EcoScope

Ecocentric management for sustainable fisheries and healthy marine ecosystems

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1 Executive Summary

The need to implement an ecosystem-based approach to management is enshrined in numerous regulations and strategies, at both global and European level. In practice, however, there are still many knowledge gaps and uncertainties, and implementing ecosystem-based fisheries management (EBFM) remains challenging. The Horizon 2020 funded EcoScope project aims to develop a series of e-tools that will serve as an easy-to-use decision support system to implement EBFM. In order to make these tools and their outputs fit for purpose, EcoScope strives to understand the needs of end-users and stakeholders by involving them in the design and development of the tools, and by performing foresight exercises. The aim of this report is to inform the development of the EcoScope e-tools by (1) providing a holistic picture on the international, European and sea-basin wide policy landscape that directly or indirectly influence the needs of policy makers and stakeholders in regards to EBFM; and (2) identifying key stakeholder needs related to these policy commitments. To this end the report provides an overview of the main international and European policies, strategies and bodies relevant to EBFM and ecosystem modelling. Moreover, it identifies critical policy-related needs, which the EcoScope tools could help address. These needs arise from current or upcoming policy commitments and were also reported by stakeholders during a survey and a foresight workshop. The report highlights the most pressing topics and EBFM related questions of stakeholders; discusses preferred output formats for the results; and identifies barriers that need to be overcome for the effective uptake of models in decision-making. Understanding this policy landscape and concrete policy commitments is key to understanding the needs of EcoScope's main stakeholders and appreciating concrete situations in which the EcoScope tools may be used. This report therefore aims to inform the development of the EcoScope e-tools and represents a further step in EcoScope's commitment to making the tools as effective and useful as possible, and in supporting the implementation of legal requirements concerning EBFM.

2 Introduction

Fishing strongly impacts all levels of biological organisation and community structure including organisms, habitats and ecosystems (Jackson et al., 2001), raising a pressing need for managing fisheries in the context of an ecosystem, i.e. an ecosystem-based fisheries management (EBFM). Applying EBFM requires a shift from traditional single-species management to a more complex approach, encompassing multi-species interactions, environmental forcing, habitat status and human activities. EBFM recognises the need to acknowledge the effects of fishing on the whole ecosystem, considering ecological, economic, and social trade-offs and ensuring a balance between food security and healthy ecosystems. The concept of EBFM is enshrined in many European and global policies. For instance, in the EU, the Common Fisheries Policy (CFP) states that an *"ecosystem-based approach to fisheries management needs to be implemented"* and both the Marine Strategy Framework Directive (MSFD) and the Marine Spatial Planning Directive (MSPD) promote an ecosystem-based approach to management. Internationally, the Convention of Biological Diversity (CBD) was the first organisation to endorse an ecosystem approach as their primary framework for action in the mid-1990s, and the UN Food and Agriculture Organisation (FAO) strongly promotes an ecosystem approach to fisheries, with technical guidelines on the ecosystem approach to fisheries already published in 2003 (FAO, 2003). In practice, however, there are still many knowledge gaps and uncertainties, and it is therefore challenging to implement an EBFM approach.

The EcoScope project, funded by Horizon 2020, aims to develop a series of e-tools that will serve as an easy-to-use decision support system to implement EBFM. These tools will include an interoperable platform (the EcoScope Platform) and a robust decision-making toolbox (the EcoScope Toolbox), which will be available through a single public portal[1]. The **EcoScope Platform** will organize and homogenise climatic, oceanographic, biogeochemical, biological and fisheries datasets for European Seas to a common standard and format that will be available through interactive mapping layers. The **EcoScope Toolbox**, a sustainability scoring system based on assessments of all ecosystem components, ecosystem and economic models, will operate as a decision-support tool for examining fisheries management and marine policy scenarios and spatial planning simulations, and will incorporate methods for dealing with uncertainty. Novel assessment methods for data-poor fisheries, including non-commercial species, as well as for biodiversity and the conservation status of protected megafauna, will be used to assess the status of all ecosystem components across European Seas and test new technologies to evaluate the environmental, anthropogenic and climatic impact on ecosystems and fisheries. **Ecosystem models** will be created using Ecopath with Ecosim (EwE) for eight case study areas (Fig. 1) and will form the basis for **testing and evaluating various management and policy scenarios**. They will allow users to explore the impact of very concrete management options, such as the effects of adding a new Seasonally Closed Area in the Adriatic

[1] EcoScope website: https://ecoscopium.eu/

Sea on fish stocks, on the wider marine ecosystem and on fisher's profitability. Moreover, a new edition of the **Maritime Spatial Planning (MSP) Challenge Simulation Platform**[2] will be created to cover the eastern Mediterranean Sea, which will include a fisheries module to visualise the effects of different fisheries management scenarios. The fisheries edition will then be applied to existing MSP Challenge simulation platform editions, covering five out of the eight case studies (Baltic Sea, North Sea, Adriatic Sea, Aegean and Levantine Seas) by the end of the project.

Figure 1: EcoScope case study areas, for which Ecopath with Ecosim (EwE) ecosystem models will be implemented to test and evaluate various management and policy scenarios.

In order to make these tools and their outputs fit for purpose, EcoScope strives to understand the needs of end-users and stakeholders. To this end, the EcoScope project performed a stakeholder survey (Stakeholder survey – insights for the EcoScope Toolbox; Task 8.3.1) and organised a foresight workshop in February 2022 (Foresight workshop 1: Policy Maker and Stakeholder

[2] MSP Challenge simulation platform: https://www.mspchallenge.info/

requirements workshop; Task 8.2.2) with the aim to understand the main needs, challenges and barriers of stakeholders that will be using the EcoScope tools and/or their outputs, and to involve them in the design of these e-tools and their outputs. The aim of this report is to provide EcoScope with a holistic picture on the international, European and sea-basin wide policy landscape that directly or indirectly influence the needs of policy makers and stakeholders with regards to EBFM. The report includes the main international and European policies, strategies and bodies relevant to EBFM and ecosystem modelling. Based on this holistic picture, the report highlights critical policy-related needs, which the EcoScope tools could help address, as elucidated from the stakeholder survey and the first foresight workshop. Understanding this policy landscape and concrete policy commitments is key to understanding the needs of EcoScope's main stakeholders and the concrete situations in which the EcoScope tools may be used. This report will therefore inform the development of the EcoScope e-tools and represents a further step in EcoScope's commitment to making the tools as effective and useful as possible and in supporting the implementation of legal requirements concerning EBFM.

3 Policy landscape

3.1 Global policy landscape

The **United Nations (UN)**, founded in 1945, is the intergovernmental organisation under which most of the global treaties, frameworks, and bodies relevant for EBFM and healthy marine ecosystems fall. In 1982, the UN created the **UN Convention on the Law of the Sea (UNCLOS)**[3]: the international framework for all marine and maritime activities. UNCLOS sets out the legal framework within which all activities in the Ocean and seas must be carried out, including for the conservation and sustainable use of the Ocean. It sets limits to various maritime zones (i.e. territorial waters, Exclusive Economic Zone, continental shelf and high seas) and recognises the rights of coastal states to control fish harvests in adjacent waters. It has a number of provisions on navigation, maritime zone jurisdictions, deep sea mining, protection of the marine environment, scientific research and settlement of disputes. EU fishing activities take place under the framework of UNCLOS and the rights and duties of states with respect to the use of Ocean space and resources are defined therein.

In 1995, UNCLOS was supplemented by an implementing agreement with considerable bearing of fisheries: The **UN Fish Stocks Agreement (UNFSA)**[4] on highly migratory and straddling fish stocks. UNFSA establishes a set of rights and obligations for States to conserve and manage fish stocks, associated and dependent species as well as to protect biodiversity in the marine environment. It sets out mechanisms for international cooperation and identifies **Regional**

[3] UN Convention on the Law of the Sea (UNCLOS): https://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm
[4] UN Fish Stock Agreement (UNFSA): https://sustainabledevelopment.un.org/topics/oceans/unfishstock

Fisheries Management Organisations (RFMOs)[5] as the mechanism through which States can fulfil their obligations to manage and conserve stocks. RFMOs are international organisations that regulate fishing activities in the high seas. They provide a forum for states to fulfil their duty to cooperate regarding fisheries in the high seas, as set out in UNCLOS and UNFSA. While some RFMOs have a purely advisory role, most have management power to set catch and fishing effort limits, technical measures and control regulations. The EU, represented by the European Commission, plays an active role in 5 tuna-RFMOs and 12 non-tuna RFMOs[6] and must adopt the management measures implemented by those RFMOs. To the extent that those measures are not already covered by law, the EU must transpose these measures into law, so that they become applicable to vessels flying the flags of Member States (Popescu, 2019).

In a recent development, widely seen as a historic decision shaping future Ocean governance (Popescu, 2019), a new instrument is currently being negotiated under UNCLOS, called the '**Biodiversity Beyond National Jurisdiction (BBNJ) Treaty**'[7] or 'Treaty of the High Seas'. This treaty will be a legally binding international agreement, with the aim to conserve and sustainably use marine biological diversity in waters beyond national jurisdiction. The aim is to achieve more holistic management of high seas activities and better balance the conservation and sustainable use of marine resources, including through the establishment of area-based management tools, such as Marine Protected Areas (MPAs).

The main UN bodies with relevance for EBFM are the Food and Agriculture Organisation (FAO), the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) and the UN Environment Program (UNEP). The UN **Food and Agriculture Organisation (FAO)**[8] is a specialised agency of the United Nations that was established in 1945 and leads international efforts to defeat hunger. Its goal is to achieve food security for all and make sure that people have regular access to enough high-quality food to lead active, healthy lives. The strategic objectives of FAO include making fisheries more productive and sustainable. FAO's **Fisheries and Agriculture Division (NFI)** is responsible for promoting the management of fisheries. Their mandate is centred on monitoring wild resources, collecting and disseminating statistics and information on the sector and elaborating management advice. This information is made public in FAO's biannual flagship publication: **State of World Fisheries and Aquaculture report**. The latest edition, published in 2020[9], had a particular focus on sustainability. FAO plays a leading

[5] Regional Fisheries Management Organisations (RFMOs): Who are they, what is their geographic coverage and what types of RFMOs exist: https://www.cbd.int/doc/meetings/mar/soiom-2016-01/other/soiom-2016-01-fao-19-en.pdf
[6] RFMOs, in which the EU plays an active role: https://ec.europa.eu/oceans-and-fisheries/fisheries/international-agreements/regional-fisheries-management-organisations-rfmos_en
[7] BBNJ Treaty: https://www.un.org/bbnj/
[8] FAO: https://www.fao.org/home/en; FAO's role in fisheries: http://www.fao.org/fisheries/en/
[9] FAO's State of World Fisheries and Aquaculture 2020: https://www.fao.org/documents/card/en/c/ca9229en/

role in international fisheries policy, including through the **Committee of Fisheries (COFI)**[10]. COFI was established in 1965 and is the only global inter-governmental forum where FAO Members meet to review and consider the issues and challenges related to fisheries. COFI provides periodic global recommendations and policy advice to governments, regional fishery bodies, civil society organisations, and the private sector. The Committee has fostered the development and adoption of several binding- and non-binding agreements with the aim to improve resource sustainability and biodiversity conservation. FAO works with a wide range of partners, including governments, regional fisheries bodies, cooperatives and fishing communities on: (i) implementing its **Code of Conduct for Responsible Fisheries** [11], (ii) implementing the **Ecosystem Approach to Fisheries**, (iii) supporting member countries in developing and implementing guidelines related to bycatch management and reduction of discards, and (iv) implementing **International Plans of Action (IPOA)**, among many other topics. The action plans are implemented in close collaboration with intergovernmental organisations (e.g. CITES, CMS, IUCN and other NGOs) and include: Reducing Incidental Catch of Seabirds in Longline Fisheries[12]; Conservation and Management of Sharks[13]; Management of Fishing Capacity[14]; and Prevent, Deter, and Eliminate Illegal, Unreported and Unregulated Fishing (IUU)[15]. FAO strongly promotes the ecosystem approach to fisheries and has produced a number of publications on the topic, including on best practices in ecosystem modelling for informing EBFM (see Table 1).

Table 1: Selected FAO publications on Ecosystem-Based Fisheries Management (EBFM)

Publisher	Year	Title	Link
UNEP (in collaboration with **FAO**)	2001	Ecosystem-based Management of Fisheries: Opportunities and Challenges for Coordination between Marine Regional Fishery Bodies and Regional Seas Conventions	Download
FAO	2003	The ecosystem approach to fisheries. Issues, terminology, principles, institutional foundations, implementation and outlook.	Download
FAO	2005	Putting into practice the ecosystem approach to fisheries	Download

[10] FAO's Committee on Fisheries (COFI): http://www.fao.org/about/meetings/cofi/en/
[11] FAO's Code of Conduct for Responsible Fisheries: https://www.fao.org/documents/card/en/c/e6cf549d-589a-5281-ac13-766603db9c03/
[12] IPOA seabirds and longlines: https://www.fao.org/fishery/en/ipoa-seabirds
[13] IPOA sharks: https://www.iucnssg.org/ipoa.html
[14] IPOA fishing capacity: https://www.fao.org/fishery/en/ipoa-capacity
[15] IPOA IUU: https://www.fao.org/fishery/en/ipoa-iuu

FAO	2008	Fisheries Management 2. The Ecosystem Approach to Fisheries 2.1 Best Practices in Ecosystem Modelling for Informing an Ecosystem Approach to Fisheries	Download
FAO	2009	Geographic Information Systems to support the ecosystem approach to fisheries	Download
FAO	2009	Ecosystem Approach to Fisheries and Aquaculture. Implementing the FAO Code of Conduct for Responsible Fisheries	Download

The UN **Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO)** was established in 1960 and is part of the United Nations Educational, Scientific and Cultural Organisation (UNESCO). IOC-UNESCO is the UN body responsible for supporting global Ocean science and services and provides a platform for coordination, information and sharing of knowledge. The 150 IOC Member States work together to protect the health of the Ocean by coordinating programmes on areas such as Ocean observations, tsunami warnings and marine spatial planning. IOC is supporting all its Member States to build their scientific and institutional capacity in order to achieve global goals, including the UN Sustainable Development Goals. **IOC's Medium-Term Strategies** (2014-2021 and 2022-2029, the latter still in draft-form)[16] include the following three high-level objectives relevant for EBFM and EcoScope: (i) healthy Ocean ecosystems and sustained ecosystem services (including developing indicators of Ocean status, prediction or detection of changes in ecosystem state, and transforming management of single sectors into an **ecosystem-based approach**); (ii) increased resilience and adaptation to climate change; and (iii) scientifically-founded services for the development of the sustainable Ocean economy (including Ocean observations, data and information management, forecasting, and knowledge-based management approaches, such as marine spatial planning and coastal zone management).

The **UN Environmental Programme (UNEP)**, established in 1972, is the global authority for setting the environmental agenda, advocating for the global environment, and promoting the coherent implementation of the environmental dimension of sustainable development within the UN system. In 1974, UNEP's main mechanisms for the conservation of the marine and coastal environment and for promoting sustainable use of marine resources was established: the **Regional Seas Programme**[17]. The Regional Seas Programme implements region-specific activities, bringing together stakeholders including governments, scientific communities and civil societies. To date, UNEP's Regional Seas Programme consists of three types of **Regional Seas**

[16] IOC's Medium-Term Strategy for 2014-2021: https://unesdoc.unesco.org/ark:/48223/pf0000228221 and 2022-2029 (still in draft form): https://unesdoc.unesco.org/ark:/48223/pf0000368030
[17] UNEP's Regional Seas Programmes: https://www.unep.org/explore-topics/oceans-seas/what-we-do/regional-seas-programme

Conventions and Action Plans (RSCAPs) (i.e. UNEP-administered, non-UNEP administered, and independent) across 18 different regions. For Europe, the four relevant conventions are: the **Barcelona Convention** (UNEP-administered), the **Bucharest Convention** (non-UNEP administered, but established under the auspices of UNEP), as well as **OSPAR** and **HELCOM** (both independent; see section 3.2.2 for more information). UNEP recognises the importance of an ecosystem-based approach to Ocean governance in its **Medium-Term Strategy (2022-2025)**[18], and pledges that it will promote and reinforce **ecosystem-based Ocean governance** through the Regional Seas Programme.

The **Convention on Biological Diversity (CBD)**[19] is a multilateral treaty, originally conceived by UNEP, that entered into force in 1993. The CBD has three main objectives: (i) conservation of biological diversity, (ii) sustainable use of the components of biological diversity, and (iii) fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. With 196 member countries, the CBD is among the most widely ratified international treaties on environmental issues. The CBD provides an international framework, which member countries have to translate into **National Biodiversity Strategies and Action Plans (NBSAPs)**. The **ecosystem approach** is a central principle in the implementation of the CBD that has been adopted as the primary framework for action since 1995. Each of the Convention's work programmes incorporates the ecosystem approach in its goals and activities, and the central role of the ecosystem approach is also reflected in the **Strategic Plan for Biodiversity 2011-2020**[20]. The Strategic Plan for Biodiversity 2011-2020, comprises a vision for 2050, five strategic goals and twenty ambitious targets, collectively known as the **Aichi Biodiversity Targets**. Aichi target 6 aims to attain sustainable fisheries through EBFM: "*By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits*". The **Post-2020 Global Biodiversity Framework** is currently under negotiation and the adoption of this framework is expected to occur in the third quarter of 2022 during the UN Biodiversity Conference in Kunming, China.

The **Convention on Migratory Species (CMS)**[21]**,** also known as Bonn Convention, is an environmental treaty of the UN for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the countries through which migratory species pass and lays the foundation for internationally coordinated conservation measures. The arrangements under

[18] UNEP's Medium-Term Strategy (2022-2025): https://www.unep.org/resources/policy-and-strategy/people-and-planet-unep-strategy-2022-2025
[19] CBD: https://www.cbd.int/
[20] CBD Strategic Plan for Biodiversity 2011-2020: https://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf
[21] CMS: https://www.cms.int/

CMS range from legally binding **Agreements** to less formal instruments, such as **Memoranda of Understanding (MoU)**. To date, 19 international MoU and 7 Agreements have been signed under CMS, of which the following three are particularly relevant for EcoScope: Memorandum of Understanding on the Conservation of Migratory Sharks (**MoU Sharks**)[22], Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (**ASCOBANS**) [23] and Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (**ACCOBAMS**)[24]. MoU Sharks includes 37 species of sharks and rays and aims to achieve and maintain a favourable conservation status for these species. ASCOBANS and ACCOBAMS aim to protect cetaceans in European waters (see section 3.2.2 for more information).

The **UN-Oceans**[25] is an inter-agency mechanism formed in 2003 that seeks to enhance the coordination, coherence and effectiveness of competent organizations of the UN systems, including FAO, UNEP, IOC-UNESCO, CBD and CMS. UN-Oceans aims to strengthen the coordination of these organisations through sharing of ongoing and planned activities and by facilitating input to reports and inter-agency information exchange, such as experiences, best practices, methodologies and lessons learned in Ocean related matters. UN-Oceans holds tri-annual conferences[26].

The **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)**[27] is an international agreement between governments that aims to protect endangered plants and animals. CITES aims to ensure that international trade of wild animals and plants does not threaten the survival of these species in the wild. Although CITES was adopted 1975, it is only in recent years that a number of commercial marine species have been included in CITES Appendices, including several shark and sea cucumber species. CITES has been criticised for playing an insufficient role in regulating marine fish species. Concerns include inadequate data, applicability of CITES listing criteria, roles of national fisheries agencies, enforcement challenges, as well as CITES' lack of experience with marine fishes, identification and by-catch problems (Vincent et al., 2014). Nevertheless, it has been suggested that all these arguments can be countered and that CITES could constitute a relevant and appropriate instrument for promoting sound marine fisheries management (Vincent et al., 2014). To support the implementation of CITES in the fisheries context, in 2020, **FAO** developed a **handbook on Implementing CITES through national fisheries legal framework**[28] in collaboration with the CITES Secretariat. The

[22] MoU Sharks: https://www.cms.int/sharks/en/legalinstrument/sharks-mou
[23] ASCOBANS: https://www.cms.int/en/legalinstrument/ascobans
[24] ACCOBAMS: https://www.cms.int/en/legalinstrument/accobams
[25] UN-Oceans: http://www.unoceans.org/home/en/
[26] UN-Oceans conferences: https://www.un.org/en/conferences/ocean2022
[27] CITES: https://cites.org/eng
[28] FAO handbook (2020) - Implementing CITES through national fisheries legal framework: https://www.fao.org/3/cb1906en/cb1906en.pdf

International Union for Conservation of Nature (IUCN) has been heavily involved in CITES since it's conception and continues to provide data from the **IUCN Red List of Threatened Species**[29] to enable Parties to the Convention to make evidence-based decisions on issues related to trade of plants and animals. The IUCN Red List uses a set of scientific criteria[30] to evaluate the extinction risk of species and subspecies. The resulting seven Red List classes (Fig. 2) provide a barometer indicating the urgency of conservation measures for thousands of species. In 2015 and 2016, the European Commission commissioned two reports on the Red List status of European marine species and habitats, resulting in the **European Red List of marine fishes**[31] and **European Red List of Habitats: Part 1. Marine habitats**[32].

Figure 2: IUCN Red List of Threatened Species classes[33]. EX: extinct; EW: Extinct in the wild; CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concerns. Other classes, not depicted in this image, are Data Deficient (DD) and Not Evaluated (NN).

The **Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)**[34] is an independent intergovernmental body established in 2012, for which UNEP provides the secretariat. The aim of IPBES is to strengthen the science-policy interface by analysing and synthesising existing scientific information on biodiversity and ecosystem services for decision-making purposes. Among other services, IPBES produces assessments that feed into the work of several international conventions, including the CBD as well as other international, European, and national initiatives. IPBES performs regular and timely assessments of knowledge on biodiversity and ecosystem services and their interlinkages resulting in the **Global Assessment Report on Biodiversity and Ecosystem Services**[35]. The latest global assessment report

[29] IUCN Red List of Threatened Species: https://www.iucnredlist.org/
[30] IUCN Red List criteria: https://www.iucnredlist.org/resources/categories-and-criteria
[31] European Red List of Marine Fishes: https://www.iucn.org/ur/content/european-red-list-marine-fishes
[32] European Red List of Habitats. Part 1. Marine habitats: https://www.iucn.org/content/european-red-list-habitats-part-1-marine-habitats
[33] Image source: https://www.clearias.com/iucn-classification-critically-endangered-endangered-and-vulnerable/
[34] IPBES: https://ipbes.net/
[35] IPBES Global Assessment Report on Biodiversity and Ecosystem Services: https://ipbes.net/global-assessment

(2019)[36] advises to implement the following specific actions to sustain and conserve fisheries: an **ecosystem-based approaches to fisheries management**, spatial planning, effective quotas, marine protected areas, protecting and managing key marine biodiversity areas, reducing run-off pollution into Ocean, and working closely with producers and consumers. Moreover, it highlights the strong impact that fisheries have had on marine ecosystems, as well as the accelerating effects of climate change, which are already impacting fisheries. In 2016, IPBES published the **Methodological Assessment Report on Scenarios and Models of Biodiversity and Ecosystem Services**[37], which delivered several key findings and guidance on the use of ecosystem models to inform policy, which have a high relevance for EcoScope (see section 4.2.3 for further details).

The **Intergovernmental Panel on Climate Change (IPCC)**[38] is the United Nations body for assessing the science related to climate change and can be considered the "sister-organisation" of IPBES. IPCC was established in 1988 and provides regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. The objective of the IPCC is to provide all levels of government with scientific information that they can use to develop climate policies. IPCC reports are also a key input into international climate change negotiations. IPCC is currently in its **Sixth Assessment cycle**[39] and the final synthesis report is due to be released in September 2022, in time to inform the 2023 UN Global Stocktake progress review of countries towards the Paris Agreement goals. In the fifth IPCC Assessment report[40], four **Representative Concentration Pathways (RCPs)** were used to characterize possible greenhouse gas concentration trajectories and potential impacts (RCP2.6, RCP4.5, RCP6, and RCP8.5). These RCPs will also be used in the EcoScope models to forecast impacts of climate change for different scenarios.

In 2015, all UN Member states adopted the **2030 Agenda for Sustainable Development**. At its heart are the **UN Sustainable Development Goals (SDGs)**[41], which are an urgent call for action by all countries to end poverty, protect the planet and improve the livelihoods and prospects of everyone. The 17 SDGs (Fig. 3) provide the main global instrument to focus societal efforts on sustainable development for society and the environment, including the Ocean. **SDG 14 Life Below Water**, the goal most relevant to EBFM, aims to conserve and sustainably use the oceans, seas and marine resources for sustainable development.

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[36] IPBES Report on Biodiversity and Ecosystem Services 2019 – Sumary for Policy Makers: https://ipbes.net/sites/default/files/inline/files/ipbes_global_assessment_report_summary_for_policymakers.pdf
[37] IPBES Methodological Assessment Report on Scenarios and Models of Biodiversity and Ecosystem Services: https://ipbes.net/assessment-reports/scenarios
[38] IPCC: https://www.ipcc.ch/
[39] IPCC Sixth Assessment cycle: https://www.ipcc.ch/ar6-syr/
[40] IPCC Fifth Assessment report – synthesis report: https://www.ipcc.ch/report/ar5/syr/
[41] UN SDGs: https://sdgs.un.org/goals

Figure 3: UN Sustainable Development Goals (SDGs), including SDG 14 Life Below Water[42].

Many of the SDG goals are strongly interlinked, so that achieving one will support another. Each goal is accompanied with a set of targets and indicators to further define the progress towards achieving the goals and their implementation. In total, 169 targets have been set, of which 10 belong to SDG 14. Table 2 provides an overview of SDG 14 targets and associated indicators that are particularly relevant for EBFM and EcoScope.

Table 2: Selected SDG 14 targets and indicators with relevance for EBFM and EcoScope

Target number	Target	Indicator
14.2	Sustainably manage, protect and restore ecosystems	Number of countries using ecosystem-based approaches to managing marine areas
14.4	Sustainable Fishing	Proportion of fish stocks within biologically sustainable levels.
14.5	Conserve coastal and marine areas	Coverage of protected areas in relation to marine areas
14.6	End subsidies contributing to overfishing	Progress by countries in the degree of implementation of international instruments

[42] Image source: https://www.unbrussels.org/the-sustainable-development-goals-sdgs/

		aiming to combat illegal, unreported and unregulated fishing
14.7	Increase economic benefits from sustainable use of marine resources	Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries.
14.8	Increase scientific knowledge, research and technology for Ocean health	Proportion of total research budget allocated to research in the field of marine technology
14.A	Implement and enforce international sea law	Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United Nations Convention on the Law of the Sea

The **UN Decade of Ocean Science for Sustainable Development (Ocean Decade)**, implemented by IOC-UNESCO, runs from 2021 to 2030 with the vision of "the science we need for the Ocean we want". The Decade aims to support efforts to reverse declining Ocean health while engaging with a range of stakeholders worldwide to create improved conditions for sustainable development of the Ocean (Koho et al., 2021). The Ocean Decade is closely linked with achieving the UN SDG 14 (Life Below Water) goal and the 2030 Agenda for sustainable development. Through a unifying framework and stronger international cooperation, the Ocean Decade aims to achieve seven **Ocean Decade Outcomes**[43]. These Decade Outcomes are accompanied by ten **Ocean Decade Challenges**[44], which represent the most immediate and pressing priorities for the Ocean Decade. The following five Decade Challenges are particularly relevant for EBFM and EcoScope, as EcoScope has the potential to contribute to their successful implementation: (i) *Challenge 2: Protect and restore ecosystems and biodiversity*: Understand the effects of multiple stressors on ocean ecosystems, and develop solutions to monitor, protect, manage, and restore ecosystems and their biodiversity under changing environmental, social and climate conditions. (ii) *Challenge 3: Sustainably feed the global population*: Generate knowledge, support innovation, and develop solutions to optimise the role of the ocean in sustainably feeding the world's population under changing environmental, social and climate conditions. (iii) *Challenge 4: Develop a sustainable and equitable ocean economy*: Generate knowledge, support innovation, and develop solutions for equitable and sustainable development of the ocean economy under changing environmental, social and climate conditions. (iv) *Challenge 5: Unlock ocean-based solutions to climate change*: Enhance understanding of the ocean-climate nexus

[43] Ocean Decade outcomes: https://www.oceandecade.org/vision-mission/
[44] Ocean Decade challenges: https://www.oceandecade.org/challenges/

and generate knowledge and solutions to mitigate, adapt and build resilience to the effects of climate change across all geographies and at all scales, and to improve services including predictions for the ocean, climate, and weather. (v) *Challenge 8: Create a digital representation of the Ocean*: Through multi-stakeholder collaboration, develop a comprehensive digital representation of the ocean, including a dynamic ocean map, which provides free and open access for exploring, discovering, and visualizing past, current, and future ocean conditions in a manner relevant to diverse stakeholders.

Finally, the **UN Decade on Ecosystem Restoration (Restoration Decade)**, implemented by UNEP and FAO, runs in parallel to the Ocean Decade from 2021-2030. This Decade defines ecosystem restoration as assisting in the recovery of ecosystems that have been degraded or destroyed, as well as conserving the ecosystems that are still intact. The Restoration Decade aims to prevent, halt, and reverse the degradation of ecosystems on every continent and in every Ocean. It will therefore also play an important role in achieving international commitments in relation to SDG 14 (Life Below Water) and contributing to healthy and productive marine ecosystems. It is also foreseen that the new **CBD Post-2020 Biodiversity Framework** will catalyse ecosystem restoration of terrestrial and marine ecosystems as a basis for progress towards the SDGs[45].

[45] The Post-2020 Global Biodiversity Agenda Across the UN System: https://www.cbd.int/article/unemg-report-2021

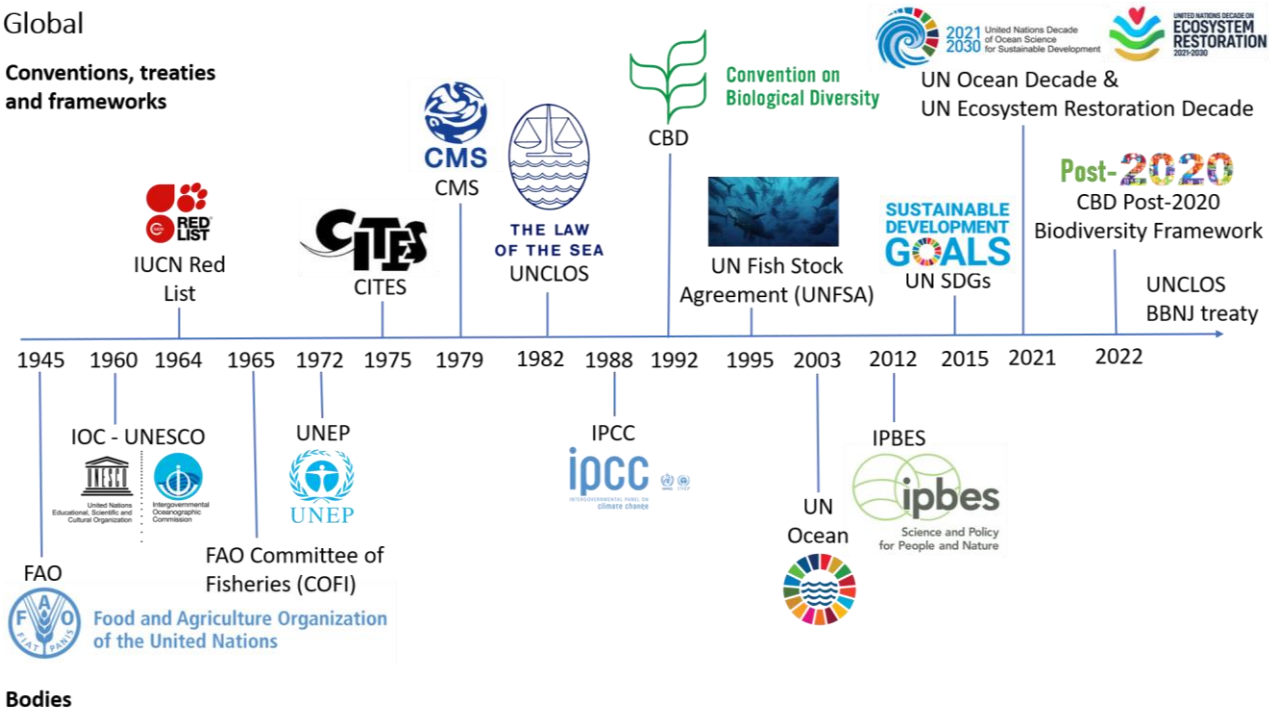

Figure 4: A timeline of key global conventions, treaties, frameworks, and bodies with relevance for ecosystem-based fisheries management (EBFM).

3.2 European policy landscape

The **European Commission (EC)** was founded in 1958 and is the executive branch of the European Union (EU). The EC promotes the general interest of the EU by proposing and enforcing legislation as well as by implementing policies and the EU budget. The Commission is divided into departments known as **Directorates-General (DGs)** that handle a set of specific responsibilities. The most relevant DGs for implementing policies and strategies relevant for an ecosystem-based fisheries management (EBFM) are the Directorate-General for Maritime Affairs and Fisheries (DG MARE), the Directorate-General for Environment (DG ENV) and the Directorate-General for Research and Innovation (DG RTD). **DG MARE** (originally called DG Fish) was established in 1976. The responsibilities of DG MARE include to: (i) ensure that the Ocean resources are used sustainably and that coastal communities and the fishing sector have a prosperous future; (ii) promote maritime policies and stimulate a sustainable blue economy; and (iii) promote Ocean governance at international level. **DG ENV** was established in 1973 with the mandate to protect, preserve and improve Europe's environment for present and future generations. It develops and carries out the Commission's policies on the environment (including on the marine environment). **DG RTD** is the Commission's department responsible for EU policy on research, science, and innovation. DG RTD funds science and research, including on EBFM,

under the EU framework programmes for research and innovation, of which the most recent is called Horizon Europe.

To implement EBFM, both fisheries and environmental legislations are relevant. In Europe (and internationally), environmental and fisheries regulations and advisory bodies are separated, and this has been criticised as an impediment in the implementation of EBFM (e.g. Ramirez-Monsalve, Raakjær, Nielsen, Laksá, *et al.*, 2016). The following sections provides an overview of this dichotomous EU policy landscape.

3.2.1 Fisheries regulations and advisory landscape

The **Common Fisheries Policy (CFP)** [46] is the fisheries policy of the EU that lays out a set of rules for sustainably managing European fishing fleets and conserving fish stocks. Under the CFP, all European fishing fleets have equal access to EU waters and fishing grounds[47], and the EU has exclusive competence concerning the conservation of marine biological resources. This means that Member States cannot legislate on matters relating to common fisheries resources themselves. Instead, legislation is implemented through the CFP and the resulting EU regulations are directly applicable in Member States. The CFP regulation not only applies to management of fisheries in EU waters, but also to international EU fisheries relations and bilateral fisheries agreements signed with third countries (Popescu, 2019). The CFP was introduced in 1970 and has since been reformed several times. In the 1983 reform, the system of catch limits shared among Member States as 'quotas' (i.e., **Total Allowable Catches**) was introduced. The 1992 reform endeavoured to remedy the serious imbalance between fleet capacity and catch potential, but the measures introduced were not sufficiently effective to halt overfishing, and the depletion of many fish stocks continued at an even faster rate (Breuer, 2022). The latest reform occurred in 2013 (Reg. EU 1380/2013) and introduced the target to achieve exploitation of all stocks at **Maximum Sustainable Yield (MSY)** by 2020, as well as to implement an **ecosystem-based approach to fisheries management** (Reg.1380/2013, article 2). EBFM is defined in this regulation as: "*an integrated approach to managing fisheries within ecologically meaningful boundaries which seeks to manage the use of natural resources, taking account of fishing and other human activities, while preserving both the biological wealth and the biological processes necessary to safeguard the composition, structure and functioning of the habitats of the ecosystem affected, by taking into account the knowledge and uncertainties regarding biotic, abiotic and human components of ecosystems*" (Reg.1380/2013, article 4). With this reform, the adoption of **Multiannual Management Plans (MAPs)** became a priority to ensure long-term

[46] CFP reform of 2013: Regulation (EU) No 1380/2013: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1380

[47] Although the principle of equal access to all EU waters is enshrined in the CFP, there is a derogation in place which allows coastal states to reserve access to the first 6 miles of their coastal waters to their national fleets. This derogation is in place since 1983 and has been maintained ever since, renewed with each CFP reform (Popescu, 2019).

management of stocks in different sea basins. Four plans have been adopted concerning: (i) stocks of cod, herring and sprat in the Baltic Sea, adopted in 2016[48]; (ii) demersal stocks in the North Sea, adopted in 2018[49], (iii) stocks in Western Waters, adopted in 2019[50], and (iv) stocks in the western Mediterranean Sea, also adopted in 2019[51]. These four plans also stress the need to implement EBFM (article 3 of each multiannual plan). The latest CFP reform also introduced a **landing obligation** and **regionalisation of decision-making**. The landing obligation was phased in by 2019 to end the practice of discarding fish back into sea. The regionalisation of decision-making offer Member States the possibility to adopt conservation measures based on **joint recommendations** by the Member States concerned (Reg.1380/2013, article 11). In practice this means, that to implement any conservation measure, such as excluding fishing from a protected area, all concerned Member States (i.e., all Member States that fish in that area) must agree on a joint recommendation. This recommendation is then transposed into legislation by the Commission. Finally, the latest CFP reform also introduced **fleet capacity ceilings** per EU country, obliging Member States to ensure a balance between fishing capacity and fishing opportunities over time. Although progress has made towards the MSY target in the North-East Atlantic, the state of the stocks in the Mediterranean and Black Sea remain well above MSY levels (Popescu, 2019).

The 2013 reform of the CFP also brought an overhaul of the technical measures. These measures had been accumulating over time, forming a highly complicated regulatory structure. In 2019, a new simplified and clearly structured framework for technical measures was adopted, the **Technical Measures Regulation**[52], which is more adapted to the needs of each region (Popescu, 2019). The new Technical Measures Regulation are a set of rules stipulating how, where and when fishers may fish. These can differ from one basin to another, in accordance with regional conditions. The measures include regulations on minimum landing sizes, minimum mesh sizes, specifications for design and use of gears, and closed areas and seasons. EU countries can agree on regional technical measures, adapted to the specific circumstances of a sea basin, which the EC then transposes into legislation. The technical measures regulation aims to de-centralise the management of technical features to the regional level. Every three years, the Commission then assesses the extent to which the technical measures achieve the objective and targets of the CFP (as stipulated in article 31 of the regulation 2019/1241).

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[48] Multiannual plan for the stocks of cod, herring and sprat in the Baltic Sea (Regulation (EU) 2016/1139): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016R1139

[49] Multiannual plan for demersal stocks in the North Sea (Regulation (EU) 2018/973): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R0973

[50] Multiannual plan for stocks fished in the Western Waters (Regulation (EU) 2019/472): https://eur-lex.europa.eu/eli/reg/2019/472/oj

[51] Multiannual plan for the fisheries exploiting demersal stocks in the western Mediterranean Sea (Regulation (EU) 2019/1022): https://eur-lex.europa.eu/eli/reg/2019/1022/oj

[52] Technical Measures Regulation (Regulation (EU) 2019/1241): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R1241

In addition to the Technical Measures Regulation, the **Mediterranean Regulation**[53] provides a set of management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea. The Mediterranean Regulation includes measures on fisheries restriction in protected habitats (e.g. prohibition to fish above seagrass beds with gears that can damage the beds), establishing protected areas, restricting certain fishing activities (such as explosives and toxic substances), and establishing minimum mesh sizes and minimum conservation sizes of marine organisms.

Within the current 2013 CFP governance system, several actors are expected to provide advice relevant for EBFM. The CFP states that the EC shall seek the best available scientific advice from advisory bodies and relevant scientific bodies when setting or reviewing fisheries management measures. Data collected by EU countries under the **Data Collection Framework (DCF)**[54] form the basis for the work of these bodies. Under the DCF EU Member States collect, manage, and make available a wide range of fisheries data needed for scientific advice, including biological, environmental, economic, and social data. Collected data needs to be accurate, reliable, timely and stored safely. In addition, Member States must ensure improved availability of data. The data collected under the DCF is then sorted, quality-checked and analysed by the **Joint Research Centre (JRC)** and the **International Council for the Exploration of the Sea (ICES)**. JRC's data is made available to the **Scientific, Technical and Economic Committee for Fisheries (STECF)**, who formulate scientific recommendations in the form of reports. This advice is used by the EC – along with ICES data - for preparing the yearly proposal for fishing quotas (Ramirez-Monsalve et al., 2021).

[53] Mediterranean Regulation (Regulation (EC) No 1967/2006): https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32006R1967
[54] Data Collection Framework (Regulation (EU) 2017/1004): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R1004

Figure 5: Workflow of the advice provided by Scientific, Technical and Economic Committee for Fisheries (STECF) under the Common Fisheries Policy (CFP)[55].

Within the CFP, the **Scientific, Technical and Economic Committee for Fisheries (STECF)**[56] is listed as a scientific body to be consulted by the EC. STECF is a group of fisheries experts appointed by DG MARE for three years, who provide advice on fisheries management. The Commission may consult STECF on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, or similar topics. STECF may also provide the Commission opinions on its own initiative. The EC requests advice from STECF in the form of a terms of reference (ToR) with pre-defined questions and members of STECF evaluate the science and technology behind the request. In practice, STECF undertakes limited scientific work, but mainly reviews the scientific advice received from external science bodies (Hegland and Raakjaer 2020 cited in Ramirez-Monsalve et al., 2021). In a recent study, members of the STECF were asked whether there is room to provide additional input on EBFM, besides the pre-defined questions in the ToRs. The answers of the interviewees indicated that a convergence has taken place, where STECF introduces ecosystem approach components when they see it convenient and relevant, while DG MARE staff increasingly introduce EBFM components in its requests (Ramirez-Monsalve et al., 2021).

The **Joint Research Centre (JRC)** is the Commission's science and knowledge service, which employs scientists to carry out research to provide independent scientific advice and to support implementation of EU policy, such as the CFP. Although the CFP does not identify the JRC as a direct provider of advice, JRC can provide EBFM advice through the STECF. For instance,

[55] Image source: https://stecf.jrc.ec.europa.eu/
[56] STECF: https://stecf.jrc.ec.europa.eu/index.html

members of **JRC's fisheries team** have participated in many of the STECF working groups and contributed to STECF reports. The JRC also coordinates the scientific advice process of STECF by collecting, quality-checking, and analysing the fisheries data from EU Member States and making it available to STECF. Moreover, JRC provides the secretariat of STECF. On an ad-hoc basis JRC may also be asked for direct advice by the EC (Ramirez-Monsalve et al., 2021).

The **International Council for the Exploration of the Sea (ICES)**[57] is another key scientific advisory body of the EC, which supports the implementation of the CFP. ICES is an intergovernmental marine science organisation with 20 member countries, and a network of nearly 6,000 scientists from over 700 marine institutes. ICES' principal functions are to promote, develop, publish and disseminate marine research, and to provide non-biased, non-political scientific advice to member nation governments and international regulatory organisations. ICES provides scientific assessments and advice to the EC for the stocks of the North-East Atlantic and the Baltic Sea. The advice provided by ICES include: (i) advice on fishing quotas or fishing opportunities; (ii) fisheries overviews and advice on mixed fisheries, multi-species interactions, and by-catch issues; and (iii) ecosystem overviews, where primary pressures from anthropogenic activities are identified and assessed for each of the ICES ecoregions. The last two components represent the scientific basis for ecosystem-based decisions in ICES (Ramirez-Monsalve et al., 2021). ICES consists of an **Advisory Committee (ACOM)**, which responds to requests for advice from clients, such as the EC, and a **Scientific Committee (SCICOM)**, the main scientific body in ICES. In addition, ICES coordinates the work of around 150 **Expert Groups** that generate scientific knowledge and conduct the analyses that underpin ICES advice (see Table 3 for a selection of Expert Groups relevant for EcoScope).

Table 3: Selected ICES Expert Groups with relevance for EcoScope

Acronym	Expert group name	Link
WGSAM	Working Group on Multispecies Assessment Methods	Website
WGECO	Working Group on Ecosystem Effects of Fishing Activities	Website
WGMIXFISH	Working Group on Mixed Fisheries Advice	Website
WGCOMEDA	Working Group on Comparative Ecosystem-based Analyses of Atlantic and Mediterranean marine systems	Website
SICCME	ICES/ PISCES Strategic Initiative on Climate Change Impacts on Marine Ecosystems	Website

[57] ICES: https://www.ices.dk/Pages/default.aspx

WGBESEO	Working Group on Balancing Economic, Social and Ecological Objectives	Website
WGBIODIV	Working Group on Biodiversity Science	Website
WGBYC	Working Group on Bycatch of Protected Species	Website
WGISUR	Working Group on Integrating Surveys for the Ecosystem Approach	Website
WGEF	Working Group on Elasmobranch Fishes	Website
WGIAB	Joint ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea	Website

In 2019, ICES published a **Science Plan**[58] describing scientific priorities and objectives to deliver "Marine ecosystem and sustainability science for the 2020s and beyond". This plan presents seven interrelated scientific priorities for ICES, of which the following two are most relevant for EcoScope: (i) *generating science and advice for wild-capture fisheries*, and (ii) *developing tools, knowledge and evidence for conservation and management*. Specific tasks associated with these two priorities that are of particular relevance for EcoScope include:

- improving stock assessment methods, including for data-limited situations and addressing uncertainty;
- further understanding and operationalising the EBFM and MSY concept, including their application in mixed, multispecies and mesopelagic fisheries; and
- developing methods to support the implementation of relevant marine policies (e.g. CFP, Marine Strategy Framework Directive); and improving ICES' capacity to provide ecosystem-based advice.

In the EU, ICES only provides scientific stock assessments and advice for the North-East Atlantic and the Baltic Sea. In the Mediterranean and the Black Sea, scientific stock assessments and advice are provided by two Regional Fisheries Management Organisations (RFMOs): the General Fisheries Commission for the Mediterranean (GFCM), and the International Commission for the Conservation of Atlantic Tunas (ICCAT).

The **General Fisheries Commission for the Mediterranean (GFCM)**[59] was established under FAO with 22 member countries and the EU. Its main objective is to ensure the conservation and sustainable use of living marine resources in the Mediterranean and in the Black Sea. GFCM

[58] ICES Science Plan: https://www.ices.dk/news-and-events/news-archive/news/Pages/ICES-Science-Plan-questions-and-answers.aspx
[59] GFCM: https://gfcm.org/

uses the data it collects from GFCM member countries, and the assessments performed by its Scientific Advisory Committee to publish its biennial flagship report, called the **State of the Mediterranean and Black Sea Fisheries (SoMFi)**[60]. SoMFi provides a comprehensive and up-to-date review of the status and trends of fisheries in the Mediterranean and the Black Sea. It is an important information source on the main issues related to these fisheries and as a support tool for strategic decision-making and to monitor progress towards the main goals and objectives set by the GFCM. GFCM's **Scientific Advisory Committee of Fisheries (SAC)** is responsible for assessing all species (except for tuna or tuna-like species) in the Mediterranean and the Black Sea. SAC subsequently provides scientific stock assessment advice to STECF for all stocks under EU sovereignty. SAC's mandate includes to: (i) collect and assess data relevant for the conservation and management of fisheries; (ii) assess the status and trends of relevant populations and ecosystems using the appropriate indicators; (iii) provide independent advice to facilitate the adoption of recommendation concerning the sustainable management of fisheries and ecosystems, including the **ecosystem approach to fisheries**; and (iv) provide support with the implementation of the multiannual management plans. Efforts to include EBFM aspects within the scientific advice provided by SAC are reflected in some of GFCM activities. For instance, its SAC Subcommittee on Marine Environment and Ecosystem (SCMEE) has started to develop a plan[61] to implement EBFM within the GFCM geographical area. Moreover, GFCM has created a series of working groups to address environmental aspects associated with fishing, including: impacts on elasmobranch, monk seal, red coral and sea turtles; minimising impacts of longline fishing on seabirds; and implementation of Marine Strategy Framework Directive (MSFD) indicators, marine protected areas, and vulnerable marine ecosystems (Ramirez-Monsalve et al., 2021).

The most up to date goals and objectives of GFCM are given in the **GFCM 2030 Strategy**[62]. The GFCM 2030 Strategy offers a common vision and guiding principles to achieve sustainable fisheries and aquaculture in the Mediterranean and Black Sea, and outlines five targets that contribute to this overarching vision for sustainability. Target 1 (*Healthy Seas and Productive Ecosystems*) is most relevant for EcoScope and includes the following actions, which are aligned with EcoScope objectives:

- provide advice on alternative potential management options for key fisheries;
- establish effective area-based measures to minimize and mitigate impacts on vulnerable species, sensitive habitats and essential fish habitats to meet international spatial conservation targets;

[60] GFCM SoMFI report: https://www.fao.org/gfcm/publications/somfi/en
[61] SCMEE Transversal Workshop on Ecosystem Approach to Fisheries: https://gfcmsitestorage.blob.core.windows.net/documents/web/ftp/fi/document/gfcm/sac8/dma6e.pdf
[62] GFCM 2030 Strategy: https://www.fao.org/publications/card/fr/c/CB7562EN/

- determine the fishing footprint of bottom contact fisheries and their potential interactions with essential fish habitats, sensitive habitats, and vulnerable marine ecosystems; and
- implement an adaptation strategy to address the potential effects of climate change and non-indigenous species on fisheries and on the marine environment and ecosystems, including by integrating adequate mitigation and adaptation measures within management plans.

The **International Commission for the Conservation of Atlantic Tunas (ICCAT)**[63], the second RFMO that provides advice on Mediterranean fish stocks, compiles fisheries statistics from its members and other entities, coordinates research, including stock assessments and develops scientific-based management advice. Scientific assessments of all tuna or tuna-like species in the Mediterranean is provided to STECF by the **Standing Committee on Research and Statistics (SCRS)** of ICCAT. According to a recent study, ICCAT has been developing the scientific foundations for an EBFM in ICCAT since 2005, with a focus on developing an EBFM understanding and EBFM tools (Ramirez-Monsalve et al., 2021). In addition, the status and trends of selected ecosystem indicators have been described, and a review of five tuna RFMOs in terms of their application of EBFM has taken place. However, the application of the EBFM concept is still considered to be “patchy” in ICCAT, with challenges relating mainly to the understanding of the EBFM concept and the requirements for its implementation (Ramirez-Monsalve et al., 2021).

Although **GFCM** and **ICCAT** provide the main stock assessment advice in the Mediterranean and Black Sea, **STECF** is also asked on an ad-hoc basis to provide stock assessment advice. For instance, at the end of the 2000s decade, STECF was requested by the EC to assess through the **JRC** the status of demersal and small pelagic stocks in the Mediterranean and Black Sea, and to provide fisheries management advice (Ramirez-Monsalve et al., 2021).

The final component in the CFP advisory landscape is the **Advisory Councils (ACs)**[64]. ACs are stakeholder-led organisations that provide the Commission and EU countries with recommendations on fisheries management matters related to the CFP. This may include advice on conservation and socio-economic aspects of management, as well as advice on simplification of rules. The CFP stipulates that ACs should be composed of 60% of fisheries sector representatives and 40% of other interested groups, such as environmental organisations and consumer groups (Reg. 1380/2013, Annex III). Advisory Councils are consulted by the EC in the context of regionalisation, e.g., when drafting joint recommendations and other measures. ACs may also submit information, recommendations, or suggestions to the EC on their own initiative (Reg. 1380/2013, article 44). With the ACs the Commission aims to bring stakeholders closer to

[63] ICCAT: https://www.iccat.int/en/
[64] Advisory Councils: https://ec.europa.eu/oceans-and-fisheries/fisheries/scientific-input/advisory-councils_en

the decision-making process (Ramirez-Monsalve et al., 2021). ACs are considered an important mechanism for the implementation of EBFM in Europe, because they provide experienced-based information, and they provide a platform to discuss social, economic and ecological outcomes for fisheries (Ramirez-Monsalve et al., 2016b).

The ACs that are most relevant for EcoScope include the **Baltic Sea Advisory Council (BSAC)**[65], the **Black Sea Advisory Council (BLAC)**[66], the **Mediterranean Sea Advisory Council (MEDAC)**[67], the **North Sea Advisory Council (NSAC)**[68] and the **Pelagic Stocks Advisory Council (PELAC)**[69]. Some of these ACs have created subgroups to assess topics explicitly related to ecosystem management. For instance, PELAC has established an Ecosystem Focus Group[70], BSAC has established a Working Group for ecosystem-based management[71] and NSAC has established the Ecosystem Working Group[72]. Before 2013, ACs provided their advice directly to the EC, but since the 2013 CFP reform ACs provide their advice to the **Member States Regional Groups (MSRGs)**. MSRGs are Member States groups that are organised by sea basin to cooperate and to submit joint recommendations (e.g., for conservation measures or multiannual management plans). Since MSRGs operate at the scale of regional marine ecosystems they are very relevant for implementing EBFM. However, they have no legal requirements for transparency and stakeholder involvement, and some MSRGs have been criticised for not sufficiently integrating the advice provided by ACs (Ramirez-Monsalve et al., 2021).

3.2.2 Environmental and maritime legislation and bodies

The marine environmental legislation of the EU is composed to a large degree of directives. Unlike other types of EU regulations, such as the CFP, directives are not automatically applicable throughout Member States, but require transposition into national law. The directives must become law in the Member States by a certain deadline, which is specified in each directive. Therefore, for each of the directives mentioned below, equivalent national level legislation exists in the EU Member States.

[65] BSAC: http://www.bsac.dk/
[66] BLAC: https://www.blsaceu.eu/
[67] MEDAC: http://en.med-ac.eu/index.php
[68] NSAC: https://www.nsrac.org/
[69] PELAC: https://www.pelagic-ac.org/
[70] PELAC Ecosystem Focus Group: http://www.bsac.dk/getattachment/Meetings/External-events/Pelagic-AC-briefing-meeting-on-climate-change/Agenda-Ecosystem-FG-Climate-17-March-2021.pdf.aspx?lang=en-GB
[71] BSAC working group for ecosystem-based management: http://www.bsac.dk/BSAC-Working-groups/Sub-group-for-ecosystem-based-management
[72] NSAC Ecosystem Working Group: https://www.nsrac.org/

The **Marine Strategy Framework Directive (MSFD)**[73] is Europe's most important and holistic directive on protecting the marine environment. After the CFP, it is also the second most important European Directive in the context of EBFM. The MSFD was established in 2008 and has the goal of achieving **Good Environmental Status (GES)** in European Waters, with an original deadline of 2020. This directive is an important piece of legislation to implement SDG 14 (Life Below Water) in Europe. The MSFD stipulates that GES is to be achieved through an **ecosystem approach** to the management of human activities (article 3). To help Member States interpret what GES means in practice the directive sets out **11 descriptors** (Figure 6), which describe what the environment will look like when GES has been achieved. Four of these descriptors (D) are associated with fisheries, namely: D1 - biodiversity is maintained; D3 - the population of commercial fish species is healthy; D4 - elements of food webs ensure long-term abundance and reproduction; and D6 - the seafloor integrity ensures functioning of the ecosystem. Member States must assess the state of these descriptors through monitoring programs (article 11). The Directive also stipulates that a coherent and representative network of Marine Protected Areas (MPAs) must be created. In order to achieve GES, each Member State is required to develop a national **Marine Strategy**, i.e., a strategy for its marine waters. These Marine Strategies must be kept up to date and reviewed every six years.

The first implementation cycle of the **MSFD** ran from 2012-2017 and Member States reported on the state of the environment in their marine waters, as well as on the objectives and targets they set themselves to reach GES by 2020. In 2020, the Commission published a **report on the first implementation cycle of the Marine Strategy**[74]. This report showed that while the MSFD is one of the most comprehensive and ambitious marine environmental protection frameworks worldwide, the EU's marine environment is still facing many challenges such as overfishing and unsustainable fishing practices, plastic litter, excess nutrients, underwater noise and other types of pollution. For instance, the report showed that there has been a steep reduction of elasmobranchs (40% decline) in the Mediterranean Sea, and that a high proportion of Europe's seabed (79% of the coastal seabed and 43% of the shelf/slope) is physically disturbed, mainly due to bottom trawling (COM/2020/259 final).

The **MSFD** is currently in its second implementation cycle of the marine strategies, which runs from 2018-2023. By 2023, the MSFD must be reviewed (as set out in article 23 of the directive). This review will follow an evaluation, impact assessment and public consultations. Where appropriate and necessary, amendments to the MSFD will be proposed.

[73] Marine Strategy Framework Directive (Directive 2008/56/EC): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0056

[74] Report on first implementation cycle of the Marine Strategy (COM/2020/259 final): https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593613439738&uri=CELEX:52020DC0259

Figure 6: Good Environmental Status (GES) descriptors of the Marine Strategy Framework Directive (MSFD)[75].

The **European Environmental Agency (EEA)**[76] is the environmental agency of the EU, tasked with providing sound, independent and reliable information to policy-making and the public. The EEA also manages **WISE-Marine**[77], a European Marine Information System which provides access to data gathered by Member States through the MSFD and other relevant environmental policies. All this data is synthesised in an EEA report called **Marine Messages**, which gives an overview of the current state of European Seas. The latest publication, Marine Messages II[78], was published in 2019 and highlights that the EU has not yet met politically agreed targets for commercially exploited species, whether as defined by the CFP or the MSFD. It also stresses that the populations of commercially exploited species across all EU marine regions have not yet achieved GES according to MSFD Descriptor 3. According to the report, achieving these challenges and reducing sea floor impacts from fishing gears are among the most pressing challenges that must be tackled.

The **Water Framework Directive (WFD)**[79] is closely linked to the MSFD. The WFD was introduced in 2000 and sets the goal of achieving **Good Status** (including Good Ecological Status and Good Chemical Status), for all EU surface and groundwaters by 2015 (with the possibility of extending this deadline until 2027 at the latest). The WFD applies to rivers, lakes, estuaries,

[75] Image source: https://www.msfd.eu/rages/D6_4.pdf
[76] EEA: https://www.eea.europa.eu/
[77] WISE-Marine: https://water.europa.eu/marine
[78] EEA Marine Messages II: https://www.eea.europa.eu/publications/marine-messages-2
[79] Water Framework Directive (Directive 2000/60/EC): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32000L0060

groundwater, and coastal marine waters. For the marine environment, the WFD specifically covers marine territorial waters (12 nautical miles) for aspects of chemical quality, and marine coastal waters (up to 1 nautical mile) for aspects of ecological quality. Similar to the MSFD, Member states prepare River Basin Management Plans that require the implementation of measures to contribute to the achievement of Good Ecological Status and Good Chemical Status of water bodies by 2027. These plans are implemented and reviewed on a six-year cycle. To date, River Basin Management Plans have been published in 2009, 2015 and 2021.The actions taken in these plans aim to reduce marine pollution from land-based sources and to protect ecosystems in coastal and estuarine waters, which are vital habitats for many marine species.

The **Birds and Habitats Directives** are EU's nature legislation and form the backbone of biodiversity policy and nature protection in the EU. The core objective of the Birds and Habitats Directive is to achieve **Favourable Conservation Status** of habitats and species listed in the directives. Favourable conservation status is defined as: "*population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats; the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis"* (Directive 92/43/EEC, article 1). The **Birds Directive**[80] aims to protect all 500 wild bird species naturally occurring in the European Union. Adopted in 1979 and modified in 2009, the Birds Directive is the oldest environmental legislation in the EU. Member States are required to establish a network of **Special Protection Areas (SPAs)** for all bird species listed under Annex I of the Birds Directive, including many seabird species. The SPAs should include the most suitable territories for these species. The **Habitats Directive**[81] was adopted in 1992 and aims to protect over 1,000 animal and plant species, as well as 200 habitat types. Under the Habitats Directive, Member States must strictly protect all species listed under Annex IV of the Directive, which includes all cetaceans and several marine turtle species. Moreover, Member States must designate **Sites of Community Importance (SCIs)** for species listed under Annex II and habitats listed under Annex I of the Habitats Directive. Although the Directive has a strong bias towards terrestrial ecosystems, nine broad marine habitat types are listed for conservation[82]. Once the Commission approves the SCIs, the sites must be designated as **Special Areas of Conservation (SACs)** within six years at the most. Designation as a SAC means that management and conservation measures have to be applied. The SPAs designated under the Birds Directive and the SCIs and SACs designated

[80] Birds Directive (Directive 2009/147/EC): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009L0147
[81] Habitats Directive (Directive 92/43/EEC): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31992L0043
[82] Habitats Directive – marine habitats: https://ec.europa.eu/environment/nature/natura2000/marine/docs/appendix_1_habitat.pdf

under the Habitats Directive together make up the **Natura 2000 network**[83]. The Natura 2000 network includes more than 3,000 marine Natura 2000 sites, which cover almost 10% of the EU marine area[84].

Reporting under the Habitats and Birds Directives requires Member States to monitor the habitats and species listed in the Annexes and sent reports to the Commission every six years. These reports feed into the **State of nature in the EU report** which is prepared by the European Environmental Agency (EEA) every six years. This State of nature report provides an overview on species and habitats status, both at national and EU level. It also addresses the status of the Natura 2000 network and its possible contribution to the status of species and habitats. The latest State of nature in the EU report was published in 2020[85]. The report shows that the conservation status for most marine habitats and species is either bad or poor (i.e., unfavourable-bad or unfavourable-inadequate in the nomenclature of the Directives; see Fig. 7). There is also a large proportion of "unknown" conservation statuses in marine habitats and species, indicating a need for much stronger data collection. Moreover, several strictly protected species under the Birds and Habitats Directive (particularly dolphins, harbour porpoises and seabirds) are subject to unsustainable bycatch. This has led the Commission to initiate infringement procedures[86], urging the respective countries to take action to reduce bycatch.

[83] Natura 2000 viewer: https://natura2000.eea.europa.eu/
[84] Natura 2000 network: https://ec.europa.eu/environment/nature/natura2000/marine/index_en.htm
[85] State of Nature Report 2020: https://www.eea.europa.eu/publications/state-of-nature-in-the-eu-2020
[86] Infringement procedures regarding bycatch: https://ec.europa.eu/commission/presscorner/detail/en/INF_20_1212

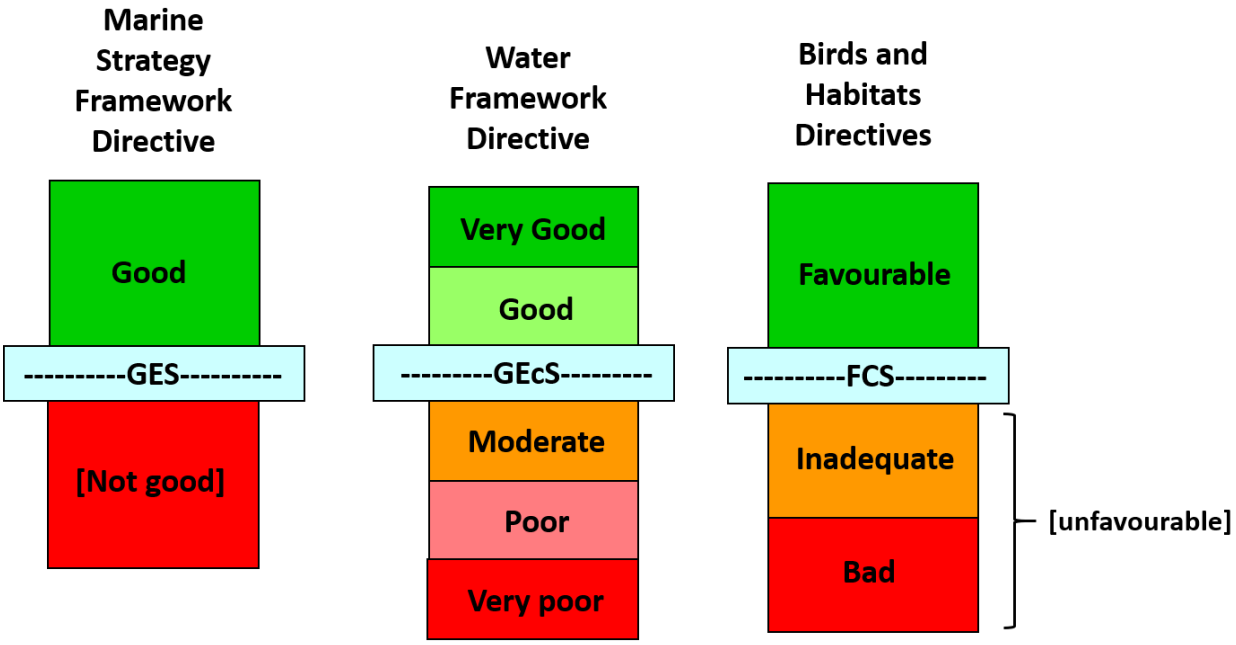

Figure 7: Ecosystem status classification according to the Marine Strategy Framework Directive (MSFD), the Water Framework Directive (WFD), and the Birds and Habitats Directives. GES= Good Environmental Status; GEcS= Good Ecological Status; FCS= Favourable Conservation Status[87].

The Habitats Directive implements the **Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)**[88] in Europe. The Bern Convention is a binding international legal instrument that covers most of the natural heritage in Europe and extends to some African countries. The convention came into force in 1982 and aims to protect natural habitats and endangered species, including migratory species. The three main aims of the convention are to: (i) conserve wild flora and fauna; (ii) promote cooperation between states; and (iii) provide particular attention to endangered and vulnerable species. Under the Bern Convention **Areas of Special Conservation Interest** are set up, which together form the **Emerald Network**[89]. The EU produced the Habitats Directive to fulfil its obligations under the Bern Convention, and the Natura 2000 network is considered the contribution from the EU Member States to the Emerald Network.

[87] Image credit: European Commission; redrawn after: https://slideplayer.com/slide/16562551/
[88] Bern Convention: https://www.coe.int/en/web/bern-convention
[89] Emerald Network: https://www.coe.int/en/web/bern-convention/emerald-network

The **Integrated Maritime Policy (IMP)**[90] is a policy framework aiming to foster the sustainable development of all sea-based activities and coastal regions by improving the coordination between all sea-related EU policies. Established in 2007, the framework aims to contribute to the sustainable development of maritime and coastal regions with regard to shipping, seaports, shipbuilding, maritime jobs, the environment and fisheries management. The IMP covers the following cross-cutting sectoral issues that require the coordination of multiple stakeholders: blue growth, marine data and knowledge, maritime spatial planning, integrated maritime surveillance, and sea basin strategies[91]. The MSFD along with the Habitats and Birds Directives are the environmental pillars of the IMP.

The **Marine Spatial Planning Directive (MSPD)**[92] was adopted in 2014 as part of the IMP and establishes a common framework for maritime spatial planning in the EU. The directive places the legal requirement for all EU Member States with coastal seas to develop and implement Marine Spatial Plans by 2021, at the latest. The aim of the directive is to promote the sustainable development and co-existence of maritime activities, including fisheries, aquaculture, the energy sector, maritime transport, tourism, and recreational use, and to balance this development with the need to protect the marine environment. The MSPD states that an **ecosystem-based approach** is to be implemented, and that the collective pressure of all activities must be kept within levels compatible with achieving good environmental status (Dir. 2014/89/EU, preamble). Moreover, Member States shall consider economic, social, and environmental aspects when developing their Marine Spatial Plans (Dir. 2014/89/EU, article 5). The Commission has committed to preparing guidance on implementing an ecosystem-based approach to marine spatial planning as part of its Sustainable Blue Economy Strategy (COM/2021/240)[93].

The **Regional Sea Conventions (RSCs)** are crucial bodies for coordinating the implementation of legal requirements of EU marine environmental policies (particularly the MSFD, but also the Birds and Habitats Directives). The RSC are intergovernmental organisations that aim to protect the marine environment and bring together Member States and neighbouring countries that share marine waters. The RSCs provide a platform to improve regional and cross-regional coherence of national implementation and make their experience and established structures of cooperation available to increase the efficiency of national implementation. The MSFD, for instance, requires that Member States develop Marine Strategies by using existing regional cooperation structures,

[90] Integrated Maritime Policy (COM(2007) 574 final): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52007DC0575
[91] More information on each of these cross-cutting fields can be found here: https://www.europarl.europa.eu/factsheets/en/sheet/121/integrated-maritime-policy-of-the-european-union#:~:text=The%20EU's%20Integrated%20Maritime%20Policy,and%20by%20developing%20cross%2Dcutting
[92] Marine Spatial Planning Directive (Directive 2014/89/EU): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0089
[93] Sustainable Blue Economy Strategy (COM/2021/240): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:240:FIN

such as the RSCs. RSCs are relevant for EBFM because they oversee environmental action in regional marine ecosystems. However, their mandate does not include fisheries, and thus their advice is not fully integrated in the EU EBFM advice landscape and mostly arrives through different channels (Ramirez-Monsalve et al., 2021). In Europe, the four RSCs are: **OSPAR Convention** (North-East Atlantic), **Helsinki Convention** (Baltic Sea), **Barcelona Convention** (Mediterranean Sea) and **Bucharest Convention** (Black Sea).

The **OSPAR Commission**[94] implements the **Oslo-Paris Convention for the Protection of the Marine Environment in the North-East Atlantic (OSPAR)**. This RSC was signed in 1992 and is the current legislative framework regulating international cooperation on environmental protection in the North-East Atlantic. The Convention focuses on: (1) the prevention and elimination of all types of pollution in its area of jurisdiction, (2) the protection and conservation of its marine ecosystems and biodiversity, and on (3) assessing the quality of the marine environment. The role of the OSPAR Commission is to harmonise policies and strategies, including identifying priorities for action, and creating programmes and measures for the protection of the marine environment. The **Ecosystem Approach** is one of OSPAR's guiding principles and is embedded in its strategy for 2030, the **North-East Atlantic Environmental Strategy (NEAS) 2030**[95]. NEAS 2030 sets out collective objectives to tackle the triple challenge facing the ocean: biodiversity loss, pollution, including marine litter, and climate change. This includes commitments to further develop the **OSPAR network of MPAs**[96], identify habitats suitable for restoration, and develop methods for the analysis of cumulative effects in the marine environment. OSPAR has also developed a priority **List of Threatened and/or Declining Species and Habitats**[97] for which protection should be established in the North-East Atlantic. Although OSPAR is a relevant actor in EBFM in Europe through its role in coordinating environmental action in the North-East Atlantic, the OSPAR convention[98] states that it will not adopt any measure or question relating to the management of fisheries. Instead OSPAR shall dialogue and cooperate with competent bodies on those matters (OSPAR convention, annex V, article 4).

The Baltic Marine Environmental Protection Commission, also known as the **Helsinki Commission (HELCOM)**[99] implements the **Convention for the Protection of the Marine Environment in the Baltic Sea Area (Helsinki Convention)**. The Helsinki Convention, signed in 1974 and updated in 1992, aims to achieve a sustainable use of natural resources in the Baltic Sea, to conserve natural habitats and biological diversity and to protect ecological processes. The

[94] OSPAR: https://www.ospar.org/
[95] OSPAR NEAS Strategy 2030: https://www.ospar.org/convention/strategy
[96] OSPAR network of MPAs: https://www.ospar.org/work-areas/bdc/marine-protected-areas
[97] OSPAR List of Threatened and/or Declining Species and Habitats: https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats
[98] OSPAR Convention: https://www.ospar.org/convention/text
[99] HELCOM: https://helcom.fi/

Baltic Sea Action Plan (BSAP)[100], adopted in 2007 and updated in 2021, is HELCOM's strategic programme of measures and actions to achieve good environmental status. Although the goal of achieving GES has not been achieved to date, the plan has resulted in a number of improvements, including reduction in nutrient inputs to the sea, a better state of biodiversity and a decrease in maritime incidents and spills. The updated plan is therefore still in force with a focus on eutrophication, hazardous substances, maritime activities, and biodiversity. The plan stresses the need of applying an **ecosystem approach** and includes several actions related to fisheries, including reducing the impact of fisheries inside MPAs, restoring coastal fish communities through no-take areas and seasonal closures, and working on reducing the bycatch of Harbour Porpoises in the Baltic Proper. **HELCOM's Group on Ecosystem-based Sustainable Fisheries (Fish Group)** [101] , established in 2014, is composed of fisheries representatives, environmental authorities of the Baltic Sea countries, the EU, and observers. The Fish Group has the mandate to work on topics related to implementing an ecosystem-approach in fisheries and to explore how the fisheries sector could contribute to reaching GES in the Baltic Sea. HELCOM has published several **maps on essential fish habitats**, which are publicly available online on HELCOM's MAP and Data service[102]. The maps show potential spawning areas of cod, sprat, and herring, which are the most important commercial fish species in the Baltic Sea. The map also includes key areas for European and Baltic flounder, perch, and pikeperch. The **HELCOM MPA network**[103] aims to protect marine and coastal habitats and species specific for the Baltic Sea and with high nature values. Many of the HELCOM MPAs are also designated as Natura 2000 sites and each site has a unique management plan.

The **Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)**[104] was adopted in 1976 and is implemented by the United Nations Environmental Program Mediterranean Action Plan (**UNEP-MAP**). The Barcelona Convention was adopted in the framework of the Mediterranean Action Plan, which was the first regional action plan to be established by UNEP Regional Seas Programme. The Barcelona Convention and its seven Protocols constitute the principal legal framework for the protection of the marine environment and sustainable use of the Mediterranean. Under the Protocol on Specially Protected Areas and Biological Diversity (SPA/BD), Parties are called to protect areas of particular value through the establishment of **Specially Protected Areas of Mediterranean Importance (SPAMIs)**, and to protect the threatened and endangered species listed in the Protocol's Annexes. **Regional Action Plans**[105] have also been developed under this Protocol to protect species listed in the Protocol, including for cartilaginous fishes, cetaceans, and marine

[100] HELCOM Baltic Sea Action Plan (BSAP): https://helcom.fi/baltic-sea-action-plan/
[101] HELCOM's fish group: https://helcom.fi/helcom-at-work/groups/fish-group/
[102] HELCOM's Map and Data service: https://maps.helcom.fi/website/mapservice/index.html
[103] HELCOM MPAs: https://helcom.fi/action-areas/marine-protected-areas/
[104] Barcelona Convention: https://www.unep.org/unepmap/who-we-are/barcelona-convention-and-protocols
[105] UNEP-MAP Regional Action Plans: https://www.rac-spa.org/programs

turtles. UNEP-MAP cooperates with GFCM on topics relevant for EBFM, including on: (i) promoting an **ecosystem-based approach** for the conservation of marine ecosystems and the sustainable use of marine living resources; (ii) mitigating the impacts of fisheries and on the marine habitats and species; and (iii) identifying, protecting, and managing marine areas of particular importance in the Mediterranean Sea[106].

The **Convention for the Protection of the Black Sea against Pollution (Bucharest Convention)**[107] is the fourth Regional Sea Convention relevant for the EU and includes the six riparian Black Sea countries. The Bucharest Convention was adopted in 1992 and is implemented by the **Black Sea Commission**. The main aim of the Convention is to reduce and control pollution in the Black Sea to protect and preserve the marine environment. The Black Sea Commission adopted the **Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea**[108] in 2009. This Action Plan has three main goals: to reduce pollution, manage living resources, and ensure sustainable human development. It also requires member countries to develop national Black Sea Strategic Action Plans. The EU is currently not party to the Bucharest Convention (which is only open to national states) but has expressed its wish to become a full member. This would be beneficial for Romania and Bulgaria and would facilitate closer coordination in the implementation of the MSFD in the Black Sea[109].

Two final bodies in the EU policy landscape that are relevant for EBFM are **ASCOBANS**[110] and **ACCOBAMS**[111]. ASCOBANS and ACCOBAMS are agreements under the Bonn Convention for the protection of cetaceans. ASCOBANS is the Agreement on the Conservation of Small Cetaceans of the Baltic, North-East Atlantic, Irish and North Seas, and ACCOBAMS is the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea, and contiguous Atlantic area. Both agreements are legal tools that aim to reduce threats to cetaceans, particularly by improving current knowledge on those animals. The **ASCOBANS Strategic Plan for Migratory Species 2015-2023**[112] and **ACCOBAMS Strategy 2014-2025**[113] lay out the

[106] UNEP/MAP and FAO GFCM Memorandum of understanding: https://wedocs.unep.org/bitstream/handle/20.500.11822/10862/unep_eu_og_pre_%208.pdf?sequence=1&isAllowed=y
[107] Bucharest Convention: http://www.blacksea-commission.org/_convention.asp
[108] the Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea: http://www.blacksea-commission.org/_bssap2009.asp
[109] International cooperation of the EC with the Black Sea: https://ec.europa.eu/environment/marine/international-cooperation/regional-sea-conventions/bucharest/index_en.htm
[110] ASCOBANS: https://www.ascobans.org/
[111] ACCOBAMS: https://accobams.org/
[112] ASCOBANS Strategic Plan for Migratory Species 2015-2023: https://www.ascobans.org/sites/default/files/document/MOP8_Inf_5.1.a_StrategicPlan_MigratorySpecies_2015-2023.pdf
[113] ACCOBAMS Strategy 2014-2025: https://www.accobams.org/wp-content/uploads/2016/06/ACCOBAMS_Strategy.pdf

strategic objectives of both organisations, including tackling issues with an impact on cetacean conservation (such as fisheries, navigation, tourism, pollution, and climate change); and collection and dissemination of knowledge on cetaceans, including proposing new measures and supporting the implementation of area-based conservation measures. Both organisations use **Species Action Plans** as a framework for international collaboration. These plans include practical and achievable management actions that have the greatest chance of achieving measurable improvements in the conservation status of cetacean populations, including the necessary levels of protection for critical habitats. **ASCOBANS** currently has four **Species Action Plans**[114]: three covering Harbour porpoise (*Phocoena phocoena*) populations in the North Sea and Baltic Sea, and one for the Common dolphin (*Delphinus delphis*) in the North-East Atlantic. Bycatch is highlighted as an essential priority in these action plans. This includes specific actions that EcoScope could help address, such as identifying the highest risk fisheries in terms of activities and spatial extent, as well as including these species in ecosystem models. **ACCOBAMS** also has two **Species Conservation Management Plans**[115], including a conservation plan for the Common dolphin (*Delphinus delphis*) in the Mediterranean and one for all cetaceans in the Black Sea. The conservation plan for the Common dolphin also includes an action relevant for EBFM and EcoScope, namely, to manage fishing of small epipelagic fish stocks in a way that the energetic needs of Common dolphin are accounted for.

3.2.3 Overarching strategies

The **European Green Deal**[116]**,** adopted by the European Commission in 2019, represents Europe's novel growth strategy to transform the EU into a fair and prosperous society and make the EU's economy sustainable and resilient in the face of climate- and environmental challenges. The Green Deal aims to transform the EU into a resource-efficient economy by 2050, where there are no net emissions of greenhouse gases and economic growth is decoupled from resource use. It also aims to protect, conserve, and enhance EU's environment, protect the health and well-being of citizens from environment-related risks and impacts, and ensure no person and no place are left behind. To reach climate neutrality by 2050, the Commission adopted a new **European Climate Law**[117] in 2021. This law sets the target of reducing net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels and achieving climate neutrality (i.e. net-zero greenhouse gas emissions) by 2050. Climate neutrality is to be achieved by cutting emissions, investing in green technologies, and protecting the natural environment. To meet the requirements of this law, it is foreseen that Marine Renewable Energy areas will have to expand significantly.

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[114] ASCOBANS Species Action Plans: https://www.ascobans.org/en/documents/action-plans
[115] ACCOBAMS Species Conservation Management Plans: https://accobams.org/species_/conservation-plans/
[116] EU Green Deal (COM/2019/640): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN
[117] European Climate Law (Regulation (EU) 2021/1119): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1119

In the **EU Strategy on Offshore Renewable Energy**[118] the Commission proposed an increase of Europe's offshore wind capacity from its current level of 12 GW to at least 60 GW by 2030 and to 300 GW by 2050.

The EU's blue economy is fundamental to meeting the objectives of the EU Green Deal, including the environmental and climate objectives. To fully embed the blue economy into the Green Deal, the Commission adopted **a new approach for a Sustainable Blue Economy**[119] in the EU in 2021. This agenda for a blue economy, puts a strong green spin on the Blue Economy Strategy, and aims to make the transition from 'Blue Growth' to 'Sustainable Blue Economy'. The Sustainable Blue Economy agenda also stresses the importance of applying an **ecosystem-based management** approach to human activities (including fisheries and marine spatial planning). For the sustainable management of fisheries, the Sustainable Blue Economy Strategy advocates for digitalisation and to use advanced tools for fisheries (including ecosystem modelling), which is in line with the tools that EcoScope is developing.

The **EU Biodiversity Strategy 2030**[120], adopted in 2021, is a core part of the European Green Deal. The strategy is a holistic and long-term plan to protect nature and reverse the degradation of ecosystems. It is also the proposal for the EU's contribution to the upcoming international post-2020 biodiversity framework under the CBD. A core commitment under the Biodiversity Strategy is the **expansion of protected areas** to cover 30% of land and 30% of the sea. Moreover, one third of these protected areas, i.e., 10% on land and 10% on sea, must be strictly protected. Strict protection is defined as leaving natural processes essentially undisturbed to respect the areas' ecological requirements. The Biodiversity Strategy also sets ambitious restoration targets, including the development of a new **Nature Restoration Law**[121] with legally binding EU nature restoration targets. For the marine ecosystems, the Strategy indicates, that this will probably include restoration of marine biodiversity hotspots, carbon-rich ecosystems, and important fish spawning and nursery areas. Moreover, habitats and species should show no deterioration in conservation status and trends, and at least 30% of species and habitats protected under the Birds and Habitats Directives should reach favourable conservation status or show a positive trend. These measures aim to strengthen the protection of the marine ecosystems and to restore them to achieve GES. The Biodiversity Strategy also stresses the need for an **ecosystem-based approach** to the management of human activities at sea. For fisheries, it sets the targets to maintain or reduce fishing mortality to or under MSY levels; eliminate or reduce bycatch,

[118] EU Strategy on Offshore Renewable Energy (COM/2020/741): https://ec.europa.eu/energy/sites/ener/files/offshore_renewable_energy_strategy.pdf
[119] Sustainable Blue Economy Strategy (COM/2021/240): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:240:FIN
[120] Biodiversity Strategy 2030 (COM/2020/380): https://ec.europa.eu/info/sites/default/files/communication-annex-eu-biodiversity-strategy-2030_en.pdf
[121] Nature Restoration Law: https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030/eu-nature-restoration-targets_it

particularly for sea mammals, turtles and birds that are threatened with extinction or in bad status; and to tackle practices that damage the seabed. In line with these commitments, a new **Action Plan to conserve fisheries resources and protect marine ecosystems** will be developed by the Commission. This plan will investigate limiting the use of fishing gear most harmful to biodiversity and the seabed. It will also assess how to reconcile the use of bottom-contacting fishing gear with biodiversity goals, given the damage that bottom-contacting fishing gear causes to the seabed and the wider ecosystem. By 2024, the Commission will review the Biodiversity Strategy to assess progress and whether further action is needed to meet its objectives.

The **EU Mission: Restore our Ocean and Waters (Mission Ocean)**[122] was launched in 2021 and is implemented by DG RTD. EU Missions are a new way to bring concrete solutions to some of our greatest challenges. They have ambitious goals and will deliver concrete results by 2030. The Mission Ocean will support the implementation of key EU policy and regulatory initiatives relevant for the marine environment, including the European Green Deal. The three main objectives of the Mission are: (i) protect and restore marine and freshwater ecosystems and biodiversity; (ii) prevent and eliminate pollution of our Ocean, seas, and waters; and (iii) make the sustainable blue economy carbon-neutral and circular. Each of these objectives have specific targets, which are linked to key EU policy commitments. For instance, objective 1 (protect and restore marine and freshwater ecosystems and biodiversity) includes the targets of the Biodiversity Strategy 2030 of protecting at least 30% and strictly protecting 10% of EU's seas. Moreover, it includes the targets of implementing the marine nature restoration targets of the upcoming Nature Restoration Law, including on degraded seabed and coastal ecosystems. For each of the three objectives, the Mission will deploy innovative solutions at basin-scale in so called "lighthouses". Lighthouses are the Mission's sites to pilot, demonstrate, develop, and deploy activities. Two key enablers will support all three objectives, namely: (1) to foster a digital ocean and water knowledge system, including through the **European Digital Twin of the Ocean (DTO)**[123]; and (2) to promote a participatory governance based on public mobilisation and engagement. The EU Digital Twin of the Ocean will be a digital representation of the Ocean and its processes. It will use real-time and historical data to represent the past and present and create models to simulate future scenarios. The ambition is to make Ocean knowledge readily available to the society by providing innovative user-driven and interactive visualisation tools. All these features match closely with the tools that EcoScope is developing, making the EcoScope tools relevant to feed into the Digital Twin Ocean and the Mission Ocean. The main aim of the EU's

[122] EU Mission Ocean: https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/healthy-oceans-seas-coastal-and-inland-waters_en

[123] European Digital Twin of the Ocean (DTO): https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/healthy-oceans-seas-coastal-and-inland-waters/european-digital-twin-ocean-european-dto_en

Digital Twin Ocean is to help design the most effective ways to restore marine and coastal habitats, support a sustainable blue economy and mitigate and adapt to climate change.

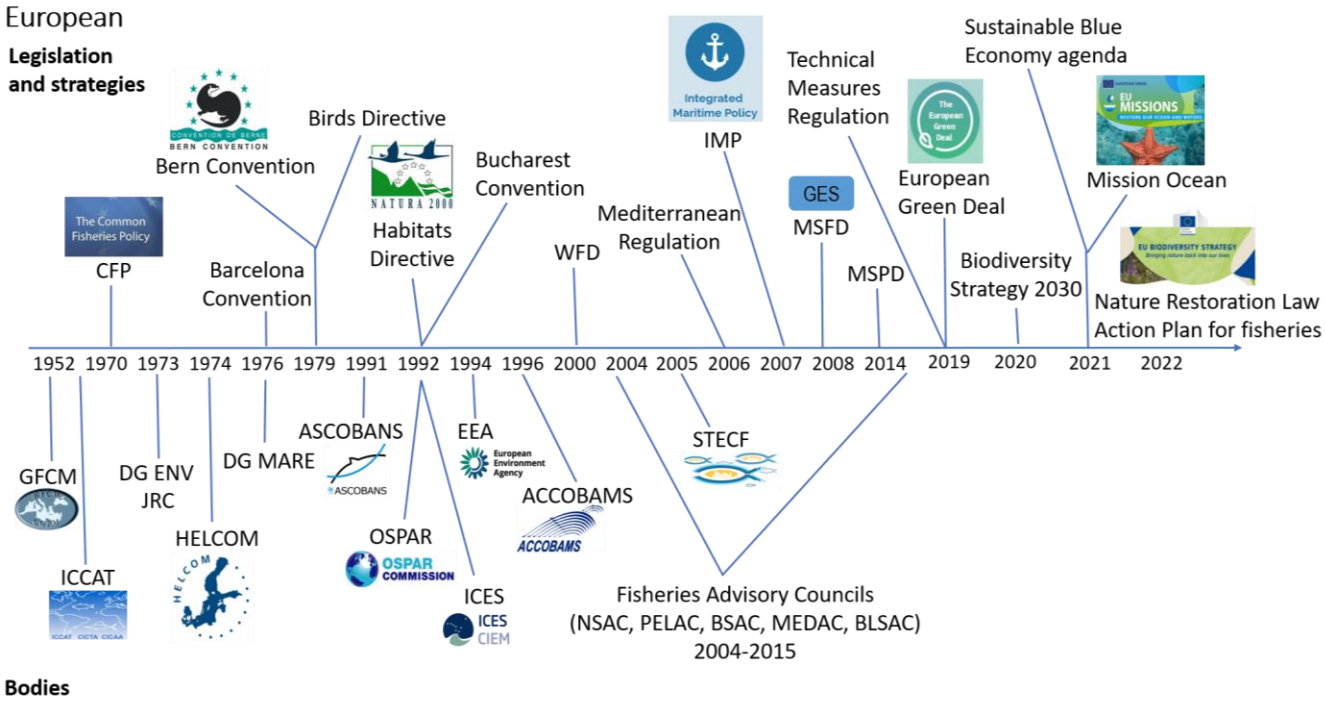

Figure 8: A timeline of key legislation, strategies, and bodies for European seas with relevance for ecosystem-based fisheries management (EBFM).

3.2.4 Strategic research agendas

Strategic Research and Innovation Agendas (SRIAs) identify priority research areas and activities to be carried by an organisation or partnership. The following SRIAs are relevant for EcoScope's case study areas and reflect research needs associated with meeting EU policy objectives.

The **Joint Baltic Sea and North Sea Strategic Research and Innovation Agenda (BANOS SRIA)**[124] aims to foster high-level cooperative research and innovation across the **Baltic Sea** and the **North Sea** to support sustainable use of ecosystem goods and services with robust scientific knowledge and know-how. With HELCOM, OSPAR and ICES as strategic partners, it is foreseen that the BANOS SRIA will deliver policy relevant results and knowhow to many management issues facing the Baltic Sea and the North Sea. The three strategic objectives of BANOS are Healthy Seas and Coasts, Sustainable Blue Economy, and Human Wellbeing. The three

[124] BANOS SRIA: https://www.banoscsa.org/files/7273/Banos_2021_SRIA_web_FINAL.pdf

objectives have a strong emphasis on the long-term sustainability and resilience of the marine ecosystems and its biodiversity, including the development of **ecosystem-based management approaches**. The BANOS programme aims to become a major provider of knowledge underpinning the policy measures for achieving GES in the Baltic Sea and the North Sea. Strategic objectives of the BANOS SRIA relevant for EcoScope are:

- A.1.3: Understanding the Potential of Marine Organisms and Ecosystems to Adapt to Environmental Changes;
- A.1.4: Operationalisation and Assessments for the Implementation of the Ecosystem Approach;
- A.3: Digital Ocean – Competent Ecosystem Modelling, Assessments and Forecasting, including;
    - A.3.1: Development of Artificial Intelligence for Marine Ecosystem Data Analysis and Models;
    - A.3.2: Ecologically Relevant Modelling of Underwater Landscapes; and
- B.1.1: Sustainable Harvesting, Extraction and Use of Marine Living and Mineral Resources.

The **BlueMed Strategic Research and Innovation Agenda (BlueMed SRIA)**[125] is the strategy of reference for the countries bordering the **Mediterranean Sea** to work together for a healthy, safe, and productive Mediterranean. The strategy was developed in 2014 between the European countries bordering the Mediterranean Sea, and it was subsequently adopted by all member countries of the **Union for the Mediterranean** [126]. The BlueMed SRIA therefore fosters collaboration and Blue Growth research and innovation activities on both sides of the Mediterranean. Strategic actions relevant for EcoScope include:

- B.1: Develop optimal fishing strategies, technologies, and practices to implement an ecosystem-based management of Mediterranean fisheries;
- B1.3: Develop innovative methods and tools for monitoring and governing Mediterranean fisheries, in line with existing policies;
- B2.3: Develop climate adaptation and mitigation strategies;
- D2.2: Characterize ecological niches of target species to improve their preservation and reduce the number of extinctions;
- E1.2 Support Maritime Spatial Planning and Integrated Coastal Zone Management through research on multi-level governance and management of multi-stakeholder processes, improving the dialogue with civil society;

[125] BlueMed SRIA: http://www.bluemed-initiative.eu/wp-content/uploads/2018/12/BLUEMED-SRIA_Update_2018.pdf
[126] Union for the Mediterranean: https://ufmsecretariat.org/

- E1.4 Provide scenarios of environmental change, investigating the impacts on biodiversity and ecosystems goods and services, of alternative socioeconomic development pathways, policy options and blue growth scenarios;
- E2.6 Develop tools/software to assess the cumulative impacts of human activities, including the role of land-based stressors, to ensure an eco-sustainable exploitation of marine resources, considering social and economic aspects; and
- E3.1 Develop tools to evaluate and select optimal zones for the implementation of Marine Renewable Energy farms with a multi-criteria approach (e.g. wind/solar/currents/energy potential, characteristics of seabed, interaction with other marine activities, environmental impacts, etc.).

The **EU Strategy for the Adriatic and Ionian Region (EUSAIR)**[127] is an EU macro-regional strategy that was jointly developed by the Commission and the **Adriatic-Ionian Region** countries and stakeholders. The strategy addressed four main pillars: (i) Blue Growth; (ii) Connecting the Region; (iii) Environmental Quality; and (iv) Sustainable Tourism. Specific objectives connected to these pillars include to ensure a good environmental and ecological status of the marine and coastal environment in line with EU law and the ecosystem approach of the Barcelona Convention; to contribute to the goal of the EU Biodiversity Strategy, and to promote sustainable and responsible fishing practices that will provide a steady stream of income for coastal areas. The EUSAIR Action Plan[128] reflects the concrete actions for the region that will be carried out. The indicative actions include:

- Scientific cooperation on fisheries and fish stocks;
- Sustainably managing fish stocks;
- Enhancing the network of Marine Protected Areas; and
- Implementing Maritime Spatial Planning and Integrated Coastal Management.

The **Black Sea Strategic Research and Innovation Agenda (SRIA)**[129] is a strategic document intended to guide stakeholders from academia, funding agencies, industry, policy, and society in addressing four main pillars to achieve a healthy, resilient, and better-valued **Black Sea**. These four pillars are: (1) addressing fundamental Black Sea research challenges; (2) developing products, solutions and clusters underpinning Black Sea Blue Growth; (3) building of critical support systems and infrastructure to enable policy; and (4) education and capacity building. Strategic actions of the SRIA relevant for EcoScope include:

[127] EUSAIR: https://www.adriatic-ionian.eu/wp-content/uploads/2018/04/For-a-prosperous-and-integrated-Adriatic-and-Ionian-region.pdf
[128] EUSAIR Action Plan: https://www.adriatic-ionian.eu/wp-content/uploads/2020/04/EUSAIR-SWD-2020.pdf
[129] Black Sea Strategic Research and Innovation Agenda: http://connect2blacksea.org/the-sria/

- Enhance food systems research including fisheries, recruitment, stock assessment and sustainability, MPAs, biotech (such as alternative protein sources);
- Support and promote methodologies for science-based policymaking, foresight and cost-benefit analyses and other financial instruments towards the assessment of the innovative and feasibility potential of projects;
- Develop sustainable fisheries and high-tech aquaculture including multi-use platforms; and
- Produce, collect, and make available compatible high-quality data sets (the FAIR principles and open data access).

The **Ocean and Human Health Strategic Research Agenda (SRA)** [130] provides a comprehensive overview of the required research and capacity to develop Oceans and Human Health in Europe. The SRA was developed by the EU-funded H2020 project Seas, Oceans and Public Health in Europe (SOPHIE) as a result of the growing awareness that the health of the Ocean has a direct impact on our wellbeing. This Agenda outlines the key research priorities and collaborations needed to inform policies and practices to protect the health of both the Ocean and humans. These priorities are categorised in three priority areas: (i) sustainable seafood and healthy people; (ii) blue spaces, tourism, and well-being; and (iii) marine biodiversity, biotechnology and medicine. The following priority research questions listed in the SRA are most relevant for EcoScope:

- How much will climate change affect Ocean productivity and cause changes in biodiversity such as species abundance, size, and location?
- How does increasing the human use of blue spaces affect the coastal and marine ecosystems and biodiversity?
- Can we demonstrate the benefit of designated MPAs to human as well as Ocean health?

4 Stakeholder needs

4.1 Policy related needs

As seen in the previous sections, the need to implement an ecosystem-based approach is enshrined in numerous policies and strategies, and various directives, strategies and bodies contribute to its implementation. In the EU, the ecosystem-approach is implemented cross-sectoral, and this results in key EBFM related needs that arise from each regulation and strategy. The CFP provides the rules and regulations that govern EU fisheries. The MSFD defines marine ecosystem health and sets the boundaries for an overall ecosystem-approach by the requirement to achieve and maintain Good Environmental Status. The Birds and Habitats Directives contribute to an ecosystem approach with the requirements to protect vulnerable species and habitats and

[130] Ocean and Human Health SRA: https://sophie2020.eu/strategic-research-agenda/

establish networks of protected areas. The MSPD lays the foundation for a sustainable multiple use of the sea; and the Biodiversity Strategy 2030 provides key commitments relevant for an EBFM and for ensuring a healthy marine environment. The Ocean Decade and the Mission Ocean are catalysing initiatives that bring numerous stakeholders together to achieve common visions. The following section will discuss the specific EBFM needs that arise from some of these directives and strategies in more detail.

The current **CFP** regulation observes that an EBFM needs to be implemented, and this requires advice on biotic, abiotic, social and economic components (Ramirez-Monsalve et al., 2021). In order to be able to provide sound advice and implement an EBFM, the following needs have been identified by the Commission (COM 2008/187 final)[131]. First, there is a **need for long-term predictions**. This is because multiple and often conflicting interests need to be reconciled in the process. While there may be short-term contradictions between social and ecological objectives, such contradictions largely disappear in the long-term, making long-term predictions essential. Second, there is a **need to include the effects of climate change** in the predictions because it is essential that fisheries should be conducted in a way which is robust to environmental change. Exploitation of fish stocks should therefore always allow for resilience to climate change. Third, there is a need to base management on the predictions of the diverse ecosystem effects of fisheries and of management measures, i.e., a **need for predicting the consequences of diverse scenarios.** This includes the description of ecosystems and their structure, processes and functions using all available knowledge. The document also elaborates on several issues that need to be addressed to ensure an EBFM. These include **reducing fishing pressure to MSY**; **protecting sensitive species and sensitive habitats**; and taking measures **to prevent distortions in the food web** and **ensure that natural ecosystem processes are not disrupted** (e.g., dependence of seabird colonies on sand eels for breeding success). Finally, the document highlights the importance of **expanding the current assessment of the status and trends of fish stocks and of the impact of fishing on ecosystems**.

The **Birds and Habitats Directive** require the strict protection of species listed in Annex I of the Birds Directive and Annex IV of the Habitats Directives. This includes numerous seabirds, all cetaceans, as well as five marine turtle species[132]. However, several of these strictly protected species are susceptible to bycatch. At least 29 seabird species listed in Annex I of the Birds Directives were found to be susceptible to bycatch (STECF, 2020), and bycatch is a high concern for the strictly protected Harbour porpoise (*Phocoena phocoena*) in the Baltic Sea and the Common dolphin (*Delphinus delphis*) in the Bay of Biscay. This has led environmental NGOs to

[131] The role of the CFP in implementing an ecosystem approach to marine management" (COM 2008/187 final): https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0187:FIN:EN:PDF
[132] Marine turtles requiring strict protection under the Habitats Directive: *Caretta caretta*, *Chelonia mydas*, *Lepidochelys kempii*, *Eretmochelys imbricate*, *Dermochelys coriacea*

send letters of complaints to the Commission, requesting action[133], and the Commission has started Infringement procedures[134]. **Finding solutions to significantly reduce bycatch of strictly protected species** is thus a significant need of the Commission, which has also asked ICES advice on this matter[135]. In addition, bycatch is identified as an essential priority in the ASCOBANS Species Action Plans[136] for the Harbour porpoise in the North Sea and the Baltic Sea, and for the Common dolphin in the North-East Atlantic. Other priorities in these action plans are to **identify the highest risk fisheries in terms of activities and spatial extent**, and to **include Harbour porpoise and Common dolphin in ecosystem models**.

The **Biodiversity Strategy 2030** aims to put Europe's biodiversity on a path to recovery by 2030 and contains specific actions and commitments, relevant for EBFM, that Member States must meet. The expansion of Marine Protected Areas (MPAs) to cover 30% of the sea, with 10% strict protection, is a key commitment under the Biodiversity Strategy. **Finding the most suitable areas to designate for protection** will thus be an important need for Member States and the Commission, which EcoScope could help fill with its ecosystem modelling tools. Another key commitment is the restoration of marine ecosystems. Legally binding restoration targets will be published with the Nature Restoration Law and **meeting the restoration targets** will be important. Since the legally binding restoration targets will also include passive restoration (i.e., removing pressures), the EcoScope tools can also help to meet this target. **Substantially reducing the negative impacts on the seabed, particularly from bottom-contacting gears** is another important commitment. It is foreseen that the Action Plan to conserve fisheries resources and protect marine ecosystems that will be published in 2022 will provide concrete measures and targets that Member States will have to meet. These measures will probably include limiting the use of fishing gear most harmful to biodiversity, such as bottom trawling. Finally, the Biodiversity Strategy sets the targets to maintain or **reduce fishing mortality to or under MSY levels**, and to eliminate or **reduce the levels of bycatch to a level that allows species recovery and conservation**. These commitments and targets are key guiding principles for the EU policy landscape for the next 10 years, and it is thus critical that the EcoScope tools are fine-tuned as much as possible to helping implement these goals.

To reach climate neutrality by 2050, the **European Climate Law** and the **EU Strategy on Offshore Renewable Energy** set the ambitious targets of reducing net greenhouse gas

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[133] NGOs call on the EC to take action over huge amounts of cetacean deaths: https://seas-at-risk.org/press-releases/groups-call-on-the-european-commission-to-take-action-over-huge-number-of-cetacean-deaths/

[134] Commission urges France, Spain and Sweden to take action to reduce bycatch: https://ec.europa.eu/commission/presscorner/detail/en/INF_20_1212

[135] ICES advice summary (2020) on EU request to prevent bycatch of the common dolphin in the Bay of Biscay and the Harbour Porpoise in the Baltic Proper: https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2020/Special_Requests/eu.2020.04.pdf

[136] ASCOBANS Species Action Plans: https://www.ascobans.org/en/documents/action-plans

emissions by at least 55% by 2030 and increasing Europe's offshore wind capacity five-fold by 2030 and 25-fold by 2050. Achieving these targets will require a significant **expansion of Marine Renewable Energy**: another need of Member States. The EcoScope tools could help evaluating where best to place the additional Marine Renewable Energy areas, and the impact that the placement of these areas will have on other users of the Ocean.

The **Digital Twin of the Ocean (DTO)** is an important element of the **Ocean Decade** and the **EU Mission Ocean**. For the Ocean Decade, the digital Ocean ecosystem is seen as a cornerstone of success. It will contribute to understanding the Ocean using historical, contemporary, and modelled data, to describe the past and current conditions and predict future Ocean conditions (UNESCO-IOC, 2021). For the Mission Ocean, the DTO is expected to support a sustainable blue economy, including fishing, aquaculture, transport, offshore energy, etc. It should allow assessments of the state of ecosystems, habitats, and the impacts of human activities; testing for "what-if" scenarios, including forecasts of short and long-term changes; development of biodiversity conservation strategies; and management of sustainable economic activities[137]. The characteristics of the DTO are highly correlated with what the EcoScope tools can do, making EcoScope a potentially important contributor of meeting these needs.

The **Ocean Decade** also has needs associated with meeting the seven **Ocean Decade Outcomes**. The Decade Outcomes are: (i) a clean Ocean; (ii) a healthy and resilient Ocean; (iii) a productive Ocean; (iv) a predicted Ocean; (v) a safe Ocean; (vi) an accessible Ocean; and (vii) an inspiring and engaging Ocean. The needs include to stimulate the development of marine spatial planning, marine protected areas, and other ecosystem-based management approaches. Moreover, the Decade should create a better understanding of the interactions and interdependencies of environmental conditions and processes. Defining safe and sustainable thresholds for economic operations in the Ocean is also important to help policy-makers and stakeholders implement a truly sustainable blue economy. Finally, improved access to understanding present and future Ocean conditions is a pre-requisite to the development of sustainable Ocean economic policies and ecosystem-based management, and to balancing blue-green growth to ecosystem protection (UNESCO-IOC, 2021). EcoScope can make a definite contribution to these needs of the Ocean Decade.

Finally, strategic research agendas, strategic plans and species action plans reflect key needs of organisations and partnerships that are relevant for policy and which EcoScope could help address. For instance, the **Strategic Research and Innovation Agendas (SRIAs)** of EU sea basins outline research needs associated with meeting policy objectives in those basins (see

[137] A transparent & accessible ocean: Towards a Digital Twin of the Ocean: https://ec.europa.eu/info/sites/default/files/research_and_innovation/green_deal/gdc_stakeholder_engagement_topic_09-3_digital_ocean.pdf

section 3.2.4). The **Strategic Plans of organisations**, such as ICES Science Plan[138] and the GFCM Strategy 2030[139] (section 3.2.1), offer important insights into the needs of these bodies, which are critical to implementing an EBFM. The **Species Action Plans** of ASCOBANS[140] and ACCOBAMS[141] (section 3.2.2) highlight key questions relevant for the conservation of cetaceans and the implementation of an EBFM.

4.2 Stakeholder needs – survey and workshop results

4.2.1 Policy questions and scenario testing

The specific needs of key stakeholders in relation to ecosystem modelling and implementing EBFM were gauged through a stakeholder survey and a foresight workshop[142]. To inform the development of the EcoScope e-tools, several questions in the survey were aimed at understanding stakeholder needs related to scenario testing. This included understanding key topics, specific questions, and policy commitments relevant for stakeholders that could be addressed with ecosystem modelling. The **key policy commitments**, for which stakeholders indicated that ecosystem modelling can help provide answers were the **MSFD**, the **CFP** and the **Biodiversity Strategy 2030**. For the MSFD, achieving Good Environmental Status and descriptors D1 (biodiversity is maintained), D3 (the population of commercial fish species is healthy), D4 (elements of food webs ensure long-term abundance and reproduction) and D6 (the sea floor integrity ensures functioning of the ecosystem) were mentioned. For the CFP, the main commitments that stakeholders thought ecosystem modelling could help with were implementing an EBFM, exploiting all stocks at or below MSY, and establishing fish stock recovery areas. For the Biodiversity Strategy 2030, implementing the protected areas target of 30% protection and 10% strict protection were seen as highly relevant, as well as the upcoming commitments under the **Nature Restoration Law** and **Action Plan for Fisheries and the Marine Environment**. These policy commitments reflect key directives and strategies for implementing EBFM in Europe.

Stakeholders were also asked to select the five **most relevant topics** for them. The most relevant topics to these stakeholders were (in order of relevance): (i) **effects of climate change**; (ii) **bycatch**; and **protected areas/ fisheries restricted areas**; (iii) **biodiversity indicators**; and (iv) **trade-offs between different uses of marine and coastal areas**; and **species distribution** (Fig. 9).

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[138] ICES Science Plan: https://www.ices.dk/news-and-events/news-archive/news/Pages/ICES-Science-Plan-questions-and-answers.aspx
[139] GFCM 2030 Strategy: https://www.fao.org/publications/card/fr/c/CB7562EN/
[140] ASCOBANS Species Action Plans: https://www.ascobans.org/en/documents/action-plans
[141] ACCOBAMS Species Conservation Management Plans: https://accobams.org/species_/conservation-plans/
[142] For more information see EcoScope deliverables D.8.1: Report of stakeholder survey and D.8.3: Report on First Foresight Workshop

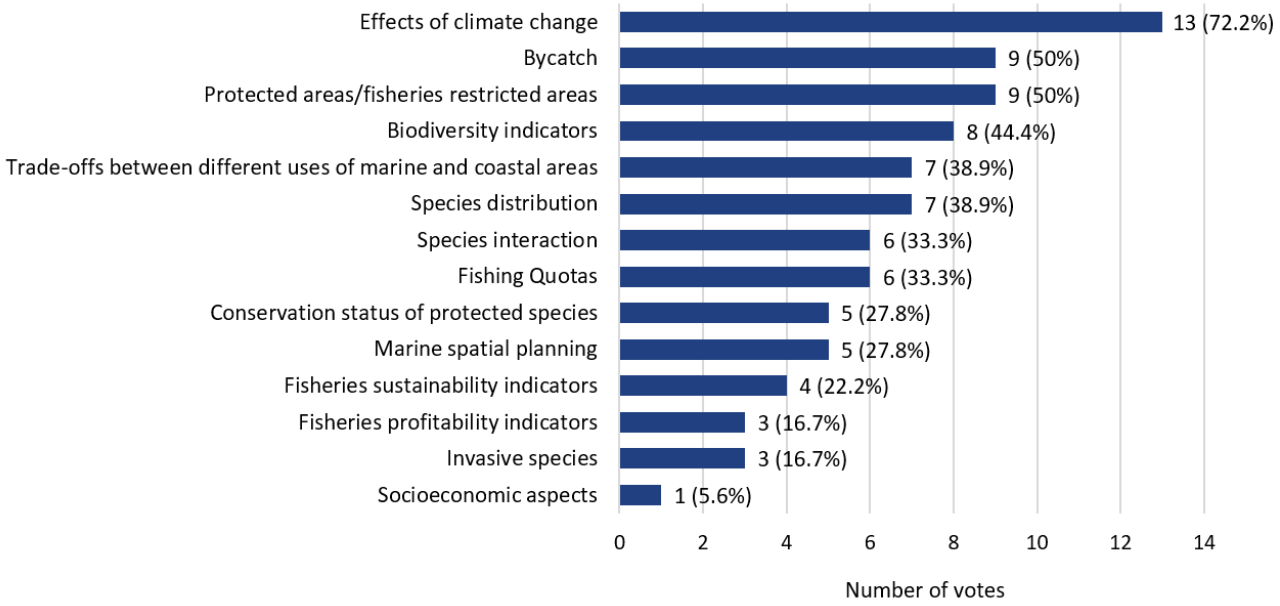

Figure 9: EBFM topics ordered by relevance as voted in a stakeholder survey by 18 respondents (EcoScope task 8.3.1; deliverable D.8.1).

Understanding the **effects of climate change** was the most relevant topic for the stakeholders. The main questions that stakeholders had on this topic where: (i) what are the impacts on fish stocks and other species? (e.g., distribution and productivity); (ii) which fishing quotas are sustainable with climate change; and (iii) will it lead to regime shifts? Obtaining knowledge on the effects of climate change is relevant for meeting the objectives of many EU and international policies and commitments (e.g., the CFP, the MSFD, the Birds and Habitats Directive, as well as the Biodiversity Strategy 2030 and the Ocean Decade). Addressing potential effects of climate change is also an objective of the GFCM Strategy[143], ICES' strategic Science Plan[144], as well as the BANOS SRIA[145], the BlueMed SRIA[146], and the Ocean and Human Health SRA[147].

The second most relevant topic for the respondents (with equal votes) were bycatch and protected areas/ fisheries restricted areas. For **bycatch** specific questions were: (i) what are population impacts of specific bycatch levels on marine sensitive species (e.g. harbour porpoise in the Baltic and common dolphin in the Bay of Biscay); (ii) what is the "allowed" bycatch of a protected/

[143] GFCM 2030 Strategy: https://www.fao.org/publications/card/fr/c/CB7562EN/
[144] ICES Science Plan: https://www.ices.dk/news-and-events/news-archive/news/Pages/ICES-Science-Plan-questions-and-answers.aspx
[145] BANOS SRIA: https://www.banoscsa.org/files/7273/Banos_2021_SRIA_web_FINAL.pdf
[146] BlueMed SRIA: http://www.bluemed-initiative.eu/wp-content/uploads/2018/12/BLUEMED-SRIA_Update_2018.pdf
[147] Ocean and Human Health SRA: https://sophie2020.eu/strategic-research-agenda/

sensitive species (and the species that these species depends on) that will allow recovery or sustaining healthy levels; (iii) how can different management scenarios reduce the bycatch of protected species; and (iv) what are the best gear modification options to minimize capture of juveniles/vulnerable species? As discussed in the previous section, reducing bycatch of protected species is currently a main priority under the Birds and Habitats Directives, and minimising bycatch is also an important objective of the Biodiversity Strategy 2030.

The main questions for **protected areas/ fisheries restricted areas** were: (i) which areas should be protected across a certain region to harness maximum positive effects; (ii) what are the most valuable ecosystems to designate protected areas and strictly protected areas and how do they overlap with areas important for fishing (and other uses); and (iii) how would the closure of a certain area to certain fisheries affect the species diversity/abundance in *x* years? These questions reflect the commitments made under the Biodiversity Strategy 2030, as well as objectives under the MSFD and the Birds and Habitats Directives.

For the topic of **biodiversity indicators**, the questions centred mostly around objectives of the MSFD and the Biodiversity Strategy 2030, namely: (i) what is the threshold of good environmental status for marine biodiversity; (ii) what would be the effect of reductions on 'charismatic species' (relevant to MSFD D1); and (iii) what are the best ecosystem-based indicators for biodiversity, in relation to the Biodiversity Strategy targets?

For **trade-offs between different uses of marine and coastal areas**, the specific questions of stakeholders were mainly on reducing the impacts of bottom trawling, reflecting the upcoming commitments under the Biodiversity Strategy 2030 and the Action Plan for Fisheries and the Marine Environment. The specific questions were: (i) what is the effect of reducing trawling (or other fishing techniques) in all marine protected areas and in x% of marine area on (1) economic performance of fisheries and (2) on restoring biodiversity; (ii) what are the impacts of closure of x% bottom trawling area; and (iii) what are the trade-offs of the impact of preserving seabed habitats or areas of higher sensitive species occurrence (through 'strictly protected' MPAs) vs. the impact on economic activities, particularly on fishing?

Stakeholders also mentioned several questions on **fishing quotas** for which they would need answers. These questions were: (i) which fishing quotas are really sustainable (e.g. considering impacts of climate change, interspecies interactions and ecosystem resilience to stressors); (ii) are current quotas (also FMSY; BMSY) sustainable in an ecosystem context - also in light of future climate change; (iii) what is the fishing mortality that allows a harvested species to develop its role in the ecosystem (e.g. predator prey-interactions, etc.); (iv) what is the exploitation rate that ensures that all species in a mixed fishery are maintained at "healthy" levels; and (v) how would *x*% reduction in quota of a certain species change its biomass in *x* years? Would it cause changes in abundance of other species?

Addressing the topics of relevance and specific questions of policy makers, practitioners, and other relevant stakeholders in EcoScope's ecosystem models is critical if the tools

are to inform policy and decision-making. Despite clear capability and progress in marine ecosystem modelling, many models are designed to answer scientific questions, not policy questions, which hinders uptake in policy (Heymans et al., 2018). Ecosystem models that are designed to address policy questions need to be linked to policy goals and targets and require a good understanding of policy requirements. Effective application and uptake of scenarios and models in policymaking and decision-making **requires close involvement of policy makers, practitioners and other relevant stakeholders throughout the entire process of scenario development** (IPBES, 2016; Heymans et al., 2018). This was also a request of two stakeholders, one from the EC and one from a scientific advisory body, **during the EcoScope Foresight workshop**. These stakeholders questioned how EcoScope will identify the policy issues, because the models need to be tailored to those issues and cannot be generic. Moreover, the **stakeholders asked to be kept involved to investigate how the needs of upcoming EC policy initiatives could be integrated in the models**. Thus, it is critical that the EcoScope project carefully matches the scenarios, models, and tools to the needs of key stakeholders, by involving them in the design throughout the entire process. This is particularly relevant for those stakeholders which are most likely to use the EcoScope tools and which have a high influence in the EBFM decision-making landscape. For instance, during the EcoScope workshop, ICES was pointed out as a key stakeholder that should be kept closely involved to ensure that the models are taken up by this organisation.

A good **example of stakeholder involvement** is the regional implementation plan developed for the Balearic Islands in the framework of the EU Myfish project[148]. This study was a first step toward the application of the EBFM in the Balearic Islands by developing a harvest strategy with defined objectives, targets, limits, and clear management control rules aimed at optimizing socioeconomic and ecological objectives in the framework of the new CFP. Different management scenarios designed to achieve that goal were modelled for the main demersal commercial fisheries from the study area, the bottom trawl and small-scale fisheries. Throughout the process there was strong involvement of relevant stakeholders through meetings and constant feedback. The management scenarios were agreed with stakeholders, and local stakeholders were involved in how to best present the model results from the selected management scenarios (Quetglas et al., 2017). Similarly, **continued engagement with key stakeholders of the EcoScope case study areas will be critical** to ensure that the models deliver policy relevant outputs, and that the results are taken up by decision-makers.

4.2.2 Scenario and data results visualisation

Both the survey and the workshop assessed stakeholder needs regarding the output format of the EcoScope tools. The results of the survey identified that the preferred formats included **visual spatial** formats, **interactive** maps, and **infographics.** Furthermore, the respondents wanted an

[148] Myfish project: https://www.myfishproject.eu/

online **user-friendly, easy to use** and **easy to understand** tool with many **customisable** functionalities, including spatial representations. **"Gamifying" models** were also suggested to make the tools easier to use. The workshop also discussed how best to present the data. It concluded that **simple plots** and **simple summaries** would be most useful, presenting the main outcomes of different management scenarios. Moreover, the simplified overview could have the **option to explore further** to see how those results came to be. For the sustainability scoring system, one stakeholder suggested that this could include the option of disaggregating the score of each category into the multiple indicators that fed into it and presenting these results as a traffic light system.

The needs of the stakeholders align overall with what EcoScope is planning to develop. For instance, the EcoScope Platform will be in a visual-spatial format, consisting of interactive maps with customisable functionalities. The MSP Challenge Simulation Platform "gamifies" ecosystem models by using game technology to engage and immerse users. The project also plans to use infographics as a means for presenting scenario results. Figure 10 is an example of a **Decision Support Table (DST)** that could be used to present EcoScope's ecosystem modelling scenario results in a simple way that is easy to understand.

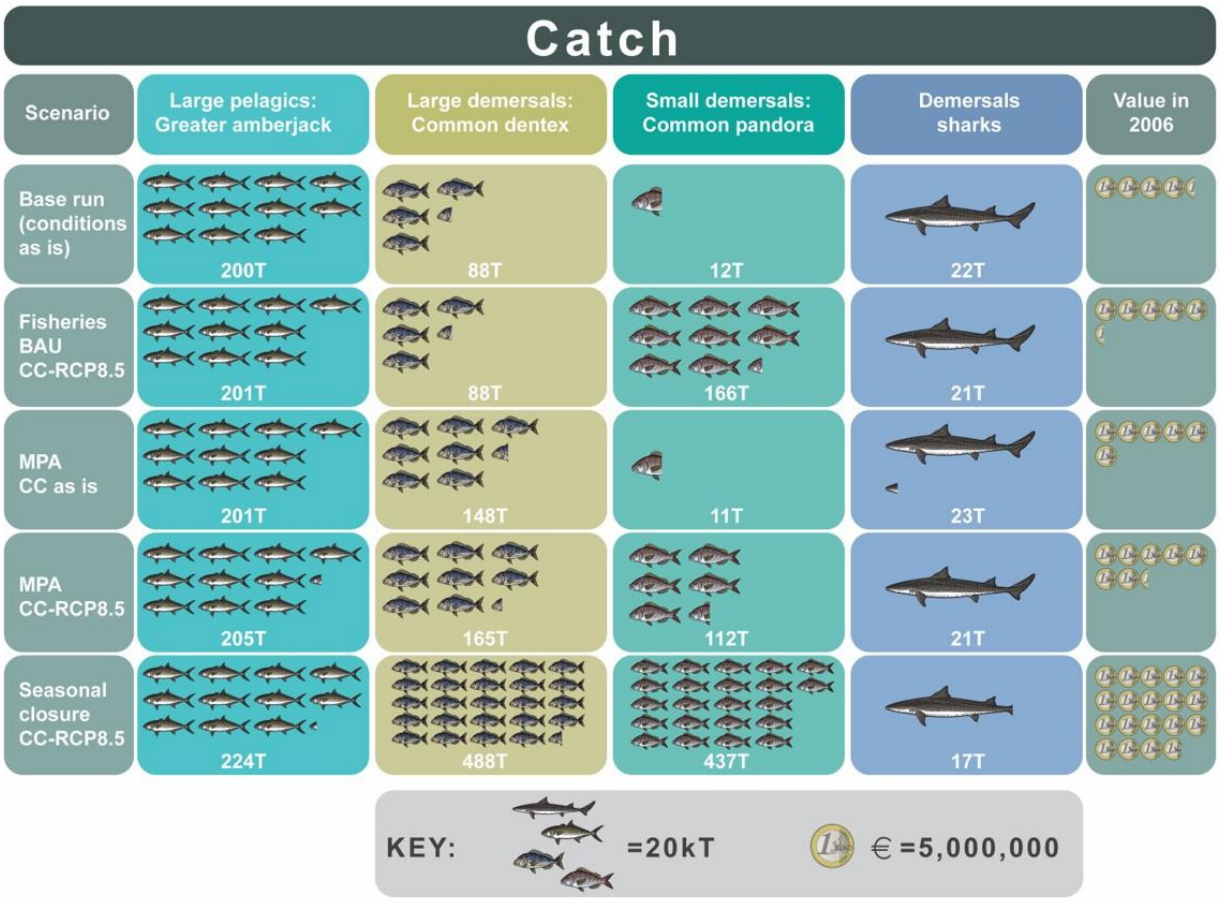

Figure 10: Example of a Decision Support Table (DST) infographic that could be used to communicate ecosystem modelling scenario results in a simple manner. This graphic was shown as part of the EcoScope First Foresight Workshop and is based on graphics originally produced by the EU Myfish project. Image credit: Gideon Gal

DSTs are graphical tables that reflect the effects and trade-offs of implementing different management options. These graphics are designed to convey complex, alternative management scenarios in a simple and understandable way to support fisheries managers in their decision making. The Myfish project produced a DST to convey the outcomes of different modelled EBFM management scenarios (Figure 11). This DST was produced with a strong involvement of local stakeholders (Quetglas et al., 2017), and could be used as a framework to present the management scenario results in the EcoScope project.

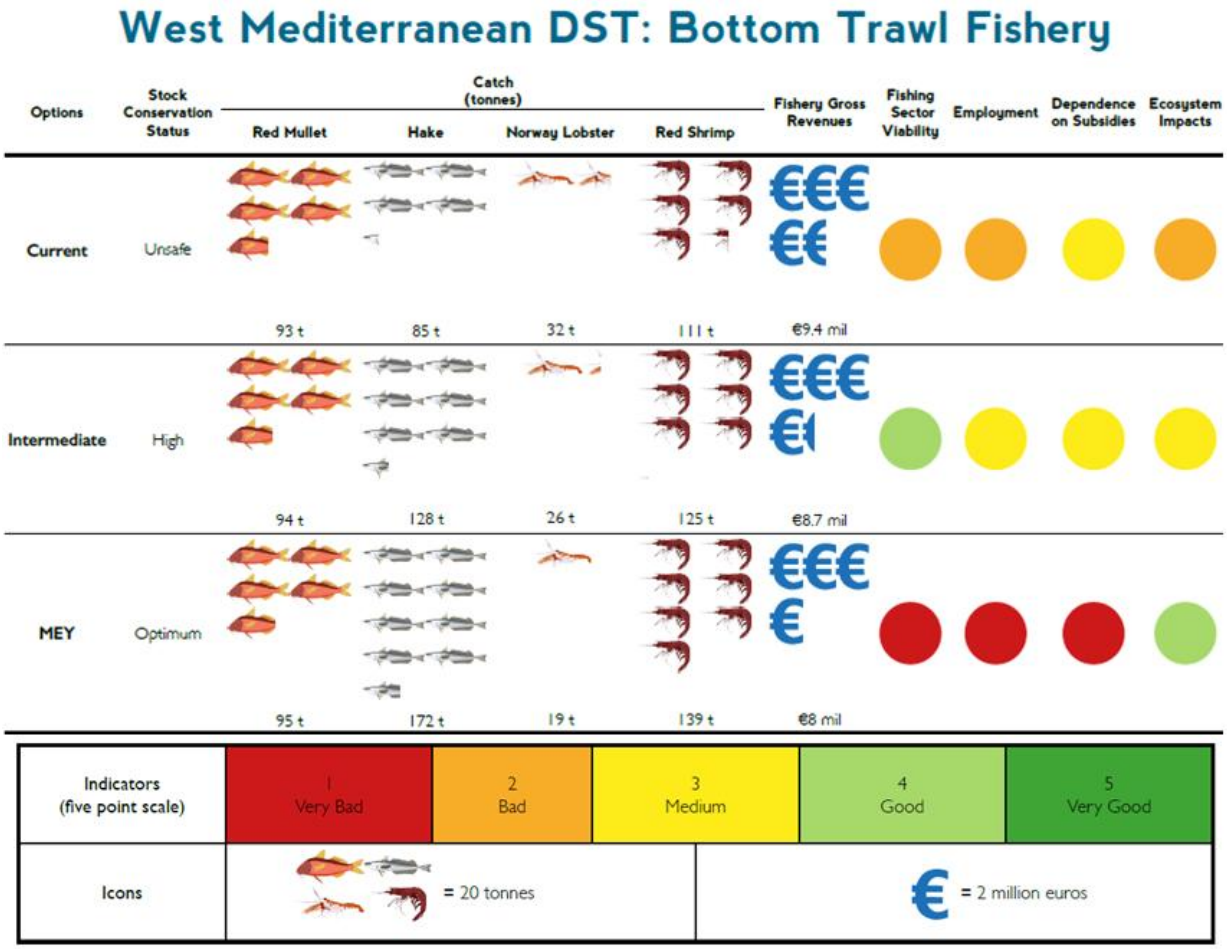

Figure 11: Decision Support Table (DST) reflecting the ecosystem model results of different management scenarios for the main commercial bottom trawl fisheries of the Balearic Sea. Image source: Quetglas et al., 2017 (CC BY 4.0)

In order to make the graphical outputs of EcoScope relevant to stakeholders, it is important to **involve stakeholders in the design**, as was done in the Myfish project (Quetglas *et al.*, 2017; Figure 11). Co-creating the graphical outputs with relevant stakeholders was also a recommendation given during the EcoScope workshop.

4.2.3 Uptake of ecosystem model and scenario results in policy making

Although stakeholders were positive about the use of ecosystem models as a tool for managers in meeting EU policy requirements, some concerns emerged during the survey. The three main **barriers** were: reliability of the model's results; insufficient data; and having enough trust in the model outputs. There was a general concern about the **reliability and realism of the model and their forecasts**, including the accuracy of the models due to limited understanding of some ecological processes and data scarcity. **Insufficient data**, data limitations and the quality of input data were key concerns. A lack of data was also seen as one of the main impediments in implementing an EBFM. Many stakeholders voiced concerns about **model limitations**, given the complexity of ecological systems and questioned if these systems can be adequately described by models. The respondents also questioned whether models can properly quantify **uncertainty** in a whole ecosystem scenario. Thus, trust in the models was seen as a key barrier and it was suggested to better understand and communicate the limitations and uncertainties of the models.

How to address and communicate uncertainty was further discussed during the stakeholder workshop. Recommendations included: (i) using a range of possible values, instead of final numbers; (ii) focusing on communicating trends, rather than a specific value, as these are easier to communicate and have less uncertainty; and (iii) labelling the certainty of the results, rather than the uncertainty. A good example for the latter is the IPCC summary report for Policy Makers[149], where results are labelled with "*high confidence*", "*medium confidence*", and "*low confidence*". In addition, it was suggested to include information stating by whom/ how the models had been validated to increase trust in their outputs.

The concerns that stakeholders reported during the survey and the workshop align closely with **insights of previous work**. Previous studies from IPBES and the European Marine Board also found that **communicating model limitations and uncertainty is vital** if the models are to be used in decision-making (IPBES, 2016; Heymans et al., 2018, 2020). Uncertainty associated with models is currently poorly evaluated and reported and this can lead to serious misconceptions regarding the confidence level with which results can be used in decision-making (IPBES, 2016). Reporting uncertainty therefore increases the confidence with which the outputs can be used for decision-making as well as the credibility of models (Heymans et al., 2018). These reports also

[149] IPCC report for policy makers: https://www.ipcc.ch/sr15/chapter/spm/

found that **large gaps of appropriate data** is a significant barrier, since lack of appropriate data will often limit the ability of a model to predict (IPBES, 2016; Heymans et al., 2018).

The IPBES report concluded that several **barriers** have impeded the widespread use of scenarios and ecosystem models in decision-making. These barriers include: (i) a **lack of understanding of the benefits and limits of using scenarios and ecosystem models** for assessment and decision support among decision-makers; (ii) **insufficient involvement of, and interactions between, scientists, stakeholders and policymakers** in developing scenarios and models to assist policy design and implementation; and (iii) **inadequate characterization of uncertainties** derived from data constraints, problems in system understanding and representation or low system predictability (IPBES, 2016).

For EcoScope's models and scenario outputs to be taken up in decision-making it is therefore critical that these barriers are overcome. A better understanding of the limitations of the EcoScope toolbox and clear communication of the limitations and uncertainties of the models (including the data feeding into the models) and scenario outputs is thus essential. The EcoScope project should build an understanding of models among stakeholders in a manner that allows them to understand the limitations but also the probabilities with which they predict. This includes clearly communicating limitations and uncertainties and should include reflecting the confidence level of scenario outputs. Moreover, stakeholders should be closely involved in developing the scenarios of each case-study areas as discussed in previous sections.

5 Conclusion

The need to implement an ecosystem-based approach is enshrined in numerous global and European policies and strategies, and several bodies contribute to its implementation. The Commission identified that to implement an EBFM there is a need for long-term predictions and a need for predicting the consequences of diverse scenarios (COM 2008/187 final). Marine ecosystems are an important tool for this purpose. They integrate data and knowledge; improve understanding on ecosystem functioning; and complement monitoring and observation efforts. They also offer the potential to predict the response of marine ecosystems to future scenarios and to support the implementation of ecosystem-based management in the Ocean (Heymans et al., 2018). The EcoScope tools, which include ecosystem modelling and scenario testing, have the potential to meet some of these critical needs of stakeholders. This report provided an overview of the global and European policy landscape that is driving the needs of stakeholders, as well as an overview of key EBFM needs. Key topics of concern included effects of climate change; bycatch; protected areas/ fisheries restricted areas; and reducing the impacts of trawling. The most relevant policy commitments for EcoScope were the MSFD, the CFP and the Biodiversity Strategy 2030, with its associated Nature Restoration Law and Action Plan for Fisheries and the Marine Environment. The commitments and targets of the Biodiversity Strategy 2030 represent key guiding principles for the EU policy landscape for the next ten years and will therefore constitute a strong driving force of stakeholder needs. Addressing the main topics of

relevance and specific questions of stakeholders with the EcoScope models is critical if these tools are to inform decision-making. Moreover, it is important to continue to closely involve stakeholders in scenario development and in designing graphical outputs to ensure that the tools are fit-for-purpose and can be used in decision-making. Close involvement of stakeholders will further be beneficial to overcome the main barriers that can hinder uptake of models and scenarios, including a lack of understanding of the benefits and limits of ecosystem models; insufficient involvement and interaction with stakeholders; and inadequate characterization of uncertainties (IPBES, 2016). If these barriers are overcome and the models can address critical policy questions, the EcoScope project will make an important contribution to the EBFM needs of stakeholder.

6 Index of policies, strategies and bodies

A	Action Plan to conserve fisheries resources and protect marine ecosystems	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea, and contiguous Atlantic area (ACCOBAMS)
ACCOBAMS Species Conservation Management Plans	ASCOBANS Strategic Plan for Migratory Species 2015-2023	Advisory Councils (ACs)
Aichi Biodiversity Targets	Agreement on the Conservation of Small Cetaceans of the Baltic, North-East Atlantic, Irish and North Seas (ASCOBANS)	ASCOBANS Species Action Plans
ASCOBANS Strategic Plan for Migratory Species 2015-2023	**B**	Baltic Sea Advisory Council (BSAC)
Baltic Sea Action Plan (BSAP)	Black Sea Advisory Council (BLAC)	Black Sea Commission
Black Sea Commission Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea	Black Sea Strategic Research and Innovation Agenda (SRIA)	BlueMed Strategic Research and Innovation Agenda (BlueMed SRIA)
Biodiversity Beyond National Jurisdiction (BBNJ) Treaty	Biodiversity Strategy 2030	**Birds and Habitats Directives** Birds Directive
C	Committee of Fisheries (COFI)	Common Fisheries Policy (CFP)

Convention for the Protection of the Black Sea against Pollution (Bucharest Convention)	Convention for the Protection of the Marine Environment in the Baltic Sea Area (Helsinki Convention)	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)
Convention on Biological Diversity (CBD)	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Convention on Migratory Species (CMS)
Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)	**D**	Data Collection Framework (DCF)
European Digital Twin of the Ocean (**DTO)**	Directorate-General for Environment (DG ENV)	Directorate-General for Maritime Affairs and Fisheries (DG MARE)
Directorate-General for Research and Innovation (DG RTD)	**E**	European Commission (EC)
European Climate Law	European Environmental Agency (EEA)	European Green Deal
EU Strategy for the Adriatic and Ionian Region (EUSAIR)	**F**	Food and Agriculture Organisation (FAO)
G	General Fisheries Commission for the Mediterranean (GFCM)	GFCM 2030 Strategy
H	Habitats Directive	Helsinki Commission (HELCOM)
HELCOM's Group on Ecosystem-based Sustainable Fisheries (Fish Group)	**I**	Integrated Maritime Policy (IMP)
Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO)	IOC's Medium-Term Strategies	Intergovernmental Panel on Climate Change (IPCC)
Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)	International Commission for the Conservation of Atlantic Tunas (ICCAT)	International Council for the Exploration of the Sea (ICES)
ICES Science Plan	International Plans of Action (IPOA)	IUCN Red List of Threatened Species

J	Joint Baltic Sea and North Sea Strategic Research and Innovation Agenda (BANOS SRIA)	joint recommendations
Joint Research Centre (JRC)	**M**	Marine Spatial Planning Directive (MSPD)
Marine Strategy Framework Directive (MSFD)	Mediterranean Regulation	Mediterranean Sea Advisory Council (MEDAC)
Member States Regional Groups (MSRGs)	EU Mission: Restore our Ocean and Waters **(Mission Ocean)**	Multiannual Management Plans (MAPs)
N	Natura 2000 network	Nature Restoration Law
North Sea Advisory Council (NSAC)	**O**	Ocean and Human Health Strategic Research Agenda (SRA)
Oslo-Paris Convention for the Protection of the Marine Environment in the North-East Atlantic (OSPAR)	OSPAR Commission	OSPAR's North-East Atlantic Environmental Strategy (NEAS) 2030
P	Pelagic Stocks Advisory Council (PELAC)	Post-2020 Global Biodiversity Framework
R	Regional Fisheries Management Organisations (RFMOs)	Regional Seas Programme
Regional Sea Conventions (RSCs)	**S**	Scientific, Technical and Economic Committee for Fisheries (STECF)
Species Action Plans	Strategic Research and Innovation Agendas (SRIAs)	EU Strategy on Offshore Renewable **Energy**
UN Sustainable Development Goals (SDGs)	Sustainable Blue Economy Strategy	**T**
Technical Measures Regulation	**U**	United Nations (UN)
the UN Convention on the Law of the Sea (**UNCLOS)**	UN Decade of Ocean Science for Sustainable Development (Ocean Decade)	UN Decade on Ecosystem Restoration (Restoration Decade)

UN Environmental Programme (UNEP)	UNEP's Medium-Term Strategy (2022-2025)	UNEP-MAP
UNEP-MAP Regional Action Plans	UN Fish Stocks Agreement (UNFSA)	UN-Oceans
W	Water Framework Directive (WFD)	

7 List of Abbreviations

AC	Advisory Councils
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
ACOM	ICES Advisory Committee
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BANOS SRIA	Joint Baltic Sea and North Sea Strategic Research and Innovation Agenda
Barcelona Conv.	UNEP/MAP Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean
Bern Convention	Convention on the Conservation of European Wildlife and Natural Habitats in Europe
BlueMed SRIA	BlueMed Strategic Research and Innovation Agenda
Bucharest Conv.	Convention for the Protection of the Black Sea against Pollution
BLAC	Black Sea Advisory Council
BSAC	Baltic Sea Advisory Council
BSAP	HELCOM's Baltic Sea Action Plan
BBNJ	Biodiversity Beyond National Jurisdiction
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora

CMS	Convention on Migratory Species (also known as Bonn Convention)
COFI	FAO Committee of Fisheries
CFP	Common Fisheries Policy
DCF	Data Collection Framework
DG	Directorate-General of the European Commission
DG ENV	Directorate-General for Environment
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DST	Decision Support Table
DTO	European Digital Twin of the Ocean
EBFM	Ecosystem-Based Fisheries Management
EC	European Commission
EEA	European Environmental Agency
EU	European Union
FAO	Food and Agriculture Organisation
Fish Group	HELCOM's Group on Ecosystem-based Sustainable Fisheries
GDP	Gross Domestic Product
GES	Good Environmental Status (under the MSFD)
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
IMP	Integrated Maritime Policy
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPOA	International Plans of Action

IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre
MAPs	Multiannual Management Plans under the CFP
MAP	Mediterranean Action Plan under UNEP
MEDAC	Mediterranean Sea Advisory Council
Mission Ocean	EU Mission: Restore our Ocean and Waters
MoU	CMS Memoranda of Understanding
MoU Sharks	Memorandum of Understanding on the Conservation of Migratory Sharks
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MSPD	Marine Spatial Planning Directive
MSRG	Member States Regional Group
MSY	Maximum Sustainable Yield
NBSAPs	National Biodiversity Strategies and Action Plans (under the CBD)
NEAS	OSPAR's North-East Atlantic Environmental Strategy
NSAC	North Sea Advisory Council
Ocean Decade	UN Decade of Ocean Science for Sustainable Development (2021-2030)
OSPAR	Oslo-Paris Convention for the Protection of the Marine Environment in the North-East Atlantic
HELCOM	Helsinki Commission, implementing the Convention for the Protection of the Marine Environment in the Baltic Sea Area (Helsinki Convention)
PELAC	Pelagic Stocks Advisory Council
SAC	Scientific Advisory Committee of Fisheries (GFCM)
SCICOM	ICES Scientific Committee
SCRS	Standing Committee on Research and Statistics (ICCAT)

SPAMIs	Specially Protected Areas of Mediterranean Importance (under the Barcelona Convention)
SRA	Strategic Research Agenda
STECF	Scientific, Technical and Economic Committee for Fisheries
RCP	IPCC Representative Concentration Pathways
RSC	Regional Sea Convention
Restoration Decade	UN Decade on Ecosystem Restoration (2021-2030)
RFMO	Regional Fisheries Management Organisation
RSCAPs	UNEP Regional Seas Conventions and Action Plans
SACs	Special Areas of Conservation (under the Habitats Directive)
SCIs	Sites of Community Importance (under the Habitats Directive)
SDG	UN Sustainable Development Goal
SoMFi	GFCM State of the Mediterranean and Black Sea Fisheries Report
SPAs	Special Protection Areas (under the Birds Directive)
SRIAs	Strategic Research and Innovation Agendas
UN	United Nations
UNCLOS	UN Convention on the Law of the Sea
UNESCO	UN Educational, Scientific and Cultural Organization
UNEP	UN Environment Program
UNFSA	UN Fish Stocks Agreement
WFD	Water Framework Directive

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