The implementation of ecosystem-based approaches applied to fisheries management under the CFP

EASME/EMFF/2018/011 Specific Contract Lot 1 No.1

EASME/EMFF/2018/011 Specific Contract Lot 2 No.3

Final Report

June 2022

Stichting Wageningen Research (WMR & WEcR), MRAG Europe (in association with MRAG Ltd), Institute of Food Safety, Animal Health and Environment (BIOR), Centre for Environment, Fisheries and Aquaculture Science (Cefas), Danmarks Tekniske Universitet (DTU), Eigen Vermogen van het Instituut voor Landbouw- en visserijonderzoek (EVILVO), National Marine Fisheries Research Institute (NMFRI), Swedish University of Agricultural Sciences (SLU), Johann Heinrich von Thuenen-Institute, Federal Research Institute of Rural Areas, Forestry and Fisheries (vTI)
January – 2022

EUROPEAN COMMISSION

European Climate, Infrastructure and Environment Executive Agency
Unit D.3 — Sustainable Blue Economy

Contact: CINEA EMFAF CONTRACTS

E-mail: cinea-emfaf-contracts@ec.europa.eu

European Commission
B-1049 Brussels

EUROPEAN COMMISSION

The implementation of ecosystem-based approaches applied to fisheries management under the CFP

EASME/EMFF/2018/011 Specific Contract Lot 1 No.1

EASME/EMFF/2018/011 Specific Contract Lot 2 No.3

Final Report

European Climate, Infrastructure and Environment Executive Agency

EUROPEAN COMMISSION

Luxembourg: Publications Office of the European Union, 2022

PDF	ISBN 978-92-95225-57-2	doi: 10.2926/57956	HZ-09-22-512-EN-N

European Climate, Infrastructure and Environment Executive Agency

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Term	Description
AC	Advisory Council
CBD	Convention on Biological Diversity
CFP	Common Fisheries Policy
CS	Case Study
DCF	Data Collection Framework
EAF	Ecosystem Approach to Fisheries
EAFM	Ecosystem-based Approach to Fisheries Management
EASME	Executive Agency for Small and Medium-sized Enterprises
EBFM	Ecosystem-Based Fisheries Management
EBM	Ecosystem-Based Management
EMFF	European Maritime and Fisheries Fund
eNGO	Environmental Non-Governmental Organization
EU	European Union
GFCM	General Fisheries Commission for the Mediterranean
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
ITQ	Individual Transferrable Quota
JRC	Joint Research Centre
LO	Landing Obligation
MAP	Multi-Annual Plan
MCRS	Minimum Conservation Reference Size
MLS	Minimum Landing Size
MPA	Marine Protected Area
MRF	Marine Recreational Fisheries
MS	Member State (of the European Union)
MSC	Marine Stewardship Council
MSFD	Marine Strategy Framework Directive
OR	Outermost Region (of the European Union)
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PETS	Protected, Endangered and Threatened Species
RAC	Regional Advisory Council
RFMO	Regional Fisheries Management Organization
STECF	Scientific, Technical and Economic Committee for Fisheries
TAC	Total Allowable Catch
TCM	Technical Conservation Measures
TMR	Technical Measures Regulation
TURF	Territorial Use Rights in Fisheries
UNCLOS	United Nations Convention on the Law of the Sea

GLOSSARY

Term	Description
EAFM challenge	EAFM challenges hinder the performance of an EAFM process to achieve policy objectives or societal goals. Examples are potential fisheries impacts on the ecosystem and fishing opportunities or obstacles that hamper the governance of an EAFM process and hence the implementation of appropriate management measures.
Ecosystem	An ecological system composed of biological communities of interacting organisms and their physical environment. Humans are an integral part of an ecosystem.
Ecosystem-based Approach to Fisheries Management	Here we distinguish between the concept of Ecosystem-based Approach to Fisheries Management (EAFM) and the actual implementation of an Ecosystem-based Approach to Fisheries Management, as there can be many different configurations depending on the context. We have not adopted any specific definition but work from a suite of common principles that drive the implementation of an EAFM.
Fishery	"A group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area" (ICES, 2003). The commercial fisheries correspond to a unity of gear type, target species (group), area and time of the year, and can therefore be expected to have the same (or sufficiently similar) impacts on the ecosystem and its different components. A fishery is the basic unit to which management measures apply. A fishery may consist of several métiers.
Policy instrument	An intervention in the governance arrangements often covering the advisory and decision-making processes intended to facilitate the implementation and/or enforcement of management measures. Policy instruments typically target actors in the social system.
Management measure	"Management measures are the specific elements of fisheries control which are embodied in regulations and which become a focus for surveillance activities."[1] In the context of the social-ecological system that is at the basis of EAFM, we define measures as operating solely in the ecological system where they mitigate the impact of fishing on the ecosystem including all its relevant components and aspects.
Management Strategy	The combination of a policy instrument and a management measure (this study). The policy instrument is the means to implement the measure.
Management Plan	An internally consistent combination of different management measures and policy instruments aimed at achieving a selection of policy objectives for a specific ecosystem and its socio-economic/institutional context.
Métier	"Part of the activity of a fishing fleet taking place in a given area, with a specific gear and targeting a specific (assemblage of) species" (ICES, 2003). For practical reasons, the métier definition chosen for this work was the Data Collection Framework (DCF) métiers used by Member States for reporting landings data.
Obstacle	In the context of EAFM, an obstacle hampers the implementation process of particular management measures, thereby compromising the achievement of relevant policy objectives or societal goals. An obstacle involves governance arrangements which specifically involve the advisory process or the decision-making process.

[1] https://www.fao.org/3/v4250e/V4250E05.htm

ABSTRACT

The Common Fisheries Policy states that an Ecosystem-Based Approach to Fisheries Management (EAFM) needs to be implemented. This study provides a state-of-play of the implementation of EAFM in the North and Baltic Seas, Western Atlantic and Outermost Regions. At the core of this assessment, the study identified three types of "EAFM challenges" that need to be addressed in order to advance EAFM. In addition, typologies were developed for the main EAFM components (fisheries, management measures and policy instruments), and used to assess the available fisheries management information. The analyses revealed that existing measures are largely targeting only one type of EAFM challenge, i.e. mitigating fishing impacts using both input and output measures. Although a lack of consolidated information on existing management measures prevented a full in-depth assessment, some key obstacles were identified in the governance arrangements that should facilitate an EAFM.

The advisory process should build on a transdisciplinary knowledge base, integrating various interdisciplinary scientific and local indigenous (e.g. fisher) knowledge to consider the full social-ecological system. Including context and stakeholder interests in decision-making can enhance the feasibility, appropriateness and impact of chosen management measures. The uptake of scientific advice beyond single-species stock assessments into decision-making should also be improved.

RÉSUMÉ

La politique commune de la pêche (PCP) prévoit la mise en œuvre d'une approche écosystémique de la gestion de la pêche (EAFM). Cette étude fournit un état des lieux clair de la mise en œuvre de l'EAFM dans la mer du Nord, la mer Baltique, l'Atlantique Ouest et les régions ultrapériphériques. Au cœur de cette évaluation, l'étude a identifié trois types de « défis de l'EAFM » qu'il convient de relever pour faire progresser l'EAFM. En outre, des typologies ont été développées pour les principales composantes de l'EAFM (pêcheries, mesures de gestion et instruments de politiques), et utilisées pour évaluer les informations disponibles sur la gestion des pêches. Les analyses ont révélé que les mesures existantes ne ciblent en grande partie qu'un seul type de défi de l'EAFM, à savoir atténuer des impacts de la pêche en utilisant à la fois des mesures d'entrée et de sortie. Bien que le manque d'informations consolidées sur les mesures de gestion existantes ait empêché une évaluation complète et approfondie, certains obstacles clés ont été identifiés dans les dispositions de gouvernance qui devraient faciliter une EAFM.

Afin de prendre en compte l'ensemble du système socio-écologique, le processus consultatif doit s'appuyer sur une base de connaissances transdisciplinaires, intégrant diverses connaissances scientifiques interdisciplinaires et natives locales (par exemple, les pêcheurs). La prise en compte du contexte et des intérêts des parties prenantes dans le processus décisionnel peut améliorer la faisabilité, la pertinence et l'impact des mesures de gestion choisies. Il convient également d'améliorer l'intégration des avis scientifiques au-delà de l'évaluation des stocks d'une seule espèce dans la prise de décision.

EXECUTIVE SUMMARY

The Common Fisheries Policy (CFP), European Union (EU) regulation 1380/2013 states that an ecosystem-based approach to fisheries management (EAFM) needs to be implemented. While there are various ecosystem approaches or ecosystem-based approaches linked to fisheries management, they appear to address similar or largely overlapping sets of objectives. Therefore, for the purpose of this study, the term 'Ecosystem-based Approach to Fisheries Management (EAFM)' was assumed to be similar to those other expressions. It was used to represent a fisheries governance framework that takes its conceptual principles and operational methods from conventional single-species fisheries management on the one hand, and ecosystem management on the other. These include accounting for the dynamic nature of ecosystems and their ecological integrity and biodiversity, explicit consideration of sustainability and the recognition of fisheries management as part of a social-ecological system.

To address the additional complexity associated with an EAFM requires interdisciplinary science and adaptive management, including increased stakeholder involvement. However, the difficulty of doing so in practice has resulted in EAFM remaining a largely conceptual approach with few operational examples, which often lacks appropriate guidance to advance its implementation.

Rather than continuing to examine EAFM as a concept, this study sought to provide a clear state-of-play of the implementation of EAFM in order to achieve policy objectives beyond the target species in specific EU marine areas, i.e. the North Sea, Baltic Sea, Western Atlantic and Outermost Regions. For these areas, the study provides an inventory of EAFM challenges that need to be addressed in order to advance EAFM, a characterization of the relevant types of fisheries and the types of measures that have been applied with their legal and scientific basis. In doing so, the study structured the available information and highlighted local examples of successful measures and policy instruments together with the obstacles that have hampered the implementation of an EAFM in practice.

This study was designed so that it could address two main objectives:

- Assess the current state of affairs pertaining to the implementation of EAFM, with a focus on measures and the governance required, in terms of their operational readiness.
- Provide recommendations to advance the implementation of EAFM aimed at addressing the identified challenges in order to achieve CFP and other policy objectives.

To respond to these objectives, a five-step EAFM process inspired by a similar process for an 'Ecosystem-based Approach to Maritime Spatial Planning':

1. **Defining** the frame for EAFM, starting with its aim to achieve specific policy objectives or societal goals within the social and environmental context and including the legal setting. We identified a number of EAFM challenges that, if addressed, may contribute to achieving these objectives and societal goals. Note that these objectives and societal goals are often understood to refer to the state of the ecosystem and fishing opportunities but may also involve social or economic objectives/goals.

2. **Developing** the knowledge base (which may include scientific as well as local indigenous knowledge) driven by the policy objectives or societal goals to be achieved, the relevant fisheries and potential EAFM measures. We identified a number of challenges that require an understanding of the interaction of specific fisheries with the ecosystem and how this may be mitigated through specific measures. Addressing these challenges may contribute to achieving these objectives and societal goals.

3. **Assessing** and weighing the EAFM alternative scenarios using the knowledge base and appropriate tools. This results in scientific advice that identifies preferred management and policy approaches.

4. **Implementing** a specific management plan based on informed decision-making guided by best practices. This plan is an internally consistent combination of different management measures and policy instruments aimed at achieving a selection of policy objectives for a specific ecosystem and its socio-economic/institutional context.

5. **Following-up** with an assessment of the state of affairs pertaining to the implementation of EAFM. This includes both the EAFM process, including the preceding steps, as well as its performance in achieving the specific policy objectives or societal goals. Addressing EAFM challenges is a way to show advancement.

These five stages represent one EAFM cycle where the follow-up step provides the basis for the advancements in the next EAFM cycle, supporting an adaptive process.

Based on a review of the literature, it was possible to identify a hierarchical typology of EAFM challenges that distinguished three main types of EAFM challenges:

1. Challenges to **mitigate fishing impacts** on fishing opportunities and the wider ecosystem, including by-catch, habitat impacts and impacts on food webs.

2. Challenges to improve the **advisory process and its knowledge base** by incorporating the effects of the environmental (ecological) context on fish, fishing opportunities and fisheries. This includes any environmental effects (e.g. from climate) on target and non-target species or habitats affecting their vulnerability and/or spatio-temporal distribution as well as the effects of other anthropogenic pressures, such as the effect of eutrophication or contaminants on productivity.

3. Challenges to improve the **decision-making process**. These include all potential effects of the social context on fisheries management and its governance. This, in turn, includes economic aspects, such as where short-term profits may be at odds with long-term sustainability; management aspects, such as a lack of clear policy targets, and social aspects, including stakeholder disagreements and low levels of participation.

Addressing these EAFM challenges can advance an EAFM and ultimately improve performance in terms of achieving the policy objectives and societal goals identified in the defining step. To assess the current state of affairs pertaining to the implementation of an EAFM it was necessary to identify and define the key EAFM components, i.e. the fisheries (both commercial and recreational), the management measures and their legal settings.

Commercial fisheries were identified based on defining fisheries as: "a group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area" (ICES, 2003). These fisheries could reasonably be expected to have sufficiently similar impact on the ecosystem, and could be used as the basic unit for the assessment. Landings and species composition by the métiers used by Member States for reporting landing data were analyzed to identify 227 fisheries relevant for EAFM from the initial 517 métiers (156 in European waters, excluding Mediterranean and Black Seas, and 71 in the Outermost Regions). National recreational fisheries were also identified where the existing data suggested that they were contributing to removals so should be included.

A review of existing management measures, which could be applied in order to manage fisheries, identified three broad types of measures:

1. **Input measures**, including Technical Conservation Measures (TCM) consisting of gear-based TCM (e.g. mesh size changes or sorting grids) and spatial/temporal TCM (e.g. no-take zones or real-time closures) and capacity and effort controls (e.g. decommissioning or licensing).

2. **Output measures**, including Total Allowable Catch (TAC) controls, landing size controls and discard bans.

3. **Ecosystem restoration measures** including restocking schemes and stock enhancement (e.g. through habitat restoration or artificial reefs).

The review revealed other types of interventions that become relevant if the full social-ecological system is considered as an EAFM requires. These were identified as policy instruments which, in contrast to the management measures operating in the ecological system, operate in the social system. Examples of such policy instruments include regulatory instruments, such as co-management or self-management; economic instruments (e.g. tariffs, taxes and charges and, permit or quota trading and subsidies for alternative gears); information and public engagement measures such as eco-labelling that include EAFM objectives; and interventions to enhance monitoring and research and improve the knowledge base.

The study also considered the legal basis for the measures implemented, primarily whether this was at the EU or Member State level. This suggested that measures to mitigate impacts on commercial stocks were often based on the EU level, through the Common Fisheries Policy (CFP). In contrast, measures to mitigate impacts on the wider ecosystem and policy instruments to improve the governance often had their basis in Member State legislation.

The role of the EAFM context was further explored through 12 in-depth case studies. The case studies explored various combinations of measures, EAFM challenges and fisheries, and were used to provide insight into the advisory and decision-making process used to identify and implement measures. The case studies were used to identify potential best practices that might have wider applicability and highlighted the important roles of uncertainty and disagreement within these processes, drawing attention to the role of science as well as other knowledge types.

The case studies also revealed that decision-making processes are also affected by issues of institutions, participation and power that both enable and prevent the use of evidence and the implementation of measures. Key lessons learned included:

- The development of the knowledge base needs to move towards inter- and transdisciplinarity.
- Scientific knowledge is one type of knowledge and it is important to ensure that other types of knowledge, including that of fishers and other stakeholders, can contribute to the knowledge base.
- Development of the knowledge base is important but its uptake in the decision-making process is key for a successful EAFM process.
- Stakeholder involvement should occur throughout the EAFM process, starting with the defining step, where the relevant policy objectives and societal goals are being identified.An important challenge involves conflicts between different stakeholder groups.
- Decision-making should be clearly linked to the advisory process, taking account of the knowledge base and stakeholder interests and applying principles of good governance, including issues of legitimacy, inclusiveness, fairness, and accountability.

An assessment of the performance of EAFM to date and the extent to which it was 'functioning properly' was outside the remit of this study. Instead the focus was on the progress made from single-species management towards an EAFM. To assess such progress, we assumed a continuum of increasingly more EAFM, that progressively addresses a wider set of EAFM challenges starting from conventional single-species fisheries management and moving towards a more comprehensive EAFM. On this basis, progress can be made to advance EAFM along this continuum, achieving an increasingly wider range of policy objectives by improving the knowledge base, advisory and decision-making processes.

In order to 'assess the current state of affairs pertaining to the implementation of EAFM' it was necessary to structure the existing information. A relational database was created that played an important role in linking the fisheries and measures/policy instruments with the EAFM challenges. It provided an overview of the extent to which EAFM challenges are addressed by the current state of affairs. This serves as a basis to formulate recommendations for the (further) advancement of the implementation of EAFM. The first analysis, using the database, indicated that existing measures are mostly mitigating fishing impacts using both input and output measures. Therefore, the majority of measures are still primarily focused on conventional single-species fisheries management.

To advance an EAFM it is therefore necessary to address the different EAFM challenges and (further) expand the policy objectives beyond the commercial species, improve the knowledge base and seek to address obstacles within the existing advisory and decision-making processes. The analysis, however, was severely hampered by the lack of a comprehensive and consistent overview of the fisheries management measures in place. A key recommendation is therefore to start a process for the routine collection of such information. The findings of this study (e.g. typology of fisheries, management measures and proposed policy instruments) can contribute to guide this process. Also, the database can provide a tool to monitor further progress in implementing EAFM.

The annual TAC and quota process could be a relatively easy starting point for implementing a move towards EAFM. Applying the typology of EAFM challenges developed in this project could make this more explicit as an important first step. This would require the various advisory bodies, e.g. ICES or STECF, to ensure that the knowledge base is adequate and informed by an inter- and transdisciplinary perspective, thereby increasing the credibility of the knowledge base. As a prerequisite, a better understanding of EAFM principles and relevant concepts is needed if there is to be more EAFM advice.

Further improvement can be achieved through stakeholder involvement and a more explicit consideration of the context in which the EAFM process occurs. This builds trust in the EAFM process and increases the legitimacy of its outcome. Importantly, this applies to each of the steps in the EAFM process starting with the defining step. Effective EAFM also requires that decision-making is tightly linked to the advisory process and that it applies principles of good governance, including issues of legitimacy, inclusiveness, fairness, and accountability. Efforts have been made, through the process of regionalization, to enable stakeholders to contribute to policy processes but these could go further.

The synthesis of all outputs in this project (i.e. EAFM challenges, typologies of fisheries, management measures), and its application to assess the current state of affairs in fisheries management and the implementation of an EAFM specifically, enabled the study to reach the following conclusions:

1. The overall conclusion of the assessment was that current fisheries management is dominated by conventional single-species advice on which the TAC/quota management is based. The first step toward more EAFM is through the implementation of TCMs to mitigate by-catch. All other EAFM initiatives mainly consist of regulatory or economic policy instruments, not measures.

2. Hierarchical typologies of the relevant components (i.e. EAFM challenges, fisheries and measures) are appropriate to structure EAFM and assess the state of affairs in relation to EAFM.
3. The three main categories of EAFM challenges appear comprehensive and useful as they cover what appear to be the main overall challenges, i.e. (1) mitigating fisheries impact on the ecosystem, (2) the advisory process and (3) decision-making. While these three main categories are not likely to change, some of the more detailed (below sub-type) challenges may need to be revisited and, in some cases, combined.
4. The typology for the commercial fisheries appears suitable in an EAFM context. However, it could be expanded to include recreational fisheries to a greater extent. The current typology is based on the fisheries' interaction with the ecological system and could be further developed to incorporate their link to specific fishing communities to encompass the whole social-ecological system as EAFM requires.
5. The hierarchical typology of management measures was essential to structure the immense variety of detail that emerged from the review of existing measures.
6. Although not specifically requested, we found that EAFM requires the explicit distinction between the management measures and the policy instruments as the means to implement them. Separating them from management measures is not only an improvement from a conceptual perspective but has many practical advantages as the two operate in distinct parts of the social-ecological system, require different expertise and scientific disciplines, and/or involve different governance actors. This study provided a first tentative typology of policy instruments but, considering their importance in EAFM, especially in relation to 'operational readiness', this needs to be revisited and improved.
7. The application of both measures and policy instruments and their typologies (as part of a relational database to assess the current state of affairs in relation to EAFM) showed internal consistency (e.g. measures mainly link to the type 1 fishing impact challenge, policy instruments to the type 2 and 3 EAFM challenges that involve respectively the advisory and decision-making processes) and their potential usefulness for such assessments.
8. The bottleneck for the EAFM assessment was the availability of a comprehensive list of management measures, appropriately categorized at an adequate level of detail. As it currently stands, only a few rather randomly collected datasets were available, and it was not always clear how to categorize and assess them or how they matched the measures typology presented here. The current typologies of both measures and policy instruments should be tested and improved (certainly the policy instruments) so that they can be used to generate comprehensive lists of EAFM measures and policy instruments for each of the regional seas to be applied in future assessments.
9. The two focal points of the 'operational readiness' assessment, i.e. measures and policy instruments, appear relevant. However, the key issue that determines ‘operational readiness’ is the specific context, mostly ecological/environmental for the measures, and social/institutional for the governance. In order to advance operational readiness of EAFM in its specific context we propose to collate generic information that allows a first scrutiny of potential measures or policy instruments that can be considered ready for operation against a selection of essential tenets, e.g. socially desirable/tolerable, legally permissible, administratively achievable and politically expedient and then further evaluate this selection in the specific context where EAFM is supposed to be implemented.

***

RÉSUMÉ EXÉCUTIF

La politique commune de la pêche (PCP), règlement 1380/2013 de l'Union européenne (UE) stipule qu'une approche écosystémique de la gestion des pêches (EAFM) doit être mise en œuvre. Bien qu'il existe plusieurs approches écosystémiques ou approches fondées sur les écosystèmes liées à la gestion de la pêche, elles semblent viser des objectifs similaires ou pour le moins largement communs. Par conséquent, aux fins de la présente étude, le terme « approche écosystémique de la gestion des pêches » (EAFM) a été considéré comme synonyme de ces autres expressions. Il a été utilisé pour représenter un cadre de gouvernance des pêches qui tire ses principes conceptuels et ses méthodes opérationnelles de la gestion conventionnelle des pêches monospécifiques, d'une part, et de la gestion des écosystèmes, d'autre part. Il s'agit notamment de la prise en compte de la nature dynamique des écosystèmes, de leur intégrité écologique et de leur biodiversité, de la prise en compte explicite de la durabilité et de la reconnaissance de la gestion de la pêche comme faisant partie d'un système socio-écologique.

Faire face à la complexité supplémentaire associée à une EAFM nécessite la mise en place d'une science interdisciplinaire et d'une gestion adaptative incluant notamment une participation accrue des parties prenantes. Cependant, à cause de la difficulté à les réaliser, l'EAFM reste une approche largement conceptuelle offrant peu d'exemples pratiques et souvent dénuée de conseils appropriés pour faire avancer sa mise en œuvre.

Plutôt que de continuer à examiner l'EAFM en tant que concept, cette étude a cherché à fournir un état des lieux clair sur la mise en œuvre de l'EAFM pour atteindre les objectifs de politiques au-delà des espèces cibles dans des zones marines spécifiques de l'UE, par exemple la mer du Nord, la mer Baltique, l'Atlantique occidental et les régions ultrapériphériques. Pour ces zones, l'étude fournit un inventaire des défis à relever pour faire progresser l'EAFM, une caractérisation des types de pêches concernés et des types de mesures qui ont été appliquées avec leur base juridique et scientifique. Ce faisant, l'étude a structuré les informations disponibles, mis en lumière des exemples locaux de mesures et d'outils de politiques réussis ainsi que les obstacles qui entravent la mise en œuvre d'une EAFM.

Cette étude a été conçue de manière à pouvoir répondre aux deux principaux objectifs de l'étude :

- Évaluer l'état actuel de la mise en œuvre de l'EAFM, en mettant l'accent sur les mesures et la gouvernance requise en termes d'état de capacité opérationnelle.
- Fournir des recommandations pour faire avancer la mise en œuvre de l'EAFM visant à relever les défis identifiés afin d'atteindre la PCP et d'autres objectifs de politiques.

Pour répondre à ces objectifs, il a été établi un processus d'EAFM en cinq étapes inspiré d'un processus similaire pour une « approche écosystémique de la planification de l'espace maritime » :

1. **Définir** le cadre de l'EAFM, en commençant par son but d'atteindre des objectifs de politiques ou des buts sociétaux spécifiques dans le contexte social et environnemental, et y inclure le cadre juridique. Nous avons identifié un certain nombre de défis EAFM qui, s'ils sont relevés, peuvent contribuer à la réalisation de ces objectifs et buts sociétaux. Il convient de noter que ces objectifs et buts sociétaux sont souvent compris comme se référant à l'état de l'écosystème et aux possibilités de pêche, mais peuvent également impliquer des objectifs/buts sociaux ou économiques.

2. **Développer** la base de connaissances (qui peut inclure des connaissances scientifiques et des connaissances natives locales) en fonction des objectifs politiques ou des buts sociétaux à atteindre, des pêcheries concernées et des mesures potentielles de l'EAFM. Nous avons identifié un certain nombre de défis qui nécessitent une compréhension de l'interaction existante entre des pêcheries spécifiques et l'écosystème et de la manière

dont cela peut être atténué par des mesures spécifiques. Relever ces défis peut contribuer à la réalisation de ces objectifs et buts sociétaux.

3. **Évaluer** et pondérer les scénarios alternatifs de l'EAFM en utilisant une base de connaissances et les outils appropriés. Il en résulte un avis scientifique qui propose des approches privilégiées en matière de gestion et de politique.

4. **Mettre en œuvre** un plan de gestion spécifique basé sur une prise de décision éclairée et guidée par les meilleures pratiques. Ce plan est une combinaison cohérente en interne de différentes mesures de gestion et d'instruments de politiques visant à atteindre une sélection d'objectifs politiques pour un écosystème spécifique et son contexte socio-économique/institutionnel.

5. **Suivre,** c'est à dire essentiellement faire une évaluation de l'état d'avancement de la mise en œuvre de l'EAFM. Cela inclut à la fois le processus de l'EAFM, c'est-à-dire les étapes précédentes, et sa performance dans la réalisation d'objectifs de politiques spécifiques ou de buts sociétaux. Relever les défis de l'EAFM est un moyen de montrer que l'on avance.

Ces cinq étapes représentent un cycle EAFM où l'étape de suivi fournit la base des avancées dans le cycle EAFM suivant de ce qui est essentiellement un processus adaptatif.

Sur la base d'une revue de la littérature, il a été possible d'identifier une typologie hiérarchique des défis de l'EAFM qui distingue trois types de défis principaux de l'EAFM :

1. Des défis pour **atténuer les impacts de la pêche** sur les opportunités de pêche et sur l'écosystème au sens large, notamment les prises accessoires, les impacts sur l'habitat et les impacts sur les réseaux alimentaires.

2. Des défis pour améliorer le **processus consultatif et sa base de connaissances** en intégrant les effets du contexte environnemental (écologique) sur les poissons, les opportunités de pêche et les pêcheries. Cela comprend tous les effets environnementaux (par exemple, ceux du climat) sur les espèces ou les habitats cibles et non cibles, qui affectent leur vulnérabilité et/ou leur distribution spatio-temporelle, ainsi que les effets d'autres pressions anthropiques sur la productivité, tels que l'eutrophisation ou les contaminants.

3. Des défis pour améliorer le **processus de prise de décision**. Il s'agit de tous les effets potentiels du contexte social sur la gestion de la pêche et sa gouvernance. Cela inclut notamment des aspects économiques (par exemple lorsque les bénéfices à court terme peuvent être en contradiction avec la durabilité à long terme), des aspects de gestion (comme l'absence d'objectifs de politiques clairs) et des aspects sociaux (notamment les désaccords entre les parties prenantes et les faibles niveaux de participation).

En s'attaquant à ces défis, on peut faire progresser l'EAFM et en fin de compte, aussi améliorer ses performances en termes de réalisation des objectifs de politiques et des buts sociétaux identifiés lors de l'étape de définition. Pour évaluer l'état actuel de la mise en œuvre de l'EAFM, il était nécessaire d'identifier et de définir les éléments clés de l'EAFM, c'est-à-dire les pêcheries (commerciales et récréatives), les mesures de gestion et leur cadre juridique.

Les pêcheries commerciales ont été identifiées sur la base de la définition suivante : « un groupe de voyages de navires ciblant les mêmes (ensembles d') espèces et/ou stocks, utilisant des engins similaires, pendant la même période de l'année et dans la même zone » (ICES, 2003). On peut raisonnablement s'attendre à ce que ces pêcheries aient des impacts suffisamment similaires sur l'écosystème, et elles pourraient être utilisées comme unité de base pour l'évaluation. Les débarquements et la composition par espèce des métiers utilisés par les États membres pour la déclaration des données de débarquement ont été analysés afin d'identifier 227 pêcheries pertinentes pour l'EAFM parmi les 517 métiers initiaux (156 dans les eaux européennes à l'exclusion de la Méditerranée et de la mer Noire et 71 dans les régions ultrapériphériques). Les pêcheries récréatives nationales ont également été identifiées lorsque les données existantes suggéraient qu'elles contribuaient aux prélèvements et devaient être incluses.

Un examen des mesures de gestion existantes qui pourraient être appliquées pour gérer les pêcheries a permis d'identifier trois grands types de mesures :

1. Les **mesures d'entrée**, y compris des mesures techniques de conservation (MTC) comprenant des MTC basées sur l'équipement (par exemple, des modifications du maillage ou des grilles de tri) et des MTC spatiales/temporelles (par exemple, des zones de non-prélèvement ou des fermetures en temps réel) et des contrôles de la capacité et de l'effort (par exemple, le déclassement ou l'octroi de licences).

2. Les **mesures de sortie**, y compris les contrôles des Totaux Admissibles de Captures (TAC), les contrôles de la taille des débarquements et les interdictions de rejet

3. Les **mesures de restauration des écosystèmes**, y compris les programmes de repeuplement et le renforcement des stocks (par exemple, par la restauration de l'habitat ou les récifs artificiels).

L'examen a révélé d'autres types d'interventions qui deviennent pertinentes si l'on considère l'ensemble du système socio-écologique comme une exigence de l'EAFM. Il s'agit d'instruments de politiques qui, contrairement aux mesures de gestion utilisées dans le système écologique, fonctionnent dans le système social. Parmi les exemples de ce type d'instruments de politiques, citons les instruments réglementaires tels que la cogestion ou l'autogestion ; les instruments économiques (par exemple, les tarifs, les taxes et les redevances, les échanges de permis ou de quotas et les subventions pour les engins alternatifs) ; les mesures d'information et d'engagement du public telles que l'éco-étiquetage qui inclut les objectifs de l'EAFM ; et les interventions visant à renforcer le suivi et la recherche et à améliorer la base de connaissances.

L'étude a également examiné la base juridique des mesures mises en œuvre, que ce soit au niveau de l'UE ou des États membres. Cela a mis en lumière que les mesures visant à atténuer les impacts sur les stocks commerciaux étaient souvent fixées au niveau de l'UE, au moyen de la PCP. En revanche, les mesures visant à atténuer les incidences sur l'écosystème au sens large et les instruments de politiques destinés à améliorer la gouvernance trouvent souvent leur fondement dans la législation des États membres.

Le rôle du contexte de l'EAFM a été exploréau moyen de 12 études de cas approfondies. Les études de cas ont exploré diverses combinaisons de mesures, de défis EAFM et de pêcheries, et ont été utilisées pour donner un aperçu du processus consultatif et décisionnel utilisé pour identifier et mettre en œuvre les mesures. Les études de cas ont été utilisées pour identifier les meilleures pratiques potentielles qui pourraient être appliquées de façon plus large et ont souligné les rôles importants de l'incertitude et du désaccord dans ces processus, en attirant l'attention sur le rôle de la science ainsi que d'autres types de connaissances.

Les études de cas ont également révélé que les processus décisionnels sont aussi affectés par des questions d'institutions, de participation et de pouvoir qui permettent et empêchent à la fois l'utilisation de preuves et la mise en œuvre de mesures. Les principales leçons à retenir sont les suivantes :

- L'élaboration de la base de connaissances doit s'orienter vers l'inter- et la transdisciplinarité.

- Les connaissances scientifiques sont un type de connaissances et il est important de veiller à ce que d'autres types de connaissances, y compris celles des pêcheurs et des autres parties prenantes, puissent contribuer à la base de connaissances.
- Le développement de la base de connaissances est important, mais son intégration dans le processus de prise de décision est la clé de la réussite du processus de l'EAFM.
- L'implication des parties prenantes doit se faire tout au long du processus de l'EAFM, en commençant par l'étape de définition, où les objectifs de politiques et les buts sociétaux pertinents sont identifiés. Un défi important concerne les conflits entre les différents groupes de parties prenantes.
- La prise de décision doit être clairement liée au processus consultatif, en tenant compte de la base de connaissances et des intérêts des parties prenantes et en appliquant les principes de bonne gouvernance, notamment les questions de légitimité, d'inclusion, d'équité et de responsabilité.

L'évaluation des performances de l'EAFM et de son « bon fonctionnement » n'entre pas dans le cadre de cette étude. Au lieu de cela, l'accent a été mis sur les progrès réalisés pour passer d'une gestion monospécifique à une EAFM. Pour évaluer ces progrès, nous avons considéré un continuum de plus en plus EAFM, qui s'attaque progressivement à un ensemble plus large de défis liés à l'EAFM, en partant de la gestion traditionnelle des pêcheries mono-espèces pour arriver à une EAFM plus « mature ». Sur cette base, des progrès peuvent être faits pour faire avancer l'EAFM le long de ce continuum et atteindre un éventail de plus en plus large d'objectifs de politiques en améliorant la base de connaissances et les processus consultatif et de décision.

Afin d' « évaluer l'état actuel de la situation relatif à la mise en œuvre de l'EAFM », il est nécessaire de structurer les informations pertinentes. À cette fin, a été créée une base de données relationnelle qui a joué un rôle important dans la mise en relation des pêcheries et des mesures/outils de politiques avec les défis de l'EAFM. Elle fournit une vue d'ensemble de la mesure dans laquelle les défis EAFM sont abordés par la situation actuelle. Cela sert de base pour formuler des recommandations pour l'avancement (ultérieur) de la mise en œuvre de l'EAFM. Cette première analyse utilisant la base de données a indiqué que la plupart des mesures existantes atténuent les impacts de la pêche en utilisant à la fois des mesures d'entrée et de sortie. Ainsi, la majorité des mesures sont encore principalement axées sur la gestion conventionnelle des pêcheries mono-espèces.

Pour faire progresser l'EAFM, il est donc nécessaire de relever les différents défis de l'EAFM et d'élargir (encore) les objectifs politiques au-delà des espèces commerciales, améliorer la base de connaissances et de chercher à lever les obstacles au sein des processus consultatifs et décisionnels existants. L'analyse a toutefois été sérieusement entravée par l'absence d'une vue d'ensemble complète et cohérente des mesures de gestion de la pêche en place. Une recommandation clé est donc de lancer un processus de collecte systématique de ces informations. Les conclusions de cette étude (par exemple, la typologie des pêcheries, les mesures de gestion et les instruments de politiques proposés) peuvent contribuer à guider ce processus. De plus, la base de données peut fournir un outil pour suivre les progrès futurs de la mise en œuvre de l'EAFM.

Le processus annuel des TAC et des quotas pourrait constituer un point de départ relativement facile pour mettre en œuvre une évolution vers l'EAFM. L'application de la typologie des défis de l'EAFM développée dans ce projet pourrait rendre cela plus explicite, ce qui constitue une première étape importante. Ce type de changement exigerait que les différents organes consultatifs, par exemple le CIEM ou le CSTEP, veillent à ce que la base de connaissances soit adéquate et alimentée par une perspective inter- et transdisciplinaire, ce qui accroîtrait la crédibilité de la base de connaissances. Une meilleure compréhension de l'EAFM, de ses principes et concepts pertinents est indispensable pour fournir davantage d'avis sur elle.

D'autres améliorations peuvent être apportées par l'implication des parties prenantes et par une prise en compte plus explicite du contexte dans lequel se déroule le processus de l'EAFM. Cela renforcerait la confiance dans le processus EAFM et accroîtrait la légitimité de ses résultats. Il est important de noter que cela s'applique à chacune des étapes du processus EAFM, en commençant par l'étape de définition. Une EAFM efficace exige aussi que la prise de décision soit étroitement liée au processus consultatif et qu'elle applique les principes de bonne gouvernance, en incluant les questions de légitimité, d'inclusion, d'équité et de responsabilité. Des efforts ont été faits, au moyen du processus de régionalisation, pour permettre aux parties prenantes de contribuer aux processus politiques. Pourtant, ces efforts pourraient aller plus loin.

La synthèse de tous les résultats des tâches individuelles de ce projet (c'est-à-dire les défis EAFM, les typologies de pêche et les mesures de gestion), et son application pour évaluer l'état actuel de la gestion de la pêche et plus particulièrement la mise en œuvre d'une EAFM ont permis de tirer les conclusions suivantes :

1. La conclusion générale de l'évaluation est que la gestion actuelle des pêches est dominée par des avis conventionnels se rapportant à une seule espèce, sur lesquels repose la gestion des TAC/quotas. La première étape vers plus d'EAFM passe par la mise en œuvre de mesures MTC visant à atténuer les prises accessoires. Toutes les autres initiatives EAFM consistent principalement en des instruments de politique réglementaires ou économiques, et non en des mesures.
2. Les typologies hiérarchiques des composantes pertinentes (c'est-à-dire les défis EAFM, les pêcheries et les mesures) sont appropriées pour structurer l'EAFM et évaluer l'état de la situation par rapport à l'EAFM.
3. Les trois principales catégories de défis EAFM semblent complètes et utiles car elles couvrent ce qui semble être les principaux défis généraux, à savoir (1) l'atténuation de l'impact de la pêche sur l'écosystème, (2) le processus consultatif et (3) la prise de décision. Bien que ces trois grandes catégories ne soient pas susceptibles de changer, certains des défis plus détaillés (ci-dessous des sous-types) devront peut-être être réexaminés et, dans certains cas, combinés.
4. La typologie de la pêche commerciale semble adaptée au contexte de l'EAFM. Toutefois, elle pourrait être élargie pour inclure davantage la pêche récréative. La typologie actuelle est entièrement basée sur l'interaction entre les pêcheries et le système écologique et devra peut-être être révisée pour incorporer leur lien avec des communautés de pêche spécifiques afin d'englober l'ensemble du système socio-écologique, comme l'exige l'EAFM.
5. La typologie hiérarchique des mesures de gestion s'est avérée essentielle pour structurer l'énorme variété de détails qui sont ressortis de l'examen des mesures existantes.
6. Bien que cela n'ait pas été spécifiquement demandé, nous avons remarqué que l'EAFM exige la distinction explicite entre les mesures de gestion et des instruments de politiques comme moyen de mise en œuvre. Les séparer des mesures de gestion n'est pas seulement une amélioration d'un point de vue conceptuel, mais présente de nombreux avantages pratiques, car les deux fonctionnent dans des parties distinctes du système socio-écologique, requièrent une expertise et des disciplines scientifiques différentes, et/ou impliquent des acteurs de gouvernance différents. Cette étude a fourni une première typologie provisoire des instruments de politiques, mais compte tenu de leur importance dans l'EAFM, notamment en ce qui concerne l' « état de capacité opérationnelle », elle doit être revue et améliorée.
7. L'application des mesures et des instruments de politiques et de leurs typologies dans le cadre d'une base de données relationnelle pour évaluer l'état actuel de la situation en matière d'EAFM a montré une cohérence interne (par exemple, les mesures sont principalement liées au défi de l'impact de la pêche de type 1, les instruments de politiques aux défis EAFM de type 2 et 3 qui impliquent respectivement les processus de conseil et de prise de décision) et leur utilité potentielle pour de telles évaluations.
8. L'obstacle à l'évaluation de l'EAFM était la disponibilité d'une liste complète de mesures de gestion, catégorisées de manière appropriée à un niveau adéquat de détail. Dans l'état actuel des choses, seuls quelques ensembles de données collectées de manière plutôt aléatoire étaient disponibles. De plus, il n'était pas toujours évident de savoir

comment les catégoriser et les évaluer ou comment ils correspondaient à la typologie des mesures présentée ici. Les typologies actuelles des mesures et des instruments de politiques doivent être mises à l’épreuve et améliorées (certainement les instruments de politiques) afin qu'elles puissent être utilisées pour générer des listes complètes de mesures et d'instruments de politiques de l'EAFM pour chacune des mers régionales, à appliquer dans les évaluations futures.

9. Les deux axes de l'évaluation de l’ « état de capacité opérationnelle », à savoir les mesures et les instruments de politiques, semblent pertinents. Cependant, la question clé qui détermine l’« état de capacité opérationnelle » est le contexte spécifique, principalement écologique/environnemental pour les mesures, et social/institutionnel pour la gouvernance. Afin de faire avancer l'état de capacité opérationnelle de l'EAFM dans son contexte spécifique, nous proposons de rassembler des informations génériques permettant un premier examen des mesures ou instruments de politiques potentiels pouvant être considérés comme prêts à l'emploi au regard d'une sélection de principes essentiels, par exemple : socialement souhaitable/tolérable, juridiquement admissible, administrativement réalisable, politiquement opportun, puis d'évaluer cette sélection dans le contexte spécifique où l'EAFM est censée être mise en œuvre.

***

1 INTRODUCTION

Within the Common Fisheries Policy (CFP), European Union (EU) regulation (1380/2013) states that an ecosystem approach to fisheries management (EAFM) must be implemented. This study was therefore requested to:

- Assess the current state of affairs pertaining to the implementation of EAFM, with a focus on measures and the governance required, in terms of their operational readiness
- Provide recommendations to advance the implementation of EAFM aimed at addressing the identified challenges in order to achieve objectives of the CFP and other policies.

To that end, the study first needed to establish an operational definition of EAFM as a process with structural components and criteria that allow it to be assessed. At the start of this study EAFM was mostly still a concept that was often used in many EU policy documents and for which many different definitions exist, but none has ever been applied to assess the extent to which it can be considered operational and/or how to (further) advance its implementation. Described below is the approach followed in this study, starting from the many existing EAFM definitions, developing an operational process and its main structural components and identifying so-called EAFM challenges that need to be addressed in order to advance an EAFM which can be used as assessment criteria. This report provides a summary of the study, its key findings on the current state of play and conclusions related to advancing an EAFM. This summary is based on an extensive analysis structured around nine interlinked tasks:

Task 1 - Identifying the legal setting for EAFM
Task 2 - Identifying the relevant fisheries
Task 3 - Identifying and describing the ecosystem challenges addressed by an EAFM
Task 4 - Identifying and describing the EAFM measures
Task 5 - Analysing the scientific underpinning of the EAFM measures
Task 6 - Identifying best practices for EAFM
Task 7 - Classifying and categorising management measures
Task 8 - Organising an expert workshop on EAFM development and implementation
Task 9 - Synthesis: recommendations for the application of EAFM

Key results are captured in the annexes to this report and are referred to throughout. Further detail of the approach, methods and findings associated with each task are available in the separate task reports. This report completes the final task, i.e. the synthesis. Although the overall outline according to the tasks is maintained there is no strict one-to-one match between the tasks and annexes as some tasks, i.e. Task 2, are split over two annexes while others, i.e. Tasks 5 and 6, are combined in a single annex.

1.1 Defining EAFM

The expression 'Ecosystem-based Approach to Fisheries Management (EAFM)', as used in the CFP, includes the terms 'ecosystem', 'approach', and 'fisheries management' which are defined in the scientific literature (e.g. FAO, 2021; FAO, 2003). Used together, they imply a process using specific means to achieve selected objectives. Several comparable expressions are used such as an 'Ecosystem approach', usually in the form of '….to fisheries' (EAF) or 'to fisheries management' (EAFM) and 'Ecosystem-Based Fisheries Management' (EBFM) where the distinctions between the underlying concepts may still remain fuzzy and tend to overlap. The review in (FAO, 2003) illustrates the fact that the various expressions refer to what appear to be in practice highly convergent, if not entirely similar, processes which target the same or largely overlapping sets of objectives. Therefore, when we use the expression "Ecosystem-based Approach to Fisheries Management (EAFM)" we assume this to be similar to the other expressions mentioned above.

An EAFM is recognized as a form of fisheries governance framework (e.g. Röckmann et al., 2015; Long et al, 2015), taking its conceptual principles and operational instruments from conventional single-species fisheries management on the one hand, and ecosystem management on the other. The study adopted the principles used in a review by (Long et al., 2015) on ecosystem-based management (EBM, see Box 1), while recognizing that an EAFM focuses specifically on the fisheries system, as opposed to EBM, which has a broader focus encompassing all human activities.

Box 1. Principles of an Ecosystem-based Approach

A review by Long et al. (2015) identifies a set of common principles. The top 15 principles – highlighted in bold – are the main ones found across different sources. These principles also overlap with the 11 principles that are not highlighted.

- **Consider ecosystem connections**
- **Appropriate spatial & temporal scales**
- **Adaptive management**
- **Use of scientific knowledge**
- **Stakeholder involvement**
- **Integrated management**
- **Sustainability**
- **Account for the dynamic nature of ecosystems**
- **Ecological integrity and biodiversity**
- **Recognise coupled social-ecological systems**
- **Decisions reflect societal choice**
- **Distinct boundaries**
- **Interdisciplinarity**
- **Appropriate monitoring**
- **Acknowledge uncertainty**

Acknowledge ecosystem resilience
Consider economic context
Apply the precautionary approach
Consider cumulative impacts
Organizational change
Explicitly acknowledge trade-offs
Consider effects on adjacent ecosystems
Commit to principles of equity
Develop long-term objectives
Use all forms of knowledge
Use incentives

EAFM can provide an integrated framework that addresses the three pillars of sustainability, i.e. ecological, economic and social (including institutional) and thus objectives related to both ecosystem conservation as well as the socio-economics of the fishery. As an approach, EAFM is able to capture all the relevant aspects and components of ecosystems, as well as the fishery-induced pressures that affect them at appropriate levels of detail (e.g. in case of the ecosystem: seafloor as a whole or specific habitats, or fish in general, (groups of) species, or stocks) and takes into account the context (both environmental and social). Objectives that involve important ecosystem components are contained within a range of policies and directives, including the Common Fisheries Policy (CFP), Marine Strategy Framework Directive (MSFD), Habitats Directive and Birds Directive. The wide range of ecosystem objectives in these policies contrasts with the dominant focus on single species approaches in conventional fisheries management. This focus considers only the (few) commercially important species, often in isolation and with relatively modest requirements pertaining to the knowledge base and governance arrangements that support the implementation of resulting management strategies. The overall objective to implement an EAFM within the CFP has initiated a gradual move towards a more sophisticated approach but with increased requirements.

With the introduction of Multi-Annual management Plans (MAPs) in the CFP, the EU has made a move towards EAFM given that the currently agreed MAPs allow consideration of concepts such as predator-prey relationships, the definition of natural mortality of fish stocks and resource competition. The MAPs also allow for better planning and thereby create more stability for fleets. While the consequences of mixed fisheries considerations on the compatibility of catch advice for different stocks are routinely presented by ICES and STECF, the extent to which this advice is translated into actual management is not clear. Furthermore, information on estimated by-catch of protected, endangered and threatened species (PETS) is not routinely provided and the extent to which food web dynamics are included in single species fisheries management has yet to be fully documented.

Impacts of bottom fishing fleets on seabed habitats can be calculated annually (ICES, 2019) but are not included in fisheries management advice. Moving beyond single-species management requires additional trade-offs to be considered, such as between the requirement of a long-term sustainable exploitation of different fished stocks, the (often short-term) yield they can provide and conservation of (non-target) species or habitats. Where this translates into potentially smaller allowable catches it can be more challenging to adopt due to potential socio-economic consequences. These socio-economic aspects of an EAFM have been receiving increased attention and, in the process, recognizes the need to achieve sustainability across the three pillars. Thus, to advance an EAFM from conventional, single species-focused objectives and measures, there is a need for greater consideration of these wider ecosystem effects and their socio-economic consequences as well as the social (including institutional) and environmental context in which they occur.

1.2 Assessing EAFM

Given the complexity associated with including different ecosystem components and their food web interactions, as well as different social actors (including institutions) and interactions, EAFM remains a largely conceptual paradigm with few operational examples and still lacks generic guides to its implementation in EU marine waters. Rather than continuing to examine EAFM as a concept, this study has sought to provide a clear state-of-play of progress towards operational EAFM in specific EU marine waters. This involved the explicit consideration of policy objectives beyond the status and level of exploitation of the target species, and the knowledge base and governance arrangements to support this.

This report is built around a five-step cyclical EAFM process (see Figure 1), adopted from a recent study on implementing an Ecosystem-based Approach in Maritime Spatial Planning (Piet, 2021). This was deemed relevant as fisheries management is likely to be one of the main actors in Maritime Spatial Planning so that having similar processes and a shared understanding of an ecosystem-based approach is likely to facilitate the integration of fisheries into Maritime Spatial Planning. The requested assessment of the state-of-play fits nicely in this cyclical EAFM process as the final step to conclude what we now consider the first EAFM cycle for all EU waters except the Mediterranean and Black Seas (input for these seas will follow in the next year), i.e. the North Sea, Baltic Sea, Western Atlantic and Outermost Regions. To that end this study provides a review of the legal settings that lend context to an EAFM, the EAFM challenges that must be addressed and the (types of) management measures that can be implemented for the different (types of) fisheries under the CFP, together with the scientific underpinning and best practices that can advance EAFM. This assessment is based on the use of a relational database that uses typologies for EAFM challenges, fisheries, measures and policy instruments to structure the available information on the operational EAFM that is in place. In addition it seeks to advance operational EAFM and to that end highlights examples of successful management as well as potential governance obstacles that may hamper the implementation of an EAFM.

1.3 Outline report

This report further consists of:

- In chapter 2 we present the cyclical five-step EAFM process together with the main elements needed to address the main objectives for this study. Firstly, the EAFM challenges provide the criteria to assess progress in the implementation of EAFM. Secondly, we provide hierarchical typologies of the main EAFM components, i.e. legal setting, fisheries and management measures. In addition we provide operational examples of best practices that can be applied to address some of the EAFM challenges. Finally we introduce a relational database as the main tool for our assessment.
- The outcome of the assessment is presented in chapter 3. Here the relational database applies these typologies from the previous chapter to structure the existing fisheries management information in order to provide an assessment of the progress achieved to date in implementing EAFM.
- Chapter 4 then builds on this, showing how the implementation of EAFM may be (further) advanced drawing on the lessons from this study.
- Finally we present the relevant detail from the outputs of the various tasks in the project in the Annexes to this report. Note that these outputs have provided the basis for the presented approach and assessment, but as several of these took place at the beginning of the project their findings may have been reinterpreted in the light of the advancing insight over the duration of the project and the specific wording in the main report may therefore slightly deviate from (but never contradict) what is in the annexes.

2 A FIVE-STEP EAFM IMPLEMENTATION PROCESS AND ITS COMPONENTS

This assessment of the current state-of-play pertaining to the implementation of an ecosystem-based approach to fisheries management (EAFM) is based on our consideration of EAFM as a five-step process (Figure 1). This enabled us to consider the implications for EAFM at each step. A summary of these implications is presented in the following sections of the report. These implications then provide the basis for a set of recommendations to make further progress towards the implementation of EAFM. The five-step process consists of the following steps (see Figure 1):

- **Defining** the frame for EAFM, starting with its aim to achieve specific policy objectives or societal goals within the social and environmental context, including the legal setting and the identification of the fisheries likely to compromise the achievement of these objectives/goals. Note that these objectives and societal goals are often understood to refer to the state of the ecosystem and the fishing opportunities but may also involve social or economic objectives/goals.
- **Developing** the knowledge base (which may include scientific as well as local indigenous knowledge) driven by the policy objectives or societal goals to be achieved, the relevant fisheries and potential EAFM measures. We have identified a number of challenges that require an understanding of the interaction of specific fisheries with the ecosystem and how this may be mitigated through specific measures. Addressing these challenges may contribute to achieving these objectives and societal goals.
- **Assessing** and weighing the EAFM alternative scenarios using the knowledge base and appropriate tools. This results in scientific advice involving one (or more) preferred management strategies (=policy instrument and a management measure).
- **Implementing** the measures through specific policy instruments based on informed decision-making guided by best practices.
  Follow-up in which both the EAFM process (i.e. the preceding steps), as well as its performance in terms of addressing the challenge(s) and achieving the specific policy objectives or societal goals, are evaluated. The relational database developed in the project is a tool that can support this step and provide guidance for the subsequent EAFM cycles. EAFM should be considered an adaptive process where the follow-up initiates the next cycle and includes feedback on individual steps.

Stakeholder involvement can be part of any step and should take place throughout the EAFM process. How the tasks undertaken in the project relate to the process is also shown in Figure 1. The process begins by **defining** the ecosystem and the set of policy objectives and societal goals that may be compromised by commercial and recreational fisheries. The identification of the relevant fisheries at an appropriate level of detail is supported by our fisheries typology (Annex 2), while the legal setting (Annex 1) sets the basis for management.

Identifying and selecting the most appropriate management measures and policy instruments within that specific context requires a solid knowledge base and is supported by the management measures typology (Annex 4) and best practices (Annex 5). The same knowledge base is also applied in the **assessing** step, where one of the challenges (Annex 3) is to improve the knowledge base and advisory process. The **implementation** step can be improved by addressing the decision-making challenges (Annex 3), for example through best practices (Annex 5). Finally the **follow-up** step determines to what extent the current EAFM (database tool, Annex 7) manages to achieve the policy objectives, i.e. the management performance challenge (Annex 3) and provides recommendations on how to advance in subsequent EAFM cycles. Again, the database tool (Annex 7) can be instrumental in providing this guidance.

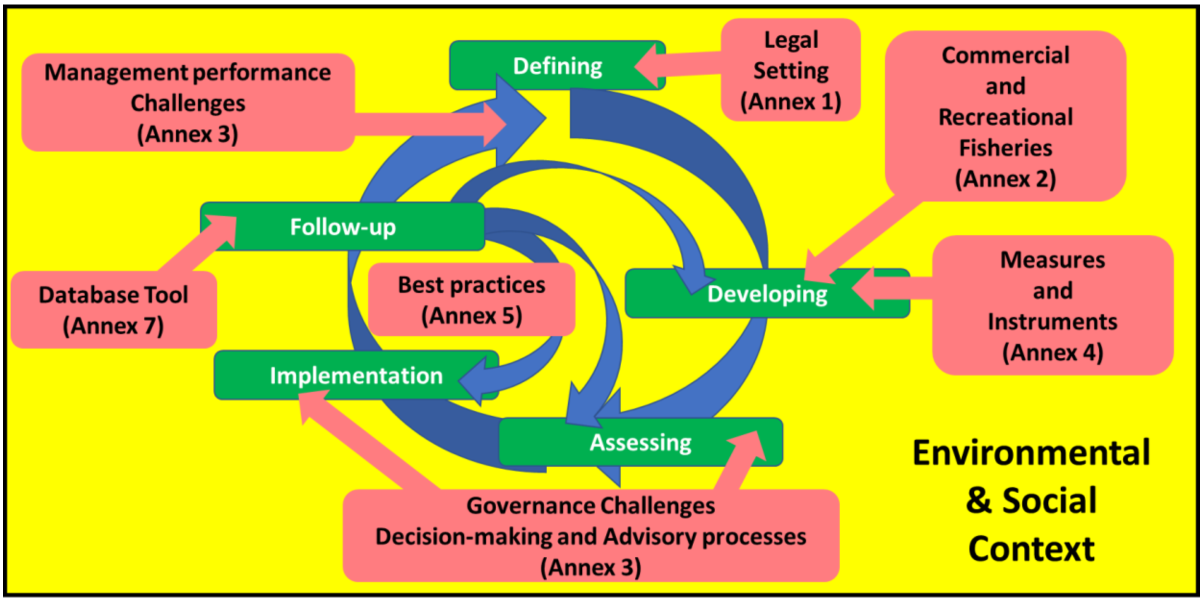


Figure 1. The five-step adaptive EAFM process embedded in the regional context, including its legal setting, governance and institutional set-up (yellow box). Each of the topics in the red boxes were explicitly addressed in the project and are covered in more detail in the annexes. Note that while each topic predominantly sits in one (or more) specific step(s), the 'best practices' potentially apply to the entire process as well as the governance and institutional aspects of the context.

2.1 EAFM Challenges

An 'EAFM challenge' is any impact on the ecosystem or obstacle in the governance process that compromises the achievement of the policy objectives or societal goals. An EAFM challenge (or challenges) can be addressed through the implementation of appropriate management measures to mitigate the (potential) fisheries impacts, and/or through policy instruments to alleviate the obstacles that hamper the implementation of those measures. One of the key difficulties lies in being able to determine which measures are most appropriate given the context and having the necessary institutional arrangements and resources to implement them.

EAFM challenges ultimately all contribute to the achievement of one or more policy objectives (e.g. Good Environmental Status, Maximum Sustainable Yield). This involves an ecosystem component potentially under threat (e.g. commercial fish stock, non-target species or habitat) by a specific fishery (or fisheries), thereby compromising the achievement of the objective(s), and the management to mitigate this threat. EAFM challenges may therefore act directly on the fisheries and the mitigation of the threat, or indirectly through the processes which drive the implementation of the management. The former should mostly be considered in their environmental context, the latter in their social (including institutional) context.

2.1.1 Typology of EAFM challenges

The review of the scientific literature resulted in three main types of EAFM challenges, as shown in Figure 2. In the course of this project the EAFM challenges were reinterpreted and slightly reworded (but without compromising the initial outcome of the literature review) to allow a better use of these EAFM challenges as criteria to assess advancement of EAFM. These EAFM challenges have been elaborated as a typology consisting of three main categories, each with a number of specific sub-challenges (see Table 1):

1. Type 1 challenges to mitigate fisheries impacts on the marine ecosystem that compromise the achievement of policy objectives. These include all fishing impacts on fishing opportunities (e.g. size-selective fishing on the overall biomass of the stock as well as its size distribution) as well as the wider ecosystem. This impact may vary in space and time. By-catch may affect non-target species and mobile gears may disturb habitats which, in turn, may have knock-on effects on both the fishing opportunities and the wider ecosystem through food-web interactions.
2. Type 2 challenges to improve the advisory process, the underlying knowledge base and hence the quality of the advice by including the effects of the environmental (ecological) context on fish, fishing opportunities and fisheries. This may include the incorporation of natural variability in stock assessments, the consideration of environmental effects/trends (e.g. climate) on target and non-target species or habitats affecting their vulnerability and/or spatio-temporal distribution or the effects (e.g. on productivity) of other anthropogenic pressures such as eutrophication or contaminants.
3. Type 3 challenges to improve the decision-making processes by including the social context of fisheries and the governance processes that drive management. This may involve economics where short-term profits may be at odds with long-term sustainability, or market forces determining which species are targeted. This may also involve management where policy targets are left undefined or marine space for fisheries becomes increasingly limited (e.g. due to MPAs or windfarms) and fishing effort is displaced. Finally, there are institutional issues at play, such as stakeholder disagreements, low levels of participation and co-management or poor enforcement.

Details of the challenges and how they were identified are provided in Annex 3 and were separately published in a peer-reviewed journal (Bastardie et al., 2021). Table 1 shows how the different EAFM challenges relate to each of the five-steps in the adaptive EAFM process. Here, only two levels of detail were considered, i.e. the three types and relevant sub-types. Distinguishing the most detailed level in the typology (as shown in Figure 2, e.g. 1.1.1) was deemed not relevant.

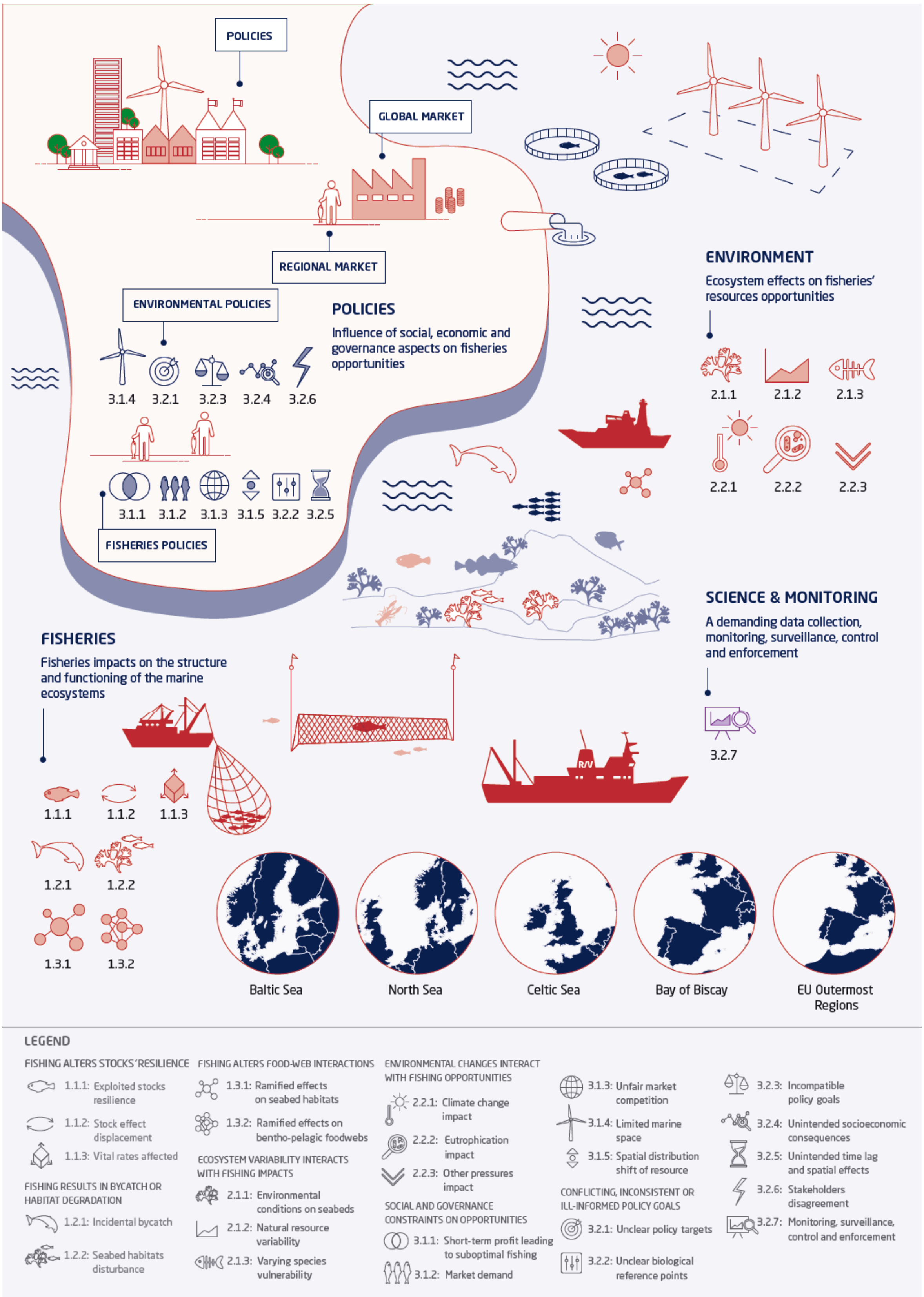


Figure 2. Conceptual model of fisheries as a component of a social-ecological system, with the EAFM challenges that emerged from the review considering the Baltic Sea, North Sea, Western Atlantic and Outermost Regions (for explanation of the symbols and challenge IDs, see Table 1). The EAFM challenges are shown here at their most detailed level which is combined into the sub-types shown in Table 1. Source: Bastardie et al., 2021.

Table 1. Hierarchy of EAFM challenges and their relevance to each step of the EAFM process. The first major group of challenges covers the potential impacts on the ecosystem that may compromise the achievement of the policy objectives; the second examines the development of the knowledge base and its use in the advisory process; the third looks at the obstacles that hamper the decision-making process. These EAFM challenges are based on the ecosystem challenges identified in the literature review (see Annex 3 and Bastardie et al., 2021).

EAFM Challenges typology		EAFM process steps				
Types	**Sub-types**	**Defining**	**Developing**	**Assessing**	**Implementation**	**Follow-up**
Type 1: How to mitigate fisheries impacts on the marine ecosystem that compromise achievement of selected policy objectives	Catch and by-catch of commercial species/stocks	Sustainable exploitation of fishing opportunities	Stock assessment models	Assessments usually provide TAC advice	Implementation of the preferred EAFM-measures based transdisciplinary scientific advice and taking into account the wider context, including the legal setting and institutional set-up. This also requires a consideration of potential policy instruments.	Follow-up process must be in place. This includes monitoring of the performance of the measures as well as appropriate follow-up compliance. Outcome is guidance to improve the next adaptive management cycle
	By-catch of other ecosystem components and habitat disturbance	Conservation of the wider ecosystem	Understanding of the direct impacts of fisheries on non-target species and habitats and how these can be mitigated through different measures.	Assess the effects of management to reduce these direct ecosystem effects		
	Indirect effects through the food web		Develop ecosystem models to identify potential indirect effects.	Assess indirect effects		
Type 2: How to improve the advisory process, the underlying knowledge base and hence the quality of the advice	Inherent "natural" variability of the fishing opportunities	Sustainable exploitation of fishing opportunities	Improved parametrisation of stock assessment models	Improved TAC advice ICES fisheries overviews		
	Anthropogenic (e.g. other sectors) and environmental changes/trends (e.g. climate) interact with fishing opportunities		Understanding effects of environmental drivers (e.g. climate models) and other anthropogenic pressures (e.g. Cumulative Impact Assessments)	ICES Ecosystem overviews	A consideration of fisheries as part of cross-sectoral ecosystem-based management	
Type 3: How to improve the decision-making processes by including the social context on fisheries and the governance processes that drive management	Socio-economic context (including institutional set-up). influences on the exploitation and management of fishing opportunities	Achieving sustainability across all dimensions, i.e. environmental, social and economic. Trade-offs need to be explicitly considered	A trans-disciplinary knowledge base is required as it needs to cover the full social-ecological system. That is including governance and explicitly considering all maritime activities	ICES Ecosystem overviews extended to also consider the human dimension	Implementation of the appropriate policy instruments resulting in the implementation of the preferred management measures. The decision-making process is more transparent and inclusive and improved through a consideration of best practices (including good governance) and taking account of the wider socio-economic context including the legal setting and institutional set-up. Trade-offs are made explicit.	An appropriate follow-up process must be in place. This includes monitoring the performance of the policy instruments. Outcome is guidance to improve the next adaptive management cycle
	Governance of the EAFM process. Conflicting, inconsistent or ill-informed policy goals across industries and stakeholders					

2.1.2 Challenges: implications for EAFM

The three main EAFM challenges identified in our typology (subsection 2.1.1) draw on the analysis of EAFM challenges (see Annex 3) to pinpoint the different parts of the five-step EAFM process step where action is needed to address them:

- The type 1 challenges mitigate the (potential) impacts of fishing on the ecosystem. These are driven by the policy objectives selected at the defining step and require specific management interventions. These include the conventional fisheries management measures which currently dominate and are aimed at commercial stocks only but, as part of EAFM, these may also cover the wider ecosystem including non-target species or habitats.
- The type 2 challenges address the advisory process and knowledge base including effects of ecosystem variability, variations in productivity or climate change.
- The type 3 challenges primarily address the decision-making process. The implication of the analysis is that progress towards an EAFM requires that explicit attention is given to moving beyond addressing what is effectively only a limited subset of the type 1 challenges and, to a greater extent, include the wider set of challenges associated with the wider ecosystem and consider management within the full social-ecological system (e.g. including the institutional context). The typology of challenges provides a means to more explicitly document the EAFM challenges that EAFM is intended to address.

2.2 Characterization of Fisheries

In order to assess and map the measures applied to address EAFM challenges, it was important to identify the relevant fisheries to which they had been applied, including both commercial and marine recreational fisheries (MRF).

2.2.1 Typology of commercial fisheries

The relevant commercial fisheries under the CFP were identified for each of the regions considered in the study. Within the study, a fishery is defined as "*a group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area*" (ICES, 2003). As such, they can reasonably be expected to have the same (or sufficiently similar) impact(s) on the ecosystem and its different components, and can be used as the basic unit to which management measures apply.

The study used existing métiers as the basis for identifying these groups, where a métier is defined as "*part of the activity of a fleet taking place in a given area, with a specific gear and targeting a specific (ensemble of) species*" (ICES, 2003). For practical reasons, the métier definition chosen for this work was the Data Collection Framework (DCF) métiers used by Member States for reporting landing data collected. These métier definitions use generic classes (DEF: demersal fish, SPF: small pelagic fish, CRU: crustaceans), rather than species-specific ones. The advantage of this approach is that métiers can be identified from fishing fleet data in the national registers of fishing vessels. Fisheries were constructed by merging the métiers of different fleets operating with a similar gear and the same target species, and that are carried out in the same area and period of the year (Figure 3 below).

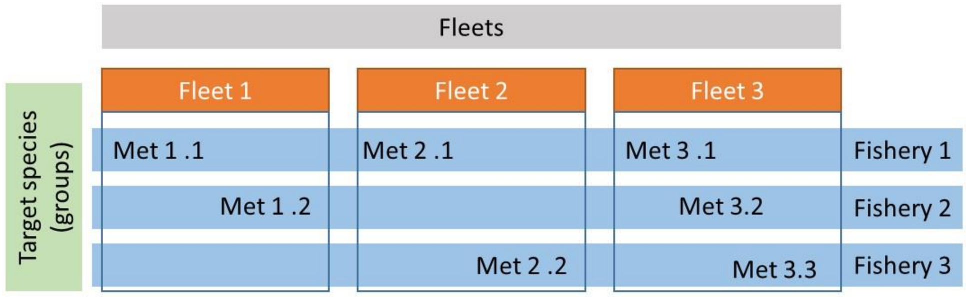
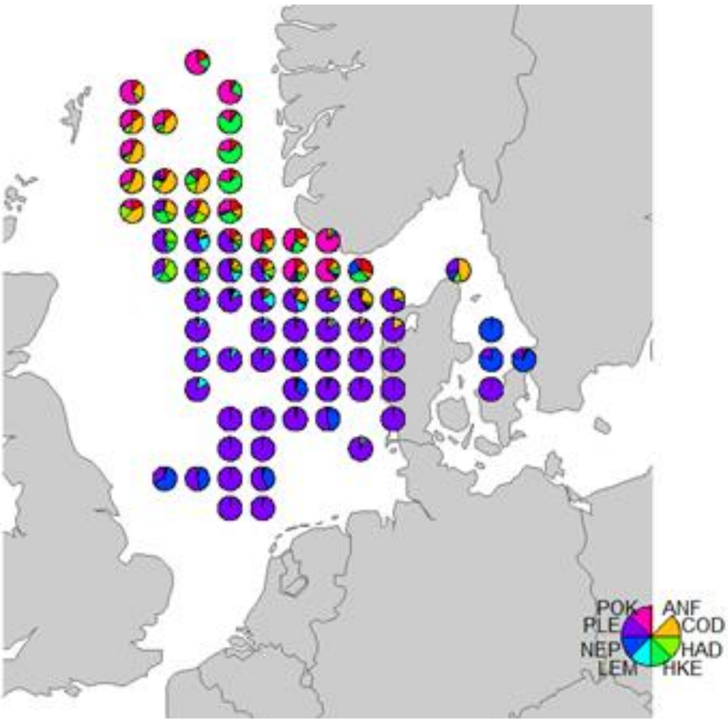


Figure 3: Fisheries defined as the ensemble of similar métiers from national fleets that have the same (set of) target species.

In practice, the identification of the relevant commercial fisheries is based on an analysis of the landings and species composition at the métier level 6. By plotting the species composition of landings by métier spatially, different types of fisheries can be identified (Box 2).

Box 2: Distinguishing fisheries in terms of landings composition

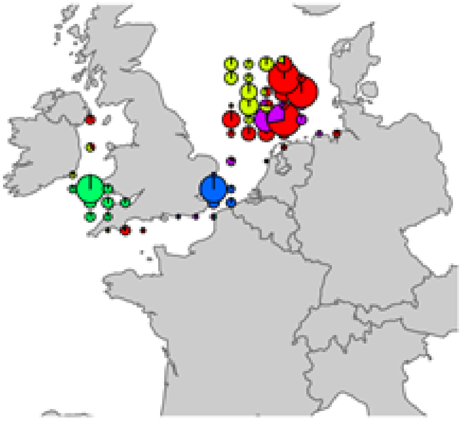
In the case of the Danish OTB_MDC>=120_0_0 métier, there is a clear spatial gradient in the landing species composition, with mainly plaice (with some Nephrops) in the landings from central North Sea area, and a mixture of gadoids species, with mainly cod, hake and saithe in the Norwegian trench area. In this case, the same métier is clearly involved in two distinct fisheries, one on plaice and Nephrops, and the other on gadoids, in different areas of the North Sea.

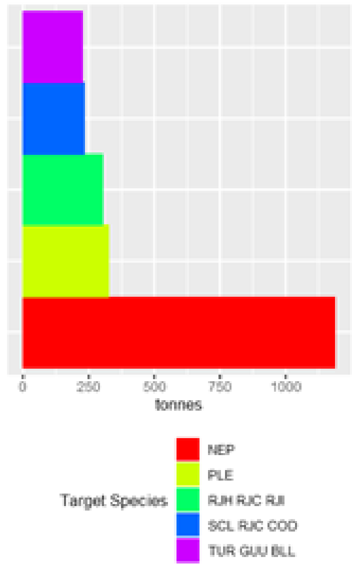


Another type of analysis characterized fisheries in terms of their target species. To that end, one or more clusters were identified for each métier level 6 per country (See Box 3).

Box 3: Distinguishing fisheries in terms of target species

For the Belgian métier OTB_MDC_80_89, there are five clusters with their corresponding main target species (or group of species) identified by the method based on total landings over 2014-2016. The bar plot on the right shows the sum of the landings (all species combined) across all the statistical units in each cluster (identified by its target species). In this case, most of the landings correspond to statistical units (quarter/year/ICES rectangle) where Nephrops was the target species. They mainly come from the eastern-central North Sea. Plaice is also identified as the target species in another cluster with landings primarily from the statistical units located in the western central North Sea, and another cluster targets ray species in the Celtic Sea.





Combining the results of the two types of analysis resulted in a reduction from the initial 517 métiers to 156 relevant fisheries with an additional 71 fisheries identified across the Outermost Regions (see Annex 2 for details and Box 4 for an example of fisheries in the Baltic).

Box 4. Example from the Baltic Sea with for each gear type the specific fisheries (with specific target species if applicable).

- demersal fisheries with otter trawls
    - cod targeting fishery (possibly combined with flatfish) in the Baltic Proper
    - mixed fisheries on demersal fish in the Skagerrak-Kattegat
    - plaice fishery in the Skagerrak-Kattegat
    - nothern prawn fishery in the Skagerrat-Kattegat
- pelagic fisheries using otter trawl
    - monospecific herring and sprat fisheries and mixed herring/sprat fisheries
- Danish seine fishery
- dredge fisheries
    - Monospecific cockles, mussels, and oyster fisheries
- fyke net fishery
- pelagic fisheries using mid-water trawls
    - mixed sprat and herring fishery
    - sprat fishery
    - sandeel fishery
    - cod fishery
- pots fisheries
    - herring fisheries mixed with other species
        - cod, eel and herring fishery
        - herring
        - herring and perch
        - herring, mixed freshwater species fishery and salmon
        - herring, round goby
    - mixed crustaceans fresh water fish fisheries
        - Nephrops, edible crab
    - anadromous/catadromous fish fisheries
        - eel, salmon
- pelagic fisheries using purse seine
    - mixed fisheries dominated by herring
        - herring and sprat
        - herring, freshwater bream and whitefishes nei
- gillnet and trammel nets fisheries targeting demersal fish
    - cod fisheries
    - mixed cod/flatfish fishery
    - monospecific flatfish fisheries
        - plaice
        - sole
        - flounder
        - turbot
    - mixed and other fisheries
        - mixed demersal fish
        - round goby
- gillnet and trammel nets fisheries targeting pelagic fish
    - herring fisheries
    - lump sucker fishery
- Longlines
    - Mixed demersal fish
        - Cod and eel fishery
        - Mixed demersal fish

2.2.2 Relevant recreational fisheries

For many of the stocks for which information on marine recreational fisheries (MRF) removals was available, it was found that the total biomass removed was significant. In some cases, recreational removals surpassed that of the commercial fisheries targeting the same stocks (e.g. Hyder et al., 2017; Radford et al., 2018). For example, Figure 4 shows the catches per country for seabass in the North Sea and pollack in the Celtic Sea and English Channel. Despite frequently being significant, only in case of seabass in the North Sea, are removals by recreational fisheries currently considered in stock assessments.

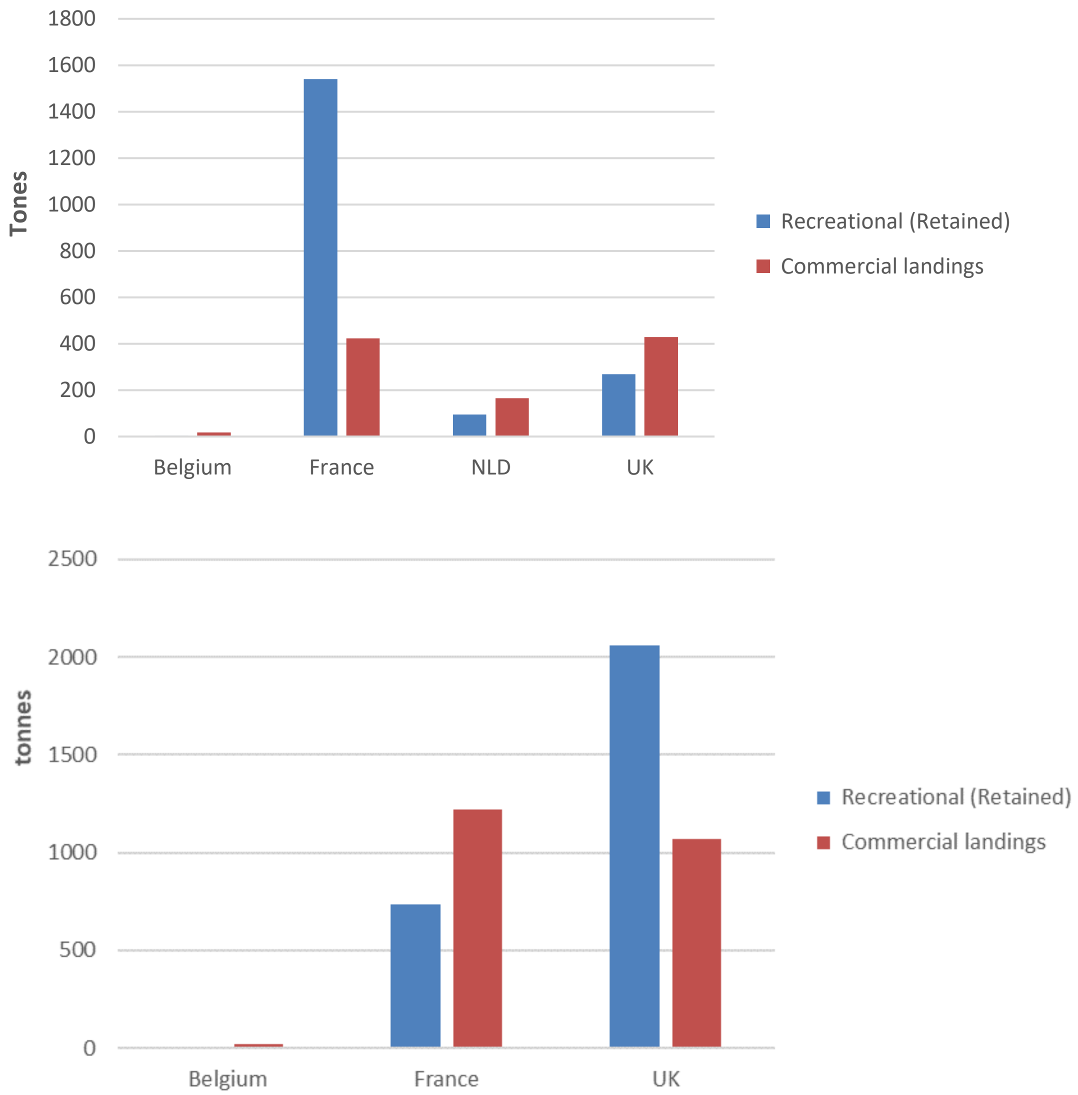


Figure 4: Recreational vs commercial catch (retained) estimates by country of two stocks, North Sea seabass (upper panel) and pollack in the Celtic Seas and English Channel (lower panel) NLD = Netherlands.

Because the majority of marine recreational fishing effort occurs in the coastal areas, there can be conflict with coastal or small-scale commercial fishing. However, because landings data do not allow the catches of these small-scale commercial fisheries to be distinguished from the total landings, the significance of these conflicts is difficult to assess. Given the nature of the data and data availability, for this study marine recreational fisheries were considered as unique métiers within each Member State. The reason for this decision is due to how MRF is defined in the current DCF regulation, i.e. using the REC code. Hence MRF were aggregated to this level. The recreational fisheries métier thus comprises the three main MRF types that are considered within the ICES recreational fisheries expert group (fishing from shore, fishing from boat and spearfishing), where data was available for them.

2.2.3 Fisheries characterization: implications for EAFM

The identification of fisheries at an appropriate level of aggregation is important for two reasons. Firstly, from a practical perspective, it can reduce the effort needed to establish the knowledge base required to provide advice. From this perspective, the reduction of the initial métiers to the final 227 commercial fisheries is useful in assessing the current challenges and measures and also has the potential to reduce future effort needed, and thus resources required, to develop the knowledge base in order to advance EAFM. The analysis of recreational fisheries indicates that there is a need to increase the knowledge base related to the impact of this activity as well as conflicts with commercial fishing. Secondly, it can enable challenges and measures to be identified at an appropriate scale. This second reason draws attention to three issues revealed by the analysis.

The analytical approach using the existing DCF and national fleet data allowed the relevant commercial fisheries to be identified While these appear appropriate for our purposes, it is also important to acknowledge that sometimes more detail may be required. Both EAFM challenges (Chapter 2.1) and management measures (Chapter 2.3) may occasionally involve impacts caused by, or measures applied to, fisheries at a more detailed scale than proposed here. For example, a number of single species fisheries (e.g. mackerel, herring, horse mackerel) appear under the same pelagic DCF métier. This is also the case for some demersal fisheries, although they are often more mixed by nature. By-catch issues can also be different even within the DCF métiers as vessels within the métier may be targeting different assemblages of by-catch species and the need for more specific measures within the métier could risk being overlooked (e.g. the Belgian métier presented in box 3 targets both plaice and Nephrops for which mitigation is likely to require different measures). Thus, our definition of fisheries relevant for EAFM may require a more precise description of the target species (groups) than the one used to define DCF métiers. **Before any recommendations to the DCF can be made it would make sense to engage in a transdisciplinary process with fishers to validate this EAFM fisheries typology. Such validation could also be used to identify relevant social and economic factors associated with the fisheries that might affect fisher behavior (e.g. Schadeberg et al., 2021).**

The analysis included both commercial and recreational fishing. However, fisheries management is currently almost exclusively focused on commercial fishing, despite the evidence that, for several stocks/species, or specific (often coastal) areas, recreational fisheries may have a significant impact. For this reason, it may be necessary to incorporate recreational fishing into assessments under an EAFM, as is the practice in other parts of the world. Additionally, the analysis led to the identification of recreational fisheries at the Member State scale. **The knowledge base is not yet developed sufficiently to be able to either define the individual fisheries and/or to combine the recreational fishing impacts with those of commercial fishing on the same stock.**

The final issue is that the fisheries were developed by an aggregation procedure based on their target species and the area they operate in, assuming that this adequately represents the potential impacts of each specific fishery on the ecosystem. Because EAFM requires the consideration of the full social-ecological system there is a need to also understand the linkages between the fishery and the wider social system, including both the economic and governance arrangements (e.g. Arthur et al., 2011). **The extent to which the fisheries identified in this study are appropriate to develop this understanding is currently unknown, but could be a useful starting point in identifying fisheries that are relevant in both ecological and social systems. A first exercise could be to test how the current typology can be matched to specific fishing communities.**

2.3 EAFM measures and policy instruments, their legal setting and implementation

The primary goal of the implementation of EAFM measures is to achieve the policy objectives identified in the defining step (Figure 1) which requires addressing the EAFM challenges through the implementation of management measures. Using the concept of Social-Ecological Systems (e.g. Berkes, 2011), we therefore distinguish between the management measures affecting the ecological system and the policy instruments required for their implementation, while still targeting specific governance arrangements that lie within the social system. As Figure 5 illustrates, EAFM challenges related to fishing impacts on the ecosystem (i.e. type 1 challenges, see section 2.1) can typically be addressed through one or more management measures (M) intended to achieve specific policy objectives (O) and which require a policy instrument (I) for their implementation. Policy instruments can thus be considered as a means to implement the measure and typically involves the advisory and/or decision-making processes (i.e. the Governance). The type 2 challenges relate to the scientific advice, while the type 3 challenges relate to the decision-making. We propose that a management strategy, often used in the context of Management Strategy Evaluation, should be the combination of a policy instrument with a management measure. This is because, in an EAFM context, management strategy evaluation should include the full social-ecological system and thus requires inter-linked elements represented in the social (i.e. policy instrument) and ecological (i.e. management measure) systems. Thus we define a policy instrument as an intervention in the governance arrangements covering the advisory and decision-making process, typically through policies, which is intended to facilitate the implementation and/or enforcement of management measures. Measures mitigate the impact of fishing on the ecosystem, including all its relevant components and aspects.

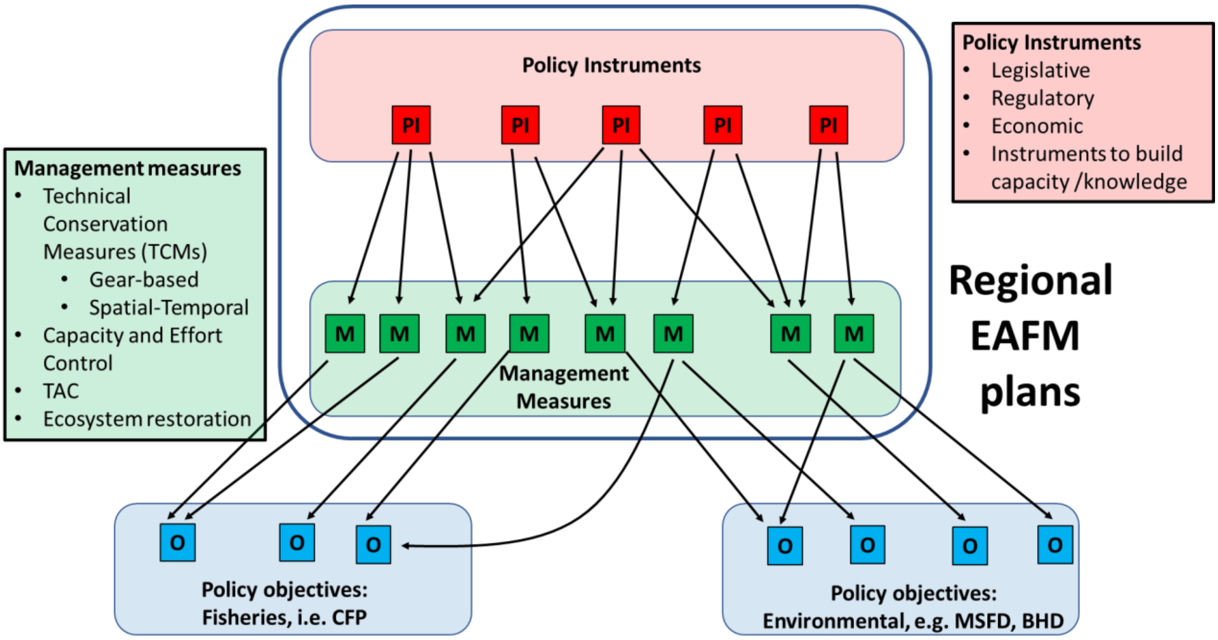


Figure 5. Implementation of EAFM through a Policy Instrument (PI) and a Measure (M) with the purpose of achieving specific policy objectives (O). The PI operates in the social system as the means to get a M implemented, the M operates in the ecological system where it mitigates the fishing impact that compromises a specific O. An EAFM plan is the combination of all measures and policy instruments that are applied in a region.

2.3.1 Typology of management measures

To develop the typology of management measures a review of the scientific and grey literature was coupled with interviews with key stakeholders in the relevant Member States or representing European fisheries (see Annex 4). From this review it was found that there was were only a limited set of measures. From the perspective of a measure typology, there was no need to differentiate between measures applied as part of 'conventional' fisheries management, i.e. addressing target stocks, and what would be termed EAFM measures. There is a limited set of measure types which may be applied to ascertain a sustainable exploitation of the fishing opportunities, i.e. conventional single-species fisheries management, but these same types of measures may be implemented to achieve wider ecosystem goals, for example related to conservation. A by-catch reduction device may mitigate the by-catch of specific commercial or PET (Protected, Endangered or Threatened) species. Similarly, a closed area can be applied to protect a commercial species or a habitat. Clearly the technical details of the measure will differ, as may the uptake within the fishery depending on the purpose and context.

The applied typology of management measures in Figure 6 distinguishes three main types of management measures, i.e. 1. Input measures (i.e. targeting the fishing fleets using both active and passive gears), 2. Output measures (i.e. targeting the catches), and 3. Measures aimed at active ecosystem restoration (i.e. targeting the ecosystem). In addition the figure shows different sub-types of Input measures (e.g. Technical Conservation Measures (TCM), Capacity and Effort Control measures), different sub-types of Output measures (e.g. TAC controls, Landing size controls and Discard bans) or sub-types of ecosystem restoration (e.g. through restocking schemes or stock enhancement through habitat restoration). And each of these sub-types may be further sub-divided (see Annex 4). For example, the gear-based TCMs may consist of mesh size changes, mesh configuration changes, square mesh panels or cylinders aimed at improving size-selectivity or various by-catch reduction devices, sorting grids or benthos release panels to exclude/reduce by-catch of specific species (e.g. species, PETs). Similarly the Spatio-Temporal TCMs may consist of strict nature reserves, specific habitat-/ or species management areas or no-take zones sometimes with an added temporal component like specific closed seasons or real time closures.

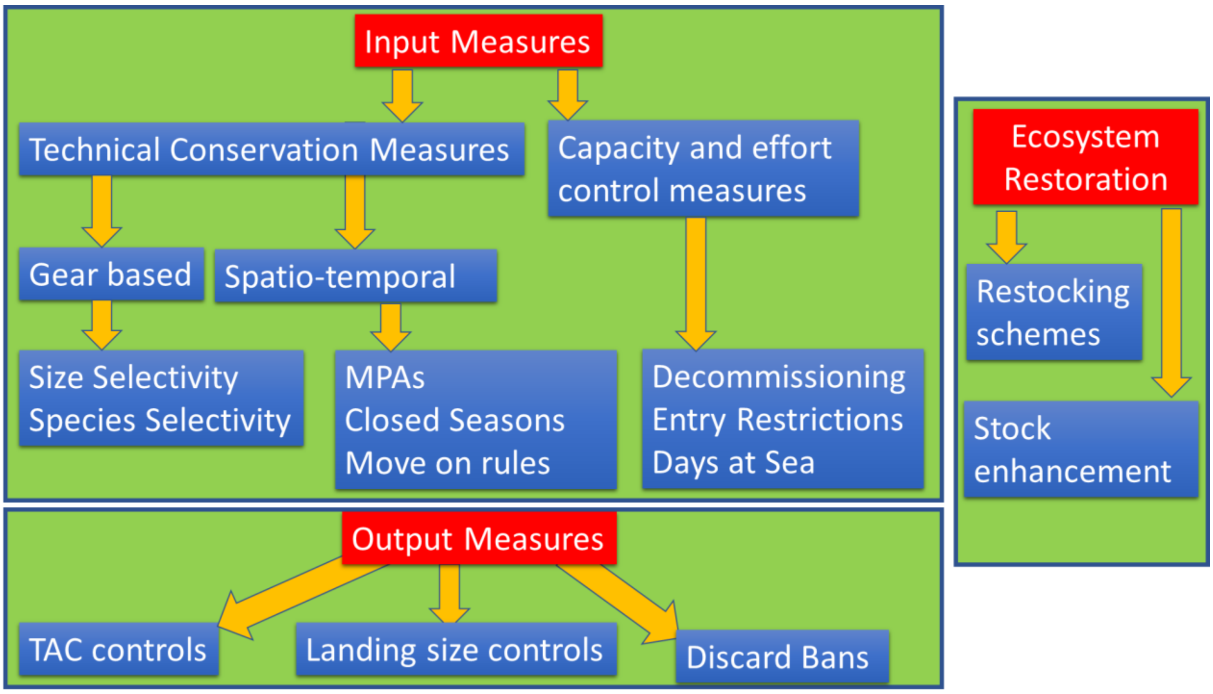


Figure 6: Management measures typology.

2.3.2 Typology of Policy Instruments

The review also reveals management interventions that are considered policy instruments as these operate in the social system. Here we propose a tentative typology for the policy instruments:

- Regulatory policy instruments aimed at the governance arrangements. These include co-management, self-management or results-based management.
- Economic policy instruments such as pricing mechanisms (e.g. tariffs, taxes and charges, trading of permits), payments, or liability schemes. These specifically include Individual Tradeable Quota (ITQs) or subsidies for alternative gears.
- Policy Instruments involving information, awareness-raising, and public engagement. Eco-labelling (e.g. Marine Stewardship Council, MSC) would fall under this category as it specifically includes EAFM objectives in their certification process.[2]
- Policy instruments initiating monitoring and research that is aimed at improving the knowledge base (e.g. the DCF).

Note this typology is not intended to be exhaustive as policy instruments are not supposed to be part of this study

For an assessment of the current state of affairs pertaining to the implementation of EAFM, the extent to which measures and policy instruments have been implemented across four regions, i.e. Baltic Sea, North Sea, Western Atlantic and Outermost Regions, is assessed. EAFM is as much a process as an endpoint (Ramírez-Monsalve et al., 2021). Therefore to assess the progress, we propose a gradient of increasingly more EAFM, whereby the lowest level consists only of the implementation of management measures to address the first part of the EAFM challenge sub-type "Catch and by-catch of commercial species/stocks" (see Table 1), i.e. catch, representing typical conventional single-species fisheries management, on which the TAC/quota management is based. The latter part of that EAFM challenge sub-type, i.e. by-catch, advances along the gradient but still represents management typically aimed at CFP objectives, as represented by discards bans and the landing obligation. Then, there is a further advancement corresponding to objectives beyond the fisheries opportunities (ecosystem) represented by EAFM challenge sub-type "By-catch of other ecosystem components and habitat disturbance by-catch" and finally there is the EAFM challenge sub-type "Indirect effects through the food web" (see Table 1). Thus, pertaining to the mitigation of fisheries impacts, there is a gradient in terms of purpose consisting of measures aimed at mitigating fishing impacts on target stocks, to by-catch considerations that also involve non-target fish species, to fishing impacts on the wider ecosystem (both directly as well as indirectly) representing a gradual advancement of management from conventional single-species fisheries management towards increasingly more EAFM.

To assess progress towards more EAFM, data on management measures and EAFM challenges for the relevant fisheries were linked. In fact, the measures only address the direct impacts of fishing on the ecosystem (hence covering challenge type 1, see Table 1). In addition, there are challenges involving the knowledge base and advisory process covering challenge type 2 and the governance and social context influencing the decision-making process covering challenge type 3 which may both be addressed largely through the use of policy instruments. Policy instruments are intended as the primary means to implement measure(s) and thus improving the knowledge base and

[2] The role of the governance system is then to set the regulatory framework in whichthe certification process takes place with, for example, a definition of minimum standards.

governance arrangements should enhance the EAFM process and its performance to achieve policy objectives.

2.3.3 Matching EAFM challenges, measures and policy instruments

The review of scientific and grey literature coupled with interviews with key stakeholders in the relevant Member States also sought to identify the linkages between the EAFM challenges on the one hand and some of the possible management measures and policy instruments on the other (Figure 7). The results clearly support the necessity of management measures to address the type 1 EAFM challenges (e.g. Fishing at MSY and Habitat protection). However, the results also reinforced the point made above that identified obstacles in the implementation process of management measures which were predominantly addressed through the use of policy instruments: (1) through interventions to improve the knowledge base (i.e. Funding research and monitoring), (2) in the governance arrangements involving the decision-making processes to facilitate the implementation and/or enforcement of management measures (i.e. Integrative management, Fishing at MSY), (3) the stakeholder processes that apply throughout the EAFM process (i.e. Build trust and participatory management). This highlights the need to think in terms of management strategies consisting of both the measures and also the policy instruments when assessing their effectiveness and transferability and how they relate to the objective for which the management measure(s) were implemented.

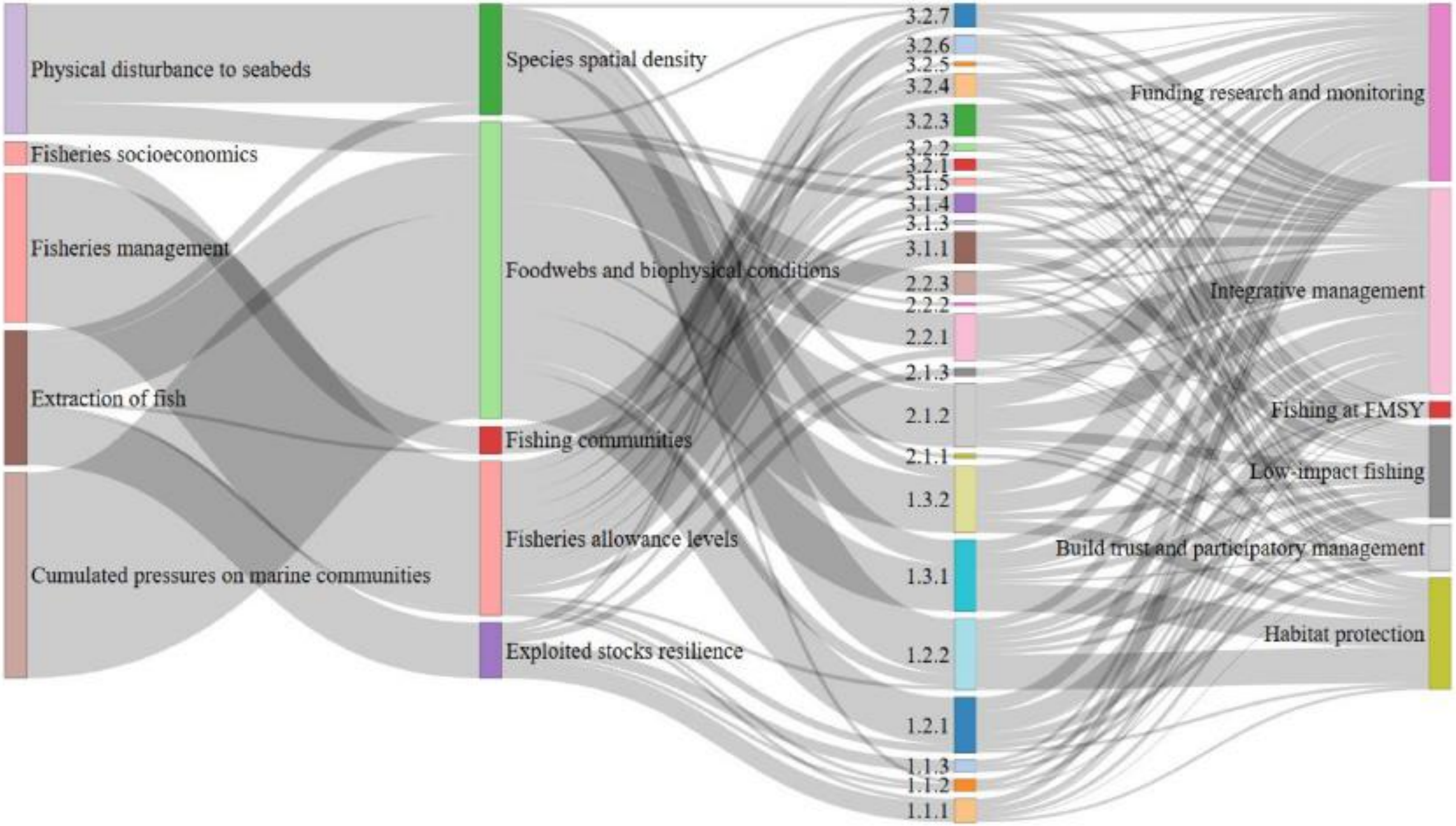


Figure 7: Management measures and Policy Instruments (at the far right) to address EAFM challenges (left, at different levels of detail) and the specific ecosystem components they may involve (2nd from the left). The 3rd column gives the EAFM challenges where the first digit corresponds to the main types in Table 1. The column to the right shows the observed management interventions. From Bastardie et al. (2021). Note that the typology of both the challenges as well as the Management measures and Policy Instruments has evolved since this was constructed

2.3.4 Legal basis for management measures

The legal setting of EAFM is mainly defined at the level of European Union legislation, with the Basic Regulation of the Common Fisheries Policy (CFP) of 2013 at the core, and its (now repealed) predecessor of 2002. Internationally, an EAFM operates within the context of several international and legally binding agreements. This includes the United Nations Convention on the Law of the Sea (UNCLOS), the Convention of Biological Diversity (CBD) and the 2003 FAO technical guidelines for responsible fisheries. The European legislation on the management of ecosystems and fisheries draws from these international agreements (Figure 8).

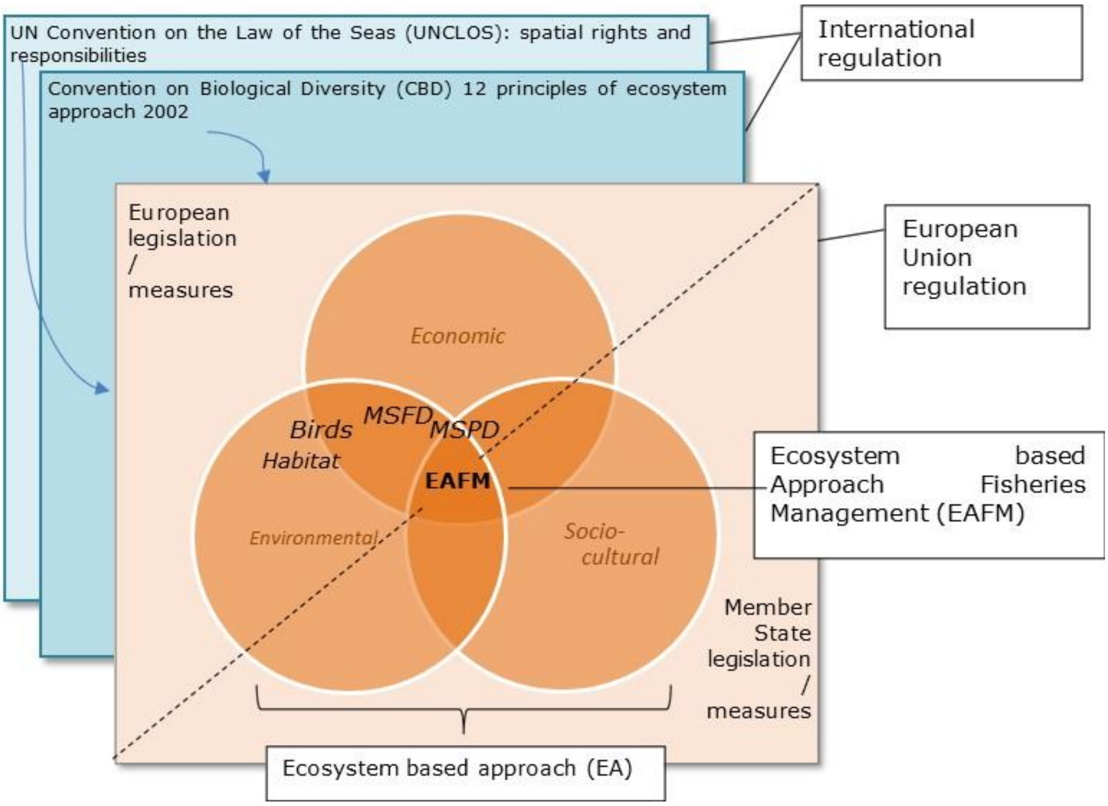


Figure 8: The Ecosystem Approach to Fisheries Management (EAFM) in context.

The environmental legislation with which the CFP must set a coherent standard includes the Marine Strategy Framework Directive[3] referred to in Article 2 (5)(j) of the Basic Regulation as well as the Birds Directive[4], the Habitats Directive[5] and the Water Framework Directive[6].

[3] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance) *(OJ L 164, 25.6.2008, p. 19).*

[4] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (*OJ L 20, 26.1.2010, p. 7*).

[5] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (*OJ L 206, 22.7.1992, p. 7*).

[6] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (*OJ L 327, 22.12.2000, p. 1*).

To develop a typology for the legal basis of management measures, the Common Fisheries Policy and relevant and related EU environmental legislation was reviewed (see Annex 1). This included the Marine Strategy Framework Directive; the Birds and Habitat Directives; the Water Framework Directive and the Maritime Spatial Planning Directive[7]. The review also considered the directions given by the CFP on how to implement EAFM and references to it in the CFP legal framework, in particular: the Technical Measures Regulation; the Data Collection Framework Regulation; the Deep Sea Stocks in the North East Atlantic Regulation and the EMFF Regulation. A review of these policies highlighted that even though an EAFM is considered or even advocated in most policy documents, there is little, if any, direction on how it is to be implemented in practice. However, the policies do provide a basis for measures to be developed and this will be considered using the legal typology described below.

Based on the results of the review, EAFM measures were categorized by reference to the final legal basis under which they are adopted, resulting in two basic categories: (a) measures contained in legislation adopted by the EU; and (b) measures contained in legislation adopted by a Member State in cases where the necessary authority has been conferred by EU law (more specifically, by the basic Regulation).

(a) Measures adopted by the EU included those related to a) regulations adopted by the European Parliament and the Council in accordance with the ordinary legislative procedure, as in the case of EAFM measures contained in the Technical Measures Regulation (TMR) or the Deep Sea Stocks in the North East Atlantic Regulation; and b) regulations adopted by the European Commission as a delegated act or an implementing act (hereafter a 'Commission Regulation') in cases where the necessary legal powers are conferred upon the Commission in a policy instrument adopted in accordance with the ordinary legislative procedure such as the Basic Regulation or the TMR.

(b) Measures adopted by a Member State have their basis in legislation adopted by a Member State. This needs to be in accordance with the limited scope permitted by the Basic Regulation regarding conservation measures that are necessary for compliance with EU environmental legislation (Article 11); as emergency measures based on evidence of a serious threat to the conservation of marine biological resources or to the marine ecosystem relating to fishing activities (Article 13); or to establish non-discriminatory measures for the conservation and management of fish stocks and the maintenance or improvement of the conservation status of marine ecosystems within its territorial sea if the EU has not adopted measures addressing conservation and management specifically for that area, or specifically addressing the problem identified by the Member State concerned (Article 20).

While it was not possible to collect information on the full set of measures from both the EU and individual MS affecting all the fisheries, the available information still illustrates the legal basis of the measures that have been adopted to address the diverse types of EAFM challenges based on a count of the different measures (Table 2). Details of the available data are provided in Annex 7).

[7] Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning (OJ L 257, 28.8.2014, p. 135).

Table 2: Legal basis for measures adopted to address the three types of EAFM challenges across all sea basins (for details of the challenge types, see Table 1)

EAFM challenges	Measures adopted by the EU	Measures adopted by a Member State	Measures adopted by an RFMO
Type 1 - challenges to mitigate fisheries impacts	373	407	40
Type 2 - challenges to improve the advisory process and knowledge base		20	
Type 3 - challenges to improve the decision-making process		15	

The results indicate that the majority of measures have been introduced to address type 1 EAFM challenges relating to target stocks and by-catch. These have been introduced through the CFP, including the TAC and quota process and the landing obligation. Measures have also been introduced by Member States to address type 1 challenges probably relating to impacts on the wider ecosystem beyond target stocks as required under the MSFD. Based on the available data, the results of the legal analysis also suggest that there have been fewer measures introduced to address EAFM challenges of types 2 and 3. Furthermore, the legal basis for these is often at Member State level. This may reflect the current focus of the CFP on the type 1 challenges and the introduction of measures to address aspects of ecosystem-based management through the MSFD which is implemented by the Member States.

It should be noted however that the reporting of management measures under both the CFP and the MSFD does not facilitate this kind of analysis. **Information about the measures introduced under the CFP is not systematically collated to allow an assessment of the full set of measures that apply to a particular fishery, or across all fisheries**. Given the need to understand how measures interact with one another and can be used to address the type 2 challenges in particular, this is essential information. Under the MSFD, the Member States report shortcomings. For example, a number of measures are clearly EU fisheries measures under the CFP, while others seem to be part of more general management measures (e.g. closed areas), which may or may not have EAFM relevance. There are also a number of references within the MSFD reporting to measures adopted by Regional Fisheries Management Organizations (RFMOs) that are specifically implemented at the EU level through EU legislation, as well as decisions by Regional Seas bodies such as OSPAR, which appear to be primarily conservation measures. And this leads to a decisive point: many Member State measures listed are essentially conservation or environmental protection measures related to the sea and life in the sea that may in turn contribute to healthier marine ecosystems but which are not fisheries measures as such.

2.3.5 Characterizing existing management: implications for EAFM

Within the CFP Multi-Annual management Plans (MAPs) were applied as a first attempt to advance towards EAFM. In this study we introduce the EAFM plan (see Figure 5) as a further move towards EAFM. An EAFM plan is considered successful if appropriate management measures are applied within the legal setting to achieve the policy objectives and societal goals identified at the defining step of the EAFM process. The review of management measures was useful in highlighting that there are a limited range of management measures that can be applied to mitigate fishing impacts, including input and output measures, often applied as a way to restrict impact of fishing, and measures to actively restore (aspects of) the ecosystem, which may enhance the productivity of fish stocks. As the assessment indicates, the majority of the measures mitigate the fishing impacts on target stocks through catch and by-catch (i.e. type 1

EAFM challenges). There has been relatively little effort to address type 2 EAFM challenges which aim to improve the advisory process and its knowledge base. The assessment also supports the need for policy instruments to alleviate obstacles related to the decision-making process leading to the implementation of the measures (i.e. type 3 EAFM challenges).

An inventory of measures was created (Annex 4) and the review of the evidence indicates that the measures can be applied to achieve the policy objectives of single commercial stocks (i.e. MSY), which we consider typically represents conventional, single species, fisheries management, or they can be aimed at policy objectives that involve the wider ecosystem (e.g. reduce by-catch or protect seafloor habitats). What matters most is how the measure is applied, i.e. the implementation process, including the scientific advice and its knowledge base, and the decision-making process based on this advice in the context of the full social-ecological system. To that end, we introduced policy instruments as interventions that provide the means to implement management measures. Thus policy instruments are tightly linked to the governance arrangements and the social dimension of the fishery and thus differ from management measures which are typically grounded in the ecological system.

2.4 Best practices to support an EAFM process

We adopted the following definition for 'best practices' within the context of EAFM: "Best practices are the working standards or ethical guidelines that provide the best course(s) of action in a given situation"[8]. As this is highly context-dependent, the analysis was based on a set of Case Studies (CSs), with each CS focused on identifying best practices that could be relevant for the EAFM. These relate to the overall process of the implementation of one or more management measures to address one or more EAFM challenges related to particular fisheries operating in that specific context or study area.

Following on from the review of the management measures, two parts of the EAFM process were distinguished for which best practices would be key to advancing the implementation of an EAFM that related to governance arrangements and the ways in which management measures were identified and selected to address the EAFM challenges (see Figure 9):

(1) the knowledge base and how it was used in the advisory process, and

(2) the decision-making process and how this operated within the social context.

A set of criteria that could be used to assess the potential for improvement in these separate parts of the EAFM process were derived based on this approach:

- Advisory process. This critically depends on the knowledge base, how this underpins the measure and how this is used to generate the advice. The knowledge base could be scientific and/or be derived from expert knowledge, including local indigenous knowledge. The criteria relevant to the knowledge base and advisory process relate to the quality of the evidence and includes: quality, trust, evidence type (monodisciplinary or multi/cross-disciplinary approach) and the extent to which fishers’ knowledge is used (Mauser et al., 2013; Stephenson et al. 2016; Macher et al., 2021).
- Decision-making process. This aspect of the analysis considers the way in which decisions are taken, including the uptake of advice, involvement of stakeholders and consideration of the relevant actors and their respective roles (Hegland et al., 2012; Röckmann et al., 2017). The relevant criteria for decision-making included:

[8] https://www.investopedia.com/terms/b/best_practices.asp

evidence-based and with clear objectives, transparency, stakeholder involvement and regionalization. These criteria were based on existing good governance principles.

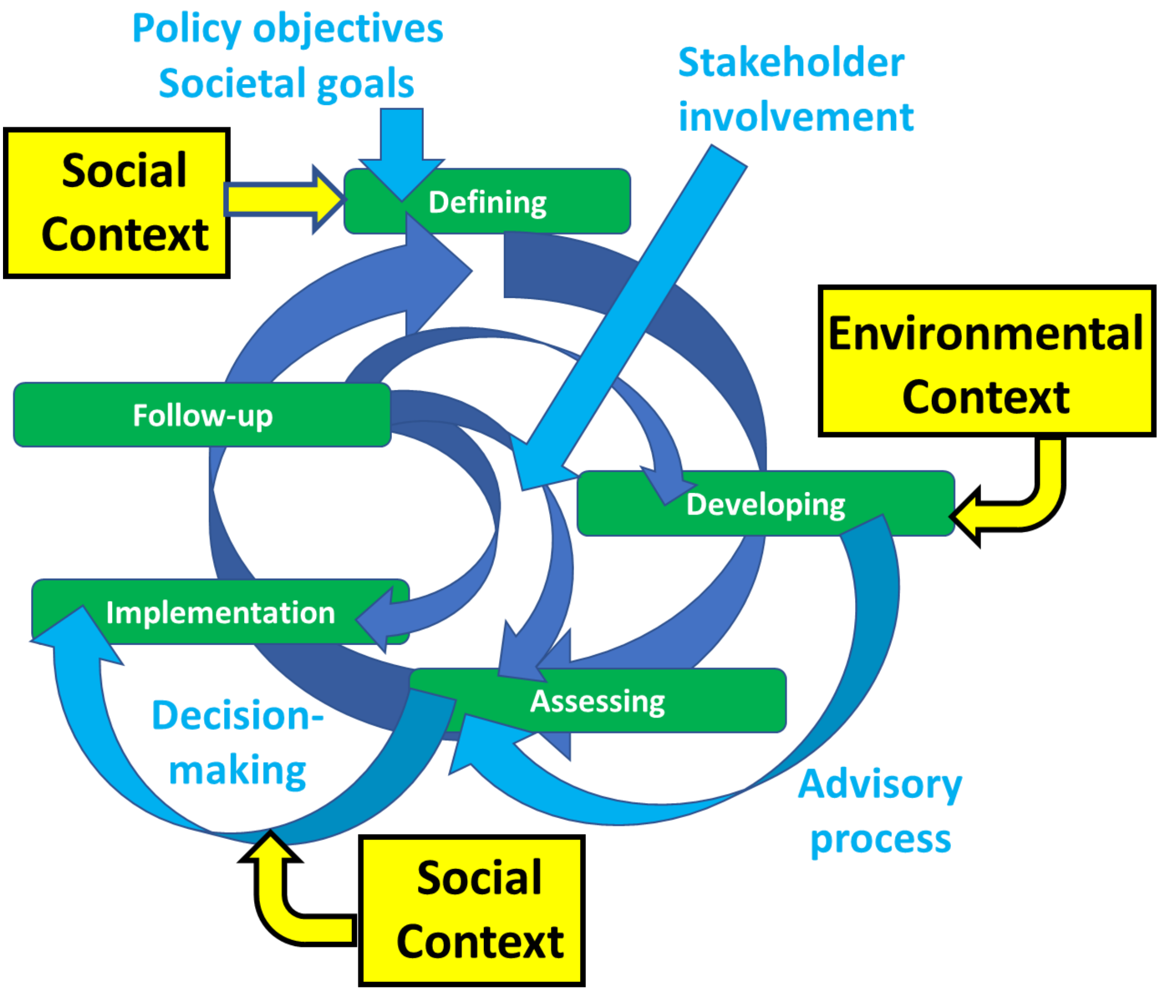


Figure 9: EAFM process and the main governance arrangements (in light blue) for which the identified best practices are most applicable. The relevance of specific context is reflected in the yellow boxes. Stakeholder involvement applies throughout the EAFM process. The environmental context applies specifically to the development of the knowledge base which is at the core of the advisory process.

2.4.1 Case studies

A total of twelve CSs were selected (see Table 3 and Annexes 5 and 6), representing various combinations of measures, challenges and fisheries. All twelve CS were systematically assessed to identify potential best practices that might have wider applicability, taking full consideration of the context in which the implementation process occurred. It was found that the majority of CSs focused on the implementation of management measures. The remaining two CSs (Sustainability indicators BE and Shrimp MSC NL-DE-DK) focused on the use of policy instruments, addressing issues of self-management to facilitate the implementation of measures, rather than the measures themselves.

With regard to the type of management measures, the majority of the CSs (seven of the ten) focused on input measures. This included gear-based TCM (e.g., pulse trawl NL and By-catch ES), spatial and temporal TCM (e.g., MPA Baltic and spurdog by-catch UK). One CS considered capacity and effort restrictions (Red snapper in French Guiana). Other CSs concerned the use of more than one management measure, in each case input TCM measures combined with TAC output measures (CS8 – Gulf of Cadiz Anchovy Fishery; CS9 – hunting of grey seals as a management measure in the Baltic Sea; and CS10 – effects of density dependent growth of fish on management).

For the two stages of an EAFM process (i.e. developing the knowledge base for advice and the decision-making process) for which best practices can help to advance, the above-mentioned criteria, along with other criteria closely related to good governance, such as regionalization (Hegland et al., 2012) and transparency (Röckmann et al., 2015) were selected in order to identify best practices from the case studies described in previous sections. The criteria used to characterize the Knowledge base supporting the advisory process and the decision-making were:

Knowledge base and advice

- Quality: expert opinion, Peer-reviewed literature and regional data available
- Trust: level of trust in evidence is low, medium or high
- Evidence type: monodisciplinary, multi/cross-disciplinary or transdisciplinary approach
- Fishers' knowledge: the knowledge base included the use of fishers' knowledge

Decision-making

- Evidence-based and with clear objectives: commitment evident in the case study documentation.
- Transparency: basis for decision-making evident
- Stakeholder involvement in decision-making: degree of participation in decision-making from consultative to collaborative co-design
- Regionalization: evidence of forms of decentralization and localization of decision-making

All criteria were ranked for each of the CSs, using a qualitative approach from 'high' for possible best practices to 'low' for obstacles that could hamper the EAFM process, the creation and uptake of the advice and successful implementation of the management measures which should ultimately result in the achievement of policy objectives (Table 3 and Annexes 5 and 6). In most CSs, the quality and credibility of the evidence used was high, though all were primarily based on scientific evidence rather than existing fisheries knowledge, which was poorly utilized. The N2000 DE and Red snapper French Guiana case studies were the only ones ranked with low quality and credibility of the evidence used, and Seals Baltic CS was identified as being based on low quality scientific underpinning.

It is also relevant to note that, pertaining to the use of inter- or trans-disciplinarity approaches deemed key in EAFM, there were only two CSs (Sustainability indicators BE and MPA Baltic) and one management measure, Anchovy Gulf of Cadiz, that use a multidisciplinary approach for constructing their knowledge base. With regards to the decision-making process and the criteria used to characterize it, regionalization was the best applied criterion, since all CSs were using existing information and data at regional scale. In contrast, stakeholder involvement in decision making was the lowest rated criterion, with only six CSs in which their participation was allowed, coinciding with the best ranked of the 12 case studies. Transparency was ranked high in most of the CSs, except for the N2000 DE, Red snapper French Guiana, Pulse trawl NL and Anchovy Gulf of Cádiz. It is worth noting that for most CSs, the decision-making process was evidence-based and with clear objectives, except for the N2000 DE and Red snapper French Guiana CS.

Table 3: Ranking of criteria by Case Study using a traffic-light approach to represent the criteria for the two parts of an EAFM process that were previously distinguished (see Figure 9), i.e. developing the knowledge base and provision of advice, decision-making process, in relation to the management measures that were implemented. Green color represents high quality and trustable evidence, based on transdisciplinary research, with a decision-making process characterized by its clear objectives, high transparency, stakeholder involvement and regionalization. Red color represents poor quality, credibility and monodisciplinary based evidence, excluding fishers' knowledge and with a decision-making process characterized by its lack of clarity in the definition of objectives, lack of transparency, poor stakeholder involvement and regionalization. Orange represents intermediate values. Further detail on the criteria can be found in Annex 6.

Case Study	Implemented management measure	Knowledge base and advice				Decision-Making process			
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholder involvement	Regionalization
1.Technical conservation measures to protect Kattegat cod	Marine protected areas to promote the rebuilding of cod population	Green	Green	Red	Red	Green	Green	Green	Green
2.Sole-directed pulse trawling in The Netherlands	Introduction of pulse trawling to reduce impact on sea bottom and CO2 emissions.	Green	Green	Red	Red	Green	Red	Orange	Green
3.Spanish Bottom Trawling in ICES subareas 6 and 7	Use of selective fishing gear to reduce discards with the LO framework	Green	Green	Green	Orange	Green	Green	Green	Green
4.Designation of Natura 2000 sites in the German EEZ	Protected areas	Red	Red	Red	Red	Red	Red	Red	Green
5.Bratten Marine Protected Area in the Baltic Sea	Establish no-take zones	Green	Green	Green	Red	Green	Green	Green	Green
6.Spurdog By-catch Avoidance Programme in the United Kingdom	Measures to avoid the by-catch of spurdog and thus reduce discards and the choke effect under the LO	Green	Green	Red	Red	Green	Green	Green	Green
7.Territorial User Rights in French Guiana	Granting of fishing opportunities in EU waters to fishing vessels flying the Venezuela flag in the EEZ off the coast of French Guiana	Red	Red	Red	Red	Red	Red	Red	Green

Case Study	**Implemented management measure**	**Knowledge base and advice**				**Decision-Making process**			
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholder involvement	Regionalization
8.Anchovy in the Gulf of Cadiz	Protection of nursery area (Guadalquivir)	Green	Green	Red	Red	Green	Green	Amber	Green
	TAC control	Green	Green	Red	Red	Green	Red	Red	Green
	SFPA between Spain and Morocco	Green	Green	Green	Red	Green	Green	Red	Green
9.Hunting of grey seals as a management measure in the Baltic Sea	Restricted hunting of seals to diminish gear damage	Amber	Green	Red	Red	Amber	Green	Amber	Green
10. Effects of density-dependent growth of fish on management and TAC, exemplified on Baltic sprat	TAC control	Green	Green	Green	Red	Red	Red	Red	Green
11. Fisheries sustainability monitoring Belgium	Monitoring instrument to assess socio-economic and ecological impacts of fleets	Green	Green	Green	Amber	Green	Green	Green	Green
12. Self-regulation of brown shrimp fishery in the southern North Sea via MSC certification	MSC certification	Green	Green	Red	Red	Green	Green	Green	Green

Collectively, the case studies provide useful insights into the ways in which measures were implemented that relate to the advisory and decision-making processes.

2.4.2 Best practices to advance the knowledge base and advisory process

Based on the CSs, the following observations could be made about the advisory process and its knowledge base:

- Overall, the CSs indicated that science was often, but not always, the basis for the implementation of management measures. Furthermore, even where scientific evidence was available, measures were not always implemented. Additionally, for certain measures (e.g. By-catch ES), measures were implemented and then adjusted after scientific evidence became available from an initial phase of voluntary adoption.
- In some CSs, decisions to implement measures were based on limited knowledge (e.g. MPA Baltic) but legal requirements meant that the EU Commission or Member State needed to act. In the MPA Baltic CS, designating Natura 2000 sites as required was only the first step and there followed a lengthy process of deciding on the management measures to be implemented for the sites.
- Several CSs describe the inclusion of stakeholder knowledge (especially the fishing sector) in the process of identifying management measures, suggesting that it can facilitate the implementation and acceptance of the measure (e.g. TCM Kattegat, MPA Baltic and Anchovy Gulf of Cadiz).
- Several CSs show that scientific evidence was not always (fully) utilized. Examples were the TURFs in French Guiana (Red snapper French Guiana) where limiting fishing pressure was the objective and Sprat Baltic where the scientific evidence was not used due to the nature of the advisory processes within ICES. Anchovy Gulf of Cadiz provided an example of where the evidence used was limited to fisheries issues (protection of a nursery area from fishing) overlooking evidence of wider interactions due to the effect of other human activities (agriculture, shipping, poor sewage treatment) that also may impact the nursery area. This would be an example of addressing the type 2 EAFM challenge “Anthropogenic (e.g. other sectors) and environmental changes/trends (e.g. climate) interact with fishing opportunities” but which would require additional measures.
- For some CSs there is only scarce scientific information to support measures. For example, in Seals Baltic hunting of grey seals in the Baltic Sea was allowed to proceed despite evidence of its likely ineffectiveness.
- The case studies also show how policy instruments could affect the advisory process. The Sustainability Indicators BE CS should provide additional information to the knowledge base. In Shrimp MSC NL-DE-DK, achieving MSC certification of the North Sea shrimp fishery was a driver for the use of scientific evidence to determine appropriate management measures.
- Finally, pulse trawl NL revealed that the link between scientific evidence and whether a measure will be implemented may not be straightforward. This highlights the critical importance of the context in which the decision is made and how the governance can affect the uptake of scientific advice in the decision-making process.

2.4.3 Best practices to advance the decision-making process

Based on the CS the following observations were made concerning the nature of the decision-making process:

- Disagreement or different interests amongst stakeholders affects the decision-making process. For example, where several countries are involved, decision-making can become less straightforward due to the diverging interests of the fishing sectors in the different countries. Where there was less divergence and measures were beneficial for each party, implementation was more straightforward (Anchovy Gulf of Cadiz).

- Scale can play a key role. While decisions on measures may be made at the regional level, they are implemented and have impacts at the local level. Where this is the case, there can be a lack of local stakeholder involvement at the highest level which can mean that important evidence of local concerns and impacts are overlooked or downplayed, thus affecting the successful implementation of management measures, e.g. pulse trawl NL.
- Several CSs describe the inclusion of stakeholders (especially the fishing sector) in the process of identifying management measures like facilitating the implementation and acceptance of the measure (e.g. TCM Kattegat, MPA Baltic and Anchovy Gulf of Cadiz). In some CSs, management measures were proposed by the fishing sector, or the sector was heavily involved in the development of the measures (e.g. By-catch ES) to achieve the management objective. In Sustainability indicators BE and shrimp MSC NL-DE-DK, measures were even introduced by fishers on a voluntary basis indicating that, with the right incentives and freedoms, the fishing sector could initiate and facilitate the implementation of EAFM measures.
- Mitigation of specific fishing impacts is not always the initial driver for decisions on management measures. As MPA Baltic illustrated, legal requirements could be the basis for implementing measures (a protected area), even where there is limited scientific evidence of what these will achieve. Similarly, political pressure could also play a role, as pulse trawl NL illustrated, and Seals Baltic described in the introduction of seal hunting. In the seal case potential losses for the fishing sector were addressed despite an absence of scientific evidence for the effectiveness of the measure.
  Sprat Baltic highlighted the importance of the connection between the advisory process and its uptake in decision-making. In this case, the scientific evidence was available but the absence of a link between the two processes appeared to prevent its use in decisions on introducing or adapting measures.

In summary, the case studies explore a range of measures and policy instruments applied in various contexts. The case studies highlight that both the advisory and decision-making processes experience different expressions of uncertainty and disagreement. While scientific evidence underpinned many measures and policy instruments, there was also a role for other knowledge types and in some cases the measures were identified or implemented by fishers (Sustainability indicators BE and Shrimp MSC NL-DE-DK). The decision-making process was also affected by issues within institutions, participation and power, with participation of fishers helping to facilitate implementation of measures (MPA Baltic and Anchovy Gulf of Cadiz) and stakeholders seeking to use their power to influence decision-making (Seals Baltic). In other cases, institutional arrangements prevented the use of available evidence (Sprat Baltic).

2.4.4 Best practices: implications for EAFM

The case studies identified a number of practices that could assist with progressing an EAFM and these concern both the advisory and decision-making processes. These are discussed in turn:

Knowledge base and advisory process

Advancing an EAFM has recognized the need for a policy-driven process that should be evidence-based (e.g. Röckmann et al., 2015; Berghöfer et al., 2008). The feedback at the stakeholder workshops (see Annex 8) supported this and indicated that evidence should cover everything required to guide management to achieve social, economic and institutional objectives. As the CSs indicate, there should also be consideration of EAFM challenges that involve the wider ecosystem or interactions with other sectors and effects of climate change. This will further increase the complexity of the analysis and there should be reflection as to whether the type of science (quantitative modelling) used for stock assessment to inform Total Allowable Catches (TACs) should dominate EAFM. Related to this point, the analysis of the CSs showed that decision-making on the implementation of management measures drew on different knowledge types. While measures in general had some degree of scientific underpinning, there were examples where stakeholders (especially the fishing sector) contributed knowledge, even going as far as to propose management measures that facilitated the implementation and acceptance of the measure. Looking at ways to broaden the knowledge base and the use of alternative, transdisciplinary approaches (e.g. Mascher et al., 2021) to quantitative modelling (e.g. Bentley et al., 2019) may help address the difficulties in terms of information requirements, associated with increasing complexity. There is broad agreement within the literature that inclusive processes create trust and transparency, and can ultimately build consensus which, in turn, enhances compliance with the management measures (Chuenpagdee and Jentoft, 2019; Röckmann et al., 2015). In contrast, insufficient, or ineffective, engagement can lead to evidence being overlooked or excluded. Indeed, an issue highlighted by several of the CSs as well as the stakeholder workshops was that evidence was not always (fully) utilized or that there were obstacles in the governance arrangement preventing uptake of advice in the decision-making process. The main lessons learned are:

- The development of the knowledge base requires inter- or transdisciplinarity and an integrated perspective, consisting of not only ecological assessments, but also social and economic assessments.
- Scientific knowledge is only one type of knowledge and it is important to also ensure that other types of knowledge, including that of fishers can contribute to the knowledge base[9]. This is where there are important insights from work on local indigenous knowledge in the social sciences and on collaborative approaches such as co-design (e.g. Bovaird and Loeffler, 2012) and community science (Charles et al., 2020) which can make important contributions.
- Development of the knowledge base is important but uptake of the scientific advice in the decision-making process is key for a successful EAFM process and it is therefore critical to raise awareness amongst decision-makers of the benefit and need for other knowledge types and alternative advisory processes to support an EAFM.

Decision-making process

To advance from current governance arrangements that primarily support conventional single-species fisheries management to those that can address (more) EAFM will require political will. In the first instance, it is important to recognize that the starting point has to be the existing decision-making structures and processes. In this respect, the governance arrangements related to decision-making follow two main routes within the context of the CFP.

The first, related to stock assessments and TAC allocations is relatively direct: scientific advice is provided to the European Commission (Parliament and Council) independently by ICES and recommendations are subsequently raised at the December Council meeting where the Council of Ministers (AGRIFISH) make the final decisions. Further evidence involving socio-economic aspects or the effectiveness of measures is provided by STECF but this tends to come late in the process. The case studies indicated that within this process the knowledge base is largely restricted to scientific knowledge, with a limited role for other knowledge types. The knowledge base is focused primarily on the EAFM challenges related to the commercial stocks, with still little consideration given to the other type 1 challenges involving the wider ecosystem, let alone the type 2 challenges related to the advisory process or the type 3 challenges in the decision-making.

The second route involves the regional groups and consultations with stakeholders, primarily through the Regional Advisory Councils (RACs) that were created after the 2002 reforms and later renamed Advisory Councils (ACs) following the 2013 CFP reforms (e.g.

[9] Fishers knowledge, for example, may currently be included in the advice from advisory councils but not systematically in the broader advisory process.

Hegland et al., 2012). This route aims to incorporate both technical and non-technical advice in recommendations to the Commission and Member state groups on the design and implementation of management measures. The introduction of the regional groups and the establishment of Advisory Councils were supposed to add some elements of decentralization and regional stakeholder involvement, thereby addressing the criticisms of the CFP such as initiating primarily top-down management. However, the analysis of the CSs showed that the regional groups may still largely enact top-down decision-making with often little bottom-up involvement of stakeholders (such as in case of the implementation of the Landings Obligation - Uhlmann et al., 2019; de Vos et al., 2016).

Both of these routes have been criticized for being hampered by relatively weak participation and consequently low buy-in of the measures. This, in turn, can lead to low compliance with the measures. The main lessons learned were:

- Stakeholder involvement should occur from the start of the EAFM process, i.e. defining the steps, where the relevant policy objectives and societal goals are being identified, and an important challenge involves conflicts between different stakeholder groups. This need not just be between the fishing sector and eNGOs but could also be between the fishing sector and other sectors (e.g. in a Marine Spatial Planning context). Stakeholder engagement in advisory process helps ensure that outputs remain relevant to societal needs; considerations of risk and uncertainty, normative values, and trade-offs between management objectives is not something to be explored solely by researchers (Dickey-Collas and Ballesteros, 2019)
- Decision-making should be better linked to the advisory process and take account of the knowledge base and stakeholder interests and apply principles of good governance, including issues of legitimacy, inclusiveness, fairness and accountability. As a way forward Ramírez-Monsalve et al. (2016) suggest that EAFM advice should make the trade-offs explicit that determine how the decisions would create winners and losers within the fisheries sector (e.g. targeting the predator fish species or the prey)

2.5 Relational database and its application as part of the follow-up process

A cycle of an EAFM process is completed in the final Follow-up step in which its performance is evaluated in terms of achieving the specific policy objectives or societal goals and the extent to which the different challenge(s) have been addressed (Figure 1). Here, we present a relational database that can support this Follow-up step and which is built on the basic structuring of the relevant information (e.g. fisheries, management measures, challenges) presented in the previous chapter. This relational database (i.e. a standalone offline Microsoft Access database) enabled the structuring and collection of information through a series of simple user forms that allowed data to be viewed and updated (see Annex 7 for details). The structure of the database was based on linking the following typologies:

- EAFM challenges (chapter 2.1);
- Types of fisheries (chapter 2.2);
- Management measures and their legal setting (chapter 2.3);
- Best practices and scientific underpinning (chapter 2.4).

Developing a common structure for the distinct types of information also included coordination with EASME/EMFF/2018/011 Lot 2: Specific Contract No. 2 - Overview of the state of data collection and scientific advice in the EU Outermost Regions, as that project was responsible for providing data on the Outermost Regions (ORs). The structure that has been developed will also be used in the study on EAFM in the Mediterranean and Black Seas (Service Contract No. EASME-EMFF-2019-1.3.2.6-02-SI2.837773) to provide a database that holds information on EAFM challenges and measures for all EU waters.

The creation of a relational database ensured that the data could be collected, stored and maintained in a consistent manner. An important feature of the database, and strength of this approach, is that it provides the possibility to link data from various sources in an efficient and systematic way. Thus, fisheries can be linked to EAFM challenges, management measures, sea basins, etc. This underpins potential analysis, for example to identify differences in the types of implemented management measures or EAFM challenges addressed by sea basin, fishery or species. The more specified, accurate and complete the data is, the more informative the outcome of the analysis in terms of assessing the current EAFM process as well as guiding the next cycle. For an initial trial of the application of the relational database as part of the Follow-up step, requests were made to DG MARE to secure data that could be used in combination with the typologies needed to populate the database. The list of information discussed and requested included:

- Current quota measures (e.g. by species, area, MS, amount);
- Closed (or open) season restriction measures (e.g. season only March – April);
- Closed area restriction measures (e.g. 7d closed to trawling);
- Effort limitations (e.g., number of vessels, tonnage limits, HP limits (combined for fleet), number of licences);
- Gear-based TCMs (e.g. size limits on mesh size, hook shape and size restrictions);
- Selectivity-based TCMs (e.g. Requirements to use streamer (tori lines), by-catch reduction devices);
- Discard bans (e.g. Landing obligation); and
- Landing size controls.

Where data was available, it was added to the database and the source of the data was included as a key field. The structure of the database allows for various queries to be run to interrogate the database and provide information on, for example, the measures used to address challenges, the types of measures by fishery, types of challenges associated with different fishery types etc.

In developing and populating the database, three key difficulties were encountered. The first was that a wide variety of data sources exists and this immediately created issues with different terminologies and classifications. This was resolved using the typologies that had been developed within Tasks 1-4 and categorizing the data according to them. A second difficulty was if and to what extent the measures addressed specific EAFM challenges. To the best of our knowledge, this has not been conducted on this scale before and interpretation and identification of each particular challenge or measure was not always straightforward. The third difficulty was in the linking of measures, challenges and fisheries, e.g. as a result of differences in the description of geographical regions (e.g. as ICES rectangle or sea basin).

2.5.1 Relational database: implications for EAFM

The relational database turned out to be a key requirement for the Follow-up step as this provided consistent categories of all the main components, i.e. measures and fisheries, as well as their linkages. This is a necessity to allow any evaluation of current EAFM and potential progress in subsequent EAFM cycles pinpointing the types of challenges that can be addressed to advance this process. With the typologies established, the main difficulty appeared to be in getting a comprehensive overview of all the data on the measures applied to a fishery. These were often not comprehensive in that technical measures might be recorded separately from TACs and other measures, such that there was no single source that captured all measures that applied to a particular fishery. Furthermore, an assumption had to be made that implementation dates relate to the date the measure was introduced. Yet, as STECF (2020) note, they may be affected by lead-in times and may not be fully implemented. More consistent and comprehensive documentation of the measures introduced in the fisheries and the challenges they seek to address is required for any future mapping exercise and/or assessment of progress with advancing an EAFM.

3 SYNTHESIS: AN EAFM PERSPECTIVE

This section provides an overview of progress to date with implementation of an EAFM under the CFP, the types of EAFM challenges that are currently being addressed and the extent to which EAFM has advanced beyond a focus on the commercial stocks alone across the four regions, i.e. the North Sea, Baltic Sea, Western Atlantic and Outermost Regions. This is based on data and information collated about measures, challenges and fisheries and the linkages between them recorded as entries or links within the database. For data sources please refer to Annex 7. The overview essentially implies that this study can be considered as the follow-up step of a first EAFM cycle (see chapter 2, specifically figures 1 and 9). As such the recommendations proposed by this study should then be used to inform the next EAFM cycle.

3.1 Assessment of EAFM implementation

Across all the regional seas, the measures implemented were mostly aimed at the type 1 challenges, i.e. mitigating fishing impacts, confirming that the measures as defined in this study primarily operate in the ecological system (see Figures 10-12) and that conventional single-species fisheries management remains the primary focus across all the geographic areas considered in this study.

In the **North Sea** (Figure 10), these were mostly TAC controls and TCMs (both gear-based as well as spatio-temporal) to protect the commercial fish stocks. This typically represents conventional single-species fisheries management. Fisheries management in the **Baltic Sea** (Figure 11) and in the **Western Atlantic** (Figure 12) are similar to that in the **North Sea** in terms of its emphasis on conventional fisheries management measures, i.e. aimed at the protection of commercial stocks. The Baltic differed from the North Sea and Western Atlantic in that there was more emphasis on TCMs, although TACs continued to have a key role. In the **Outermost Regions** the focus was also on target species and by-catch, but mainly through the use of input measures such as gear-based measures and spatial restrictions. Compared with the other regions, there was less emphasis on TAC controls and more on capacity and effort restrictions. There were both similarities and differences in the policy instruments that have been introduced across the different regions. Overall the policy instruments primarily targeted actors in the social system but were applied differently across the regions in terms of the EAFM challenges they addressed.

In the **North Sea**, management was found to be primarily aimed at the sustainable exploitation of the commercial stocks (Figure 10). Key measures include TAC controls (29 measures), discard bans (10 measures) and gear-based (19 measures) covering 140 different fisheries, including recreational fisheries. Examples of some of the measures include real time closures and minimum mesh sizes in cod trawl fisheries, size selective grids for Nephrops trawls and bans on the use of recreational fishing with nets. However, next to the conventional fisheries management measures, there are what can be considered to be more EAFM measures in place to mitigate by-catch of species other than the commercial stocks (51 measures), mostly through gear modifications and real-time closures (three directed at demersal trawl and seine fisheries). These measures include species selective gears in the shrimp trawl fishery, sorting grids in mixed demersal trawl fisheries and measures to reduce the seabed impacts of otter trawl and beam trawl gears in demersal finfish and shrimp fisheries.

In the **North Sea** (Figure 13), the policy instruments appeared to be fairly evenly spread across all three EAFM challenge types: improving existing fisheries management, for example through voluntary agreements for the protection of species and habitats (21 links to type 1 EAFM challenges); improving the knowledge base and advisory process (17 links to type 2 EAFM challenges) and improving decision-making processes through research studies and greater inclusion of social considerations (20 links to type 3 EAFM challenges). Policy instruments to improve the governance arrangements of fisheries management and facilitate the implementation of management measures included co-management, self-management or results-based management and economic instruments like payments or pricing mechanisms or tradeable fishing concessions (such as ITQs).

Fisheries management in the **Baltic Sea** also mostly consisted of conventional fisheries management measures (Figure 11) aimed at the commercial stocks including TAC controls and recreational bag limits (12 fisheries), discard bans (nine fisheries) and landing size controls (seven fisheries). Spatial and temporal TCMs have also been introduced into seven fisheries, including spawning closures for the Baltic cod and closures to protect sandeel and horse mussels. The overall emphasis has been on output measures, including size limits for some commercial fish. Wider environmental concerns in the Baltic include invasive species and there have been measures to address some of these, for example through the targeting of the round goby (*Neogobius melanostomus*). There have also been measures introduced to minimize impacts on other species, including protection of harbour porpoise and seabirds.

Fewer policy instruments were identified in the **Baltic Sea**, with examples introduced into only 12 fisheries (Figure 14) The identified policy instruments were mostly applied to improve the knowledge base and advisory process. For example by considering the indirect effects of fishing and including additional information on anthropogenic and environmental changes (nine links to type 2 EAFM challenges). Several of the policy instruments concerned advice on the impacts and management of non-native and introduced species.

Fisheries management in the Western Atlantic (Figure 12) also consists mostly of conventional management measures addressing target stocks and by-catch with 37 TACs and five discard bans. Output measures have been introduced to 42 fisheries. Input measures, including technical control measures have been introduced to 19. Examples of input measures include spatial management and real time closures in the Celtic Sea and the use of mesh size changes to alter selectivity patterns in mixed demersal fisheries. Measures to address wider environmental concerns associated with the type 1 EAFM challenges include combatting invasive species, shifting to low seabed impact gears, e.g. in the Iberian otter trawl fisheries, prevention of cetacean by-catch through acoustic deterrence. The Iberian otter trawl fishery has also seen initiatives that relate to the type 2 EAFM challenges by increasing stakeholder participation and contribution of knowledge to address management issues.

In the **Western Atlantic** (Figure 15), there was a total of 53 examples of policy instruments. Of these, the policy instruments that addressed the type 2 EAFM challenges (14) reflected the ecosystem challenges of complex and dynamic multi-species fisheries in this sea basin, e.g. in the Celtic Sea. This included research on fishing patterns in the demersal trawl fisheries to inform fishing opportunities. Type 1 EAFM challenges were addressed through 11 policy instruments and also reflected the complex interactions between ecosystem dynamics and fishing activity and supported the introduction of measures, including gear-based measures to address the implications of altered food-web interactions.

The situation in the **Outermost Regions** regarding management measures is similar to elsewhere (Figure 16), with the majority of management measures addressing type 1 EAFM challenges, target species and by-catch (197 examples of input measures and 78 output). Technical input measures were highly varied, reflecting the diversity of fishing methods and included restrictions on net lengths and mesh sizes (e.g. Martinique, Reunion), prohibitions on respiratory equipment in dive fisheries (Guadeloupe), minimum longline hook sizes (Madeira and Azores). As with other regions, spatial and temporal closures have been an important set of management measures, including limits on the depths at which gillnets can be used (e.g. Guadeloupe). In contrast with the other regions where TACs have had an important role, in the Outermost Regions output measures instead focused on the application of landing size restrictions, e.g. for parrotfish (Canary Islands), urchin (Guadeloupe) and lobster (Martinique) fisheries and minimum landed weight restrictions, e.g. in octopus (*Octopus vulgaris*) fisheries. Wider environmental concerns associated with the type 1 EAFM challenges have also been addressed through both input and output management measures, including measures to reduce incidental mortality of seabirds and bans on the trade of sharks (e.g. Mayotte).

In the **Outermost Regions** (Figure 16) the majority of identified measures focused on conventional fisheries management challenges (i.e. EAFM challenge type 1). Many of the fisheries were identified as data-poor (including both the environmental and socio-economic dimensions) and key challenges relate to the knowledge base (i.e. EAFM challenge type 2) and the key policy instruments used to address this included targeted actions to improve data (e.g. through observer programs and sampling schemes for small-scale fisheries), data analysis and identification of appropriate reference points and management measures. In response to this there have been a number of research initiatives and monitoring programs to address existing shortcomings.

The analysis provides an initial indication of where the emphasis lies within fisheries management across each of the regional seas. However, the results are based on the available data and reported in terms of the entries or links as they have been established in the database. This database, however, is not comprehensive and is based on the measures provided to date by DGMARE and sourced independently through the interviews and data collection activities in the relevant MS and the Outermost Regions (see Annex 7). The analysis therefore presents the state of affairs as represented by the sources currently included in the database.

While the developed typologies and their application in a relational database work well to structure and analyze the current state of EAFM as well as any future progress, their utility would be improved by the creation of a comprehensive and consistent overview of the current and future fisheries management measures.

Figure 10: North Sea measures implemented to address EAFM challenge subtypes showing the application of policy instruments

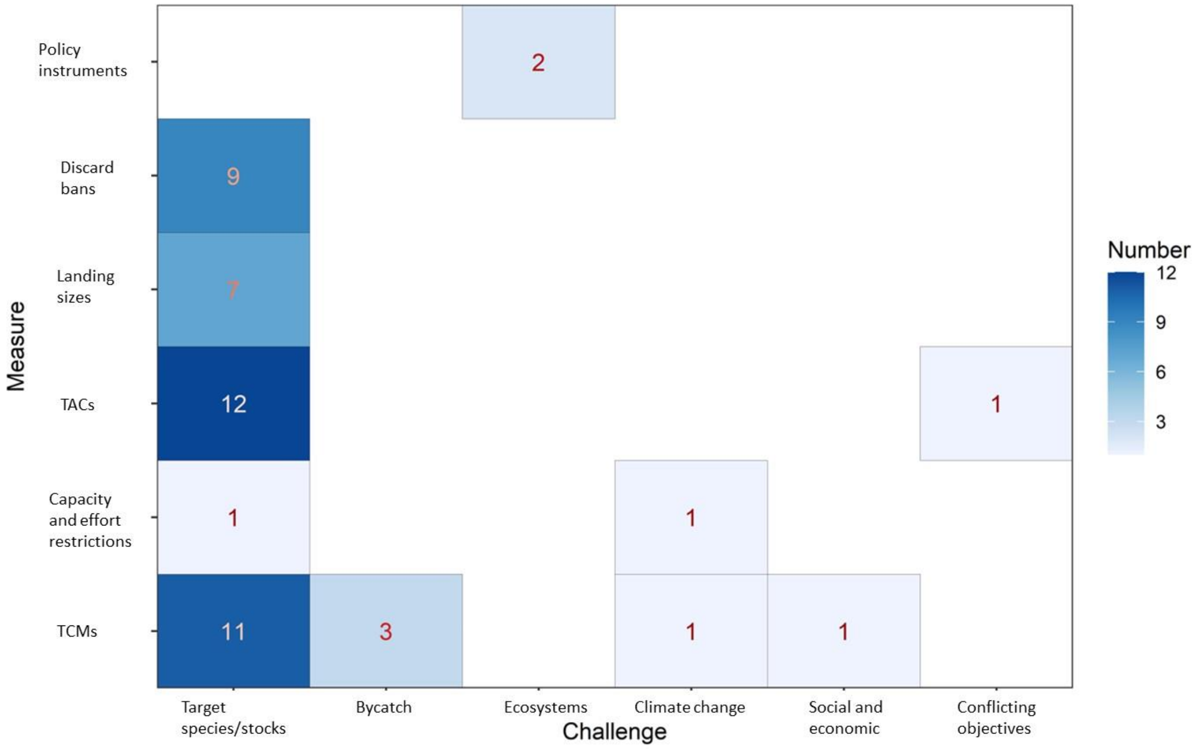


Figure 11: Baltic Sea measures implemented to address EAFM challenge subtypes showing the application of policy instruments

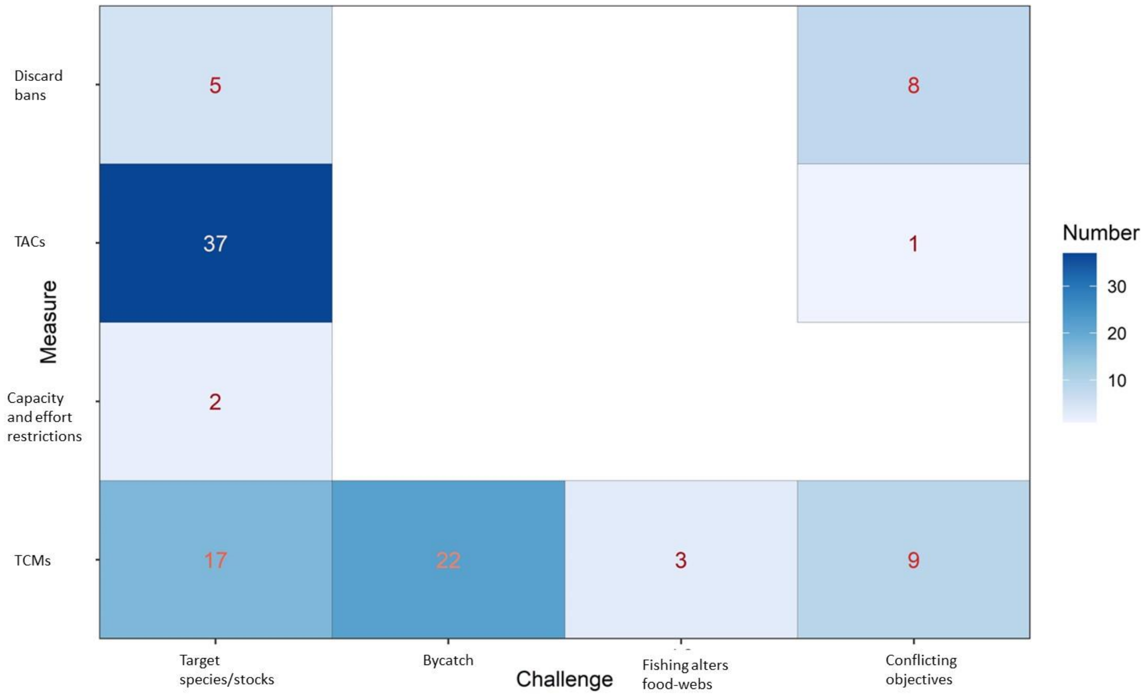


Figure 12: Western Atlantic measures implemented to address EAFM challenge subtypes showing the application of policy instruments

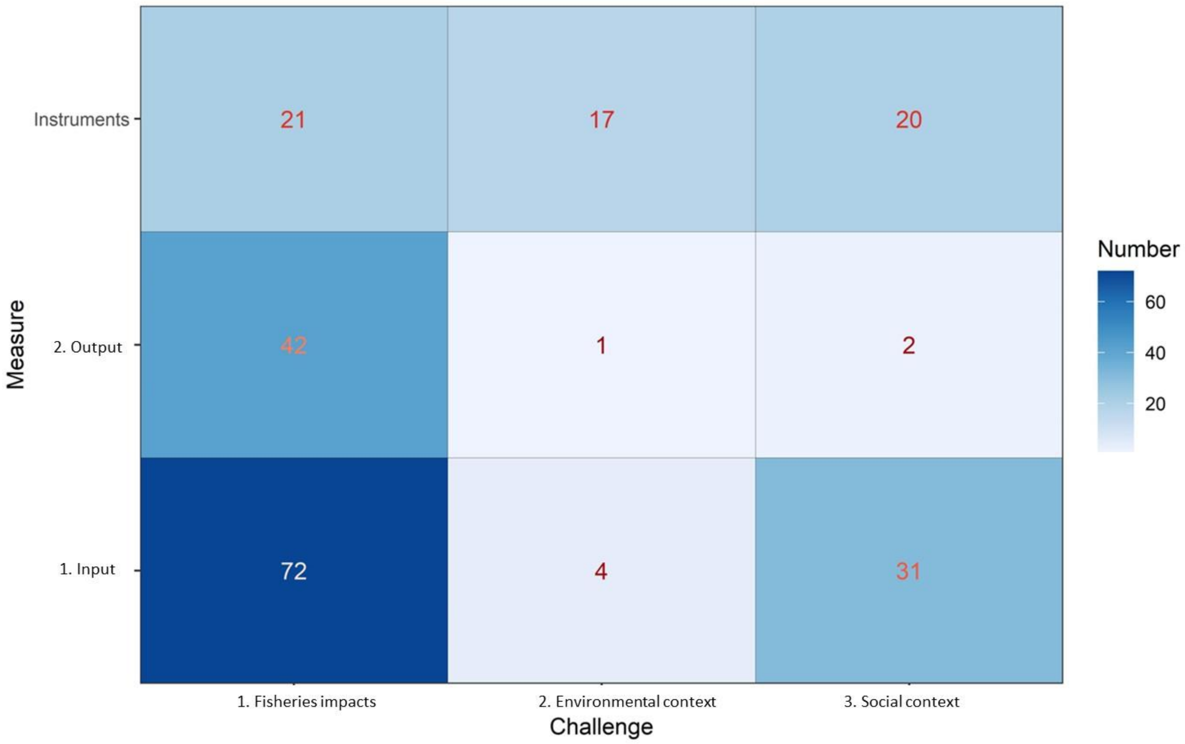


Figure 13: North Sea measures implemented to address EAFM challenges

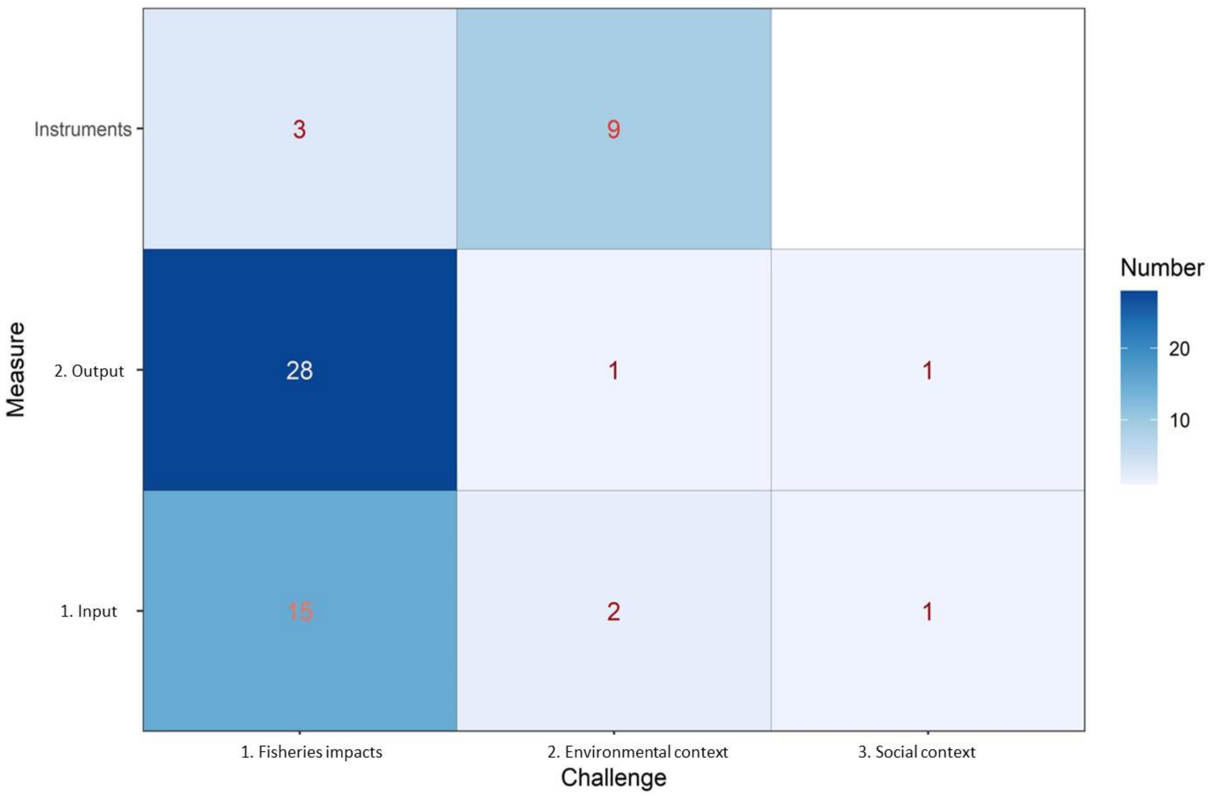


Figure 14: Baltic Sea measures implemented to address EAFM challenges

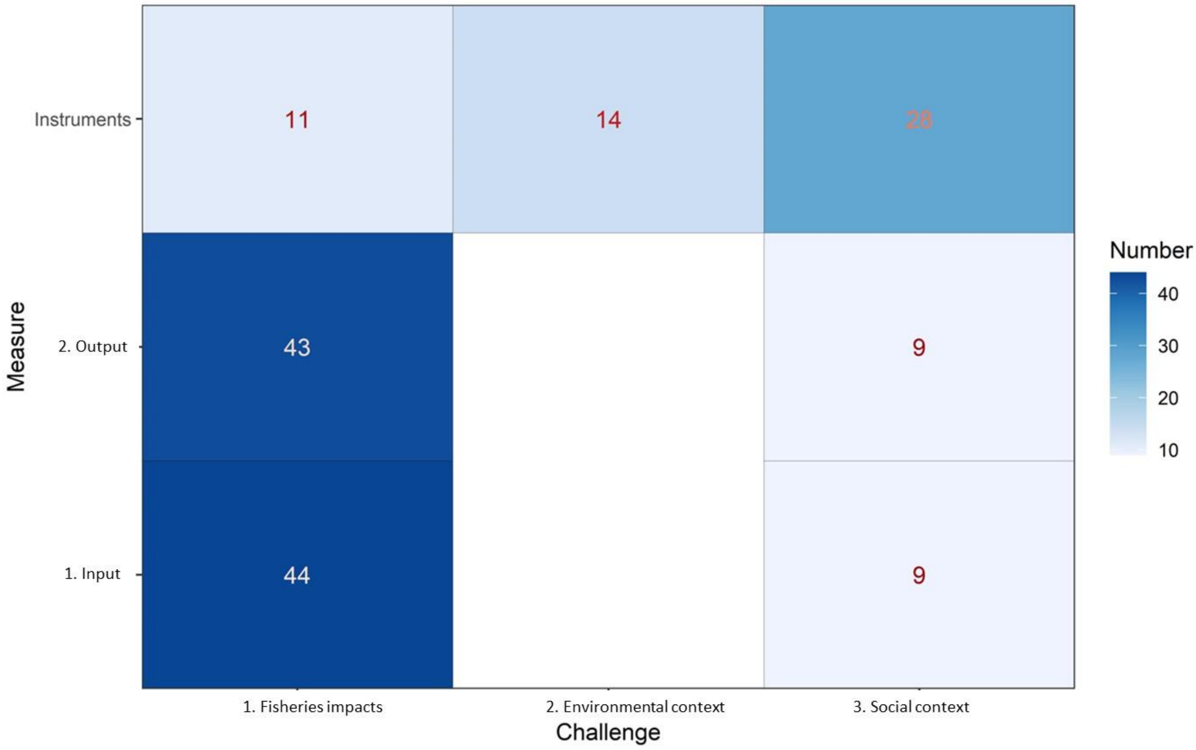


Figure 15: Western Atlantic measures implemented to address EAFM challenges

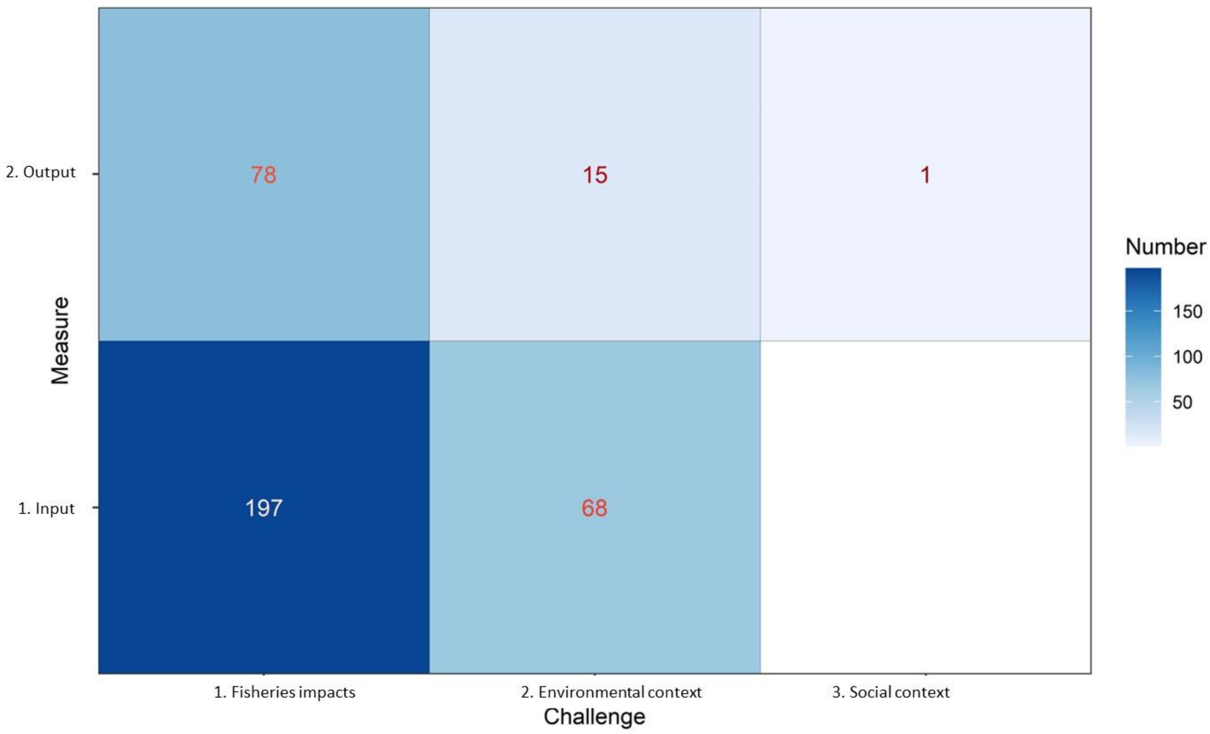


Figure 16: Outermost Regions measures implemented to address EAFM challenges

3.2 Assessment of operational readiness of EAFM

As part of this study, an assessment was requested of the operational readiness of (specific elements of) EAFM in place, including the measures, their scientific evidence and governance. This assessment should distinguish between:

- EAFM measures and governance that have already been implemented and are functioning properly
- EAFM measures and governance that are "close to market", i.e. required by legislation, evidence ready to be provided by the science community and that support measures that could be used by managers in the near term. Where possible, we will point to existing evidence and/or best practices to ease their implementation.
- EAFM measures and governance for which there is a high demand (whether through legislative requirements or demands from stakeholders), but for which obstacles exist that prevent their implementation, e.g. lack of data, unclear advice, lack of outreach, weak science base. Where possible, we will point to existing evidence and/or best practices to ease their implementation.
- EAFM measures and governance for which there is no prospect of near or mid-term progress, preferably explaining the reasons for this, e.g. incompatible with entrenched legislation (such as relative stability), no scientific consensus, or unrealistic data requirements. Here we propose recommendations of alternative approaches that can support the same measures or address the same challenges but that have better operational readiness.

In order to address this request, some clarification was required. To start with, there was no agreed definition or assessment criteria provided for what was meant by "functioning properly". As a way forward, we propose two perspectives that determine if an EAFM process is "functioning properly":

- In terms of its performance, a process is perceived to be contributing to the achievement of policy objectives or societal goals.
- In terms of its process, it fulfils as many of the EAFM principles (see Box 1, section 1.1) as possible and takes account of the specific context in which the EAFM process takes place.

At this stage, however, an assessment against policy objectives other than those relating to the commercial stocks is not possible. Firstly because assessment of the performance of EAFM was not part of the remit of this study and secondly because the few typical EAFM measures already in place were implemented fairly recently so any assessment of their performance is likely to be premature.

To arrange EAFM measures and policy instruments in terms of how 'close to market' they are, we considered the 10 tenets for successful, sustainable management (see Elliott, 2013 for a comprehensive list) and applied two criteria which can be assumed to represent some of these tenets:

- Legislation exists as has been implemented by either the EU or a MS.
- Implementation was to mitigate the impacts of any of the fisheries included in this study. The fact that they were implemented and the number of different fisheries for which they were implemented were assumed to cover tenets like 'Ecologically sustainable', 'Technologically feasible', 'Socially desirable/tolerable' or 'Administratively achievable' and hence provides some indication of operational readiness.

While this analysis is entirely dependent on the data available it did suggest that in terms of operationalizing measures, technical conservation measures and capacity and effort restrictions were implemented through both EU (both Commission and Council and Parliament) and national legislation (Table 5). Output measures and TAC controls, which tend to more directly affect the target stock, were, on balance, more likely to be implemented through EU legislation, and the CFP in particular. The relatively high figures for MS legislation are affected by data from the Outermost Regions, where there are more likely to be local regulations introduced.

Table 5: Indication of operational readiness of EAFM measures for which information on the legal basis was also available indicating how close to market they were. The number of counts represent how often legislation existed to allow their implementation targeting a specific fishery.

EAFM measure category	Measure type	Legislation EU	Legislation EU (Commission)	Legislation EU (Council and Parliament)	Legislation MS	Regional Fisheries Management Organization
Input measures	Technical Control Measures	4	6	84	187	10
	Capacity and effort restrictions	2		9	36	1
Output measures	TAC controls	77		2	36	1
	Landing size controls	3	7		21	15
	Discard bans	14	28	2	17	
	Landed species restrictions				107	9
Ecosystem restoration measures	FAD management				13	

Table 5 provides a first and rather crude indication of operational readiness of EAFM measures grouped by measure category (level 1) and type (level 2) according to the typology (see figure 6 and Annex 4), more specifically how close to market they were, in terms of the number of different fisheries targeted. From the perspective of advancing an EAFM there are two points to make about the introduction of management measures. The first is that the MS legislation in Table 5 is biased by the measures that are in place in the Outermost regions. The second is that TAC controls are still by far the main management measure in place and for which annual TAC and quota setting remains an important decision-making process which would benefit from an improved knowledge base (by addressing type 2 EAFM challenges) and the (further) incorporation of socio-economic considerations (by addressing type 3 EAFM challenges). The second is that the diversity of fisheries and fishing methods has meant that a lot of measures, particularly input measures, have had to be developed locally to reflect the context-specific nature of fishing activity. This flexibility is important and ways need to be found to also enable the development of locally-appropriate responses to policy objectives.

From an operational readiness perspective, the single measure “closest to market” are the 'conventional' TAC controls, that are mostly based in EU legislation. Other measures that can be potentially applied as part of EAFM are the TCMs, both gear-based as well as spatial/temporal, for which the legal setting exists both at EU and MS level. However, pertaining to their operational readiness in the context of EAFM, clearly 'the devil is in the detail' as there can be many varieties of measures within the broad categories shown in Table 5. For example, while specific gear-based TCM may appear to be operationally ready because they have been applied in several fisheries to mitigate by-catch of specific commercial "choke" species this does not reflect on its readiness to mitigate by-catch of sensitive non-target or even non-fish species, let alone disturbance of seafloor habitats. Then there is the context in which the measure is implemented and how this is incorporated into the implementation process, which ultimately determines if a measure is successful or not.

3.3 Conclusions of the synthesis

The synthesis of all outputs of the individual work tasks in this project (i.e. EAFM challenges, typologies of fisheries, management measures), and its application to assess the current state of affairs in fisheries management and the implementation of an EAFM specifically, rendered the following conclusions:

1. The overall conclusion of the assessment is that current fisheries management is dominated by conventional single-species advice on which the TAC/quota management is based. The first step toward more EAFM is through the implementation of TCMs to mitigate by-catch. All other EAFM initiatives mainly consist of regulatory or economic policy instruments, not measures.
2. Hierarchical typologies of the relevant components (i.e. EAFM challenges, fisheries and measures) are appropriate to structure EAFM and assess the state of affairs in relation to EAFM.
3. The three main categories of EAFM challenges appear comprehensive and useful as they cover what appear to be the main overall challenges, i.e. (1) mitigating fisheries impact on the ecosystem, (2) the advisory process and (3) decision-making. While these three main categories are not likely to change, some of the more detailed (below sub-type) challenges may need to be revisited and, in some cases, combined.
4. The typology for the commercial fisheries appears suitable in an EAFM context. However, it probably needs to be expanded to include recreational fisheries. The current typology is entirely based on the fisheries' interaction with the ecological system and may need to be revised to incorporate their link to specific fishing communities so that it encompasses the whole social-ecological system as EAFM requires.
5. The hierarchical typology of management measures was found to be essential to structure the immense variety of detail that emerged from the review of existing measures.
6. Although not specifically requested, we found that EAFM requires the explicit distinction between the management measures and the policy instruments as the means to implement them. Separating them from management measures is not only an improvement from a conceptual perspective but has many practical advantages as the two operate in distinct parts of the social-ecological system, require different expertise and scientific disciplines, and/or involve different governance actors. This study provides a first tentative typology of policy instruments but, considering their importance in EAFM, especially in relation to 'operational readiness', this needs to be revisited and improved.
7. The application of both measures and policy instruments and their typologies as part of a relational database to assess the current state of affairs in relation to EAFM showed internal consistency (e.g. measures mainly link to the type 1 fishing impact challenge, policy instruments to the type 2 and 3 EAFM challenges that involve respectively the advisory and decision-making processes) and their potential usefulness for such assessments.
8. The bottleneck for the EAFM assessment was the availability of a comprehensive list of management measures, appropriately categorized at an adequate level of detail. As it currently stands, only a few rather randomly collected datasets were available and for which it was not always clear how to categorize and assess them or how these matched the measures typology presented here. The current typologies of both measures and policy instruments should be tested and improved (certainly the policy instruments) so that they can be used to generate comprehensive lists of EAFM measures and policy instruments for each of the regional seas to be applied in future assessments.
9. The two focal points of the 'operational readiness' assessment, i.e. measures and policy instruments, appear relevant but the key issue that determines 'operational readiness' is the specific context, mostly ecological/environmental for the measures and social/institutional for the governance. In order to advance operational readiness of EAFM in its specific context we propose to collate generic information that allows a first scrutiny of potential measures or policy instruments that can be considered ready for

operation against a selection of essential tenets, e.g. Socially desirable/tolerable, Legally permissible, Administratively achievable and politically expedient (Elliott, 2013), and then further evaluate this selection in the specific context where EAFM is supposed to be implemented.

4 ADVANCING THE IMPLEMENTATION OF EAFM

The potential to advance the implementation of EAFM based on the findings from this study is shown in Figure 17.

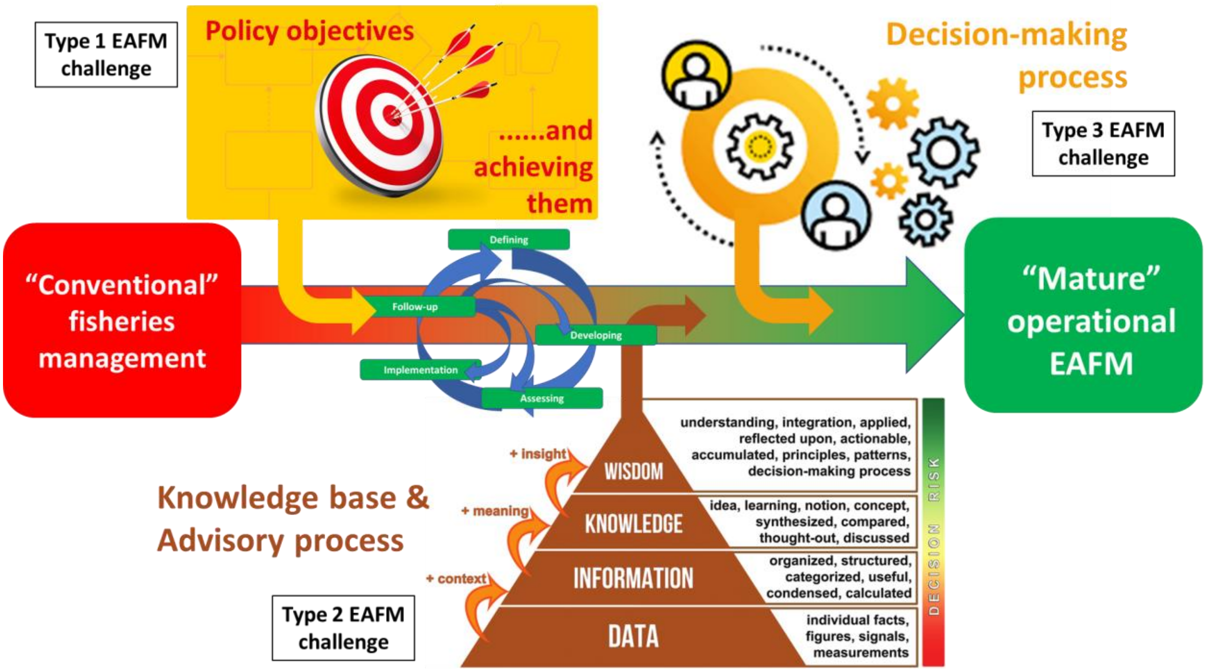


Figure 17. The role of the adaptive process to advance EAFM in several adaptive cycles from conventional single-species management into increasingly more mature operational EAFM. It also shows the critical role of the three types of EAFM challenges, i.e. type 1 involving the achievement of a wider range of policy objectives, and two governance arrangements, i.e. the advisory (type 2) and decision-making processes (type 3), that need to be addressed to support this.

4.1 Analysis

The analysis of current measures revealed that these mainly address target species and to a lesser extent by-catch issues (EAFM challenge Type 1, sub-type "Catch and by-catch of commercial species/stocks", see table 1). The typologies that have been developed and the relational database of measures can potentially assist monitoring the progress of EAFM as more EAFM challenges are addressed and the database of measures and policy instruments continues to be updated. The case studies show that the measures that have often been implemented are mostly supported by science, although the contents and hence coverage of the knowledge base can be limited, i.e. focused on the effect of fishing on single stocks without consideration of the wider ecosystem or the social system. To progress EAFM, the results suggest that the knowledge base and advisory process can be improved by addressing type 2 challenges, but that type 3 challenges involving the decision-making process in the specific context of that social-ecological system is more likely to determine the successful implementation. While management measures aimed at the fishing opportunities are generally well established, there is less certainty about their effectiveness in addressing the type 1 EAFM challenges associated with the wider ecosystem (i.e. beyond the commercial fish stocks). Feedback from stakeholders obtained through two workshops (see Annex 8) highlighted a need for evidence to show which measures have been most effective to address a specific EAFM challenge in a specific context (i.e. ecological and social). Related to type 3 EAFM challenges, there is less certainty about the precise nature of the possible improvements using policy instruments because even where there are examples of 'best practice' these may not be easily transferred as they may be very context-specific. The case studies helped to highlight this issue. The context, including issues of uncertainty, different interests and power imbalances between stakeholders were all shown to create obstacles hampering the successful implementation of management measures. This could be resolved through the application of appropriate policy instruments but few, if any, of the policy instruments could be considered 'close to market'. The assessment of the case studies identified some important guiding principles for developing the knowledge base and for the selection of management measures. These included the importance of participatory processes, integration of different knowledge types, e.g. of social and environmental sciences as well as its further extension with local (e.g. fishers) knowledge. A successful implementation also requires ensuring accountability through a strong link between the knowledge base, its use in the advisory process and subsequent uptake in the decision-making process. This was also highlighted in a study on improving EAFM advice in Europe (Ramírez-Monsalve et al., 2021).

The analyses indicate that advancing the implementation of EAFM requires attention to the key areas of the governance arrangements, i.e. advisory processes and decision-making. In that respect, it should be recognized that modifying current management and governance arrangements must start with what is already in place in the specific context in which EAFM is supposed to operate, together with the opportunities and constraints that this represents. This applies for the management measures (and their acceptability and performance), the knowledge base (in terms of contents and quality) and the governance arrangements (who decides and how and what ecosystem aspects are addressed). Furthermore, EAFM processes are, and will remain dynamic, with multiple objectives, multiple stakeholders and a wide array of social, economic and environmental conditions all subject to change over time. For these reasons, it is less appropriate to talk of adopting best practices aimed at fixed solutions than to recognize that it is possible to move towards increasingly better practices by using the current state of play as a baseline and applying EAFM principles (see Box 1, section 1.1) as part of a gradual and adaptive process to guide the advancement of EAFM. This study has identified two main avenues through which progress can be advanced: (1) the advisory process and its knowledge base and (2) the decision-making process, each elaborated in more detail below.

Improving the advisory process and its knowledge base

For the advisory process there is a need to improve the knowledge base. There are two elements to this. Firstly, there is the more general point of ensuring that science is inter- and transdisciplinary to be able to consider the whole range of policy objectives and societal goals as these should also include the social and/or economic dimensions of sustainability that includes institutional aspects. Secondly, the knowledge base should be expanded to cover more of the ecosystem than the commercial stocks (e.g. seabed habitats, PET species) as well as socio-economic information. Pertaining to the commercial stocks the scientific stock assessments will need to include a wider range of ecosystem aspects and their effects on fisheries' resources and opportunities, including natural variability, long-term trends or the (cumulative) impacts of other anthropogenic activities.

This can probably best be illustrated using the three main components of the ICES advice: (1) the annual stock assessments and fishing opportunities advice to inform the TAC and quota process, (2) the fisheries overviews and (3) the ecosystem overviews. In recent years there has been a gradual process of incorporating ecosystem trends and variability into the stock assessments to improve fishing opportunities advice. A recent audit among ICES stock assessment working groups showed that just under 50% of all stock assessments had some consideration of ecosystem trends and variability and the majority of management strategy evaluations had at least one element of ecosystem trends and variability incorporated. Almost 73% of the stock assessments of the data rich stocks incorporate at least one element of ecosystem trends and variability, and almost 55% of forecasts (Dickey-Collas et al., 2022). This provides clear evidence of advances in ICES to address EAFM challenge type 2 that directly affect science advice. Additionally, ICES fisheries overviews provide information on the commercial fish stocks and their exploitation not only from a single species perspective but now also include mixed fisheries advice (thus addressing EAFM challenge type 2) and information on the effects of fisheries on the wider ecosystem, i.e. beyond the target stocks. Specifically two effects are described, i.e. Physical disturbance of benthic habitats by bottom trawl fishing gear and fisheries by-catch of PETS (thus contributing to advance on EAFM challenge type 1). To what extent this is taken up in the decision-making process, however, is unclear.

A next step towards interdisciplinarity and broadening the fisheries knowledge base would be to better contextualize the fisheries, including from a socio-economic perspective. The ecosystem overviews provide key signals within the environment and the main pressures acting on the ecosystem thereby providing context to interpret the regular fishing opportunities advice which, albeit not incorporated in the advice, does help in advancing against challenge type 2. The initiative to extend the ecosystem overviews so that they also include the human dimension is a first step to address EAFM challenge type 3 in the ICES advisory process but does not guarantee uptake in the decision-making process. For example, in the Celtic Seas ecosystem overview fishing ports were used as a proxy for fishing communities and thus directly linked to fisheries (next up to make this linkage is the North Sea ecosystem overview). These examples clearly illustrate how the ICES advisory process is gradually advancing notably with the type 2 EAFM challenges where its competence lies. While this is exemplary for advancements in the advisory process, there are more advisory bodies in addition to ICES that deliver advice on a range of elements with EAFM relevance. Advice on the status of fishery resources is also provided by JRC and the Scientific Committees of GFCM and ICCAT; status of the ecosystems where fishing activities are taking place is also provided by JRC in cooperation with European Environment Agency and Regional Sea Conventions (e.g. OSPAR, HELCOM) and information on impacts of human activities is also provided by STECF (Ramírez-Monsalve et al., 2021). For all these advisory bodies it applies that a better understanding of EAFM principles and concepts is a prerequisite to advance EAFM.

It is also important to consider alternative knowledge types in an EAFM. Inclusivity should thus also extend to the integration of different scientific disciplines of other knowledge types associated with fishers and other (non-science) stakeholders. To be effective, inter- and transdisciplinary teams will require a high-level mutual understanding between disciplines and with other stakeholders of EAFM principles and concepts (e.g. sustainable, healthy, good environmental status). As well as quantitative information, qualitative information (both observational and experiential) has value and can support the knowledge base (e.g. Johannes and Nelis, 2007; Moon et al. 2014, 2021). Scientific knowledge is one form of knowledge and other experiences and understandings amongst stakeholders can also be important and provide different insights and information (e.g. Long and Long, 1992). The inclusion of these types of knowledge can be facilitated by forms of transdisciplinary science (e.g. Macher et al., 2021; Klein, 2004; Chuenpagdee and Jentoft, 2019). Addressing this element presents a strong argument for increased contributions of social scientists to advance EAFM. This comes with a requirement for the non-social scientists to learn how to work with these other knowledge types. Macher et al. (2021) argue that this requires capacity development to help to develop new skill sets, methods and professionals to support the process.

There is also a need to consider decision-makers or managers in the advisory process. As Macher et al. (2021) identify, more engagement of decision-makers and managers is necessary to increase the interactions with scientists and other stakeholders (e.g. Röckmann et al., 2015). This has the potential to reveal the opportunities and constraints related to the advisory process, enabling decision-makers and managers to explicitly request advice which would require such transdisciplinary science. This would be an example of a pulling mechanism which is distinguished from pushing mechanisms where advice suppliers provide EAFM advice which may or may not be used in the decision-making processes (Ramírez-Monsalve et al., 2021). In relation to those mechanisms they mention obstacles that may hamper the connection between the advisory and decision-making processes which prevent the uptake of salient advice: (1) pulling mechanisms enabled by the policy framework but where the advisory bodies' capacity to inform actual policy decisions is limited. (2) pushing mechanisms where advice suppliers are providing EAFM advice, but advice recipients do not have a clear path to use it. Overall, decision-makers are reluctant to receive advice that does not link directly to their current list of tactical and strategical management decisions which, in turn, follow from the selection of policy objectives EAFM strives to achieve.

An example of a potential pulling mechanism that would result in a broadening of knowledge base by bringing in more inter- or transdisciplinary science would be the explicit incorporation of social and/or economic policy objectives. This would then also create a need for policy instruments that can enable appropriate and equitable allocations of fishing opportunities and may also require alternatives to quantitative modelling. The EAFM challenges identified in this study potentially provide an entry point for various groups of people (within the fisheries and other sectors and across disciplines) to agree on sets of common concerns and begin to work together to address them. This can provide the basis for co-design that enables different knowledge types to be integrated. Mackinson and Middleton (2018) propose a systematic move towards institutionalization of co-design and co-delivery processes as opposed to the current ad-hoc collaborative research initiatives seeking to fill evidence gaps and promote shared learning and problem solving.

The three types of ICES advice, i.e. stock assessment, fisheries overviews and ecosystem overviews, may help illustrate how EAFM can be advanced in the advisory process. As stated previously, any improvement of the stock assessments has immediate management consequences (i.e. often a change in TAC). In contrast there is no formal procedure to incorporate information from the fisheries overviews or ecosystem overviews in the decision-making process (but feedback was received that, for the fisheries overviews, this may occur). As a way forward an option would be to explore if, and to what extent, such a procedure could improve the saliency, credibility and legitimacy of advice and improve the decision-making process.

By identifying the challenges and mapping the current state of play and necessary subsequent steps, this study can contribute to developing this understanding. Progress will also require greater coordination within and across fisheries. Currently fisheries management is almost exclusively focused on commercial fishing, despite the evidence that for several stocks/species, recreational fisheries may have a significant impact. EAFM provides an opportunity to incorporate recreational fishing into stock assessments and the advisory process, as is the practice in other parts of the world.

The typologies in combination with the relational database can facilitate the process by providing a common structure for the many different components, with often varied levels of detail interacting with one another. The case studies provide context-specific examples and illustrate how integration of different knowledge types can be beneficial. For example, the By-catch ES CS described how research institutes in Spain worked with fishers to develop selectivity technologies that were incorporated into the fisheries regulations. While there is often a willingness to collaborate between fishers and scientists, unfamiliarity with working together can make this difficult in practice. Yet the risk is that without such collaboration, the results may be inaccurate and/or legitimacy may be undermined. There is a significant role here for social scientists to facilitate these co-design processes that are often value laden, providing a basis for cooperative research based on deliberation and dialogue rather than confrontation, resulting in more inclusive advisory processes. The Spurdog by-catch UK CS provided an example of a transdisciplinary research partnership between a Producer Organization, policy makers, government scientists and an NGO to develop and implement a real-time by-catch reporting system. Such inclusive approaches that provide opportunities to contribute evidence and to collectively assess the evidence can enhance acceptability of management measures and increase compliance.

Improving the decision-making process

A key improvement could be achieved through (more) explicit consideration of the context in which the decision-making occurs. This may be jurisdictional where implementation may be decided by both Member States (or sometimes even non-Member States) or the EU. This can involve the economic context where the market determines which species to target or where it may prevent a level playing field. Alternatively, it can be the social-ecological context where other sectors may compete for limited marine space and resources, or climate change influencing the spatial distribution of stocks. Such changes in spatial distribution may, in turn, interact with the jurisdictional considerations mentioned earlier. Making explicit which part(s) of the context will be explicitly considered in the EAFM process should already occur in the defining step of the process as this has consequences for every subsequent step in the EAFM process, notably that of developing the knowledge base.

In the previous section on the advisory process it was established that the type 2 EAFM challenges that relate directly to the advice on fishing opportunities and feed into the stock assessment process are immediately taken up in the decision-making with consequences on management (usually TAC changes). For the type 2 EAFM challenges that would enhance advice on the wider ecosystem (i.e. beyond the fishing opportunities) there is no such process and hence there is no uptake in the decision-making process. As a way forward to enhance uptake of advice beyond the stock assessments, one option would be to assess how this additional advice might improve management. If there is scope for improvement, options for formalizing this can be explored together with decision-makers.

To improve decision-making, this study found that stakeholder involvement is important in building trust in the EAFM process and the legitimacy of its outcome. Involvement should begin from the defining step where this contributes to saliency in terms of the policy objectives that are selected and including the credibility in the knowledge base. It is also important that decision-making is tightly linked to the advisory process and that its knowledge base is supported by a stakeholder involvement process and applies principles of good governance, including issues of legitimacy, inclusiveness, fairness and accountability. Efforts have been made, through the process of regionalization, to enable stakeholders to contribute to policy processes but these could go further. Indeed, Jones and Seara (2020) found that in relation to ecosystem approaches, when asked, fishers identified aspects of social impacts and fishers' participation in decision-making as important considerations for them. However, given vested interests and situations where there may be winners and losers, it should not be assumed that this will be straightforward or that consensus can be readily achieved.

4.2 Final Conclusions

The findings from this study to advance EAFM beyond conventional single-species management rendered the following conclusions:

- The hierarchical typologies of the relevant components (i.e. EAFM challenges, fisheries, measures and policy instruments) are appropriate to assess progress in the implementation of EAFM. Advancement should occur as part of adaptive iterative cycles such as the proposed five-step EAFM process.
- Many of the identified management measures are operationally ready and can be implemented to mitigate fisheries impacts beyond those on the commercial species. Obstacles for their implementation primarily arise from deficits in the governance arrangements which are very context-specific.

- Some general guidance is provided on how to advance EAFM, focusing on two of the most relevant governance arrangements: the advisory and the decision-making processes.
- The stepwise EAFM process, hierarchical typologies and relational database provide a framework that should facilitate the communication between the many EAFM actors and allow an increased exchange of knowledge and best practices from other EAFM initiatives to further advance the EAFM implementation in EU waters.

5 REFERENCES

Arthur, R.I., MacFadyen, G., Cappell, R., Delaney, A., Triantaphyllides, G., Caillart, B. and Agnew, D. 2011. Regional social and economic impacts of change in fisheries-dependent communities. Impact Assessment Studies Related to the CFP. Fish/2006/06

Bastardie, F., Brown, E.J., Andonegi, E., Arthur, R., Beukhof, E., Depestele, J., Döring, R., et al. 2021. A Review Characterizing 25 EAFM challenges to Be Addressed by an Ecosystem Approach to Fisheries Management in Europe. Frontiers in Marine Science 7 (2021); ISSN: 2296-7745. 2021.

Bentley, J.W., Serpetti, N., Fox, C., Heymans, J.J. and Reid, D.G. 2019. Fishers' knowledge improves the accuracy of food web model predictions. ICES Journal of Marine Science 76(4): 897-912

Berghöfer, A., Wittmer, H. and Rauschmayer, F. 2008. Stakeholder participation in ecosystem-based approaches to fisheries management: a synthesis from European research projects. Marine Policy 32(2): 243-253

Berkes, F. 2011. Restoring unity: the concept of marine social-ecological systems. p9-28 in: R.E. Ommer, R.I. Perry, K. Cochrane and P. Cury (eds.) World fisheries: a social-ecological analysis. Blackwell Publishing

Bovaird, T., and Loeffler, E. 2012. From Engagement to Co-production: The Contribution of Users and Communities to Outcomes and Public Value. Voluntas, 23: 1119-1138.

Charles, A., Loucks, L., Berkes, F., and Armitage, D. 2020. Community science: A typology and its implications for governance of social-ecological systems. Environmental Science & Policy, 106: 77-86.

Chuenpagdee, R. and Jentoft, S. 2019. Transdisciplinarity for Small-Scale Fisheries Governance: analysis and practice. Springer

De Vos, B.I., Döring, R., Aranda, M., Buisman, F.C., Frangoudes, K., Goti, L., Macher, C., Maravelias, C.D., Murillas-Maza, A., van der Valk, O. and Vasilakopoulos, P. 2016. et al 2016. New modes of fisheries governance: Implementation of the landing obligation in four European countries. Marine Policy 64: 1-8

Dickey-Collas, M., Ballesteros, M., 2019. Swinging back? Science ethos and stakeholders' engagement in ICES advisory processes. (Fishing industry as authors of ICES expert group reports). In: https://www.ices.dk/news-and-events/news-archive/news/Pages/Science-ethos-and-stakeholders-engagement-in-ICES-advisory-processes.aspx.

Dickey-Collas, M., Trenkel, V., Ojaveer, H. & Miller, D. 2022. ACOM sanctioned analysis of ICES produc-tivity questionnaire (Ad Hoc). ICES Scientific Reports. 4:12. 12 pp. http://doi.org/10.17895/ices.pub.10037

Elliott, M. 2013. The 10-tenets for integrated, successful and sustainable marine management. Marine Pollution Bulletin, 74: 1-5.

FAO. 2021. Legislating for an ecosystem approach to fisheries – Revisited – An update of the 2011 legal study on the ecosystem approach to fisheries. FAO EAF-Nansen Programme Report No. 36. Rome

FAO 2003. Fisheries management. 2. The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries No. 4: 112.

Hegland, T.J., Ounanian, K., and Raakjær, J. 2012. Why and how to regionalise the Common Fisheries Policy. Maritime Studies, 11: 1-21.

ICES, 2003. Report of the study group on the development of fishery-based forecasts. CM 2003/ACFM: 08

ICES. 2019. EU request to advise on a seafloor assessment process for physical loss (D6C1, D6C4) and physical disturbance (D6C2) on benthic habitats. ICES Document sr.2019.25 – https://doi.org/10.17895/ices.advice.5742.

Johannes R.E. and Neis, B. 2007. The value of anecdote. In: Haggan N., Neis B. and Baird I.G. eds. Fishers' Knowledge in Fisheries Science and Management. UNESCO Publishing.

Klein, J.T. 2004. Prospects for transdisciplinarity. Futures 36(4): 515-526

Long, N. and Long, A. (eds.) 1992. Battlefields of knowledge: interlocking of theory and practice in social research and development. Routledge

Long, R.D., Charles, A. and Stephenson, R.L. 2015. Key principles of marine ecosystem-based management. Marine Policy, 57: 53-60.

Macher, C., Steins, N.A., Ballesteros, M., Kraan, M., Frangoudes, K., Bailly, D., Bertignac, M., Colloca, F., Fitzpatrick, M., Garcia, D., Little, R., Mardle, S., Murillas, A., Pawlowski, L., Phillipe, M., Prellezo, R., Sabatella, E., Thébaud, O. and Ulrich, C. 2021. Towards transdisciplinary decision-support processes in fisheries: experiences and recommendations from a multidisciplinary collective of researchers. Aquatic Living Resources 34(13)

Mackinson, S. and Middleton, D.A.J., 2018. Evolving the ecosystem approach in European fisheries : Transferable lessons from New Zealand' s experience in strengthening stakeholder involvement. Marine Policy 90, p. 194–202. https://doi.org/10.1016/j.marpol.2017.12.001.

Mauser, W., Klepper, G., Rice, M., Schmalzbauer, B.S., Hackmann, H., Leemans, R., Moore, H. 2013. Transdisciplinary global change research: the co-creation of knowledge for sustainability. Current Opinion in Environmental Sustainability 5: 420–431.

Moon K., Cvitanovic C., Blackman D.A., Scales I.R. and Browne, N.K. 2021. Five Questions to Understand Epistemology and Its Influence on Integrative Marine Research. Front Mar Sci. 2021;8:1-9. doi:10.3389/fmars.2021.574158

Moon K, Blackman D.A. 2014. Guide to Understanding Social Science Research for Natural Scientists. Conserv Biol. 28(5):1167-1177. doi:10.1111/cobi.12326

Piet, G.J., Strosser, P., Zamparutti, T., Ruskule, A., Veidemane, K., Dworak, T., Lieberknecht, L., Gea, G., Oulès, L., Besançon, M., Loudin, S. and Milkova, T. 2021. A practical approach toward an Ecosystem-based Approach in Maritime Spatial Planning. European Climate, Infrastructure and Environment Executive Agency (CINEA). European Commission

Radford, Z., Hyder, K., Zarauz, L., Mugerza, E., Ferter, K., Prellezo, R., Strehlow, H.V., Townhill, B., Lewin, W.-C. and Weltersbach, M.S. 2018. The impact of marine recreational fishing on key fish stocks in European waters. PLOS One

Ramírez-Monsalve, P., Nielsen, K.N., Ballesteros, M., Kirkfeldt, T.S., Dickey-Collas, M., Delaney, A., Hegland, T.J., et al. 2021. Pulling mechanisms and pushing strategies: How to improve Ecosystem Approach Fisheries Management advice within the European Union's Common Fisheries Policy. Fisheries Research, 233.

Röckmann, C., van Leeuwen, J., Goldsborough, D., Kraan, M. and Piet, G. 2015. The interaction triangle as a tool for understanding stakeholder interactions in marine ecosystem-based management. Marine Policy 52:155-162STECF 2020. Review of technical measures (part 1) (STECF-20-02). Scientific, Technical and Economic Committee for Fisheries, Publications Office of the European Union, Luxembourg

Röckmann, C., Kraan, M., Goldsborough, D. and van Hoof, L. 2017. Stakeholder participation in marine management: the importance of transparency and rules for participation. p289-306 In: P.S. Levin and M.R. Poe (eds.) Conservation for the anthropocene ocean: interdisciplinary science in support of nature and people. Academic Press

Stephenson, R.L., Paul, S., Pastoors, M.A., Kraan, M., Holm, P., Wiber, M., Mackinson, S., et al. 2016. Integrating fishers' knowledge research in science and management. ICES Journal of Marine Science, 73: 1459-1465.

Uhlmann, S.S., Ulrich, C., and Kennelly, S.J. 2019. The European landing obligation : reducing discards in complex, multi-species and multi-jurisdictional fisheries. Springer Open, Cham, Switzerland.

ANNEX 1: TYPOLOGY FOR THE IDENTIFICATION OF THE LEGAL BASIS OF MANAGEMENT MEASURES

Given that the measures themselves are specified in legal instruments one approach would be to characterise them all as individual legal measures and to prepare the typology accordingly. Such an approach would not, though, be coherent with the requirements of Task 4 and or serve much purpose given that there are few if any substantive legal differences between one measure and another: a measure is a measure.

A potentially more useful approach is to categorize EAFM measures by reference to the final legal basis under which they are adopted.

This results in two basic categories: (a) measures contained in legislation adopted by the EU; and (b) measures contained in legislation adopted by a Member State in cases whereby the necessary authority has been conferred by EU law (more specifically, by the basic Regulation).

Measures adopted by the EU

In terms of legislation adopted by the EU it is possible to further distinguish between:

(a) legislation in the form of a regulation adopted by the European Parliament and the Council in accordance with the ordinary legislative procedure, as in the case of EAFM measures contained in the TMR or the Deep Sea Stocks in the North East Atlantic Regulation; or
(b) legislation in the form of a regulation adopted by the European Commission as a delegated act or an implementing act (hereafter a 'Commission Regulation') in cases where the necessary legal powers are conferred upon the Commission in an instrument adopted in accordance with the ordinary legislative procedure such as the Basic Regulation or the TMR.

It is also possible to further distinguish between Commission acts (in the form of regulations or decisions) that are adopted to give effect to the EAFM in accordance with the CFP in terms of:

(a) minimising impacts on non-target fish species (in connection for example with the landing obligation); and
(b) those that are adopted to minimise broader ecosystem effects including measures to give effect to EU environmental law (such as the declaration of closed or restricted areas to protect habitats, cetaceans or other non-fish species).

It is also possible to distinguish between measures contained in Commission acts (regulations or decisions) by reference to the actors involved in the initiation of the process.

These could include:

(a) measures adopted on the initiative of the EC;
(b) measures adopted on the initiative of a single Member State;
(c) measures adopted on the joint recommendation of two or more Member States (and which might include recommendations made on the basis of regionalisation in accordance with article 18, such as the Scheveningen Group or by a regional seas convention).

Measures adopted by a Member State

As outlined above, the other major type of EAFM measure will be contained in legislation adopted by a Member State in accordance with the limited scope permitted by the Basic Regulation namely:

(a) to establish conservation measures that are necessary for compliance with EU environmental legislation in accordance with the article 11 of the Basic Regulation. As noted above such measures can only be adopted within part of the territorial sea in which the fishing vessels of other Member States do not have access;
(b) as emergency measures on evidence of a serious threat to the conservation of marine biological resources or to the marine ecosystem relating to fishing activities in accordance with article 13 of the Basic Regulation; or
(c) to establish non-discriminatory measures for the conservation and management of fish stocks and the maintenance or improvement of the conservation status of marine ecosystems within its territorial sea if the EU has not adopted measures addressing conservation and management specifically for that area or specifically addressing the problem identified by the Member State concerned in accordance with article 20.

ANNEX 2: FISHERIES IDENTIFIED FOR EACH GEOGRAPHICAL AREA

Below are listed the fisheries identified in Task 2 (highlighted in blue) for each gear type (highlighted in green) in each geographical area (highlighted in yellow). The métiers level 6 involved in each fishery are identified by the code combining the country, the métier level 6 code (or gear description when not available), the part of the area where the fishery is conducted and the quarters of the year.

Baltic Sea	
demersal fisheries with otter trawls	
cod targeting fishery (possibly combined with flatfish) in the Baltic Proper	
Cod	SWE_OTB_DEF_>=105_Baltic_Q1-Q4
	DNK_OTB_DEF_>=105_1_120_Baltic_
	FIN_OTB_DEF_>105_Southern Baltic_Q1-4
	DNK_OTB_MCD_90-119_0_0_Skagerrak-Kattegat_
	EST_OTTER >=105_Baltic Proper_Q1-2
	GER_Otter mesh >90mm_Western and central Baltic_
cod and flounder	LVA_OTB_DEF_>=105_1_120_Baltic Proper_Q1-4
	POL_OTB_DEF_>=105_1_120_Baltic_Q1-Q4
mixed fisheries on demersal fish in the Skagerrak-Kattegat	
plaice dab and flounder	DNK_OTB_DEF_>=105_1_120_Baltic_
plaice sole brill	DNK_OTB_MCD_90-119_0_0_Skagerrak-Kattegat_
saithe witch haddock	DNK_OTB_MCD_90-119_0_0_Skagerrak-Kattegat_
witch monkfish hake	DNK_OTB_MCD_90-119_0_0_Skagerrak-Kattegat_
Demersal fish (saithe, haddock, witch flounder, cod)	SWE_OTB_DEF_>=120_0_0_Skagerrak, Kattegat_Q1-Q4
Mixed Nephrops and demersal fish	SWE_OTB_MCD_90-119_Skagerrak, Kattegat_Q1-Q4
plaice fishery in the Skagerrak-Kattegat	
	DNK_OTB_MCD_90-119_0_0_Skagerrak-Kattegat_
Nephrops fishery in the Skagerrak-Kattegat	
	SWE_OTB_CRU_70-89_2_35_Skagerrak, Kattegat_Q1-Q4
	DNK_OTB_MCD_90-119_0_0_Skagerrak-Kattegat_
northern prawn fishery in the Skagerrak-Kattegat	
prawn	SWE_OTB_CRU_32-69_0_0_Skagerrak, Kattegat_Q1-Q4
	SWE_OTB_CRU_32-69_2_22_Skagerrak, Kattegat_Q1-Q4
pelagic fisheries using otter trawl	
monospecific herring and sprat fisheries and mixed herring/sprat fisheries	
herring	POL_OTB_SPF_32-104_0_0_Baltic_Q1-Q4
	EST_OTTER 16-31_Gulf of Finland_Q1, Q4

Herring and sprat	SWE_OTB_SPF_16-104_0_0_Baltic_Q1-Q4
	GER_Otter mesh <90mm_Western Baltic_
sprat	POL_OTB_SPF_16-31_0_0_Baltic_Q1-Q4
Danish seine fishery	
flounder fisheries	
	LVA_SDN_DEF_>=105_1_110_Latvian coast_Q2-4
	EST_DEM_SEINE >=105_Estonian coast_Q2-3
dredge fisheries	
monospecific cockles, mussels, and oysters fisheries	
Cockles	DNK_DRB_MOL_0_0_0_Baltic_
Mussels	DNK_DRB_MOL_0_0_0_Baltic_
oysters	DNK_DRB_MOL_0_0_0_Baltic_
fyke net fishery	
eelpout, round goby	LVA_FYK_FWS_>0_0_0_Latvian coast_Q2-3
pelagic fisheries using mid-water trawls	
herring fishery	
	FIN_OTM_<16_0_0_SD 29-30_Q1-4
	POL_OTM_SPF_32-104_0_0_Baltic_Q1-Q4
	GER_OTM_SPF_32-54_0_0_Western Baltic_Q1 and Q4
	FIN_OTM_SPF_16-104_Bothnian Sea and Bothnian Bay_Q1-4
mixed sprat and herring fishery	
	DNK_PTM_SPF_16-104_0_0_Baltic_
	FIN_OTM_<16_0_0_Gulf of Finland_Q1-4
	SWE_OTM_SPF_16-104_0_0_Baltic_Q1-Q4
	GER_OTM_SPF_16-31_0_0_Western and central Baltic_Q1
	LVA_OTM_SPF_16-31_0_0_Baltic Proper and Gulf of Riga_Q1-4
	SWE_OTM_SPF_16-31_0_0_Skagerrak, Kattegat_Q1-Q4
	DNK_OTM_SPF_16-31_0_0_Skagerrak-Kattegat_
	SWE_OTM_SPF_32-69_0_0_Skagerrak, Kattegat_Q1-Q4
	EST_PEL_TRAWL <16_Gulf of Finland_Q4
	EST_PEL_TRAWL 16-31_Estonian EEZ_Q1-4
	FIN_OTM_<16_0_0_Bothnian Bay_Q1-4
sprat fishery	
	DNK_PTM_SPF_16-104_0_0_Baltic Sea_
	DNK_PTM_SPF_32-89_0_0_Baltic Sea_
	FIN_OTM_SPF_16-104_Gulf of Finland _Q1-4
	POL_OTM_SPF_16-31_0_0_Baltic_Q1-Q4
sandeel fishery	
	POL_OTM_DEF_<16_0_0_Baltic_Q1-Q4

cod fishery	
	LVA_OTM_DEF_>=105_1_120_Baltic_Q2, Q4
pots fisheries	
herring fisheries mixed with other species	
Cod, eel and herring fishery	GER_pots_Western Baltic_
herring	EST_POTS 31-49_Estonian coast_Q2
Herring and perch	EST_POTS NONE_Estonian coast_Q2
herring, mixed freshwater species fishery and salmon	FIN_Pots_SD 29-31_Q1-4
Herring, round goby	LVA_FPO_FWS_>0_0_0_Latvian coast_Q1-4
mixed crustaceans fresh water fish fisheries	
Nephrops, edible crab	SWE_Pots_and_traps_Skagerrak, Kattegat_Q1-Q4
ana/catadromous fish fisheries	
eel, salmon	SWE_Pots_and_traps_Baltic_Q1-Q4
pelagic fisheries using purse seine	
mixed fisheries dominated by herring	
Herring and sprat	SWE_PS_SPF_16-69_Skagerrak, Kattegat_Q1-Q4
herring, freshwater bream and whitefishes nei	FIN_Purse seines_SD 29 and 32_Q1-4
gillnet and trammel nets fisheries targeting demersal fish	
cod fisheries	
	DNK_GNS_DEF_110-156_0_0_Baltic_
	LVA_GNS_DEF_110-156_0_0_Baltic Proper and Latvian coast_Q1-4
	LVA_GNS_FWS_>0_0_0_Latvian coast_Q1-4
Mixed cod/flatfish fishery	
	GER_Trammel net mesh >90mm_Western Baltic_
	GER_Gillnet mesh >90mm_Western Baltic_
	SWE_GNS_GTR_DEF_Skagerrak, Kattegat, Baltic Sea_Q1-Q4
Monospecific flatfish fisheries	
plaice	DNK_GNS_DEF_110-156_0_0_Baltic_
sole	DNK_GNS_DEF_110-156_0_0_Baltic_
flounder	DNK_GNS_DEF_110-156_0_0_Baltic_
turbot	LVA_GNS_DEF_>=157_0_0_Latvian coast_Q2
mixed and other fisheries	
mixed demersal fish	POL_GNS_DEF_110-156_0_0_Baltic_Q1-Q4
round goby	LVA_GNS_DEF_60-70_0_0_Latvian coast_Q2
gillnet and trammel nets fisheries targeting pelagic fish	
herring fisheries	
	EST_GILL 31-49_Estonian coast_Q2-3
	GER_Gillnet mesh <90mm_Western Baltic_

	GER_Trammel net mesh <90mm_Western Baltic_
	FIN_GNS_10-30_Bothnian_Q1-4
	SWE_GNS_SPF_Skagerrak, Kattegat, Baltic_Q1-Q4
	LVA_GNS_SPF_16-109_0_0_Latvian coast_Q1-2
	POL_GNS_SPF_32-109_0_0_Baltic_Q1-Q4
	FIN_GNS_10-30_Gulf of Finland_Q1-4
lump sucker fishery	
	DNK_GNS_DEF_110-156_0_0_Baltic_
longlines	
mixed demersal fish	
Cod and eel fishery	GER_longlines_Western Baltic_
mixed demersal fish	POL_LLS_DEF_0_0_0_Baltic_Q1-Q4

North Sea	
beam trawlers	
plaice, sole and mixed plaice and sole fisheries	
plaice	BEL_TBB_DEF_>=120_Central_Q3, Q4
	SCO_TBB_DEF_>=120_0_0_Central_ Q2, Q3, Q4
	UK(Eng+Whl)_TBB_DEF_>=120_0_0 _central, eastern and southern_Q2+3
	NLD_TBB_DEF_>120_0_0_Northeastern_Q1-4
	SCO_TBB_DEF_100-119_0_0_central_Q2, Q3, Q4
	UK(Eng+Whl)_TBB_DEF_100-119_0_0 _central and southern_all Q
	SCO_TBB_DEF_80-89_0_0_central_Q1, Q2, Q4
	NLD_TBB_DEF_90-119_0_0_central_Q2-4
	UK(Eng+Whl)_TBB_MCF_70-99_0_0 _central and southern_Q1,4
	GER_Beam trawl mesh > 120 mm_central_
	GER_Beam trawl mesh 100-119mm_central_
plaice and sole	NLD_TBB_DEF_80-89_0_0_central and southern_Q1-4
	GER_TBB_DEF_80-90_0_0_central and southern_
sole	BEL_TBB_DEF_70-99_southern_all Q
shrimp fishery	
	UK(Eng+Whl)_TBB_CRU_<16_0_0 _ southern_all Q
	NLD_TBB_CRU_13-31_0_0_southern_Q1-4

	BEL_TBB_CRU_14-31_southern_Q3, Q4
	UK(Eng+Whl)_TBB_CRU_16-31_0_0 _southern_all Q
	GER_TBB_CRU_16-32_0_0_eastern_
mussels fishery	
	GER_Beam trawl mesh 33-70mm_eastern_
otter trawl fisheries	
mixed demersal fish fisheries targeting gadoids and anglerfish	
cod saithe monkfish hake	DNK_OTB_MCD_>=120_0_0__
mixed Demersal fish (saithe, haddock, witch flounder, cod)	SWE_OTB_DEF_>=120_0_0_Kattegat, North Sea_Q1-Q4
mixed demersal fish fishery targeting whiting and cod	UK(Eng+Whl)_OTB_MCD_80-99_0_0 _central_all Q
mixed demersal fish species (cod/whiting, saithe, haddock, hake)	UK(Eng+Whl)_OTB_DEF_>=120_0_0 _northern_all Q
mixed demersal including anglerfish haddock and whiting	SCO_OTB_MCD_70-99_0_0_northern_all Q
mixed demersal including whiting, haddock and anglerfish	SCO_OTB_MCD_100-119_0_0_northern_all Q
mixed demersal species including cod, pollock, whiting, haddock, anglerfish, ling, megrims Nephrops	SCO_OTB_DEF_>=120_0_0_northern_all Q
mixed fishery	UK(Eng+Whl)_OTB_MCF_32-54_0_0 _northern_Q2-3
witch monkfish hake	DNK_OTB_MCD_90-119_0_0_Kattegat_
saithe witch haddock	DNK_OTB_MCD_90-119_0_0_Kattegat_
Mixed Nephrops and demersal fish	SWE_OTB_MCD_90-119_Kattegat_Q1-Q4
targeted cod and saithe fisheries	
Cod	NLD_Otter trawl mesh >120mm_southern_Q1-2
saithe	GER_Otter trawl mesh >120mm_northern_
Nephrops fisheries	
	SWE_OTB_CRU_70-89_2_35_Kattegat_Q1-Q4
	NIR_OTB_CRU_70-99_0_0__all Q
	DNK_OTB_MCD_>=120_0_0__
	NIR_OTB_MCD_100-119_0_0__all Q
	SCO_OTB_MCD_100-119_0_0_northern_all Q
	SCO_OTB_MCD_70-99_0_0_northern_all Q
	DNK_OTB_MCD_90-119_0_0_Kattegat_
	BEL_OTB_MD_70-99_central_Q2-3
	NLD_Otter trawl 80-89mm_central_Q2-3
Northern prawn fisheries	

	SWE_OTB_CRU_32-69_0_0_Kattegat_Q1-Q4
	SWE_OTB_CRU_32-69_2_22_Kattegat_Q1-Q4
Norway pout fishery	
	DNK_OTB_DEF_<16_0_0__
	DNK_OTB_DEF_16-31_0_0__
plaice fishery	
plaice	SCO_OTB_DEF_>=120_0_0_central and southern_All
	UK(Eng+Whl)_OTB_DEF_100-119_0_0 _southern and central_all Q
	DNK_OTB_MCD_>=120_0_0__
	DNK_OTB_MCD_90-119_0_0_Kattegat_
	NLD_Otter trawl 80-89mm_central_Q1 and Q4
	NLD_Otter trawl 90-119mm_central_Q2-3
	NLD_Otter trawl mesh >120mm_Central Eastern_Q2-4
	GER_Otter trawl mesh 100-119mm_central_
Plaice and Nephrops	GER_Otter trawl mesh 80-99mm_central_
plaice sole brill	DNK_OTB_MCD_90-119_0_0_Kattegat_
sandeel fishery	
	DNK_OTB_DEF_<16_0_0__
	SWE_OTB_DEF_<16_0_0__Q2
	DNK_OTB_DEF_16-31_0_0__
	SCO_OTB_MPD_<16_0_0_central_Q2
	DNK_OTB_SPF_<16_0_0__
	GER_Otter trawl mesh <16mm_central_
Shrimp fishery	
	UK(Eng+Whl)_OTB_CRU_16-31_0_0 _southern_all Q
	NLD_Otter trawl mesh 16-31_southern_Q3-4
squid fisheries	
	SCO_OTB_SPF_32-54_0_0_Northern_Q3, Q4
monospecific herring and mackerel fisheries	
herring	SCO_OTB_SPF_32-54_0_0_Northern_Q3, Q4
	DNK_OTB_SPF_32-69_0_0__
mackerel	SCO_OTB_SPF_32-54_0_0_Northern_Q1, Q4
	DNK_OTB_SPF_32-69_0_0__
Danish seine fisheries	
monospecific plaice and haddock fisheries and mixed gadoid and flatfish fisheries	

haddock	NIR_SDN_DEF_>=120_0_0_Northern_Q1, Q3, Q4
haddock, whiting and plaice fishery	UK(Eng+Whl)_SDN_DEF_>=120_0_0 _Northern_Q2,3
whiting, cod, haddock hake, megrim and pollock	SCO_SDN_DEF_>=120_0_0_Northern_All
plaice	UK(Eng+Whl)_SDN_DEF_100-119_0_0 _Northern_Q2,3
demersal seine fisheries	
demersal fish fisheries	
Cod and plaice	NLD_Demersal seine mesh 120mm_Northern_Q1-4
Saithe	GER_Demersal seine mesh >120mm__
mixed small pelagic and demersal fish and cephalopods fishery	
Mixed fishery (pelagic and demersal fish and cephalopods)	NLD_Demersal seine mesh 90-119mm_eastern_Q1-4
Mixed fishery (pelagic and demersal fish and squids)	NLD_Demersal seine mesh 80-89mm_southern_Q1-4
dredge fisheries	
diverse shellfish fisheries	
great Atlantic scallop	SCO_DRB_MOL_0_0_0_northern_All
great Atlantic scallop	UK(Eng+Whl)_DRB_MOL_0_0_0 _southern_allQ
Mussels	GER_dredge_eastern_
Razor shell fishery	NLD_Dredge_southeast_Q1-4
mid-water trawling fisheries	
herring fishery	
	FRA_OTM_SPF_32-54_0_0_northern_Q23
	GER_OTM_SPF_32-54_0_0_northern_Q3
	NIR_OTM_SPF_32-54_0_0_northern_Q3
	NLD_OTM_SPF_32-54_0_0_northern_Q3
	SCO_OTM_SPF_32-54_0_0_northern_Q2, Q3
	UK(Eng+Whl)_OTM_SPF_32-54_0_0_northern_Q3
	SWE_OTM_SPF_16-31_0_0_Kattegat_Q1-Q4
	SWE_OTM_SPF_32-69_0_0_Kattegat_Q1-Q4
mackerel fishery	
	IRL_PTM_SPF_32-54_0_0 and /PTM_SPF_100-119_0_0_northern_Q1 and Q4
	NIR_OTM_SPF_32-54_0_0_northern_Q1, Q4

	NLD_OTM_SPF_32-54_0_0_northern_Q1 and Q4
	SCO_OTM_SPF_32-54_0_0_northern_Q1, Q4
	UK(Eng+Whl)_OTM_SPF_32-54_0_0_northern_Q1 and Q4
	FRA_OTM_SPF_80-89_0_0_northern_Q2-3
sandeel fishery	
	DNK_PTM_SPF_16-31_0_0__
sprat fishery	
	SWE_OTM_SPF_16-31_0_0__Q1-Q4
	DNK_PTM_SPF_16-31_0_0__
	GER_OTM_SPF_16-31_0_0__Q3
	NLD_OTM_SPF_16-31_0_0_Southern_Q3-4
	DNK_OTM_SPF_16-31_0_0 _Kattegat_
pots fisheries	
crustaceans and molluscs fisheries	
Edible Crab and lobster	GER_pots_eastern_
Edible Crab and lobster	NLD_Pots_Southeastern_Q1-3
Edible crabs and whelks	UK(Eng+Whl)_FPO_CRU_0_0_0 __All Q
edible crabs, Nephrops and European lobsters	SCO_FPO_CRU_0_0_0_northern_All Q
edible crab and Nephrops	SWE_Pots_and_traps_Kattegat_Q1-Q4
whelks	SCO_FPO_CRU_0_0_0_southern_All Q
purse seine fisheries	
small pelagic fish fisheries	
Herring, mackerel, sprat	SWE_PS_SPF_16-69_Kattegat, North Sea_Q1-Q4
mackerel	SCO_PS_SPF_32-54_0_0_northern_Q3, Q4
Scottish seine fisheries	
mixed demersal fish fisheries	
gadoids	DNK_SSC_DEF_>=120_0_0__
plaice	DNK_SSC_DEF_>=120_0_0__
mackerel fishery	
	BEL_SSC_DEF_70-99_southern_Q2 and Q3
gillnet and trammel net fisheries	
monospecific gillnet fisheries on anglerfish, cod and sole	
Anglerfish	SCO_GNS_DEF_>=220_0_0_northern_All
	GER_Gillnet_northern_

Cod	GER_Gillnet _northern_
	SCO_GNS_DEF_150-219_0_0_northern_Q2
Sole	GER_Gillnet_southern_
	NLD_Gillnet mesh 100-109_southern_Q2-3
	NLD_Gillnet mesh 90-99_southern_Q1-3
mixed demersal fish fisheries	
Mixed demersal fish (cod and flatfish)	NLD_Trammel net 110-149mm_southern_Q1-4
mixed Demersal fish (cod, flatfish)	SWE_GNS_GTR_DEF_Kattegat_Q1-Q4
Mixed demersal fishery	NLD_Gillnet mesh 110-149_southern_Q1-4
mixed demersal fish fisheries and crustaceans of cephalopods	
mixed fishery dominated by sole/thornback ray and cuttlefish	UK(Eng+Whl)_GNS_DEF_80-89_0_0 _southern_allQ
mixed fishery for flatfish and demersal elasmobranchs	UK(Eng+Whl)_GNS_DEF_100-109_0_0 _central and southern_All Q
Mixed lobster and demersal fish	NLD_Gillnet mesh >150_souhtern_Q1-2
small pelagic fish fisheries	
Herring, mackerel	SWE_GNS_SPF_Kattegat_Q1-Q4
longline fisheries	
hake fishery	
	FRA_O15M_LLS_DEF_NONE_0_0_northern_Q1-4
	SCO_LLS_FIF_0_0_0_nothern_All
mackerel fishery	
	SCO_LLS_FIF_0_0_0_northern_Q1, Q2, Q4
hooks and lines fishery	
cod and mackerel fisheries	
Cod, mackerel	SWE_Hook_and_lines_Kattegat_Q1-Q4

West of Scotland	
otter trawl fisheries	
deep sea fishery	
Deep sea species	FRA_OTB_DEF_sup100_0_0__Q1-4
mixed demersal fish fisheries	
haddock, hake, anglerfish	NIR_OTB_DEF_>=120_0_0__Q1, Q4
Pollock hake	FRA_OTB_DEF_sup100_0_0__Q1-4
Mixed demersal fishery/80%/ANF/HAD/HKE/LEZ/NEP/WHG	IRL_OTTER-100-119__Q1-4

Mixed demersal fishery/89%/ANF/HAD/HKE/LEZ/NEP/WHG	IRL_OTTER-70-99__Q1-4
mixed demersal species including cod, pollock, whiting, haddock, anglerfish, ling, megrims Nephrops	SCO_OTB_DEF_>=120_0_0__All
Nephrops (and crab) fisheries	
Nephrops	SCO_OTB_CRU_70-99_0_0__All
	NIR_OTB_MCD_100-119_0_0__All
	SCO_OTB_MCD_100-119_0_0__All
	SCO_OTB_MCD_70-99_0_0__All
Edible crab	SCO_OTB_CRU_0_0_0__Q3, Q4
Cephalopods fishery	
squid	SCO_OTB_CRU_55-69_0_0__Q2, Q3
Small pelagic fish fisheries	
sprat	SCO_OTB_MPD_16-31_0_0__Q4
mackerel	SCO_OTB_SPF_32-54_0_0__Q1, Q4
Blue whiting	SCO_OTB_SPF_32-54_0_0__Q1, Q2
Danish seine fishery	
haddock	
	NIR_SDN_DEF_>=120_0_0__Q1, Q3, Q4
Dredge fishery	
Scallops	
great Atlantic scallop	SCO_DRB_MOL_0_0_0__All
mid-water trawling fisheries	
monospecific small pelagic fish fisheries	
Blue whiting	FRA_OTM_SPF_32-54_0_0__Q1 (WI), Q2 (WS)
	GER_OTM_SPF_32-54_0_0__Q2
	NLD_OTM_SPF_32-54_0_0__Q2
herring	SCO_OTM_SPF_55-69_0_0__Q3
horse mackerel	NIR_OTM_SPF_32-54_0_0__Q1
Mackerel	IRL_PTM_SPF_32-54_0_0 and /PTM_SPF_100-119_0_0__Q1 and Q4
	FRA_OTM_SPF_32-54_0_0__ Q1&4
	GER_OTM_SPF_32-54_0_0__Q1 and 4
	NIR_OTM_SPF_32-54_0_0__Q1, Q4
	NLD_OTM_SPF_32-54_0_0__Q1 and Q4
	SCO_OTM_SPF_32-54_0_0__Q1, Q4
	UK(Eng+Whl)_OTM_SPF_32-54_0_0__Q1 and Q4

	SCO_OTM_SPF_55-69_0_0__Q1, Q4
sprat	SCO_OTM_SPF_<16_0_0__Q4
	SCO_OTM_SPF_16-31_0_0__Q4
Pots Fishery	
whelks	
Edible crab	NIR_FPO_CRU_0_0_0__All
Edible crabs and whelks	UK(Eng+Whl)_FPO_CRU_0_0_0 __ All Q
edible crabs, Nephrops and European lobsters	SCO_FPO_CRU_0_0_0__All
whelks	
	NIR_FPO_CRU_0_0_0__Q1, Q2
gilnets fishery	
Anglerfish fishery	
	SCO_GNS_DEF_>=220_0_0__All
	SCO_GNS_DEF_100-109_0_0__Q2, Q3
	SCO_GNS_DEF_80-89_0_0__Q2
	UK(Eng+Whl)_GNS_MCD_>=220_0_0 __all Q
longline fishery	
hake fishery	
	ESP_LLS_DEF_0_0_0__Q1, Q2, Q3, Q4
	UK(Eng+Whl)_LLS_FIF_0_0_0 __all Q
	SCO_LLS_FIF_0_0_0__All

Rockall	
otter trawl fisheries	
mixed demersal fish fisheries with anglerfish haddock hake and megrims	
	IRL_OTTER-100-119__Q1-4
	IRL_OTTER-70-99__Q1-4
gillnet fishery	
anglerfish fishery	
	UK(Eng+Whl)_GNS_MCD_>=220_0_0 __all Q

West of Ireland	
otter trawl fisheries	
mixed demersal fisheries targeting mainly anglerfish, haddock, megrim and hake	
	SCO_OTB_MCF_80-99_0_0__Q1, Q2, Q4
	SCO_OTB_MCF_100-119_0_0__all Q
	IRL_OTTER>=120__Q1-4
	IRL_OTTER-100-119__Q1-4

	IRL_OTTER-70-99__Q1-4
	ESP_OTB_DEF_70-99_0_0__all Q
Nephrops fisheries	
	NIR_OTB_MCD_100-119_0_0__all Q
	SCO_OTB_MCF_100-119_0_0__Q2, Q3
squid fisheries	
	SCO_OTB_MCF_100-119_0_0__Q1, Q4
mackerel fishery	
	SCO_OTB_SPF_32-54_0_0__Q1, Q4
Danish Seine fisheries	
gadoid fisheries	
haddock	NIR_SDN_DEF_100-119_0_0__all Q
whiting	NIR_SDN_DEF_100-119_0_0__all Q
Demersal Seine fisheries	
gadoid fisheries with cod haddock hake megrim whiting	
	IRL_DEM_SEINE-100-119__Q1-4
	IRL_DEM_SEINE->=120__Q1 & 4
Dredge fishery	
scallops fishery	
great Atlantic scallop	NIR_DRB_MOL_0_0_0__all Q
mid-water trawling fisheries	
tuna fishery	
Albacore	IRL_PTM_LPF_?120_0_0__Q3
monospecific small pelagic fish fisheries	
Boarfish	IRL_PTM_SPF_32-54_0_0__Q3-Q4
Blue whiting	IRL_PTM_SPF_32-54_0_0__Q1-2
	FRA_OTM_SPF_32-54_0_0__Q2
	GER_OTM_SPF_32-54_0_0__Q2
	NIR_OTM_SPF_32-54_0_0__Q1
	NLD_OTM_SPF_32-54_0_0__Q2
	SCO_OTM_SPF_32-54_0_0__Q1
Herring	IRL_PTM_SPF_32-54_0_0__Q4
Horse mackerel	IRL_PTM_SPF_32-54_0_0__Q1
	NLD_OTM_SPF_32-54_0_0__Q1 and Q4
	UK(Eng+Whl)_OTM_SPF_32-54_0_0__Q1 and Q4
Mackerel	FRA_OTM_SPF_32-54_0_0__Q1&4
	GER_OTM_SPF_32-54_0_0__Q1 and 4
	NIR_OTM_SPF_32-54_0_0__Q1, Q4
	SCO_OTM_SPF_32-54_0_0__Q1, Q4
	SCO_OTM_SPF_55-69_0_0__Q1, Q4
pots fisheries	
crabs and whelks fishery	

	IRL_POTS-NONE__
gillnet fisheries	
monospecific fisheries on anglerfish and on hake	
Anglerfish	SCO_GNS_DEF_>=220_0_0__All
	SCO_GNS_DEF_80-89_0_0__Q2
Hake	SCO_GNS_DEF_100-109_0_0__Q1, Q4
	FRA_GNS_DEM_110-149_0_0__Q1 Q4
mixed fishery on gadoids	
Mixed demersal	IRL_GILL-120-219__Q1-2
longline fishery	
hake fisheries	
	ESP_LLS_DEF_0_0_0__Q1, Q2, Q3, Q4
	UK(Eng+Whl)_LLS_FIF_0_0_0 __all Q
	SCO_LLS_FIF_0_0_0__All

Irish Sea	
beam trawlers	
sole and skate fisheries	
skates	BEL_TBB_DEF_70-99__all Q
sole	BEL_TBB_DEF_70-99__all Q
otter trawl fisheries	
Nephrops fisheries	
	NIR_OTB_CRU_<55_0_0__Q1,2,4
	UK(Eng+Whl)_OTB_CRU_70-79_0_0 __all Q
	NIR_OTB_CRU_70-99_0_0__all Q
	SCO_OTB_CRU_70-99_0_0__all Q
mixed demersal fish fisheries dominated by hake haddock and anglerfish	
haddock, hake, anglerfish	NIR_OTB_DEF_>=120_0_0__Q1, Q4
hake and pollack	NIR_OTB_MCD_100-119_0_0__Q2, Q3, Q4
Mixed demersal fishery	IRL_OTTER-100-119__Q1-4
Mixed demersal fishery	IRL_OTTER-70-99__Q1-4
haddock	NIR_OTB_MCD_100-119_0_0__all Q
danish seine fisheries	
haddock fisheries	
	NIR_SDN_DEF_>=120_0_0__Q1, Q3, Q4
	NIR_SDN_DEF_100-119_0_0__all Q
dredge fisheries	
diverse shellfish fisheries	
great Atlantic scallop	NIR_DRB_MOL_0_0_0__all Q
Mussels	NIR_DRB_MOL_0_0_0__Q3
queen scallop	NIR_DRB_MOL_0_0_0__all Q
	SCO_DRB_MOL_0_0_0__all Q

	IRL_DREDGE-NONE__Q1-2
mid-water trawling fisheries	
herring fisheries	
	NIR_OTM_SPF_32-54_0_0__Q3, Q4
pot fisheries	
crab and whelk	
Edible crab	NIR_FPO_CRU_0_0_0__all Q
Edible crabs and whelks	SCO_FPO_CRU_0_0_0__all Q
Edible crabs and whelks	UK(Eng+Whl)_FPO_CRU_0_0_0 __All Q
set gillnet fisheries	
herring fishery	
	NIR_GNS_SPF_50-59_0_0__Q4
mixed fishery for flatfish and demersal elasmobranchs	
	UK(Eng+Whl)_GNS_DEF_100-109_0_0 __All Q

English Channel	
beam trawl fisheries	
diverse monospecific and mixed demersal fish fisheries	
Anglerfish	BEL_TBB_DEF_70-99__all Q
mixed fishery	UK(Eng+Whl)_TBB_MCF_<16_0_0 __all Q
mixed fishery	UK(Eng+Whl)_TBB_MCF_70-99_0_0 __all Q
sole	BEL_TBB_DEF_70-99__all Q
otter trawler fisheries	
cuttlefish fishery	
cuttlefish	SCO_OTB_MCF_100-119_0_0_Western channel_Q1, Q3, Q4
	UK(Eng+Whl)_OTB_MCF_70-99_0_0 _Western channel_all Q
	SCO_OTB_MCF_80-99_0_0_Western channel_Q1, Q3, Q4
Cuttlefish, gurnard, rays	FRA_OTB_DEF_80-89_0_0_Western channel_Q1-4
cuttlefish, sharks, plaice	FRA_OTB_DEF_80-89_0_0_Estearn Channel_Q1-4
mixed demersal fish fisheries	
mixed demersal species	SCO_OTB_MCF_100-119_0_0__All
mixed demersal species	UK(Eng+Whl)_OTB_MCF_<16_0_0 _western English_all Q
mixed pelagic fish fisheries	
Mackerel and sardine	FRA_OTB_DEF_inf70_0_0_English Channel_Q1-4
sardine and sprat	UK(Eng+Whl)_OTB_SPF_16-31_0_0 _western Channel_Q4
Danish seine fisheries	
mixed demersal fisheries	

Mixed fishery	UK(Eng+Whl)_SDN_MCF_80-89_0_0 _Eastern channel_Q2,3
mixed pelagic fisheries	
Sardine anchovy	UK(Eng+Whl)_SDN_MPD_<16_0_0 _Western Channel_Q4,1
demersal seine fisheries	
Mixed fishery (pelagic and demersal fish and cephalopods)	
	NLD_Dem seine 90-119mm_Eastern channel_Q1-4
	NLD_Dem seine 80-89mm_Eastern channel_Q1-4
dredge fisheries	
scallops fisheries	
	SCO_DRB_MOL_0_0_0__All
	FRA_DRB_MOL_80-99_0_0__Q1 Q4
	FRA_DRB_MOL_inf32_0_0__Q1 Q4
	IRL_DREDGE-NONE__Q1-2
	BEL_DRB_MOL__All year
other bivals fisheries	
Cockles	FRA_DRB_MOL_inf32_0_0__Q1-4
Mussels	FRA_DRB_MOL_80-99_0_0__Q2 Q3
seaweed fisheries	
	FRA_DRB_MOL_32-54_0_0__Q2-3
	FRA_DRB_MOL_80-99_0_0__Q2 Q3
mid-water trawling fisheries	
herring fisheries	
	FRA_OTM_SPF_32-54_0_0__Q4
	GER_OTM_SPF_32-54_0_0_eastern Channel_Q4
	NLD_OTM_SPF_32-54_0_0_eastern Channel_Q4
	UK(Eng+Whl)_OTM_SPF_32-54_0_0_eastern Channel_Q4
sardine fishery	
Sardine	GER_OTM_SPF_16-31_0_0_Western Channel_Q4
	NLD_OTM_SPF_16-31_0_0_Western Channel_Q3-4
sardine and sprat	UK(Eng+Whl)_OTM_SPF_16-31_0_0 _Western Channel_all Q
anchovy and sardine	UK(Eng+Whl)_OTM_SPF_16-31_0_0 _Western Channel_all Q
other mixed small pelagic fish fisheries	
Mackerel, whiting	FRA_OTM_SPF_80-89_0_0_Western Channel_all Q
mixed fishery	UK(Eng+Whl)_OTM_SPF_<16_0_0 _Western Channel_all Q
mixed fishery	UK(Eng+Whl)_OTM_SPF_55-69_0_0 _Western Channel_all Q

other	
Seabreams, sharks	FRA_OTM_SPF_80-89_0_0__Q2-3
purse seine	
mixed pelagic fish	
	UK(Eng+Whl)_PS_SPF_16-31_0_0 _western Channel_Q3 and 4
pots fisheries	
crabs and whelks fisheries	
edible crab	FRA_FPO_CRU_NON_0_0__Q1-4
Edible crabs and whelks	UK(Eng+Whl)_FPO_CRU_0_0_0 __All Q
Spider crab	FRA_FPO_CRU_NON_0_0__Q1-4
scottish seine fisheries	
mullet fisheries	
	BEL_SSC_DEF_70-99_Eastern Channel_Q1 and Q4
gillnets fisheries	
monospecific demersal fish fisheries	
Anglerfish	SCO_GNS_DEF_100-109_0_0_western Channel_Q2, Q3
seabass	UK(Eng+Whl)_GNS_MPD_60-69_0_0 _eastern Channel_Q4 and 1
	UK(Eng+Whl)_GNS_DEF_90-99_0_0 _eastern Channel_Q1,4
mixed demersal fish fisheries	
mixed fishery dominated by pollack	UK(Eng+Whl)_GNS_DEF_150-219_0_0 _western Channel (7e)_Q1 mainly
mixed fishery dominated by sole/thornback ray and cuttlefish	UK(Eng+Whl)_GNS_DEF_80-89_0_0 _western Channel_all Q
mixed fishery for demersal fish	UK(Eng+Whl)_GNS_DEF_110-149_0_0 __all Q
mixed fishery for flatfish and demersal elasmobranchs	UK(Eng+Whl)_GNS_DEF_100-109_0_0 __All Q
pollack/ling/saithe	UK(Eng+Whl)_GNS_MPD_50-59_0_0 _western Channel_Q1
sole / smoothhound	UK(Eng+Whl)_GNS_DEF_90-99_0_0 _eastern Channel_Q2,3
monospecific pelagic fish fisheries	
Sardine	UK(Eng+Whl)_GNS_SPF_10-30_0_0 _western Channel_Q3,4
mixed small pelagic fish fisheries	
mixed pelagic fish fishery dominated by pilchard	UK(Eng+Whl)_GNS_SPF_31-49_0_0 _western Channel_all Q
mixed pelagic fishery dominated by herring	UK(Eng+Whl)_GNS_MPD_70-79_0_0 _eastern Channel_Q4
crab fishery	
Spider crab	FRA_GNS_CRU_sup110_0_0__Q1-4
set longlines fisheries	
monospecific fisheries	

mackerel	UK(Eng+Whl)_LLS_FIF_0_0_0 _western Channel_all Q
Sharks	FRA_U15M_LLS_DEF_NONE_0_0__Q1-4
trammel nets fisheries	
monospecific fisheries	
plaice	UK(Eng+Whl)_GTR_DEF_90-99_0_0 _eastern Channel_all Q
sharks	FRA_GTR_DEM_90-99-0-0__Q1-4
mixed demersal fish fisheries	
anglerfish and hake fishery	UK(Eng+Whl)_GTR_DEF_>=220_0_0 _ western Channel_all Q
mixed demersal fishery	UK(Eng+Whl)_GTR_DEF_110-149_0_0 _eastern Channel_all Q
mixed demersal fishery	UK(Eng+Whl)_GTR_DEF_150-219_0_0 __all Q
Plaice, sharks, cod	FRA_GTR_DEM_100-109-0-0_eastern Channel_Q2-3
Plaice, sharks, cod	FRA_GTR_DEM_110-149_0_0_eastern Channel_Q2-3
Rays, sharks, pollack	FRA_GTR_DEM_110-149_0_0__Q1-4
seabass and smoothhound fishery	UK(Eng+Whl)_GTR_DEF_100-109_0_0 _eastern Channel_all Q
Sole, plaice	FRA_GTR_DEM_90-99-0-0__Q1-4

Celtic Sea	
beam trawl fisheries	
diverse demersal fish fisheries	
Anglerfish	BEL_TBB_DEF_70-99_Celtic_Q1-4
sole	BEL_TBB_DEF_70-99_Celtic_Q2, Q4
Mixed demersal fishery	IRL_BEAM-70-99_North Celtic_Q1-4
otter trawler fisheries	
mixed demersal fisheries targeting mainly anglerfish, megrim and hake	
Anglerfish, megrim, hake	UK(Eng+Whl)_OTB_DEF_100-119_0_0 _Celtic_all Q
Anglerfish, megrim, hake	FRA_OTB_DEF_80-89_0_0_Celtic_Q1-4
Anglerfish, megrim, hake	FRA_OTB_DEF_inf70_0_0_Celtic_Q1-4
Anglerfish, megrim, hake	FRA_OTB_DEF_sup100_0_0_Celtic_Q1-4
Anglerfish, rays, sharks	FRA_OTB_DEF_sup100_0_0_Celtic_Q1-4
Mixed demersal fishery	IRL_OTTER>=120_North Celtic_Q1-4
Mixed demersal	IRL_OTTER-100-119_Celtic_Q1-4
Mixed demersal	IRL_OTTER-70-99_Celtic_Q1-4
Haddock, whiting, cod	FRA_OTB_DEF_sup100_0_0_Celtic_Q1-4
mixed fishery	UK(Eng+Whl)_OTB_MCF_32-54_0_0 _Bristol Channel_Q2-3
Nephrops fisheries	
	NIR_OTB_CRU_70-99_0_0_Celtic_All
	SCO_OTB_MCF_80-99_0_0_northern Celtic Sea_Q2-3
Danish seine fisheries	
whitefish fisheries	

haddock	NIR_SDN_DEF_>=120_0_0_Celtic_Q1,3-4
whiting	NIR_SDN_DEF_100-119_0_0_notrh celtic_Q1-4
demersal seine fisheries	
mixed fisheries	
Mixed demersal fishery	IRL_DEM_SEINE-100-119_North Celtic_Q1-4
Mixed demersal fishery	IRL_DEM_SEINE->=120_North Celtic_Q1 & 4
dredge fishery	
shellfish fishery	
Shellfish	IRL_DREDGE-NONE_North Celtic_Q1-2
mid-water trawling fisheries	
monospecific herring and sprat fisheries	
Herring	IRL_PTM_SPF_32-54_0_0_Celtic_Q3-4
Sprat	IRL_PTM_SPF_16-31_0_0_Celtic_Q1,4
pots	
crab and whelk fishery	
Edible crabs and whelks	UK(Eng+Whl)_FPO_CRU_0_0_0 _Coastal fishery_All Q
Edible crabs	IRL_POTS-NONE_Celtic_
gillnet fisheries	
mixed demersal fish fisheries	
Anglerfish	UK(Eng+Whl)_GNS_MCD_>=220_0_0 _shelf edge_all Q
Mixed demersal fishery	IRL_GILL-120-219_North Celtic_Q1-2
Mixed demersal fishery	UK(Eng+Whl)_GNS_DEF_110-149_0_0 _western Celtic_Q2-3

Bay of Biscay	
beam trawl fishery	
sole	
	BEL_TBB_DEF_70-99_Biscay_Q3
otter trawler fisheries	
Mixed demersal fish with cephalopods fisheries	
Cephalopods and mullet	FRA_OTB_DEF_70-79_0_0_Biscay_Q1-4
Flatfish and squid	FRA_OTB_DEF_inf70_0_0_Biscay_Q1-4
Mixed demersal fish fisheries	
hake, megrim, anglerfish, pout etc.	ESP_OTB_DEF=>70_0_0_Biscay_Q1, Q2, Q3, Q4
Mixed Nephrops and demersal fish fisheries	
Nephrops, hake	FRA_OTB_DEF_70-79_0_0_Biscay_Q2-3
Nephrops, hake	FRA_OTB_DEF_80-89_0_0_Biscay_Q1-4
hake fishery	
Hake	ESP_PTB_DEF=>70_0_0_Biscay_Q1, Q2, Q3, Q4
mid-water trawling fisheries	

albacore tuna	
	IRL_PTM_LPF_?120_0_0_Biscay_Q3
	FRA_OTM_LPF_100-119_0_0_Biscay_Q3-4
	FRA_OTM_LPF_100-119_0_0_Biscay_Q3-4
small pelagics monospecific fisheries	
Anchovy	FRA_OTM_SPF_16-31_0_0_Biscay_Q2-4
mackerel	FRA_OTM_SPF_32-54_0_0_Biscay_Q1-2
	GER_OTM_SPF_32-54_0_0_Biscay_Q1 and 4
	FRA_OTM_SPF_70-79_0_0_Biscay_Q3-4
Sardine	FRA_OTM_SPF_16-31_0_0_Biscay_Q2-4
	FRA_OTM_SPF_80-89_0_0_Biscay_Q2-3
other fisheries mid-water trawling fisheries	
Hake	FRA_OTM_SPF_100-119_0_0_Biscay_Q1-4
Seabreams, mullets and jack mackerel	FRA_OTM_SPF_70-79_0_0_Biscay_Q3-4
Whiting, meagre cephalopods	FRA_OTM_SPF_70-79_0_0_Biscay_Q3-4
purse seine fisheries	
small pelagic fish monospecific fisheries	
Anchovy	ESP_PS_SPF_0_0_0_Biscay_Q2
	FRA_PS_SPF_16-31_0_0_Biscay_Q1-4
Sardine	FRA_PS_SPF_16-31_0_0_Biscay_Q1-4
Sardine and Horse mackerel	ESP_PS_SPF_0_0_0_Biscay_Q1-4
gillnets and trammel nets fisheries	
anglerfish fisheries	
	SCO_GNS_DEF_>=220_0_0_Biscay_All
	FRA_GTR_DEM_110-149_0_0_Western part of Brittany_Q2-3
	FRA_GTR_DEM_sup220_0_0_Western part of Brittany and Bay of Biscay_Q1-4
	FRA_GTR_DEM_100-109-0-0_South Bretagne_Q2-3
hake fisheries	
	SCO_GNS_DEF_100-109_0_0_Biscay_Q1, Q4
	ESP_GNS_DEF=>100_0_0_Biscay_Q1, Q2, Q3, Q4
	FRA_GNS_DEM_100-109_0_0_Biscay_Q1-4
	FRA_GNS_DEM_110-149_0_0_Biscay_Q2-3
	FRA_GTR_DEM_100-109-0-0_Southern part of the Bay of Biscay_Q1-4
mixed fisheries	
Pollack, seabass, seabreams	FRA_GNS_DEM_110-149_0_0_Biscay_Q1 Q4
Rays, sharks, pollack	FRA_GTR_DEM_110-149_0_0_Biscay_Q1-4
Sole and seabass	FRA_GTR_DEM_100-109-0-0_Biscay_Q1-4
Sole, seabass and hake	FRA_GTR_DEM_110-149_0_0_Southern part of the Bay of Biscay_Q1 Q4
longlines fisheries	
hake fisheries	

	FRA_O15M_LLS_DEF_NONE_0_0_cont. slopes_Q1-4
	FRA_U15M_LLS_DEF_NONE_0_0_Biscay_Q1-4
	ESP_LLS_DEF_0_0_0_Biscay_Q1-4
other demersal fish fisheries	
Conger eel	FRA_O15M_LLS_DEF_NONE_0_0_Biscay_Q1-4
Conger eel	FRA_U15M_LLS_DEF_NONE_0_0_Biscay_Q1-4
pots fisheries	
crustaceans	
Edible crab	FRA_FPO_CRU_NON_0_0_Biscay_Q1-4
Spider crab	FRA_FPO_CRU_NON_0_0_South Bretagne_Q1-4

Iberian Sea	
otter trawl fisheries	
small pelagic fish monospecific fisheries	
Horse Mackerel	PRT_OTB_DEF_>=70_0_0_Portugal _Q1-Q4 PRT_OTB_DEF_55-69_0_0_Portugal _Q1-Q4 ESP_OTB_MPD=>55_0_0_Iberian coast_Q1, Q3, Q4
Mackerel	ESP_OTB_MPD=>55_0_0_Iberian coast_Q1, Q2
Blue whiting	ESP_PTB_MPD=>55_0_0_Iberian coast_Q1, Q3, Q4
Mackerel	ESP_PTB_MPD=>55_0_0_Iberian coast_Q1, Q2
mixed demersal fish fisheries	
Mixed demersal species	PRT_OTB_DEF_<16_0_0**(i)_Western central_Q1-Q4
Mixed demersal species	ESP_OTB_DEF=>55_0_0_Iberian coast_Q1, Q2, Q3, Q4
mixed Nephrops and pelagic fish fisheries	
Nephrops, blue whiting, hake	PRT_OTB_CRU_>=70_0_0_Southwest/South PRT_Q1-Q4
Nephrops, Trachurus spp.	PRT_OTB_CRU_55-69_0_0_Southwest/South PRT_Q1-Q4
drifting longlines fishery	
Black scabbard fish fishery	
	PRT_LLD_DWS_0_0_0_West central offshore PRT_Q1-Q4
handlines fishery	
mackerel fishery	
	ESP_LHM_SPF_0_0_0_Iberian coast_Q2
Purse seine fisheries	
targeted monospecific small pelagic fish fisheries	
Anchovy	ESP_PS_SPF_0_0_0_Iberian coast_Q2
Sardine	ESP_PS_SPF_0_0_0_Iberian coast_Q1-4
Horse mackerel	ESP_PS_SPF_0_0_0_Iberian coast_Q1-4
Sardine	PRT_PS_SPF_16_0_0_All PRT continental_Q1-Q4

anchovy	PRT_PS_SPF_16_0_0_All PRT continental_Q1-Q4
horse mackerel	PRT_PS_SPF_16_0_0_All PRT continental_Q1-Q4
chub mackerel	PRT_PS_SPF_16_0_0_All PRT continental_Q1-Q4
set gillnets fisheries	
monospecific demersal fish fisheries	
Anglerfish	ESP_GNS_DEF=>100_0_0_Iberian coast_Q1, Q4
Hake	ESP_GNS_DEF=>100_0_0_Iberian coast_Q1, Q2, Q3, Q4
mixed demersal and small pelagic fish fisheries	
Hake, Trachurus spp.	PRT_GNS_DEF_80-99_0_0**(ii)_All PRT continental_Q1-Q4 ESP_GNS_DEF_80-99_0_0_Iberian coast_Q1, Q2, Q3, Q4
longlines fisheries	
Mixed demersal species	
Black scabbard fish	PRT_LLS_DWS_0_0_0_West central offshore PRT_Q1-Q4
Hake, conger	ESP_LLS_DEF_0_0_0_Iberian coast_Q1, Q2, Q3, Q4
Mixed demersal species	PRT_LLS_DEF_0_0_0_All PRT continental_Q1-Q4
trammel net fisheries	
Mixed demersal species	
Mixed fishery	ESP_GTR_DEF_60-70_0_0_Iberian coast_Q1, Q2, Q3, Q4
Rays and skate, anglerfish, sole, seabass	PRT_GTR_DEF_>=100_0_0**(ii)_All PRT continental_Q1-Q4

the Azores	
Blackspot seabream	PRT_LLS_DEF_0_0_0_Azo***_Azores seamounts_Q1-Q4

Canary Islands	
Tuna species	ESP_LHP_LPF_0_0_0__Q2, Q3
Small pelagic species	ESP_PS_SPF_0_0_0__Q1, Q2, Q3, Q4

Off shore areas	
Albacore	ESP_LLS_DEF_0_0_0_Wide range following species migratory pattern. _Q3

In addition to the fisheries identified within the Baltic Sea, North Sea and Atlantic Western Waters, the following commercial and artisanal fisheries were identified in the Outermost Regions

Location and description of the fishery
AZORES
Azores - Deepwater demersal (bottom longline)
Azores - Small pelagic (purse seine)
Azores - Deepwater demersal (drifting longlines)
Azores - Demersal (artisanal handline)
Azores - Inshore demersal (artisanal gillnets)
Azores - Inshore demersal (artisanal pots and traps)
Azores - Large pelagic (pelagic longline)
Azores - Large pelagic (pole and line)
CANARY ISLANDS
Canary Islands - Artisanal inshore demersal (nets/traps/hand lines)
Canary Islands - Artisanal large pelagic (handline, longline and pole & line)
Canary Islands - Artisanal small pelagic (purse seine)
Canary Islands - Deepwater demersal
GUADELOUPE
Guadeloupe - Bottom longline
Guadeloupe - Hand line (with or without pole)
Guadeloupe - Large pelagic lines and longlines
Guadeloupe - Lobster net
Guadeloupe - Lobster pots
Guadeloupe - Miscellaneous fish pots
Guadeloupe - Seines
Guadeloupe - Trammel
Guadeloupe - Trolling line
Guadeloupe - Urchin and echinoderms free diving
Guadeloupe - Circling driftnet
Guadeloupe - Conch free diving
Guadeloupe - Deep longline

Location and description of the fishery
Guadeloupe - Deep nets
Guadeloupe - Deep pots
Guadeloupe - Fixed driftnet
Guadeloupe - Free diving
Guadeloupe - Gillnet
MADEIRA
Madeira - Artisanal demersal (handline, longlines)
Madeira - Artisanal hand harvesting
Madeira - Deepwater demersal (drifting longlines)
Madeira - Large pelagic (handline, pole and line, baitboat)
Madeira - Small pelagic (purse seine)
MARTINIQUE
Martinique - Bottom gillnet
Martinique - Handline (with or without pole)
Martinique - Longline
Martinique - Offshore trolling lines
Martinique – Pots
Martinique - Seines
Martinique - Surface nets
Martinique - Trammel net
Martinique - Bottom longline
Martinique - Circling gillnet
Martinique - Coastal trolling line
Martinique - Conch net
Martinique - Drifting longline
Martinique - Fish aggregating device (FAD)
Martinique - Fixed driftnet
Martinique - Free diving

Location and description of the fishery
MAYOTTE
Mayotte - Encircling gillnets
Mayotte - handlines and pole and lines
Mayotte - Non mechanised handlines and pole and lines
Mayotte - Non mechanised handlines and pole and lines
Mayotte - Set gillnets
Mayotte - Troll line for large pelagic fish
REUNION
Reunion - Beach seine
Reunion - Set nets
Reunion - Troll lines
Reunion - Cales
Reunion - Drifting longlines
Reunion - Pole and line
Reunion - Pole and line, manual
Reunion - Pole and line, manual
Reunion - Pole and line, mechanised
Reunion - Set longline
FRENCH GUIANA
French Guiana - Artisanal demersal set gillnets weakfish
French Guiana - Artisanal drifting pelagic gillnet
French Guiana - Bottom trawl shrimp
French Guiana - Longline snapper

ANNEX 3: TYPOLOGY OF ECOSYSTEM CHALLENGES ADDRESSED BY AN EAFM

The table below summarizes the ecosystem challenges addressed by an EAFM that were identified through the literature review undertaken in Task 3 of the study. Within each of the three key literature reviews (fishing impacts, environmental context, society context), we sub-categorized articles and reports based on the type of challenge (a combination of pressure and ecosystem component), to give a three-character "challenge ID". Additional, fisheries specific, challenges were identified through consultations undertaken by local partners and these are included in the supplementary Material of Bastardie, F., Brown, E. J., Andonegi, E., Arthur, R., Beukhof, E., Depestele, J., Döring, R., Eigaard, O. R., García-Barón, I., Llope, M., Mendes, H., Piet, G., & Reid, D. (2021). A Review Characterizing 25 Ecosystem Challenges to Be Addressed by an Ecosystem Approach to Fisheries Management in Europe. Frontiers in Marine Science, 7, [629186]. https://doi.org/10.3389/fmars.2020.629186

Challenges id	Specific Challenges	Ecosystem	Supporting References
Fisheries impacts on the structure and functioning of marine ecosystems			
Fishing alters exploited stocks' resilience			
1.1.1	Altered stock size or stock size composition from selective fishing might have far-reaching consequences in altering resilience of the exploited populations		Aranda et al. (2019), Dickey-Collas et al. (2014), Lindegren et al. (2014), Ravard et al. (2014), STECF (2018a), Ter Hofstede et al. (2011), Vinther and Eero (2013)
1.1.2	Time and space translocation of the effects		Bastardie et al. (2017), Bell et al. (2015), Blanchard and Bouncher (2001), Estrella-Martínez et al. (2019), Isomaa et al. (2013), Ferro et al. (2008), Harma et al. (2012), Hüssy et al. (2016), Lindegren et al. (2014), STECF (2018a)
1.1.3	Long-term change in species vital rates		Andersen and Brander (2009), Estrella-Martínez et al. (2019), Hidalgo et al. (2017), Isomaa et al. (2013), , Lindegren et al. (2013), Kokkonen et al. (2019), Moritz et al. (2015), Ostman et al. (2014) STECF (2018a), STECF (2019a)
Fishing results in by-catch or habitat degradation			
1.2.1	Degrading ecosystem components with by-catch or incidental catch induced by the exploitation of commercial species, possibly up to the extinction point		Lucena Frédou et al. (2016), Maes et al. (2018), Milessi et al. (2002), Milessi et al. (2002), Ramírez-Monsalve et al. (2016), STECF (2017b), STECF (2020), Torres-Irineo et al. (2014), Torres-Irineo et al. (2014)
1.2.2	Disturbance of exploited marine seabed habitats		Asch and Collie (2008), Asci et al. (2018), Allen and Clarke (2007), Bradshaw et al. (2001), Coates et al. (2016), Dinmore et al. (2003), Duplisea et al. (2002), Duineveld et al. (2007), Diesing et al. (2013), EP (2014), Greenstreet et al. (2007), Hélias et al. (2018), Hermsen et al. (2003), Hiddink et al. (2007), Hiddink et al. (2006b), Josefson et al. (2018), Kenchington et al. (2007), Nilsson et al. (2003), Mendez et al. (2017), Merillet et al. (2018), Oberle et al. (2016), Ramalho et al. (2018), Ramos et al. (2011), Reiss et al. (2009), Robinson et al. (2008), Szostek et al. (2016), Trimmer et al. (2005), Tulp et al. (2020), van Denderen et al.

		(2015), van Denderen et al. (2014), van der Reijden et al. (2018), Varisco and Vinuesa (2007), Ward and Larcombe (2008)
Fishing alters food-web interactions		
1.3.1	Ramification effects or cumulated pressure effects on seabed habitats vulnerable habitats, and essential fish habitats	Allen and Clarke (2007), Daly et al. (2018), Bailey et al. (2019), Bennecke and Metaxas (2017), Callaway et al. (2007), Dannheim et al. (2014), Duineveld et al. (2007), EP (2014), Frid et al. (2001), Fock (2011), Godbold et al. (2013), Hawkins and Robert (2004), Hiddink et al. (2006b), Hiddink et al. (2016), Hinz et al. (2017), Hourigan et al. (2009), ICES (2019), Jenkins et al. (2004), Jennings et al. (2001b), Jennings et al. (2001), Johnson et al. (2015), Kaiser et al. (2002), Kraufvelin et al. (2018), Mellet et al. (2011), Nilsson et al. (2003), Schratzberger and Jennings (2002), Shepard et al. (2010), Simpson et al. (2006), Sköld et al. (2018), Simpson et al. (2006), STECF (2019a), Tillin et al. (2006), van der Molen et al. (2013), Vergon and Blanchard (2006), Wienberg et al. (2013)
1.3.2	Changing trophic interactions in the bentho-pelagic system with possible far-reaching indirect changes	Bell et al. (2018), Blanchard and Bouncher, (2001), Blanchard et al. (2004), Boyd et al. (2018), Costalago et al. (2019), Daewel et al. (2011), Datta and Blanchard (2016), Daan et al. (2005), Dickey-Collas et al. (2014), Engelhard et al. (2014), Engelhard et al. (2008), Erauskin-Extramiana et al. (2019), González-Irusta et al. (2017), Harma et al. (2012), Hidalgo et al. (2017), Hiddink et al. (2016), Hiddink et al. (2012), Kraufvelin et al. (2018), Jennings et al. (2002), Jennings et al. (2001b), Jennings et al. (2002), Link and Garrison (2002), Lynam et al. (2017), MacKenzie et al. (2011), Myers et al. (2007), Meier et al. (2012), Niiranen et al. (2012), TerHofstede et al. (2011), Niiranen et al. (2012), Martins et al. (2012), Perkins et al. (2018), Ravard et al. (2014), Ramalho et al. (2018), Shepard et al. (2010), Sguotti et al. (2016), Shin et al. (2005), Smith et al. (2014), Sánchez and Olaso (2004), Tomczak et al. (2009), Vergon and Blanchard (2006)
Ecosystem effects on fisheries' resources opportunities		
Inherent ecosystem variability and ecosystem component attributes interact with fishing impacts to affect fishing opportunities		
2.1.1	Fishing combines with environmental conditions on seabed habitats	Callaway et al. (2002), Drabble (2012), Frid et al. (2001), Hiddink et al. (2012), Kirby et al. (2007), Lindley et al. (2010), Oberle et al. (2016), Pecuchet et al. (2016), Rijnsdorp et al. (2018), Szostek et al. (2016), Trimmer et al. (2005), van der Molen et al. (2013)
2.1.2	Fishing combines with natural variability to impact resource availability / productivity	Bell et al. (2018), Blanchard and Bouncher (2001), Dos Santos Schmidt et al. (2017), Embling et al. (2012), Estrella-Martínez et al. (2019), Frederiksen et al. (2004), Gasche et al. (2013), Goñi et al. (2015), Hawkins et al. (2017), Hernvann and Gascuel (2020), Planque et al. (2010), Rochet et al. (2010), Rochet et al. (2013), Rouyer et al. (2014), Olsen et al. (2011),

		Ter Hofstede et al. (2011), Trifonova et al. (2015), Vilela and Bellido (2015),Voss et al. (2019), Wikström et al. (2016), Wright et al. (2014), Zimmermann et al. (2019)
2.1.3	Fishing combines with varying species susceptibility, vulnerability or responsiveness	Bastardie et al. (2020), Beukhof et al. (2019), Elliott et al. (2018), EP (2014), McLean et al. (2019), Pecuchet et al. (2018), Pennino et al. (2019), Stallings (2009), Ramalho et al. (2018), von Nordheim et al. (2018)
Anthropogenic and environmental changes interact with fishing opportunities individually and cumulatively		
2.2.1	Fishing combines with climate change to impact fisheries via changes in ecosystem-wide productivity and changes in resource distribution	Auber et al. (2015), Aranda et al. (2019), Bartolino et al. (2014), Church et al. (2019), Daewel et al. (2011), Engelhard et al. (2014), EP (2014), Furness (2002), Goikoetxea et al. (2013), Gacutan et al. (2019), Gatti et al. (2018), Hedd et al. (2009), Hiddink et al. (2012), Holmgren et al. (2012), Hawkins et al. (2017), Jansen (2014), Jennings et al. (2001), Kadin et al. (2019), Kirby et al. (2007), Le Bris et al. (2018), Lindegren et al. (2014), Meier et al. (2012), Pitois et al. (2012), Rouyer et al. (2014), Sguotti et al. (2018), Selim et al. (2016), Svedäng and Hornborg (2015), Mackinson (2014), Mérillet et al. (2020), Murillo et al. (2020), Sguotti et al. (2016), Shepard et al. (2010), Shepard et al. (2012), STECF (2018a), Tillin et al. (2006), Tomczak et al. (2013), Thøgersen et al. (2015), Trifonova et al. (2017),Véron et al. (2020), Voss et al. (2019), Voerman et al. (2013)
2.2.2	Fishing combines with eutrophication to impact fisheries via a change in ecosystem-wide productivity	Bossier et al. (2018), Bergström et al. (2018), Fock (2011), González-Irusta et al. (2014)
2.2.3	Fishing combines with combinations of other pressures to impact the productivity of a subset of ecosystem components	Aas et al. (2018), Anderson et al. (2014), Burthe et al. (2014), Christensen t al. (2015), Costalago et al. (2019), Engelhard et al. (2014)., Faulks et al. (2016), Fujii (2015), Furness (2002), Hawkins et al. (2017), Königson et al. (2015), Kabat et al. (2012), Kaplan et al. (2018), Maes et al. (2018), Pita et al. (2017), STECF (2020)
Influence of social, economic and governance aspects on fishing opportunities		
Social and governance constraints on fishing opportunities		
3.1.1	Fisheries and fisheries management embarked in short term profit leading to suboptimal fishing from overfishing or underfishing	Aranda et al. (2019), Borges et al. (2018), EEA (2016), EP (2014), Dickey-Collas et al. (2014), Ferro et al. (2008), Fock et al. (2014), Furness (2002) Goti-Aralucea et al. (2018), Hiddink et al. (2006b), ICES (2020b), ICES (2018a), ICES (2018b), Mellet et al. (2011), Mullon et al. (2016), O'Higgins and Roth (2011), Rindorf et al. (2017), STECF (2018a), STECF (2017b), STECF (2017c), STECF (2018a), Svedäng and Hornborg (2015), Pita et al. (2017), Thøgersen et al. (2015), Torres et al. (2013), Ziegler and Hornborg (2014)
3.1.2	A market demand influencing what species assemblages to target	Aranda et al. (2019), EP (2014), Ferro et al. (2008), Floc´h et al. (2008), Graziano et al. (2018), Morgan (2016), Mullon et al. (2016), Rochet et al. (2013), Seara et al. (2017), STECF

		(2018a), STECF (2020), Papaioannou et al. (2014), Voss et al. (2014)
3.1.3	A competition with market places overruling fair competition	Aranda et al. (2019), EEA (2016), Floc´h et al. (2008), Goti-Aralucea et al. (2018), Mullon et al. (2016), Morgan (2016)
3.1.4	Competition for a limited marine space	Christensen et al. (2015), EP (2014), Girardin et al. (2015), Hatchard et al. (2014), Jentoft and Knol (2014), Mackenzie et al. (2013), ORFISH (2019), Papaioannou et al. (2014), Raoux et al. (2018), Sánchez and Olaso (2004), STECF (2018a)
3.1.5	Changing opportunities from stock spatial distribution shift	Aranda et al. 2019, Bastardie et al. (2017), Bjørndal et al. (2014), Bossier et al. 2018, Brown et al. (2018), Costalago et al. (2019), Jansen (2014), Leitão et al. (2018), Pennino et al. (2019), Gacutan et al. (2019), Graziano et al. (2018), Henriques et al. (2016), Morgan (2016), Ramírez-Monsalve et al. (2016), Rubio et al. (2020), STECF (2017c), STECF (2019a), STECF (2020), Tidd et al. (2015)
Conflicting, inconsistent or ill-informed policy goals across industries and stakeholders		
3.2.1	Policy targets for EAFM not defined, or loosely defined	Beare et al. (2013), Cheung et al. (2018), von Schuckmann et al. (2019) , EEA (2016), Frederiksen et al. (2004), Goti-Aralucea et al. (2018), Gröger et al. (2014), ICES (2020a), Ojaveer et al. (2018), Ramírez-Monsalve et al. (2016), Soma et al. (2014), STECF (2019b), STECF (2019c), Rijnsdorp et al. (2016)
3.2.2	Risk of mismanagement from unfit biological reference points	Aranda et al. (2019), Brunel and Boucher (2007), Casini et al. (2011), Dickey-Collas et al. (2014), Froese et al. (2008), Goti-Aralucea et al. (2018), Kempf et al. (2016), Luzenczyk et al. (2017), Mackinson et al. (2018)
3.2.3	Management options or policy goals not addressing conservation issues, or possible incompatible policy goals among the economic, social, and environmental dimensions	Alzorriz et al. (2016), Aranda et al. (2019), Bastardie et al. (2020), Bellanger et al. (2018), Borges et al. (2018), Burgess et al. (2018) Casini et al. (2011), Crilly and Esteban (2013), EEA (2016), Eero et al. (2012), Goti-Aralucea et al. (2018), ICES (2016), Kraufvelin et al. (2018), O'Higgins and Roth (2011), Mackinson et al. (2018), Meek et al. (2011), Mellet et al. (2011), Ramírez-Monsalve et al. (2016), Reiss et al. (2010), STECF (2017c), STECF (2018a), STECF (2019a), STECF (2019b), STECF (2019c), , STECF (2020), Voss et al. (2014), Ziegler and Hornborg (2014)
3.2.4	Mismanagement from unforeseen and unintended socio-economic consequences	Alzorriz et al. (2016), Aranda et al. (2019), Batsleer et al. (2018), Beare et al. (2013), Bellanger et al. (2018), Chagaris et al. (2019), Dickey-Collas et al. (2014), Girardin et al. (2015), Goti-Aralucea (2019), Graziano et al. (2018), Kokkonen et al. (2019), Krag et al. (2016), Mackinson et al. (2018), Morgan (2016), Ramírez-Monsalve et al. (2016), Sangil et al. (2012), STECF 2017a), STECF (2017b), STECF (2017c)STECF (2018a), STECF (2018b), STECF

		(2019a), STECF (2019b), STECF (2019c), STECF (2020), Villasante et al. (2019)
3.2.5	Unintended effects from time lags, spatial ecology, and spatial fishing effort displacement	Aranda et al. (2019), Bartolino et al. (2014), Bastardie et al. (2020), Batsleer et al. (2018), Beare et al. (2013), Bradshaw et al. (2001), Burthe et al. (2014), Bigné et al (2019), Costalago et al. (2019), Dickey-Collas et al. (2014), Dinmore et al. (2003), Duplisea et al. (2002), Erauskin-Extramiana et al. (2019), EP (2014), Frelat et al. (2018), Froese et al. (2008), Greenstreet et al. (2007), Greenstreet et al. (2011), Goti-Aralucea et al. (2018), Goti-Aralucea (2019), Hélias et al. (2018), Heikinheimo et al. (2011), Hiddink et al. (2006b), Hiddink et al. (2012), Hinz et al. (2017), Holmgren et al. (2012), ICES (2016), Kabat et al. (2012), Lindegren et al. (2014) Baltic Sea, Mackenzie et al. (2013), Mellet et al. (2011), Niiranen et al. (2012), Reiss et al. (2009), Robinson et al. (2008), Sangil et al. (2012), Simpson et al. (2006), Szostek et al. (2016), Tidd et al. (2015), van Denderen et al. (2015b)
3.2.6	Stakeholders disagreement, low level of co-management and inefficient translation of science	Aas et al. 2018, Aranda et al. 2019, Beare et al. (2013), Borges et al. (2018), Christou et al. (2017), Floor et al. (2013), Froese et al. (2008), Goti-Aralucea et al. (2018), Haapasaari et al. (2007), Hatchard et al. (2014), Krag et al. (2016), Maya Jariego et al. (2018), Mellet et al. (2011), Milessi et al. (2002), Morgan (2016), O'Higgins and Roth (2011), Ojaveer et al. (2018), Ramírez-Monsalve et al. (2016), Seara et al. (2017), Soma et al. (2018), STECF (2017c), STECF (2018a), STECF (2019b), STECF (2019a), STECF (2020), Varela-Lafuente et al. (2019), Verschueren et al. (2019)
3.2.7	Perfectible science, control and monitoring: a demanding data collection, monitoring, surveillance, control and enforcement	Aranda et al. (2019), Bartolino et al. (2014), Callaway et al. (2002), Chagaris et al. (2019), Christensen-Dalsgaard et al. (2019), Dickey-Collas et al. (2014), Diesing et al. (2013), EMB (2019), Elliott et al. (2018), Embling et al. (2012), Frederiksen et al. (2004), Gerritsen et al. (2013), González-Irusta et al. (2017), Goti-Aralucea (2019), Greenstreet et al. (2011), Haapasaari et al. (2007), Hiddink et al. (2006a), Jennings and Blanchard (2004), Johnson et al. (2015), Luzenczyk et al. (2017), Marshall et al. (2016), McLaverty et al. (2020), McLean et al. (2018), Nicholson and Jennings (2004) Lot 1 North Sea, ORFISH (2019), Pecuchet et al. (2016), Reiss et al. (2009), Reiss et al. (2010), Rijnsdorp et al. (2016), Shepard et al. (2012), Sköld et al. (2018), Svedäng and Hornborg (2015), STECF (2017c), STECF (2018a), STECF (2019a), STECF (2019b), STECF (2020), Szostek et al. (2016), Tidd et al. (2015), Torres et al. (2013), Varela-Lafuente et al. (2019), Vergon and Blanchard (2006), van Denderen et al. (2014), van der Reijden et al. (2018), von Schuckmann et al. (2019)

ANNEX 4: TYPOLOGY OF MANAGEMENT MEASURES AND POLICY INSTRUMENTS IDENTIFIED FROM THE LITERATURE

Typology of management measures and instruments

1. INPUT MEASURES:

1.1. Technical Conservation Measures (TCM)

1.1.1. Gear Based TCM

1.1.1.1. Size Selectivity targeted measures
- 1.1.1.1.1. Mesh size changes
- 1.1.1.1.2. Mesh configuration changes
- 1.1.1.1.3. Square Mesh Panels
- 1.1.1.1.4. Square Mesh Cylinder

1.1.1.2. Species Selectivity
- 1.1.1.2.1. Bycatch Reduction Devices
- 1.1.1.2.2. Sorting grids – TEDs – Swedish Grid
- 1.1.1.2.3. Separator Panels -Scottish separator trawl
- 1.1.1.2.4. Benthos Release Panels Dutch or Belgian Beam trawlers
- 1.1.1.2.5. Long line – circle hooks

1.1.2. Spatial and Temporal TCMs

1.1.2.1. Spatial TCMs - Marine Protected Areas
- 1.1.2.1.1. Strict Nature Reserve
- 1.1.2.1.2. Habitat/Species Management Area
- 1.1.2.1.3. Protected Seascape: No-take zones
- 1.1.2.1.4. Protected Area with Sustainable Use of Natural Resources

1.1.2.2. Temporal Technical Conservation Measures
- 1.1.2.2.1. Closed seasons – incl. spawning and nursery area closures
- 1.1.2.2.2. Real Time Closures (RTC)
- 1.1.2.2.3. Move on rules

1.2. Capacity and effort control measures

1.2.1. Fishing capacity control measures
- 1.2.1.1. Decommissioning
- 1.2.1.2. Entry restrictions on the number of fishing licenses
- 1.2.1.3. Jointly entitled "Capacity reduction schemes (CRS)"

1.2.2. Fishing effort control Measures
- 1.2.2.1. kWh or days at sea controls
- 1.2.2.2. Total Allowable Effort

1.3. Management Measures for Passive Gears
- 1.3.1.1. Gill nets and Trammel nets
- 1.3.1.2. Longline measures
- 1.3.1.3. Traps and pots

2. OUTPUT MEASURES:

2.1. TAC controls

2.2. Landing size controls (MLS, MCRS)

2.3. Discard Bans (including LO)

3. ECOSYSTEM RESTORATION

3.1. RESTOCKING SCHEMES

3.2. STOCK ENHANCEMENT

4. GOVERNANCE AND ECONOMIC INSTRUMENTS

4.1. Tradeable fishing concessions (ITQs)

4.2. Co-management and Results-based-management

4.3. Self-management

4.4. Payments or pricing mechanisms

4.5. Eco-labelling

ANNEX 5: SUMMARY OF LESSONS LEARNT FROM THE CASE STUDIES

The results from the case studies are presented in relation to the broad categories of the management measures typology (see Annex 4): input measures, output measures and policy instruments.

Input measures

" Input controls are restrictions put on the intensity of use of gear that fishers use to catch fish (FAO) These are measures that aim to change the "effort" involved in fishing in the broadest sense. They are very broadly divided into "Technical measures" either gear based or area/time based. But would also include straight forward effort restrictions, fleet reduction measures etc." (from Task 4 draft)

Case 1) Technical conservation measures to protect Kattegat cod

The case study describes a suite of technical conservation measures, which were put in place in 2009, with the aim of reducing the impact of fishing on the Kattegat cod stock to help stock recovery. A joint Danish and Swedish scientific expert group was first tasked by the ministries to propose suitable technical conservation measures. The measures that were implemented through the establishment of four different zones, together covering over 3000 km^2 in the south-eastern Kattegat. Different measures were implemented across these zones ranging from mandatory use of species selective demersal trawls during spawning season in the less stringently regulated zone to a complete ban of all fishing activities in the most regulated zone (647 km^2).

As these measures were implemented before the introduction of the regionalisation procedures introduced with the last reform of the CFP, the measures were not implemented through EU-legislation but instead in mirrored national Swedish and Danish regulations. Stakeholders were consulted before the implementation and soon after the introduction of the measures, a discussion about a gradual broadening of objectives of the measures emerged, particularly in Sweden. The broadening of objectives coincided with the introduction of the EU Marine Strategy Framework Directive. Thus, compared to the initial aims of the measures, that were solely intended to help rebuilding the local Kattegat cod stock, the focus shifted to discussions about the potential additional value of the fully closed area for reaching broader objectives. These included preserving ecosystem functions and the contribution of the area closure to achieving good environmental status. The technical conservation measures to protect the Kattegat cod stock have subsequently been evaluated several times and are still in place.

Case 2) Sole-directed pulse trawling in the Netherlands

The case study of the Dutch sole-directed pulse trawl fishery in the North Sea examines the transition of the conventional beam trawler fleet to a fleet using an innovative alternative fishing gear, the pulse trawl. The development of this gear was initiated by a taskforce on 'Sustainable North Sea fisheries', which was tasked to develop an economic and ecologically sustainable future perspective for the Dutch North Sea demersal fleet. Pulse trawling was one of the elements put forward in the transition towards a more economic and ecologically sustainable fishery.

The first trials of the gear on a commercial vessel started in 2004. As electric fishing was banned in the EU, commercial fishing with the gear would require a change in policy. The EU saw potential in this development and in 2006 a derogation was granted. A further five commercial fishing vessels followed in 2008 with the support of an investment scheme that the Dutch Ministry had arranged with the European Commission. These five vessels eventually demonstrated the reliability and profitability of the technique, after which more Dutch demersal fishers decided to invest and adopt the gear. The experiences during the fuel price crisis in 2008 highlighted the need for fleets to transition to less fuel dependent gears for the long-term viability of the sole fishery. In 2010 the limit of licenses allowed under the derogation (5% of the fleet) was reached. The Dutch Ministry and the Producer Organisations with the support of Dutch eNGO's agreed to seek expansion of the number of licences. This was agreed with the EU commission based on EU Council regulation on conservation of fishery resources through technical measures (Article 43 of Council Regulation (EC) No 850/98, referring to fishing operations conducted solely for the purpose of scientific investigations). These 42 licences were soon also fully in use, resulting in a request to further increase these to a total of 84 licences in 2014. These were granted based on the regulation "avoidance and minimisation of unwanted catches" (Article 14 in CFP Regulation (EU) No 1380/2013, referring to pilot projects). The process taken by the Dutch government to continuously expand the number of licenses lead to irritation with the other Member States. In addition, with the expanding pulse fleet, stakeholders from neighbouring countries expressed concern about this process as well as the impact of pulse fishing on the environment and on the profitability of competing fleets. This lead to increasingly stronger protests from various societal groups (e.g. French fishers and eNGO's) up to the point, on 16 January 2018 following political debate, that the European Parliament voted on the ban of electrified fishing gear. It furthermore decided that the use of the pulse technique would be prohibited from July 2021 onwards.

Case 3) Spanish Bottom Trawling in ICES SubAreas 6 and 7

The case study describes how the problem of unwanted catches is being addressed by employing the best available science to improve the selectivity of the trawl gear and how subsequent regulations are based on science. Spanish bottom trawlers operating in subareas 6 and 7 face problems with unwanted catches of species for which Spain has little or no quotas e.g., haddock, pollock, boarfish, greater silver smelt, etc. Within the framework of the Landing Obligation, this situation leads to the so called choke effect and risks the closure of fisheries as vessels lack quotas or exceed the available quotas. The obligation to land fish with little market value, or fish which cannot be traded for human consumption (below Maximum Conservation Reference Size - MCRS), compromises the economic viability of the fleets. This requires effective selectivity to avoid the unwanted catches while maintaining catches of the target species (e.g., megrim, anglerfish, hake, nephrops and ling).

Selectivity improvement is also required to contribute to a successful implementation of the landing obligation since it reduces the incentive to discard unwanted fish with low economic value and that requires extra work onboard to sort and store. Mesh sizes, mesh configurations and devices have been tested with the support and experience of boatowners and skippers to improve selectivity. Between 2017 and 2018, research trials were conducted in subareas 6 and 7 onboard commercial vessels based in Basque and Galician ports. Experiments in these ICES subareas were designed and conducted by two Spanish research institutes with the support of regional skippers and other technicians. The technological improvements resulting from the trials have shown promising results and have been incorporated into the Spanish fisheries regulatory body. It is worth pointing out that further research is required to continue improving selectivity to minimize the by-catch of unwanted species, recognised as particularly difficult to achieve in mixed fisheries.

Case 4) Designation of NATURA 2000 sites in the German EEZ

NATURA 2000 is a network of nature conservation areas in the European Union, which aims to protect Europe's rich but vulnerable habitats and species. The network contains more than 20,000 sites from all EU Member States and includes both terrestrial and marine protected areas, including the EEZ. The legal background for the NATURA 2000 network is the Habitats Directive (HD, entered into force 1992) and the Birds Directive (BD, entered into force 1979). The selection procedure for identification and nomination of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) are laid down in Annex III of the HD and in Article 4 of the BD. This case study focuses on the identification of protected areas in the German EEZ in the North Sea and Baltic Sea.

NATURA 2000 was established in 1992, but for legal reasons the selection and establishment of NATURA 2000 sites were initially only possible in the Territorial Waters and not in the EEZ. After the publication of the EU Commission opinion (1998) and the London High Court decision (LO 1336/1999), the German Federal Natural Conservation Act was amended in 2002 and the statutory basis for the implementation of NATURA 2000 sites in the EEZ was established. Information on the occurrence of habitat types and species to be protected in the offshore areas was lacking. Therefore, several scientific projects were carried out or commissioned by the BfN under the umbrella of the HabitatMareNATURA2000 project. This survey program commenced in 2002 with the aim of identifying, locating and assessing habitats and species which fulfil the requirement of the HD and the BD. After two years of intensive research (around 20 projects), these results, together with the output of the project MINOS were used to map the habitat types and species relevant for the HD and the bird species and regularly occurring migratory birds relevant for the BD. Based on these maps, eight SACs and two SPAs (three SACs and one SPA in the North Sea and five SACs and one SPA in the Baltic Sea) were nominated in May 2002 to the European Commission, this covers 31% of the German EEZ. However, the overall conservation value of these MPAs depends on the collective effort of all involved Member States. This is illustrated by the case of the NATURA 2000 sites in Germany, where the legal basis for sites was extablished and scientific studies undertaken but the resulting management plans have not been fully implemented.

Case 5) Bratten MPA in the Baltic Sea

Bratten is an area with species and habitats of high conservation value due to the bathymetry characterised by steep rock walls, canyons and pockmarks on the slope (100 – 500 m) towards the Norwegian Deep in the Skagerrak. The exposed rock walls host deep water Coral gardens, sponge communities, large predatory fish, and dense seapen fields in the surrounding soft bottoms. The area was designated as a NATURA 2000 site for reef structures and is part of OSPAR’s network of marine protected areas. A major challenge for the management and conservation of the area concerns the location of Bratten MPA within one of the most important fishing grounds in the Skagerrak for Northern shrimp *Pandalus borealis* and demersal fish. These fishing grounds, located outside territorial waters in in the Swedish EEZ, are intensively fished by bottom trawlers from both Sweden and Denmark. In addition, the integration of EU nature conservation policy and the Common Fisheries Policy (CFP) was poorly developed during the early phases of the process. This made the application of an Ecosystem Approach to Fisheries Management slow and difficult in practice. The aim of the measures finally established, was to ensure adequate protection from harmful fishing activities interacting with designated habitats and species in the marine protected area (MPA) Bratten in the Swedish EEZ. The measures include the establishment of no-take zones where all fisheries are prohibited, and for control purposes compulsory use of Automatic Identification System (AIS) for all vessels fishing in the area. Scientific activities supported the establishment of the Bratten area stepwise by: (1) mapping habitats, (2) characterising biodiversity, (3) assessing the use by fishing activities, (4) identifying threats to habitats and species, (5) evaluating the effects of alternative management scenarios on fisheries. Throughout the process stakeholders were involved and consulted.

Case 6) Spurdog By-catch Avoidance Programme

The spurdog (*Squalus acanthias*) by-catch avoidance programme was a trial of a fisheries management measure designed to reduce the early closure of fisheries, which could occur due to high catches of species with low or zero Total Allowable Catch (TAC). The programme design was based on knowledge gathered during a pilot study and during workshops that included the local fishing industry, relevant agencies, and NGOs. The programme itself was a transdisciplinary research partnership between the Cornish Fish Producers Organisation (CFPO), Defra, Cefas, the Marine Management Organisation (MMO) and the Shark Trust. It involved the development and use of a real-time reporting system, that would indicate the risk of spurdog by-catch. This would allow fishers to avoid spurdog aggregations and reduce incidents of by-catch. The overarching aims of the programme were to reduce fishing pressure on spurdog, aid stock recovery and reduce wasteful discards.

The programme was reviewed by the Scientific, Technical and Economic Committee for Fisheries (STECF) in 2014, 2015 and 2016. It noted that the programme incentivised movement of fishing away from spurdog aggregations, that it had the potential to rebuild the stock by promoting a reduction in fishing mortality, and that it provided useful information on abundance and distribution of spurdog. What was particularly useful was the data on seasonal movement, distribution, by-catch, and discard survival of spurdog in the Celtic Sea, Bristol Channel and western English Channel – which was lacking before this programme began. The effectiveness of the measure cannot be fully assessed as the participating vessels still had the option to continue fishing whilst discarding spurdog by-catch after their TAC had been met.

It was mentioned that in the future, consideration needs to be given to the long-term development of the technology required for the deployment of a real-time spatial management and avoidance system, the possibilities of multi-species by-catch programmes and the potential to mitigate unwanted catches of other species.

Case 7) TURFs in French Guiana

The case study describes how the Red snapper fishery in the water of French Guiana would benefit from a more ecosystem-based management. Liners from the Bolivarian Republic of Venezuela have been fishing in the EEZ of French Guiana since at least 1986. Since 2006 this fishing has been regulated through a formal agreement based on Territorial Use Rights for Fisheries (TURFs). The latest iteration of this agreement is the "European Council, COUNCIL DECISION (EU) 015/1565 of 14 September 2015".

Under the terms of the agreement, the EU issues fishing authorisations to a limited number of fishing vessels flying the flag of the Bolivarian Republic of Venezuela. These authorisations allow the vessels to fish in the part of the EEZ that lies more than 12 nautical miles from the base lines. The measure allocates around 45 licences each year to Venezuelan vessels and requires the shipowners holding a licence to land at least 75% of the snapper catch in ports of French Guiana (the remaining 25% being only subject to a ban on landing then in neighbouring Martinique), and 50% of shark catches to be processed in the facilities of the local processing company with which it has signed a contract.

To underpin the measure, stock assessments are carried out on a semi-regular basis (annually since 2016), based on requests by the French authorities (DPMA). These assessments, though subject to a high level of uncertainty affecting the input data, have highlighted year after year the need to reduce fishing pressure, particularly on the juvenile fraction of the Red Snapper population that is subject to growth overfishing. Moving away from a management system based on the number of licenses is suggested, with measures proposed such as: limitation of overall fishing effort (number of days at sea), adoption of a TAC (as successfully implemented in the South Atlantic) and/or technical measures to reduce catches of juveniles. A clear priority identified is to improve the quality of data used in the stock assessments, through scientific surveys, but also possibly through a change in the regulation that would facilitate biological sampling.

The current management measure has not been amended yet, but the stock assessment results have nonetheless been used as a basis for rejecting requests from the industry to increase the number of authorised vessels. Some contestation of the management measures also occurs on the basis of the socio-economic arrangements. This is related to the fact that the rights to purchase catches from Venezuelan vessels are held by just two companies. Other economic actors have asked to be allowed to participate but these issues have not been solved yet. Currently it is evident that neither the existing science nor the reactions of local economic actors are fully taken into account in the management measures.

Case 8) Gulf of Cadiz Anchovy Fishery

The anchovy (*Engraulis encrasicolus*) fishery is considered to be the most emblematic Spanish fishery in the Gulf of Cadiz (GoC) due to its economic and cultural relevance. This fishery is carried out by purse seiners that operate in the Gulf of Cadiz and Moroccan fishing grounds.

A key consideration for management is whether or not the GoC and Moroccan anchovy populations are part of the same stock is still a matter of scientific debate.

- In the GoC the anchovy stock and its fishery is probably the best monitored as it is covered by (1) assessment with two dedicated acoustic surveys per year (summer and autumn) and one Daily Egg Production Method (DEPM) every other year and (2) fishery-dependent information (landing statistics and biological sampling). The southern component of the stock (division 9a) is annually assessed within ICES WGHANSA as category 3 (ICES advice 2020) and monitored within the Data Collection Framework (DCF). Fishing opportunities advice is given by ICES and a TAC is agreed by the EU, Spain and Portugal and shared between Span and Portugal though assigned national quotas. The ecology of this species is also well known as it has received much attention during the last decades (references below).
- Off the coast of Morocco, the stock is assessed by the Fishery Committee for the Eastern Central Atlantic (CECAF) working group on assessment of pelagic resources – north. There is also a Moroccan national assessment carried out by the Moroccan National Institute of Fisheries Research (INRH). The fishery is regulated by the corresponding EU-Morocco Sustainable Fisheries Partnership Agreement (SFPA) while the fishing opportunities advice is provided by the EU-Morocco Joint Scientific Committee (JSC) based on the previous stock assessments. Fleet characteristics and fishery statistics (species composition, landings, effort, length distributions of landings) are monitored by Instituto Español de Oceanografía (IEO). The question arises whether this SFPA has consequences for the Gulf of Cadiz fishery/stock and vice versa.

Output measures

“Output controls are direct limits on the amount and sizes of fish coming out of a fishery, and are standard management measures in the EU and worldwide.” (from Task 4 draft). These CS consider the implementation and scientific basis for various output measures.

Case 9) Hunting of grey seals as a management measure in the Baltic Sea

Following successful protection measures and improved environmental conditions, the population of grey seals in the Baltic Sea has increased in size and distribution since the

1980s. As a consequence, conflicts with fisheries have increased. Rising financial losses due to seal-induced damage to fishermen's gear and catch, parallel with stakeholder lobbying, and motions to the Government lead to a reintroduction of seal hunting, as a mitigation measure to reduce damage to catch and gear, in the Baltic Sea in the late 1990s/early2000s.

HELCOM Recommendations have been a key tool in the conservation and management of seals in the Baltic Sea since the 1980s, and national management plans for grey seals have been developed in Sweden, Finland, Åland, Denmark and Estonia. Prior to the implementation of the hunting measures, and after the first two years of protective hunting in Sweden, evaluations of the measure could not find any strong evidence that restricted hunting decreased seal-induced damage to fishing gear. However, other studies have indicated that there are certain seals that have adapted their behavior and thus it is a limited part of the seal population that is responsible for the majority of the damage. What has been driving the implementation of the hunting measure is the assumed link between growing aggregate seal population and increasing damage and economic losses for the commercial fisheries, rather than scientific evidence showing statistically significant decreases in damage to fishing gear following protective hunting. No comprehensive evaluation of the mitigative effects of two decades of grey seal hunting in the Baltic Sea has yet been carried out. The possible psychological effects of the measure, whereby hunting seals provides fishermen with the ability to take action and defend their fishing gear and/or fishing grounds, could also be an important factor.

From the review of the measure, we could not find a clear scientific underpinning for the setting of national hunting quotas, or for how total seal quotas at the Baltic Sea level relate to the general long-term management principles. In the case of Sweden, which was object of a more in-depth review, we also could not find mechanisms to allocate quotas across the different regions to avoid the risk of locally unprecautionary hunting pressure.

Case 10) Effects of density dependent growth of fish on management and TAC, exemplified on Baltic sprat

The aim of the measure is exploitation of the Baltic sprat at sustainable fishing mortalities, F_{msy} (MSY approach), which should enable high long-term yields. The basis of the ICES estimate of sprat F_{msy} uses long-term stochastic simulations in which only recruitment is considered density dependent, as it is related to stock biomass through stock-recruitment relationship. Other basic data and parameters such as growth rate, maturity and natural mortality have been assumed constant in the simulations, thus are treated as density independent. However, it was demonstrated, that sprat growth is density dependent and neglecting this phenomenon may lead to biased and underestimated F_{msy} and thus underestimation of catches consistent with MSY. The CS summarises evidence for density dependence of sprat growth and presents effects of density dependent growth on the estimate of F_{msy} and related catches. It is expected that exploitation of sprat at F_{msy} which considers density dependence would give approximately 25% higher catches than catches advised with current non-density-dependent F_{msy}.

Alternative policy instruments

These measures include decentralisation measures, certification schemes and the development of co-management arrangements.

Case 11) Belgium: Fisheries on sustainability track

The measure 'Fisheries on sustainability track' (FoST) is a collaborative effort of various Belgian stakeholders to (1) track sustainability of the Belgian fisheries, to (2) set targets to improve sustainability and to (3) formulate actions to realise these targets.

The first objective, i.e. to **track sustainability of Belgian fisheries**, is based on the scientific underpinning using the FoST tool. The FoST tool defines sustainability according to scientific input from ILVO, the Flanders Research Institute for Agriculture, fisheries and food. Sustainability was defined through social (n=3), economic (n=3) and ecological (n=5) indicators which are jointly assessed for each individual fishing vessel. The ecological indicator (1) stock status, (2) the spawning season, (3) the benthic impact, (4) fuel efficiency and (5) adaptations for a low-impact fishery. Some of the indicators are conform international standards, such as the ICES stock assessments, while others are tuned to the Belgian fishing industry. The fifth indicator for instance is a flexible category where fishers who, for instance, investigate in improved size-selectivity, are rewarded by a better score. The 'benthic impact' assessment aligns with the ongoing initiatives of the MSFD Descriptor 6 on 'seafloor integrity'. Fishers that have lower penetration depth or who avoid sensitive benthic habitats get a better score. The economic indicators include (6) the return on assets, (7) revenues per unit of fishing effort, (8) financial stability. Social indicators are (9) safety, (10) animal welfare and (11) remuneration. Computation of the indicators requires direct input from individual fishing vessels, of which about 75% participate voluntarily.

The second and third objectives of the measure, i.e. to **set sustainability targets** and to **formulate concrete actions** to move towards these targets, are realised through the formal ratification of the multi-stakeholder engagement in the 'Convenant'. The FoST sustainability assessment is presented in the Convenant, implying that all relevant stakeholders are informed of the monitoring of the sustainability of Belgian fisheries. The Convenant then sets targets to improve fisheries sustainability and discusses concrete actions to move towards these targets. The Belgian PO and fishers are motivated to participate as the FoST sustainability assessment fosters market access and market visibility. The Ministry responsible for fisheries policy and its management body 'Department of Agriculture and Fisheries' are motivated to align these actions with its national policy and, as such, also facilitate the compliance to management measures. The eNGO recognises that the improvement of Belgian fisheries sustainability is a long-term process which requires incremental steps that fishers comply to, and is motivated to keep track of this improvement process and to help setting ambitious but realistic standards. The scientific research institute ILVO (Flanders Research institute for Agriculture, Fisheries and Food) is motivated as science-industry collaborations provides several benefits, including improved insights in the industry activities as well as improved data access.

Case 12) Self-regulation of brown shrimp fishery via MSC certification

The North Sea shrimp (*Crangon crangon*) is a short-living species and are mainly caught by Dutch, German or Danish beam trawls in the ICES Area IVb and IVc of the North Sea. The fishery operates within the 12 nautical miles (coastal region) as well as the EEZ. The North Sea brown shrimp fishery is currently subject to some technical regulations and national measures but is neither regulated with quotas nor fishing effort limitations.

The shrimp fishery is an example of a fishery regulated voluntarily through certification according to MSC standards. This has two main effects. On the one hand, certification was intended to secure access to wholesalers and retailers, who have increasingly announced that they should source only certified fish and seafood in the longer term. On the other hand, it was important to counteract the increasing criticism from eNGOs, about the negative impacts of shrimp fishing on the seabed. In this way, certification of the shrimp fishery would verify it as sustainable.

The Dutch shrimp fishers entered the MSC certification scheme in 2007, followed by the German fishers in 2009. In December 2015, the Dutch, Danish and German Producer Organisations (POs) adopted a shared Brown Shrimp Management Plan, which has been under development for several years by the POs and came into force on the 1st January 2016. This management plan was the first in the century-long history of shrimp fishing and was an essential requirement for MSC certification procedure. The main measures within the management plans are technical regulations, such as a gradual increase in mesh size and weight and size limits of fishing gear as well as the implementation of a harvest control rule. The harvest control role comes into force if the LPUE measured at the end of the month drops below the precautionary reference point. This triggers a reduction in fishing effort for the next two weeks. If this measure does not work, fishing effort will continue to be gradually reduced. The aim of reducing fishing effort is to allow smaller shrimp to grow to a larger size during the season before capture.

The MSC assessment process began on 28th January 2016 and in December 2017, the fishery was certified as sustainable. Thus, the self-imposed comprehensive rules and control mechanisms in their fishing activities can create the basis for the long-term protection of the North Sea shrimp stock and the careful management of the Wadden Sea ecosystem.

ANNEX 6: RESULTS OF RANKING OF ASSESSMENT CRITERIA BY CASE STUDY

CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
1.Technical conservation measures to protect Kattegat cod	Marine protected areas to promote the rebuilding of cod population	**High.** A joint memorandum was produced by two research institutes upon national governments request. The analysis was based on best available science and data.	**High.** The analysis and proposal were conducted by two national research institutes.	The analysis was **monodisciplinary** focusing on biological and ecological impacts. An ex-ante evaluation considering social and economic scientists would have been useful to envisage potential fishers' distress and provide alternative options.	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** The objective was clear: to promote the rebuilding of the cod population	**High.** The memorandum was subject to the revision by the fishing sector and other stakeholders.	**High.** Stakeholders were involved after the memorandum by the research institutes was made produced. It was contested by the fishing sector and the original proposal had to change.	**High**. The Case study was addressing regional challenges and measures.	**High.** Since the MPAs implantation (2009), several evaluations have been conducted concerning the original objectives and potential changes in the original measures. Some analyse the economic impacts.
2.Sole-directed pulse trawling in the Netherlands	Introduction of pulse trawling to reduce impact on sea bottom and CO_2 emissions.	**High.** National Researchers and ICES conducted research on the technical viability of the technique and on the low ecological implications of	**High.** The trials at sea and analysis were conducted by research institutes which employ the best	**Monodisciplinary.** The process was basically conducted by natural scientists. No ex-ante impact	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** The objective was clear: to diminish the impact on the bottom and emissions.	**Low.** It is not clear what factors and actors led the EU Parliament to ban the use of pulse trawling and on which scientific evidence the	**Medium-high.** Diverse stakeholders were involved in the debate on the implementation of the technique.	**High**. The Case study was addressing regional challenges and measures. Good regional	**Low.** After implementation there was a race for fishing licences (given the technical and economic viability of the technique) which led to concerns on

CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
		the use of this technique.	available science	assessment was conducted to assess the socio-economic impacts			decision was based.	However, it seems that the vision of other fishing fleets) was not incorporated in the process, which would have been valuable provided potential side effects on other fleets.	data available and used.	overfishing, spill over effects on other grounds and unfair competition with other fleets.
3.Spanish Bottom Trawling in ICES SubAreas 6 and 7	Use of selective fishing gear to reduce discards with the LO framework	**High.** Scientific trials at sea were conducted by research institutes	**High.** The trials at sea and analysis were conducted by research institutes which employ the best available science	**Monodisciplinary.** The process is conducted by natural scientists. Nonetheless, technical inputs were suggested by the fishers.	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** The objective was clear: to reduce bycatch and the risk of choke species.	**High.** The process and outcomes are described in research reports.	**High.** Stakeholders led the initiative to find a solution for the problem of discards and the risk of choke species. Contributed with their empirical knowledge.	**High**. The Case study was addressing regional challenges and measures. Good regional data available and used.	**High.** Monitoring of the activities of the fleets employing the selectivity improvements is conducted in the framework of the DCF and control regulation.
4.Designation of NATURA 2000 sites in the	Protected areas	**Low.** A limited availability of scientific information on species and habitats in the EEZ	**Low.** A lot of criticism of the selected areas (from too much to not enough)	**Monodisciplinary.** Limited scientific information	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**Low.** The objective is not based on solid scientific evidence	**Low.** Due to the legal requirement to designate the area a short process with	**Low.** There was a limited involvement of stakeholders with ability to comment on a first draft of the	**High**. The Case study was addressing regional challenges and measures. Good regional	**Low.** A monitoring of the areas just started

CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
German EEZ							limited public information	areas to be designated	data available and used.	
5.Bratten Marine Protected Area in the Baltic Sea	Establish no-take zones	**High.** Scientific departments at Swedish universities participated in the characterization of the ecological values of the area and on impacts of fishing on the ecosystems and economic importance of the area. The scientific results backed up a Joint Recommendation by Sweden and Denmark and was scrutinized by STECF.	**High**. The evaluations were in hands of specialised departments at universities and the process was peer-reviewed by a third scientific party in Denmark.	**Multidisciplinary.** The process included natural and economic researchers.	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** The objective to establish the no-take zone was clear. Nonetheless it was contested by part of the fishing industry.	**High.** The process has been transparent involving all parties and even has gained and international dimension since it became a Joint Recommendation Moreover, the research was partially funded by Interreg's and thus its outcomes subject to revision by third parties.	**High.** Fishing sector, eNGOs, anglers and authorities participated in the process. Although there were tensions between the eNGOs objectives and the industry interests.	**High**. The Case study was addressing regional challenges and measures. Good regional data available and used.	**Low.** No systematic monitoring of the effects was put in place after implementation (2017)
6.Spurdog Bycatch Avoidance Programme	Measures to avoid the bycatch of spurdog and thus reduce discards and the choke effect under the LO	**High.** Evidence has been provided by research institutes trough a pilot program with participation of fishermen. The program was	**High.** The design of the trials at sea and analysis were conducted by a research institute which employ the	**Monodisciplinary.** The scientific process was conducted by natural scientists. Nonetheless, fishers cooperated	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** Objectives were clear i.e., reduce bycatch and let spurdog to survive	**High.** The process was made public and interested parties were invited to participate. The outcomes of the pilot studies were	**High.** The pilot study design was based on knowledge, collated during workshops with participation of local fishing industry and relevant	**High**. The Case study was addressing regional challenges and measures. Good regional	*Not applicable, since the measure in not in place yet.*

CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
		evaluated by STECF which concluded that it provided useful evidence on spurdog fisheries, although no conclusive. Nevertheless, STECF considers that the initiative motivates a positive change in fishers' behaviour.	best available science	with scientists.		after catching.	assessed by STECF.	agencies and NGOs	data available and used.	
7.Territorial User Rights in French Guiana	Granting of fishing opportunities in EU waters to fishing vessels flying the Venezuela in the EEZ off the coast of French Guiana	**Low.** The measure is based on Territorial Users Rights (TURFs) in Fishers establishing 45 licenses for vessels to operate in the area. No scientific basis is provided for that decision.	**Low.** No science behind the decision to grant these licences just historical presence in the waters.	**Monodisciplinary.** Science used in relation to this measure is mostly technical grey literature, published by the national institute in the context of their monitoring of fisheries in French Guiana.	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**Low.** The objective of providing opportunities for vessels with TURFs in Guiana`s waters is clear, but it is not based on science.	**Low.** There is an agreement to land 75% of the catches in French Guiana but data about the landings in Venezuela are not available.	**Low.** It seems that when the agreement was signed it was not a consultation process. Currently the agreement is being contested since two factories have exclusive rights to buy the fish and other parties wish to participate.	**High.** The Case study was addressing regional challenges and measures. Good regional data available and used.	**Low.** The stock is assessed by the national institute, being its state overexploited. However, the agreement is not being revised neither the effort is restricted, which maintains almost the same level since 1980s. There is no monitoring of the catches landed outside French Guiana.

CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
										Catches by vessels targeting other resources are not sampled either.
8.Anchovy in the Gulf of Cadiz	Protection of nursery area (Guadalquivir)	**High.** The scientific underpinning was provided by the national research institute based on data collected and research conducted in the area.	**High.** The regional government requested the scientific of the national research institute to provide the scientific justification of the measure.	**Monodisciplinary.** Research was led by natural scientists. Decisions were based on scientific outputs. Empirical knowledge that argues against the creation of the protection areas were assessed by scientists and dismissed. Socioeconomic analysis was not employed to assess the impact of the measure.	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** The objective was clear: to protect a nursery area from fishing activities.	**High.** Decisions are baked up by a scientific process. Results were discussed with stakeholders.	**Medium-high.** Fishers and eNGOs were involved in the process of setting the protected area.	**High**. The Case study was addressing regional challenges and measures. Good regional data available and used.	**Low-medium**. The stock is monitored and its state assessed by ICES. There is a Commission for the monitoring of the reserve but is regarded as not including all the sectors affecting the quality of the water in the reserve e.g. agriculture sector

CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
	TAC	**High.** The TAC is recommended by ICES. The process of TAC setting is sound and lies on acoustic data and other data collected under the DCF.	**High.** ICES employ the best available science and data to determine the TAC.	**Monodisciplinary.** The process is conducted by natural scientist.	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** TAC was adopted to establish management measures for a stock shared with Portugal	**Low.** Although the scientific process is transparent, the TAC setting differs from that recommended by the ICES. Thus, TAC does not strictly follow scientific advice and seems to be driven by political decisions.	**No stakeholder involvement** occurs in the establishment of the TAC	**High**. The Case study was addressing regional challenges and measures. Good regional data available and used.	**High.** The stock is monitored and its state assessed by ICES.
	SFPA between Spain and Morocco	**High.** The scientific background is provided by the CECAF and by the EU-Morocco joint scientific commission	**High.** Both countries trust in the scientific underpinning of the agreement and the levels of effort allowed are based on that advice	**Multidisciplinary.** The agreement was based not only on natural scientific aspects but also on socioeconomic aspects for estimating the EU payment and support to fisheries institutional capacity building in Morocco		**High.** The objective was clearly set up, which is to provide alternative economic opportunities for Spanish fishing fleets e.g., for the fleet based on Andalusia.	**High.** There is a protocol between both parties where conditions are detailed. The scientific committee in turn guarantee the transparency of the scientific process.	The agreement is a political process between the EU and a third country and involving scientist for advice, but **no stakeholders are involved**.	**High**. The Case study was addressing regional challenges and measures. Good regional data available and used.	**High.** Follow up of the state of the resources, compliance with the conditions is part of the commitments of the EU

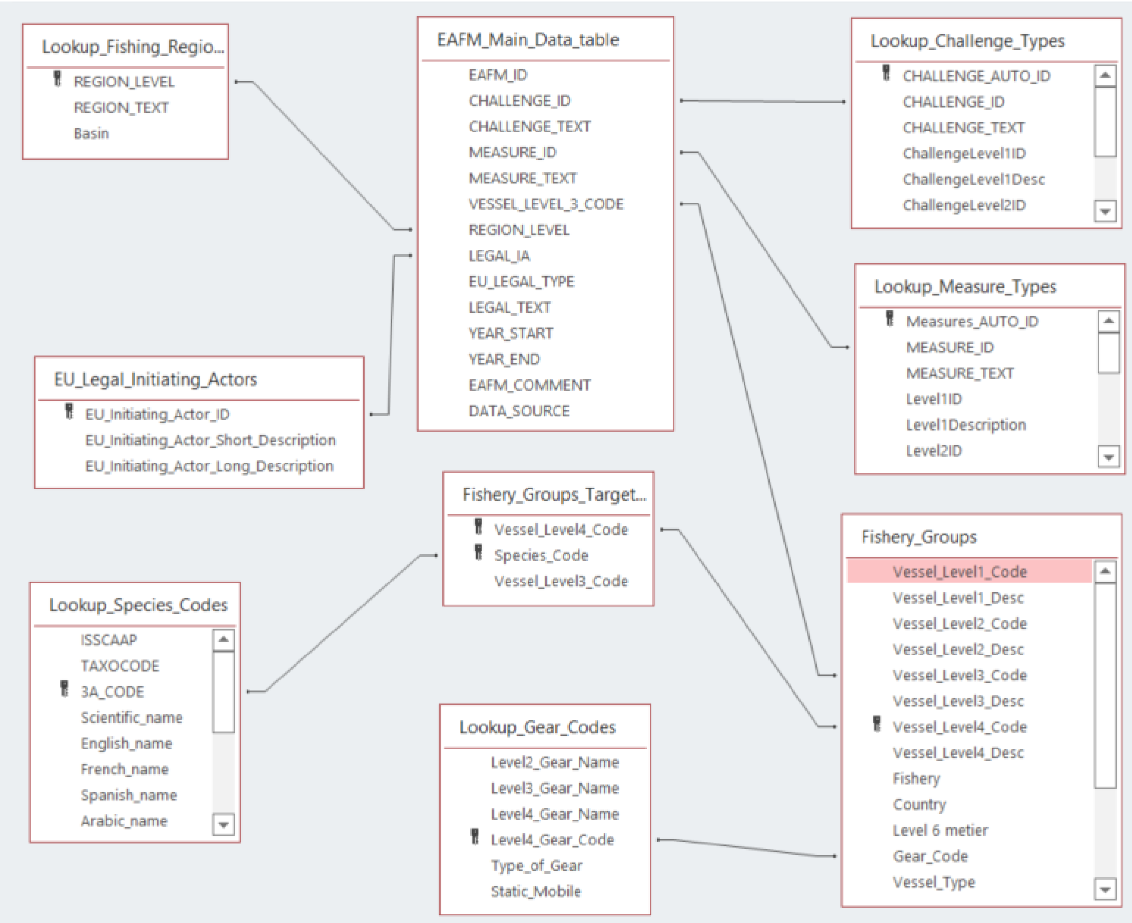
CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
9.Hunting of grey seals as a management measure in the Baltic Sea	Restricted hunting of seals to diminish gear damage	**Low-Medium.** Different studies were conducted but could not found strong evidence that restricted hunting has effects on grey-seal damage in Baltic Sea fisheries In the other hand, assessment of the seal population and data collection appears as a valid approach to estimate population abundance	**High.** The analyses were conducted by research institutes.	**Monodisciplinary.** The process basically included natural scientists, although this could have been approached from a multidisciplinary perspective including social and economic sciences to understand the effect of hunting in the reduction of conflicts between fishers and seals.	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**Medium.** Although the objective was clear there was not based on strong evidence about the effect of allowed hunting on conflicts with fishers.	**High.** The process was transparent the results of the research were discussed with HELCOM and backed up legislative decisions.	**Medium.** Fishers and other interest groups were not actively engaged during the process their inputs on the results of the implementation have been requested to observe the results of the implementation.	**High**. The Case study was addressing regional challenges and measures. Good regional data available and used.	**Medium.** Lack of systematic follow up studies to accomplish such evaluation. Nonetheless, questionaries were distributed amongst fishers to identify the effects of the implementation.
10.Effects of density dependent growth of fish on management and TAC,										

CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
exemplified on Baltic sprat										
11.Fisheries on sustainability track in Belgium	Monitoring instrument to assess socio-economic and ecological impacts of fleets	**High.** The research was led by the national research institute in the framework of one scientific research project.	**High.** The wide arrange of parties involved in the development of the tool trusted in the quality of the research underpinning the tool and, vice versa, researchers trust on stakeholders' knowledge an information.	The tool was produced by a **multidisciplinary** team involving natural, social, and economic scientists.	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** The objective was clear: to evaluate socio-economic and ecological impacts of fishing.	**High.** The process was open to the diverse parties for contribution and revision.	**High.** A wide arrange of stakeholders such as fishers, eNGOs and administration have contributed to the process and benefited from the use of the tool.	**High.** The Case study was addressing regional challenges and measures. Good regional data available and used.	The management measure is *per se* a monitoring instrument, although a voluntary one and may even require more vessels to participate.
12.Self-regulation of brown shrimp fishery via MSC certification	MSC certification	**High.** Certification criteria are based on time series of fisheries data and data from regular scientific research activities	**High.** Specific data collection by the fishers and cooperation of science and fishers with trials on commercial vessels	**Monodisciplinary** Data collection for scientific purposes, no socio-economic impact assessment as not	**Low.** Existing fisheries (expert) knowledge poorly used in the CS.	**High.** The objective was clear: to initiate the eco certification process to obtain a price premium and conservation	**High.** Initiative by the fishing sector itself	**High.** Initiative by the fishing sector itself	**High.** The Case study was addressing regional challenges and measures. Good regional data available and used.	**High.** Regular monitoring of the fishery to assess the fulfilment of the criteria

CS	Management measure	Evidence				Decision-Making				Follow-up
		Quality	Trust	Type	Fishers' knowledge	Evidence-based with clear objectives	Transparency	Stakeholders involvement	Regionalization	Monitoring
				required for certification		of the resource				

ANNEX 7: DATABASE DESIGN AND INFORMATION SOURCES

The basic structuring for the analysis and data collection was through the use of a relational database in the form of a standalone offline Microsoft Access database that enabled the collection of information through a series of simple user forms that allowed data to be viewed and updated.



Database entity relationship diagram

Data Sources

EAFM Database Table	Sources
EAFM_Main_Data_table	Task 5 Case study templates
	EU MSC Fisheries
	EU Quotas 2019
	MSFD information from DG ENV
	Hyder, K, Radford, Z, Prellezo, R, Weltersbach, MS, Lewin, WC, Zarauz, L, Ferter, K, Ruiz, J, Townhill, B, Mugerza, E, & Strehlow, HV, 2017. Research for PECH

EAFM Database Table	Sources
	Committee - Marine recreational and semi-subsistence fishing - its value and its impact on fish stocks, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels
	ANNEX IV INVENTORY OF EU TECHNICAL MEASURES REGULATIONS
	REGIONALISATION STUDY templates
	Task 3 Partner Templates
	Report on OR for EASME/EMFF/2018/1.3.2.4-Lot2-02
	Scientific, Technical and Economic Committee for Fisheries (STECF) 2021. Review of the Technical Measures Regulation (STECF-21-07). Publications Office of the European Union, Luxembourg, EUR 28359 EN, ISBN 978-92-76-45890-6, doi:10.2760/790781, JRC127718
	Scientific, Technical and Economic Committee for Fisheries (STECF) 2020 Review of technical measures (part 1) (STECF-20-02). EUR 28359 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-27161-1, doi:10.2760/734593, JRC123092.
EU_Legal_Initiating_Actors	Task 1 report
Fishery_Groups	Task 2 Report
Fishery_Groups_Quarters	Task 2 Report
Fishery_Groups_Target_Species	Task 2 Report
Lookup_Challenge_Types	Task 3 Report
Lookup_Fishing_Regions	Task 2 Report combined with additional regions from task 4 report
Lookup_Gear_Codes	The international standard statistical classification of fishing gear (ISSCFG)
Lookup_Measure_Types	Task 4 report
Lookup_Species_Codes	FAO ASFIS List of Species for Fishery Statistics Purposes

ANNEX 8: STAKEHOLDER FEEDBACK ON THE PRELIMINARY STUDY RESULTS

Workshop 1

The governance aspects that workshop participants wanted to be considered were related to:

- Make sure that management applies also for the longer term and can be adaptive.
- Make sure that there is coherence between the different policy objectives (different legislations at EU level: Marine Strategy Framework Directive (MSFD) and Common Fisheries Policy (CFP) as well as between different jurisdictional levels: national vs EU or EU vs non-EU).
- Make sure the EAFM measures as operationalized contribute to the achievement of policy objectives or societal goals and that their performance can be assessed. This also requires good monitoring of compliance to measures (thus have a good follow-up after implementation including feedback loop). There is however a challenge in aiming to achieve multiple objectives, e.g. multispecies MSY versus socio-economic objectives as well as the selection of the objectives themselves – are all objectives considered equal? If not, then how to prioritize?
- Make sure that a precautionary approach is considered.
- Make sure that there is political commitment to reach policy objectives.
- Stakeholders point out that difficult trade-offs need to be made; EAFM is about taking measures that affect the social-ecological system, thus policy objectives can be in conflict with interests of specific sectors. Some stakeholders emphasize that there are critical ecological limits that should be adhered to and not overridden by politics (i.e. fish more than advised). Others emphasize that the ecological limits depend on policy objectives (i.e. a precautionary approach vs MSY).

The skills required to implement an EAFM that participants highlighted included:

- Skills to perform scenario-studies, skills to understand cumulative effects and understand the concept of impacts in both ecological and social dimensions.
- A need to have a better understanding of EAFM and more EAFM advice from scientific bodies.
- More multi- and inter-disciplinary teams and access to the required data (based on adequate monitoring). For scientists to effectively work together in an interdisciplinary manner a high-level understanding between disciplines is needed (i.e. common understanding of specific concepts).
- Need for skills to understand how people can and do respond to the measures that are introduced and how this relates to 'success'?.

In relation to the right place to implement new management measures, participants highlighted:

- The Advisory Councils (ACs), the EU Commission, ICES, Member States (often together), Regional Sea Conventions depending upon scale
- The existing advisory process to set the annual TAC-quota as a good starting point to move towards an EAFM.

Workshop 2

The workshop focused on enhancing the utility of the database as a tool to support an EAFM. Types of questions (queries) that participants thought relevant included:

- How to apply the tool to assess the implementation of EAFM? [i.e. as part of a decision tree where the tool provides guidance for each decision]
- Which EAFM measures were effective?
- With which health warnings, and risks does the tool come? Are there any gaps, conflicting interests?
- A key challenge to EAFM is cross sectoral cooperation. Can the tool take this into account?
- How are the governance instruments embedded in the social system?
- Does the tool link the measures to different policy objectives (i.e. CFP or MSFD)
- Is there a way to connect to, incorporate local knowledge?
- Can we see whether measures have been top-down or participatory?
- How may climate affect the planning and outcome of EAFM?
- Can it warn against choke risk in mixed fisheries?

Participants also suggested data sets that could help to increase the information within the database:

- Reporting by member states for other directives with relevance for fisheries, e.g. the birds and habitats directive and the marine strategy framework directive.
- National data from reporting on MPAs and recreational fisheries,
- Also highlighted were potential gaps including human interactions and other impacts for which data may be lacking, e.g. pollution and offshore energy.

Finally participants considered the wider challenges with operationalizing an EAFM. Important challenges identified included:

- Uncertainty (lack of data, quality of data) can be an obstacle in operationalizing EAFM but can also be used as an excuse for inaction, which should be critically examined.
- Complexity is another potential obstacle: there might be reluctance because doing EAFM is seen as too complex. Yet the participants agreed that although EAFM is complex, that is not a reason not to do it.
- As well as inaction, ‘panic’ actions can compromise the chance of success and this may be related to the advice process, including ability to move beyond single species and (lack of) evidence of effectiveness.
- Greater coordination needed at MS level notably in terms of cooperation between stakeholders.

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at:

https://europa.eu/european-union/contact_en

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

– at the following standard number: +32 22999696, or

– by email via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications

You can download or order free and priced EU publications from:

https://publications.europa.eu/en/publications

Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1952 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

Open data from the EU

The EU Open Data Portal (http://data.europa.eu/euodp/en) provides access to datasets from the EU. Data can be downloaded and reused for free, for both commercial and non-commercial purposes.

HZ-09-22-512-EN-N

doi: 10.2926/57956
ISBN 978-92-95225-57-2

Publications Office
of the European Union