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EcoScope Project Newsletter

Ecocentric management for sustainable fisheries and healthy marine ecosystems

Issue 2: February 2024

EcoScope is a Horizon 2020 research project funded under the Blue Growth Call

The Ecoscope project is co-ordinated by the Aristotle University of Thessaloniki (AUTH) and brings together 24 international partners from 18 countries across the UK, Europe, Scandinavia, Israel, Canada and the Philippines.The partners include universities and research institutions, NGO's, technology companies and businesses.

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In this issue

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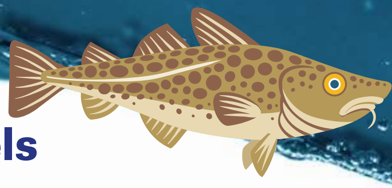
Editorial



Setting the baselines for examining fisheries management scenarios using ecosystem models under uncertainty and climate change

Athanassios C. Tsikliras, AUTH

The EcoScope Project aims to promote an effective and efficient, ecosystem-based approach to fisheries management.

The four-year (2021-2025) project addresses ecosystem degradation and anthropogenic impact that cause fisheries to be unsustainably exploited in several European Seas and promotes efficient, holistic, sustainable, ecocentric fisheries management that will aid towards restoring fisheries sustainability and ensuring balance between food security and healthy seas.

The overall objective of EcoScope is to co-design and develop an efficient, holistic, ecosystem-based approach to sustainable fisheries management that stakeholders and end-users, including policymakers and advisory bodies, can easily use. This will be achieved through the design and development of the EcoScope Platform and the EcoScope Toolbox. The Platform will organise and homogenise large fisheries and other relevant datasets in a common standard type and format. The Toolbox will incorporate available (existing and new) assessment tools and methods and ecosystem models, which will be used to support integrated ecocentric management commensurate with safeguarding economic viability, within the policies and directives of the EU.

As the first half of the project ends, we take the opportunity to reflect on some of the achievements and progress toward meeting the overall aims and objectives of EcoScope.

Two of the five distinct, yet interrelated, phases that form the EcoScope project were completed during the first 18 months of the EcoScope [Preparatory actions for the identification of knowledge and management gaps (WP2) and the Collection of big datasets on bottom-up (WP3) and top-down (WP4) forcing on ecosystems] (Figure 1). In addition, a large part of the socio-economic preferences (WP7), and the co-designing of e-tools and scenarios testing (WP8) has been achieved with the active involvement of key stakeholders who expressed their views and needs. At the same time, a series of ecosystem-based models have been prepared - or modified from pre-existing models - in all eight case study areas, as planned in the proposal. The preparatory phase and the collection of datasets for European Seas, as well as their standardisation in a common type and format in the EcoScope Platform, allows the project to proceed to the next analytical phases [Quantification for management and planning through assessments of ecosystem components (WP5) and ecosystem models (WP6)] that will be applied to the eight case studies (Figure 1).

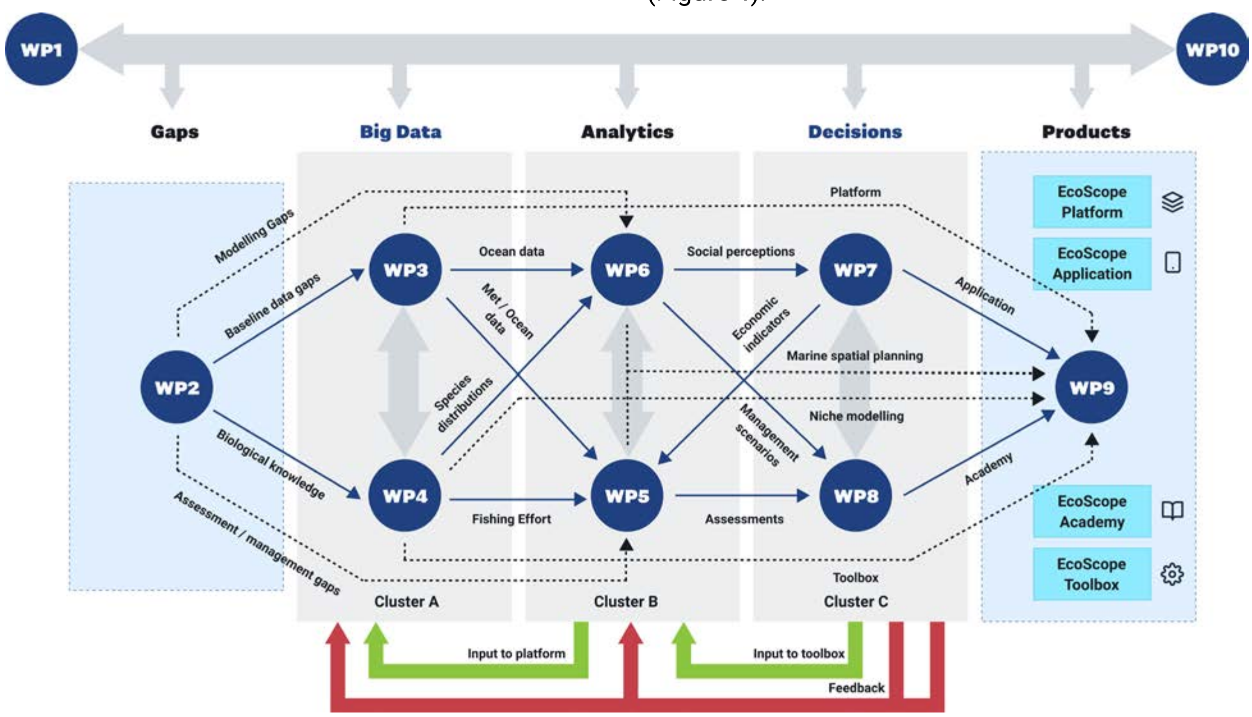


Figure 1. Graphical presentation of the EcoScope project WPs showing the temporal phases at the top (Gaps – Big Data – Analytics – Decisions – Products) their groupings into clusters and the inter-relationships among them.

Editorial Continued...

Ecosystem models are performed using the Ecopath with Ecosim (EwE) suite which will form the basis for testing and evaluating the various fisheries management and policy scenarios within the context of climate change. The EwE suite (www.ecopath.org) is one of the most widely used modelling tools for investigating food-web-related questions in marine ecosystems and examining management hypotheses.

Within the EwE suite, three different kinds of modules are available: a trophic mass balance, a time dynamic and a space-time dynamic routine. EcoScope will include all kinds of EwE ecosystem modules for all case studies as they are the necessary basis for developing, testing and assessing a range of fisheries and ecosystem management and policy scenarios.

This aligns EcoScope with the EU Green Deal, the EU Biodiversity Strategy for 2030, the Marine Strategy Framework Directive (MSFD) and the Maritime Spatial Planning (MSP) Directive. The ecosystem models are coupled with environmental, climatic and oceanographic data (from WP3) and forcing variables (from WP4) to develop the basis required to conduct and run the management scenarios. Some of the management scenarios will run across all case studies while others will be tailored to the specific characteristics of each case study (e.g., the presence of alien species in the Levantine Sea).

This special edition newsletter focuses on the EcoScope ecosystem models and their importance to the project, its outputs and ecocentric fisheries management. We highlight some of the regional models for the Baltic Sea, Adriatic Sea and Israel EEZ and shelf region and their roles within the project and beyond.

Overview of the models

Gideon Gal, IOLR

Ecosystem models using the Ecopath with Ecosim suite (EwE) lay at the core of the ecological modelling conducted in EcoScope. The EwE modelling suite provides the user with tools for constructing a static mass balance model (Ecopath), a temporal dynamic model (Ecosim) and a spatially-temporally dynamic model (Ecospace). This set of models allows the user to simulate the interactions within the food web, the impacts of drivers (i.e. climate change), pressures (i.e. fisheries) and the projected consequences of policy options. The EwE suite of algorithms is one of the most popular modelling tools for investigating food-web-related questions in marine and freshwater ecosystems and examining management hypotheses, and studying and evaluating the impacts of environmental and anthropogenic pressures on the systems. All three types of models (Ecopath, Ecosim, Ecospace) can be used to explore past and future impacts of fishing and environmental change on the ecosystem. EwE models have been used to describe ecosystems in theoretical, spatial and policy analyses. The models are a pivotal and necessary product in EcoScope as they form the basis for testing and evaluating the various management and policy scenarios.

At the basis of EwE, a set of linear equations are used to estimate missing parameters under an assumption of mass balance. Ecosim calibrates the models to known biomass and catch data, and provides outputs that include historic and future biomass dynamics of each group through time, changes in mortality, food consumption and diets, and numerous ecological indicators. Ecospace replicates the dynamic analyses over a grid of spatial cells and makes predictions to address policy questions such as the establishment of marine protected areas, the effects of fishing effort and changes in essential fish habitats. Ecospace allows simulation of the ecosystem as it dynamically allocates biomass across a raster grid map, which indicates the number of habitats to which functional groups and fishing fleets are assigned. This permits alternation of trophic interaction rates, based on species habitat affinities, the location of those habitats and the regions in which the various fishing methods are utilised. In addition, external physical data (e.g. temperature, currents) and satellite data (e.g. primary production) can be input into the model and used for simulations and scenario testing. Habitats, marine protected areas (MPAs) and fisheries restricted areas (FRAs) can be added and altered, thereby allowing evaluation of temporal and spatial policies and environmental change.

The EcoScope project includes a total of eight case studies. All the case study sites have some level of EwE models in place, and within the project, we will finalise the development of the EwE models at all sites. As a consequence, a number of Ecosim models will be available at each site and Ecospace models will be developed and implemented at select sites, based on the availability of sufficient data. Case study-specific issues such as MPAs, FRAs, and the presence and effect of non-indigenous species will be included in the model development where relevant.

Overview of the models continued...

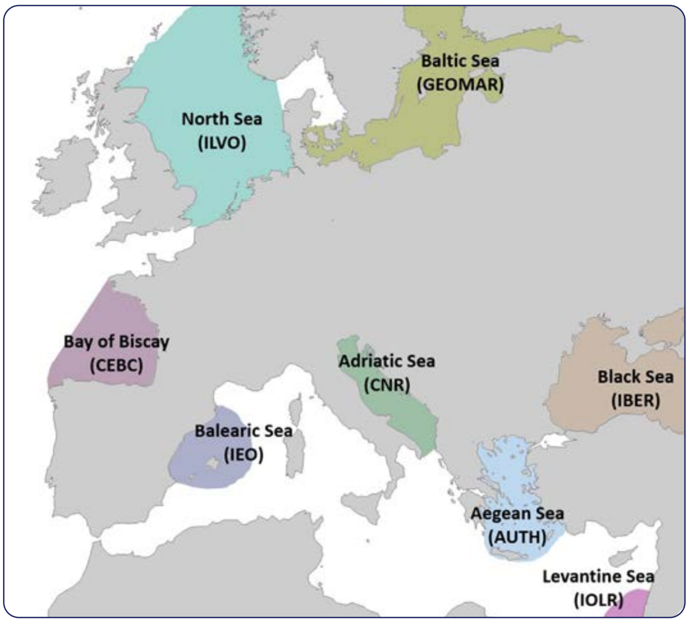
A key product of this action is the set-up and testing of management, policy and environmental scenarios, which will partly be determined based on input from policymakers and stakeholders during the planned stakeholder meetings. Multiple-level scenarios will be determined and developed. These will include local- and national-level policy and environmental issues. Thus, scenarios will also examine the synergistic effects of multiple stressors and policies on the fisheries. European-wide policy drivers, such as the Oceans and Human Health strategic research agenda, developed by H2020 SOPHIE, the Common Fisheries Policy (CFP) and the Marine Strategy Framework Directive (MSFD) will also be examined to evaluate their impact on the case study sites as well as at a holistic European-wide view.

As with all models, there is a degree of uncertainty associated with the EwE models and their outcomes. There are a number of sources of uncertainty associated with model results which are often difficult to quantify. As the outcomes of the model simulations are to provide support in the decision-making process by policymakers it is important to understand the impact of the uncertainty on model results. We will therefore extend the simulation capabilities of EwE with scenario testing under uncertainty and deep uncertainty. One approach for minimising uncertainty in the scenario testing process is by applying the Robust Decision Making (RDM) approach. The scenarios will be conducted using this approach in which the focus is not on agreeing on the assumptions of what the future will look like, but rather on the decisions. The significance of this approach is that there is no need for an agreement on the magnitude or nature of climate change, for example, but rather what is the best strategy to manage fisheries into the future given the uncertainty in future climatic conditions, what are the weaknesses in the strategy and how can they be mitigated? Evaluation of the possible strategies will result in possible solutions best optimised across plausible future realities. However, under the RDM approach rather than determining a decision for certain conditions, there would be an assessment of the reaction of fisheries, to a wide range of plausible future conditions without focusing on the likelihood of possible future conditions.

Focus on regional EcoScope models

Within EcoScope, eight case-study areas are identified: The Bay of Biscay, The Aegean Sea, The North Sea, The Israeli EEZ, The Black Sea, The Balearic Islands, The Western Baltic Sea, and The Adriatic Sea.

Here we take a closer look at three ecosystem models that have been developed or adapted within the EcoScope project: The Western Baltic Sea, The Adriatic Sea and the Israeli EEZ. All three models are Ecopath with Ecosim (EwE) models.



The Western Baltic Sea ecosystem model

Marco Scotti and Marcela C. Nascimento, GEOMAR

Within the framework of EcoScope, team GEOMAR developed the first Ecopath with Ecosim (EwE) ecosystem model of the Western Baltic Sea (WBS), a transition area with distinctive oceanographic and ecological features compared to neighbouring basins. The model matches ICES subdivisions 22 and 24, a choice that facilitated data retrieval and might help knowledge transfer for management purposes. The steady-state network of carbon exchanges in 1994 was built using Ecopath and constitutes the starting point to simulate stock biomass and catch dynamics with Ecosim.

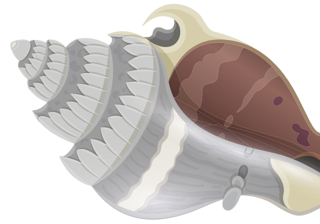
After validating the EwE model for the period 1994-2019, using independent data obtained from ICES reports, Ecosim was applied to simulate future trends of stock biomass and catch up to 2100. The main forcing factor used was fishing mortality, which accounted for alternative scenarios ranging from the continuation of present fishing pressure (business as usual, BAU) to ecosystem-based fisheries management (EBFM). EBFM implements principles of fish biology (i.e. do not exploit any stock beyond the maximum sustainable yield) and ecology (i.e. less pressure should be exerted over low trophic-level species as they provide carbon to other consumers in the food web).

GEOMAR participation in EcoScope resulted in the extension of the model to include multiple stress factors, with the impacts of ocean warming and changes in the concentration of phytoplankton that were simulated concurrently with alternative fisheries management scenarios. Altogether, EwE simulations showed that EBFM outperforms the BAU scenario by reconstituting a healthy size for the heavily depleted stocks of western Baltic cod and western Baltic spring-spawning (WBSS) herring, the most important commercial targets in the area.

Moreover, the use of EwE illustrated that EBFM results in higher yields than BAU and contributes to protecting the population of harbour porpoises from a steep decline that might threaten its persistence. The merits of EBFM over BAU are preserved also in the presence of other stress factors such as the impact of ocean warming on fish recruitment (negative for the western Baltic cod and the WBSS herring) and changes in phytoplankton biomass, which depend on the interplay between nutrients' concentrations and ocean warming.

The present EwE model has the role of filling in a gap in the Baltic Sea region since the area corresponding to ICES subdivisions 22 and 24 was never described before by any ecosystem model. It portrays ecosystem-level dynamics and quantifies the impacts of fisheries in an area characterised by heavy exploitation of fish resources. The model provides the first interrelated assessment of different trophic guilds, as required by the EU Marine Strategy Framework Directive (MSFD), and shows how EBFM enables sustainable management of fish stocks without harming the diversity of other species in the ecosystem, as requested by the EU's Common Fisheries Policy (CFP).

The value of the model transcends the boundaries of the study area as it illustrates that developing management strategies inspired by fish biology and ecological principles responds to the need to preserve the productivity of fish stocks of commercial interests without threatening the healthy state of other trophic guilds. The EBFM scenario proposed for the WBS model might then be tested using the EwE models of other EU basins as it allows implementation of the requests of EU legislation to preserve a long-term, sustainable use of fish resources.



The Adriatic Sea ecosystem model

Giuseppe Scarcella, CNR and Simone Libralato, OGS

A food web model was developed by the OGS and CNR team for the GFCM Geographical Sub Areas (GSA) 17 and 18 to support ecosystem-based fisheries management (EBFM). The Adriatic Sea is a semi-enclosed basin characterised by high productivity due to important freshwater inputs and a very extended shelf, which has been heavily trawled for decades. The six countries on the Adriatic sea shores host fisheries with different degrees of development, capacity and history of exploitation that is carried out through a wide series of gears and targeting several fish species.

The food web model describes the ecosystem, which covers an area of approximately 120,000 km^2 from shore to 800m depth, through 73 functional groups that describe the priority species (in age classes), other species with commercial importance, species of ecological importance, plus all other components of the ecosystem from plankton to top predators.

The Adriatic fisheries are described through 33 fishing fleets that result from a combination of gear, and segments based on the vessel's length overall (LOA) and countries.

Data for the years 2004-2006 are used to develop the Ecopath steady-state network model whose realism and accuracy were tested using comparison with stable isotope results as well as checking the consistency of parameters across the trophic level with ecological rules (Prebal).

The time dynamic module Ecosim was run from 2000 to 2020 using as bottom-up drivers of phytoplankton (diatoms, dinoflagellates), zooplankton (micro-, meso- and macro-zooplankton), bacterioplankton and detritus groups (suspended detritus and bottom detritus) biomass obtained from the 3D biogeochemical model for the Mediterranean (MedBFM). The top-down forcing used was the fishing effort dynamics over the 2000-2022 reconstructed combining different sources of data, including VMS for Croatia and Italy by gear and fleet segment. The resulting dynamics were calibrated for the years 2000-2018 using fishery-independent data from MEDITS and SOLEMON trawl surveys and results from SAC-GFCM stock assessments.

Within EcoScope the calibrated Adriatic model will be used to test uncertainty on bottom-up and top-down forces on ecosystem dynamics, indicators and management actions. This will allow us to better disentangle the role of historical changes in productivity and effort on the dynamics of renewable resources at sea. Moreover, the model will be used to test fisheries management alternatives by running the model up to 2050 under alternative management and climate scenarios. Results are expected to provide spatio-temporal information on the effects of management and might be used to support policymakers.

The Israeli EEZ ecosystem model

Eyal Ofir, IOLR

Within the context of the EcoScope initiative, the team at the Israel Oceanographic and Limnological Research (IOLR) developed an Ecopath model (EwE), specifically tailored for the Israeli Exclusive Economic Zone (EEZ). This Ecopath model stands as a fundamental building block for subsequent Ecosim and Ecospace models. Its construction was driven by the imperative of aligning it with the unique characteristics of the Israeli marine ecosystem.

The adaptation of the Ecopath model hinged upon three overarching objectives that sought to harmonise it with the required Ecospace model. These pivotal objectives included:

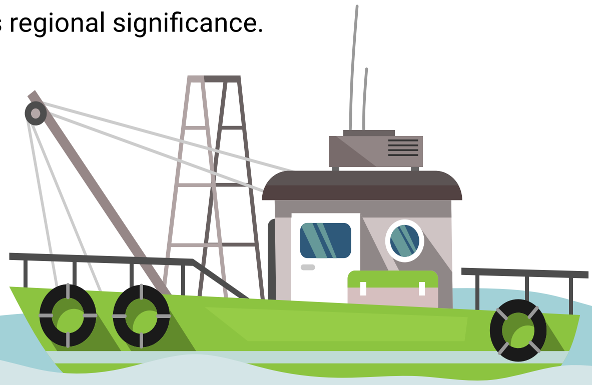
- Addressing the Invasive species challenge:
The first objective centred on comprehensively understanding the impact of invasive species on the local ecosystem. A primary concern was evaluating the potential displacement of native species from their natural habitats due to invasive species encroachment.
- Exploring Deep-Sea Dynamics: The second objective aimed at unravelling the mysteries of the deep-sea ecosystem within the Israeli EEZ. Focusing on the distribution patterns and behaviours of deep-sea species, this objective was important to allow the incorporation of our understanding of the deep-sea habitat.
- Examining Fishing Policy Implications: The third objective focused on the fishing policies and their effects on the ecosystem. By simulating various fishing scenarios and policy changes, in tandem with future climate change, the modified Ecopath model sought to predict the ecological outcomes of shifts in fishing practices, vital for sustainable fisheries management.

To accomplish these objectives effectively, a new Ecopath model was developed. The model structure included the categorisation of species into distinct groups, differentiating between fish and invertebrates, and further classifying them based on their habitats, continental shelf, slope, and deep sea. Additionally, a clear separation between invasive and native species was introduced to address the unique challenges posed by invasive organisms. Updating the species list with data from the IOLR database ensured the model's accuracy and relevance.

The Israeli continental shelf area faces a multitude of environmental pressures. These pressures encompass natural phenomena like climate change and rising seawater temperature, as well as the introduction of Red Sea species, which is altering the ecological balance. Human activities, notably fishing, also contribute to the complex dynamics of the ecosystem.

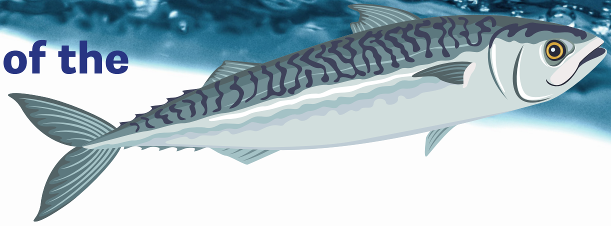
The development of the Ecopath model not only facilitates an examination of required fishing policies within the Israeli EEZ but also accommodates the consideration of additional processes specific to the region. This multifaceted approach allows for a comprehensive assessment of policy needs in ecosystems exposed to a wide array of pressures.

Moreover, the model's application within the Israeli EEZ presents an opportunity to explore broader ecological processes in the Eastern Mediterranean. This region serves as a crucial transit hub for invasive species routes to the central Mediterranean, underscoring the model's regional significance.



EcoScope tools and implementation of the EU fisheries action plan

Ana Rodriguez, European Marine Board



On 21 February 2023, the European Commission adopted a new Action Plan for fisheries called "Action plan: Protecting and restoring marine ecosystems for sustainable and resilient fisheries". This action plan contributes to delivering the Biodiversity Strategy for 2030 and its commitment to legally and effectively protect 30% of European Seas, with one third being strictly protected.

The three objectives of the action plan are to:

- Contribute to reaching and keeping fish stocks at sustainable levels
- Reduce the impact of fishing on the seabed, and
- Minimise fisheries impacts on sensitive species, such as dolphins, harbour porpoises, sea birds, sharks and sea turtles.

The main actions to achieve these objectives are:

- Phasing out mobile bottom fishing in marine protected areas (MPAs) by 2030, and
- Increasing selectivity of fishing gear, protecting sensitive species and applying measures to reduce their bycatch.

Further actions to achieve these objectives are to support the fisheries sector in the transition by maximising the use of available funds, strengthening the knowledge base, research and innovation, improving implementation, monitoring and enforcement, and improving governance, stakeholder involvement and outreach.

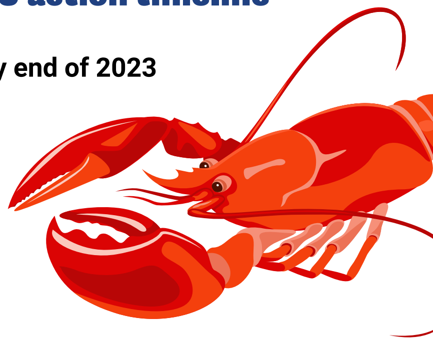
The EcoScope tools will be able to advise on how best to achieve some of these objectives, including suggesting possible management options to minimise bycatch of the species selected by Member States (see table below for details), modelling the effects of excluding trawling from all MPAs as required in the action plan, and suggesting which areas are most suited for the 10/30% MPA expansion, as required in the Biodiversity Strategy for 2023. In addition, it is important to note that this action plan is not legally binding. Therefore, another important contribution EcoScope could make is to model the effects of different levels of compliance with the action plan. For instance, the models could answer questions such as "what are the ecological and socio-economic consequences of different degrees of bottom trawling (e.g. 0%, 20%, 60%) in MPAs", or "what are the ecological and socio-economic consequences of not complying with the maximum allowable seabed disturbance value, which will be agreed on by Member States soon" (see table on next page).

For more detailed information on the main actions and the associated timelines required by the EU action plan for fisheries, see the table on the next page.

You can read the full action plan here:

https://oceans-and-fisheries.ec.europa.eu/system/files/2023-02/COM-2023-102_en.pdf

EU fisheries action plan continued...

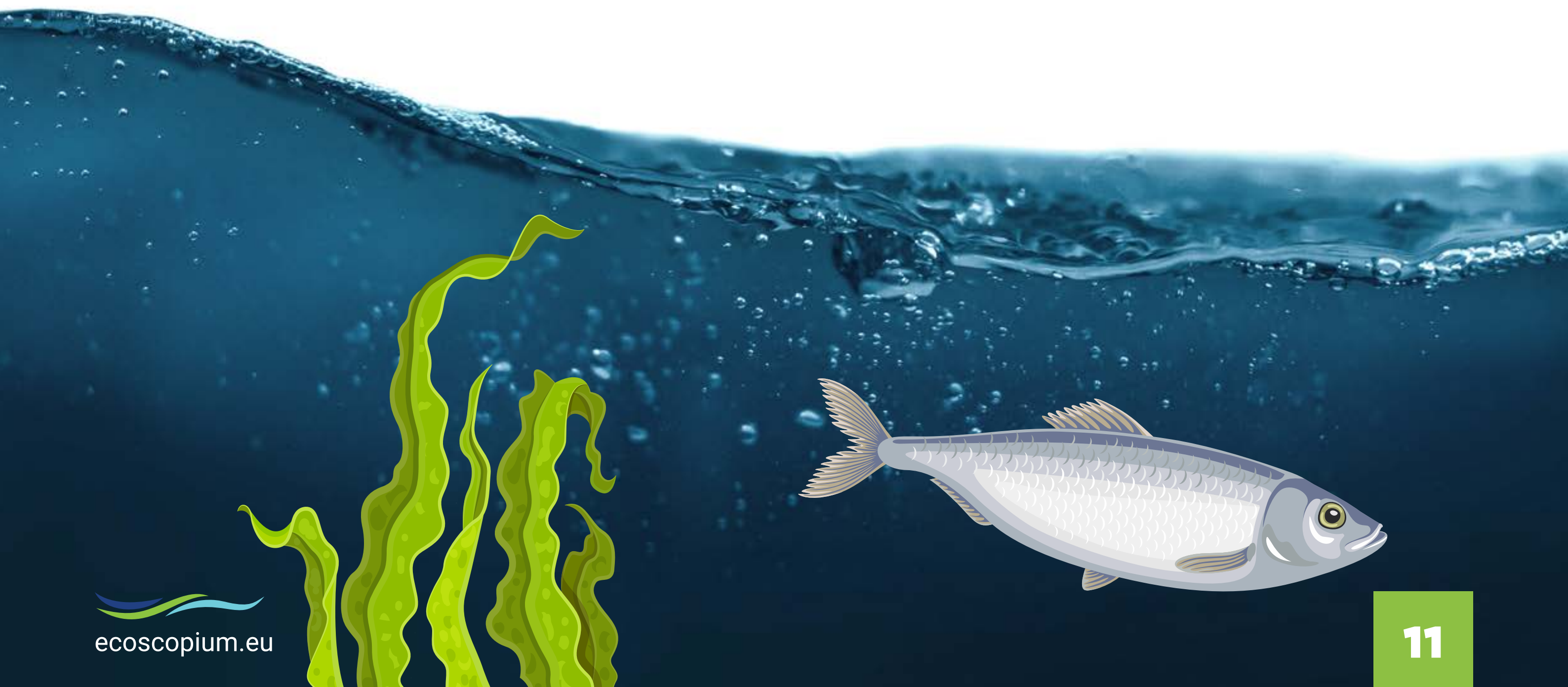


Overarching action	Main actions (for member States)	EU action timeline
Reducing by-catch Actions to improve fishing selectivity and reduce the impact of fisheries on sensitive species	Develop threshold values for maximum allowable mortality rate from incidental catches of species selected by Member States, relevant for that country (e.g. for birds, mammals, reptiles and non-commercially-exploited species of fish and cephalopods) & adopt fisheries management measures to implement these threshold values.	**By end of 2023**
Reducing by-catch Actions to improve fishing selectivity and reduce the impact of fisheries on sensitive species	Adopt national measures or submit joint recommendations to the Commission to minimise by-catch for the following species (to the right).	**By the end of 2023:** harbour porpoise in the Baltic Proper and the Black Sea, the Iberian Atlantic and the common dolphin in the Bay of Biscay **By the end of 2024:** several sharks and rays, sturgeons, turtles, Balearic shearwater & monk seal (angel sharks, common skate, guitarfish, Maltese skate, great white shark, sand tiger shark, smalltooth sand tiger shark, spiny butterfly ray, sturgeons, marine turtles, Balearic shearwater and Mediterranean monk seal) **By 2030:** remaining sensitive marine species at risk of incidental catches, prioritising those in 'unfavourable conservation status' [Habitats and Birds Directives] (e.g., species of birds, mammals, reptiles and non-commercially-exploited species of fish and cephalopods)
Reducing by-catch Actions to improve fishing selectivity and reduce the impact of fisheries on sensitive species	Improve the protection of the European eel through management plans, including impact of fisheries & non-fisheries related impacts	**By the end of June 2024**
Reducing by-catch Actions to improve fishing selectivity and reduce the impact of fisheries on sensitive species	Implement additional measures to boost selectivity, starting with the fish stocks with the highest expected biological gains, including location or time-specific measures where there is clear evidence of high concentrations of fish below the minimum conservation reference size (based on the work STECF[1] , the GFCM[2] and other scientific institutions, such ICES[3]).	**By 2030**

EU fisheries action plan continued...

Overarching action	Main actions (for member States)	EU action timeline
Reducing by-catch **Actions to improve fishing selectivity and reduce the impact of fisheries on sensitive species**	Create new and effectively manage all MPAs, ensuring strict protection of important fish spawning and nursery areas.	**By 2030**
Increasing seabed integrity **Reducing the impact of fishing (particularly trawling) on the seabed**	Member States to agree on and implement threshold values for seabed integrity (which are currently being developed under the Marine Strategy Framework Directive[4]).	**By mid-2023**
Increasing seabed integrity **Reducing the impact of fishing (particularly trawling) on the seabed**	Reduce the impact of fishing on the seabed by: • Prohibiting mobile bottom fishing in all Natura 2000 MPAs • Not allowing mobile bottom fishing in any newly established MPA • Providing an overall outline of how this will be achieved & a more detailed plan for at least 20% of each Member State's marine waters	**By the end of March 2024**
Increasing seabed integrity **Reducing the impact of fishing (particularly trawling) on the seabed**	Mobile bottom fishing has to be phased out in all MPAs by 2030 at the latest.	**By 2030**

[1] https://stecf.jrc.ec.europa.eu/
[2] https://www.fao.org/gfcm/en/
[3] https://www.ices.dk/Pages/default.aspx
[4] https://environment.ec.europa.eu/topics/marine-and-coastal-environment_en



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