marshall *et al* 2021).

Swedish grid: Swedish scientists and the fishing industry worked together to develop and implement a grid in the Nephrops trawl fishery to minimise bycatch of whitefish. The grid works by allowing Nephrops to pass through the bars of the grid, which are too narrow to allow larger fish to pass. Instead, these fish are guided upward to an escape hole. The grid rejects all large fish bycatch, essentially making the Swedish Nephrops fishery a single species fishery (Catchpole *et al* 2006). Compared to the traditional trawl, catches of cod were reduced by 75%, whiting by 77% and juvenile Nephrops by 60% (Nilsson 2023). The innovation became mandatory in Swedish waters and enabled Nephrops fishing to continue when whitefish stocks were low.

LED lights: The West Coast US pink shrimp fishery overlaps with the habitat range of the eulachon (or candlefish) which is facing declining stocks, likely as a result of climate change, habitat loss and the impacts of fisheries. Researchers found that by placing LED lighting on the foot ropes of the nets it reduced unwanted catch of eulachon by 80-90%. By 2018, 100% of vessels in the fishery adopted this method and the use of LED lights has spread to shrimp fisheries across California, Oregon and Washington. The addition of the LED lights also reduced bycatch of slender sole by 69%, dark-blotched rockfish decreased by 82% and other rockfish by 56% (MSC 2024).

Norwegian bycatch programme: The Norwegian Reference Fleet is a group of randomly selected active fishing vessels tasked with providing information about general fishing activity to the Institute of Marine Research (IMR). This self-sampling programme is used as a platform for supporting stock assessments with additional biological data including fishing effort, catch composition and bycatches.

Alongside reporting of retained catches, bycatches and discards are also reported at regular intervals. Bycatch of seabirds, sea mammals and rare fish species (e.g. porbeagle and basking shark) as well as bycatch of corals and sponges are also recorded for every fishing operation. Crew are given training on species identification and are issued the necessary literature to assist in species identification. If crew are uncertain about a species, they are encouraged to send photographs or samples to IMR for verification.

Fishers are motivated to follow the protocol both through payment and an understanding of the importance of the collected data for management of the fisheries. Payment is effort based, with a price both for number of fish measured and number of species recorded in each catch, in order to give an incentive for fishers to take time to follow the procedures correctly. The fishing vessels commitment to self-sampling is outlined in a contract, which also states that data shall not be requested for enforcement purposes. This ensures that vessels can honestly report their catches without risk of prosecution, ensuring the data reflect the true catches. To date, this agreement has not been compromised (Clegg and Williams 2020).

Data collected contributes to improved understanding of fishing pressure for stock assessments, and feeds into the Norwegian marine fishing strategy to determine required management measures.

5.2.2 Discards

EAFM stage (Figure 2)	1
GBF Target 5	Sustainable; Legal; Preventing over exploitation; Minimizing impacts on non-target species and ecosystems; Applying the ecosystem approach 
Policy score (1-5)	3
Implementation score (1-5)	2
Data availability (1-5)	2
Data reliability (1-5)	2

During the fishing process, unwanted catches may be returned to sea (discarded). The FAO estimates that annually 9.1 million tonnes (10% of annual catches) are discarded, and 20 million individuals of endangered, threatened and protected species were captured and discarded from fisheries annually (Gray and Kennelly, 2018). About 46% (4.2 million tonnes) of total annual discards were from bottom trawls (FAO 2015). While some species such as shellfish, skates or rays may have a higher chance of survivability (European Commission 2022) when returned to the sea, others will inevitably die, impacting the stock size even if not landed and reported.

Discarding tends to happen where:

- Fish is smaller than the legal size;
- The fishermen do not have quota for it;
- the fish is of low market value or damaged;
- It is prohibited to catch that species (European Commission, 2022).

The FAO CCRF questionnaire (2022) asked members about discarded species and found that 83% of respondent countries consider discards in their fisheries activities/programmes, ranging from 77% of countries in Africa, Latin America and the Caribbean, to 100% in North America, Europe and the Southwest Pacific (FAO 2022).

The Sea Around Us project uses FAO data to visualise the landings and discard data (Figure 16). Data on discards generally comes from observer programs in high-value large industrial fleets, or from self-reporting in logbooks. FAO data indicates that discards have been decreasing globally since mid-1990s, likely due to the development of more selective gear, an increase in the retention of catch that was previously discarded and a decrease in the abundance of previously discarded species (Gilman 2020).

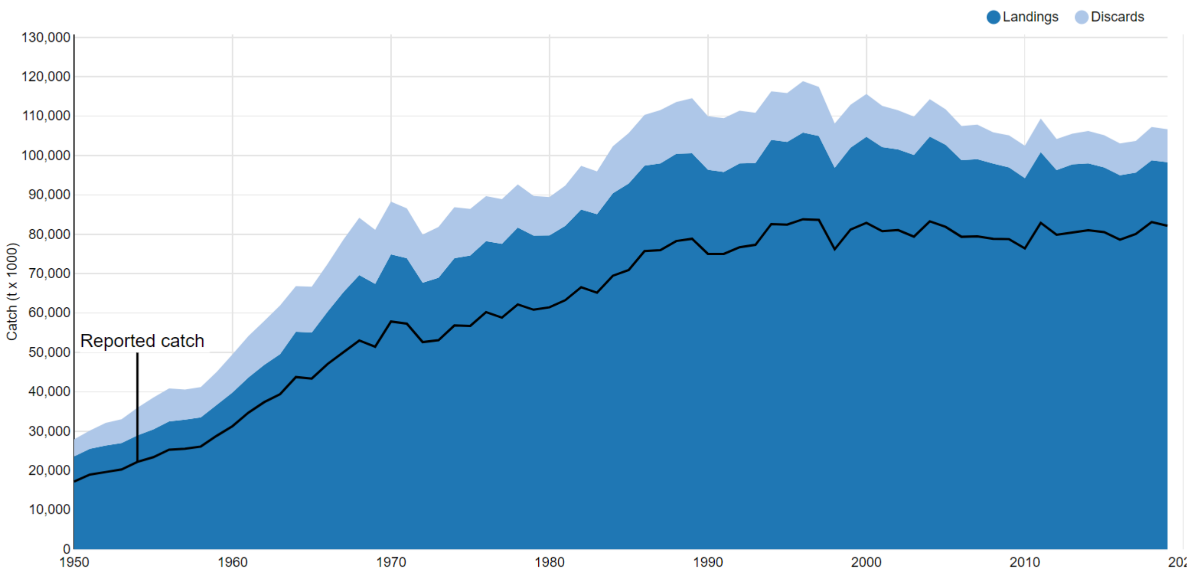


Figure 16. Global landings and discards data from the Sea Around Us project, using FAO (2021) data

This suggests that while discarding is still a significant issue, the trend is decreasing, and a large number of countries have identified it as an area of concern and have introduced measures to address it.

Key approaches to managing and reducing discards can be seen globally through policies and practice, including (Suuronen and Gilman, 2020):

- Modifications to fishing practices and gear to increase selectivity;
- Managing the temporal and spatial distribution of fishing effort;
- Landing obligations;
- Retention bans;
- Bycatch caps;
- Effort limits;
- Size restrictions.

Measures that reduce discards often align with measures to reduce bycatch or limit fishing effort on target species. Many of these examples are most successful when stakeholders understand the issue and are engaged in finding solutions.

Increased survivability: For species that are caught but considered to have high survivability, introducing guidelines for handling and returning to the sea under 'survivability exemptions' may be an option. An example of this could be in returning undersized crab from a hauled pot, which is generally resilient as long as it has not been left in the pot too long (soak time) and carefully removed from the gear in once piece (Suuronn and Gilman 2020). This policy is applied as a Survival Exemption[1] for some species (such as Norway lobster, skates and rays) and gear types in EU waters, allowing fish to be discarded under certain conditions based on the likelihood of a fish being able to survive being caught and returned to the sea.

Consumer campaigns: National marketing campaigns such as 'Hugh's fish fight' in the UK and 'Eat These Fish' in the USA encouraged consumers to think more broadly about their fish preferences with the intention of taking the pressure off the usual 'Top 5' fish species eaten by the public and shifting to lesser known species that are still sustainable but would otherwise be thrown back due to a lack of market interest. This increases the market for species that previously would have been discarded, increasing fleet profitability and reducing waste. A similar project has been set up for the Great Australian Bight trawl fishery, which identified latchets (*Pterygotrigla polyommata*) and ocean jackets (*Nelusetta ayraud*) as having high potential for increased sales in markets in Adelaide, Sydney and Melbourne (Koopman *et al*., 2017).

100% Fish Project: The 100% Fish Project was set up by the Iceland Ocean Cluster to reduce discarding by incentivising the Icelandic seafood industry to utilize more of each fish, increase the value of each fish landed, support new business opportunities, increase employment and decrease waste. The project has enabled businesses to work with the fishing industry to develop a range of products using fish and fish parts that would usually be discarded. Products include supplements, proteins, cosmetics, pharmaceuticals, fashion items, furniture and other high-value products made from different parts of the fish. The impact of the saved waste in Iceland has been huge – for Atlantic cod, 90% of every fish is utilised instead of wasted and estimates indicate the Iceland now receives 30% more value from each cod than other countries. This project has now been expanded to different seafood species and different markets globally. Examples include Hake in Namibia and Tuna in Walleye in the North American Great Lakes (Iceland Ocean Cluster, 2023).

At-sea observer programmes and Remote Electronic Monitoring (REM): At-sea human observer programs currently produce the most accurate data on discards, however remote electronic monitoring (REM) is becoming more common in large-scale fisheries. REM has the capacity to provide a wider coverage than human observers are able to and may overcome sampling bias present in human onboard observer programmes. Other monitoring approaches, including logbooks, fishery-independent surveys and fisher interviews, produce relatively unreliable discard estimates, while port sampling only provides information on landed catch (Suuronn and Gilman 2020).

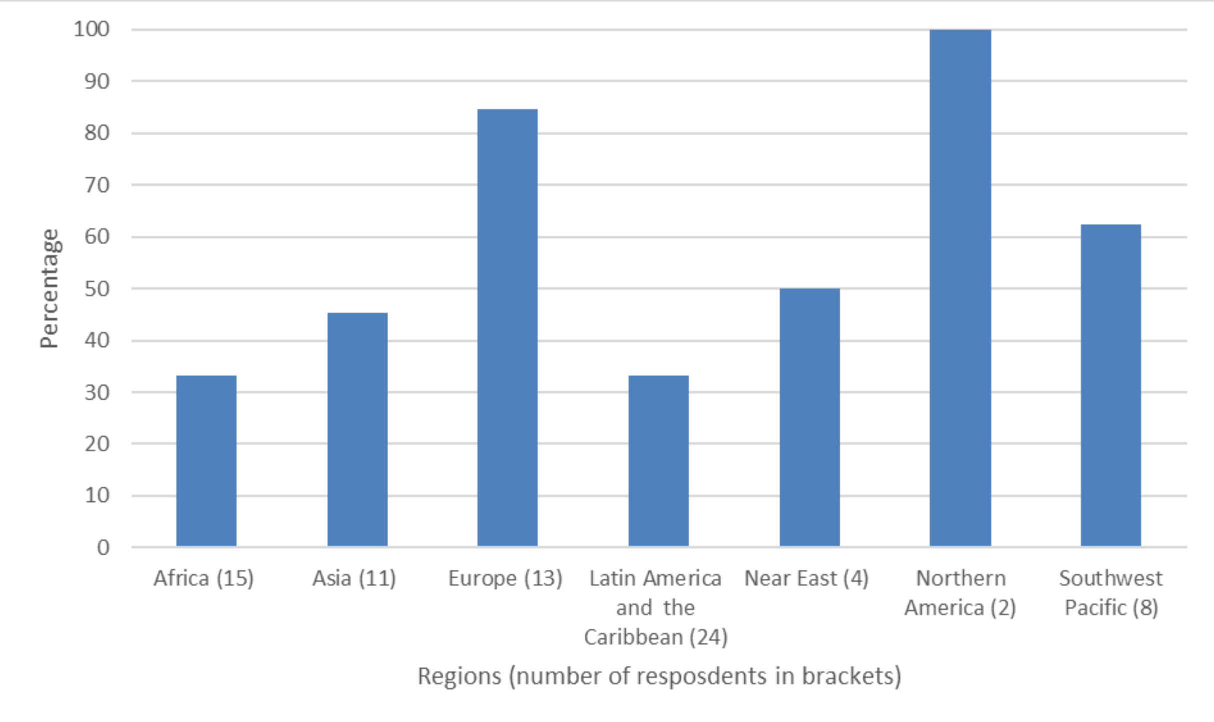
5.2.3 Ghost gear

EAFM stage (Figure 2)	1
GBF Target 5	Sustainable; Minimising impacts on non-target species and ecosystems; Applying the ecosystem approach 
Policy score (1-5)	2
Implementation score (1-5)	2
Data availability (1-5)	2
Data reliability (1-5)	2

Ghost gear, or Abandoned, Lost and Discarded Fishing Gear (ALDFG) is directly responsible for the mortality of fish and other species, such as whales, dolphins, seals and turtles (some of which are endangered). Abandoned pots on the seabed or lost gillnets can start a cycle of ghost fishing, where trapped species attract scavengers that also get trapped. Large marine mammals may become entangled in the ropes that connect pots or traps to buoys floating on the surface. The unselective capture of marine species by ghost gear also harms efforts to fish sustainably, reducing population size without contributing to food production or livelihoods (MSC 2024). Indirectly, it can also alter seabed and marine environments, create problems for navigation when gear gets caught in ships' propellers, in the worst cases leading to capsizing and fatalities. Ghost gear can also be washed ashore as litter, becoming a danger to birds and other coastal species (FAO 2021).

It is estimated that 640,000 tonnes of fishing gear is lost or abandoned in the oceans every year. FAO and the United Nations Environment Program (UNEP) estimate that one tenth of all waste in the oceans is made up of this ghost gear (FAO 2022a). This is the same as 2.5% of all fishing gear annually, including over 78,000 km^2 of nets, more than 25 million pots and traps and 740,000 km of longlines (MSC 2024). EAFM provides an opportunity to address these impacts, further contributing to the requirement of minimising impacts on non-target species and ecosystems in GBF Target 5. Countries around the world are working to improve the management of fish stocks, and this could be drastically undermined if the impacts of ghost fishing continue to increase (FAO 2022a).

The FAO CCRF questionnaire (2022) found that only 26% of respondents had information on gear loss rates in their country and showed an average level of concern about ADLFG of 3.47 out of 5 (1 being low and 5 being high). Only 53% of respondents had information available by gear type, and these were limited to information on trawl; lobster pots; gillnets and entangling nets; and longline. The biggest concerns about ALDFG were: harm to the environment, loss of fish stocks, entanglement of wildlife, economic losses to fisheries and hazards to navigation. 49% of respondents reported having requirements for gear marking (Figure 17), and the most widely used types of gear marking were marking pen or spray (79%), and printed metal or plastic tags (58%).



Source: FAO, 202

Figure 17. The respondents to the FAO CCRF questionnaire (2022) that have requirements for gear marking

There are many international organisations, activities and agreements focusing on ghost gear, and numerous national and local initiatives implemented around the world. The FAO is working with global ghost gear organisations to collect data, which will provide an overview of the current status of the ALDFG issue globally, support long-term trend analyses and monitoring of ghost fishing, and guide development of mitigation measures (FAO 2022a). The OECD (2022a) provides a table of good practices to address ghost gear.

Although measures to address ALDFG have so far been prioritised less than other components of EAFM, there are still global examples of mitigation and management techniques. Many measures involve working with local stakeholders to raise awareness of the issue and to try to develop local business opportunities for retrieved gear.

Nigeria Fishing Net Gains programme: Outreach, workshops and seminars provide an opportunity for collaboration between government and stakeholders to develop best practices for addressing ghost gear by targeting ghost gear to create economic opportunities for coastal communities. There are plans to hold a craft workshop for women in local communities to teach them to design crafts from end-of-life fishing gear, which can be sold for additional income.

Volunteers constructed collection sites for end-of-life fishing gear to ensure that fishers have a place to dispose of their nets at the end of their useful life, and will provide women who have attended the craft workshops with a supply of materials for their work. Alongside community work, volunteer divers are being trained to collect data on ghost gear and recover it, where safe and feasible. This data will be added to the Global Ghost Gear Initiative (GGGI) data portal and will provide additional context for an otherwise data-poor region (GGGI 2024).

Canadian Ghost Gear Fund: The Ghost Gear Fund is a federally funded program led by Fisheries and Oceans Canada, intended to support Canada's commitment to preventing and mitigating the risk of ghost fishing and encouraging the development of sustainable fishing practices. As of December 2023, a total of 2,197 tonnes of fishing gear and aquaculture debris had been retrieved (excluding ropes and buoys). This comprised 34,351 units of gear and 825 km of rope retrieved. If the owner of retrieved gear can be identified, they are contacted to inform them that their gear has been recovered. Owners are then given the option to collect their gear or relinquish ownership. As of December 2023, 4,007 units of gear had been tracked to its owner.

In 2020, a recycling depot specifically designed for ocean plastics, including end-of-life fishing gear, was built in Ucluelet, B.C. The recycling depot turns ghost gear plastic into plastic pellets that will be used in the manufacturing of secondary plastic products, including kayaks. Additional fishing gear recycling opportunities are being developed in Powel River, B.C. (Government of Canada 2024).

MSC ghost gear conditions: Through the MSC certification process, fisheries are required to identify the impacts of ghost gear from their fishery and introduce mitigation measures. Innovative examples include:

- The Alaska Pacific cod fisheries monitor gear loss and assessed the impacts of lost gear (long lines, pots and trawl nets) on ecosystems. Cod fishing pots in these fisheries have biodegradable escape panels and escape rings to minimise ghost fishing.
- The Normandy and Jersey lobster fisheries tag all pots with boat registration and year. Fishers must report lost pots and only a limited number of replacement tags are available. This system motivates fishers not to lose their pots.
- The impact of lost Fish Aggregating Devices (FADs) can be reduced by using biodegradable materials such as bamboo, balsa wood, and hemp fibres. FADs can also be constructed without netting (a non-entangling design), which reduces capture of species such as sharks and turtles (MSC 2024).

5.2.4 Endangered, Threatened and Protected (ETP) species

EAFM stage (Figure 2)	1
GBF Target 5	Sustainable; Legal; Preventing over exploitation; Minimizing impacts on non-target species and ecosystems; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	3
Data reliability (1-5)	2

Fishing activities often overlap with the movements and behaviour of endangered, threatened and protected (ETP) species. Direct impacts of fishing on ETP species include entanglement in fishing gear, capture and death. There can also be indirect impacts from fishing including changing migration routes or reducing food or safe habitats. Managing fishing impacts on these populations is critical to allow endangered species to recover (MSC, 2024). There remain large knowledge gaps in understanding the actual level of impact fishing activities may be having on ETP species globally (FAO 2015), but the interest from NGOs and the general public particularly in charismatic ETP species is increasing awareness and encouraging improved management and data collection.

IUCN Red List[34]

The IUCN red list is a global index on the conservation status of species and habitats. It contains data for 15,646 species present in marine systems (Figure 18). For marine species that have information on population trends, 89 are considered to be increasing, 1,773 stable and 1,583 decreasing. Of those in the critically endangered, endangered and vulnerable categories, 10 populations are increasing, including those of the Adriatic and Atlantic sturgeon, Mediterranean monk seal, blue whale and southern bluefin tuna. However, of the species in these categories, there are still 831 that show decreasing population trends and a further 426 that do not have enough information to determine their status. According to the IUCN data, the largest threats to marine species are intentional use (small-scale harvest), and unintentional effects (from large-scale harvest and small-scale harvest).

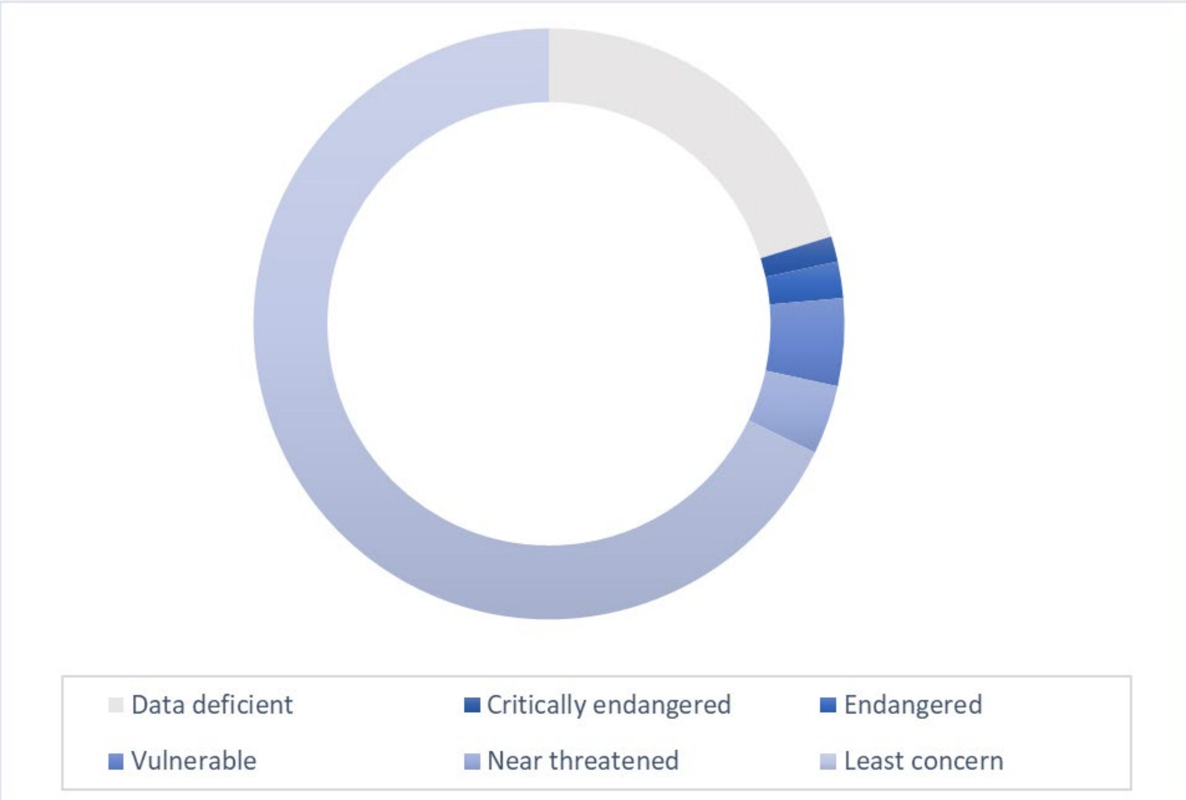


Figure 18. Conservation status of global marine species from the IUCN red list (2024)

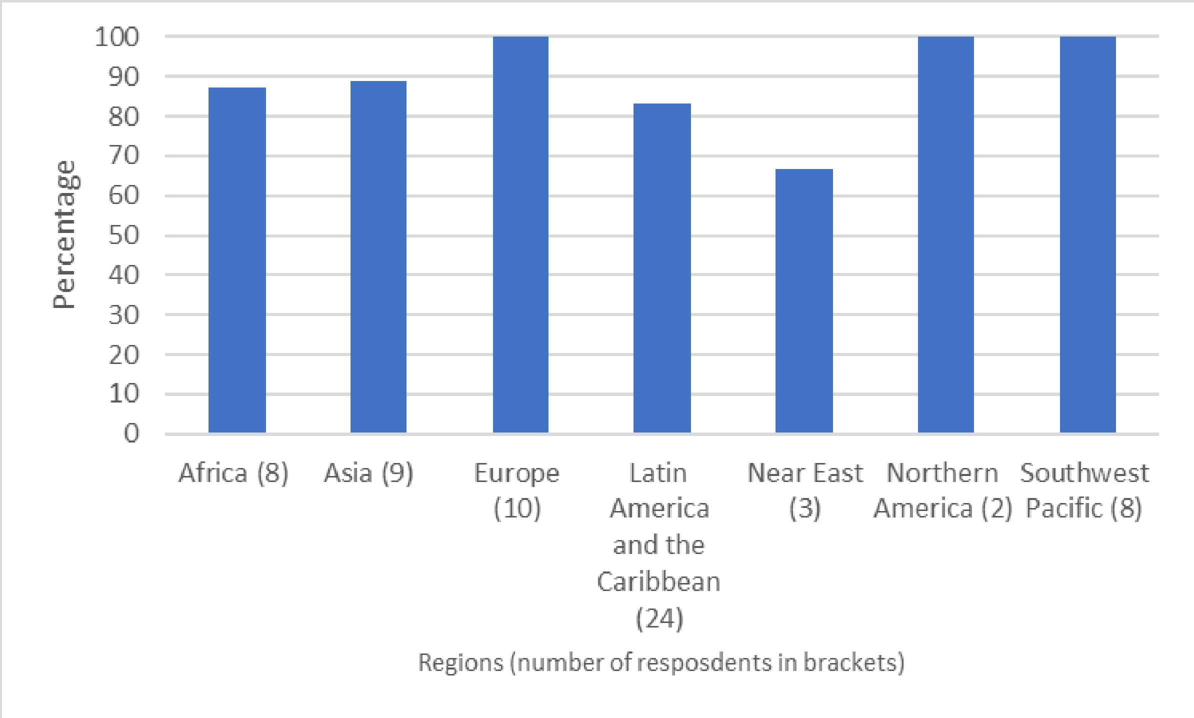
The FAO (2022) questionnaire on the implementation of the CCRF found that 89% of respondents had measures implemented through management plans to provide for the protection of endangered species (Figure 19) and that 83% of respondents were regularly monitoring ETP species. These

34 IUCN Red List of Threatened Species. www.iucnredlist.org Accessed 06 June 2024

percentages have declined since 2019, presumably as a result of different respondents and fewer responses to the questionnaire. In relation to sharks and seabirds specifically:

- 71% of respondents had already developed a national action plan for sharks, and 50% intended to do so.
- 61% of respondents had already developed a national action plan for seabirds and 78% intended to do so.

Measures taken by respondents to mitigate the impacts of gear on seabirds included: legal framework improvement, observer programmes, technical measures, mandatory release of birds, bird scaring devices, and mandatory workshops and codes of practice. Measures taken to mitigate the impact of fishing on sharks include: regulations on shark finning, improved observer programmes and data collection, gear modification, improved traceability and trade restrictions.



Source: FAO, 2022

Figure 19. The respondents to the FAO CCRF questionnaire (2022) that have activities in place to provide for the protection of ETP species

Living Planet Index[35]

The Living Planet Index (LPI) is a measure of the state of the world's biological diversity based on population trends of vertebrate species from terrestrial, freshwater and marine habitats. The LPI was adopted as part of the GBF monitoring framework as an indicator to measures progress towards a number of GBF targets. The global abundance of 18 of 31 oceanic sharks and rays has declined by 71% over the last 50 years. This collapse in their abundance reflects an increase in extinction risk for most species. In 2020, three-quarters (77%, 24 species) were threatened with an elevated risk of extinction.

35 Living Planet Index. www.livingplanetindex.org Accessed 06 June 2024

For example, the oceanic whitetip shark has declined by 95% globally over three generation lengths and has consequently moved from vulnerable to critically endangered on the IUCN Red List (WWF 2022).

International Whaling Commission[36]

The International Whaling Commission (IWC) records total catches of cetaceans since the 1985 moratorium on fishing for whales. There are small scientific and cultural allowances for catching whales, but cetaceans are also subject to bycatch through entanglement in lines. In 2021 and 2022, 70 large whales were recorded as bycatch globally; a significant proportion of these are humpback whales, which are classed as endangered by the IUCN (IWC, 2024).

Migratory Species

The recent report on the State of the Worlds Migratory Species (UNEP-WCMC 2024) found that 97% of fish species listed on the Convention on the Conservation of Migratory Species of Wild Animals (CMS) are at risk of extinction and on average CMS species are found to be decreasing in population abundance. The report highlighted the urgent needs for measures to protect these species considering the deteriorating conservation status of CMS-listed fish, including sharks and rays, and the impact of incidental catch on many populations of seabirds, marine mammals and marine turtles.

The report found an increasing trend for populations of aquatic mammals listed on CMS, likely due to the improved status of certain whale species following international restrictions on whaling. However, as this was an aggregated global trend for all aquatic mammals on the CMS, it may hide decreasing population status of individual species (UNEP-WCMC, 2024).

Convention on International Trade in Endangered Species of Wild Fauna and Flora

The 1975 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a multilateral treaty to protect endangered plants and animals from international trade that could threaten their survival in the wild (FAO, 2022). This is important as fisheries and aquaculture products are among the most traded food commodities in the world. There are currently almost 2,400 marine species listed in CITES Appendices (FAO, 2022).

The management and recovery status of ETP species attracts a significant amount of concern and attention. When implemented, EAFM should help to address concerns over ETP populations by managing fish stocks in a way that takes account of the impacts of fishing pressure and fishing gear on ETP species. Since 2020, 166 improvements have been made to benefit ETP species through the MSC certification process, and the increased focus on EAFM globally should deliver further sustainable management (MSC 2024).

Examples of measures introduced to mitigate the impacts of fishing on ETP species are wide ranging and vary depending on the fishery and ETP species involved. Increasing pressure from NGOs has led to the creation of innovative approaches that could be scaled up across similar fisheries globally. As well as the development of several bycatch solutions websites:

- The Bycatch Mitigation Hub[37]
- Bycatch Solutions Hub[38]

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36 International Whaling Commission. https://iwc.int/en/ Accessed 06 June 2024

37 The Bycatch Mitigation Hub - Clean Catch UK. https://www.cleancatchuk.com/hub/ Accessed 06 June 2024

38 SFP Bycatch Solutions Hub. https://bycatchsolutions.org/solutions/ Accessed 06 June 2024

Reducing turtle bycatch in Réunion: Coastal longline swordfish fishers from Réunion are reducing bycatch and improving survival rates for marine turtles through training on identifying, handling and releasing turtles. Fishers are being equipped with onboard turtle handling kits, including a prototype net/spinner designed to remove caught turtles from the water with care, without pulling on lines or hooks. Turtles with hooks that cannot be removed on board are transported to a veterinary rehabilitation centre, where the survival rate is an estimated 80%. To date, this collaboration between fishers and scientists has saved more than 400 turtles (MSC 2024).

South African hake fishery: The fishery reduced seabird bycatch mortalities by 90%, and created a 99% reduction in albatross deaths. Bird-scaring lines consist of a top rope with brightly coloured streamers hanging down and set parallel to the trawl cables off the back of the vessel. The streamers scare or confuse seabirds and prevent them from coming into contact or colliding with the trawl cables. It is a simple, cheap and an effective method to reduce bird bycatch. The project has resulted in greater collaboration between government, fisheries and environmental NGOs in the country through increased transparency and trust gained between stakeholders (MSC 2024).

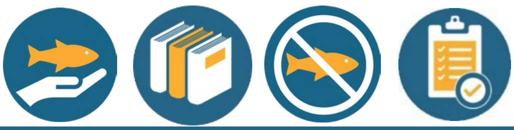
LED lights on nets: To reduce ETP bycatch in coastal gillnets along Mexico's Baja California peninsula, nets have been illuminated with green LED lights. The technology significantly reduced total discarded bycatch biomass by 63%, which included significant decreases in elasmobranch (95%), Humboldt squid (81%), and unwanted finfish (48%). Additionally, illuminated nets significantly reduced the mean time required to retrieve and disentangle nets by 57%, and were not found to make any significant differences in target fish catch or value (Senko *et al.*, 2022).

Circle hooks on longlines: In circle hooks, the pointed tip is bent back towards the shaft decreasing the spacing between the sharpened tip and shaft and changing the hook angle. The shape of the circle hook makes it harder for turtle bycatch to get hooked due to differences in jaw morphologies, but does not impact catch rates in fish and can even in some cases increase catch rates. As a result, they are effective at decreasing ETP bycatch rates in longline fisheries, especially for sea turtles. In addition, in instances when the hook is swallowed, sea turtles are less likely to be gut hooked (hooked in the stomach or throat) which is a major cause of sea turtle post-release mortality in longline fisheries (Bycatch Solutions Hub 2024).

Safe release protocols: In Pakistan, fishermen have been trained to collect data on bycatch and ETP species. This has also provided an opportunity to outline methods for ensuring safe handling and release of whale sharks, sea turtles and rays. Data log sheets and cameras were provided to crew so they could report and film any ETP interactions with fishing gear, and the footage was reviewed with the fishermen to educate them on safe handling procedures. A guidebook was developed to support fishermen in releasing ETP species alive from their nets while maintaining their own safety. The guidebook includes step-by-step instructions on how to safely release a range of species from nets (Razzaque *et al.*, 2020).

Ropeless pots: Ropeless pots and creels use triggers to release buoys, attached to submerged pots/creels, allowing them to float to the surface for retrieval. Such systems may be time controlled or use acoustic triggers and avoiding the need for vertical lines in the water column, which pose a threat of entanglement for marine mammals and turtles. Successful testing has been completed in the USA for traps for lobster, crab, and bass to depths of about 90 metres in various ocean conditions and bottom types. As yet, their implication for mitigating bycatch is undetermined, although trials are underway in Scotland and North America, and acoustic-release triggers are already in use in southern rock lobster fisheries in New South Wales, Australia. Where switching to ropeless systems is not currently feasible, the Scottish Entanglement Alliance (SEA) recommends reducing excess rope in the water column by setting the riser length to the water depth and using a weighted rope on the riser. More recent research by the SEA has also revealed that a high proportion of whale entanglements are caused by groundlines, a rope which links creels (pots) together on the seabed and often floats. Research suggests that ensuring groundlines are made from a material that sinks and allows them to lie on the seabed could reduce entanglements (Leaper, 2022).

5.2.5 Illegal, Unreported and Unregulated fishing (IUU)

EAFM stage (Figure 2)	1
GBF Target 5	Sustainable; Legal; Preventing over exploitation; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	2
Data reliability (1-5)	2

According to the FAO (2022) illegal, unreported and unregulated (IUU) fishing activities are responsible for the loss of 11–26 million tonnes of fish each year, which is estimated to have an economic value of US$10–23 billion. IUU activity covers:

- Illegal fishing refers to fishing activity that breaks local or international law, as set by a fishing management body. It can include fishing without a licence or permit, fishing in a closed-off area, fishing with prohibited gear, fishing above a quota, or the fishing of prohibited species.
- Unreported fishing refers to fishing activity that is not reported to the relevant authorities or is misreported and contravenes local or international law.
- Unregulated fishing refers to fishing vessels operating without being subject to any regulations. This could be fishing in areas where conservation or management measures have not been put in place, or when vessels from nations who have not joined the relevant management organisation fish within its waters without following the rules (MSC 2024).

IUU fishing undermines national and regional efforts to conserve and manage fish stocks, and inhibits progress towards achieving the goals of long-term sustainability (FAO 2022). If IUU fishing targets vulnerable stocks that are subject to strict management controls or moratoria, efforts to rebuild those stocks to healthy levels will not be achieved, threatening marine biodiversity, food security for communities who rely on fisheries resources for protein and the livelihoods of those involved in the sector (FAO 2024). As IUU is a global concern throughout international supply chains, solutions need to be considered at that level as well. GBF Target 5 has an explicit focus on the legal harvesting of species, and the implementation and enforcement of EAFM will help address this through sustainable management measures that take account of all removals from a fish stock and the wider social and economic impacts of illegal activity.

The IUU fishing risk index website calculates country rankings for risk of IUU activity. In 2023, China was considered to have the highest level of risk of IUU activity globally, followed by Russia, Yemen, India and Iran. While China's IUU risk level has decreased slightly since 2021, the four other countries in the top 5 all saw increased risk levels. Best performing countries in 2023 included Romania, Finland, Belgium, Sweden and Australia. As a region, Europe has the lowest risk of IUU activity. It should be noted that this website provides an indication of likelihood and risk for IUU but does not provide definitive quantitative analysis.

Based on FAO (2022a) data on the status of global fishing resources, China, India and Russia make up more than 25% of reported global landings so the presence of IUU activity could have significant impacts.

The Sea Around Us uses FAO data to visualise the estimated volume of unreported catch (Figure 20). IUU estimates have decreased since peaking in 1990s, but still represent a significant proportion of pressure on fisheries.

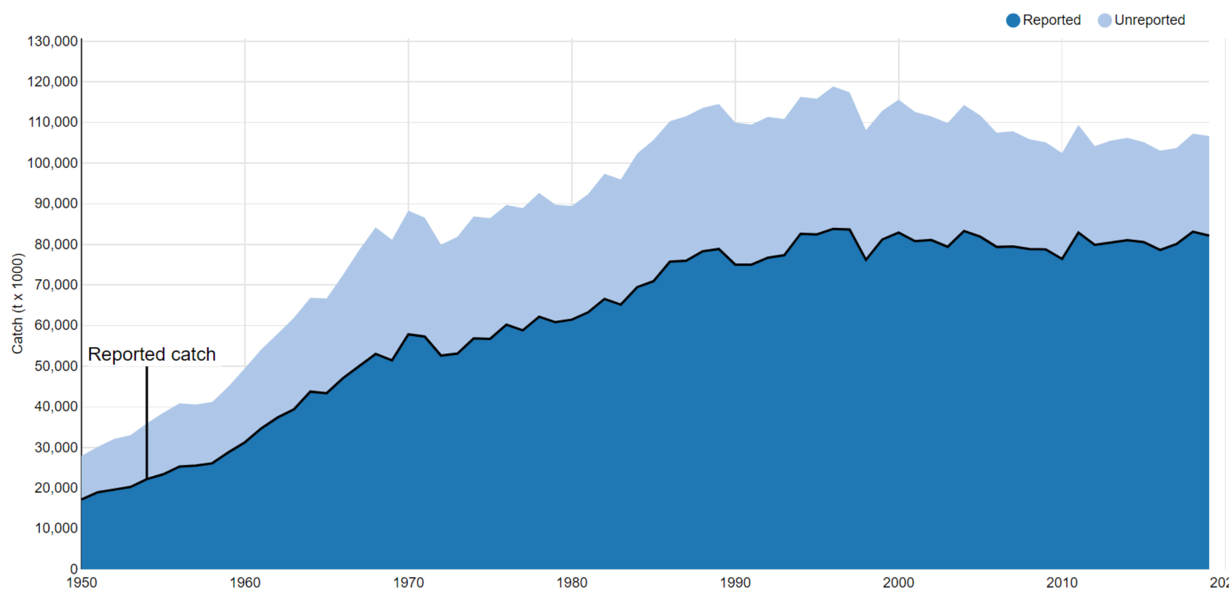
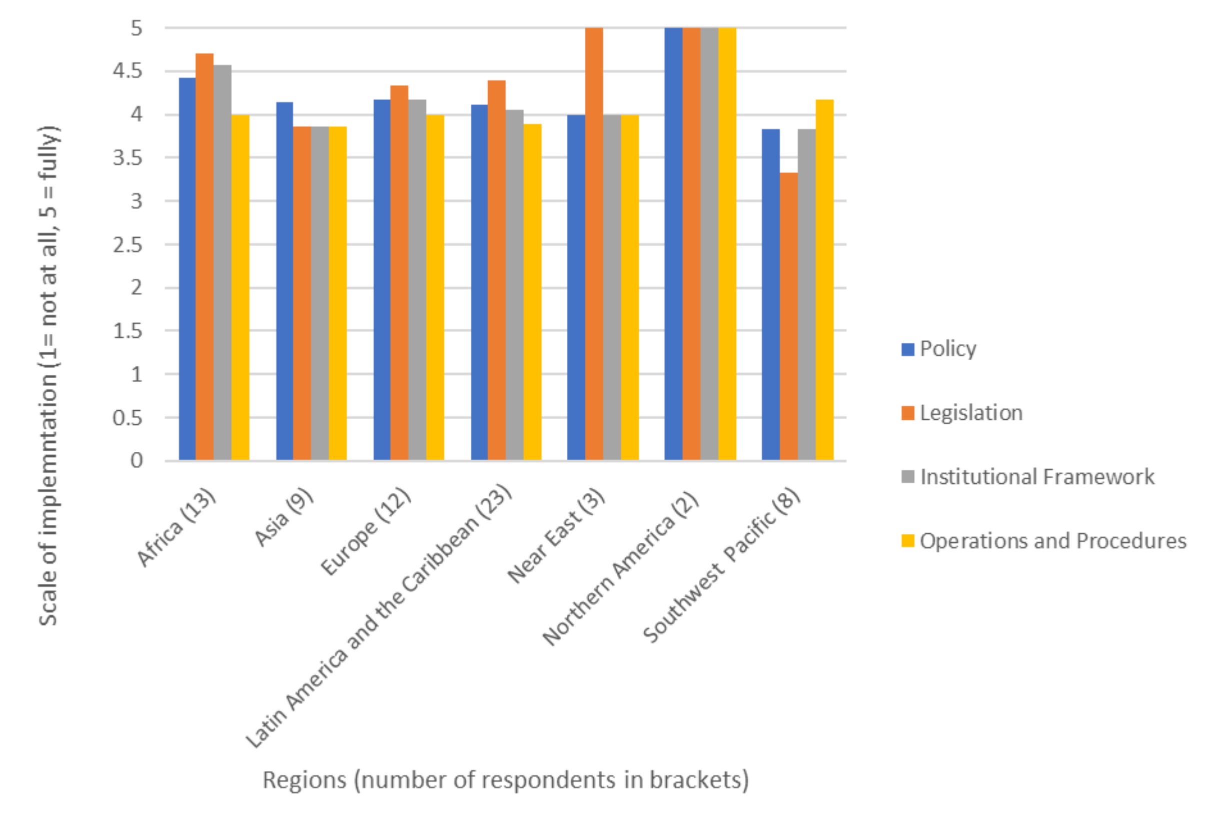


Figure 20. Estimated unreported catch as a fraction of global landings from the Sea Around Us project using FAO data (2020)

The FAO CCRF questionnaire (2022) found that 83% of respondents reported that IUU fishing was perceived as a problem. 67% reported to have developed a National Plan of Action to Prevent, Deter and Eliminate IUU Fishing (NPOA-IUU). Of those that had implemented an NPOA-IUU, using a 1-5 scale, respondents reported an average degree of implementation with regard to policy (4.17), legislation (4.26), institutional framework (4.13), and operations and procedures (4.00) (Figure 21).



Source: FAO, 2022

Figure 21. Extent of respondents to the FAO CCRF questionnaire (2022) that have implemented measures to prevent, deter and eliminate IUU activity

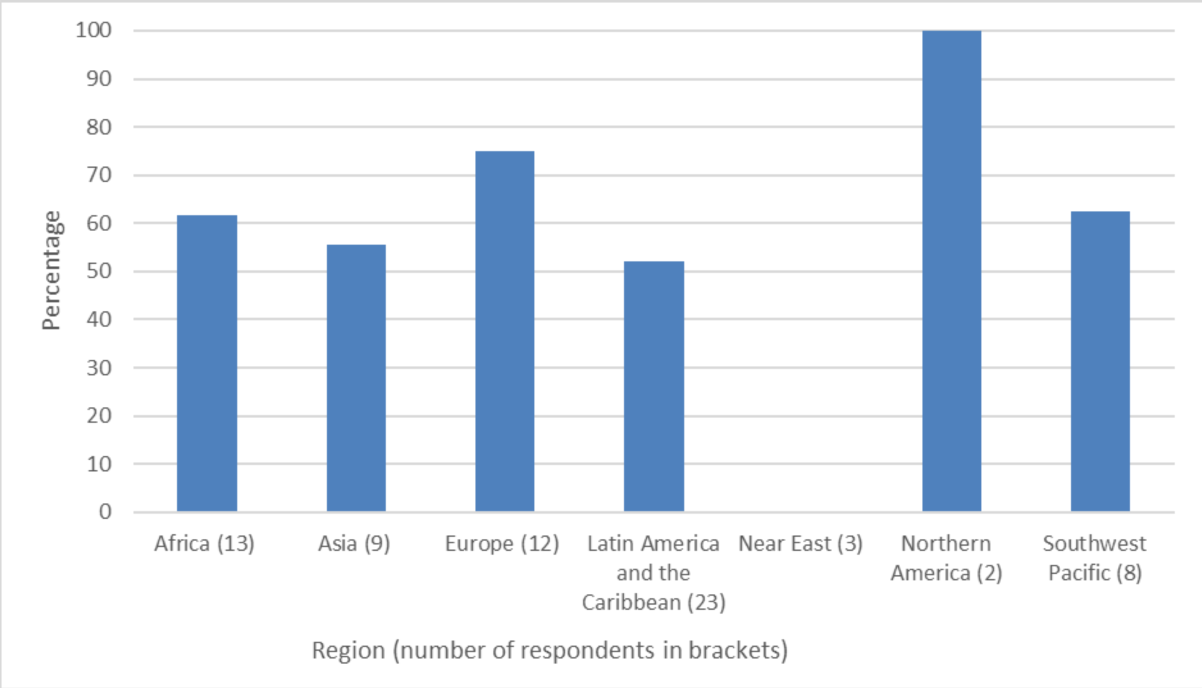
There has been progress in the implementation of measures to tackle IUU fishing globally. The FAO (2022) monitors IUU activity as a metric within the Sustainable Development Goals. In 2022, the current progress by countries in the degree of implementation of international instruments aiming to combat IUU fishing was considered close to target (based on a score of 4 out of 5). By the end of 2022, the Agreement on Port State Measures (PSMA), the first binding international agreement to specifically target IUU fishing (FAO 2024), and which entered into force in 2016, comprised 74 Parties, including the European Union (on behalf of its 27 Member States). This means that the Agreement now effectively covers over 100 nations (Figure 22).

In addition, during the 2018–2022 period, globally, the degree of implementation of these instruments has risen from 3 to 4 (out of a maximum score of 5), indicating good overall progress, with close to 75% of countries scoring highly in their degree of implementation of relevant international instruments in 2022 compared to 70% in 2018 (FAO 2022).

The FAO CCRF questionnaire (2022) found that only 3% of respondents were not implementing any measures to prevent, deter and eliminate IUU. The following measures were being implemented to prevent, deter and eliminate IUU fishing (Figure 23):

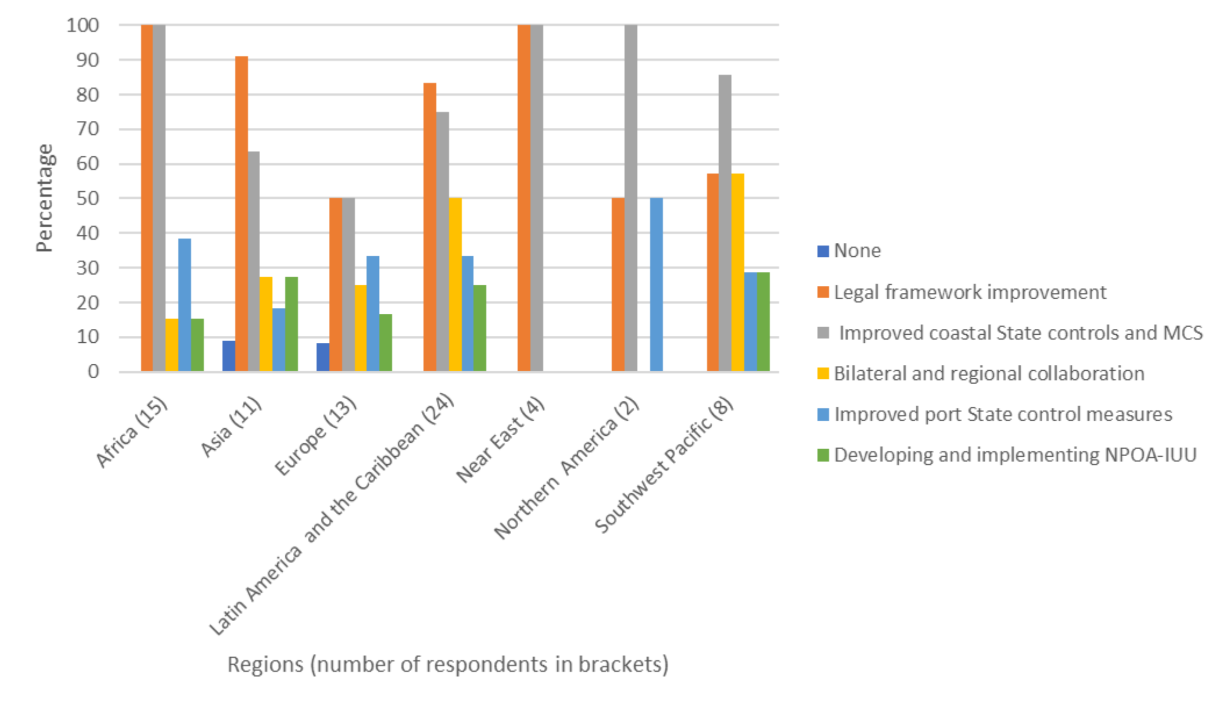
- Legal framework improvement (79% of respondents);
- Improved coastal state control and monitoring, control and surveillance (MCS) (76%);

- Improved port state control measures (31%);
- Bilateral and regional collaboration (34%);
- Developing and implementing a national plan of action for IUU (21%).



Source: FAO, 2022

Figure 22. Percentage of respondents to the FAO CCRF questionnaire (2022) who are party to the PSMA



Source: FAO, 2022

Figure 23. Measures implemented by respondents to the FAO CCRF questionnaire (2022) to prevent, deter and eliminate IUU activity

There are a wide range of examples available in how different countries and regions are approaching the issue of IUU fishing. Long *et al*. (2015) outlined strategies that could be used, including:

- Enhanced regional cooperation and a joined-up approach across governments, civil society, science, industry and the private sector;
- Digitally documenting catch data to promote global exchange of information on vessel registration, licences, unloading records, catch location and information, and crew documentation;
- Tighter controls at ports based on the ratification and implementation of the PSMA;
- Global transparency in fisheries makes it far more difficult to bring IUU fish to port; and
- Technological advances to make it simpler to track the movements of both fishing vessels and fish catch through the value chain.

US Seafood Import Monitoring Scheme: In 2018, United States implemented the Seafood Import Monitoring Program (SIMP) to combat IUU fishing and seafood fraud by requiring chain of custody evidence for species imported into the country. This prevents the sale of IUU seafood in the United States. Countries intending to access the large US seafood market will be incentivised to enhance management and traceability to comply with the SIMP (Leonardo and Deeb 2022).

Toothfish (Chilean seabass): The South Georgia Patagonian toothfish fishery uses effective surveillance to exclude unlicensed vessels from its waters. For licensed vessels a strict vessel licensing system is enforced and no trans-shipment is allowed. Landing points are limited and are closely controlled. The catch position and weight of every box of fish caught is recorded in real time using tamper-proof satellite technology and on-board weighing scales, and given a barcoded label to ensure illegal fish cannot enter the supply chain. This fishery is now MSC certified, demonstrating how good fisheries management can reverse the trend of illegal fishing and replace it with a sustainable and well managed fishery (OECD 2022).

Rights-based fisheries management: Rights-based management programmes allocate exclusive entitlements to an entity (person, company, vessel, community) to fish. Rights-based management has been shown to deliver better fisheries management and compliance, and disincentivises illegal behaviour due to the interest rights holders have in sustainably managing the fishery. The benefits of rights-based management depend entirely on the rights being adequately determined and fairly distributed. It is important to properly design the management systems to ensure the incentives align with compliance requirements. Many fisheries globally are managed through a form of rights-based management, incentivising fishermen to be accountable for the stocks they are fishing (Newman, 2015). Examples of rights-based fisheries management can be seen globally, including in Iceland, Japan, Chile and New Zealand.

Trade measures: EU regulations require non-EU countries that wish to export fish to the EU to meet strict standards for fisheries management. If these standards are not met, the countries may be 'carded', which means that they could ultimately face exclusion of their fish from the EU market (IUU watch 2024). In 2019, Ecuador was given a yellow card by the European Commission after being accused of inadequate enforcement efforts to address IUU fishing. In response, Ecuador took steps to strengthen fisheries management and clamp down on IUU fishing within its waters. In 2020, it introduced new measures to safeguard fishery resources that included more severe penalties for offenders. In 2021, Ecuador published data from its vessel monitoring system on the Global Fishing Watch map, making the movements of the country's 700 commercial fishing vessels and 500 smaller vessels visible to the world. This allows relevant authorities to see where vessels have been fishing and identify potentially suspicious activity, such as fishing within a protected area (Global Fishing Watch, 2022).

MSC chain of custody: The MSC Chain of Custody certification is a comprehensive traceability program that traces seafood from the point of sale back to an MSC-certified fishery. It ensures that MSC-labelled products are sourced from a fishery that is MSC certified as sustainable, and it protects buyers and the fishery from fraudulent labelling and risks from fisheries carrying products from IUU fishing. To obtain MSC Chain of Custody certification, wholesalers and distributors must pass an independent, third party audit to demonstrate they have internal traceability systems and reliable operational systems in place to ensure that MSC-certified seafood is kept separate from non-certified seafood. Worldwide, 66 countries have MSC Chain of Custody businesses, making up 46,800 supply chain sites globally (MSC 2024).

Indonesia: Indonesia has taken a hard stance against IUU fishing by implementing policies designed to curb this activity within its Exclusive Economic Zone (EEZ). The new policies make use of three key approaches: sinking illegal vessels, banning foreign fishing vessels and banning transfers of fish at sea. Indonesia has sunk 318 fishing boats (primarily from Vietnam, the Philippines and Malaysia) engaged in illegal fishing activities since the implementation of their IUU policies in 2014. Transshipment at sea, or the transfer of fish between boats, was also banned by Indonesia in 2014 because transshipment can mask where and by whom fish are caught. The local, legal fleet has since been allowed to resume transshipment at sea, provided boats comply with stringent regulations requiring an onboard observer, a vessel monitoring system (VMS) and onboard cameras. Fishing and transshipment activities by foreign boats are still banned. IUU policies have reduced total fishing effort by at least 25% and has the potential to generate a 14% increase in legal catch and a 12% increase in profit (Leonardo and Deeb 2022; Cabral *et al* 2018).

5.3 Habitat interactions

The potential impact of fishing gear on the seabed and on vulnerable habitats has been high on the global ocean agenda since the 1990s (FAO 2022). Gear interactions with the seabed can be direct or indirect, for example bottom towed gear directly interacts with the seabed by disturbing benthic communities as fishing activity occurs, whereas static gear such as pots may indirectly be dragged along the seabed during deployment or due to bad weather and turbulent waters (Jennings and Kaiser 1998). Target 5 of the GBF requires minimising impacts of fishing on non-target species and ecosystems and the implementation of an ecosystem approach to fisheries management requires that the wider ecosystem, including the impact of fishing on habitats is addressed through management measures.

The most common approach to managing sensitive habitats is through spatial management, but there are other tools already in use, such as gear modifications, that can also contribute to a reduction of the impacts of fishing. Understanding the impacts of fishing on habitats is an important first step in determining the appropriate management technique, and there have been several approaches to gathering this information.

BENTHIS project: This EU programme, coordinated by Wageningen Marine Research, studied the impacts of fishing on benthic habitats by studying the vulnerability of different benthic ecosystems in European waters and analysing the physical impact of the current fishing practices on benthic organisms and geo-chemical processes. Together with fishermen, researchers conducted trials with innovative fishing gears that reduce the impact of fishing on habitats. Semi-pelagic otter doors were shown to reduce bottom impact and also reduce the fuel cost without affecting the catch rate of the target species. Sea trials with the blue mussel fishery showed that fishers could reduce their footprint by deploying acoustic equipment to detect mussel concentrations that allow the fishers to more precisely target the mussel beds and hence reduce fishing in areas with low mussel density. Bio-economic models were developed to quantify the effect of mitigation measures on the socio-economy of the fishing sector. The models allow an integrated assessment of both the ecology and the social and economic consequences (Rijnsdorp 2017).

Ecological risk assessments: Fisheries managers in Australia address habitat impacts of all offshore bottom contact fisheries in Australian waters through a risk assessment framework – the Ecological Risk Assessment for the Effects of Fishing (ERAEF). Its progressively quantitative hierarchical approach enables higher-risk interactions to be identified and prioritised and screens out lower-risk interactions. The approach makes the best use of all available data, but it can also be inferential where data are lacking. A set of quantifiable attributes for habitats are used to describe the 'susceptibility' of each habitat to damage that may be caused by specific fishing gears and resilience is factored in as a habitat's 'productivity' (ability to recover from damage). In the case of the otter trawl fishery, a set of 158 habitat types were considered, of which 46, mostly on the outer continental shelf and slope, were identified as potentially higher risk and an ecological risk management strategy was developed to mitigate the impacts of fishing on these habitats (Williams *et al.*, 2011).

5.3.1 Spatial management

EAFM stage (Figure 2)	2
GBF Target 5	Sustainable; Preventing over exploitation; Minimising impacts on non-target species and ecosystems; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	4
Data reliability (1-5)	3

Spatial management of fishing activity can be permanent or seasonal, and designed to protect juveniles and spawning grounds as well as to mitigate the impacts of gear on sensitive habitats or to protect habitats important for the functioning of the wider ecosystem. Spatial management areas designed to regulate sustainable fishing activity often generate additional benefits for species, ecosystems and fishing communities, as well as support social and economic development (FAO 2022).

The self-reported data used in Protected Planet indicates that, as of August 2024, 8.35% of the ocean is currently protected through 18,692 marine protected areas, and when other effective area-based conservation measures (OECMs)[39] are included, this increases to 8.46% (211 OECMs). Activities permitted in, and access to, protected areas vary depending on their conservation objectives of the protected area, but MPAs do not necessarily need to be highly, fully or strictly protected for wider biodiversity benefits to be seen, and often the use of spatial management for fisheries can support access for small scale fishers and low impact gear while still delivering the economic and social benefits and a sustainable fishery (Rees *et al* 2021).

OECMs complement MPAs, by recognising the long-term *in situ* biodiversity benefits of management measures, even if such biodiversity benefits are not the primary objective of such measures. OECMs are not as commonly implemented as MPAs, but many fisheries closures, such as those that protect VMEs, are currently being considered, particularly by RFMOs (e.g. NEAFC and NAFO).

There is evidence that closed areas can increase biomass, diversity, and ecosystem functions (Kleisner *et al*. 2012). However, the use of protected areas as a tool to rebuild stocks or prevent overfishing has mainly been shown to be successful where stocks are severely overfished (Holborn 2020). EAFM requires consideration of social and economic impacts of management, and MPAs and closed areas risk displacing fishing effort to other areas, decreasing economic viability and social or cultural impacts from loss of traditional fishing grounds (Pendleton *et al* 2018). FAO (2022) states the importance of focusing on the use of co-management to design area-based management that achieves social, economic and environmental objectives.

Iceland mixed fishery: The Ministry of the Environment developed a National Strategy Plan for the preservation of biological diversity (Ministry of Environment 2010). Two of the key elements of this strategy are (a) develop fishing methods with less impact on marine ecosystems, and (b) protect vulnerable benthic ecosystems. Act 97/1997 also provides a framework which allows managers to close vulnerable habitats to fishing as and when the need arises.

Temporary and permanent closures are in place to protect spawning grounds, but also have a secondary effect of protecting seabed habitats from being damaged by fishing activities. There are permanent area closures are in place to protect Lophelia reefs and hydrothermal vents. Existing closed areas are clearly marked on maps used by all vessels, surrounded by buffer zones, and any infringement triggers an alarm with the Coast Guard compliance team, using the VMS position of the vessel. Detailed habitat mapping is undertaken to identify further sensitive areas and the intention is to protect these, and bycatch reporting procedures include collection of information on invertebrates such as corals, sponges, soft corals etc.

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

Lyme Bay reserve: In 2008, more than 200 km² of Lyme Bay, UK, were closed to bottom towed fishing to protect local reefs, corals and sea fans. The closure was implemented to allow benthic habitats to recover from the impacts of mobile fishing gear. After an initial influx of a large number of static gear vessels into the area after the initial exclusion of mobile gear, the number of boats operating in the area was limited to 40 using static gear, and operating under a memorandum of understanding and a voluntary code of conduct. Fishermen restrict pots and nets to agreed levels in the interests of the environment and in line with conservation objectives (Rees *et al* 2021). The closure to bottom towed gear has resulted in displacement of these vessels to outside the closed area and reports of lower subjective wellbeing and material losses for towed gear fishermen (Rees 2021). This demonstrates the importance of considering all stakeholder needs during the fishery management process.

Monitoring studies have been conducted in the area since 2008 by the University of Plymouth in partnership with the fishermen and regional Inshore Fisheries and Conservation Authorities (IFCAs) and these show that reefs and fish stocks are recovering. Between 2008 and 2013 there was a four-fold increase in the diversity of reef species, a doubling of scallop landings, a quadrupling of juvenile lobsters and the abundance of protected pink sea fan increased seven-fold (Rees *et al* 2021). When the area was hit by extreme storms in 2014 the recovering marine community was severely damaged, but research shows how the reefs are bouncing back far quicker than previous recovery rates following initial protection of the area, indicating how the MPA has increased the resilience of the reef ecosystem (Lyme Bay Reserve 2024).

Patagonian scallop fishery: The fishery is split into ten management units and a TAC established for each unit. The fishery is then managed through a rotational system so that no area is fished for prolonged periods to preserve habitat and maintain recruitment of scallops and the benthic habitat. The scallop stock has been maintained at a healthy level as the closed rotational areas provide a source of larvae for continue reproduction of scallops, but also but also benthic invertebrate communities in the different management units have been maintained over time (Morsan *et al* 2023).

Shells of processed scallops are returned to sea at point of capture in order to help preserve the habitat structure as the scallops are considered the principal keystone species that structures the benthic habitat of scallop beds. There is a Management Plan ensuring sustainability of scallop populations which indirectly also ensures the sustainability of benthic habitat of scallop beds. The importance of spatial closures for the benthic community has been demonstrated by evidence that biomass of species impacted by trawling recovers quicker in the non-fished area (Morsan *et al* 2023).

5.3.2 Protection of sensitive habitats and VMEs

The FAO guidelines (2005) state that:

'A marine ecosystem should be classified as vulnerable based on the characteristics that it possesses. The following list of characteristics should be used as criteria in the identification of VMEs.

- *Uniqueness or rarity – an area or ecosystem that is unique or that contains rare species whose loss could not be compensated for by similar areas or ecosystems. These include: habitats that contain endemic species; habitats of rare, threatened or endangered species that occur only in discrete areas; or nurseries or discrete feeding, breeding, or spawning areas.*

- *Functional significance of the habitat – discrete areas or habitats that are necessary for the survival, function, spawning/reproduction or recovery of fish stocks, particular life-history stages (e.g. nursery grounds or rearing areas), or of rare, threatened or endangered marine species.*
- *Fragility – an ecosystem that is highly susceptible to degradation by anthropogenic activities.*
- *Life-history traits of component species that make recovery difficult – ecosystems that are characterized by populations or assemblages of species with one or more of the following characteristics: o Slow growth rates; o Late age of maturity; o Low or unpredictable recruitment; or o Long-lived.*
- *Structural complexity – an ecosystem that is characterized by complex physical structures created by significant concentrations of biotic and abiotic features. In these ecosystems, ecological processes are usually highly dependent on these structured systems. Further, such ecosystems often have high diversity, which is dependent on the structuring organisms.'*

One of the biggest challenges in protecting sensitive marine habitats is identifying and documenting their distribution, and understanding how fishing interactions impact on their function and structure. Data collection and mapping tools such as EMODnet provide an overview of different habitats and VMEs, but are only as good as the data they are based on. There are also national and international conventions that identify the importance of protecting marine habitats, but these need to be reflected in changes to activities on the water.

MSC fisheries: MSC fisheries are required to demonstrate that they are mitigating the impact of gear on benthic habitats. The West Greenland shrimp fishery now use a new net with a lighter trawl door to minimise its impacts on the sea floor. Research is currently underway to better understand the impacts of the Australian West Coast Crystal Crab fishery on the seafloor by developing a novel underwater monitoring system to capture footage of the deep-sea habitats in which the fishery sets crab pots. The system will be automated and illuminate the seafloor, allowing the research team to identify a fishery's potential impacts. In addition to this, MSC, working in collaboration with University of Bangor, developed a Benthic Impacts Tool to help fisheries understand and manage their impacts on the seafloor (MSC 2024).

South African hake: In South Africa, a certified hake trawl fishery in shallow and deep waters off the west and south coasts restricts its activities to historical trawl grounds to limit its impact on the sea floor. The fishery has supported research including a five-year experiment looking at changes to the ocean floor after areas were closed to trawling. This research found deep sea anemones and starfish living on the dark sea floor along with many more species. A VME encounter protocol and move-on rule has been developed and requires:

- Report of encounters with VME indicator taxa, at or above specified threshold limits.
- Management actions that must occur in response to encounter reports, and associated points of responsibility.
- Defined spatial exclusions from areas in which VME encounters are reported.
- Review of encounter information and the application of move-on rules triggered.

A pilot project to develop a monitoring protocol for VME indicator organisms has been undertaken and observers conduct invertebrate sampling during one trawl per day (5% and 10% of voyages) (Durholtz 2019).

Deep-sea Fisheries Guidelines (FAO 2009): promote area-based measures that permit bottom fishing where impacts on biodiversity are low, but prohibit fishing in areas where biodiversity is fragile (e.g. on VMEs). In most RFMOs, 100% of the area has bottom fisheries measures in the high seas, and these are supported by other measures dealing with small pelagic and tuna fisheries. The measures incentivise deep-sea fisheries to provide nutrition, income and employment while eliminating negative impacts on biodiversity, thus supporting sustainable use of fisheries resources as well as biodiversity conservation goals of the CBD (FAO 2022).

CCAMLR: In response to a global call for action to mitigate the impact of bottom trawling on VMEs, CCAMLR developed methods for identifying VMEs and encounter protocols for fishing vessels. CCAMLR has adopted a suite of measures to address the protection of VMEs and restrict the distribution of bottom fisheries by closing areas to fishing, along with a complete prohibition on the use of gillnets. Bottom fishing is prohibited in water shallower than 550 m around the entire Antarctic continent. The Southern Ocean is characterised by extremely limited data on benthic marine ecosystems, demonstrated by the proportion of new species discovered by recent focused research efforts to study the marine benthic fauna of the region (CCAMLR 2024). This data limited situation, combined with slower growth rates of benthic species in these cold waters means the impacts of fishing gear on VMEs may be magnified because of the much longer time taken to recover (Duarte *et al* 2020).

5.3.3 Gear modifications

EAFM stage (Figure 2)	2
GBF Target 5	Sustainable; Preventing over exploitation; Minimising impacts on non-target species and ecosystems; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	4
Data reliability (1-5)	3

The impacts of fishing gear on seabed habitats vary depending on the frequency and intensity of fishing, the physical properties of the seabed, the level of natural disturbance and the resilience and recovery times of benthic species. While closed areas provide the opportunity for undisturbed management of seabed habitats, they are not always socially or economically viable. In some fisheries, the approach has been taken to implement gear modifications that reduce the interaction of fishing gear with the seabed while still allowing commercial fishing to take place (McConnaughey *et al*, 2019).

Bottom trawling accounts for almost a quarter of fish landed and on average 14% of the seabed is estimated to be trawled globally (Amoroso *et al* 2018). Regionally, trawled areas can cover up to 80% of the seabed area and often hotspots can be identified that are trawled every year (Amoroso *et al* 2018). The extent of trawling and its ability to act as a significant source of protein means that managing and mitigating the habitat interactions of trawl gear is an important aspect of EAFM. There are currently 19 dredge fisheries and 44 bottom trawl fisheries certified to the MSC Standard. For these fisheries to be certified they must have demonstrated appropriate understanding of the level of impact on habitats and have a suitable mitigation system in place to limit the level of impact. Some of these fisheries use closed areas to protect the most sensitive habitats, but many have successfully demonstrated the use of gear modifications to reduce the impact of gear on the habitat while maintaining a viable fishery.

Limiting the weight and durability of gear: Industry-sponsored studies have shown that alternative designs and materials can reduce the penetration depth and overall weight of scallop dredges, thereby reducing gear wear, fuel consumption, bycatch and seabed impacts, while increasing catch efficiency (McConnaughey *et al* 2019). By reducing the weight and durability of the gear it may discourage use in rough areas of the seabed that commonly support sensitive benthic species and habitats (McConnaughey *et al* 2019).

Reducing physical contact and penetration depth of gear within the seabed: lifting gear above the seabed has been addressed in many ways. By creating openings under the footrope fishermen in Bering Sea (2011) and central Gulf of Alaska (2014) flatfish fisheries were able to reduce unobserved mortality of commercially valuable crab species while reducing habitat disturbance by 24% (van Marlen *et al.*, 2009).

The 'sumwing' beam trawl is being trialled in the UK after success in Europe. A hydrofoil wing skims just above the bottom of the trawl reducing both penetration depth and fuel consumption by 10% (van Marlen *et al.*, 2009).

Operational changes: Innovative technology can further reduce the impacts of trawling, due to efficiency gains that reduce the level of effort required to catch quota. Technologies such as the use of acoustic and video imaging for pre-catch identification and catch monitoring of Barents Sea cod could potentially increase catch rates of target species and correspondingly reduce the trawling footprint (McConnaughey *et al* 2019).

Canadian groundfish forum: All Canadian vessels fishing in the Bering Sea adopted a new type of fishing gear, known as modified trawl sweeps, which reduce bottom contact of the gear by 90%. Modified trawl sweeps elevate most of the parts of the trawl that herd fish off the ocean bottom, which reduces bottom impacts and also reduces bycatch of king and tanner crab. The effectiveness of modified trawl sweeps in reducing mortality and disturbance on benthic species such as sea whips, basket stars, sponges, and crab species is well-documented, peer reviewed, and verified by NOAA scientists (Smeltz *et al.*, 2019).

5.4 Ecosystem structure

The wider impacts of a fishery on the ecosystem it operates in and how this can be managed is one of the more advanced stages of EAFM. Often this is a result of the difficulty in fully understanding the impacts of the fishery or being able to attribute ecosystem changes to fishing activity. Ecosystem based analytical models have been used for many years to support fishery managers in understanding the potential repercussions of management scenarios, occasionally resulting in innovative approaches to managing a fishery and its impacts on the ecosystem.

The degree of uncertainty associated with this type of management highlights the importance of stakeholder participation in identifying ecosystem linkages and the implementation of an adaptive approach to management that can quickly identify the need for change. This is increasingly important with the additional pressure from climate change.

5.4.1 Mixed fishery management

EAFM stage (Figure 2)	3
GBF Target 5	Sustainable; Preventing over exploitation; Minimising impacts on non-target species and ecosystems; Applying the ecosystem approach
Policy score (1-5)	2
Implementation score (1-5)	2
Data availability (1-5)	2
Data reliability (1-5)	2

Traditionally, fisheries management has been single species, but there is increased awareness of the need for a mixed fishery approach. Single species stock assessments are available for roughly 50% of global fisheries (FAO 2022). However, managing a single species without considering that other fish species may also be caught with it could lead to unintended consequences. This is especially relevant in a mixed fishery scenario such as the North Sea or the North West Atlantic (Kuhn *et al.*, 2023), where managing one species at MSY may cause other species to be overexploited, risking the population status, or underexploited, foregoing potential food and nutritional benefits. Addressing mixed fishery management through EAFM contributes to the GBF Target 5 requirement of ensuring sustainability and preventing overexploitation.

There have been several attempts to provide scientific advice that accounts for these interactions, although translating this into management and quota distribution remains a challenge. Mora *et al* (2009) found that approximately 7% of fisheries are using holistic models as the basis of management recommendations, including a broad set of biological and environmental data on fisheries to enable ecosystem-wide understanding of fisheries drivers and impacts. Where approaches to mixed fishery management are being implemented in practice, Sun *et al*. (2023) reflect that the diversity highlights a lack of global consensus on best management practices.

Hilborn *et al* (2020) explained that it is not possible to selectively fish all individual species in a mixed fishery at their optimum rate, because social objectives may involve minimising environmental impacts or maximising profits and jobs instead of optimising biological yield. Implementing EAFM in mixed fisheries will require consideration of ecological, social and economic needs, and demonstrates the importance of stakeholder collaboration and continued monitoring of performance to ensure management is successfully achieving the agreed objectives. Furthermore, ICES (2012) states that achieving single- or multi-species MSY may not be sufficient to ensure all aspects of a healthy ecosystem and may need to be supplemented with measures to mitigate undesirable impacts on ecosystems.

Section 5.2 discussed gear modifications that have been used to reduce the bycatch of non-target species. These innovations can also be used for increased selectivity in the fish being caught in a mixed fishery. For example, different fish species have been shown to behave differently to different configurations of lights on nets so if cod swim upwards away from the net and haddock swim downwards into the net, it may improve the selectivity of the gear where there is a smaller quota available for cod than haddock (MSC, 2024; Senko *et al.*, 2022).

ICES mixed fishery advice: When a fishery captures a mixture of species it is not entirely possible to control which species and how much of each is caught, so it may not be possible to achieve the single-stock MSYs (translated into TACs) of all the stocks simultaneously. Either the TACs for some stocks will be exceeded in trying to catch the TACs of other stocks, or the TACs for some stocks will not be caught in order to prevent TACs for other stocks from being exceeded. ICES has developed a mixed-species fisheries model to help fishery managers understand where trade-offs may need to be made to meet fishery and environmental objectives (ICES, 2012). Multispecies fishing mortality strategies can be developed to achieve MSY on a multispecies basis, and to evaluate trade-offs between species based on preferences from managers and stakeholders (ICES, 2012).

Management Strategy Evaluation: Management Strategy Evaluation (MSE) is a tool to gauge the relative performance of fishery management options. For the most part, MSEs have been applied to single-species management procedures. However, to be more inclusive of all the biological and technical interactions occurring within a system, ecosystem-based strategies are emerging. In order to test the feasibility of these strategies, a full ecosystem model needs to be used as an operating model. Mass balance food web models include many features that managers are interested in and therefore can be useful as an operating model. This approach allows fishery managers to run a range of scenarios to understand the likely success of different harvest control rule scenarios in the context of the wider ecosystem (Perryman *et al* 2021).

'Pretty good yield' ranges: A multi-stock harvest control rule (HCR) that uses single stock assessment results and fishing mortality ranges to generate a consistent catch advice among stocks was tested for the demersal mixed fishery operating in Bay of Biscay and Celtic Sea. The HCR produced consistent catch advice among stocks when there was only a single fleet exploiting them and removed the impact of the discard ban. However, in a multi-fleet framework the performance of the HCR varied depending on the characteristics of the fleets. This approach provides more consistency in catch allocation for fishermen over time but means that the full economic potential for some species is not possible (Garcia *et al* 2020).

F_{ECO}: Using a case study of the Irish Sea, stock-specific ecosystem indicators were used to set an ecosystem-based fishing mortality reference point (F_{ECO}) within the "Pretty Good Yield" ranges for fishing mortality which form the present precautionary approach adopted in Europe by ICES. F_{ECO} can be used to scale fishing mortality down when the ecosystem conditions for the stock are poor and up when conditions are good. This approach provides a streamlined quantitative way of incorporating ecosystem information into catch advice and provides an opportunity to operationalise ecosystem models and empirical indicators (Bentley *et al.*, 2021). When applied in the Irish Sea information was gathered through stakeholder workshops to ensure local ecosystem knowledge was included in the model.

5.4.2 Trophic level impacts

EAFM stage (Figure 2)	3
GBF Target 5	Sustainable; Preventing over exploitation; Minimising impacts on non-target species and ecosystems; Applying the ecosystem approach 
Policy score (1-5)	2
Implementation score (1-5)	2
Data availability (1-5)	2
Data reliability (1-5)	2

The trend of fishing down the food web, where there has been a shift in landings from higher trophic level species to lower trophic level species, is well documented (Essington *et al* 2006). This process not only removes the higher predators, opening up space for alternative species to enter the food web and alter the ecosystem structure, but may also lead to the removal of small fish that are prey for many larger species (Pauly *et al.*, 1998).

The FAO marine capture data for 2022 indicated that a significant proportion of global fish landings come from populations of low trophic level species, and Smith *et al* (2011) states that forage fish constitute 30% of global landings. Pauly and Palomares (2005) demonstrated that, between 1950 and 1994, the mean trophic level of fishery landings decreased, reflecting a gradual transition from long-lived, high trophic level fish toward short-lived, low trophic level, invertebrate and planktivorous pelagic fish.

Part of the reason that Asian fisheries have continued to have high catches may be the ecosystem effect of reducing the biomass of large predatory species, allowing smaller, faster-growing species to become more productive, as well as enabling some key species to change their life-history and mature at younger ages (Hilborn *et al*, 2020). Fish populations also compete for food and habitat, and some fish predate on other fish. Removing a large proportion of one species will have repercussions for the population size of species above or below it in the food web.

This is a difficult area to manage as there are so many unpredictable interactions, and fishing may be one of many pressures causing shifts of trophic structure. Once an ecosystem's state shifts because of changes in the food web, this can leave it less resilient to further changes, including climate change, and often unable to recover to its previous state, even when left alone. The collapse of the Canadian Groundfish fishery resulted in changes in the community structure across the Scotian Shelf including a transition to invertebrate-dominated fisheries, a widespread decline in body size of groundfish, and an increase in diversity of small-bodied fish in the absence of large predators. These ecosystem changes have persisted for more than 20 years (Shackell *et al*., 2021).

A Mean Trophic Index has been developed from the Sea Around Us project and was endorsed as a potential indicator of biodiversity by the parties to the CBD in 2004. It is designed to measure the decline of mean trophic level over time, with high scores indicating that catches consist of higher trophic level species, and a decrease in score over time indicating that countries are depleting stocks of high trophic level species and moving to lower trophic level species. Currently only seven countries score the maximum of 100 (Cape Verde, Comoros, Maldives, Malta, Romania, St Vincent and the Grenadines and Singapore). The largest global fishing countries all have low scores: China scores 20.4, Indonesia scores 5.6, Peru scores 9, Russia scores 10, and USA scores 13. There is currently no data available on how this number has changed over time so the lower numbers may be misleading for countries such as Peru that historically fish for lower trophic level species such as anchoveta from large, well-managed stocks (Smith *et al* 2011).

Managing the impacts of fishing on the food web is complex, and often requires complex scientific models. Aside from fishing mortality, one of the key sources of mortality is predation mortality, and the development of multi-species models (such as the SMS model for the North Sea) that take into account predator-prey interactions allow predation mortality to be estimated based on the biomass of upper-trophic level species. These estimates are included in the assessments for North Sea species (cod, whiting, herring, sprat, sandeel). However, there remains a need for fishery managers to balance this advice with social and economic considerations when setting fishing limits. The following examples provide evidence of how stock assessments and a holistic approach to fisheries management can account for ecosystem interactions while still providing the social and economic benefits from a sustainable, well-managed fishery.

South Africa anchovy and sardine: In 2008, South Africa implemented a decade-long field experiment to understand how fisheries may be affecting the African penguin *Spheniscus demersus*. Fishing for anchovy and sardine was prohibited within relatively small areas around four African penguin breeding colonies, two in the Benguela upwelling ecosystem and two in the adjacent Agulhas region. For the Benguela, fisheries closures within the birds' primary foraging range increased their breeding productivity and reduced parental foraging efforts, indicating that the fisheries are competing with the birds for food. The African penguin is endangered, its population continues to decline, and fisheries closures have been demonstrated to improve demographic traits that contribute to population growth. Closing these areas to fishing would increase penguin food supplies and may help to meet societal goals of halting the decline of the penguin population, as well as maintaining the economic and cultural services provided by fisheries and ecotourism (Sydeman *et al*., 2021).

Southern Ocean krill fishery: In the Southern Ocean, Antarctic krill make up an estimated biomass of around 379 million tonnes. Of this, over half is eaten by whales, seals, penguins, squid and fish each year, and is replaced through reproduction and subsequent growth of the krill population. They are important in the food chain and are considered a keystone species in the Southern Ocean ecosystem. CCAMLR is the authority tasked with the scientific assessment and management of krill fisheries in Antarctica, to avoid an increase in krill catches in the Southern Ocean that could have a serious effect on populations of krill and other marine life (CCAMLR, 2024).

Fishing is set at very precautionary levels, and a trigger limit prevents the catch from exceeding a certain level. The total allowable catch for the southwest Atlantic is currently about 5.6 million tonnes annually. However, CCAMLR restricts the fishery to a catch limit of 620,000 tonnes; even if all this was taken it would amount to only 1% of the total krill population. The actual annual catch is around 0.3% of the unexploited biomass of krill. CCAMLR has agreed that any expansion in the krill fishery should not happen unless the scientific data indicate that it will continue to be sustainable.

Scientists use computer models that simulate the krill population, taking into account what is known and what is not known about the ecosystem. This fishery has been MSC certified since 2010, and is considered by independent assessors to be very well managed with very low impacts on the ecosystem (MSC 2024).

Welsh cockle bird food model: Cockles are an important inshore fishery in Wales but they are also crucial for the survival of overwintering birds such as oystercatchers. To manage the fishery in a way that ensures sufficient cockles are available for birds when they arrive in August, Natural Resources Wales (NRW) apply the Stillman bird food model (BFM) developed specifically for allocation of TAC in cockle fisheries (O'Kane *et al* 2023).

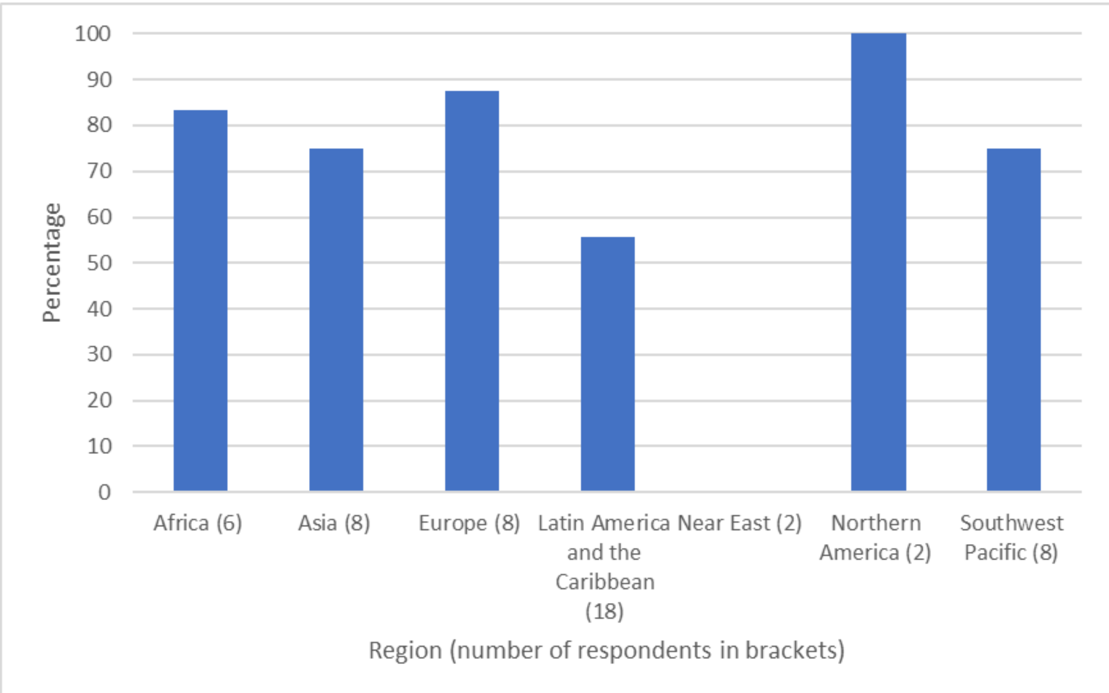
The BFM can be summarised as follows using the Dee Estuary as the example:

- A bird food requirement is estimated for the estuary using an individual-based model; it uses the mean peak number of birds (overwintering in this case) multiplied by their physiological requirements to estimate the number of cockles required to maintain the population over winter. The current model is precautionary, in that it assumes that all the food requirements need to be met by cockles, whereas in practice it is known that oystercatchers also eat other species; also it is based on peak mean oystercatcher numbers rather than mean numbers over the season.
- An annual spring survey of cockle abundance and density by size class is carried out in April/May in order to determine an initial TAC, which will be applied at the start of the fishing season (01 July). The TAC is determined by subtracting the bird food requirement from the calculated biomass to provide the amount that can be fished.
- Cockle biomass is known to fluctuate within the season, driven by environmental factors such as beds being washed out, overcrowding and other mortality events, and therefore there is an additional survey in the Autumn (usually September), which is used to estimate any changes in biomass due to mortality, based on which the TAC can be adjusted if necessary (either up or down) (MSC 2024).

5.4.3 Climate change

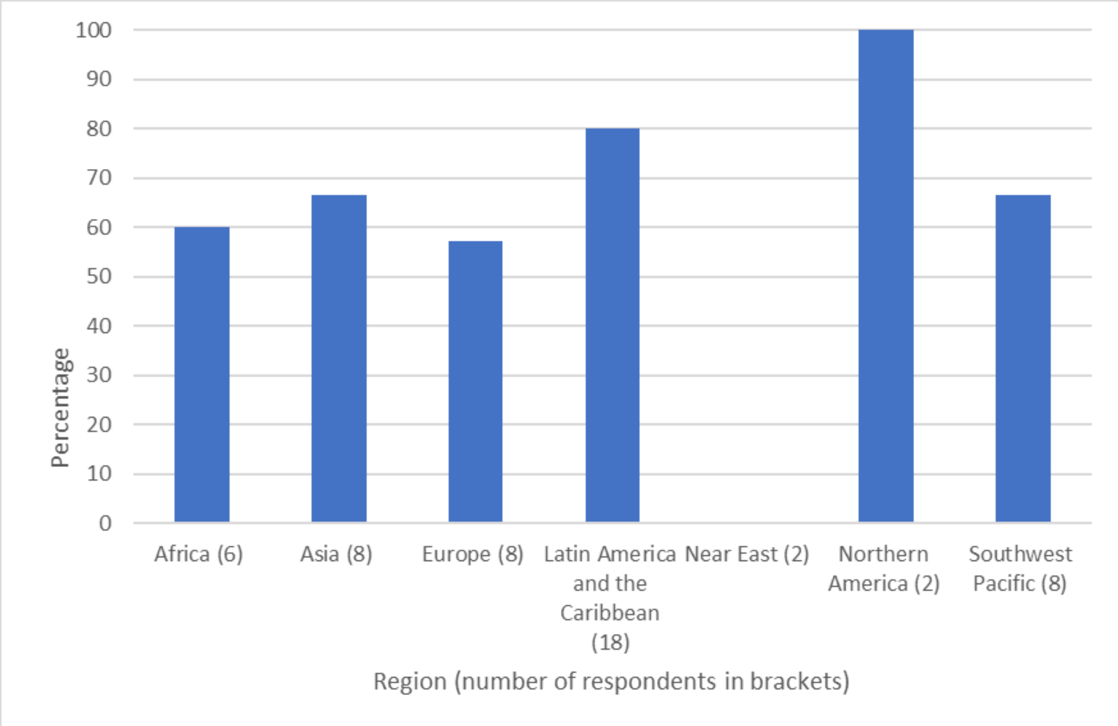
EAFM stage (Figure 2)	3
GBF Target 5	Sustainable; Minimising impacts on non-target species and ecosystems; Applying the ecosystem approach; Customary sustainable use 
Policy score (1-5)	4
Implementation score (1-5)	2
Data availability (1-5)	2
Data reliability (1-5)	2

There is increasing evidence of the impacts of climate change on aquatic ecosystems, indicating a need for the explicit consideration of climate stressors in fisheries management and a more holistic approach to activities impacting the wider ecosystem (FAO, 2022). Although climate change is not explicitly mentioned in GBF Target 5, the potential impacts it could have on fisheries and the wider ecosystem mean it is important to consider as a factor in sustainable management. The FAO CCRF questionnaire (2022) asked members about research and programmes to address the impacts of climate change on fisheries. 69% of respondents stated that research is carried out, and of these, 69% have programmes in place (Figure 24; Figure 25). The ABPmer survey indicated that development and implementation of measures to manage fisheries in the light of climate change has progressed less than other aspects of fisheries management.



Source: FAO, 2022

Figure 24. Respondents to the FAO CCRF questionnaire (2022) with climate change research being carried out



Source: FAO, 2022

Figure 25. Respondents to the FAO CCRF questionnaire (2022) with climate change programmes being carried out (only refers to those who answered positively to undertaking research)

EAFM does not directly address climate change, but implementing EAFM may help mitigate impacts and provide more resilient, adaptable ecosystems (Engler 2020). ABPmer (2018) found that the use of flexible and adaptive management approaches that allow for continuous adjustments as climate impacts are detected are important in managing fisheries when there may be unforeseen impacts from climate change.

Increased temperatures in the already warm waters of the tropics are predicted to cause declines of up to 40% in potential seafood catch by 2050 (Cheung *et al*., 2009), while the North Atlantic and North Pacific are already seeing increases in the range of some fish species (MSC 2024) as warmer water spread northwards increasing their range. The global scale of the impacts of climate change means collaboration across ecosystems and management jurisdiction, as well as including stakeholders in management decisions could help to identify and address issues more widely to implement early warning models and indicators that can support mitigation or adaptation of climate change impacts on fisheries and aquaculture (FAO, 2022a).

Climate change may cause the most harm to those who have contributed the least to the climate crisis, such as small-scale fishing and fish farming communities, in particular those living in low-income countries and islands (Gianelli 2024). FAO (2022a) indicates that notions of equity should always be at the heart of climate discussions, and EAFM should enable consideration of social and economic factors and customary sustainable use in fisheries decision making. FAO FishAdapt project has developed 120 community-based integrated management plans in Myanmar, to help increase the resilience of local fisheries and aquaculture communities and their livelihoods to climate change (FAO, 2022a).

Heenan *et al* (2015) and Holsman *et al* (2020) found that implementing EAFM in developing and developed countries will not only build resilience to the ecological and fisheries effects of climate change, it may also help address the habitat degradation and overfishing presently reducing the productivity of coastal fisheries. Given the wide range of potential impacts from climate change on different types of fisheries, there has been a correspondingly wide variety of management responses but the long-term success of these approaches is yet to be determined and will hinge on the extent to which the impacts from climate change manifest (Appendix E). Key impacts to consider include:

- Changes in species distribution;
- Changes in individual size, age of maturity and reproductive potential;
- Reduced species and ecosystem resilience;
- Loss of access to key sources of nutrition for coastal communities; and
- Loss of access to key sources of income for SSF.

There is not currently a clear indicator of the extent to which climate change is being factored into fisheries management, although guidelines for best practice management of fisheries in a changing climate have been produced by national and international fisheries experts and generally focus on the need for collaboration, monitoring and adaptive management (FAO, Australia's CSIRO, USA's NOAA, Coral Triangle Initiative).

Potential responses to mitigate the impacts of climate change focus on:

- The use of adaptive management;
- The use of ecosystem models and scenario analysis;
- Co-management and cross border collaborations;
- Diversify livelihoods and markets;
- Increased research; and
- Regular monitoring of ecosystem indicators.

In addition to some of the adaptable fishery management approaches discussed throughout this report, such as live time reporting and ecosystem modelling that will contribute to the management of fisheries in the face of climate change, examples of approaches to mitigate or adapt to climate change impacts on fisheries include:

Coral Triangle Initiative: The Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF) is a multilateral partnership of six countries working together to sustain extraordinary marine and coastal resources by addressing crucial issues such as food security, climate change and marine biodiversity. These countries are heavily reliant on fish as a source of nutrition but are expected to see significant reductions in their access to seafood as a result of climate change (Cheung *et al*., 2009). This initiative commits members to implement an ecosystem approach to fisheries management to identify, address and monitor management measures with the intention of ensuring a resilient and robust ecosystem that will support the health of their fisheries (Heenan *et al* 2015).

Preparation for emerging fisheries: As waters around the UK are warming as a consequence of climate change, species such as hake, squid and anchovy are increasingly present as their northern range expands. As populations of other species decline in the same waters where they prefer cooler waters or are outcompeted by the newer species, there is an opportunity to set up new, sustainably managed fisheries to minimise the social and economic impacts that would otherwise result from the loss of traditional stocks (Pinksy and Mantua 2014).

Real time boundaries: The East Australian longline fishery is managed through a series of limited access spatial zones to avoid Bluefin tuna bycatch. The zones are updated frequently based on known habitat preferences of bluefin tuna and the output from a near-real-time oceanographic model (Hobday *et al*., 2016). This flexibility ensures avoidance of non-target species and could be applied more widely as species behaviour alters as a result of the impacts of climate change (Pinksy 2004).

Global Environment Facility: This funding body is dedicated to confronting biodiversity loss, climate change, and pollution, and supporting land and ocean health. It is the designated institutional structure operating the financial mechanism of the CBD; it applies the guidance, including policy, strategy, program priorities, and eligibility criteria relating to access to and use of its resources from the Conference of the Parties. It has already funded a number of projects to support countries in adapting to and mitigating the impacts of climate change:

- Climate Change Resilience in the Caribbean Fisheries Sector (CC4FISH-II)
- Mainstreaming climate change and ecosystem-based approaches into the sustainable management of the living marine resources of the WCPFC
- Strengthening Adaptative Capacities to Climate Change through Capacity Building for Small Scale Enterprises and Communities Dependent on Coastal Fisheries in The Gambia
- Building Climate Change Resilience in the Fisheries Sector in Malawi (GEF 2024)

Canada-US halibut convention: This agreement establishes the division of the TAC between the two parties in a way that adjusts each year to the distribution of the fishable portion of the stock. Through annual stock assessments the coast wide exploitable biomass is calculated, and a fixed exploitation rate applied to that biomass to determine an allowable yield for each regulatory area. Each country allocation varies each year with the distribution of stocks across the management area. This approach is similar to zonal attachment (where TAC is allocated based on the share of the stock withing a country's economic zone) but is calculated every year and based only on exploitable component of the stock (ABPmer 2018).

Bering Sea pollock: Extensive monitoring of ocean conditions in the eastern Bering Sea revealed declining zooplankton prey, low pollock recruitment, and increased predator abundance from 2000–2005 (Pinsky 2004). Based on the understanding that pollock recruitment and biomass would likely continue to decline in future years, the North Pacific Fishery Management Council cut the fishery quota by nearly 50% through 2010. In 2011, new monitoring data suggested a shift back toward more favourable conditions, and the fishery quota was substantially increased. This ability to monitor and react to data by altering the TAC will contribute to the ability to maintain the biomass of target species at a level where the fishery is less likely to collapse (Pinsky 2004).

5.5 Cross cutting components

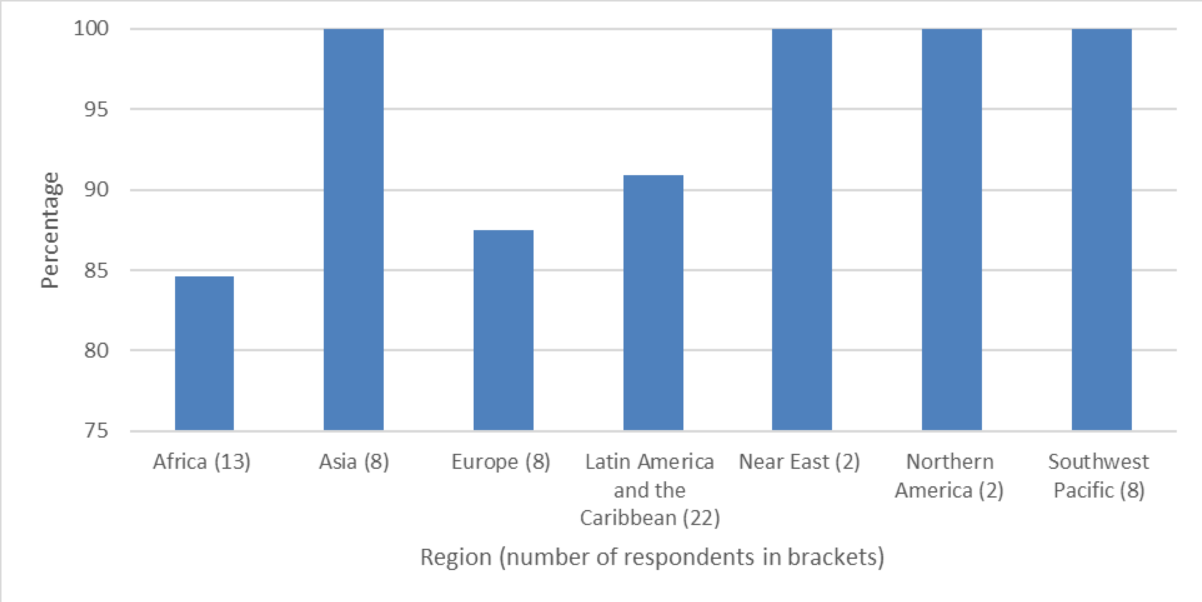
The success in addressing the components of EAFM discussed so far in Section 5 is underpinned by the need to include social and economic considerations, customary sustainable use and a participatory approach early in the process. Many countries have specific policies and legislation supporting the inclusion of these approaches in fisheries management, but often they are not prioritised, especially in the earlier stages of implementing EAFM.

5.5.1 Social and economic considerations

EAFM stage (Figure 2)	1-3
GBF Target 5	Sustainable; Legal; Applying the ecosystem approach; Customary sustainable use
Policy score (1-5)	3
Implementation score (1-5)	2
Data availability (1-5)	2
Data reliability (1-5)	2

GBF Target 5 requires the use of the ecosystem approach and consideration of customary sustainable use, both of which have social and economic aspects. The literature review found that the importance of including social and economic considerations when developing and implementing fisheries management was a key component that sets EAFM apart from traditional fisheries management. The FAO (2022) reiterated that one of the significant principles of EAFM is that 'fisheries assessment and management should be participatory, based on best available knowledge, and should cover, in an explicit and balanced way, the ecological, social and economic dimensions of fisheries', but added that imbalances remain in how these dimensions are considered globally. There are numerous societal objectives that can be met by sustainably managing fisheries resources to improve human well-being and equity between various stakeholders while ensuring that the systems that sustain these services are not irretrievably compromised (FAO 2022a).

The FAO CCRF questionnaire (2022) on the implementation of the CCRF asked members about the implementation of aspects of EAFM, and found that 92% of respondents have activities in place to consider the social and economic aspects of fishing. Implementation varied globally, with 100% of respondents in Asia, North America, Near East and Southwest Pacific stating that they had activities in place, but only 88% of responses from Europe (Figure 26). FAO (2022) also asked members if they had specific initiatives to implement the Small-Scale Fisheries (SSF) Guidelines (FAO 2015): 55% of responses were positive, whilst 42% reported that they intended doing so in the future. Initiatives already in place were most prominently related to implementing capacity development of fisheries organisations and other stakeholders (90%), supporting Small Scale Fisheries (SSF) actors to take an active part in sustainable resource management (95%), and enhancing SSF value chains, post-harvest operations and trade (90%).



Source: FAO, 2022

Figure 26. Respondents to the FAO CCRF questionnaire (2022) specifically addressing social and/or economic elements at the community and national levels, related to fishing, fish processing and services related to fishing

Sustainable development goals indicators

SDG Indicator 14.b.1 considers the degree of application of a legal / regulatory / policy / institutional framework which recognises and protects access rights for small-scale fishers, and as of 2022, FAO considered this target was met at a global level. However, this overall score masks regional variations. Northern Africa and western Asia scored lower against the SDG indicator in 2022 than in 2020. SDG indicator 14.7.1 considers sustainable fisheries as a percentage of GDP in small island developing States, least developed countries and all countries. As of 2019, FAO considered that globally the target of sustainable fisheries as proportion of GDP was below average and declining worldwide due to growing economies and declining stocks. The most significant regional declines have been observed in smaller and developing countries, which are, on average, the most reliant on fisheries for national income.

Ocean health index

The Ocean Health Index comprises several indicators of use in understanding how social and economic considerations are being addressed.

- Ensuring access to artisanal fishing for local communities: The current score indicates that many regions are addressing and meeting the needs of artisanal fishers by implementing government policies that permit or encourage them to do so and providing appropriate access to near-shore areas.
- Sustaining jobs and thriving coastal economies: This goal measures jobs and revenue from sustainable marine-related industries through number and quality of jobs (Livelihoods) and the amount of revenue produced (Economies). This score has not been meaningfully updated since the origin of the global Ocean Health Index in 2012 as the indicators were discontinued.

- Preserving sense of place: People derive a sense of identity or value from living near the ocean, visiting coastal or marine locations or just knowing that such places and their characteristic species exist. The current score indicates that many regions are preserving the marine sources that possess cultural value. The health of iconic species and protected places are two ways of assessing the cultural, spiritual, aesthetic and other intangible benefits that people value for a region.

EAF Implementation toolkit

The EAF Implementation monitoring toolkit (2012) provides details of how social and economic assessments allow stakeholder interests and concerns to be integrated into the management process. The scope of social and economic assessments varies but commonly identified topics include: resource use patterns; stakeholder characteristics (demographics); gender issues; stakeholder perceptions; organisation governance; traditional knowledge; community services and facilities; market attributes; and non-market and non-use values.

The collection and analysis of social and economic information has not been very common for fisheries. Often the implementation of ecological measures serves as a proxy for advancing social goals but Anderson *et al* (2015) demonstrated that there may not always be a correlation between environmental performance and social and economic performance. Economic evaluations focus on net economic benefits, which describe benefits through the use of prices and markets. Social evaluations tend to focus on a broader definition of benefits and costs that an entity derives from a given activity or resource (EAF toolkit 2012). In addition to the guidance provided in the toolkit, researchers have considered appropriate indicators to help guide and measure social and economic considerations in fisheries management (Bennett *et al* 2021; Smith *et al* 2019; Anderson *et al* 2015).

FAO (2022a) estimates that small-scale fisheries contribute 40% of the world's marine catch, most of which are used for human consumption. Small-scale fisheries employ more than 90% (33 million) of the world's 36 million capture fishers, and another 107 million people in fish processing, distribution and marketing (Mills *et al*., 2011); about 47% of these people are women. The heavy reliance of developing countries on small-scale fisheries needs to be considered when implementing fisheries management. Anderson *et al* (2015) suggested world fisheries fall short of their potential earnings by US$50–80 billion a year through losses of catch due to overfishing, excessive harvest cost, low processing yields, product waste, and a failure to reach the highest value markets. The result is lost income to small-scale and industrial harvesters and processors, foregone high quality protein to consumers, and reduced food and income security for fishing-dependent communities in both developed and developing regions (Anderson *et al*, 2015). FAO (2022) highlighted that there are clear linkages between IUU fishing and social issues, so implementation of EAFM that takes account of social and economic issues when designing management could contribute to a reduction in IUU activity.

Effective management systems can achieve social and economic benefits while maintaining the sustainable production of fishery resources and the function and structure of the ecosystem they depend on (European Commission 2022). In many of the gear and management innovations discussed in this report, there is potential for a win-win-win scenario that allows fishermen to generate maximum income while fishing less. This situation means that there is a reduced impact on seabed habitats and ecosystems, and often reduces fuel usage (Sciberras *et al* 2022). Accessing these innovations more widely will be important for delivering sustainable fisheries management. Examples of where social and economic factors have been considered in fisheries management include:

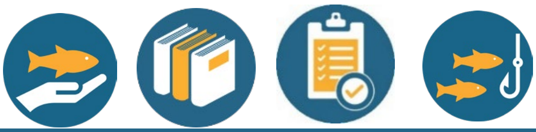
TURFs: TURFs are a form of property rights in which individuals or a group of fishers are granted access privileges and fishing rights to exploit fisheries resources within a designated area. By establishing well-defined property rights, TURFs allow fisheries managers to deal with the underlying cause of overexploitation, eliminate the "race to fish" and incentivise fishers to manage fisheries more sustainably. Studies conducted in Mexico, Brazil, Philippines, Indonesia, Japan, and Chile have found that TURFs can have a positive impact not only on fish biomass but also on promoting social change towards more sustainable fisheries, and that increase in coastal resource stewardship can occur even before economic and ecological benefits are realised. The Chilean TURF system has also played a significant role in enhancing the empowerment and social cohesion of coastal fishing organisations and act as important tool in allowing coastal communities and indigenous groups re-gain authority over the management of resources they depend on (Aceves-Bueno *et al.*, 2023).

Iceland Sustainable Fisheries: Fisheries generate a significant proportion of Icelandic GDP, account for around 7,500 jobs and are culturally important, making the sustainable, long-term viability of Iceland's fisheries resources incredibly important to the economy and society. Icelandic Sustainable Fisheries was set up by fishing and processing organisations in Iceland with the goal of demonstrating the sustainability of Icelandic fisheries through MSC certification. Currently 90% of seafood in Iceland is certified through this collaboration, which has allowed companies to pool resources so smaller-scale fisheries such as Icelandic lumpfish can join the certificate and benefit from the increased market access this provides (MSC, 2024). This ITQ system worked well in increasing the economic efficiency of the fishery but did result in the loss of small-scale operators and negative impacts on local communities, highlighting the importance of agreeing fisheries objectives through stakeholder participation.

Tuna allocation in Greece: Greece allocates several licences for bluefin tuna according to both social and environmental criteria using an objective and transparent point-based assessment system. Social criteria include small island residency, presence of children or children with disabilities in the family of the fisher, vessels under 12 m and crews with less than four people. Additionally, authorisations are given to young entrants, fostering the next generation of fishers. Environmental criteria are focused on low-impact fishing gear. No fishing licences for bluefin tuna are given to vessels with bottom trawl gear and ship-towed seine gear. The approved fishing gear is limited to hooks and lines (Seas at Risk 2024).

Cooperatives: Cooperatives in the small-scale fisheries sector are a way of maximising long-term community benefits to deal with the threats of fisheries mismanagement, livelihood insecurity and poverty. Fishery cooperatives have essential roles in facilitating information exchanges, improving communities' negotiating power with market intermediaries, building partnerships, networks, and linkages to other organisations, and fostering the sharing of traditional and indigenous knowledge. In the United States, fishery cooperatives have proven to make fishermen more efficient, reduce fishing costs, and minimise transaction costs for negotiating contracts, and help in overcoming non-industrial fisheries challenges (Sari and Rahmayanti, 2022).

5.5.2 Customary sustainable use

EAFM stage (Figure 2)	1-3
GBF Target 5	Sustainable; Legal; Applying the ecosystem approach; Customary sustainable use 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	2
Data reliability (1-5)	2

The literature review of the components of EAFM indicated the importance of the 'human element', and the GBF Target 5 explicitly calls for the consideration of indigenous and local systems for the control, use and management of natural resources. Customary use of biological resources includes spiritual, cultural, economic and subsistence functions (GBF target 5).

FAO data used in the Sea Around Us project provide an indication of how different types of fishing sector (industrial, artisanal, subsistence and recreational) contribute to global marine catch. While the majority of fisheries are industrial, there are still over a fifth of landings coming from artisanal and subsistence fishing (Figure 27). The FAO CCRF questionnaire (2022) on the implementation of the CCRF does not cover customary sustainable use and it is difficult to determine the extent that it is currently being considered in fisheries management.

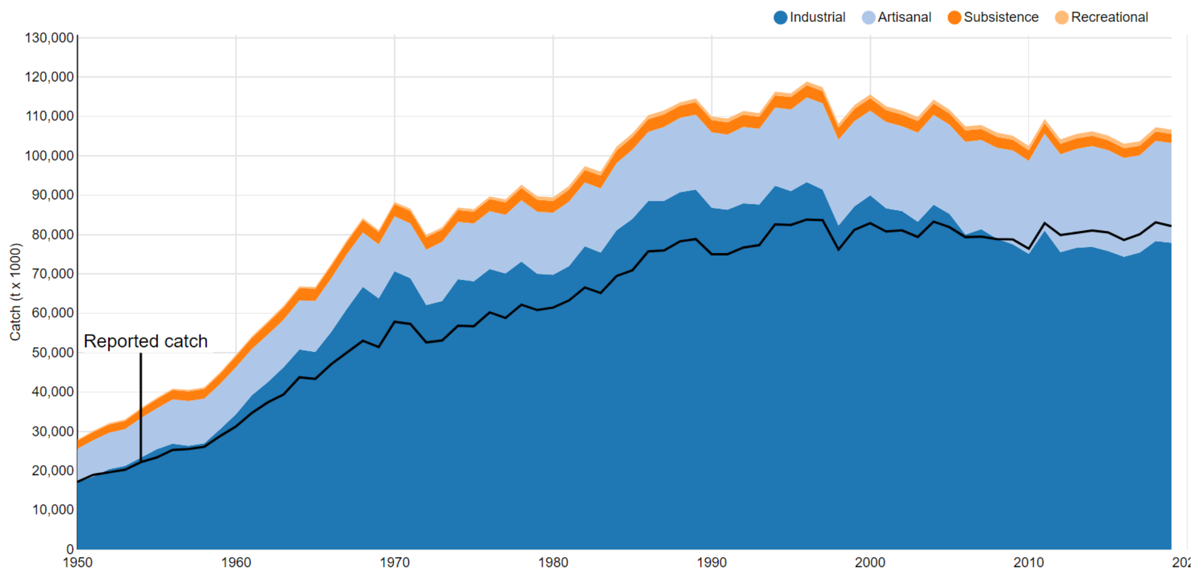


Figure 27. Proportion of global catch by fishing sector from the Sea Around Us project using FAO data

Customary sustainable use is globally recognised through the 2007 United Nations Declaration on the Rights of Indigenous Peoples, which requires:

> *Respect that Indigenous knowledge contributes to sustainable and equitable development, and proper environmental management; Indigenous peoples have the right to maintain, control, protect and develop their knowledge, sciences and intellectual property.*

The concept has also been incorporated into national policies in many countries, including Canada and Australia, as well as in cross jurisdictional agreements such as the 2009 Circumpolar Inuit Declaration on Sovereignty in the Arctic. In practice, most consideration of customary sustainable use focuses on the incorporation of indigenous, artisanal and community knowledge in fisheries management.

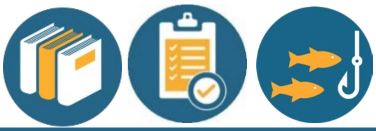
Japan: "*Satoumi*" is a Japanese term meaning a seascape where human-ecosystem interaction has resulted in increased biodiversity and productivity, thus improving the health of the environment and its ecosystem services. *Satoumi* also maintains close ties with traditional resource management techniques and tools, which aim at the protection of the targeted ecosystem. The local resource users are the principal decision makers and marine conservation is an integral part of resource use. Through adaptive management, viable coastal management measures, which highly depended on local users, have been adopted in Japan. Fisheries Cooperative Associations (FCAs) operate through compulsory membership of local fishermen who, through the right of common use, or *iriai*, are allowed to utilise cooperatively the coastal marine resources for fisheries related activities. The government shares responsibilities with the FCAs in managing the coastal areas and resources, with the support of scientists (Mizatu and Vlachopoulou, 2017).

Australia: Indigenous Protected Areas (IPAs) are a form of protected area in Australia which are dedicated by Indigenous people over their traditional land and seas. IPAs are managed by First Nations people to protect and conserve biodiversity and cultural values, in line with Traditional Owner objectives. The IPA program supports First Nations communities to voluntarily dedicate and manage their land as protected areas. The IPA program supports First Nations people to lead biodiversity conservation work on their traditional land and sea country. In April 2021, the Australian Government committed $11.6 million under the $100 million Oceans Leadership Package to the Sea Country Indigenous Protected Areas (IPA) Program. The program seeks to increase the area of sea in IPAs to strengthen the conservation and protection of Australia's unique marine and coastal environments, while creating employment and economic opportunities for Indigenous Australians (Australian Government, 2024).

Management plans are developed to protect natural and cultural values, applying First Nations' ecological knowledge alongside western science. Most IPAs are dedicated under International Union for Conservation of Nature (IUCN) Categories V and VI. These categories promote a balance between conservation and other sustainable uses. This approach delivers social, cultural and economic benefits for local First Nations communities. IPA staff will survey and monitor shore birds, construct fencing for shorebird breeding protection, undertake cultural mapping of beaches and mudflats, provide input into the development catchment management plans, and undertake environmental works on estuaries. IPA staff will research and monitor vulnerable and indicative marine and bird species, and undertake actions aimed at reducing the siltation and nutrient burden on reefs and seagrasses. The project will build the marine management capacity of IPA staff and support delivery of Sea Country education activities in local schools (Australian Government, 2024).

Canada: Cape Breton Island is home to the largest Indigenous community in Atlantic Canada and the largest Mi'kmaw community on the continent: the Eskasoni First Nation. The Eskasoni community is deeply engaged in fishing activities for food, social and ceremonial purposes, and commercially with a community-owned and community-operated fishing company that employs more than 150 fishers and contributes to nearly 10% of Eskasoni's annual revenues (Eskasoni Band Council, 2014). Since 1999, Eskasoni has been home to the *Unama'ki* Institute of Natural Resources (UINR), formed in response to rising community concerns regarding natural resources (especially fisheries) and their sustainability. One of UINR's central goals is to strengthen research and natural resource management while maintaining Mi'kmaq knowledges and worldviews. They frequently partner with external governments, organisations and universities on key environmental concerns (Reid *et al.*, 2021), using 'Two-Eyed Seeing' to bring together their respective understandings, insights and skills to address a common or shared problem. They learn from one another and in doing so produce a collectively enriched picture of a complex system (Reid *et al.*, 2021).

5.5.3 Participatory approach

EAFM stage (Figure 2)	1-3
GBF Target 5	Legal; Applying the ecosystem approach; Customary sustainable use 
Policy score (1-5)	3
Implementation score (1-5)	2
Data availability (1-5)	2
Data reliability (1-5)	2

Stakeholder engagement, co-management and the participatory approach are considered to be key components of EAFM. The FAO CCRF questionnaire (2022) asked whether management plans provided for stakeholder participation in determining management decisions and 94% of respondents indicated that this was the case for their country.

In addition to this, 46% of respondents stated that they intend to engage with stakeholders to review the definition of small-scale fisheries, and 73% considered validated stakeholder knowledge as a useful proxy indicator for stock status in the absence of reference points.

Examples of fisheries management shown throughout this report demonstrate how stakeholders have been involved at different points on the management process. The participatory process can take many different forms, from the use of fishers' knowledge in planning, to full co-management. Although there is no definitive way to measure the amount of input stakeholders have in the management process, there appears to be consensus that greater cooperation between scientists and stakeholders has resulted in increased legitimacy and more effective regulations (Sampedro *et al.*, 2017). D'Armengol *et al.* (2018) also found that co-management delivers both ecological and social benefits: it increases the abundance and habitat of species, fish catches, participation, and the fishery's adaptive capacity, as well as encouraging processes of social learning. Furthermore, co-management is more effective if artisanal fishers and diverse stakeholders become involved through an adaptive institutional framework. This highlights the importance that the participatory approach is underpinned in the legislative framework and will encourage all stakeholders to understand their roles and responsibilities. However, incorporating stakeholder perspectives into the knowledge base can often be difficult. Finding a suitable time or location to meet with stakeholders, ensuring they are not suffering from stakeholder fatigue or already demoralised by the process are all important considerations for the participatory approach. Additionally, stakeholders' perceptions tend to be qualitative, and therefore more complicated to analyse that quantitative scientific data.

Scottish pelagic fishery-dependent data collection: The Scottish pelagic industry has taken responsibility for providing scientific data through self-sampling, including catch data, acoustic surveys and egg surveys. The programme is seen by fishermen as a welcome opportunity to directly contribute to the continuous improvement of stock assessments. Experience shows that successful self-sampling schemes rely on effective feedback to fishermen, particularly in relation to what their data shows and how it is being used. This feedback helps to improve confidence in science and management, and reinforces effective collaboration between industry, science and management on achieving sustainable and profitable fisheries. The pelagic industry lends itself to a self-sampling programme because pelagic fishermen want to engage with science, have a direct stake in the information they generate, are capable and early adopters of new innovations, and they have the means for a well-organised and managed implementation (Brigden *et al.*, 2021).

Canada: The Canadian Fisheries Research Network (CFRN) was a collaboration between fishers and scientists that undertook research between 2010 and 2016 on questions about fisheries that were identified by fishers and relevant to management objectives. In selecting and developing projects, the CFRN employed a participatory process of building consensus on research objectives and methods that was critical to the overall success of the CFRN. Recognising that there were more priorities under these themes than could be addressed by the available funding, the CFRN chose to focus on projects that were highly collaborative and required the involvement of all partners. Canada's research capacity needs to address the requirements of an ecosystem approach, the need for certification, and ecosystem change, and there is an increasing need for collaboration in order to deliver on this. Each sector has unique knowledge and skills, and together they can undertake the research needed to meet the challenges of fisheries sustainability (Thompson *et al.*, 2019).

Kenya: Successful forms of fisheries management in Kenya have involved local communities in a co-management arrangement with government or non-governmental organisations. An example is the rebuilding of depleted fish stocks on Kenyan coral reefs. A network of closed areas and the exclusion of highly unselective beach seines were implemented in cooperation with local communities and led to a recovery of the biomass and size of available fish. This led to steep increases in fishers' incomes, particularly in regions that had both closed areas and gear restrictions in place (McClanahan and Mangi, 2001).

California: The California Collaborative Fisheries Research Program (CCFRP) was formed in 2006 to participate in the monitoring of marine reserves established through California's Marine Life Protection Act. This program has shown that it can serve as a model for other areas that are trying to implement collaborative research and that collaborative research can greatly contribute to the realisation of community-based co-management of marine resources. The aim was incorporate recreational and commercial fishers' knowledge in the data sets collected for adaptive management of the MPAs in the area. The CCFRP has shown that by bringing resource managers, scientists, and the fishing community together to develop true collaborative research projects, it is possible to design, evaluate, and implement statistically rigorous research projects. The data derived from these collaborative fishing projects are sufficiently robust to detect significant differences in fish abundance and sizes. In addition to the scientific credibility of the data, fishermen accept the value of the information because they were involved in collection of the data (Wendt and Starr 2009).

5.5.4 Science and the precautionary approach

EAFM stage (Figure 2)	1-3
GBF Target 5	Sustainable; Preventing over exploitation; Minimising impacts on non-target species and ecosystems; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	3
Data reliability (1-5)	3

Implementation of EAFM involves the use of best available science and the precautionary approach. Although not specifically referenced in GBF Target 5, Section C of the GBF states that the implementation of the Framework should be based on scientific evidence, and its implementation should be guided by the principles of the Rio Declaration, which includes application of the precautionary approach. These are pillars of sustainability and should underpin the development and delivery of any management measures. The FAO CCRF questionnaire (2022) found that 92% of respondents had measures in place to ensure the use of the precautionary approach to provide from conservative safety margins in decision making.

Many international frameworks refer to the use of the best available science and the precautionary approach. The definition contained in the 1992 Rio Declaration is widely recognised by states and provides practical guidance in the development and application of international law:

> *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.*

This has been translated into national policy in many countries, including as an overarching objective in the UK's Fisheries Act (2020). Mora *et al* (2009) found that 17% of countries implement precautionary approaches for at least some species. However, tracking its use in practice is difficult especially as there continues to be disagreement over whether it is an appropriate approach to managing resources.

Mora *et al* (2009) stated that the scientific basis on which management recommendations are made is critical to the success of fisheries management. Understanding fishery interactions with the environment requires the necessary science and data to be collected to support management decisions, however the precautionary approach dictates that lack of data should not be a reason to hold up the implementation of EAFM.

The ABPmer survey responses indicated that 77% of respondents participate in cross border or international collaborations to deliver fisheries management, and a further 13% were not sure. As fish stocks and ecosystems are not limited by national boundaries, the importance of cross-border collaboration in both science and management is important in capitalising on the benefits that can be generated by implementing EAFM. This has been demonstrated through the setup of RFMOs to manage high seas fisheries, many of which require collaboration of multiple nations and have agreements in place committing them to applying a precautionary approach to fisheries management.

5.5.5 Governance and policy

EAFM stage (Figure 2)	1-3
GBF Target 5	Sustainable; Legal; Preventing over exploitation; Applying the ecosystem approach 
Policy score (1-5)	4
Implementation score (1-5)	3
Data availability (1-5)	4
Data reliability (1-5)	3

This report has discussed the presence of EAFM in international and national legislation (see Section 4), including the importance of an overarching strategy specific to EAFM as well as supporting legislation and objectives relevant to each of the individual components. The presence of a strong policy framework supports the implementation of management measures and aids in decision making that may require trade-offs to meet EAFM objectives. The ABPmer EAFM survey indicated that half of the countries that responded have an overarching fisheries policy that explicitly commits managers to EAFM, and the majority of other responses indicated that while EAFM may not be explicitly stated, components such as managing bycatch and habitat interactions, taking a precautionary approach and considering social and economic impacts are part of their fisheries policies.

FAO (2021c) designed a diagnostic tool for implementing EAFM through policy and legal frameworks, and the 2021 FAO implementation monitoring toolkit also provides guidance on governance through:

- Policies and objectives;
- Legislation;
- Enabling regulation;
- Consultation processes;
- Management plan development and implementation;
- Compliance;
- Review and monitoring;
- Reporting and communication.

The reviews undertaken on EAFM implementation globally using the FAO implementation monitoring toolkit all indicate the importance of favourable policies, legislation and regulatory frameworks in implementing EAFM, and Defoe and Vasconcellos (2020) go as far as to identify institutional capacity as the fourth pillar to underpin fisheries sustainability in the Mediterranean.

The presence of a governance system with clear commitments to EAFM will support the delivery of EAFM measure in practice (Pitcher *et al* 2009). This can be strengthened by actions taken towards regional collaboration and the use of adaptive management measure as a result of regular review and feedback. ABPmer (2018) demonstrated that an adaptive management approach to pelagic species in the Northeast Atlantic through multijurisdictional collaboration could deliver greater species resilience in the face of climate change fluctuations. Collaboration across governments can also streamline research and science needs by pooling resources to address knowledge gaps at a regional rather than national level (Ramirez-Monsalve *et al* 2016) and improve monitoring, control and enforcement systems that address global IUU activity.

5.6 Summary of literature review

The literature review has examined how EAFM is being interpreted and applied globally. Key principles of EAFM were identified and progress within these reviewed.

There is significant reference to the use of the ecosystem approach in international fisheries agreements, and in many cases, this has been transferred into regional and national legislation. While there may not yet be a cohesive EAFM strategy in all countries, there is still evidence that many of the aspects of EAFM are being addressed. The literature review indicated that implementation of EAFM takes a staged approach, starting with single species management, moving to management of other fish species, bycatch and ETPs, and progressing to management of fisheries habitat and ecosystems and the social and economic aspects of fisheries. All of this includes the overarching contributions of stakeholder participation and a precautionary approach to management. The case studies suggest that in practice implementation is tailored to each fishery’s priority objectives rather than following a set sequence of stages.

Figure 28 summarises the combined global score (out of 20) for each EAFM component considered in the literature review based on the extent to which EAFM is included in policies, implemented in practice, the amount of information available and the reliability of this information. This suggests that in addition to a staged approach to EAFM, there are some aspects that attract more attention than others. In particular, data collection and management related to ETP species, and habitat impacts of fishing gear, appear more often in international policy, and management measures to mitigate impacts of vulnerable species are covered widely in the literature.

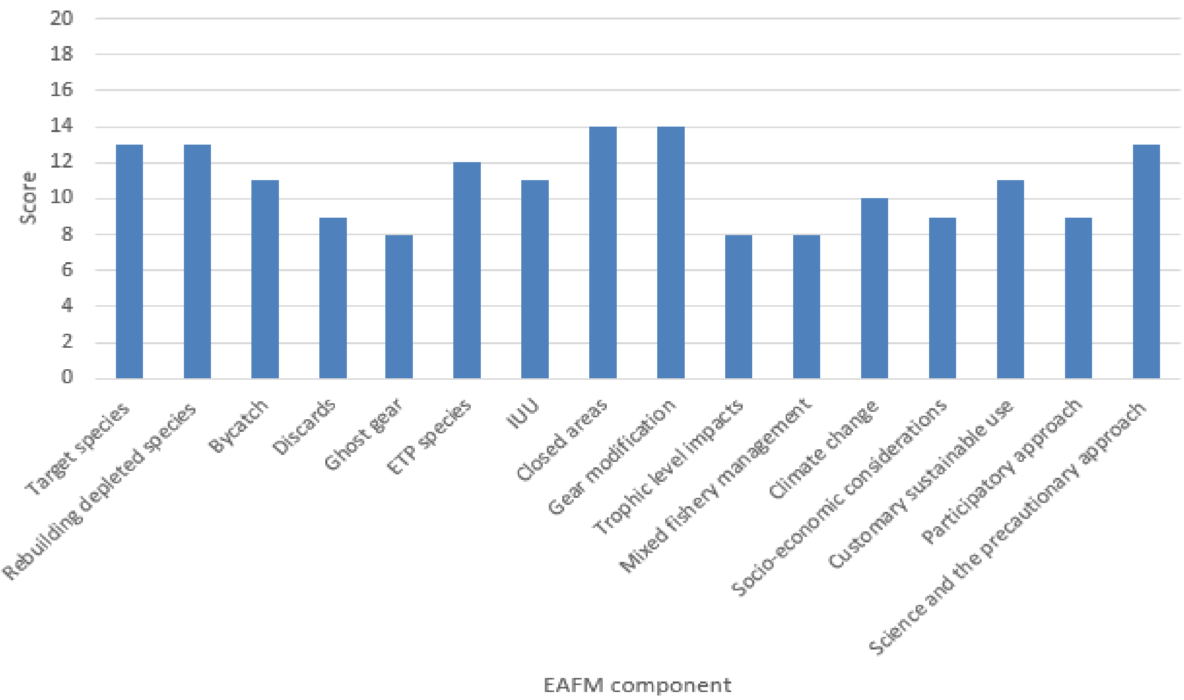


Figure 28. Performance against EAFM components from the literature review, based on the extent of incorporation in policies, implementation in practice, information availability and reliability (combined score out of 20)

As seven countries account for almost 50% of global landings, a review of their progress in implementing EAFM could provide insights into progress globally. Of these seven countries, five have committed to eradicating IUU activity through the Port State Measures Agreement. Six of these countries had ratified the CBD, and committed to the associated GBF targets, and five have made moves towards introducing protected areas in their waters. A significant proportion of landings are from bottom trawl gear which must be well managed to ensure mitigation of any impacts on benthic habitats, bycatch and discard rates. However, many of the data sources for this information caution against the accuracy of the data (Figure 29), and given that SSF are estimated to account for 40% of landings (Bitoun *et al* 2024) but are often data poor and less regulated, there is a significant gap in knowledge in determining the true performance of global fisheries.

The FAO CCRF questionnaire covers many aspects on EAFM and is a useful indicator of self-reported progress on EAFM. However, it would be beneficial to have more quantitative data to determine more accurately. Data tools such as the Sea Around Us project and the Ocean Health Index are all useful in compiling information to provide a picture of global and country level performance in several of the key components of EAFM. There is less data available than needed to provide a comprehensive understanding of the level of implementation, and the data that are available is skewed to developed countries.

The EAF implementation toolbox already provides a framework for monitoring the implementation of EAFM, and has been used in fisheries in Africa, South America, the Mediterranean as well as RFMOs. Given that the objectives of fisheries management have been shown to be fishery specific and are best developed through stakeholder collaboration, the best approach to gathering data and understanding the implementation of EAFM would be for countries to run national workshops to complete the EAF implementation toolbox as a baseline to determine specific progress indicators.

The report will use the information in the literature review to consider progress towards EAFM in ten case studies, and identify useful learnings that could be applied in fisheries globally.

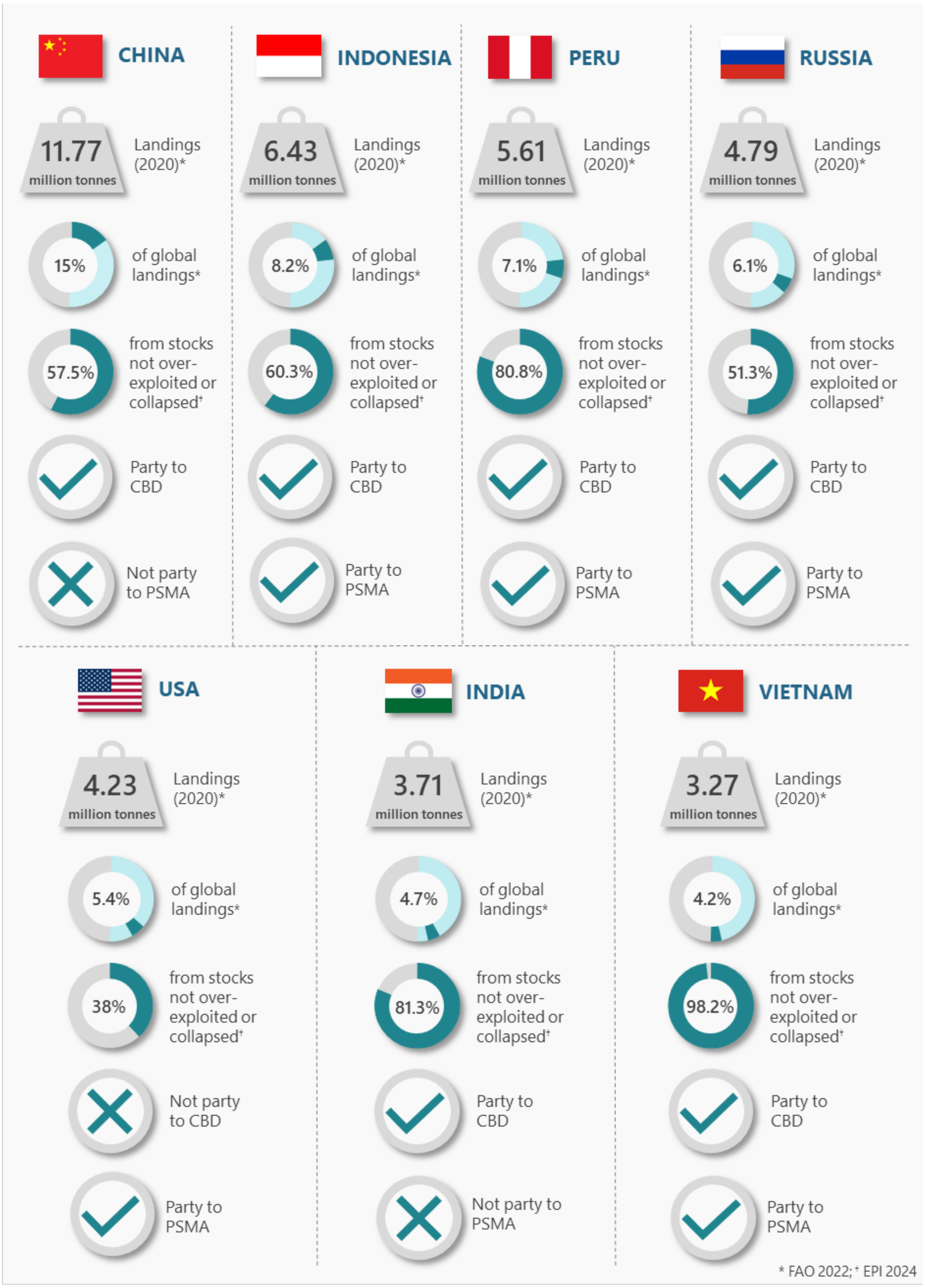


Figure 29. Review of performance of the top marine landings nations

6 Case Studies

Based on the research undertaken in the literature review, ten case studies were developed to highlight and assess where ecosystem approaches to fisheries management have been implemented, the degree to which they have been effective and how they have delivered outcomes specified in GBF Target 5. These case studies were selected to provide a range of gear types, species and regions, with the intention of identifying common best practice approaches, challenges to implementation and learnings to be considered in the future.

6.1 Background

The case studies are summarised in Table 6 and the matrix accompanying this report. Figure 30 shows the location of each of the case studies. Full details of the case studies are provided in Appendix B.

Table 6. Case study details including location, species and gear type

Case Study	Country	Species	Gear Type
CCAMLR	Multiple	Toothfish, icefish, krill	Longline, trawl
Philippines small scale fishery	Philippines	Mixed small-scale fishery	SSF, purse seine
South African hake trawl fishery	South Africa	Hake	Trawl
New Zealand deep trawl fishery	New Zealand	Deep sea orange roughy	Trawl
Canadian halibut longline fishery	Canada	Halibut	Longline
Belize - TURF	Belize	Lobster, conch, mixed reef fish	SSF
Iceland mixed trawl fishery	Iceland	Mixed white fish	Trawl
UK Lyme Bay	UK	Shellfish	Pots, hand line (previously trawlers)
WCPFC tuna fishery	Multiple	Tuna	Longline, purse seine, pole and line
Gulf of California pelagic fishery	Mexico	Sardine, herring anchoveta, anchovy, chub mackerel	Purse seine

Figure 30. Map of case study locations

6.2 Management approaches

Although these case studies present different scenarios for location, scale, gear type and fish species, there are overlaps in their approach to fisheries management and how this contributes to the implementation of EAFM. Table 7 sets out the high-level management approaches used in each case study.

As noted in the literature review, and also demonstrated in the case studies, the purpose of these measures can be applied to address multiple components of EAFM (Table 8). For example, managing a mixed fishery using a quota-based system can also be used to prevent bycatch and discard issues through quota trading prior to landing.

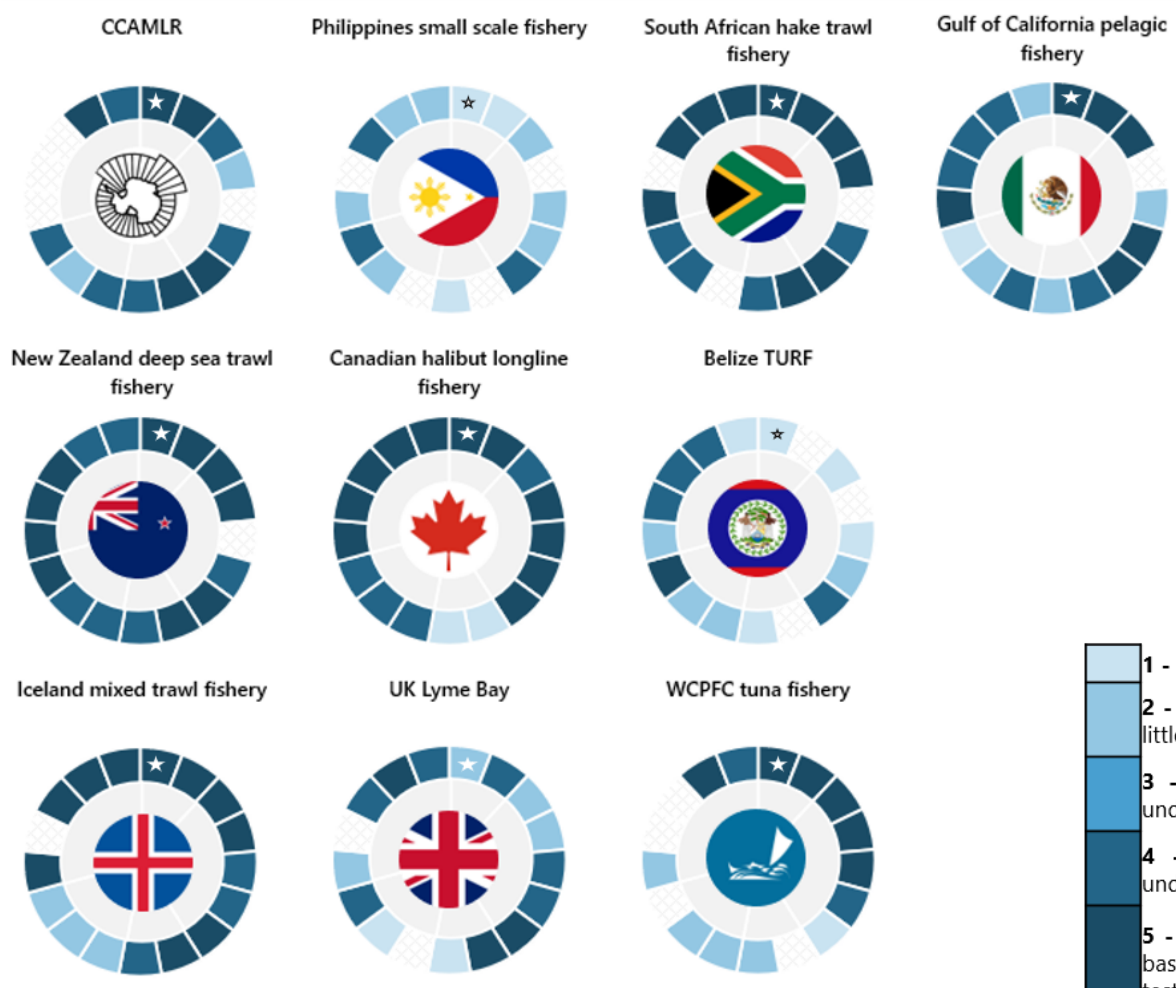
The literature indicated that EAFM is generally implemented in a staged approach, however these case studies reflect that in reality the approach to EAFM is tailored to each fishery's priority objectives. For example, where there is more selective fishing gear, there is less of a need to address bycatch or discard issues, so management has been prioritised elsewhere. Figure 31 demonstrates that the areas of climate change, mixed fishery management and trophic level impacts score lower that other components, and reflects the complexity in addressing them. It also highlights the earlier finding that different EAFM components are prioritised depending on the type of fishery and its objectives. For example CCAMLR is a regional body which does not focus on customary sustainable use as this will be addressed more directly by individual members at a country level.

Table 7. Management approaches implemented in each of the case studies

Case study	Policy instruments	Limited access	Input or output controls	Gear modifications	Spatial and temporal closures	Co management	Market incentives	Enforcement and deterrents
CCAMLR	✓	✓	✓	✓	✓		✓	✓
Philippines small scale fishery	✓	✓			✓	✓	✓	✓
South African hake trawl fishery	✓	✓	✓	✓	✓	✓	✓	✓
New Zealand deep trawl fishery	✓	✓	✓	✓	✓	✓	✓	✓
Canadian halibut longline fishery	✓	✓	✓	✓	✓	✓	✓	✓
Belize - TURF	✓	✓			✓	✓		✓
Iceland mixed trawl fishery	✓	✓	✓	✓	✓	✓	✓	✓
UK Lyme Bay	✓	✓	✓	✓	✓	✓		✓
WCPFC tuna fishery	✓	✓	✓	✓	✓		✓	✓
Gulf of California pelagic fishery	✓	✓	✓	✓	✓	✓	✓	✓

Table 8. EAFM components addressed by management approach

Management approach	Target species	Bycatch	Discards	ETP	IUU	Habitats	Ecosystems	Social and economic impacts	Customary sustainable use
Policy instruments	✓	✓	✓	✓	✓	✓	✓	✓	✓
Limited access	✓	✓	✓		✓	✓		✓	✓
Input or output controls	✓	✓	✓		✓	✓		✓	✓
Reduced fishing capacity/effort	✓	✓	✓		✓	✓		✓	
Gear modifications	✓	✓	✓	✓	✓	✓	✓		
Spatial and temporal closures	✓	✓	✓	✓		✓	✓	✓	✓
Co-management	✓	✓	✓	✓	✓	✓	✓	✓	✓
Market incentives	✓	✓	✓	✓	✓	✓	✓	✓	
Enforcement and deterrents	✓	✓	✓	✓	✓	✓	✓	✓	✓



Clockwise from the star at the top of the circle, components considered are:

- Target species management
- Rebuilding depleted stocks
- Bycatch
- Discards
- Ghost gear
- ETP species
- IUU
- Closed areas
- Gear modification
- Trophic level impacts
- Mixed fishery management
- Climate change
- Social and economic considerations
- Customary sustainable use
- Participatory approach
- Science and the precautionary approach
- Governance and policy

1 - No progress

2 - Little progress: International commitments to address some aspects of EAFM but little evidence of national policies, research or measures in practice.

3 - Some progress: Policies in place the reflect components of EAFM, research underway to understand status of component, some measures in place.

4 - Much progress: Policies in place, baselines and linkages researched and understood, measures in place that have been tested and shown to work.

5 - Comprehensively addressing: Policies in place that comprise an EAFM strategy, baselines and linkages researched and understood, measures in place that have been tested and shown to work, regular review of measures and ability to adapt/react.

NA - not an issue/not discussed in this case study.

Figure 31. Degree of progress made in each individual case study against EAFM components

6.3 Common themes contributing to success

This section considers common themes among the case studies that contributed to the successful implementation of EAFM, how these successes are contributing to meeting GBF Target 5, and the key lessons learnt.

Best practice is defined as '*a procedure that has been shown by research and experience to produce optimal results and that is established or proposed as a standard suitable for widespread adoptions*'[40]. The case studies reviewed represent a range of scenarios and yet many of the management approaches implemented through EAFM are common throughout, and provide examples that can be applied in other fisheries (Figure 32). These common themes are built on in Section 7.2 to provide recommendations for implementing EAFM.

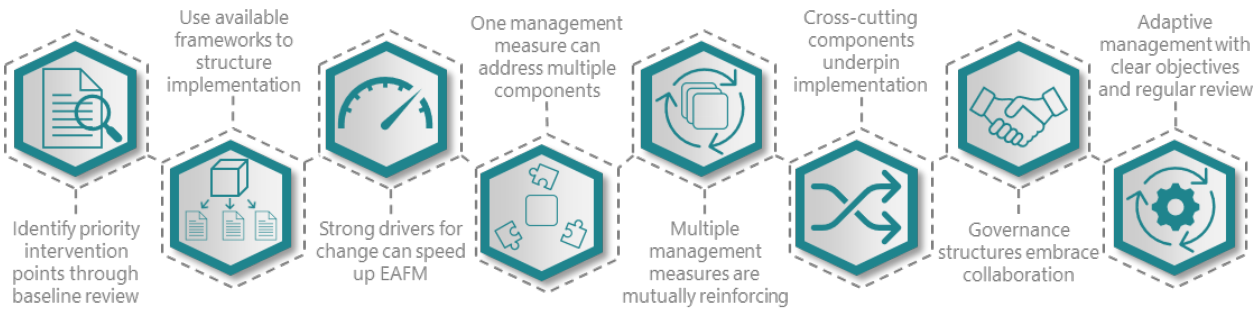


Figure 32. Common themes contributing to the success of implementing EAFM identified from case studies

Formation of a baseline understanding of the current situation is crucial to identify priority intervention points for EAFM. Generally, progress has targeted each EAFM component separately and overarching EAFM policies have evolved more recently as the concept has developed and commitments have increased. Building a fisheries management plan that points to all relevant legislation and management can help identify opportunities to further implement EAFM as well as acting as a central location to support regular review of progress. Future work would benefit from workshops and consultations with country representatives to create a baseline understanding in each fishery; and identify and agree appropriate progress indicators. Having a concerted drive for EAFM, and clear strategy to achieve it, would speed up implementation and ensure issues are more comprehensively addressed at a national level but also with international support and guidance. Frameworks are available that can support stakeholders to design and implement EAFM.

Transitioning from EAFM in policy to EAFM in practice can be slow if there is not a strong driver for change. Stock collapse, food security concerns or market access requirements have all been shown to lead to more rapid implementation of EAFM in practice. Case studies indicate the importance of setting clear objectives that address the overall issues and then identifying how EAFM can be implemented as a solution. Often biodiversity or ecosystem concerns are not the main reason for implementing EAFM, but the approach can be used to address wider issues that will be specific to each country's own situation.

40 Best practice Definition & Meaning - Merriam-Webster

It is possible to introduce one management measure that addresses multiple components of EAFM, but the most successful case studies use multiple management measures that are mutually reinforcing. For example, using a tradeable quota system to ensure that all bycatch is landed and counted against quota ensures a robust approach to stock management, but combining this with gear modifications, move-on rules and seasonal closed areas minimises interactions with juveniles or bycatch hotspots which reduces the amount of quota needed (Table 8). Basic management should control exploitation levels of the stock through input or output controls, based on best scientific information, and this management can be designed to deliverer wider EAFM.

Cross cutting components of EAFM underpin much of the progress that has been made. Basing management decisions on stakeholder contributions, science and the precautionary approach has been seen throughout the case studies, and has led to improved stakeholder buy-in and accountability, as well as management, that is adaptive to change in the face of uncertainty. This adaptive management approach will be crucial in reacting to the potential impacts of climate change.

National policies are often a first step in moving towards EAFM. Policies explicitly reference the need to balance social and economic considerations, requirements for a participatory approach including a process for undertaking this, and commitment to a precautionary approach to fisheries management. EAFM is generally implemented in a staged approach, however these case studies reflect that in reality the approach to EAFM is tailored to each fishery's priority objectives.

Implementation of a governance structure that embraces international collaborations and commits to EAFM components through legislation is important. In the case studies reviewed, international and national commitments to EAFM and/or EAFM components were demonstrated. Commitments outlined in the CBD and the Agenda for Sustainable Development underpin the use of EAFM. The FAO Code of Conduct for Responsible Fishing is the basis for many national fisheries policies, and includes references both to EAFM specifically, and to its individual components. Although in many cases the implementation of EAFM is driven at a government level, there are also several examples of fishers and processors first developing or implementing management voluntarily that contributes to EAFM.

Data collection underpins successful management. Currently, there is less data available than needed to provide a comprehensive understanding of the level of implementation, and the data that are available is skewed to developed countries. Introducing fishery dependent reporting protocols that include target species, bycatch, ETP and habitat interactions and observations is a significant first step to understanding the ecosystem context of the fishery and can be used to guide EAFM measures. In many countries, crew are trained to identify species interacting with the fishery and help to develop best practice guides specific to the gear and vessels they use.

These case studies and the examples throughout the report demonstrate the many different approaches available to address similar issues, dependent on the needs of the fishery. Innovation is continuous, and new, more effective measures may come to light that progress understanding of what best practice looks like.

6.4 Global Biodiversity Framework

The case studies and examples in this report demonstrate where EAFM implementation has contributed to the outcomes specified in the GBF, as relates to fisheries.

GBF outcome: Ensuring that the use, harvesting and trade of wild species is sustainable, safe and legal, and that areas under fisheries are managed sustainably

Countries have committed to international fisheries- and biodiversity-related agreements that specify the implementation of EAFM and its underlying components. These components have been incorporated into national and regional legislation either separately or as an overarching EAFM strategy. Depleted stocks have been identified and the necessary rebuilding plans and recovery measures implemented to improve stock status to a level where it can be considered sustainable. In many cases, fisheries have become MSC certified, demonstrating their performance at a sustainable level.

Commitment to address IUU fishing can be seen through international collaborations and commitments to international agreements such as the Port State Measures Agreement. Nationally, countries are increasingly requiring vessel registrations, logbook submissions, Vessel Monitoring Systems (VMS) and other monitoring systems to minimise the likelihood of IUU activity. Additionally financial penalties and other restrictions encourage compliance with fishing regulations. Restrictions on trade and legislation to protect ETP species will contribute to ensuring there is no market for landing these species.

Example case studies: CCAMLR, South Africa, New Zealand, Canada, Iceland, WCFPC.
Management approaches: Limited access, TACs, harvest control rules, reference points, observer coverage, inspections, fines and penalties, international collaborations, VMS, Remote Electronic Monitoring (REM).

GBF outcome: Preventing overexploitation (including overfishing)

The use of appropriate access limits, vessel licensing, and input or effort controls is a first step in preventing over exploitation. Understanding stock status and ensuring there are adaptive flexible management approaches in place that can react quickly is stock biomass changes is also important. To be able to do this data must be collected, reference points developed and ideally management scenarios modelled.

Regular review of harvest rates and stock biomass with pre-agreed harvest control rules that provide a process for managing pressure on the stocks enable adaptive management that will limit the chance of the stock being overfished. This approach will be particularly important in the face of climate change.

Collaboration across international justifications will support a holistic approach to stock management that ensures stocks straddling multiple EEZs are harvested at an appropriate level.

Example case studies: IPHC (Canada), WCPFC, CCAMLR, Philippines.
Management approaches: Limited access, TACs, harvest control rules, reference points, management strategy evaluation, data collection, precautionary approach.

GBF outcome: Minimising impacts on non-target species and ecosystems (including bycatch)

As a first step, gear modifications and spatial management enable vessels to avoid catching non-target species and juveniles or interacting with benthic habitats. Managing non-target species landings has been implemented through a tradeable quota system that ensures vessels can trade between themselves to land all their catch (Iceland, Canada) or by providing a specific bycatch quota that is taken from the overall quota allocation (Mexico, South Africa) and accounted for in stock assessments.

Discouraging interactions through devices that keep species away from fishing gear (streamer lines, pingers) will limit the opportunity for interactions to occur, and safe handling guides and training can contribute to safely returning species to sea. Live time reporting and move-on rules for bycatch or ETP hotpots and VMEs can help the fleet reduce its impacts.

Crucial to the success of these policies is the use of monitoring through either REM or observers to ensure policies are followed. Strong penalties (financial, loss of permits, prison time) can act as significant deterrents to non-compliance.

In addition to the specific examples provided in the case studies, there are other examples of best practice that have not been discussed in detail. These include many projects and best practice guides for tackling ALDFG and much research into incorporating ecosystem aspects into stock assessments and reference points. These approaches are all working together to build a more holistic approach to fisheries management.

Example case studies: South Africa, Canada, Iceland, Mexico
Management approaches: Mesh sizes, bycatch quota, temporary spatial closures, observers, biodegradable gear, reporting protocols, risk assessments, move-on rules, VMS, REM, penalties.

GBF outcome: Respecting and protecting customary sustainable use by indigenous peoples and local communities

Setting aside an allocation for each fleet segment (small-scale, by gear type, indigenous peoples) contributes to the fair use of the resource. This should not be tradeable across sectors (or only to a certain limit) to ensure that consolidation of the quota does not occur. The use of community quota, quota pools or Territorial User Rights for Fishing (TURFs) are also options for ensuring equitable access to the resource within the bounds of a sustainable overall harvest. Legislation that sets out these rights, along with a process for incorporating indigenous knowledge into fishery management decisions will contribute to the successful long-term, sustainable and holistic approach to fishing activities.

Example case studies: Canada, Belize, New Zealand
Management approaches: Legislation, priority access, quota allocation, co-management processes

GBF outcome: Providing social, economic and environmental benefits for people

The use of social and economic risk assessments can help identify and prioritise management measure that contribute to ensuring social, economic and environmental benefits for people. Providing an underlying framework for participation in management decision and setting fisheries objectives that account for social impacts can improve management outputs.

Evidence has shown that the use of the MSC Standard can provide both economic benefits through increased prices and secure markets, as well as the social benefits of increased job security both in fisheries and supply chains (Lallemand *et al*, 2016).

Where social aspects have not been considered early on in the management process, policies have needed to be altered to account for unintended consequences, by which time damage to communities may already have occurred. Ensuring early involvement in the management process and accountability for its success has also been shown to secure stakeholder buy-in and improve compliance with management measures.

Example case studies: South Africa, Canada, Philippines, Canada, Belize, Lyme Bay.
Management approaches: Social and economic risk assessments, MSC certification, subsistence quota allocation, consultation processes, co-management.

GBF outcome: Contributing to the resilience and long-term efficiency and productivity of fisheries and to food security

In addition to the management set out above, the resilience of fisheries and their contribution to food security is addressed through the development of specific social objectives that prioritise food security and subsistence needs in the approaches to fisheries management. Well-managed stocks of Alaskan pollock, mackerel and tinned tuna also contribute to global food security. This is becoming increasingly important in the face of climate change, where the use of adaptive management and regular reviews will support fisheries managers to be proactive in identifying and addressing impacts.

The protection of juveniles and spawning areas will support the continued growth of fish populations, and the use of ecosystem models to consider the needs of prey species and other trophic interactions will contribute to maintaining the overall resilience of the ecosystem.

Example case studies: Philippines, Canada.
Management approaches: Closed areas, science and the precautionary approach to setting quotas and determining reference points, ecosystem modelling, adaptive management, regular reviews.

GBF outcome: Conserving and restoring biodiversity

There are many examples of how EAFM can lead to the conservation and restoration of the wider ecosystem, for example management of spawning grounds can also protect habitats. By reducing the impact of the fishery on bycatch, ETP species and habitats also contributes to the conservation of these species.

Example case studies: South Africa, New Zealand, Belize,
Management approaches: Reporting protocols, rebuilding plans, trade restrictions, closed areas, biodegradable gear, footprint restrictions, effort limitations.

7 Summary

This report has examined how the Ecosystem Approach to Fisheries Management is being interpreted and applied globally. Key principles of EAFM were identified and progress within these reviewed. Ten case studies were identified and reviewed for important learnings and to demonstrate how best practice is being applied.

7.1 Lessons learnt

This review has identified several key themes and recommendations for successfully implementing EAFM. Lessons learnt from the literature review and the case studies are summarised below, and followed by recommendations for best practice from the case studies Specific lessons learnt from each case study are listed in Appendix C. A comparison of these lessons shows that there are overlapping themes and lessons generally fall into five categories (Figure 33).

7.1.1 Design

1. Stakeholder engagement and co-management is critical to agree overarching objectives for fisheries management, understand priorities, and develop and deliver management measures that are supported by stakeholders. Clearly stated and agreed objectives will enable to development of metrics to measure progress that are relevant and appropriate to the management in place. Early stakeholder consultation is important but there is also value in being able to move fast in decision making to make successful management interventions.
2. Understanding the usefulness of indigenous knowledge and designing a formal process for incorporating it into fisheries management through legislation can contribute to sustainable fisheries management. Consulting stakeholders is an important part of good governance, policy development and decision-making.
3. The use of social, economic and ecological risk assessments is currently limited, but they are a useful baseline activity to help understand the scope of the fishery and potential management impacts. Compromises will be needed and understanding the ecological, social and economic factors at play will aid in decision making. Management designed to achieve sustainable fishery objectives can also have ecosystem benefits even when these are not the explicit target of the policy (e.g. increasing economic efficiency results in lower seabed impact).
4. If reforms are implemented gradually and with stakeholder participation, potentially negative social consequences can be identified and the management system can be designed to minimise and mitigate such impacts. This participation can also empower fishers to be accountable for fishing activity.
5. The EAF Implementation toolkit provides a framework for developing and delivering EAFM and has been used successfully in many countries and regions. There are already training and capacity building materials available that could be more widely circulated to support fishery managers and other stakeholders to understand the requirements of EAFM (Section 7.3).
6. Commitments to international agreements that feature EAFM and its components are often a precursor to EAFM inclusion in national policies.
7. Where there are other uses for the marine environment (wind farms, aquaculture), there should be communication across management departments to ensure cumulative impacts of different activities have been considered as well as any potential conflicts.

7.1.2 Implementation

8. Progress is being made towards managing the wider interactions between fishing and ecosystems, but in many cases, there is a lack of overarching strategy and coherence to support the comprehensive implementation of EAFM. Where there are already measures in place, these may be adapted to have a wider ecosystem impact for example the contribution of fishery-related closed areas towards habitat conservation (and potential to be recognised as OECMs), or the use of bycatch reduction measures to reduce discards or interactions with ETP species. Small steps or changes may be all that is needed to shift to EAFM and some gear types have less environmental impact and require less work to convert to an EAFM. However, even when there are challenges of over exploited resources and high dependence on fisheries, there are still steps that can be taken towards EAFM.
9. Even in developed, well-resourced countries, progress in the implementation of EAFM and introducing supporting policies takes time. There are more examples of management available for the earlier aspects of EAFM and for those aspects that attract increased media, science or public interest (e.g. ETP species, MPAs). Monitoring the outputs of EAFM measures will also require patience as research shows recovery times for species and habitats can be substantial.
10. EAFM is not a one size fits all approach, and examples have been provided throughout this report for context on the range of issues that are being addressed. Appropriate management will depend on the biological, social and economic, cultural and governance of individual fisheries.
11. Having legislation and management measures that support EAFM is a first step but without enforcement and strong levels of compliance, overall objectives will not be met.
12. Adaptive management that is responsive to the state of the stock will provide managers with a mechanism to react to fluctuations in the fishery.
13. External interventions and market incentives can be an important driver to progress (EU yellow card, funding from USAID, exports, MSC certification), but changes still need to be adopted within national and local government institutions.

7.1.3 Evaluation

14. Regularly reviewing the progress of management measures will enable fishery managers to react to fluctuations more efficiently, ensure that social and economic impacts are not detrimental, and enable adaptive management in the face of climate change.
15. Improved data collection and knowledge can lead to changing perspectives for management, and applying a precautionary approach to fisheries management can ensure appropriate adaption when new information arises.
16. Annual monitoring of environmental parameters, particularly of indicator species and ecosystem interactions helps detect warning signs of potential issues.

7.1.4 Objectives

17. It is challenging to balance environmental, economic and social objectives in fisheries. Addressing one of these aspects may have unintentional consequence for the other aspects that need to be addressed in the future.
18. Management and objectives may already be in place but not explicitly termed 'EAFM'.
19. Social objectives can provide significant incentives to implement EAFM and can deliver environmental benefits concurrently.
20. Plans for bycatch and ETP species should include data collection, catch mitigation where possible, stock assessment and incorporation into wider management objectives for target species.

7.1.5 Collaborations

21. Regional collaboration is essential, not just to address fisheries in multiple jurisdictions, migratory species and overlapping ecosystems, but to support the collaboration of science and research at a global level and to encourage wider enforcement of IUU regulations. This has been seen to work in the high seas with RFMOs managing species such as tuna, and there are clearly lessons that can be learnt from these management structures.
22. The complexity of the ecosystem adds to the challenge of EAFM, but there are already studies underway in similar fisheries to model climate fluctuations and these could be adapted to consider climate change impacts elsewhere.
23. Reaching agreement among stakeholders and coordinating management actions across multiple sectors can be challenging, and requires strong governance frameworks and effective communication and collaboration among stakeholders.
24. Coordinating with other countries can provide access to additional information about the fish stocks and the ecosystem that can contribute to improved management overall.
25. Implementation does not need to happen alone – there are tools and funds available to support the process and other countries willing to collaborate.
26. Collaborative, cross-sector management is key to maximising social benefits for local communities and increasing engagement with management strategies.

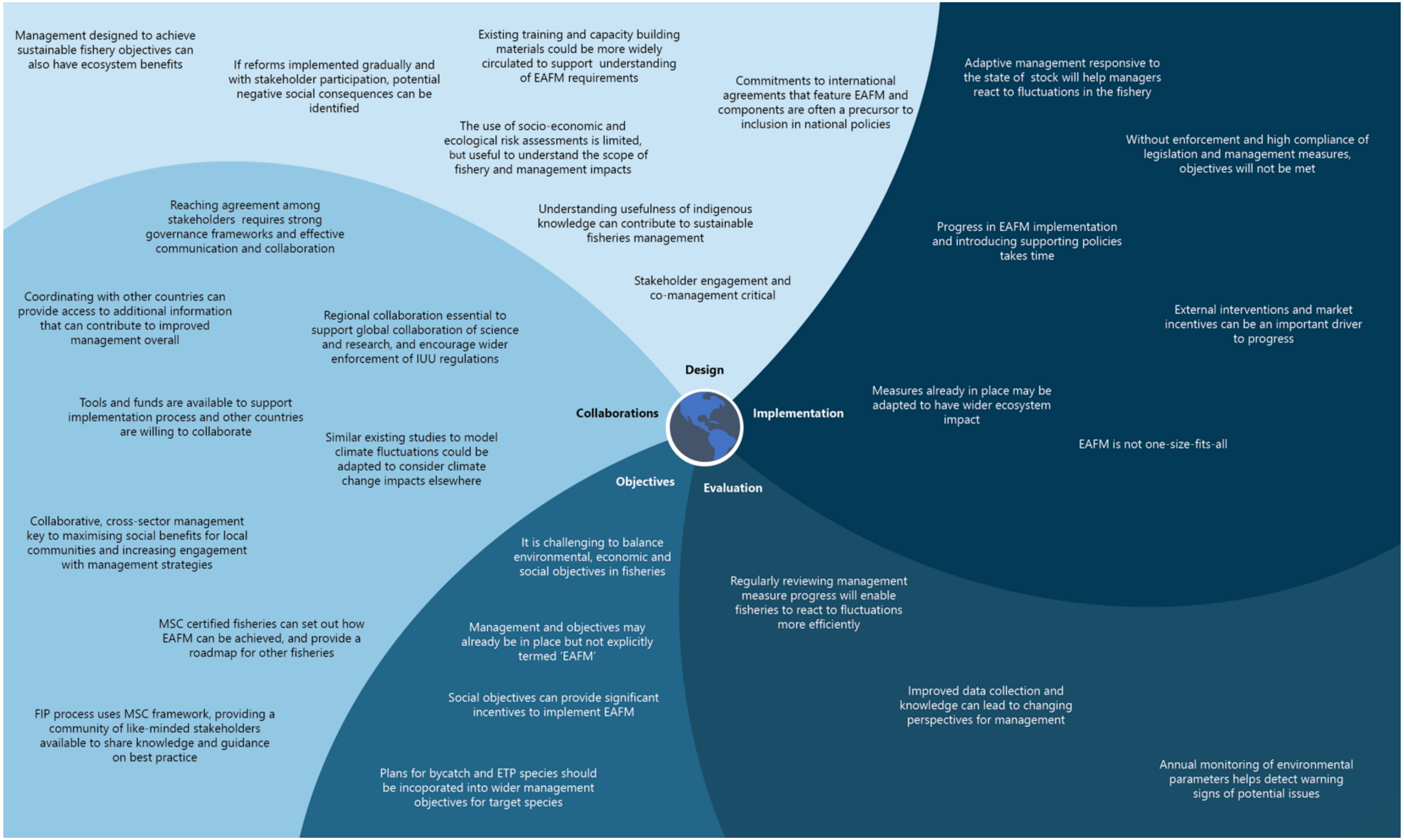


Figure 33. Summary of lessons learnt from the case studies

7.2 High level recommendations from case studies

The review of case studies identified the common themes contributing the success of implementing EAFM (Section 6.3). These themes have formed the basis for a number of recommendations for the design, implementation and evaluation of EAFM and how it can support the delivery of the GBF. Many of these recommendations align with the findings from the literature review.

Collaboration: There is a significant amount of information on approaches to implementation and sharing this knowledge will bring international benefits. An EAFM working group could be responsible for coordinating workshops to share ideas and experiences and building networks. A knowledge hub or data sharing platform could support this collaboration by recording approaches to EAFM and lessons learnt that could be shared in other fisheries locally, nationally and internationally. This is especially important as many fish stocks straddle multiple management jurisdictions and collaboration could help reduce resource requirements for data collection and stock assessments and improve enforcement to address IUU.

Establish baselines: Reviewing management measures that are already in place helps to understand how these could be modified for 'easy wins' and to enable managers and stakeholders to identify priority areas to focus the implementation of EAFM. The FAO's EAFM implementation toolkit provides guidance on this process.

Frameworks: Following a framework to achieve EAFM will help ensure that there are no gaps in the approach and that implementation follows timebound milestones. Fishery Improvement Projects enable fisheries to use the MSC Standard as a framework to address stock status, environmental impacts and develop robust management over a timebound period with stakeholder participation. On successful completion of this process the fishery could be considered for a full MSC assessment, which may improve market access and provide a price premium as an incentive for performing at a level consistent with best practice. Other frameworks include the FAO's EAFM implementation toolkit.

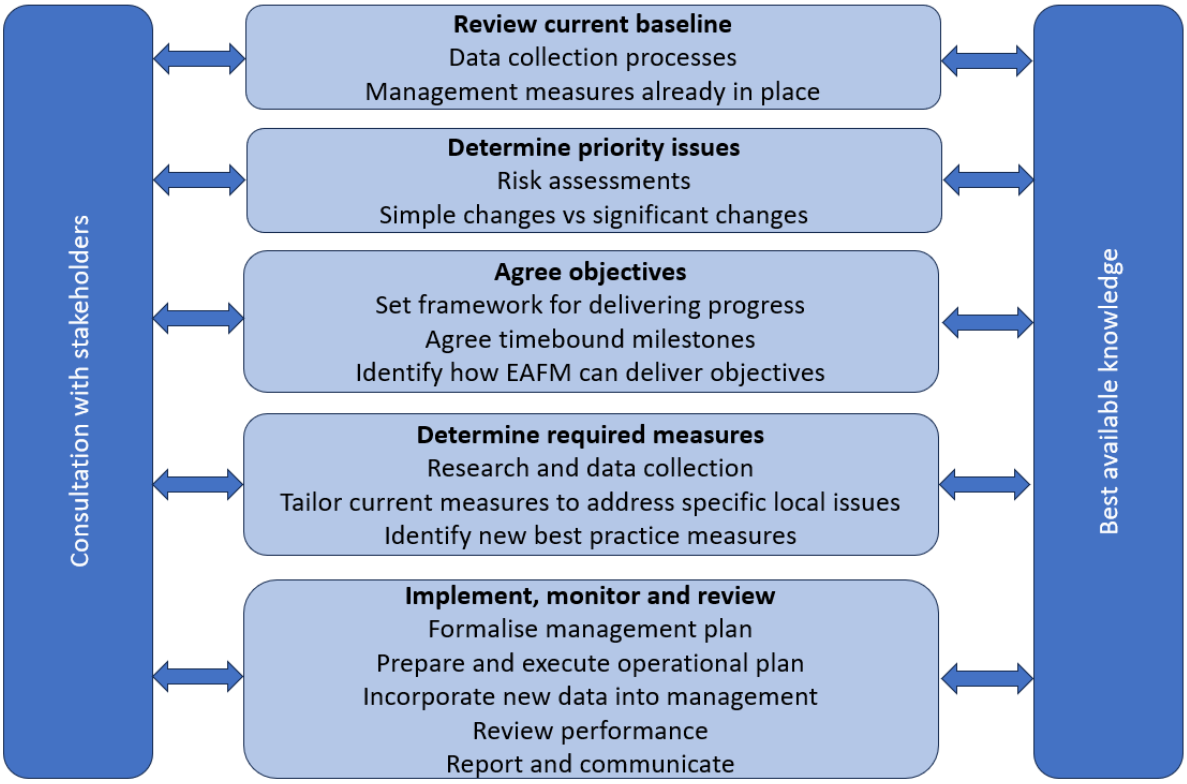
Strategy and objectives: The use of an overarching national EAFM strategy, for example through a Fisheries Management Plan, would help coordinate implementation. It can draw on existing legislation to set out how EAFM is being implemented and set out clear and transparent objectives to help prioritise resources. Early consideration of social, economic and environmental pillars through stakeholder engagement will contribute developing objectives that ensure that potential consequences are identified. Having a concerted drive for EAFM, and clear strategy to achieve it, would speed up implementation and ensure issues are more comprehensively addressed at a national level but also with international support and guidance.

Adaptive management: Developing an approach to management that can be monitored to determine when changes are needed will support managers in decision making. This should include the use of harvest control rules that set out pre-agreed actions in response to declines in stock biomass so that fishery managers can react quickly to potential stock fluctuations and stakeholders are already aware of the process. This will be especially useful as fisheries begin to see the impacts of climate change.

Data collection protocols: Consistent, coordinated approaches to data collection should be established to enable countries to develop and improve stock assessments. Fisheries dependent data is a valuable source of information that crew can be trained to collect; this process has been shown to improve fishers' buy-in to the management process. Independent observer coverage further validates information gathered, using either in-person observers or REM. Establishing recording protocols to document interactions with bycatch, ETP species and habitats is a first step to understanding the types of interactions that occur and provides data to inform management decisions. Monitoring data collected over time will help detect environmental changes and pre-empt ecosystem changes, and account for uncertainties and data gaps to implement a precautionary approach to fishery management. Responses to the FAO CCRF survey should be encouraged, and if possible, expanded on, rather than establishing new data collection processes.

Regular review of progress and reporting: Regular review of management measures should take place to ensure management objectives are being met and no unintended consequences occur. A regular review will ensure best practice measures are continually being considered and incorporated into the management system. Reporting mechanisms already exist and should be used where possible, but currently much reporting is on a national level, and does not allow for RFMOs and other shared stocks to demonstrate progress towards EAFM.

Considering these recommendations, an updated process diagram can be seen in Figure 34, which accounts for the progress that has already made against EAFM components.



Updated from: FAO 2021a, seen in Section 3.3

Figure 34. Updated progress diagram for implementing EAFM

7.3 Available resources to support implementation of EAFM

There are frameworks and guidance available to support the implementation of EAFM and of its components.

EAF Implementation Monitoring Tool (FAO 2021): has been designed by FAO to help countries monitor progress and achievement in the implementation of the ecosystem approach to fisheries (EAF) as well as identify gaps and challenges where greater efforts are required to improve the country's national fisheries management (FAO 2022). The EAF Nansen programme has used this tool globally, focusing on the development and delivery of Fishery Management Plans that meet EAFM criteria.

EAF Nansen How-To guide (FAO EAF-Nansen Project, 2016): The guide includes examples from several parts of the world to demonstrate different approaches to drafting legislation that incorporate each of these components. It also contains components that are routinely addressed during the review or development of a country's legislative framework for fisheries, such as objectives and principles, input and output controls, fishery management plans, monitoring, control, surveillance and enforcement.

MSC Fisheries Standard:[41] The fisheries standard covers many of the core components of EAFM, including sustainable management of the target species, mitigation of environmental impacts such as bycatch, ETP species and habitats, as well as the use of robust management to underpin fishing activity. EAFM components considered less by the MSC Standard are those linked to human wellbeing (social aspects, customary sustainable use).

Fishery Improvement Projects:[42] FIPs use the MSC Standard as a framework for improvement the sustainability of the fishery to a level considered best practice. To support this process, tools have been developed including capacity building training, Fishery Management Plan templates, and data limited tools.

FISHE:[43] This toolkit equips fishery managers with a low-cost and highly effective resource to help with the assessment and sustainable management of fisheries, even in the face of climate change. FISHE is particularly suitable for use in data-limited fisheries. FISHE helps users figure out what to do in order to improve the performance of a fishery. The outputs of FISHE can be combined to result in a comprehensive adaptive fishery management plan.

The FAO has also developed best practice guidance for fisheries management, addressing IUU activity, and managing small-scale fisheries.

41 The MSC Fisheries Standard www.msc.org Accessed 03 September 2024
42 Fishery Improvement Tools https://www.msc.org/ Accessed 03 September 2024
43 FISHE https://fishe.edf.org/ Accessed 03 September 2024

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9 Abbreviations/Acronyms

A&SO	Atlantic and Southern Ocean
ABNJ	Area Beyond National Jurisdiction
ABP	Associated British Ports
ACE	Annual Catch Entitlement
ACL	Automatic Location Communicator
ADD	Acoustic Deterrent Device
ALDFG	Abandoned, Lost or Discarded Fishing Gear
ASAP	Age Structured Assessment Program
ASPM	Age-Structured Production Model
ATP	Allocation Transfer Program
BATmap	Bycatch Avoidance Tool Using Mapping
BBNJ	Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction
BC	British Columbia
BCC	Benguela Current Convention
B_{ECO}	Biomass Necessary for Maintaining Ecosystem Functions
BENTHIS	Benthic Ecosystem Fisheries Impact Study
BFAR	Bureau of Fisheries and Aquaculture Resources
BFD	Belize Fisheries Department
BFM	bird food model
BMIS	Bycatch Management Information System
BMSY	Biomass Maximum Sustainable Yield
BPA	Benthic Protected Area
BPM	Bycatch Monitoring Programme
CAMLR	Conservation of Antarctic Marine Living Resources
CASAL	Catch-at-Age Stock Assessment Models
CBD	Convention on Biological Diversity
CC4FISH-II	Climate Change Resilience in the Caribbean Fisheries Sector- II
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCFRP	California Collaborative Fisheries Research Program
CCRF	Code of Conduct for Responsible Fisheries
CDS	Catch Documentation Scheme
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	CCAMLR's Ecosystem Monitoring Programme
CEP	Compliance and Evaluation Procedure
CFP	Common Fisheries Policy
CFRN	Canadian Fisheries Research Network
CIC	Community Interest Company
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
ClimateLinks	Climate Global Knowledge Portal
CMM	Conservation and Management Measure
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CMSY	Catch MSY
Coast4C	Coast 4C Ltd - Communities, Commerce, Conservation and Climate
COBI	Comunidad y Biodiversidad
COFI	Committee on Fisheries
CONAPESCA	National Commission on Aquaculture and Fisheries
COP	Conference of the Parties to the United Nations Convention on Biological Diversity

CPUE	Catch per Unit Effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTI	Coral Triangle Initiative
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security
DAS	Days at Sea
DEFF	Department of Environment, Forestry and Fisheries
DFFE	Department of the Environment, Fisheries and Forestry
Defra	Department for Environment, Food and Rural Affairs
DFO	Fisheries and Oceans Canada
DOF	Department of Fisheries
DWG	Deepwater Group
EA	Ecosystem Approach
EAA	Economic Assistance Agreement
EAF	Ecosystem Approach to Fisheries
EAFM	Ecosystem Approach to Fisheries Management
EBFM	Ecosystem Based Fisheries Management
EC	European Commission
ECOFISH	Ecosystems Improved for Sustainable Fisheries
EDF	Environmental Defense Fund
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ELO	Environmental Liaison Officer
EM	Electronic Monitoring
EMODnet	European Marine Observation and Data Network
ENSO	El Nino Southern Oscillation
EPI	Environmental Performance Index
ERA	Ecological Risk Assessment
ERAEF	Ecological Risk Assessment for the Effects of Fishing
ERAF	Ecological Risk Assessment Framework
ETP	Endangered Threatened and Protected
EU	European Union
FAD	Fish Aggregating Devices
FAO	Food and Agriculture Organization
FARMC	Fisheries and Aquatic Resources Management Council
FCA	Fisheries Cooperative Association
F_{ECO}	Target fishing pressure to maintain ecosystem function
FFA	Forum Fisheries Agency
FIP	Fisheries Improvement Project
FIS	Fisheries Innovation and Sustainability
FISH	Fisheries Improved for Sustainable Harvest
FishAdapt	Adaptive Capacity and Resilience of Fisheries and Aquaculture Dependent Livelihoods Project
FISHCORE	Philippine Fisheries and Coastal Resiliency
FISHE	Framework for Integrated Stock and Habitat Evaluation
FISHSCANNER	Device for Real-Time Information (species composition with length distribution and the total volume of each species)
FIT	Fishing Index and Threat Assessment Tool
FMA	Fisheries Management Areas
FMI	Fisheries Management Index
FMP	Fisheries Management Plan
FNA	Fins Naturally Attached
FNZ	Fisheries New Zealand

FOB	Free on Board
FSC	Food, Social, and Ceremonial
GBF	Global Biodiversity Framework
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFCM	General Fisheries Commission for the Mediterranean
GGGI	Global Ghost Gear Initiative
GIFMP	Groundfish Integrated Fisheries Management Plan
GOA	Global Ocean Alliance
GOB	Government of Belize
GPS	Global Positioning System
GT	Gross Tonnes
GYM	Generalised Yield Model
HCR	Harvest Control Rule
HRI	Healthy Reef Initiative
HSS	Harvest Strategy Standard
IATTC	Inter-American Tropical Tuna Commission
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authorities
IFQ	Individual Fishing Quota
IISD	International Institute for Sustainable Development
IMP	Interim Management Procedure
IMR	Institute of Marine Research
INAPESCA	National Institute of Fisheries and Aquaculture
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IPA	Indigenous Protected Areas
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPHC	International Pacific Halibut Commission
IRF	Iceland Responsible Fisheries
ISF	Icelandic Sustainable Fisheries
ITQ	Individual Transferable Quotas
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported and Unregulated
IWC	International Whaling Commission
JTED	Juvenile and Trash Fish Excluder Device
LAMAVE	Large Marine Vertebrates Research Institute Philippines
LED	Light-Emitting Diode
LGEEPA	General Law for Ecological Equilibrium and Environmental Protection
LGPAS	General Law for Sustainable Fisheries and Aquaculture
LGVS	General Law for Wildlife
LISIG	Low Impact Scallop Innovation Gear
LPI	Living Planet Index
M&BS	Mediterranean and Black Sea
MCCAP	Marine Conservation and Climate Adaptation Project
MCRS	Minimum Conservation Reference Size
MCS	Monitoring, Control and Surveillance
MFMR	Ministry of Marine Resources
MFRI	Marine and Freshwater Research Institute
MLS	Minimum Landing Size
MMO	Marine Management Organisation

MoU	Memorandum of Understanding
MPA	Marine Protected Area
MPI	Ministry for Primary Industries
MRAG	MRAG Ltd
MSC	Marine Stewardship Council
MSE	Management Strategy Evaluation
MSFD	Marine Strategy Framework Directive
MSY	Maximum Sustainable Yield
NAFO	Northwest Atlantic Fisheries Organization
NAO	North Atlantic Ocean
NE	Natural England
NEAFC	North East Atlantic Fisheries Commission
NEAO	North East Atlantic Ocean
NetWorks	Abandoned, Lost or Discarded Fishing Gear Recycle Programme
NFRDI	National Fisheries and Research Development Institute
NGO	Non Governmental Organization
NHA	Namibian Hake Association
NM	Nautical Mile
NOAA	National Oceanic and Atmospheric Administration
NPFC	North Pacific Fisheries Commission
NPO	North Pacific Ocean
NPOA	National Plan of Action
NRW	Natural Resources Wales
NSAP	National Stock Assessment Program
NZD	New Zealand Dollar
OECD	Organisation for Economic Co-operation and Development
OECM	Other Effective Area-Based Conservation Measure
OMP	Operational Management Procedure
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PA	Precautionary Approach
PACFIG	Pacific Fisheries Intelligence Group
PHMEIA	Pacific Halibut Multiregional Economic Impact Assessment
PICFI	Pacific Integrated Commercial Fisheries Initiative
PSMA	Port State Measures Agreement
QMA	Quota Management Area
QMS	Quota Management System
RAM	Dr. Ransom A. Myers Database
RBF	Rights-Based Fishery
REM	Remote Electronic Monitoring
RFMO	Regional Fisheries Management Organisations
SAC	Special Area of Conservation
SADSTIA	South African Deep-Sea Trawling Industry Association
SASSI	South African sustainable Seafood Initiative
SCIC	Standing Committee on Implementation and Compliance
SDG	Sustainable Development Goals
SEA	Scottish Entanglement Alliance
SEAFO	South East Atlantic Fisheries Organization
SEAO	South East Atlantic Ocean
SEAPODYM	Spatial Ecosystem and Population Dynamics Model
SES	Social-Ecological System
SESA	Strategic Environmental and Social Assessment
SFP	Sustainable Fisheries Partnership

SIDS	Small Island Developing State
SIMP	Seafood Import Monitoring Program
SIOFA	Southern Indian Ocean Fisheries Agreement
SISO	Scheme on International Scientific Observation
SMS	Stochastic MultiSpecies
SOFIA	State of World Fisheries and Aquaculture
SoI	System of Inspection
SPO	South Pacific Ocean
SPRFMO	South Pacific Regional Fisheries Management Organization
SRB	Scientific Review Board
SSB	Spawning Stock Biomass
SSF	Small Scale Fisheries
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TIDE	Toledo Institute for Development and Environment
TOKM	Te Ohu Kai Moana
TRP	Target Reference Point
TURF	Territorial User Right Fisheries
UC	University of California
UINR	Unama'ki Institute of Natural Resources
UK	United Kingdom
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	UN Trade and Development
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNEP	United Nations Environment Programme
UNFSA	United Nations Fish Stocks Agreement
UNSDG	United Nations Sustainable Development Goals
US	United States (America)
USA	United States of America
USAID	United States Agency for International Development
US$	US Dollar (America)
VADE	Voluntary, Assisted, Directed, Enforced (Framework – New Zealand)
VA-TURF	Vulnerability Assessment – Tool for Understanding Resilience of Fisheries
VME	Vulnerable Marine Ecosystems
VMS	Vessel Monitoring System
WCMC	World Conservation Monitoring Centre
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western Central Pacific Ocean
WCS	Wildlife Conservation Society
WG	Working Group
WWF	World Wildlife Fund

Cardinal points/directions are used unless otherwise stated.

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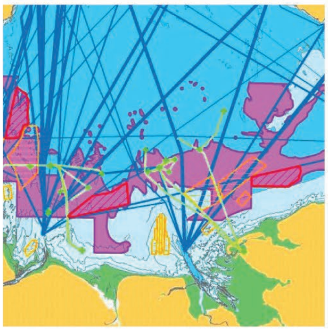
Appendices




Innovative Thinking - Sustainable Solutions

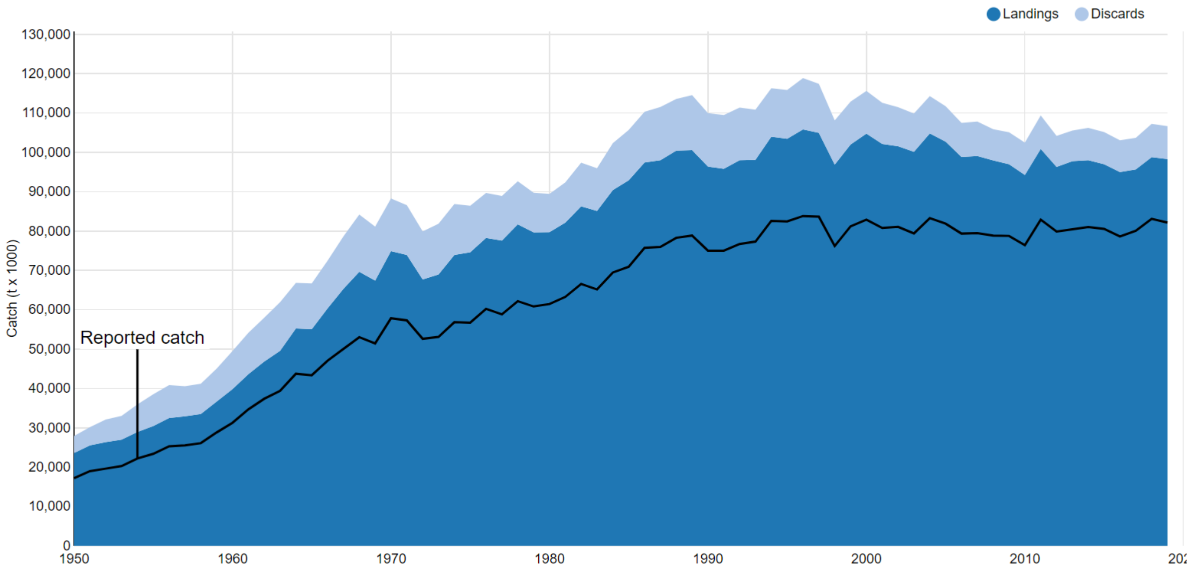
A Status of World Fisheries

The status of the world's fisheries is a useful baseline for understanding the current situation that EAFM builds upon, as well as identifying areas where there are likely successes or opportunities for EAFM.

The FAO State of World Fisheries (SOFIA) report is published every two years and uses data collected by FAO to provide an overview of the current status of fish stocks globally. The 2022 edition also contained an update on progress towards implementing EAFM.

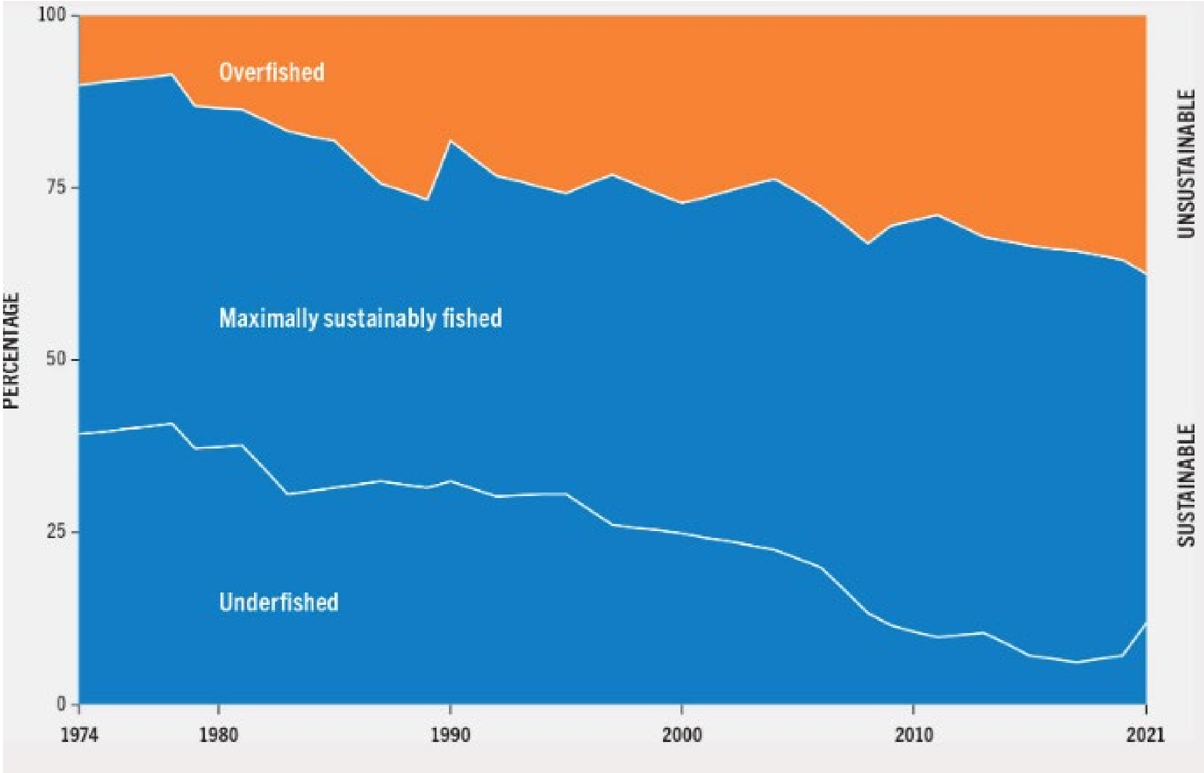
Since 1970, landings from marine fisheries have increased from approximately 60 million tonnes to 90 million tonnes. In 2021, the proportion of fish stocks within biologically sustainable levels was 62.3%, a decrease of 2.3 percentage points since 2019 (FAO 2024), and a significant decrease from 90% of stocks fished at sustainable levels in 1974. In contrast, the percentage of stocks fished at biologically unsustainable levels has been increasing since the late 1970s, from 10% in 1974 to 37.7% in 2021 (FAO 2024).

The Organisation for Economic Co-operation and Development (OECD) works with member governments, policy makers and citizens, to establish evidence-based international standards and find solutions to a range of social, economic and environmental challenges (OECD 2022). The OECD review of fisheries report collects annual information on the sustainability of fish stocks in its member states and partner countries. In 2022, OECD reviewed the status of 1,456 individual fish stocks (45% of global catches by volume) and results closely mirrored the data reported by FAO in SOFIA 2022, indicating that the OECD data could provide an approximation of the status of fish stocks globally, despite its partial geographic coverage from 38 member countries and 5 partner countries (OECD 2022), and may be a useful proxy for determining global sustainability and corroborating FAO data. However, it is important to recognise that using OECD data could leave knowledge gaps for small scale and indigenous fisheries and fisheries in developing countries.



Source: Sea Around Us, 2022

Figure A1. Historic trends in global capture fisheries by live weight



Source: FAO 2024

Figure A2. FAO global trends in the state of the worlds marine fishery stocks 1974 – 2021

In 2021, the top seven fishing countries accounted for approximately 50% of total global capture production (Figure A3), while the top 20 countries accounted for over 72% (FAO 2022a):

- China (14%);
- Indonesia (7.8%).
- Peru (7.1%).
- Russian Federation (5.9%).
- India (5.4%).
- United States of America (4.6%).
- Vietnam (3.8%).

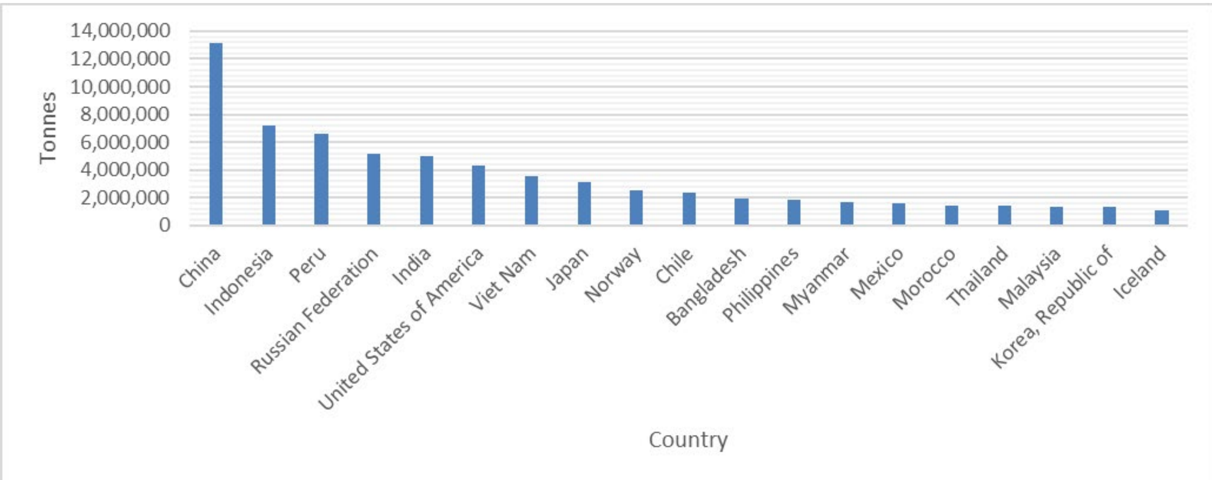
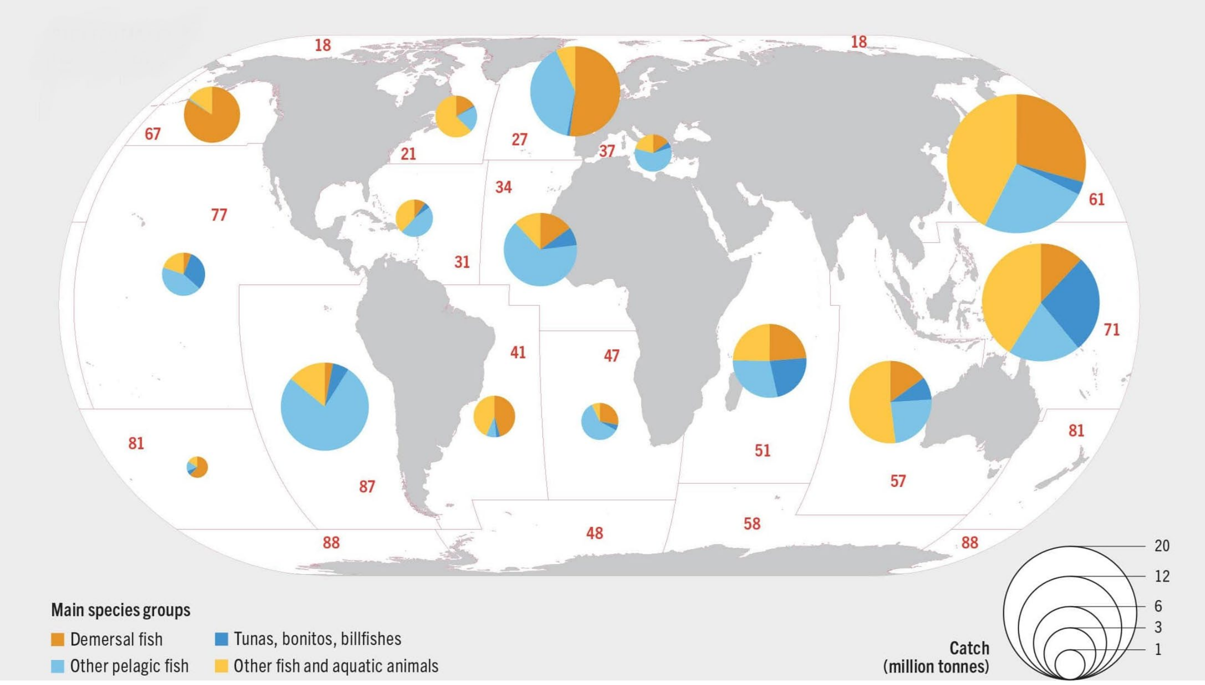


Figure A3. Landing volume by country from FAO (2021) data for top 20 landings countries

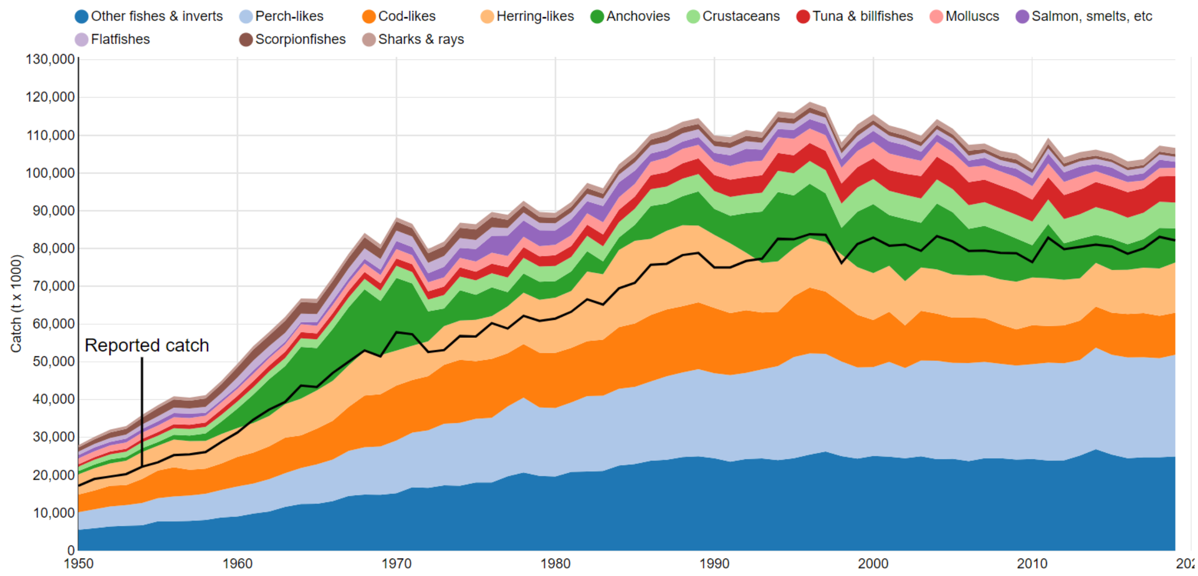
Six of these top seven countries are party to the CBD and the commitments to the ecosystem approach that come with that, however it is not clear the extent to which each country has actually begun implementing EAFM.



Source; FAO 2022a

Figure A4. Marine capture by species group for major fishing areas (average 2018 – 2020)

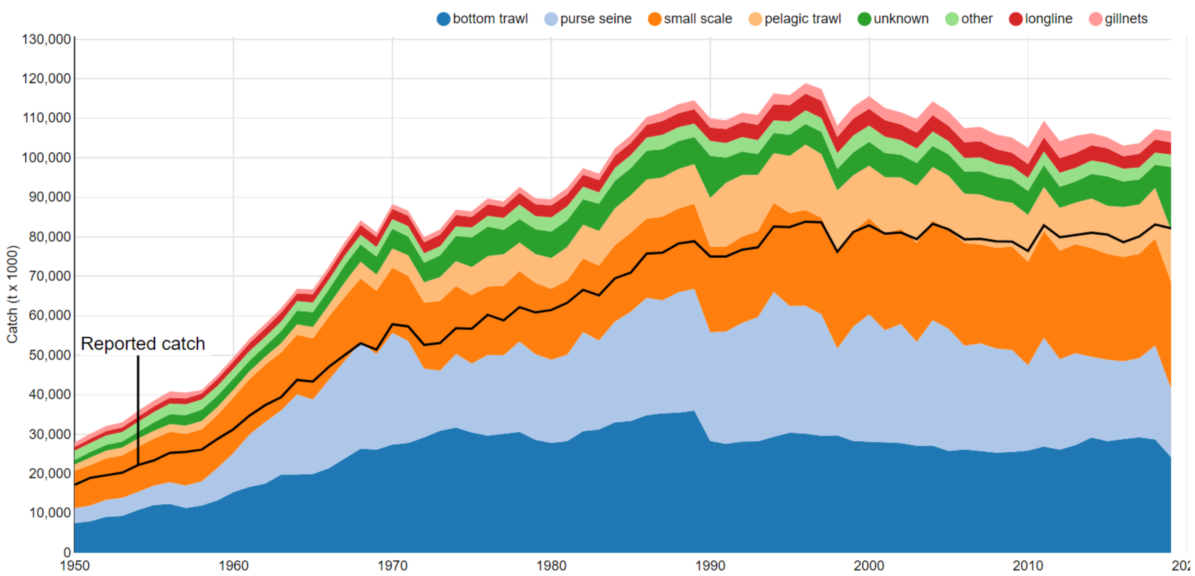
The FAO (2022) provides a breakdown of species caught globally since 2007. In 2020, a total of 66,734 thousand tonnes of finfish were landed globally, with the top three species being Anchoveta (7% of finfish; 4,896 thousand tonnes), Alaska pollock (5% of finfish; 3,544 thousand tonnes) and Skipjack tuna (4% of finfish; 2,827 thousand tonnes). A significant proportion of finfish landings comprise forage fish such as herring and sardine, which are considered important low trophic level species responsible for supporting the marine food web and contributing to the health of the wider ecosystem (Smith 2011). In 2020, there was a total of 5,635 thousand tonnes of crustaceans landed. The second most landed crustacean was Antarctic krill, (8% of crustaceans; 455 thousand tonnes). This is particularly relevant to this report given the important role that krill play as a food source for a large number of marine species (Smith *et al* 2011).



Source: Sea Around Us, 2022, using data collected by FAO, 2020

Figure A5. Species composition of global fisheries landings since 1950

The Sea Around Us project assesses the impact of fisheries on global marine ecosystems and provides detail on the type of gear being used globally (Figure A6). The largest proportion of landings are made using bottom trawls and purse seine, but a similar volume is landed by small scale fisheries. Bottom trawl gear often has a bad reputation for the wider impacts it can have on the seabed and is discussed in Section 5.3. Small-scale fishing supports both income and nutrition and comprises 90% of fishermen globally (FAO 2022a), indicating significant social and economic considerations when managing small-scale fisheries activity. Estimates of the current status of world fisheries is only as good as information collected and shared and many developing world countries and small-scale fisheries may be underrepresented in the datasets.



Source: Sea Around Us, 2022, using data collected by FAO, 2020

Figure A6. Gear type used for global fisheries landings since 1950

B Case Studies

B.1 Case Study: Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR): krill, toothfish and icefish

B.1.1 Background

CCAMLR is an international commission responsible for managing marine resources in the Southern Ocean, focusing on conserving Antarctic marine ecosystems and the sustainable use of renewable resources, where this does not exclude fish harvesting as long as it is carried out in a sustainable manner and takes account of the effects of fishing on other components of the ecosystem. As an international body, CCAMLR operates with member signatories who set conservation measures through consensus agreement to determine and regulate the use of marine resources in the Antarctic. Currently the Commission is made up of 27 Members (26 States and the EU) and a further 10 acceding states. CCAMLR's management framework incorporates a precautionary, ecosystem-based approach to fishery management at its core, considering the conservation and rational use of living resources to maintain ecological relationships[44]. The principles of the Convention can be summarised as:

- Maintenance of stable recruitment in the target species;
- Maintenance of existing relationships between harvested, dependent and related species; and
- Ensuring the ecosystem effects of fishing are reversable over a fixed period (20 – 30 years).

CCAMLR is of significant economic importance for its member Parties, particularly those involved in the toothfish, Antarctic krill, and mackerel icefish fisheries. Patagonian and Antarctic toothfish are caught using bottom-set longlines, trawl or pot gear. Icefish and krill are caught by trawl gear.

EAFM is central to CCAMLR, primarily through setting precautionary catch limits at levels low enough not to compromise the future sustainability of the target stock. The Marine Stewardship Council (MSC) certifications on these fisheries underscores their sustainability, increasing their market value and contributing to the economy of their respective nations. The ecosystem approach is also embedded in legally-binding measures, and is underpinned by CCAMLR's Ecosystem Monitoring Programme (CEMP).

B.1.2 Key legislation

Within CCAMLR, fisheries are managed through Conservation Measures (CMMs), developed by the Commission and to be implemented by the Members. Compliance with these CMMs is monitored through the Standing Committee on Implementation and Compliance (SCIC).

Conservation Measures (CMs) legally binding on all signatories.

- Catch limits & quotas: 41-01, 51-01
- Marine Protected Areas (MPAs): 91-04
- Spatial and temporal closures: 32-02, 22-06
- Vessel Monitoring Systems: 10-04
- Port state measures: 10-03

[44] CCAMLR https://www.ccamlr.org/en/fisheries/fisheries Accessed 22 July 2024

- Research and monitoring: 21-01
- Illegal, Unreported and Unregulated (IUU) fishing: 10-06, 10-07
- Data reporting and transparency: 23-01

B.1.3 Description of fishery management measures

The Convention outlines objectives and principles to conserve and ensure the rational use of Antarctic marine living resources, emphasising international cooperation as a key element of the convention structure. The Commission is the decision-making body that formulates the management framework for fisheries within the Convention Area. This involves:

- setting catch limits;
- implementing spatio-temporal closures;
- developing measures to minimise the environmental impacts of fishing activities[45];
- establishing precautionary reference points;
- specified action plans for issues, such as bird mortality; and
- long-term management plans.

These measures determine the timing, location, and methodologies of fishery operations, tailored to fishing seasons.

B.1.4 Progress against EAFM components

Stage 1

Sustainable Fisheries - Assessments are undertaken using fishery-dependent data, from both vessels' catch data and observer data (100% coverage is required on all vessels), and fishery independent data from acoustic and trawl surveys. For krill, a Generalised Yield Model (GYM) was developed to establish catch limits and establish a precautionary 'trigger level' of 1% of the unexploited biomass. The limits are set through a series of decision rules that provide an estimate of the proportion of krill biomass that can be fished while ensuring sufficient biomass remains to maintain the population and that there is enough for predators.

For Patagonian and Antarctic toothfish and Icefish stocks, commonly used models include the Statistical Catch-at-Age model, Spatially Explicit Models, and Mark-Recapture models, the latter of which estimates population sizes based on the proportion of tagged fish recaptured in a fishery. Both models estimate current population sizes and structure, and assess the impacts of fishing upon populations, exploring recruitment patterns. Currently all stocks managed through CCAMLR are considered healthy.

Bycatch - Limits on bycatch species are set out in the CMs, with move-on rules and closures being put in place if certain trigger levels are reached for species. Vessels send through detailed monthly haul by haul catch reports, through which these trigger levels can be monitored. Vessels fishing south of 60°S must retain everything onboard. All fisheries are independently monitored through fishery observers, operating under the CCAMLR Scheme on International Scientific Observation (SISO). Observers record biological details on target and bycatch species, as well as monitoring interactions of ETP species with the fishing vessels.

45 CCAMLR https://www.ccamlr.org/en/organisation/convention Accessed 22 July 2024

ETP species – Restrictions on fishing gear, mandatory bird-scaring lines, line-weighting regimes, night setting of longlines, and the use of specific mesh sizes mitigate the capture of ETP species and juveniles of the target stock. These measures are continuously reviewed and are updated based on latest scientific advice. National measures may extend beyond the requirements of CCAMLR, for instance South Georgia's longline fishery requires all hooks to be stamped with the vessel's callsign, and there are specific fishery seasonal closures that operate alongside seabird and seal breeding seasons. It is reported that Antarctic populations of some ETP species are recovering well after centuries of industrial-scale exploitation for example, humpback whales that feed in the region have rebounded to over 90% of their pre-whaling population.[46]

Stage 2

Spatial management – Research expeditions are designed to support VME identification, and policies provide a definition of a VME 'encounter' and the subsequent vessel encounter protocol. Ten or more VME indicators signify a 'VME-risk area', and vessels must stop fishing upon reaching this limit, and report the location to CCAMLR to alert all vessels, and close the area to fishing. MPAs have been established to conserve biodiversity through specific no-take zones and restricted-fishing areas. The presence of VMEs have led to explicit closed areas within larger MPAs that further restrict fishing activities, and policies are in place to assist enforce and implement these restrictions.

The trigger level catch limits within the krill fishery are split between four subareas to spread effort and prevent localised depletion. Further restrictions are in place limiting how close the fishery can operate close to land, through setting a 'buffer' zone, in an effort to reduce any impact on penguin and seal colonies.

Depth restrictions have also been put in place, primarily to protect VMEs, with prohibiting fishing shallower than 550 m. While there are no specific CCAMLR CMs in place to protect spawning grounds, in some areas National legislation has been implemented do this, preventing fishing activities within 12 NM from the shore to protect nesting icefish.

Stage 3

Trophic level impacts – CEMP monitors the effects that fishing activities have on dependent species, i.e., species that are not directly impacted by fishing but rely on the target and bycatch species of these fisheries. The CEMP monitors a number of bird species and Antarctic fur seal population, with any significant populations changes taken into account when undertaking assessment or developing CMs. Management frameworks consider interdependence of species in food webs, particularly the role of krill as a keystone species, and regular scientific assessments evaluate the impact of fishing on trophic dynamics to ensure ecosystem stability. Information from monitoring of key species and environmental parameters informs management decisions. Specifically, the Antarctic krill 'decision rules' ensure that krill levels suffice both marine and land-based predators, maintaining krill biomass levels higher than single-species management requirements (Trathan & Agnew, 2010). This is achieved by calculating harvest rates from the lowest biomass likely to occur rather than the mean biomass.

B.1.5 Cross cutting components

Climate change – Climate change is reflected in CCAMLR's management through its ecosystem-based approach, adaptive management strategies, monitoring and research. Long-term monitoring programs are in place that research effects of temperature changes and ocean acidification on marine species and habitats. Climate change has also been incorporated into key documentation, which highlights the

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46 PEW Trust https://www.pewtrusts.org/en/about/news-room/press-releases-and-statements/2024/02/26/uk-expands-marine-protections-in-south-georgia-and-the-south-sandwich-islands Accessed 22 July 2024

importance of integrating climate considerations into management decisions and conservation measures, and provides data and recommendations to adapt management strategies according to biological and ecological responses of key species and habitats to climate change.

Illegal, Unreported and Unregulated (IUU) fishing – Prior to the CCAMLR's establishment in the 1980s, species such as toothfish faced overfishing, and in the 1990s toothfish catch was estimated to be six times greater than that reported by authorised vessels[47]. The issue of IUU fishing has been addressed though mandatory use of vessel monitoring systems (VMS), mandatory reporting of catch data, on-board observers, at-sea inspections and port state measures , and CCAMLR collaborates with adjacent RFMOs to strengthen IUU mitigation efforts. CCAMLR's System of Inspection (SoI) is key to enforcing effective compliance with CMs, and has been in place for over 30 years, under constant review and improvement by the Compliance and Evaluation Procedure (CEP) (Feng, 2023). The SCIC reviews information on IUU fishing, overseeing compliance, mandating reporting on maritime inspection activities and outcomes including port inspections specified under CMMs[48], and advises recommendations[49].

CCAMLR also introduced a Catch Documentation Scheme (CDS) requiring all toothfish that are landed to have an accompanying catch document, allowing the product to traced back to the vessel and area it was taken.

Science and the precautionary approach – CCAMLR's relationship with the Antarctic Treaty[50] encourages scientific research as the basis for managing Antarctic resources, forming the foundation of CCAMLR's fishery management. The CCAMLR Commission and Scientific Committee (SC) provides fishery management advice based on the best available science through a number of key Working Groups and other committees.

The Convention states CMs are to be created and implemented on *"the basis of the best scientific evidence available"* (Miller, 2011) and the management approach is explicitly defined as being *"precautionary"* and based on an *"ecosystem"* approach. This involves assessing uncertainties, data gaps, and ecosystem relationships, before making appropriate management decisions. This supports the precautionary approach by detecting ecosystem changes early and allows for proactive management. Additionally, CCAMLR continuously monitor the progress of each fishery's catch reports, allowing them to predict when the quota will be reached and issuing fishing closure notices, after which no fishing can take place. Any 'overshoots' of the catch limits are assessed by the SCIC for compliance implications and accounted for in subsequent assessments. This ensures that fishing activities do not exceed set catch limits, preventing overfishing and accounting for wider ecosystem impacts.

B.1.6 Process for implementation

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was established by international convention in 1982 with the objective of conserving Antarctic marine life. This was in response to increasing commercial interest in Antarctic krill resources, a keystone component of the Antarctic ecosystem and a history of over-exploitation of several other marine resources in the Southern Ocean. The Convention is open for accession by any State interested in research or harvesting activities to which the Convention applies. Acceding States do not take part in the decision-making process of the Commission nor contribute to the budget (CCAMLR 2024).

47 https://www.ccamlr.org/en/compliance/iuu Accessed 22 July 2024
48 https://cm.ccamlr.org/measure-10-08-2017 Accessed 22 July 2024
49 https://www.ccamlr.org/en/system/files/e-pt8_0.pdf Accessed 22 July 2024
50 https://www.ats.aq/index_e.html Accessed 22 July 2024

CCAMLR pioneered the ecosystem approach to resource management, took action on the problem of sea bird bycatch, and has established measures to combat illegal unreported and unregulated (IUU) fishing. CCAMLR is seen as an example of best practice in managing marine resources in international waters. At the same time, CCAMLR's challenges arise in the balance between 'fishing' and 'conservation' interests; for example in the current debates over climate change and marine protected areas in the Southern Ocean. In each of these examples, CCAMLR's consensus-based decision-making process has been a central element in shaping outcomes (Nilsson *et al* 2016).

Institutional components set out the processes for decision making, scientific advice, provisions for international cooperation and collaboration along with programmes for review, monitoring and application of conservation measures. Conservation measures are reviewed and developed at each annual meeting of the Commission, and subsequently implemented by Members during the ensuing fishing season (CCAMLR 2024).

B.1.7 Summary of progress towards delivering Target 5 of the GBF

The CCAMLR Convention itself is a strategic document involving an indicator-based monitoring and evaluation system, specific to regional goals and targets, and associated with monitoring schemes – all of which are relevant to the GBF Target 5, in line with EAFM components. Employing an explicit precautionary and ecosystem-based management strategy, CCAMLR's CMs are based on best available scientific advice, considering broader ecosystem impacts. The CEMP provides an agreed-upon standard of methods for data collection, formatting and analysis, and detects ecosystem changes which inform management decisions. Measures are in place against IUU fishing, including IUU vessel lists, VMS, e-logbooks, Monitoring, Control and Surveillance (MCS) systems and international collaboration with RFMOs. Management systems are continually reviewed and updated based on scientific advice and CCAMLR's adaptive management practices are also in line with Target 5 of the GBF.

B.2 Case Study: Philippines inshore small-scale fishery

B.2.1 Background

In 2021, Philippines was the twelfth largest fishing nation, landing 1.8 million tonnes of fish (2% of global landings). Roughly half of these landings are from the small-scale fishery, and another 40% are by purse seines fishing for tuna and other pelagic species. The Philippines is a country of 111 million people, and about 2.1 million people work in seafood-related industries including for low-income families engaged in subsistence fishing. Filipinos have an average per capita fish consumption of 40 kg/year, significantly higher than the global average (SFP 2024) and get more than 50% of their dietary protein from aquatic resources.

Marine fisheries in the Philippines are divided into municipal fisheries (within 15 km from the coast) and commercial fisheries (outside municipal waters). About 55% of production comes from municipal waters, caught by a fleet of nearly 268,000 small boats (less than 3 GT) operated by subsistence and artisanal fishers. Municipal fisheries are dominated by boats using gillnets, handlines, traps and ring nets.

In 2014, Philippines received a 'yellow card' for IUU activity from the European Union. New legislation and measures were implemented as a result and the EU subsequently revoked the yellow card. While this shows significant progress in the approach to fisheries management, the Fish Right Program still indicates that 70% of fishing grounds are overfished (Aguirre, 2019) and SFP suggests that 40% of catches may still be from IUU activity and 85% are from artisanal/small-scale fisheries (which are difficult to monitor). The effectiveness of management plans in addressing these issues are limited by the

pressure from the increasing population of highly fishery-dependent coastal communities, food insecurity, and catch demand (Barboza *et al* 2024).
In 2007, the governments of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste came together to form the Coral Triangle Initiative (CTI 2021). Under the CTI, the Coral Triangle countries adopted a Regional Plan of Action which included the application of ecosystem approach to fisheries management (EAFM) as well as implementing climate change adaptation measures. EAFM has not been a common part of national fisheries legislation of the Coral Triangle countries, although most countries have a legislative framework that can be used to support EAFM. Many aspects and components of EAFM have already been practised in the region at various scales and stages. The Philippines has been the target of several internationally funded projects focussed on implementing EAFM, and if implemented successfully, it could have significant positive results for fisheries in the Philippines.

B.2.2 Key legislation

National legislation for fisheries includes:

- Fisheries Management Areas (FMA) Framework (2019)
- Philippine Fisheries Code (1998) - *encourages the adoption of a holistic approach to fisheries management and contains provisions that address EAFM concepts and embody EAFM principles*
- Fisheries Decree (1975)
- Fishery Industry Development Decree (1972)
- The Philippine Constitution (1935 & 1973 & 1986)
- Fisheries Act (1932)

B.2.3 Description of fishery management measures

The Bureau of Fisheries and Aquaculture Resources (BFAR) is responsible for the management and development of fisheries and aquatic resources in the Philippines. Fisheries management measures include:

- Limited entry and effort reduction;
- Rights-based fishery management including territorial use areas;
- Fishing effort allocation and catch shares;
- Seasonal spawning closures;
- Fishery Management Areas (FMAs);
- Gear regulations.

While the Philippines has laws, rules and regulations in place to protect its marine resources, the success of these is dependent on the level enforcement activity to ensure compliance (Oceana 2021).

In addition to national and local management, the Philippines has had several foreign-funded projects on fisheries management that have adopted some of the EAFM principles and concepts (Ramiscal and Dickinson 2012):

- FISH - Fisheries Improved for Sustainable Harvest: The aim of this project was to improve the capacity for managing fisheries and coastal resources and promote integrated fisheries management by supporting stakeholders at national and local levels.
- ECOFISH - Ecosystems Improved for Sustainable Fisheries: The aim was to conserve marine biodiversity, enhance ecosystem productivity and improve fisheries and related livelihoods. The

project developed stakeholder capacities to implement EAFM and applied innovative EAFM principles and best practices.

- FISHCORE - Philippine Fisheries and Coastal Resiliency: The US$176 million project aims to improve fisheries management, enhance the value of fisheries production, and elevate incomes in coastal communities (World Bank, 2024).
- Fish Right – The United States Agency for International Development (USAID) partnered with the Philippines government to address biodiversity threats, improve marine ecosystem governance, and increase fish biomass in select marine key biodiversity and fisheries management areas in the Philippines. Key activities include IUU assessment and risk reduction planning, climate risk management, designing appropriate harvest control rules, and support for fishing communities (BiodiversityLinks 2018).

B.2.4 Progress against EAFM components

Stage 1

Sustainable fisheries – The National Fisheries and Research Development Institute (NFRDI) established a National Stock Assessment Program (NSAP) to generate reliable data as a basis for the management and conservation of fisheries resources. The program provides a structure for single species stock assessments across FMAs using length-based population analysis and surplus production models (FAO 2023). To support information sharing and awareness raising about the status of fisheries resources, an Interactive Atlas has been developed to provide public information on the status of Philippine fisheries. The intention is for the website to be continuously expanded with more functionalities based on feedback and general best practices. Data are collected from 742 landing sites for a time-series analysis of stock status per fishing ground, to support the strengthening of FMAs across the country (NFRDI 2024).

The NSAP provides guidance on how to ensure accurate data collection and recording, to contribute to developing catch baselines that will be used to set reference points and harvest control rules as part of the strategy to implement science-based conservation and management measures. Currently, 70% of fish stocks in the Philippines are considered overfished, so establishing reference points and harvest control rules should contribute to developing rebuilding plans for these stocks.

One Filipino fishery is MSC certified, and several others are in Fishery Improvement Projects with the intention of becoming certified, reflecting the shift towards sustainable fisheries in the Philippines. FIPs provide an opportunity for fisheries to use the MSC framework to work towards a globally recognised sustainability standard, including data collection to support stock assessments, developing rebuilding plans and harvest control rules.

Bycatch - Studies have been made on the composition of bycatch species using various gear types in the Philippines to understand where this might be impacting on sustainability of the wider ecosystem. Bycatch is often used for human consumption (fresh or dried), and so consideration for the social and economic impacts of bycatch management measures is important (NFRDI 2024). Where less desirable species have been identified in the catch, a number of pilot initiatives have been tested to reduce the occurrence. The most recent initiative focussed on trialling designs for juvenile and trash fish excluder devices (JTEDs). The project resulted in the formulation of a Fisheries Administrative Order requiring all commercial trawlers in the Philippines to use the V12 or H15 JTEDs, involving stakeholder consultations at various local and national levels (Ramiscal and Dickinson 2012).

Ghost gear - Philippines is a hub of successful social enterprise schemes engaged in the recycling and upcycling of end-of-life and discarded fishing gear. The NetWorks programme started in 2012 in Danajon Bank and now operates nationally under Coast4C. Coast4C buys old fishing nets from partner communities and processes them for sale into responsible global markets to reuse in other commercial products (Coast4C 2024).

ETP species – Interactions between SSF and ETP species in the Philippines are largely understudied because of the SSF's perceived low ecological impact. Large Marine Vertebrates Research Institute Philippines (LAMAVE) is using an interview-based approach to investigate the interactions between fishers and ETP species. The survey is designed to obtain baseline information on the profile of small-scale fisheries in fishing communities and the interaction rate of marine turtles, sharks, and devil rays, as well as exploring the local ecological knowledge of fishing communities. Species that are categorised as Vulnerable, Endangered, and Critically Endangered in the IUCN Red List of Threatened Species are also protected under local and national laws, including the Amended Philippine Fisheries Code and Philippine Wildlife Act (LAMAVE, 2024).

Stage 2

Spatial management – The Philippine Fisheries Code sets out requirements for spatial restrictions that prohibit fishing in overfished areas, fishing in reserves, refuges and sanctuaries, fishing during closed seasons, or the capture of breeding or spawning fish (BFAR, 2023a). Historically, the Philippines has been committed to using spatial management to support the development of small, community-based MPAs, which help protect habitats and rebuild fish biomass (One Ocean, 2024).

The Bureau of Fisheries and Aquatic Resources (BFAR) has created twelve Fisheries Management Areas (FMAs) nationwide, with the goal of managing fishery resources sustainably. The intention is that this regional approach to management will support the implementation of EAFM by considering the range and distribution of fish stocks rather than just political or legal jurisdictions. The approach will also encourage ecological and human wellbeing in sustainable fisheries management along with science-based policies that use reference points and harvest control rules (BFAR, 2023a).

The ECOFISH project aimed to reduce the conflicts between uses and the component habitats by ensuring the compatibility of the activities and the environment where they take place by implementing a framework for area management that included site validations and stakeholder consultations, workshops, public hearings, redrafting of zonal maps and activity guides, and implementation (Christie *et al*, 2007).

Stage 3

Trophic level impacts - Through the FISH project in the Philippines, fisheries management initiatives were raised to an ecosystem scale in four pilot sites by studying the dynamics of marine ecosystems within a defined boundary, developing indices of the ecosystem's health, and setting in place fisheries management interventions for species that are key to the food web (and are an important economic commodity). However, FAO (2023) states that currently 'no countries [in the Asian region] are using ecosystem modelling to routinely evaluate fisheries and their ecosystems'.

The blue swimming crab FIP identified the need to study the trophic impact and the likelihood of cascades from the blue swimming crab fishery. This will be supported by BFAR, Local Government Units and the Philippine Association of Crab Processors.

B.2.5 Cross cutting components

Climate change - Climate stressors in the Philippines include rising sea temperatures, sea-level rise, and increased frequency and intensity of extreme weather events. USAID recognised these risks and incorporated climate impacts into activity design and implementation for the Fish Right project, strengthening the long-term sustainability of activity interventions and mainstreaming resilience into existing fisheries management plans. Fish Right has assisted 14 municipalities with applying the Vulnerability Assessment – Tool for Understanding Resilience of Fisheries (VA-TURF), which considers fisheries, reef ecosystems, and social and economic factors when identifying vulnerabilities (ClimateLinks, 2022).

Through participatory workshops, Fish Right has helped identify and prioritise ecosystem and other climate adaptation actions. Actions identified through these workshops are being incorporated into disaster risk and fisheries management plans. Over the past three years, Fish Right has assisted with the drafting, adoption, or implementation of 69 laws, policies, or regulations which incorporate EAFM (ClimateLinks, 2022).

Social and economic considerations – Fish makes up a large portion of most people's diet in the Philippines, and therefore access to it is important for food security. This is reflected in government policies that prioritise social and economic impacts and food security in fisheries management decisions (Tolentino-Zondervan and Zondervan, 2022).

Roughly 10.5% of fish landings are exported while the rest goes to local consumption and usage. The Philippines exports fish and seafood products, such as tuna, to countries such as United States, Japan, United Kingdom, Germany, Spain, Hongkong, Taiwan, the Netherlands, and South Korea. The majority of these countries require imported fish and seafoods to be sustainably produced, driving an interest from fish producers in the Philippines for independent certification to demonstrate sustainability credentials and secure foreign market access (Tolentino-Zondervan and Zondervan, 2022).

The FISHCORE project prioritises fisheries governance with a focus on the social and ecological dimensions of the Philippines resources. It is committed to using a science-based, participatory, and transparent framework designed to benefit approximately half a million fishers and stakeholders. This project adopts EAFM to support the development and implementation of appropriate fisheries management policies, improve institutional capacities for strengthened law enforcement, conduct Strategic Environmental and Social Assessment (SESA) as an integral part of Fisheries Management Plan development, to balance increasing productivity while conserving the country's natural resources (NFRDI 2024).

Illegal, Unreported and Unregulated fishing – In 2014 the EU issued the Philippines with a 'yellow card' for IUU activity, which could have led to trade sanctions if the government failed to take any action against IUU fishing. In 2015, the EU reversed its decision after amendments were made to the Philippine Fisheries Code, which imposed higher penalties against violations of the fisheries law, instituted a vessel monitoring system, created a national plan of action against IUU, froze new fishing licences for three years, provided reinforcement of human and financial resources for fisheries, plus new rules on inspection, and improved catch certification and traceability (WWF, 2015). The Philippines also reinforced cooperation with Papua New Guinea for inspection and control and coverage of the activities of the long distant fleet operating beyond Philippine waters.

In 2021, BFAR and USAID facilitated a series of workshops to assess how much of a threat IUU fishing was in a given area, why it was occurring and what was done to address it. The workshops piloted the use of the Philippine IUU Fishing Index and Threat Assessment Tool (I-FIT) developed by the USAID Fish Right Program and BFAR. I-FIT is designed to measure IUU fishing risk to guide for planning and operational decisions on the fight against IUU fishing, and a baseline for monitoring progress towards IUU fishing reduction. In pilot areas that used I-FIT, responses to IUU have increased (e.g. sea patrols, vessel registrations, and financial assistance for compliance) and IUU activity has decreased (BFAR 2022).

Participatory approach – The establishment of Fisheries and Aquatic Resources Management Councils (FARMCs) at the national, provincial and municipal levels has established a legal commitment by the government to involve stakeholders in the development and management of the fisheries industry. The development of small coastal MPAs used a co-management approach to ensure local community support and involvement (Walmsley and White, 2003).

Science and the precautionary approach – The Fisheries Code of the Philippines requires the adoption of the precautionary principle in a manner consistent with EAFM. The National Fisheries Research and Development Institute (NFRDI) was established in recognition of the crucial role of fisheries research in developing, managing, conserving and protecting the Philippines's aquatic resources. NFRDI is committed to achieving government goals to address food security and poverty alleviation concerns while also ensuring scientific information and knowledge are the basis for sustainable fisheries management and policy formulation (Rosario, 2007), and established the National Stock Assessment Program to support this objective.

Governance and Policy – In 2019, in an effort to improve fisheries sustainability, halt the decline of overexploited stocks and curb IUU, the Philippine Government established twelve Fisheries Management Areas (FMAs). The aim of these FMAs is to allow for better cooperation between BFAR and local governments sharing the same stocks, for more participatory and transparent management of fisheries among stakeholders, and to incorporate EAFM (BFAR, 2022). Objectives of the FMAs include: 1 Provide science-based, participatory, and transparent governance framework and mechanism to sustainably manage fisheries; 2 Uphold ecosystems approach to fisheries management anchored on food security; 3 Provide opportunities for supplementary livelihoods for poverty alleviation consistent with the objectives of the Amended Fisheries Code; 4 Ensure cooperation between local governments and national agencies and stakeholders.

B.2.6 Process for implementation

Fisheries management in the Philippines has been through several stages. In the 1980s, management of fisheries shifted from governance at the national level to community-based management, which focused on the implementation of local MPAs. In the 1990s, the legal and policy framework in Philippine fisheries evolved to address key sustainability issues such as livelihoods, fishing access and rights, and conservation, protection and management of fisheries. In the 2000s, there was a shift towards Integrated Coastal Management, seen in the merging of MPAs towards coastal management programs and including the role of community participation and other stakeholders. Finally, the 2010s have recognised the importance of implementing EAFM.

Over the years, a series of foreign-aided sustainability projects in Philippine fisheries have contributed to the further understanding of the management of coastal resources in the country, in particular FISH, ECOFISH, FISHCORE, Fish Right and Fishery Improvement Projects (FIPs) for tuna and blue swimming crab. To support the implementation of EAFM, many toolkits and guidance documents have been applied to fisheries in the Philippines, these include:

- EAFM Toolkits[51]
- FISHE[52]
- USAID[53]

Implementation of EAFM is still evolving, and the challenges of poverty, resource availability and such a diverse coastline will continue to place a significant role in shaping appropriate EAFM measures for the Philippines. In the near term EAFM will most likely be adopted through extension and gradual modification of conventional fisheries management (Heenan *et al*, 2013). This process has already begun; several municipal governments are grouping together to manage fisheries and habitats jointly at an ecosystem level. The advantage to this approach means several municipalities can pool funds in protecting their fishery resources and eliminate boundary disputes because their municipal waters are combined together and treated as a single management unit (Heenan *et al*, 2013).

B.2.7 Summary of progress towards delivering Target 5 of the GBF

Currently 70% of Philippines fish stocks are considered overfished, but the recent MSC certification of tuna in Philippine waters, and the establishment of several FIPs aiming for MSC certification indicates an appetite towards improving these fisheries. The Philippines has been faced with significant challenges in managing fisheries sustainably, however, its commitments to food security and mitigation of social impacts provide clear objectives that can be achieved through implementation of EAFM. Development of the National Stock Assessment Programme demonstrates progress in understanding fisheries resources with an aim of introducing precautionary and adaptive management using reference points and harvest control rules. The recent approach to managing fisheries through FMAs is intended to further contribute to the delivery of EAFM by managing at an ecosystem and stock level, which will ensure a resilient and long-term fishery resource, building food securing in a country that relies heavily on fish to provide its protein requirements. Implementation of these measures are intended to support progress towards SDG14.4 and will be reported on through the GBF monitoring framework.

B.3 Case Study: South African Hake Trawl fishery

B.3.1 Background

In 2021, South Africa was the 38th largest fishing nation, landing 491,329 tonnes of fish (FAO 2022). Approximately 100,000 people rely on the fisheries sector for their livelihood and the wild-caught seafood industry is worth $678 million (MSC, 2024). Trawled hake is South Africa's most important commercial fishery, worth almost US$200 million each year and comprising a significant portion of fish exports: around 64% of hake catch is exported (MSC, 2024). This fishery targets both deep-water hake *(Merluccius paradoxus)* and shallow-water hake *(Merluccius capensis)* and has been MSC certified since 2004, demonstrating the long-term performance of the fishery at a sustainable level.

[51] COASTFISH coastfish.spc.int/doc/coastfish_docs/technical_rep/Anon_10_EAFguidelines.pdf Accessed 22 July 2024
[52] EDF Fisheries Management Area Planning in the Philippines | EDF Fishery Accessed 22 July 2024
[53] USAID Mainstreaming Ecosystem Approach to Fisheries Management (M-EAFM) | (da.gov.ph) Accessed 22 July 2024

South Africa has a long-standing commitment to EAFM, demonstrated in both legislation and in practice. A legislative review of EAFM policies was conducted through the FAO's EAF Nansen programme and ecological risk assessments for key commercial fisheries have been undertaken with NGOs in South Africa. These have led to the development of guidelines and learnings from experiences with developing and implementing EAFM.

B.3.2 Key legislation

National legislation for fisheries includes:

- Marine Living Resources Act (1998) aims to '*provide for the conservation of the marine ecosystem, the long-term sustainable utilization of marine living resources and the orderly access to exploitation.'*
- National Environmental Management Act (1998)
- National Environmental Management – Protected Areas Act (2003)
- General Policy on the Allocation of Commercial Fishing Rights (2005)
- Policy for the Transfer of Commercial Fishing Rights (2009)
- Policy for the Small-Scale Fisheries Sector (2012)
- General Policy on the Allocation and Management of Fishing Rights (2013)
- National Environmental Management - Protected Areas Amendment Act (2014)
- Marine Spatial Planning Act (2019)

B.3.3 Description of fishery management measures

The Department of the Environment, Fisheries and Forestry (DFFE) is responsible for fisheries management in South Africa. The Operational Management Procedure (OMP) approach specifies exactly how the TAC is calculated using stock specific monitoring data (commercial and fishery-independent indices of abundance derived from commercial catch and effort data), and from demersal research surveys. Other management measures include:

- Spatial management
- Restrictive licensing scheme
- Species specific permits and access control
- Vessel size and gear restrictions
- Effort limitations preventing an increase in the number of vessels and prohibition on transferring effort to other species once quota has been used
- Landing regulations requiring the target species to make up a minimum of 50% of catch (by weight)
- Inshore and offshore fleet regulations

Hake fishery permit conditions contain a specific Ecosystem Impacts of Fishing section, to support the drive towards the implementation of EAFM in South Africa. Permit conditions include reducing damage to the seabed through restrictions on trawl gear and restriction of fishing operations to the historic fishery footprint, reducing bycatch through per-trip catch limits as well as annual bycatch limits, and restrictions on fishing in specified fishery management areas and MPAs.

B.3.4 Progress against EAFM components

Stage 1

Sustainable fisheries – The hake fishery comprises inshore and offshore stocks, and recent research indicates that the South African hake is the same stock as the Namibian hake. The assessment model used is a sex-disaggregated Age-Structured Production Model (ASPM), which is fitted directly to age-length keys and length frequency distributions. This model provides biomass reference points that are used as a basis for the harvest control rule and for annual TAC setting. The model uses comprehensive data from the South African fishery but makes assumptions about the historical Namibian hake catches based on information available.

Management objectives are agreed and possible management scenarios tested in model simulations. In recent years, the species-specific stock assessments had indicated that the stock was below MSY levels and as a result the Operational Management Plan (OMP) became a formal recovery plan. This required large initial cuts in TAC, then TAC stability over time until B_{MSY} was achieved. Currently the stock is estimated to be above the B_{MSY} level. Regulation of the inshore and offshore stocks separately is not practical and catch allocations are integrated into a single TAC. The OMP formula for the TAC has been designed to protect the hake stock most at risk and includes provisions for checking that the species-split of the catch remains consistent with that projected in the simulation tests.

The harvest strategy and its ability to sustainably manage the fishery is reviewed regularly through an international workshop. The most recent review led a panel of international peer reviewers to recommend a number of improvements on which new assessment work has already been carried out successfully to recheck that the OMP will perform satisfactorily (Andrews *et al* 2021).

Bycatch – Hake are reported to comprise 84% of the total catch in the fishery, and other species present in the catch, such as horse mackerel, are also commercially valuable and subject to catch limits to control fishing pressure as well as gear and effort restrictions, area closures and move-on rules. Horse mackerel is perhaps the most important species found in hake trawls in terms of energy flow through the ecosystem, and is incorporated into ecosystem modelling to account for removals through the hake fishery. Changes to catch limits and the proposal of new management measures in response to new information demonstrates that there are mechanisms for the modification of fishing activities in the light of identified risks.

Discards – A pilot of electronic monitoring (EM) was used to investigate discarding. This was successful in demonstrating the effectiveness of the technology and higher levels of monitoring coverage were achieved with the EM system than with a human observer (23% compared to 2% of fish catch monitored during one trip). An estimate of the discard rate in the South African demersal trawl fishery shows the average proportion of hake as less than 3%. To avoid juvenile fish, fishing is restricted to the 200–600 m depth zone to protect spawning grounds, there is a minimum mesh size, and a ban on discarding fish of marketable size. Observers on all registered trawl vessels ensure compliance with these measures.

ETP species – Previously seabird mortality was significant, and South Africa's National Plan of Action for reducing the incidental catch of seabirds was published in 2008. This plan requires vessels to use prescribed mitigation measures aimed at reducing seabird mortality to less than 0.05 birds/1000 hooks or 0.05 birds/trawl day per vessel. The fishing industry commissioned two dedicated seabird observers trained by BirdLife South Africa to work on commercial trawlers in the main fishing areas. Bird interactions with the offshore fleet were monitored and in 99% of interactions the birds were considered uninjured. Seabird bycatch reduction methods are now included in licence conditions for the use of tori lines, not using bitumen in trawl warp lubricants, and not discharging offal until tori lines are deployed. Installing tori lines led to a substantial decrease in seabird mortalities (Andrews *et al*, 2019). Since 2013 the observer programme has included observations of discarded species and bird interactions.

Stage 2

Spatial management – Spatial management relevant to fishing activity includes closed areas for spawning of key fish species in the region (kingklip) and a licence condition for trawlers to fish only within the historic footprint amounting to 4.4% of the EEZ (frozen trawl footprint or ringfence initiative) with monitoring in place to ensure that fishing is occurring in appropriate locations. The inshore trawl fleet are prohibited from fishing in nearshore protected areas designated as nursery grounds, areas of high diversity, and areas fished using lines.

A VME encounter protocol and move-on rule has been developed, requiring vessels to report encounters with VME indicator species at or above specified threshold limits which triggers the application of move-on rules. The mandate of fisheries observers includes validation of the VME reporting requirements and at-sea observer coverage levels are 10%. Information available to date demonstrates compliance with the prohibition of trawling inside MPA boundaries and with the ring-fenced trawl footprint. Identification posters have also been developed to facilitate recognition of VMEs at sea. A VME Task Team has been established and has met to consider the science, mapping and management of VMEs.

Technical measures - Trawlers are prohibited from using cod-end liners and cannot use bobbins, nylon rollers or other devices whatsoever, with a diameter in excess of 375 mm or a weight in excess of 200 kgs. The inshore fleet is restricted to vessels less than 30 m and is required to use lighter ground gear. Mesh size restrictions are in place, but vary depending on whether fishing is inshore (> 90 mm) or offshore (>110 mm). In practice the industry and observers report that inshore vessels all use 110 mm mesh cod-ends when fishing for hake.

Stage 3

Trophic level impacts – The main functions of the ecosystem components are known, and this knowledge has enabled ecosystem modelling to take place. This modelling has contributed to an understanding of the potential impacts of the hake fishery on other species. Ecosystem modelling continues to test and develop understanding of ecosystem dynamics, relationships between components, and the effects of fishery removals and climate change. Significantly increased trawling for hake is predicted to result in an increase in mesopelagic fish and cephalopods – the most important hake prey species. This may affect horse mackerel, which compete with hake prey species for food. Modelling has suggested that all groups would likely to return to their original levels within a period of 10-20 years after a period of intense fishing. Modelled communities and interactions show greater sensitivity to the combined effects of climate and fisheries removals than fisheries removals alone (Travers-Trolet *et al*. 2014).

B.3.5 Cross cutting components

Social and economic considerations – Social and economic objectives include the equitable redistribution of fishing rights. The hake TAC is split between different fishing sectors according to a predetermined allocation key: a proportion of the hake TAC is allocated to the horse mackerel fishery as a bycatch allowance, and the remaining directed catch of hake is allocated to the handline fishery (1.8%), longline fishery (6.5%), inshore trawl fishery (6.18%) and the offshore trawl fishery (83.9%). A further 1.5% is allocated to subsistence fishing.

The hake fishery provides direct employment for over 8,000 people, which nears 40% of the total direct employment in the South African fishing industry, and several studies have argued that the successful MSC certification of the fishery has contributed to the stability of these jobs (Lallemand *et al*, 2016).

Other consumer-driven initiatives include the South African sustainable Seafood Initiative (SASSI) which provides up-to-date scientifically-based information to encourage the purchase and consumption of sustainable fish species.

Illegal, Unreported and Unregulated fishing – DFFE inspect landings and audit catch, landings and processing records to ensure compliance with the TAC. Inspections are carried out both at sea and in landing ports, and all catches are inspected and weighed at off-loading points by fisheries inspectors. Skippers return logbooks from each trip, detailing fishing effort, catches, and sea-bird fatalities. The observer system is funded by the fleet and coverage currently averages around 10% coverage.

All fishing vessels are tracked in real time through DFFE Vessel Monitoring System (VMS), and records show that vessels have been fishing exclusively within the historic trawl footprint. VMS data also confirm that the fleet has complied with requirements for the protection of MPAs and VMEs. Relatively few offences have been detected, and most of these were for administrative errors resulting in a fine. DFFE has previously had significant enforcement successes (outside of the hake fishery) including detecting, apprehending and seizure of 10 IUU vessels, and intercepting, seizing and repatriating consignments of illegally shipped fish products (not hake).

Participatory approach – Stakeholder consultation takes place at various levels, including the Scientific and Resource Management working groups, in which industry associations play an active role. At these meetings, industry representative share up-to-date operational information, assist with decision-making by explaining economic and logistical matters affecting fleets, operations, and markets, and contribute to the development of mathematical models and the OMP. Decisions and recommendations made at the bimonthly meetings of these working groups are based on best available information and long-term policy.

Governance and Policy – A framework for cooperation between South Africa and Namibia is provided by the Benguela Current Convention (BCC), which was agreed between South Africa, Namibia and Angola in 2013. Under the BCC, South Africa and Namibia have been working together to achieve a better understanding of shared fish stock structure and dynamics. Both countries are signatories to UNCLOS and UNFSA, which explicitly requires Parties to adopt a precautionary approach to managing shared stocks and the marine environment.

In 2019, the Governments of South Africa and Namibia also signed a fisheries Memorandum of Understanding which outlined how they will establish a framework for further co-operation, including creating appropriate arrangements for the management of shared marine living resources, working together to develop stock assessments and management arrangements for shared stocks, as well as co-operating in strengthening joint patrols for monitoring, control and surveillance activities. With regard to research, this MoU states that specialised joint working groups should be formed for shared marine resources, and for carrying out surveys and biological analysis.

B.3.6 Process for implementation

South Africa has been committed to implementing EAFM for over a decade, and as early as 2006 the permit conditions for the hake fishery contained a specific 'ecosystem impacts of fishing' and reflected the first concrete step towards the implementation of EAFM. DFFE attributes the drive towards EAFM in the hake fishery to the MSC certification process and its requirements for continued improvements within the fishery that demonstrate best practice fisheries management. MSC certification has also provided substantial social and economic benefits to the fishery through enabling access to international markets that are increasingly demanding that seafood products are MSC certified. Recent economic studies have indicated that withdrawal of MSC certification of the South African hake trawl fishery would decrease the net present value of the fishery by about 35% over a five-year period, and result in a potential loss of up to 13,600 jobs. Certification has contributed to a number of environmental improvements to fishery management, including reduced habitat and ETP impacts and precautionary bycatch management measures (DEFF 2020).

The success of the MSC framework in improving the sustainability of the hake fishery led other South African fisheries to participate in Fishery Improvement Projects, which use the MSC framework as guidance to improve the sustainability of the fishery.

B.3.7 Summary of progress towards delivering Target 5 of the GBF

In 2020, DFFE published a report on the status of its marine fishery resources which indicated that of the 61 species with stock assessments in South Africa, the status of 37 (61%) were not of concern. This is an increase from 52% in 2016, indicating that stocks are trending in the right direction through the use of OMPs and rebuilding plans. The plans determine appropriate harvest rates to ensure management is adaptive to the state of the stock and mitigates against overfishing. The models also account for bycatch and other ecosystem aspects to ensure management is in place to minimise the impacts of the fishery. Research continues to improve management, which has been adjusted when new information arises to support the conservation of important species and habitats. The fishing industry plays an important role in managing the resources and representatives are present in various working groups to provide input on both science and management. Studies on aspects of EAFM, including habitat impacts and climate change, will contribute to future assessment models to ensure resilient and long-term sustainability of the marine resources both in South Africa and its neighbouring countries.

B.4 Case Study: New Zealand deepwater orange roughy trawl fishery

B.4.1 Background

The species comprising the majority of New Zealand's landings are from deepwater fisheries, and include hoki, ling, oreo dory, hake, and orange roughy (FAO, 2024). New Zealand boasts one of the oldest and largest orange roughy fisheries worldwide, which began in the late 1970s in Chatham Rise. The orange roughy has a lifespan recorded up to 180 years (Doonan *et al.*, 2018), however it was initially believed to be a fast-growing, highly productive target species (Hilborn *et al.*, 2006). Consequently, overfishing meant catches peaked in the late 1980s, and in the early 1990s scientists realised the species was less productive than originally believed, and action was needed to allow stock recovery.

Catch limits were enforced and reduced, and several fisheries closed, reducing catch as biomass levels were fished down to target levels. Following these management interventions, three roughy fisheries (73% of harvest) have now been MSC certified (Punt *et al.*, 2022). For the fishing period 2022-2023, the Total Allowable Catch (TAC) for orange roughy in Quota Management Area (QMA) 7A was 2,058 tonnes, and in QMA 3B, was 1,150 tonnes. These fisheries are of great economic importance to New Zealand; in 2022, 3,073 tonnes (processed weight) of orange roughy were exported, with a Free on Board (FOB) value at 49 million NZD (FNZ, 2023).

While EAFM isn't explicitly mentioned in New Zealand's national policies, its components are incorporated throughout legislation, from the Fisheries Act of 1996, to the latest Fisheries Change Programme. These initiatives strengthen fishery management for better transparency and understanding of marine resource use. For the orange roughy fishery, EAFM is evident in the comprehensive stock management practices, in terms of surveys that monitor spawning biomass and environmental parameters, efforts to rebuild depleted stock, and adaptive management that is highly responsive to stock fluctuations. Additionally, the specific fishery management plans account for the species' long lifespan and slow growth rates, and the integration of stakeholder input and customary fishing rights to ensure both ecological sustainability and social and economic benefits. New Zealand demonstrates a commitment to indigenous rights through active stakeholder engagement and the recognition of customary fishing rights, balancing ecological sustainability with social and economic factors to implement an EAFM.

B.4.2 Key legislation

National policies:

- Fisheries Act 1996
- Quota-Management System (QMS) 1986
- Fisheries Change Programme: Introduced in phases, commencing in 2017
- Harvest Strategy Standard (HSS) 2008
- National Fisheries Plan for Deepwater and Middle-depth Fisheries 2010
- Fisheries Act 1996, Wildlife Act 1953, and Marine Mammals Protection Act 1978
- National Plan of Action (NPOA) for sharks (FNZ, 2013, draft 2022) and seabirds (FNZ, 2020b)
- Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean 2012
- Te Mana o te Taiao – Aotearoa New Zealand Biodiversity Strategy 2020

B.4.3 Description of fishery management measures

Fisheries New Zealand is responsible for implementing management measures based on scientific research and industry collaboration, and for accurate data collection to manage fisheries effectively. The main approach to management is through the Quota Management System (QMS) which currently manages 98 species (642 stocks). The QMS includes:

- Individual Transferable Quotas (ITQs), where quota owners receive an Annual Catch Entitlement (ACE), based on an allocated quota per specific fish stock.
- The Total Allowable Commercial Catch (TACC) is set annually, determining maximum allowable catch for commercial fishing, keeping stocks at sustainable levels.
- The QMS divides management into Quota Management Areas (QMAs) for local species to management with direct control of harvest levels, for oversight on species population sizes, ensuring stock and resource sustainability.
- QMS system aided implementation of science-based practices to fishery management, setting TACs for species based on scientific stock assessments and encouraging sustainable fishing by allocating quotas to prevent overfishing and promoting stock health.

B.4.4 Progress against EAFM components

Stage 1

Sustainable fisheries – The HSS uses four performance measures to evaluate stock status: hard limit (10% unexploited biomass), soft limit (20% unexploited biomass), management targets, and overfishing threshold. These measures aim to reduce exploitation rates by triggering management actions, such as adjusting TACs, closing fisheries, or implementing gear restrictions, when limits are reached. As of December 2023, 87.5% of all New Zealand stocks were above the soft limit, demonstrating effective mitigation of sustainability risks (Fisheries New Zealand, 2023). The orange roughy fishery made significant progress in its sustainable practices through its QMS system, which sets TACs based on scientific assessments and resultingly, the previously overfished stocks were able to return to sustainable levels.

New Zealand's stock assessments rely on data from electronic reporting, video observation, on-board cameras, and scientific observers. Fisheries New Zealand's Fishery Assessment Working Groups evaluate stock status annually using latest data, and adjust TACs and Total Allowable Commercial Catch (TACCs) accordingly to align fishing practices with sustainability goals. The models generated vary from simple models to estimate population biomass, to considering age and length structure in spatially explicit zones. Catch-at-Age Stock Assessment Models (CASAL) is a leading framework used in assessing New Zealand's fishery stocks, including deepwater species such as orange roughy[54] that utilises single-species analytical models (Dunn *et al*., 2022).

Orange roughy stocks have fluctuated over time, and more recently the East and South Chatham Rise stocks faced a precautionary catch limit reduction and self-suspension of its MSC certificate due to recent stock data collection and analysis issues (Stern-Pirlot & Punt, 2023). The 2023 sub-stock characterisation showed commercial fishery survey estimates of spawning biomass were inconsistent with 2020 biomass and trend estimates (FNZ, 2023), with the 2020 assessment showing the stock was increasing and within the target zone, and actual data indicating declining trends in CPUE and SSB, i.e. potential local abundance declines. The 2020 assessment model was re-evaluated and the need for a new model was highlighted. The identification of stock discrepancies and subsequent actions taken, due to constant monitoring and reviewing of data, reflect successful science-based adaptive management with a precautionary approach preventing overfishing of the stock.

Bycatch – Orange roughy comprises 83% of the catch, and bycatch and discards have been regularly estimated since 1998 (Punt *et al*., 2022). All species are managed under the same QMS, and the TAC for each species is tradable, allowing fishers to access the necessary quota to cover their landings. There are no Minimum Landing Sizes (MLS) for these species, but bycatch reduction techniques such as selective gear and avoidance of certain fishing grounds are employed to minimize unwanted catch. While bycatch can include a range of species, they are all caught in very low quantities (Punt *et al*., 2022). Discarding QMS species without authorisation invokes strict penalties, reducing motives to discard.

ETP species – The orange roughy trawl fishery has been deemed low-risk with regard to captures and interactions with ETP species of seabirds, marine mammals and sharks (Punt *et al*., 2022). Vessels are required by law to report all ETP species captures to the MPI[55], who summarise this information in their Aquatic Environment and Biodiversity Annual Review report. Additionally, the DWG employs an Environmental Liaison Officer (ELO) for deepwater fishery vessels, providing training on ETP mitigation techniques, best practices, and check vessel management plans (FNZ, 2020a). These techniques and best practices include: bycatch reduction devices, bird deterrents, avoiding areas known to have high areas of ETP species, adhering to reporting requirements for ETP interactions, engaging in monitoring and research to mitigate fishery impacts on ETPs. Vessels are equipped with training materials on best practice environmental operations and procedures, and seabird mitigation gear is checked for functionality, ensuring crew and officers are aware of its need and use.

Stage 2

Spatial management – Spatial management is key to the orange roughy and trawl fisheries. Trawling is prohibited in seamount areas through the establishment of Benthic Protected Areas (BPAs) and Seamount Closure Areas (SCAs), both of which are recognised as MPAs (Punt *et al*., 2022). Large areas of the seabed are closed to bottom trawling, minimising gear contact with vulnerable benthic

[54] NIWA https://niwa.co.nz/fisheries. Accessed 22 July 2024
[55] MPI https://www.mpi.govt.nz/fishing-aquaculture/ Accessed 22 July 2024

ecosystems. This includes the establishment of protection areas. In 2007, with support from the fishing sector, New Zealand closed 1.1 million km^2 (30%) of its waters to bottom trawling. Annually less than 0.03% of New Zealand's Exclusive Economic Zone is trawled for orange roughy and fishers return to the same areas each year in order to limit the size of their fishing footprint (MSC 2024).

Technical measures – Mandatory use of electronic catch data and vessel position reporting enhance reliability and transparency of fisheries-specific data. On-board cameras will cover 85% of the total catch by volume for inshore fisheries by 2025, improving monitoring and verification of fishing practices, and ensuring fishing activities are conducted sustainably and with minimal environmental impact.

Regarding the orange roughy fishery, deepwater trawling methods are used, and gear has been modified to increase accuracy on fish aggregations and reduce seabed contact and interactions, minimising potential seabed damage. These modifications include the use of precise sonar and acoustic technologies to detect and target dense schools of orange roughy while avoiding bycatch species, such as net sounders and headline sensors, which monitor net opening, net position relative to the seabed, and aid accurate acoustic fish targeting. Additionally, the design of trawl nets has been optimized to reduce contact with the seabed and minimize habitat disturbance, such as equipping the net headropes with hard floats, to provide adequate buoyancy (Punt *et al*., 2022).

Stage 3

Trophic level impacts – The management framework in place highlights ecosystem balance and ways to mitigate fishing effects upon the broader marine food web. These include conducting regular scientific assessments to understand trophic interactions and adjust management strategies accordingly, incorporating an EAFM that consider the cumulative impacts of fishing on the entire ecosystem and; management approaches that mitigate potential impacts by adjusting fishing quotas based on ecosystem models. These in combination help to understand and mitigate trophic-level impacts.

B.4.5 Cross cutting components

Social and economic considerations – The needs of commercial and recreational fishers are balanced through the QMS system, providing flexibility in how quotas are used across sectors. The comprehensive consultation process includes industry representatives, recreational fishing groups, indigenous communities, and NGOs, ensuring distribution of benefits and costs is shared equally amongst stakeholders. Indigenous customary fishing rights (tangata whenua) are given special consideration, and the Māori Fisheries Act 2004 and subsequent regulations recognize the customary use and management of fisheries, allowing Māori to exercise traditional fishing practices sustainably. These measures ensure that the social, economic and cultural values of all stakeholders are respected and integrated into fisheries management.

Customary sustainable use – The major focus for management is on the amount of fish harvested by the commercial fishing industry so that there are sufficient fish available for non-commercial uses and for the conservation of the resource. The needs of recreational fishers and Maori interests are provided for before commercial quota levels are set. Within the commercial catch limit, access is determined by ownership of quota and ownership of Annual Catch Entitlement (ACE). The QMS is also being used in dealing with Maori claims to commercial fisheries in general. The Government has purchased quota and transferred it to the Te Ohu Kai Moana (TOKM, Treaty of Waitangi Fisheries Commission) in recognition of Maori rights to the commercial fishery. TOKM distributes quota to iwi (Maori tribes). When the initial species were introduced into the QMS, 10% was given to Maori, and 20% of commercial quotas of all new species now brought into the QMS are given to the TOKM to distribute (Akroyd *et al* 2012).

Illegal, Unreported and Unregulated fishing – New Zealand fosters transparent fishery monitoring and the orange roughy fishery management system has mandated VMS and automatic location communicator (ACL), government observer schemes, and accurate catch recording to ensure the ACE are not exceeded. The Fisheries Change Programme further strengthened management through three main initiatives:

1. mandating electronic catch data and vessel position reporting in all commercial fisheries;
2. reviewing fishing policies to improve fairness and responsiveness, incentivising better fishing practices; and
3. Improving fishery monitoring and verification through on-board cameras. Introduced in 2019 for vessels in Maui dolphin habitats, in 2023 a 68 million NZD investment[56] in on-board cameras will fund 300 commercial vessels, covering 85% of the inshore fisheries catch by volume to improve transparency and accountability (Fisheries New Zealand, 2022).

The management strategy incorporates cross cutting components, and compliance models such as the VADE (Voluntary, Assisted, Directed, Enforced) framework (Fisheries New Zealand, 2019). The MPI's VADE model promotes voluntary compliance through using education as a core tool, followed assisted compliance through monitoring and feedback, directed compliance using warnings or sanctions, and lastly enforced compliance which applies the full extent of the law. If convicted for IUU fishing, the Fisheries Act enforces sanctions dealing with non-compliance, including prison, fines up to 500,000 NZD, and quota, vessel and/or property forfeiture. This creates an incentivised environment where risks of non-compliance outweigh potential advantages of IUU fishing.

Participatory approach – New Zealand has become a leader in sustainable fishery management, applying a multi-faceted ecosystem approach. Underpinning the country's ecosystem approach is its fishery management framework, which stems from an inclusive government that utilises stakeholders at the core of its evidence-based decision-making processes, through encouraging knowledge-sharing and maximising stakeholder input. An important aspect of this is the involvement of both the Māori and the Crown, which together identify appropriate stakeholders and, with expert advice, regulate fishing activities in their respected jurisdictions. A co-management approach is in place, encouraging collaboration between Deepwater Council quota holders and Fisheries New Zealand[57,58], through regular consultations and workshops to discuss management measures, share expertise, and report monitoring activities. These collaborative efforts ensure management strategies are implemented effectively and that all parties are incentivised to comply with legal requirements.

The management system provides an incentive for industry organisations to be involved, and the New Zealand fishing industry funds scientific research and monitoring, encouraging individual fishers to attend scientific working groups as they directly benefit from the results. This strengthens management and facilitates an ecosystem-based approach, which requires knowledge of ecosystem functioning by the fishers, and highlights the importance of data collection to address data gaps. With regards to the orange roughy fishery, quota owners represented by Deepwater Council established Trident Systems, to lead research for sustainable fishery management by collaborating with independent research providers to collect data, evaluate and implement fishery management.

National Fisheries Plan for Deepwater Fisheries (Ministry for Primary Industries, 2017) involves input from diverse stakeholders, including industry representatives, tangata whenua (Māori communities), environmental organisations, and government agencies, to ensure economic and environment

56 MPI https://www.mpi.govt.nz/fishing-aquaculture/commercial-fishing/fisheries-change-programme/on-board-cameras-for-commercial-fishing-vessels/ Accessed 22 July 2024

57 Deepwater Council https://deepwatergroup.org/management/ Accessed 22 July 2024

58 Deepwater Council https://deepwater.co.nz/wp-content/uploads/2013/03/Memorandum-of-Understanding-DWG-MPI.pdf Accessed 22 July 2024

sustainability throughout New Zealand's fisheries, and more broadly aligning with the Fisheries 2030 strategy (Māori Crown Relations Unit, 2018). The orange roughy fishery is managed under this framework which regulates fishing to minimise bottom-trawling impacts on the benthos.

B.4.6 Process for implementation

The orange roughy fishery was believed to be sustainable in the 1970s, and the main goal of fishery management was to maximise sustainable yield, preventing overfishing through catch limits. The prioritisation of scientific assessments and evidence-backed decision making, were key in realising the declining population health of this species. Once assessed and realised in the 1990s that the orange roughy population was decreasing, corrective actions were already identified to allow stock recovery. TACs based on the QMS were enforced and several fisheries closed, and continual scientific assessments meant quotas could keep being adjusted accordingly. As scientific research progressed, so did the need to focus fishery management beyond the target stock, taking into account broader ecological impacts of habitats, bycatch, and ETP species. The Fisheries Act 1996 and subsequent policies began to reflect the importance of protecting the marine environment. The Act explicitly requires the avoidance, remediation, or mitigation of adverse effects on the aquatic environment, incorporating ecosystem approaches to fishery management. Moreover, the National Fisheries Plans have also since incorporated EAFM, explicitly addressing biodiversity alongside sustainable fishing practices.

New Zealand’s comprehensive regulatory framework and rigorous enforcement measures ensure high compliance and sustainable practices. New Zealand’s early adoption of electronic reporting and on-board cameras has set a high standard for transparency and accountability, demonstrated by the transparent record keeping which tracks sanctions and penalties imposed on individuals or companies in breach of regulations. Furthermore, regular and robust scientific assessments underpin New Zealand’s fisheries management, allowing for adaptive and responsive quota adjustments.

B.4.7 Summary of progress towards delivering Target 5 of the GBF

Regarding the SDG indicator 14.4.1, data for New Zealand only exists for 2018, when 82.61% of assessed stocks were within biologically sustainable levels[59]. The orange roughy stocks have been managed under a QMS since the 1980s, setting TACs to manage harvest, and adjusting quotas based on scientific information. The distinction of different orange roughy fisheries allows management strategies to be tailored to consider the specific ecosystem requirements and stocks associated with each fishery. Regular stock assessments are conducted using new technologies such as acoustic surveys to monitor fish populations. Furthermore, large areas of the seabed are closed to bottom trawling to protect the benthos from interactions with the fishing gear. Effective monitoring and compliance is key to ensure this all takes place, and trawlers are required to report catches electronically, with cameras being installed to further support and verify this data, as well as the use of observers on vessels. To coordinate and implement this, the orange roughy fishery management requires input from fishers, scientists, environmental organisations, and commercial stakeholders, and monitoring initiatives are funded by government and industry levies.

59 FAO SDG Indicator Portal. https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/1441-fish-stocks-sustainability/en Accessed 22 July 2024

B.5 Case Study: Canadian Pacific halibut longline fishery

B.5.1 Background

In 2021, Canada was the 28th largest fishing nation, landing 745,505 tonnes of fish (nearly 1% of global landings) (FAO 2022). Approximately 72,000 people make their living directly from fishing and related activities, and in 2021, the country's commercial marine fisheries were valued at $4.6 billion.

The British Colombia (BC) groundfish fishery has a long history of fishing activity covering multiple gears and over a hundred species, including Halibut, Sablefish, Rockfish, Sole, Pacific Cod, Pacific hake, and Pollock, and makes up close to 20% of Canadian fish landings. The groundfish industry is vital to the social and economic well-being of BC, providing hundreds of harvesting and processing jobs to rural coastal communities. Pacific halibut fishing is an important part of several tribal cultures and their ongoing access rights have been established through legislation and the subsequent approach to fisheries management. The stock extends along the west coast of Canada and the United States, and the multi-jurisdictional nature of the fishery resulted in the formation of the International Pacific Halibut Commission (IPHC), which is responsible for management of the fishery. Longlining is the main commercial gear used to target halibut, although there is some allowance for incidental catch in other commercial fisheries.

Fisheries and Oceans Canada (DFO) is moving away from single species fisheries management and towards an ecosystem approach to fisheries science and management. In 2023, DFO received a recommendation from the House of Commons Standing Committee on Fisheries and Oceans to speed up the implementation of EAFM in Canada given the impacts of climate change (DFO 2023).

B.5.2 Key legislation

National legislation for fisheries includes:

- The Fisheries Act (2019) is the primary piece of Canadian federal legislation relating to the management of fisheries in Canada.
- The Aboriginal Communal Fishing Licences Regulations (1993).
- Canada's Oceans Act (1996) and Ocean Strategy (2002) require fisheries management to move toward the overarching objective of ecosystem-based management.
- The Species at Risk Act.
- The Coastal Fisheries Protection Act.
- Pacific halibut stocks are managed under International Pacific Halibut Commission (IPHC), and in Canada through the Groundfish Integrated Fisheries Management Plan[60] (GIFMP). The GIFMP specifies an ecosystem-based approach to management and data collection.

In addition to these legislative and regulatory tools, DFO's Sustainable Fisheries Framework[61] provides the basis for ensuring that Canadian fisheries support conservation and sustainable use of resources. The framework includes the use of a precautionary approach to fisheries management and provides the basis for implementing EAFM.

60 GIFMP Pacific Region integrated fisheries management plan, groundfish, effective February 21, 2024 (dfo-mpo.gc.ca)
61 DFO Sustainable fisheries framework (dfo-mpo.gc.ca)

B.5.3 Description of fishery management measures

The Pacific halibut fishery is managed through the IPHC Halibut Catch Sharing Plan[62], a framework that dictates how the total allowable catch will be divided across management zones annually. IPHC regulations cover:

- Vessel licences
- In-season management changes
- Fishing periods, closed periods, closed area
- Commercial catch limits
- Size limits (32-inch minimum size)
- Logbook requirements and supervision of unloading and weighing
- Aboriginal groups fishing for food, social and ceremonial purposes in British Columbia

The IPHC has a pre-agreed harvest control rule that guides management decisions based on stock trends. Currently the harvest strategy for Pacific halibut is based on target and limit reference points, below which fishing intensity is reduced or halted to maintain stock biomass.

Management by IPHC is incorporated into Canada's Groundfish Integrated Fisheries Management Plan (GIFMP) to ensure a coordinated approach to managing the mixed groundfish fishery. Within Canadian waters, the following management measures are in place:

- Limited entry licence system
- ITQ system with specific TACs for most species of groundfish the fishery
- Quota flexibility to cover catch of non-target species
- Mesh size restrictions for the trawl nets to reduce the harvest of small fish
- Seasonal closures (Dec – Mar)
- 100% at-sea monitoring that includes GPS tracking and 100% dockside monitoring
- Closed areas to protect certain species and benthic habitats
- Prohibition on retention of halibut by non-licensed vessels.

B.5.4 Progress against EAFM components

Stage 1

Sustainable fisheries - The IPHC conducts an annual stock assessment for halibut, covering the Exclusive Economic Zones of Canada and the United States. The stock assessment combines long time-series models, reconstructing historical dynamics back to the beginning of the modern fishery, and short time-series models incorporating more comprehensive data from 1992 onwards (Valle *et al* 2024). Since 2013, the Pacific halibut fishery has been assessed using a Management Strategy Evaluation (MSE) to assess how alternative harvest strategies perform given a set of pre-defined fishery objectives to determine how likely management measures are to achieve their objectives (Valle *et al* 2024).

A large amount of information is collected on Pacific halibut each year from commercial fisheries, recreational fisheries and scientific surveys. The IPHC tracks total mortality (target commercial fishery landings, discards and research), recreational and subsistence fisheries activity in both the US and Canada. Each year a fishery-independent set line survey collects information on size/age composition, relative abundance, growth information, and spatial distribution (Valle *et al* 2024). DFO conduct routine data collection and compilation including data from observer and electronic logs; biological and environmental data from at-sea research surveys and dockside sampling.

62 IPHC Background – Basic Texts - IPHC

Discards – Only vessels with licences to capture Pacific halibut using longlines may land them. Vessels targeting groundfish using other gear are not permitted to keep halibut and are managed using a total halibut bycatch mortality cap and individual vessel bycatch quotas. If Pacific halibut are returned to the sea carefully then post-release survival rates are assumed to be 84%, and all halibut bycatch mortalities in the groundfish trawl sector must be recorded. In many areas, observers work onboard groundfish vessels and gather information regarding the amount of Pacific halibut incidentally caught and the condition of those Pacific halibut at release. From this, the IPHC calculates the total amount of Pacific halibut caught and discarded, and the discard mortality rate. Since the implementation of Individual Fishing Quotas (IFQs) for Halibut, discards averaged 3.1% of the directed catch, and have been decreasing.

Ghost gear - The Ghost Gear Fund is a federally funded program led by Fisheries and Oceans Canada, intended to support Canada's commitment to preventing and mitigating the risk of ghost fishing and encouraging sustainable fishing practices. Many of the projects supported by the Ghost Gear Fund focus on increasing Canada's recycling capacity for end-of-life fishing gear and identifying and removing ghost gear from BC. In 2020, a recycling depot was built to turn ghost gear plastic into plastic pellets that will be used in manufacturing plastic products, including kayaks. In 2021, DFO launched the new Fishing Gear Reporting System, which allows fishermen to input a description of their lost gear, the cause of loss and its location from any online device. The information is used to guide retrieval efforts and inform analyses of the ghost gear issue in Canada. Training sessions are provided to ensure that users fully understand the tool.

ETP species - Canadian waters are home to many species of birds, cetaceans and sharks that are considered ETP species, and protected under national and international legislation. In 2007, Canada released a National Plan of Action to reduce the bycatch of seabirds in longline fisheries, and the use of streamer lines became a mandatory licence condition in commercial Pacific halibut fisheries (Valle *et al* 2024). Canada has a 'fins naturally attached' (FNA) policy, as well as an import and export ban on shark fins. Shark finning and the retention of sharks, other than spiny dogfish, is prohibited and electronic monitoring data shows that compliance with the non-retention policy on sharks in the halibut fishery is high. External validation of this is done through 100% at-sea and dockside monitoring.

In 2019, measures were implemented to reduce the threat of fisheries to the orca population. Management includes fishing closures and Interim Sanctuary Zones in key orca foraging areas, as well as vessel approach distance requiring fishers to voluntarily stop fishing within 1000 m of orcas.

Stage 2

Spatial management – Although the groundfish fishery operates year-round, the harvest season for Pacific halibut does not take place during the winter months to protect the spawning process. Fishing seasons are also dependent on the conditions of target species – opening when the quality of the fish is the highest to optimise profitability (BC Seafood Alliance 2024).

DFO manages the groundfish fisheries under the Sustainable Fisheries Framework Habitat Policy, which sets out a process to assemble existing data and conduct an Ecological Risk Assessment Framework (ERAF) to determine the risk level that fishing activity is likely to cause harm to the benthic habitats. DFO has demonstrated an active and adaptive approach to habitat protection in the trawl fishery which has move-on-rules to help to minimise impacts on any areas of coral/sponge aggregations that had not been previously identified (BC Seafood Alliance 2024).

Stage 3

Mixed fishery management - Under GIFMP, the commercial groundfish sectors are considered distinct fisheries but are managed in an integrated manner so that all mortality of 'directed species' and 'retained species' that are managed with a TAC must be accounted for. This requires licence holders to reallocate ITQs between vessels to cover all mortalities, regardless of whether the catch is kept, utilised at sea, or released at sea (Valle *et al* 2024).

B.5.5 Cross cutting components

Climate change - In 2018, Canada initiated a Peer Review Process to develop a Framework for Incorporating Climate Change Considerations into Fisheries Stocks. The results of this process informed the launch of their Ecosystems Approach to Fisheries Management work which aims for the systematic integration of climate change, oceanographic and ecological data and fish stock vulnerability information into stock assessment advice in order to enable climate-ready decision-making in fisheries resource management.

Social and economic considerations - Sustainable fisheries are an essential part of the Canadian economy, providing food and jobs to thousands of people. The GIFMP contains an overview of the social and economic considerations of the fishery, including consideration of indigenous, recreational and commercial fisheries, although it notes that there is a lack of information available on the social significance of the fishery. The Canadian Government has a report on Good Practice on Social Impact Assessment, which includes the fishing sector.

The IPHC also conducts economic analyses of the halibut fishery, considering direct, indirect and induced economic impacts. In 2022, an assessment of the entire halibut value chain from hook to plate was undertaken and a model developed to help understand the wider economic impacts across the entire stock area.

Customary sustainable use - The Constitution Act, the Aboriginal Fisheries Strategy and the Sparrow Decision recognise the rights of First Nations to access fishing resources. The Supreme Court found that where an Aboriginal group has a right to fish for Food, Social, and Ceremonial (FSC) purposes, it takes priority, after conservation, over other uses of the resource.

Commercial halibut opportunities for First Nations are provided through DFO's Aboriginal Fisheries Strategy Allocation Transfer Program (ATP) and the Pacific Integrated Commercial Fisheries Initiative (PICFI). Commercial fishing licences and/or individual quotas are voluntarily retired via market-based transfers from the commercial fishery then re-issued to First Nations as a communal commercial licence. This has increased First Nations participation in the commercial fisheries without adding to existing fishing effort. In 2024, 92 of the 435 commercial halibut licence eligibilities (21%) are designated as communal commercial (Valle *et al* 2024).

The Government of Canada and the scientific community acknowledge the need incorporate Indigenous knowledge in meaningful and respectful ways. The Fisheries Act, Species At Risk Act and the Oceans Act include provisions to consider Indigenous knowledge in decision making. The trilateral partnership of the Government of Canada, the Province of BC and 17 First Nations are working together to gather information and data relevant to a marine spatial planning process in southern BC.

Illegal, Unreported and Unregulated fishing - Canada has been engaged in the development of guidance, best practices, and recommendations to support efforts to curb IUU fishing and promote sustainable fisheries management, such as the FAO Voluntary Guidelines on Transshipment.

In 2021, amendments were made to the Coastal Fisheries Protection Regulations which now enable DFO fishery officers to actively participate in high seas boarding inspections in the North Pacific Fisheries Commission Convention areas, and enforce all measures adopted by the Commissions. Canada supported the development of the Dark Vessel Detection platform and Remotely Piloted Air Surveillance platforms to support developing states in their efforts to combat IUU fishing globally. Canada leads the Pacific Fisheries Intelligence Group (PACFIG), dedicated to the sharing of best practices, lessons learned, and intelligence as a means of combatting IUU fishing in the Pacific Ocean.

In Canada, vessels must complete a DFO-approved catch harvest logbook that documents catch by species and all fishing details, including the set and haul date, time, location, and gear type. Comprehensive at-sea monitoring (100% coverage) is accomplished through remote electronic monitoring and an at-sea observer programme to verify and record the catch by species (retained and released). Data from the system is used to audit logbooks to ensure that catch is accurately represented.

Science and the precautionary approach - The Sustainable Fisheries Framework provides the foundation of an ecosystem-based and precautionary approach to fisheries management in Canada. It contains a general fishery decision-making framework for implementing a harvest strategy that incorporates the precautionary approach (PA policy). The PA policy sets out guidance on stock-specific reference points and a cap on fishing mortality at the MSY level when the stock is healthy and is scaled down to prevent stocks reaching a critical level. The PA policy also calls for adoption of a rebuilding plan if a stock reaches the critical level (Valle *et al* 2024).

Governance - The Pacific halibut stock is considered a shared stock and is managed under the IPHC between Canada and the United States. The IPHC conducts stock assessments, sets fishing regulations, including gear type, size limits, quotas by management area, opening and closing of seasons and international allocation (IPHC, 2022). Internal and external review of management measures are undertaken and an independent contractor assesses the IPHC practices, tracks effectiveness, and gauges the need for revised approaches. IPHC also has the Scientific Review Board (SRB) to provide an independent scientific review of science, and support and strengthen the stock assessment process.

In Canada, the GIFMP describes how binding regulations under the Fisheries Act, Oceans Act, Species At Risk Act, and Coastal Fisheries Protection Act work together to achieve the specified management objectives (Valle *et al* 2024).

B.5.6 Process for implementation

In 2019, DFO initiated a national EAFM initiative and established a working group (WG) to develop a national framework for the implementation of EAFM. The WG was multisectoral, including members from science, fisheries management, and policy and economics sectors. Its goals were to advance the integration of climate, oceanographic, and ecological variables into single-species stock assessments and scientific advice, thereby supporting the further implementation of EAFM; and to identify practical steps to advance the longer-term goal of ecosystem-based fisheries management (EBFM). To better understand how EAFM is being implemented across the country, highlight opportunities, and understand strengths and challenges, the WG identified case studies that evaluate how ecosystem change is being incorporated into science and fisheries management. Case studies highlighted the importance of a structured and continued level of collaboration among DFO sectors.

B.5.7 Summary of progress towards delivering Target 5 of the GBF

In 2021, reporting on SDG 14.4 indicated that 92% of Canadian fish stocks were within biologically sustainable limits (DFO 2021). The Pacific halibut fishery in Canadian waters has been MSC certified since 2009, demonstrating the long-term commitment to sustainability. The fishery is underpinned by national and international policies designed to ensure sustainable harvest while mitigating the impacts of fishing activity on the wider ecosystem. The potential for overfishing is managed through multiple measures that work together across the mixed fishery to prevent overexploitation, and clear harvest control rules are in place that are designed to react to decreasing stock biomass, along with rebuilding plans for species that require them. The flexibility of the TAC system allows quota trading to ensure that fish bycatch is minimal, and measures are in place to reduce impacts on ETP species and habitats. The use of electronic monitoring and at-sea and dockside observers ensures compliance with these policies. The use of science, the precautionary approach and participatory processes in management and decision making contribute further to deliver policies that balance social, economic and environmental objectives. Indigenous knowledge and rights are legislated for, and there is an understanding of the value this contributes to the sustainability of the fishery and the wider ecosystems, and First Nations fishing for FSC are prioritised above all objectives other than conservation.

The DFO website states '*Incorporating ecosystem information into fisheries management decision making has long been a goal of the department. Continuing research in ecosystem and fisheries science, and with considerations gathered from Indigenous groups and stakeholders, we aim to fully utilize existing ecosystem information, as well as collect new information, to improve the advice informing fisheries management decisions. This will result in a more holistic fisheries management approach … Canada's 2030 National Biodiversity Strategy will chart a path for how Canada will implement the GBF.*'

B.6 Case Study: Territorial User Right Fisheries (TURFs) in Belize

B.6.1 Background

Belize has one of the largest coral reef ecosystems, the Mesoamerican barrier reef which contains more than 500 species of finfish and invertebrates (Kleisner *et al* 2022). The fishing sector is one of the most valuable industries employing around 3,000 people who are engaged in small-scale fishing, processing and marketing. The main valuable commercial species landed are the Caribbean spiny lobster (*Panulirus argus*) and queen conch (*Lobatus gigas*). However, other species are also targeted for commercial and domestic consumption including groupers, snappers, grunts, mackerel and barracuda (FAO 2021). These fisheries have been heavily exploited (Fujita *et al*., 2017). Indeed, overfishing has led to species like Nassau grouper (*Epinephelus striatus*) and goliath grouper (*Epinephelus itajarra),* which aggregate to spawn, being listed as critically endangered on the IUCN Red List (Kleisner *et al* 2022). Fishing primarily takes place in the shallow lagoon area between land and the reef using small open boats with outboard engines, sailing sloops, and canoes. Fishers usually free dive or fish using hand lines, hook sticks, lobster traps, and shades or casitas (Martinez *et al* 2018). In 2010, Belize became one of the first countries in the world to institute a complete and permanent ban on trawling in all its waters (Oceana 2011).

To address the challenges of open access fishing, Belize implemented a rights-based fishery (RBF) management strategy in 2016, known as Managed Access, issuing tenure rights to customary fishers in nine distinct fishing zones in its territorial waters. The aim is to prevent overfishing, promote sustainable fisheries and restore depleted stocks. Belize is the only small Island developing state (SIDS) that has implemented a country-wide territorial user right fisheries (TURFs) addressing multiple species in all its territorial waters (Bowman *et al* 2021). In 2020, Belize adopted the Fisheries Resources Act, which sets out a framework for fisheries management based on the ecosystem approach to fisheries management (EAFM), application of the precautionary principle and effective enforcement (GoB 2020).

B.6.2 Key legislation

Regional agreements:

- Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region

National policies:

- Fisheries Act (1948)
- Coastal Zone Management Act
- Environmental Protection Act
- Wildlife Protection Act
- National Parks System Act
- Aquaculture Development Act
- Fisheries Resources Act (2020[63]) – states that "[*a]n ecosystem approach shall be applied widely*
- *to the conservation and management of aquatic resources'*

The Fisheries Resources Act sets out rules for the '*long-term conservation, management and sustainable use of fisheries resources of Belize through best practices, protection of the marine environment, biodiversity conservation, ecosystem preservation, prevention of overfishing, the establishment of effective data collection systems, strengthened governance and effective enforcement of and compliance with conservation measures, and improvement of the welfare and livelihoods of fishers and fishing communities. The Act sets forth provisions on the determination of total allowable catch, the development of fisheries management plans, the designation of fishing priority areas, the determination of species requiring special measures, active participation of all stakeholders, port state measures to fight against IUU fishing and prohibited fishing gear and methods*'.

B.6.3 Description of fishery management measures

Belize fisheries are managed using different regulatory instruments to address overfishing and unsustainable fishing practices such as marine protected areas (MPAs), gear restrictions and closed seasons. Prior to 2016, fisheries in Belize operated under an open access regime. From 2016 onwards, Belize rolled out the Managed Access initiative by issuing tenure rights to the fishers within nine distinct fishing zones. The key aspects of Managed Access are:

- Implementation of a national system of nine TURFs with strong involvement from fishers
- Establishment of total allowable catch limits based on scientific information and incorporating an adaptive management approach; and
- Use of financial initiatives to ensure stakeholders capture better revenues through premium markets and the strengthening of cooperatives.

Central to the Managed Access initiative is improved stewardship of fisheries management by fishers, and therefore key behavioural changes were developed in consultation with the fishers (Martinez *et al* 2018). Through licence conditions, fishers are required to:

- Provide a significant stewardship of their respective zone.
- Protect against illegal foreign fishing.
- Advocate and comply with management interventions.
- Improve compliance and provide self-enforcement.
- Improve cooperation with fisheries managers and scientists in data gathering.
- Take advantage of market opportunities to increase fishing revenues.

63 Fisheries Resources Act No.7 of 2020. | UNEP Law and Environment Assistance Platform

The key measures applied to deliver the Managed Access initiative are:

- Licensing - Fishers must prove they are customary fishers, land their catch at designated landing sites, apply for licences through a vetting committee which recommends fishers for licences to the Belize Fisheries Department (BFD). The department approves or declines applications through a written letter to the respective vetting committee. Fishers receive automatic renewal of their licence if they comply with the rules of being a licence holder.
- Transfers and new entrants - Existing licence holders are given the opportunity to transfer their licences to next of kin or a party they may recommend on the licence application form. This transfer is requested through a Managed Access Committee, which provides feedback to the BFD where they see fit. There is also provision for new entrants to enrol in a government-initiated apprenticeship program.
- Zonation – a key component of the Managed Access initiative was the establishment of nine fishing zones, eight of which are in the nearshore area where most of the fishing occurs, and an additional deep-sea zone for fisheries expansion and diversification. These zones were decided upon by fishers during the consultation process. Fishers are given the option to choose two areas they find most favourable to fish. They are then licensed to only fish in these two areas permanently. The goal of having fishers only licensed to two fishing areas is to control the number of fishers within a zone (Martinez *et al*, 2018).

B.6.4 Progress against EAFM components

Stage 1

Target species sustainability – Of the 54 stocks in Belize's waters, seven fished reef fish species, queen conch, and spiny lobster have had their stock statuses determined. Of these, only the conch and lobster assessments were conducted within the past three years (Oceana, 2021). For finfish, Babcock *et al*. (2013) used length-based indicators, a data-limited method, to estimate biomass and fishing mortality to determine overfished and overfishing status for seven finfish. Overfished and overfishing status was also determined for stoplight parrotfish (*Sparisoma viride*), which is no longer legal to harvest in Belize. As economically important species subject to export, spiny lobster and queen conch have been subject to more frequent assessments, although many of these are also not easily accessible by the general public. The department also conducts pre-season, rapid conch assessments during odd years. Currently, conch surveys are conducted in and around Belize's marine reserves with some information available on density, shell length and lip thickness available on individual locations (Oceana, 2021). Neither conch nor lobster clearly appears to be overfished (Oceana 2021).

By issuing tenure rights to fishers in nine distinct fishing zones in its territorial waters through the Managed Access initiative, Belize aims to build local capacity for self-regulation and self-organisation to its small-scale fisheries and address the challenges of open access fishing. Due to its data-limited fisheries, Belize uses a multi-indicator framework to assess conch and lobster. The framework incorporate stakeholder-defined objectives as a foundation, and uses indicators and reference points of fishery performance based on available data (McDonald *et al* 2017; Fujita *et al* 2017). Indicators from different data streams are used such that uncertainty in one indicator can be triangulated with information from other indicators (McDonald *et al*., 2017). Four years after implementation of Managed Access, stakeholder perceptions indicated that there were no changes in the level of exploitation of conch and lobster (Bowman *et al*., 2021). Lack of data collection, low enforcement and inconsistent monitoring make it difficult to ascertain how the Managed Access initiative is performing in relation to stock status (Geers *et al*., 2020). Efforts are being made to capture catch per unit effort data from fishers that could be used to inform data driven approaches to catch limits.

Bycatch - Belize fisheries are small-scale, targeting multiple species where the whole catch is usually landed. There are size limits in place for conch, lobster and Nassau grouper to protect juveniles, as well as effort controls including bans on specific gears and capture methods (gillnets, bottom trawls, scuba), closed seasons for certain species (conch, spiny lobster, sea cucumber, Nassau grouper) and a complete ban on the harvest of parrotfish and surgeonfish as well as whale sharks and nurse sharks.

ETP species - The Fisheries Act contains regulations to conserve ETP species. Sharks are managed through individual species prohibitions, seasonal closures and gear bans (i.e. ban on gillnets). Fishers are required to hold a licence to target certain species of sharks (which must be renewed annually) and must also report data on the volume and species composition in their catch. Landing of marine turtles, whale sharks, nurse sharks, and manatees is prohibited. Belize is a signatory to CITES, which regulates international trade on sharks. ETP species also benefit from Belize's network of MPAs; surveys on coastal sharks across Belize using baited remote underwater video show that nurse and Caribbean reef sharks are higher in MPAs than in fished sites (Geers *et al*., 2020).

Stage 2

Spatial management - One of the key components supporting the TURFs initiative (Managed Access) is an extensive network of closed areas. According to the Healthy Reef Initiative (HRI), 21% of Belize's territorial sea is within an MPA. This include spawning aggregation areas designed to protect spawning sites for Nassau grouper, and sites where no fishing is permitted with spearguns, nets, long lines and fish traps. Seasonal closures are in place for lobster, conch and Nassau grouper.

Stage 3

Trophic level impacts – Belize fisheries are multi-species with high diversity and low levels of production for individual species making traditional species-by-species management difficult. Research has taken place to understand the trophic interactions of the wider Caribbean marine ecosystem (Mumby *et al* 2012) as well as site specific interactions (Babcock *et al* 2013). The Government of Belize introduced a prohibition on the taking of grazers, such as parrotfish and surgeonfish as a measure to protect Belize's reef structures and wider ecosystem interactions.

Climate change - Small-scale fisheries in Belize take place in coral, mangrove, and seagrass habitats, that are threatened by coastal development and pollution. These pressures are exacerbated by climate change, cascading effects such as acidification, rapid sea level rise, and storm intensification. A recent report card on the coral reef ecosystems noted an improvement from overall poor condition to fair (McField *et al*., 2020) indicating that there has been some improvement in managing existing stressors. The reasons for this include the ban on harvesting grazers (parrotfishes) and better tourism management.

The Belize Marine Conservation and Climate Adaptation Project (MCCAP) seeks to implement priority ecosystem-based marine conservation and climate adaptation measures to strengthen the climate resilience of the Belize Barrier Reef System. The main components are: improvement of the coral reef protection regime including an expansion and enforcement of the MPAs and replenishment (no-take) zones in strategic locations to build climate resilience; promote sustainable alternative livelihoods and income diversification for affected users of the reef, and build local capacity and raising awareness regarding the importance of the overall health of the reef ecosystem to its climate resilience (MCCAP 2018).

B.6.5 Cross cutting components

Social and economic considerations – Social objectives are embedded in legislation, and the Managed Access initiative promotes long-term stewardship of the fishing grounds by local fishers who should be able to reap the potential benefits (such as higher catch rates) associated with adherence to regulations. While it has the potential to generate higher social and economic benefits than the open-access regime, Managed Access is in its early stages and such benefits have not been realised yet.

Financial incentives were included during the setup of the Managed Access initiative such as the strengthening of cooperatives and provision of improved access to premium and higher revenue markets (Martinez *et al* 2018).

IUU – Belize is a signatory of the UN FAO International Plan of Action to deter, prevent and eliminate Illegal, Unreported and Unregulated fishing. One of the reasons for giving user rights to fishers is for them to co-manage the fishing grounds and enforce fisheries regulations. The Managed Access initiative is expected to enhance enforcement against IUU activities. To deter illegal fishing by transboundary fishers, BFD conducts patrols in its borders with Honduras and Guatemala. In 2019, no-take MPAs were expanded to include areas that border Honduras and Guatemala to help control illegal fishing (GoB, 2019). Fishers are required to use logbooks to provide catch and effort data, and are responsible for ensuring accurate and relevant data that are usable by managers and other stakeholders.

Customary sustainable use - TURFs grant secure and exclusive rights to fishers who historically have depended on these areas for their livelihoods. Further, fishers are expected to become actively engaged in management design and integrated into co-management committees for each site. Fisheries management in Belize uses local knowledge provided through the Managed Access committees.

Participatory approach - The Managed Access initiative is a participatory community-based co-management strategy across Belize. It is facilitating the development of adaptive community-based management system that involves a baselines review of information, development of objectives and harvest control rules, implementation, evaluation and adjustment. Through the Managed Access initiative, local stakeholders are adding capacity to the government's efforts to establish adaptive management plans for the fisheries. Stakeholder support is at the heart of the Managed Access initiative. Stakeholders are therefore required to have a level of understanding of the strategy, be updated about its developments and status and have their views integrated into the initiative.

Managed Access Committees are made up of fishers, the BFD and other key stakeholders. Managed Access committee members serve for two years and provide integral services to the Managed Access initiative, including continued collaboration among fishers and managers and supporting fishers to remain stewards of the marine environment.

Governance and policy - The Managed Access initiative was set up by the BFD through legislation. It aims to incentivise compliance with fisheries regulations and provide voluntary compliance through improved stewardship and inclusivity in decision making. Governance of the fisheries is therefore led by the government in collaboration with fishers, NGOs and key stakeholders.

B.6.6 Process for implementation

The Belize Fisheries Department recognised that open access fishing was leading to over exploitation and risk of collapse of its fisheries with potential negative social, economic and environmental consequences. The Belize Fisheries Department, with support from Toledo Institute for Development and Environment (TIDE), Wildlife Conservation Society (WCS) and Environmental Defence Fund (EDF), formed a taskforce to initiate a rights-based fisheries approach in two pilot sites. They carried out extensive consultations and outreach efforts from 2008 to 2010 to assess the potential effectiveness of creating access rights to fishing grounds (Catzim and Walker 2013). Efforts were made to ensure the design of Managed Access matches the social, environmental and biological conditions of Belize (Catzim and Walker 2013). Viewed as a way forward to address overfishing, unregulated and illegal fishing, Managed Access was rolled out in 2016 to the whole country through nine fishing zones.

A participatory approach led by BFD involving scientists, NGOs and fishers was used to develop an adaptive management framework to ensure local ownership of the outcomes and management implications (Fujita *et al*., 2019). A series of workshops with fishers and other stakeholders were held to develop the framework. In the workshops, the fundamentals of adaptive management were introduced, and the participants then articulated consensus objectives, fishery performance indicators with metrics, and harvest control rules (Fujita *et al*., 2019). Using these variables, the scientists together with BFD Capture Fisheries Unit developed fishery management plans using a multispecies fish basket approach to manage a greater number of species to generate social, economic and ecological benefits, while accounting for the data limitations that are typical of small-scale fisheries (UNCTAD 2021).

B.6.7 Summary of progress towards delivering Target 5 of the GBF

No data are available for Belize on SDG indicator 14.4.1 to indicate progress, but data does show that Belize is doing well under 14.b.1 (Access rights for small-scale fisheries) and 14.6.1 (IUU fishing). EAFM was a guiding principle behind the development and implementation of the Managed Access initiative (Martinez *et al*., 2018). The initiative was designed to support the precautionary principle by ensuring that Managed Access focuses on the protection, conservation and use of Belize's marine resources, within the context of sustainable human development (Catzim and Walker, 2013). Belize is making progress in data limited stock assessments and empowering local communities to take responsibility for their fisheries, with the aim to manage the resources sustainably. Co-management and social objectives are a foundation of the fisheries management system, and commitments to improved science to inform fisheries management will contribute to sustainably managed fisheries. Consideration is given to the impacts of fishing on other species and habitats, and the use of MPAs for spawning areas and habitat protect contributes to the long-term resilience of the ecosystem.

B.7 Case Study: Iceland mixed species trawl fishery

B.7.1 Background

In 2021 the Icelandic seafood industry directly contributed to 8.1% of total GDP (indirectly up to 25% of GDP) and directly employed around 7,500 people, or approx. 3.9% of the total workforce (ISF 2024). Iceland is the 19th largest fishing nation, responsible for 1.14% of the world's catch in 2020 (FAO 2023). Approximately 90% of Iceland's fisheries are MSC certified, indicating that they are sustainably managed and addressing many aspects of the ecosystem approach to fisheries management.

Fishing in Iceland is generally seasonal, with vessels targeting different stocks throughout the year. Many of the smaller boats switch seasonally between Danish seine, gillnet, shrimp trawl and longline. Large trawlers may fish for cod or haddock in one season, Greenland halibut in another, then target cod or shrimp in distant waters (Gaudian *et al* 2019).

The value of fishing to the Icelandic economy has produced a strong commitment from regulators to manage the resource sustainably, and the relationship between scientists, managers and processors means legislation and enforcement contribute to a proactive approach to sustainability. Emphasis is placed on research and development of methods to deliver EAFM, including research on the effects of fishing gear on the ecosystem, particularly on the seabed and the living bottom communities.

B.7.2 Key legislation

National legislation for fisheries includes:

- Fisheries Management Act (1990, amended in 2006) – The objective of Icelandic fisheries management is to ensure conservation and efficient utilisation of marine living resources in the Icelandic EEZ. A further objective is to ensure stable employment and settlement throughout Iceland[64].
- Act concerning the Treatment of Commercial Marine Stocks (1996)
- Act on Fishing in Iceland's Exclusive Fishing Zone (1997)

In 2007, the Directorate of Fisheries published a statement that '*Sustainable fisheries management should incorporate ecosystem considerations, which entails taking into account the impacts of fisheries on the marine ecosystem and the impacts of the marine ecosystem on fisheries' (IRF 2024).*

Description of fishery management measures

Iceland states that its fishery management system is developed in accordance with international law and the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries (IRF 2024). Management measures include:

- Limited access through vessel licences and permits;
- Individual Transferrable Quotas (ITQs) used to manage target and bycatch species;
- Prohibition of discards;
- Spawning grounds closed during peak spawning season to protect juveniles;
- Temporary real-time closures triggered bycatch monitoring of juveniles and bycatch. If small fish or bycatch repeatedly exceeds guideline limits, the relevant area is closed for a longer period of time;
- Restrictions on gear types for certain time periods and fishing grounds (minimum mesh sizes, and the use of sorting grids to allow small fish to escape capture);
- Strong enforcement of measures and designation of fines and penalties for non-compliance;
- In some areas, the use of bottom fishing gear is totally prohibited, for example where there is coral, thermal vents, and in other vulnerable areas (IRF 2024).

Other measures are in place to identify and avoid or reduce ecosystem impacts of the fishery where possible (through e-logs, VMS, recording of all bycatch including benthic species). A full suite of management measures is applied as part of multi-species stock management, and includes species of key importance to the ecosystem food web such as capelin and cod (Gaudian *et al* 2019).

B.7.3 Progress against EAFM components

Stage 1

The Fisheries Management Act outlines the use of ITQs to manage target species, bycatch and discards. The more efficient nature of the fleet under this management approach means that there is less interaction with the seabed as less trips and tows are needed to catch the allocated quota (ICES 2024a).

Sustainable fisheries – Iceland's Marine and Freshwater Research Institute (MFRI) reports that 90% of stocks are considered to be fished within biologically sustainable levels. Stock assessments of species in the mixed fishery have been undertaken annually since at least 2001. A statistical catch-at-age model

64 Fisheries Management Act, 1990. | UNEP Law and Environment Assistance Platform

is used for most species assessments, although the 2024 ICES benchmarking process stated that ecosystem drivers and multi-species and mixed fisheries interactions were considered but were not included directly in the assessment framework. When setting advice for key ecosystem species such as capelin, impacts of predation from other species is included in the advice.

The data used for monitoring and assessing all Icelandic stocks are primarily obtained from landings reports, vessel register information, e-logbooks, discard and survey databases. Biological sampling programmes provide length, age, maturity and sex data on landings for input to stock assessment (Gaudian *et al*, 2019). The information is evaluated by ICES to ensure MFRI are conforming with internationally accepted approaches.

Bycatch - Measures are in place to monitor catches and close areas where bycatch becomes a concern. Gear modifications including smaller mesh sizes and sorting grids are in place to limit the catch of juveniles. A system of instant area closures is also in place for many species with the aim of minimising fishing on juveniles. For instance, for tusk, an area is closed temporarily for fishing if monitoring reveals that more than 25% of the catch is composed of fish less than 55 cm in length. Repeated instant area closures have led to the establishment of permanently closed areas (Gaudian *et al*, 2019).

ITQs allow for some, limited, flexibility between vessels to accommodate vessels landing bycatch species they do not hold quota for. If additional quota is not obtained, the fishing permit may be revoked as well as a fine levied for the illegal catch. Vessels are authorised to land a small percentage of bycatch species without the use of quota, which is sold at auction and the proceeds go to a Marine Research Fund.

Discards - Mean annual discards are estimated to be around 1% of landings and ICES considers discarding negligible for these stocks. The ITQ system enables additional quota to be obtained for non-target catches that might previously have been discarded prior to the prohibition of discards, and enforcement of the policy is strong with non-compliance leading to legal penalties.

ETP species – MFRI do not consider that the trawl fishery is impacting ETP species in the area. In 2023, two new regulations were implemented which affect ETP species: Regulation no. 849/20232 about preventing ETP bycatch, and Regulation no. 307/20233 about digital reporting and registration of catch data. Vessels are required to use bird scaring lines or sound an alarm to reduce the likelihood of bird interactions with gear, and recording and monitoring of ETP interactions has been in place since 2015.

There have been several mitigation trials for marine mammals and seabirds, including successful testing of a modified pinger device. Project FISHSCANNER aims to test a lightweight and user-friendly device that provides real time information on catch composition. It is mounted as a circular frame in front of the cod end containing stereo cameras and light, which scans all fish before they enter the cod end and uses artificial intelligence to perform real-time processing via an onboard computer. The system has the potential to be used in the identification of non-target species and ETPs (ICES, 2023).

Stage 2

Spatial management – The effort of the trawl fishery as a whole has been decreasing since the early 1990s (ICES 2024b), with fewer vessels fishing over a smaller area, reducing the pressure on benthic habitats. To avoid more sensitive inshore habitats, bottom trawling is not allowed within certain distance from land (generally around 12 NM) in Iceland (MFRI). The Ministry of the Environment developed a National Strategy Plan for the preservation of biological diversity which aims to (a) develop fishing methods with less impact on marine ecosystems, and (b) protect vulnerable benthic ecosystems. Act 97/1997 also provides a framework which allows managers to close vulnerable habitats to fishing as and when the need arises.

Temporary and permanent closures are in place to protect spawning grounds, but also have a secondary effect of protecting seabed habitats from fishing activities. There are permanent area closures in place to protect Lophelia reefs and hydrothermal vents. Existing closed areas are clearly marked on maps used by all vessels, surrounded by buffer zones, and any infringement triggers an alarm with the Coast Guard's compliance team, using the VMS position of the vessel.

Detailed habitat mapping is undertaken to identify further sensitive areas, and bycatch reporting procedures include collection of information on invertebrates such as corals, sponges, soft corals etc.

Technical measures – Developments in gear technology include the use of semi-pelagic trawl doors, which prevent bottom contact from trawl gear. This reduces resistance and thus promotes handling efficiency and reduces fuel consumption while reducing the impacts of trawl gear on benthic habitats. The trawl fisheries are actively contributing to habitat mapping programmes by recording all benthos bycatch in cooperation with researchers at MFRI, and contributing their practical knowledge on fishing areas overlaying benthos type. The Ministry of Fisheries has established a Joint Committee to explore ways to minimise the effects of fisheries on the ecosystem, involving stakeholders from different fishing sectors, small boat fisheries, the Ministry, MFRI and from the Association of Icelandic Captains and Vessel Managers (Gaudian *et al* 2019).

Stage 3

Trophic level impacts - The annual TAC for each target species is based not only on stock information and recruitment but also includes natural mortality such as predation. Studies on the feeding ecology of a large number of fish species, marine mammals and seabirds have provided information on the ecological function of most of the species caught. Biomass estimates for stocks of fish, whales and seabirds in Icelandic waters and production estimates of zooplankton species have been used to calculate the biomass of individual components in the Icelandic marine ecosystem (Astthorsson *et al*., 2007). As a result, there is a comprehensive understanding about the key elements of the ecosystems of Icelandic waters, and models have been used to evaluate interactions between fisheries and key ecosystem elements.

B.7.4 Cross cutting components

Social and economic considerations - One of the main objectives of Icelandic fisheries management, in addition to conservation and efficient utilisation of marine living resources, is to ensure stable employment and settlement throughout Iceland. After the introduction of the ITQ system, there were concerns over fleet consolidation and impacts on small-scale fishing communities. Initially the smallest boats were exempt from the ITQ system to maintain employment in rural villages, but after attempts to reduce the effort of these vessels failed, they also entered the ITQ system. In 2009, around 10% of the quota was reserved for coastal fisheries to try and safeguard this fishery and ease access for new entrants, but this did not prevent a decline in fishing employment. A number of exemptions and amendments have been made to the system to attempt to resolve this, as well as efforts to better distribute the benefits of fishing through a fishing resource rent tax paid by companies based on their profit margin of harvesting different species (Gunnlaugsson 2018).

Fisheries legislation has restrictions in place aimed at preventing excessive quota concentration so that no single company or vessel operator may control more than 12% of the value of the total quotas allocated for all species, and 12% to 35% for individual species. Regional quotas were put in place to support communities where fishing is economically significant.

The Fisheries Management Act provides the Minister of Fisheries up to 12,000 tonnes of fishing rights to offset major economic or social disturbances that may occur in times of sizeable fluctuations in catch quotas, or for regional support to smaller communities that have experienced significant reduction in employment as a result of unexpected cutbacks in quotas. Such additional quotas can be allocated for up to three years at a time.

The significant export market for Icelandic fish demands MSC certification, which has contributed to a drive to improve overall ecosystem interactions of Icelandic fisheries (Statistics Iceland 2023a). The Iceland Sustainable Fisheries group was set up in 2012 to obtain certifications for fishing gear and fish stocks in Iceland (ISF 2024).

Illegal, Unreported and Unregulated fishing - Iceland is considered to have a high level of implementation of measures to combat IUU fishing, and has been a key nation in the delivery of the Port State Measures Agreement. Enforcement of management measures is high, with widespread use of VMS, and at sea and port surveillance, resulting in levels of high compliance (Statistics Iceland 2023b). Fishing vessels are required to keep a logbook and report catches to the Directorate of Fisheries on a daily basis. 100% of the landed fish is weighed by an authorised 'weighmaster', employed by the municipality and hence independent of both buyer and seller. The Directorate operates an interactive website, where stakeholders can monitor the precise quota status for each species and observe the performance of individual vessels, their catch from each fishing trip and vessel quota status. VMS data enables effective oversight of whether area restrictions are observed.

Breaches of the law and regulations on fisheries management are subject to fines or revoking of the fishing permits, irrespective of whether such conduct is by intent or negligence. Major or repeated intentional offenders are subject to up to six years imprisonment.

Climate change - Fishing grounds of several key commercial species (e.g. haddock, anglerfish, ling, lemon sole, and witch) have extended northwards as a result of increased water temperature (ICES 2024b). Research on impacts of climate change on species and the wider ecosystem is ongoing. Benthic surveys, stock assessments, primary productivity surveys, and ecosystem modelling are carried out and provide an objective basis for confidence that the fisheries management strategy will not pose a risk of serious or irreversible harm to overall ecosystem structure and function.

Participatory approach – The ITQ system was implemented quickly, with limited consultation or participation from stakeholders in order to deliver a rapid management response to overfishing. More recently, Iceland has developed a consensus-based system for fisheries management involving continuous consultation and close cooperation between government agencies and stakeholders. At a formal level, all major interest organisations are regularly invited to sit on committees established for regular consultations with the Ministry, the Directorate and the Parliament's Permanent Committee for Fisheries and Agriculture. Consultation processes cover policies and regulatory issues, and also include discussions of the annual scientific recommendations by the MFRI. The Ministry also consults with the industry before setting the final TACs and management authorities consider the information obtained from stakeholders during decision making.

Science and the precautionary approach - Fisheries management in Iceland is primarily based on extensive research of fish stocks and the marine ecosystem and biodiversity, and decisions on allowable catches are made on the basis of scientific advice from the Icelandic Marine Research Institute. The precautionary approach is not mentioned explicitly in the Fisheries Management Act, but there is a requirement take the best scientific knowledge into account through the use of reference points. Conformity between the scientific fisheries advice and the authorities' decisions on the TAC is a principal factor for ensuring responsible fisheries management.

The Marine Research Institute carries out extensive research on the status and productivity of the commercial stocks, and long-term research on the marine environment and the ecosystem around Iceland. The results of this research are the foundations of the advice on sustainable catch levels of the fish stocks. Additionally, the institute investigates fishing gear and its impact on the ecosystem.

B.7.5 Process for implementation

Concerns over the state of fish stocks in Icelandic waters led the Icelandic government to introduce a system of individual transferable quotas (ITQs) via the Fisheries Management Act in 1990. Limited stakeholder consultation allowed these measures to be introduced rapidly but meant that subsequent amendments were needed to respond to stakeholder demands (OECD, 2017).

Management was designed to provide incentives for fishers to safeguard stocks through decreasing effort and catches, while at the same time securing their long-term economic future. Although conserving biodiversity was not an explicit objective, the reform created the necessary incentives to reduce total catch levels and thus to put the fishery on a sustainable footing (OECD, 2017). The introduction of closed areas and gear modifications designed to limit the impact of fishing on target species had a secondary benefit in protecting wider habitats and ecosystems. Additionally, the significant value of the export market allowed the Icelandic government to prioritise the implementation of holistic management measures that contribute to achieving EAFM.

B.7.6 Summary of progress towards delivering Target 5 of the GBF

Iceland currently reports that 93% of its fish stocks are within biologically sustainable levels. This case study has shown how Iceland has ensured its trawl fishery is sustainable and how overexploitation has been prevented through the use of ITQs and entry limitations. Measures are in place to minimise the impacts of the fishery on non-target species and ecosystems, and the success of these is regularly reviewed. The challenges of balancing social and economic benefits are clear, and these were addressed through the provision of community quota and a fishing fee. Through these measures, EAFM is supporting the conservation and restoration of biodiversity, and maintaining ecosystem functions and services in Iceland.

B.8 Case Study: Lyme Bay inshore fishery

B.8.1 Background

Recognised as a UK "marine biodiversity hotspot" (Hiscock and Breckels, 2007), Lyme Bay is characterised by its unique underwater geology and nationally acclaimed subtidal reefs and associated fauna, most notably pink sea fans (*Eunicella verrucosa*) which are protected under the Wildlife and Countryside Act 1981 and included in the UK Biodiversity Action Plan. The rich biodiversity and structural complexity of these benthic reefs also provides essential fish habitat (EFH) for commercial species, including the edible crab (*Cancer pagurus*), European lobster (*Homarus gammarus*) and king scallop (*Pecten maximus*). By extension, Lyme Bay became an important area for commercial fisheries, with some of the best scallop fishing grounds in the UK. Concerns about demersal-towed fishing damage were first raised in the early 1990s, which led to a series of unsuccessful voluntary closures of small reef areas dominated by pink sea fans between 2001-2005 (Appleby, 2007) and 2006 (Devon Wildlife Trust, 2007, cited in Rees *et al.*, 2010).

In 2008, more than 200 km^2 of Lyme Bay, UK, was closed to bottom towed fishing to protect local reefs, corals and sea fans. The closure was implemented to allow benthic habitats to recover from the impacts of mobile fishing gear. After the initial exclusion of mobile gear, there was influx of a large number of static gear vessels into the area after. In reaction to this, the number of boats operating in the area was limited to 40 using static gear, and operating under a memorandum of understanding and a voluntary code of conduct. Fishermen restrict pots and nets to agreed levels in the interests of the environment and in line with conservation objectives (Rees *et al* 2021). The closure to bottom towed gear has resulted in displacement of these vessels to outside the closed area and reports of lower subjective wellbeing and material losses for towed gear fishermen (Rees *et al* 2021).

To date, the MPA supports a thriving fishing community made up of approximately 40 inshore vessels from the local ports of Axmouth, Beer, Lyme Regis, and West Bay. The majority of vessels are under 10 m in length with the primary fisheries consisting of potting for crab, lobster and whelk (*Buccinum undatum*); netting for skates (Rajidae) and flatfish, including lemon sole (*Microstomus kitt*) and plaice (*Pleuronectes platessa*); and hand-diving for king scallops. Since the MPA's designation, positive trends in landings have contributed to the uplift in value inside the MPA, estimated to have risen by £1,452 per vessel per month (Rees *et al.,* 2021).

B.8.2 Key legislation

National policies:

- The Wildlife and Countryside Act 1981
- Marine and Coastal Access Act 2009
- Marine Strategy Regulations 2010
- UK Marine Policy Statement 2011
- The Conservation of Habitats and Species Regulations 2017 (transposes the EU Habitats Directive into UK law)
- Regulation (EU) 2019/1241 of the European Parliament and of the Council
- Fisheries Act 2020, including Fishery Management Plans (FMPs)

Local policies:

- Statutory measure: Lyme Bay Designated Area (Fishing Restrictions) Order 2008
- Inshore Fisheries and Conservation Authorities (IFCA) measures
- Voluntary Codes of Conduct

B.8.3 Description of fishery management measures

Fishing vessels in the Lyme Bay MPA operate in compliance with national and local legislation. This includes:

- Catch limits for quota species,
- Baseline mesh sizes,
- Restrictions on shellfish permits,
- Minimum landing sizes,
- The upcoming mandatory use of an operational inshore vessel monitoring system (I-VMS) device,
- Gear restrictions and a prohibition on the use of bottom-towed fishing gear.

A voluntary Code of Conduct for Commercial Fisheries is in place for fishers in the area and commits them to engage with managers and scientists to improve knowledge and understanding of fisheries and wildlife and to respect experimental and monitoring areas within the reserve. The Code has since been adapted to reflect research and knowledge on the sustainable levels of fishing and practices that are compatible with the reserve, with the addition of pot limits and net size limitations.

B.8.4 Progress against EAFM components

Stage 1

Target species sustainability - To date, no official stock assessments have been conducted exclusively within the confines of the Lyme Bay MPA. As such, the stock status of key commercial species within Lyme Bay is indicated by wider stock assessments carried out by Cefas on a regional basis i.e. the Western English Channel for edible crab (Cefas, 2024a) and the south west for European lobster (Cefas, 2024b). However, recently, two stock assessments have been conducted in the general Lyme Bay area for king scallop (Harvey *et al.,* 2023) and common sole (Desender and Santos, 2022) which indicate the king scallop stock is subject to overfishing, with exploitation levels consistently above the Maximum Sustainable Yield (MSY) target since 2017 (Harvey *et al.,* 2023). For common sole, despite the increasing trend in landings (nearly four times higher than in 2015), of which the majority of landings from Lyme Bay were from under 10 m vessels using set nets, Cefas found no significant changes in stock abundance or structure (Desender and Santos, 2022).

Over time, studies have demonstrated significant recovery of the benthic reef environment, leading to an increase in the abundance and diversity of reef-associated species (Sheehan *et al.,* 2013; Stevens *et al.,* 2014; Kaiser *et al.,* 2018; Davies *et al.,* 2021, 2022a). Concurrently, the diversity and total abundance of commercially exploited species inside the MPA also dramatically increased by 430% and 370%, respectively (Davies *et al.,* 2021). It is likely the increase in functional richness of the reef area has contributed to the positive increases in mobile fauna over time, including the increases in exploited fish species targeted by the local fisheries (Davies *et al.,* 2021).

Ghost gear - There is limited information on the occurrence and impact of ghost gear on protected reef features within the Lyme Bay MPA. To mitigate the risk of gear damage or loss, clear gear marking is stipulated in the voluntary code of conduct and is a key requirement for commercial netting and potting permits enforced by both IFCAs. The code of conduct requires gear to be marked and escape hatches must be used in pots deployed in the Lyme Bay reserve. Increasingly these escape hatches are being made from biodegradable material (Drakeford *et al* 2023).

ETP species - In 2020, the UK Bycatch Monitoring Programme (BPM) estimated 262 harbour porpoises, 58 common dolphins and 104 seals were caught as bycatch in net fisheries in ICES Division 7e (including Lyme Bay) (Kingston *et al.,* 2023). Mitigation measures in place to reduce bycatch include the mandatory use of acoustic deterrent devices (ADDs) for cetaceans on any bottom-set gill net or entangling net from vessels larger than 12 m.

The reduced effort and gear restrictions withing the MPA may reduce the likelihood of ETP interactions occurring, and there are protocols in place to minimise any potential interactions with potting lines, along with best practice handling guides in the event of entanglements.

Stage 2

Spatial management - Since 2008, all vessels using bottom-towed gear are prohibited from fishing in the Lyme Bay MPA. The reduction in physical disturbance of essential fish habitats, including spawning areas for sandeel and sole and nursery grounds for mackerel, plaice and ray species (Ellis *et al*., 2012), and subsequent increase in functional richness of the reef area, are likely to have contributed to the increase in fish populations over time (Davies *et al*., 2021). A recent study compared species recovery rates inside and outside of the reserve, demonstrating a 95% increase in total abundance of taxa inside, compared to just 15% outside, along with greater biodiversity and community resilience (Davies *et al.*, 2022b). The lower recovery rate outside of the reserve may also be a result of displaced towed gear fishers operating outside the reserve. This has also resulted in gear conflict over traditional potting grounds outside the reserve which are now being fished by displaced towed gear fishermen (Mangi *et al*., 2011; Rees *et al*., 2019).

There is a seasonal closure of the king scallop fishery in Area 7e from 15 May to 30 September for vessels over 12 m (MMO, 2024), which covers the Lyme Bay area.

B.8.5 Cross cutting components

Social and economic considerations - A series of studies quantified the social and economic impacts of fishery management measures in Lyme Bay, revealing both positive and negative effects, including the significant increase in commercial static fishing gears inside the MPA and increased gear conflict between static and mobile fishers outside MPA boundaries (Mangi *et al.,* 2011, Rees *et al.,* 2021). Rees *et al*. (2021) reported a decrease in static gear landings by 110 kg per vessel per month, while the value of landings had increased by £1,452 (per vessel per month) for vessels fishing inside the MPA compared to a £866 increase for vessels fishing outside the MPA. In terms of social effects, fishers predominantly using mobile demersal gear reported lower subjective wellbeing and material losses compared to static gear fishers (Rees *et al.,* 2021). This highlights the important repercussions of excluding mobile gear fishers from management discussions, and the resulting displacement of vessels that may have other unintended consequences.

Participatory approach – A three stage stakeholder participation process has been considered crucial to Lyme Bay's success. Initially, a full public government consultation informed the decision to ban bottom-towed fishing (Rees *et al.,* 2010; Fleming and Jones, 2012). To gain control over the increase in unregulated static gear effort, a working group was set up, comprising various interest groups to facilitate knowledge sharing and develop best practices in conservation and fisheries management across the whole site. Based on these principles, the Lyme Bay Fishermen's Community Interest Company (CIC) was formed in 2022, uniting 50 small-scale fishers to collaborate with IFCAs and Defra to sustainably manage Lyme Bay's marine resources. Finally, as part of their role to facilitate an ecosystem approach to fisheries management and contribute to a more contemporary and inclusive governance model, the two IFCAs conduct public consultations to engage stakeholders in decision-making regarding fishing byelaws and MPA assessments (Lowther and Rodwell 2013).

Science and the precautionary approach - The designation of the Lyme Bay and Torbay SAC under the EU Habitats Directive requires IFCAs to take a precautionary approach to fisheries management, informed by conservation advice from Natural England. IFCAs also conduct their own research and stock assessments within their district to inform management recommendations. Furthermore, annual monitoring conducted by the University of Plymouth has resulted in an ecological dataset integrated with social and economic research on MPAs. This, along with *ad hoc* research projects, has informed approaches to sustainable fisheries management in the Lyme Bay MPA, such as Rees *et al.* (2019) on sustainable levels of potting activity which is included in the voluntary Code of Conduct.

B.8.6 Process for implementation

Prior to the closure of 200 km² of Lyme Bay to bottom towed gear, voluntary measures and the original government decision to close only 41.2 km² around the known locations of pink sea fans (Devon Wildlife Trust, 2007, cited in Rees *et al.,* 2010) were not considered to be successfully limiting fishing pressure in the area. The driving force behind the UK government's decision to introduce larger spatial management of fishing activity in Lyme Bay was based on long-standing stakeholder concerns and local petitioning for wider-scale ecosystem management. Following guidance from Natural England, a public consultation - where 70% of responses favoured the of the full 200 km² closure - and an Impact Assessment (Hiddink *et al.,* 2008), the government announced the statutory closure of 200 km² to maintain the ecological structure and function of the area.

The establishment of the Lyme Bay reserve was fundamentally driven by this combination of a government-led closure and significant stakeholder participation in the initial voluntary closures and subsequent co-management. The participatory, bottom-up approach to collaboration with local stakeholders across various interest groups, such as the fishing industry, regulatory bodies and NGOs, has been integral to the development of sustainable fishing practices and fostering a sense of ownership of the area and its resources, resulting in increased social and economic benefits in the local community.

B.8.7 Summary of progress towards delivering Target 5 of the GBF

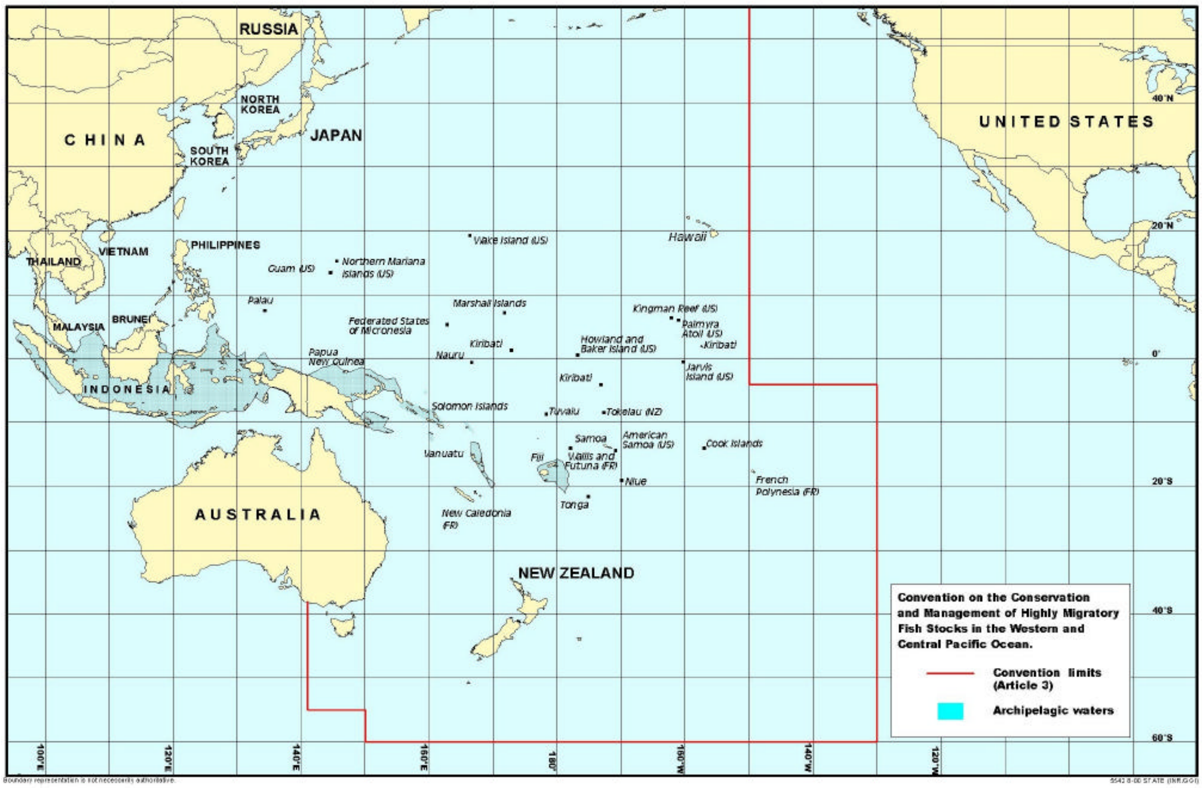
Information on progress towards SDG 14.4 is only available at a national level, and 2019 data indicates that 57.9% of UK fish stocks were within biologically sustainable levels, a decrease from 59.6% in 2017 (FAO, 2024). Research conducted in Lyme Bay has provided evidence of the advantages of using EAFM to deliver positive ecosystem-wide impacts in line with GBF Target 5. This includes minimising impacts on non-target species and ecosystems; preventing overexploitation; and ensuring the use, harvesting and trade of wild species is sustainable, safe and legal.

The ecological recovery and social and economic benefits of Lyme Bay has demonstrated the importance of incorporating co-management with local stakeholders at the heart of decision-making processes (Solandt *et al.,* 2020; Rees *et al.,* 2020). In addition, the importance of considering the potential consequences of local management decisions on a wider scale demonstrates the need for communication across management areas and consultation of all stakeholders that may be impacted by decisions.

B.9 Case Study: Western and Central Pacific Fisheries Commission (WCPFC) tuna

B.9.1 Background

WCPFC was established in 2004 as the Regional Fisheries Management Authority with responsibility for highly migratory fish stocks in the Western Central Pacific Ocean. The geographic scope of WCPFC extends to all waters of the Pacific Ocean (i.e. FAO Areas 61, 71 and 81) as defined by the WCPFC Convention Article 3.1 (See Figure B1). There are currently twenty-six Members, seven Participating Territories and seven Cooperating Non-Members. The Convention applies to all stocks of highly migratory fish within the Convention Area except sauries.



Source: WCPFC[65]

Figure B1. Map of the Western and Central Pacific Fisheries Commission (WCPFC) Convention Area

The total catch of tuna and tuna-like species in WCPFC in 2022 was 2,748,391 tonnes. Skipjack tuna (*Katsuwonus pelamis*) makes up the majority of the catch (1,718,465 tonnes in 2022, 62.5%) with significant catches of yellowfin tuna (*Thunnus albacares* at 696,868 tonnes, 25.4%) and bigeye tuna (*Thunnus obesus* at 146,951 tonnes, 5.4%). Tuna species are targeted using a wide variety of gears including purse seine, longline, pole and line, troll, handline, ringnet and driftnet. From a fisheries management perspective, all stocks are sustainably fished with the exception of the North Pacific stock of striped marlin (WCPFC, 2019a).

65 WCPFC https://www.wcpfc.int/doc/convention-area-map Accessed 22 July 2024

The main ecosystem concern raised at WCPFC20 in 2023, is the impact of climate change on tuna resources in the region and the necessary management measures to be implemented by WCPFC members to mitigate for the potential shifting patterns of tuna resources. Bycatch is also noted as an EAFM issue, with key bycatch species that are caught alongside target species recorded and assessed often in the same way as the main target species (e.g. striped marlin and Oceanic whitetip shark).

B.9.2 Key legislation

- Commission's "Rules of Procedure" 2019;
- Resolution 2008-01 - Resolution on Aspirations of Small Island Developing States and Territories;
- Resolution 2019-01 - Resolution on Climate Change as it relates to the Western and Central Pacific Fisheries Commission;
- CMM 2007-01 - Conservation and management measure for the Regional Observer Programme;
- CMM 2011-03 - Conservation and Management Measure for Protection of Cetaceans from Purse Seine Fishing;
- CMM 2013-07 - Conservation and Management Measure on the Special Requirements of Small Island Developing States and Territories;
- CMM 2018-03 - Conservation and Management Measure to mitigate the impact of fishing for highly migratory fish stocks on seabirds;
- CMM 2018-04 - Conservation and Management of Sea Turtles;
- CMM 2019-07- Conservation Management Measure for the Establishment of a List of IUU Vessels for the WCPFC;
- CMM 2022-01 - Conservation and Management Measure on a Management Procedure for WCPO Skipjack Tuna (example of CMM for target species);
- CMM 2022-04 - Conservation and Management Measure for Sharks; and
- CMM 2023-01 - Conservation and Management Measure for bigeye, yellowfin and skipjack tuna in the Western and Central Pacific Ocean.

B.9.3 Description of fishery management measures

Management measures are proactive, adaptive and provide a framework for taking the best available information about a stock or fishery whilst applying an evidence and risk-based approach to setting harvest limits, accounting for bycatch and ETP issues that may be evident. Whilst aiming for harvesting the stocks at maximum sustainable yield (MSY) the harvest strategies include the following sections:

- Defined operational objectives, including timeframes, for the fishery or stock
- Target and limit reference points for each stock
- Acceptable levels of risk of not breaching limit reference points
- A monitoring strategy using best available information to assess performance against reference points
- Decision rules that aim to achieve the target reference point and aim to avoid the limit reference point
- An evaluation of the performance of the proposed harvest control rules against management objectives, including risk assessment (MSE).

The purse seine fishery is effort limited with effort limits for each. The longline fishery has quota applied for each species and Member. There is a ban on the use (deploying, servicing or setting) on Fish Aggregating Devices (FADs) between July and September each year for the purse seine fishery between 20°N and 20°S. Some Members' domestic vessels are excluded from this ban.

B.9.4 Progress against EAFM components

Stage 1

Sustainable fisheries – Stocks undergo rigorous stock assessment on a regular basis with clear management objectives and related compliance and monitoring measures, leading to a well-managed fishery overall. Of the 20 stocks managed by WCPFC, 18 are considered sustainably exploited and only two overfished. Due to the mixed nature of the fishery no specific rebuilding plans are in place for the two overfished stocks.

The typical stock assessments used in WCPFC are spatially disaggregated, length-based, age structured population models that have been developed for the key species (target and bycatch) in the region based on Hampton and Fournier's 2002 research. Stock assessments are carried out on a regular basis by WCPFC for five tuna species (bigeye, yellowfin, skipjack, albacore and Pacific bluefin tuna), three billfish species (swordfish, striped marlin and blue marlin), and eight key shark species. The major tuna and billfish stock assessments are updated every three years, with key stock indicators updated in between if new data are available. Operating models are used to test scenarios and uncertainties that will determine the most appropriate management strategy.

Discards – Discarding practices are well monitored within the fisheries and enhanced through observer programmes with 5% coverage of the effort in each fishery. The function of the observer programme includes "collecting catch data and other scientific data, monitoring the implementation of the conservation and management measures adopted by the Commission and any additional information related to the fishery that may be approved by the Commission".

ETP species – Key ETP species that should be considered in any EAFM approach are assessed within WCPFC. Specific rules relating to the capture, monitoring of and handling and release of ETP species is defined for cetaceans, sharks, turtles and seabirds. These species are well monitored within WCPFC fisheries by the fishing fleets and enhanced through observer programmes.

WCPFC has an established Electronic Reporting and Electronic Monitoring Intersessional Working Group that will enable remote monitoring of fishing activity and better recording of interactions with ETP species. Non-entangling and biodegradable FADs being introduced by purse seine fisheries globally will further reduce bycatch and incidental mortality of ETP species. WCPFC is also one of the key contributors to the Bycatch Management Information System (BMIS)[66] which provides information on ETP bycatch species globally.

ALDFG – The two most common fishing methods used in the WCPFC region, purse seine and pelagic longline are high potential contributors to ALDFG and therefore potential ghost fishing and marine pollution. Measures put in place across purse seine fisheries to invest in biodegradable and non-entangling FADs will reduce the amount of ALDFG across the Pacific Ocean. The fleet must also:

- responsibly manage the number of drifting FADs deployed each year;
- carry equipment on board to facilitate the retrieval of lost drifting FADs;
- make reasonable efforts to retrieve lost drifting FADs; and
- report the loss of drifting FADs, and if the loss occurred in the EEZ of a coastal State, report the loss to the coastal State concerned.

[66] BMIS https://www.bmis-bycatch.org/ Accessed 22 July 2024

Stage 2

Spatial management – Spatial management of stocks within the WCPFC is clearly defined and considered appropriate for management purposes. For example, a "Northern Committee" has been established of those Members with an interest in stocks north of the Equator but mostly those north of 20°N. Those stocks between the Equator and 20°N make WCPFC management consistent with Inter-American Tropical Tuna Commission's (IATTC) management in the Eastern Pacific Ocean. There is also a FAD closure in place across the area between 20°N and 20°S between July and September.

Stage 3

Trophic level impacts – Although not incorporated into the single species stock assessment models, ecosystem modelling with clearly defined ecosystem indicators (Allain *et al.,* 2021) based on the predicted IPCC scenarios show increased fishing and climate change could generate complex trophic cascades, with resulting unpredictable increases and decreases across all trophic levels. The WCPFC Scientific Committee regularly conducts stock assessments and other analyses on target and non-target species. Based on the results of stock assessments, the Scientific Committee provides management advice and recommendations to the Commission to develop and adopt relevant conservation and management measures.

B.9.5 Cross cutting components

Climate change – WCPFC discussed the implications of climate change for regional tuna stocks and the potential negative impacts on the key commercial stocks of skipjack, yellowfin, and bigeye tuna in 2019. In response, WCPFC Resolution on Climate Change recognised the need for further work to understand the potential impacts of climate change and the relationship between climate change and fishing activities. It also committed to support "further development of science on the relationship between climate change and target stocks, non-target species, and species belonging to the same ecosystem or dependent on or associated with the target stocks, as well as interrelationships with other factors that affect these stocks and species and estimates of the associated uncertainties".

For climate change impacts and where they interact with the species-based harvest strategies, in 2022, WCPFC provisionally adopted sets of robustness operating models that can be used to evaluate candidate harvest strategies including additional uncertainties, such as the impacts of climate change on skipjack productivity. This now forms a key part of the MSE process within WCPFC.

The need for research on the key identified issue of climate change and its associated ecosystem indicators has been in place as a standing item of the WCPFC Scientific Committee (SC) agenda. A "Spatial Ecosystem and Population Dynamics Model" (SEAPODYM) was introduced and is updated annually. In terms of the assessment of climate change impacts, SEAPODYM has been highlighted as having the potential to be a useful complementary model for the spatial management linked to the existing stock assessments. SEAPODYM can account for El Nino Southern Oscillation (ENSO) phases and climate change projections and would allow some mitigation for climate change, reducing risks and allowing Members to capitalise on any opportunities presented by climate change.

Illegal, Unreported and Unregulated fishing – WCPFC objectives identify the importance of addressing IUU. The first attempt at quantifying the value and volume of IUU fishing in tuna fisheries within the Pacific Islands region estimated IUU volume is around 6.5% of the total WCPFC Convention Area catch in 2019. An update in 2021 indicated a significant reduction but was not able to attribute this to a specific management measure. WCPFC has established authorised and IUU vessel lists and associated procedures, and also shares vessel listings with other tuna RFMOs.

Precautionary approach – The precautionary approach is required under Article 6 of the WCPFC Convention. This requires the use of the best scientific information available, that the Commission should take into account, inter alia, uncertainties relating to the size and productivity of the stocks, use appropriate reference points, establish data collection procedures to obtain relevant information, including enhanced data collection when stocks are overexploited. Caution is advised and the absence of information is noted as not being a reason to increase catch or effort. Also, the Convention states that where a "natural phenomenon has a significant adverse impact on the status of highly migratory fish stocks, members of the Commission shall adopt conservation and management measures on an emergency basis to ensure that fishing activity does not exacerbate such adverse impacts".

B.9.6 Process for implementation

WCPFC was established in 2004, after many of the international agreements related to fisheries management and EAFM were already in force. This provided an opportunity to learn from and implement EAFM approaches developed by other RFMOs without facing the entrenched positions that have been seen elsewhere. Although the WCPFC Convention has not explicitly taken the ecosystem approach into its management framework, it states at the very beginning that *'(we) must be conscious of the need to avoid adverse impacts on the marine environment, preserve biodiversity, maintain the integrity of marine ecosystems and minimize the risk of long-term or irreversible effects of fishing operations*' (Shen and Song 2023). Management priorities have focused on target species and bycatch, with most ecosystem consideration related to research rather than implementation of management measures.

Currently, the WCPFC is implementing the EAFM to the western and central Pacific Ocean (WCPO) tuna fisheries through developing a holistic tuna management approach, called the WCPFC Harvest Strategy Framework, which incorporates biological, economic, social and ecosystem management objectives. The framework is composed of models, so requires very comprehensive and reliable data compared to other EAFM approaches which can be applied even under the conditions of insufficient data and information. As the issue of multispecies and mixed fisheries modelling approach is complicated, the Commission continue to review the harvest strategy workplan and adjust the process to allow enough time for the framework development and to ensure the stakeholders' full understanding and full participation in the process[67].

Key lessons learned relate to the need to provide sufficient time and resources for the development and capacity building of the participants to fully understand and participate in the process, recognition of the difficulties and collecting and using confidential data, and the insufficient collection of economic, social and ecosystem level data.

B.9.7 Summary of progress towards delivering Target 5 of the GBF

WCPFC stocks are well managed, within sustainable limits. There is a good management system with clear HCRs for key stocks and IUU fishing is considered at a low level. There is very little impact on habitats due to the nature of fishing (pelagic purse seine and longline being the main fishing gears used). Non-target species (including marine mammals, sharks, turtles and seabirds) are all monitored and assessed and mitigation measures have been adopted to reduce bycatch as far as possible.

[67] https://www.un.org/Depts/los/convention_agreements/ICSP15/WCPFC-ICSP15Contribution.pdf

WCPFC is one of the most forward thinking RFMOs when addressing social and economic issues as a majority of the Members (15/26) are considered Small Island Developing States. WCPFC has passed key resolutions on the aspirations of and special considerations for SIDS. This also attracts additional funding from donors such as the EU and US, who provide $21 million annually, to support economic development in SIDS in the region under an Economic Assistance Agreement (EAA) with the Forum Fisheries Agency (FFA). The SIDS member states[68] of WCPFC are all members of FFA, which supports their participation in the WCPFC meetings with advice, expertise, and technical assistance.

B.10 Case Study: Pelagic purse seine fishery in Sonora, Mexico

B.10.1 Background

In 2021, Mexico was the 18th largest fishing nation, landing 1.6 million tonnes of fish (approximately 1.8% of global landings) (FAO 2022). The Gulf of California pelagic fishery is Mexico's largest fishery by volume. Its 50 vessels use purse seine nets to catch pelagic species in large shoals. In 2022, landings amounted to 779,449 tonnes, contributing to a significant proportion of overall landings in Mexico (MSC, 2023).

Table B1. Volume of species landed in the Sonora pelagic fishery in 2022

Species	Volume (Tonnes)
Chub mackerel (*Scomber japonicus*)	58,544
Californian anchovy (*Engraulis mordax*)	140,905
Pacific anchoveta (*Cetengraulis mysticetus*)	116,280
Pacific sardine (*Sardinops sagax*)	261,325
Pacific thread herring (*Opisthonema libertate*)	202,395
Total	**779,449**

The small pelagic fishery in the Gulf of Mexico has been MSC certified since 2011, demonstrating its level of sustainability and a management approach that accounts for the status of the target species, the wider ecosystem impacts of the fishery, and a robust management framework. Pelagic species are vulnerable to climate fluctuations and there is significant evidence to indicate that many pelagic species are shifting their habitat range as water temperatures change. This is particularly important given that small pelagic species are low trophic level species that play a significant role in the ecosystem by contributing to the diets of other species.

B.10.2 Key legislation

National legislation:

- General Law for Sustainable Fisheries and Aquaculture (LGPAS): The main purpose of the LGPAS is '*regulating, promoting, and managing the use of fishery and aquaculture resources [….] in accordance with the participation of fishers and the overarching principles related to the integral and sustainable development of fisheries and aquaculture*'
- General Law for Ecological Equilibrium and Environmental Protection (LGEEPA)
- General Law for Wildlife (LGVS)
- Mexican Official Standards for environmental and fisheries issues[69]

68 List of SIDS | Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States

69 Official Mexican Norms and Regulatory Agreements Effective from 1993 to 2015 | Library Digital Collections | UC San Diego Library (ucsd.edu) Accessed 22 July 2024

B.10.3 Description of fishery management measures

The Small Pelagics Fisheries Management Plan[70] sets out:

- minimum landing size;
- tolerance percentage below the minimum size;
- the definition of fishing zones;
- restrictions to fishing effort;
- fishing closures;
- fishing gear characteristics (mesh size);
- the use of satellite monitoring devices;
- access permits;
- maximum volumes of bycatch by species groups;
- prohibition of target species discards;
- reference points, including the allowable biological catch, optimum yield, minimum biomass, and the maximum sustainable yield;
- control rules designed to reduce the exploitation when the biomass declines.

B.10.4 Progress against EAFM components

Stage 1

Sustainable fisheries - Stock assessments vary by species and use a single-species approach: Pacific anchoveta, Californian anchovy and chub mackerel are assessed using a surplus production dynamic model (Schaefer) with a CMSY++ method using historical catch data to provide CPUE and biomass trends in relation to MSY. Pacific sardine and Thread herring use an Age Structured Assessment Program (ASAP) model to reconstruct the biomass trajectory and estimate parameters relevant to make management decisions. These models indicate that environmental conditions play an important role in the variability of the biomass and recruitment levels. There are no ecosystem-based reference points available but the biomass reference points do consider the proportion of sardines in the diet of birds, and stocks are currently healthy (Bystrom *et al*, 2023).

There is an observer program whose objectives are to monitor fishing activities and the potential impacts on the ecosystem. Data collection includes: location, date, depth, mesh and gear size, mitigation measures, boat, species, maturity, sex, size structure, weight structure, catch, and fishing effort. Data are also collected on all species interacting with the fishery, including the species, number of organisms, observed/captured, retained/released, mitigation measures, and condition.

Bycatch - Bycatch is very low. The fishery operates using hydroacoustic equipment to locate schools of target species and direct the deployment of the purse seine net. Bycatch limits are in place for individual groups of organisms including finfish, crustaceans, molluscs, elasmobranchs, and cnidarians. The FMP also establishes the volume of the fishery's total catch that can be composed of bycatch species (0.2 – 1.0% depending on organism class), minimum size limits for small pelagic species, and the percentage of catch that can be under the minimum size.

The fishery has an on-board observer program that ensures that 10% of the fleet has independent assessors verifying sustainable fishing practices. Between 2019 and 2021 observed bycatch made up less than 1% of the total observed catch (ranging from 0.024 to 0.95%) (Bystrom *et al* 2023).

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70 AGREEMENT announcing the update of the Fisheries Management Plan for the minor pelagic fishery (sardines, anchovies, mackerel and related) in northwestern Mexico (segob.gob.mx) Accessed 22 July 2024

ETP species - There is overlap in the fishing area and the habitat ranges of a number of ETP species including turtles, cetaceans, elasmobranchs and seabirds. It is mandatory to record any sightings or interactions with ETP species in the vessel logbook, which is verified through the on-board observer programme. Skippers are required to participate in observer training annually and each vessel carries an observer manual that details ETP species mitigation measures and best practices, including guidelines for the proper handling of rays, sharks and sea turtles, as well as the various strategies that crew members can implement to reduce seabird interactions. Feedback from logbook recordings is used to regularly update the training content and reporting protocols.

Shark finning is prohibited, and there is a total ban on catching some ETP species, including sea turtles and sharks, which must be returned to the water. Bycatch mitigation strategies for seabirds include the use of water curtains, horns and other noise-making devices, rain jacket flapping, and bars around winches. Observer data indicate that these measures have reduced the fishery interactions with ETP species.

Stage 2

Spatial management – Purse seines are pelagic gear targeting shoals of fish in the water column, and considered to cause little or no damage to benthic habitats. The soft-bottom substrates over which purse seines are deployed display little or no damage due to their high rate of recovery of the effects of the disturbance (Bystrom *et al*, 2023). The fishery is closed annually between July and September while spawning takes place. The exact dates are agreed between vessel owners, processors and the federal government each year, and is dependent on the proportion of catch below the minimum size limit. The fishery is split into four fishing regions, and each vessel must operate in a specific region defined in its Fishing Permit. Movement between regions is not allowed.

In the north-west of Mexico there are 21 protected natural areas, of which seven are related to fishing activity. These are multi-purpose zones, with only a small percentage of their marine surface area fully protected from fishing activities. VMS is mandatory and the system enables the verification of logbook data to detect any increase in risk to the main habitats.

Technical measures – Gear regulations include a specification on the size of the purse seine net based on vessel size. There is a prohibition on the addition of vessels to the fleet unless they replace old active boats that will be retired.

Stage 3

Trophic level impacts - Small pelagic fish often play an important role in the structure, organisation, and function of the wider ecosystem. Currently, fisheries management in this fishery is based on a single-species approach, but several ecological models have been developed to study the trophic dynamics of small pelagics in the Gulf of California and efforts continue to consider the impact of the fishery on the ecosystem and determine the biomass level needs for the sustainability of the ecosystem.

The Small Pelagic Fishery Management Plan specifies that each species should be managed using a harvest control rule and a biomass minimum value, intended to ensure that the health of the stock is maintained by leaving a minimum of biomass for periods of low abundance. Work is ongoing toward developing B_{ECO} reference points[71] , with the intention of incorporating them into the management approach when possible. The FMP also outlines a research program that considers impacts of the fishery on the ecosystems. The fishery has remained at a level where substantial biomass is available to support an ecosystem-based harvest rate that prevent ecosystem deterioration.

71 Biomass necessary for maintaining ecosystem functions (Bystrom 2023).

B.10.5 Cross cutting components

Climate change - The General Sustainable Fisheries and Aquaculture Law (2007) law sets out obligations to *a) Promote, regulate, drive and implement climate change adaptation and mitigation actions; b) Coordinate with the federal government, other states and municipalities, the implementation of such actions; and c) Use scientific and technological research as a basis for the sustainable exploitation of fisheries and aquaculture resources, and the implementation of actions related to sustainable fisheries and aquaculture*.

Research undertaken to understand the interaction of the fishery with its ecosystem will help in mitigating the impacts of climate change by ensuring ecosystem models are based on a clear understanding of interactions.

The small pelagic fishery is already affected by climate variations, in particular the El Niño Southern Oscillation with concomitant effects on primary production, fisheries, fishing pressure on the stocks and on predators of these species. Management in the face of these variations could contribute to the development of adaptive, robust management in the face of wider climate change impacts.

Customary sustainable use - The LGPAS allows subsistence fishers and those fishing as a form of livelihood preservation to do so without permits, but prohibits the selling of products fished for these reasons. The rights for indigenous peoples to subsistence fish and to fish as a form of cultural expression are given priority and special considerations (OECD, 2021) under Federal Law which establishes '*procedures to assure the preservation of natural resources […] and if necessary to seek preferential right to access, utilization and benefit of fisheries resources to indigenous communities and people […] in those places that they occupy and inhabit*'.

Illegal, Unreported and Unregulated fishing - Mexico performs strongly against IUU policy indicators for responsibilities as a Coastal State, responsibilities as a Port State, and international co-operation (OECD, 2021). The Mexican Federal Penal Code outlines a penalty of up to nine years in prison and a fine for illegal fishing activities. Regarding the reporting of illegal activities, National Commission on Aquaculture and Fisheries (CONAPESCA) has a 24-hour telephone line dedicated to receiving complaints regarding illegal fishing activity, and these reports are investigated by the relevant authorities. Fishing permits have to be renewed every five years and fishing vessels are required to use VMS system for tracking the spatial position of fishing activity. Inspection, monitoring and control activities take place on vessels, landing sites, piers, and ports, reproduction sites including estuaries and bay and lagoon systems, and in processing and distribution sites. Since 2016 the fishing industry has supported five additional observers to complement the National Institute of Fisheries and Aquaculture (INAPESCA) observers. Observers work on 40% (19) of the fleet's vessels, which represent 100% of the boat owning companies involved in the fishery.

Participatory approach – There is a formalised consultation process defined in national legislation which outlines requirements for fishery managers to regularly seek and consider relevant information, including local knowledge. INAPESCA holds public consultation meetings to provide a space for stakeholder participation in the fishery management process.

The Sub-committee of Responsible Fishing allows stakeholders to propose, compile, review and approve legislation related to fisheries. The Mexican government's public consultation processes related to fisheries management encourages and facilitates active stakeholder engagement through regular meetings of the committees involved in drafting management plans before these documents are published in their final version.

Science and the precautionary approach – Mexico is a signatory of the FAO Code of Conduct for Responsible Fisheries and compliance with its principles is embedded in the country's fisheries sector plan. The LGPAS states that to conserve and protect fishery resources and ecosystems, CONAPESCA must adopt the precautionary principle (Bystrom *et al*, 2023).

Before the beginning of the fishing season an investigation cruise is carried out on board a fishing or research vessel to assess the reproductive state of the stock and the proportion of juveniles in the four fishing areas. During the cruises, the oceanographic conditions are also gathered, mainly by sea surface temperature distribution. Based on these results, the date for the opening of the fishing season is decided by agreement between the fisheries researchers and the fishery participants. The fishing season can be shortened or additional areas closed to fishing if pre-season exploratory fishing surveys indicate a shortage of small pelagic fish on the fishing grounds.

B.10.6 Process for implementation

Although EAFM is not explicitly stated in Mexican fisheries legislation or FMPs, the decision to enter the MSC assessment process has required the small pelagic fishery to address many components of EAFM. Landings of Pacific sardine crashed in the early 1990s and concerns were raised over stock levels and interactions with native bird populations. To demonstrate that the fishery met the best practice requirements of the MSC Standard, the fishing industry began working with a local NGO, Comunidad y Biodiversidad (COBI), to help address concerns about the interaction of the fishery with the environment. This collaboration resulted in a more rigorous design of the monitoring and reporting system, as well as higher coverage of the fishing fleet with on-board observers to record bycatch and interactions with ETP species. The work is based on science rather than personal perspectives, and evidence must be provided to support decisions. While the goal of COBI is to protect the environment, they recognise that this can be delivered complimentary to the fishery objectives.

B.10.7 Summary of progress towards delivering Target 5 of the GBF

Although this fishery did not set out with an explicit aim to implement EAFM, Mexico has committed to international frameworks that guide the use of EAFM components. Landings from the small pelagic fishery remain significantly lower than models indicate is required to maintain the functioning of the ecosystem, and the combination of closures, landing sizes and TACs contribute to preventing overfishing. The fishing gear is already considered to have limited habitat impacts, and the fishery stakeholders have worked in collaboration with conservation groups to enhance their observer programme, deliver regular observer training and provide robust bycatch reporting protocols. This fishery represents a significant proportion of landings and exports for Mexico, and by committing to sustainable activity it continues to support local jobs in both the catch and processing sectors. Future research into the wider ecosystem interactions of the fishery should contribute to making the fishery more robust in the face of climate change, and the inclusion of B_{ECO} in future TAC considerations will continue to build a robust fishery management system.

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C Key Learnings from Case Studies

C.1 CCAMLR

- Strong emphasis on scientific research, that is integrated into a robust monitoring system.
- Continual monitoring of environmental parameters, particularly of indicator species and ecosystem interactions to detect warning signs of potential issues.
- Combining scientific research with monitoring allows for a precautionary approach, setting catch limits at low enough levels to not compromise future sustainability of the target stock.
- Extensive protected areas; VMEs are recorded and trigger area closures, and MPAs establishment both protect critical habitats and biodiversity, minimising local impacts and managing spatial distribution of fishing activities.
- Comprehensive compliance through the SoI and SCIC, which together mandate VMS, catch reporting, observers, at-sea inspections, port-state measures, and require reporting from signatory states, ensuring adherence to Conservation Measures.
- Explicit ecosystem approach to fisheries in Convention documentation and legally binding CMs.

C.2 Philippines

- Developing a baseline of knowledge can help determine where to target interventions and implement EAFM most strategically
- Social objectives can provide significant incentives to implement EAFM and can deliver environmental benefits concurrently
- EAF is a slow and evolving process but even when there are challenges of over exploited resources and high dependence on fisheries, there are still steps that can be taken towards EAFM
- External interventions/incentives can be an important driver to progress (EU yellow card, funding from USAID), but changes still need to be adopted within national and local government institutions.
- Having legislation and management measures that support EAFM is a first step but without enforcement and strong levels of compliance, overall objectives will not be met
- There is not a ‘one size fits all’ approach to delivering EAFM and each fishery management body will need to determine what works best for their stakeholders and fishery objectives
- Implementation doesn’t need to happen alone – there are tools and funds available to support the process and other countries willing to collaborate
- The MSC certified Philippines tuna fishery sets out how EAFM can be achieved and highlights that there is a roadmap available for other Filipino fisheries. The FIP process uses the MSC framework to enable fisheries to systematically address aspects of EAFM within a set timeframe. The approach is used globally in many different types of fisheries, providing a community of like-minded fishery stakeholders available to share knowledge and guidance on best practice.

C.3 South Africa

- Coordinating with other countries can provide access to additional information about the fish stocks and the ecosystem that can contribute to improved management overall.
- There is no one size fits all approach to EAFM – many similar fisheries face different challenges, but equally some different types of fisheries share similar challenges.
- South Africa has been working towards EAFM for over a decade and while it has made great improvements already, it is clear that sustainable changes take time.
- Improved data collection and knowledge can lead to changing perspectives for management, and applying a precautionary approach to fisheries management can ensure appropriate adaption when new information arises.

C.4 New Zealand

- Strong levels of compliance with economic incentives for fishers.
- Importance of stock assessments and scientific advice in influencing QMS and TAC setting, that allows for an adaptive management strategy, responsive to latest scientific assessments.
- Importance of stakeholder buy-in to fishery management process, emphasising involvement across levels of decision making, including financial support, and leading to enhanced technological developments and compliance.
- Co-management between Deepwater Council and Fisheries New Zealand for science-based decisions and stakeholder integration. Enables a collaborative approach that integrates scientific expertise with industry insights for evidence-based decision-making.

C.5 Canada

- Importance of understanding the usefulness of indigenous knowledges and designing a formal process for incorporating it into fisheries management through legislation. Consulting stakeholders is an important part of good governance, policy development and decision-making.
- Addressing IUU is an international issue that requires countries to collaborate and share resources where possible.
- Flexibility in the management system can reduce discarding and support a well-managed and sustainable mixed fishery.
- Independent external review of management plans contributes to adaptive management and will be valuable in the face of climate change.
- An overarching policy that pulls together all EAFM related legislation will help ensure smoother implementation and allow for the identification of gaps in the EAFM components addressed.
- Even in a developed, well-resourced country, the process to implement EAFM once it is legislated for takes time.

C.6 Belize

- Use of data-limited stock estimates, and the support from external organisations (NGOs and academics) provide resources that could be useful support for countries in similar situations.
- Belize's existing co-management entities are adding capacity to the government's efforts to establish adaptive management plans for the small-scale fisheries.
- The Managed Access initiative was designed to empower traditional fishers by ensuring greater participation in the decision-making process.

C.7 Iceland

- Importance of early consultation but also value in being able to move fast in decision making to make successful intervention.
- Strong market incentives (e.g. exports to UK with consumer requirements) can be a driver in improving the performance of a fishery.
- Management designed to achieve sustainable fishery objectives can also have ecosystem benefits even when these are not the explicit target of the policy (e.g. increasing economic efficiency results in lower seabed impact).
- It is challenging to balancing environmental, economic and social objectives in fisheries. The ITQ system was implemented rapidly and was successful in reducing overexploitation and creating an economically more efficient and consolidated industry, however it had social consequences that have had to be subsequently addressed.
- If reforms are implemented more gradually/with more time, and with stakeholder participation, potentially negative social consequences can be identified and the management system can be designed to minimise/mitigate such impacts.

C.8 Lyme Bay, UK

- Voluntary agreements are less effective than government-led initiatives.
- Importance of annual monitoring to provide evidence on ecological recovery and social and economic impacts, and to inform fisheries management.
- Collaborative, cross-sector management is key to maximising social benefits for local communities and increasing engagement with management strategies.

C.9 WCFPC

- WCPFC have detailed plans for bycatch and ETP species, including data collection, catch mitigation where possible, stock assessment and incorporation into wider management objectives for target species is key.
- Incorporating climate change and fluctuations as a risk or uncertainty parameter in stock assessment and modelling, particularly important for the Pacific given ENSO events and should be considered by all RFMO managed stocks.

C.10 Mexico

- Management and objectives are already in place but not explicitly termed 'EAFM'.
- Small steps or changes may be all that is needed to shift current management to EAFM.
- Some gear types have less environmental impact and require less work to implement some aspects of EAFM.
- Regular review of data and management, and the ability to adapt management approaches, will become even more important under changing climate conditions.
- The complexity of this ecosystem adds to the challenge of EAFM, but there are already studies underway to model climate fluctuations and these could be adapted to consider climate change impacts.
- Reaching agreement among stakeholders and coordinating management actions across multiple sectors can be challenging, and requires strong governance frameworks and effective communication and collaboration among stakeholders.

D Potential Indicators of Implementation

Appropriate indicators will depend on the fishery and its agreed objectives and should be both comprehensive and complementary. Table D1 provides suggestions that could be used to generate a suite of indicators to reflect progress in implementing EAFM, based on the findings of the literature review.

Table D1. Potential indicators that could be used to support assessment of progress in implementing EAFM, based on the findings of the literature review

EAFM Component	Potential Indicators for the Implementation of EAFM
Target species	International agreements translated into national legislation, Sustainable fishery objectives in policy, Number of fisheries with management in place, Number of fisheries managed using reference points, Number of fisheries with stock assessments, Number of fisheries with FMPs, Number and coverage of stocks with effort or catch limits, Proportion of stocks within safe limits, Presence of a formal harvest strategy and harvest control rules, Number of MSC certified fisheries
Rebuilding depleted species	Sustainable fishery objectives in policy, Number of fisheries with rebuilding plans in place, Depleted target species populations, Trends in rebuilding depleted populations, Depleted species status designated
Bycatch	Policy goals, legislation, and incentives in place for bycatch, Number of fisheries with management in place, Number of fisheries managed using reference points, Number of fisheries with stock assessments, Number of bycatch stocks within safe limits, Number of bycatch species with FMPs, Presence of observer programmes or REM, Presence of bycatch reporting mechanisms, Measures in place to reduce bycatch
Discards	Policy goals, legislation and incentives in place for discards, Number of fisheries with stock assessments, Presence of observer programmes or REM, Presence of market incentives to discourage discards, Mandatory reporting or bans on discards, Measures in place to reduce discards
Ghost gear	Ghost gear objectives in policy, Presence of marking and tagging schemes, Presence of harbour recycling hubs, Presence of reporting mechanism
`ETP species	International agreements translated into national legislation, ETP objectives in policy, National ETP designations, Number of species with stock assessments, Presence of reporting protocols, Presence of observer programmes or REM, Percentage of fisheries for which impacts on threatened species have been assessed, Measures in place to minimise impact on ETP, Impact levels on ETP understood, Population trends improving, Conservation status improving
IUU	Commitment to PSMA, IUU objectives in policies, Presence of observer programmes or REM, Number and coverage of MCS systems in place (including IUU assessment), Level of compliance

EAFM Component	Potential Indicators for the Implementation of EAFM
Closed areas	Presence of legislation allowing actions protection of vulnerable habitats (including VMEs), Commitment to CBD 30 by 30, Habitat objectives in national policy, National VME designations identified and allocated, Percentage of protected areas, Use of ecological risk assessments, Impacts of fishing on habitats understood, Degraded habitats are recovering, Measures in place to mitigate impacts, Understanding of trawl footprint
Gear modification	Presence of legislation allowing actions protection of vulnerable habitats (including VMEs); National VME designations identified and allocated, Percentage of fishery from bottom towed gear, Presence of habitat impact mitigation and avoidance measures, Use of ecological risk assessments, Understanding of trawl footprint
Trophic level impacts	Policies to manage the wider ecosystem adopted, Understanding of ecosystem interactions and identification of weak points, Use of ecological risk assessments, Use of MSE, Use of stock assessments containing wider ecosystem inputs,
Mixed fishery management	Use of ecological risk assessments, Use of MSE, Use of stock assessments containing wider ecosystem inputs, Identification of choke species, Measure in place to reduce impacts on less healthy stocks, Presence of adaptive fishery management systems
Climate change	International agreements translated into national legislation, Climate change objectives in policy, Use of adaptive management and regular reviews, Understanding of likely impacts from climate change
Social and economic considerations	Social and economic considerations included in national policy objectives, Percentage of employment in fisheries, Diversity in fisheries, Income generated from fisheries, Percentage of SSF, Presence of market incentives, Use of social and economic risk assessments
Customary sustainable use	International agreements translated into national legislation, Customary sustainable use objectives in policy, social and economic risk assessments
Participatory approach	Participatory approach in policy objectives, Presence of co-management bodies, Presence of a structure to allow public consultation in fishery management decision, Number of self-sampling programmes, Presence of regional and international collaborative groups
Science and the precautionary approach	Science and the precautionary approach in national policy objectives, Alignment of scientific advice with policy, Presence of regional and international collaborative groups, Assessment and understanding of fishing pressure, Reporting on the FAO questionnaire on CCRF

E Overview of Literature on the Impacts of Climate Change on Fisheries

Table E1. Overview of the ecological impacts of climate change on fisheries, and examples of potential responses to mitigate these impacts

Climate Forcing	Ecological Impact	Potential Responses	Potential Concerns	Examples
Seasonal, interannual, and multidecadal oscillations and directional anthropogenic climate change	Greater variability and uncertainty in productivity	Increase the precautionary buffer between maximum sustainable yield and total allowable catch limits	Reduced fishing opportunities	Proposed reduction in harvest rates for shared US/Canada salmon (McIlgorm *et al.*, 2010)
		Integrate ecosystem monitoring into annual fisheries management decision making	Increased complexity of decision making	Changes to Bering Sea pollock quota by the North Pacific Fishery Management Council (Coyle *et al.*, 2011; NOAA, 2012)
	Changes in species distribution	Implement spatially explicit stock assessments	Increased complexity of assessment models (Hart and Cadrin, 2004)	Spatial models for yellowtail flounder (Hart and Cadrin, 2004)
Multiyear to decadal oscillations and directional anthropogenic climate change	Wide range of potential impacts	Evaluate management approaches against climate scenarios	Can be time consuming	Evaluation of management options for US West Coast groundfishes (Kaplan *et al.*, 2010)
		Reduce subsidies and other incentives for overcapacity fisheries	Can be politically and economically difficult	Proposals to reduce fishery subsidies generally (Sumaila *et al.*, 2011)
	Change in population productivity	Mitigate non-climate stressors to enhance resilience to climate impacts	May require coordination across multiple management organisations	Reduce fishing pressure on Atlantic cod (Kell *et al.*, 2005), mitigate damage to coral reefs in the tropical Pacific (Bell *et al.*, 2013)

Climate Forcing	Ecological Impact	Potential Responses	Potential Concerns	Examples
		Manage for age, spatial, genetic and temporal diversity within stocks (portfolio effects)	Relevant diversity may be cryptic or unknown	Balance harvest across multiple subpopulations in Bristol Bay (Hilborn *et al.*, 2003)
		Use stock assessments with temporally variable productivity	Increased complexity of assessment models (Dorner *et al.*, 2009)	Declining productivity in northern Alaska salmon (Collie *et al.*, 2012)
Multidecadal oscillations and directional anthropogenic climate change	Wide range of potential impacts	Rapid assessment of stock vulnerability to climate change	Limited by expert knowledge and judgement (Chin *et al.*, 2010)	Climate vulnerability of Australian sharks and rays (Chin *et al*, 2010).
		Develop regional climate change scenarios	Regional processes often poorly resolved in models, surprises will remain likely (Stock *et al.*, 2011)	Atlantic croaker in the Northeast US (Hare *et al.*, 2010), Engling sole in the California Current (Ainsworth *et al.*, 2011)
	Change in population productivity	Restrict stock assessments to current environmental regime	Detecting regime shifts in real time is difficult, and short time series create uncertainty (Haltuch and Punt, 2011)	Detection of recruitment variation in Pacific groundfish (Haltuch and Punt, 2011)
		Re-evaluate rebuilding goals and timelines	May be constrained by regulatory requirements	Full rebuilding of southern cod stocks may not be possible (Mieszkowska *et al.*, 2009)
	New species shifting into a region	Temporary moratorium on new fisheries	Reduces flexibility for fishing industry	Closure of US Arctic waters (Stram and Evans, 2009)
		Prioritise new species for research, including experimental fishing	New priorities compete for funding with existing needs	North Sea anchovy prioritised for research by ICES (Pettigas *et al.*, 2012)

Climate Forcing	Ecological Impact	Potential Responses	Potential Concerns	Examples
	Difficult social and economic transitions	Rapid assessment of social vulnerability to climate change	May require collection of new social data	Global economic vulnerability (Allison *et al.*, 2009), the Northeast US community vulnerability (Jepson and Colburn, 2013).
		Co-management between government and fishing stakeholders	Can fail if fishing incentives do not foster sustainability (Miller *et al.*, 2010)	Baja California cooperatives (McCay *et al.*, 2011)
		Promote diversification across fisheries and livelihoods	Reduced short-term economic efficiency	New fisheries for southern species in the UK (Cheung *et al.*, 2012)
		Climate adaptation fund	Rules for implementation not yet defined (Sumaila *et al.*, 2011)	Proposed endowment fund (Sumaila *et al.*, 2011)
Directional anthropogenic climate change	Changes in species distributions	Re-evaluate and potentially move stock boundaries	Existing stock boundaries often based on limited data	Proposal to re-evaluate stock boundaries for a wide range of species (Link *et al*, 2011)
		Move closed area and other management boundaries	Location may be constrained by economic, social, or regulatory factors	Dynamic bycatch avoidance in Australia and Hawaii (Howell *et al.*, 2008; Hobday *et al.*, 2016), proposal to move the North Sea "Plaice Box" (van Keeken *et al.*, 2007)
		Pre-agreements, side payments, or transferable quotas among nations	Lack of common understanding that distribution is changing, lack of existing mechanisms for side payments (Miller and Munro, 2004)	Norway/Russia examples from the Barents Sea (Miller and Munro, 2004)

Adapted from Pinksy and Mantua, 2014

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