



JRC SCIENCE FOR POLICY REPORT

Scientific Technical and Economic
Committee for Fisheries (STECF) –
The implementation of the technical
measures regulation
(STECF 25-14)
Final report pending publication numbers
for webpage release

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2026

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How to cite this report: European Commission, Joint Research Centre, *Scientific, Technical and Economic Committee for Fisheries (STECF) – The implementation of the technical measures regulation (STECF-25-14)*.

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Abstract

The Scientific, Technical and Economic Committee for Fisheries (STECF) Expert Working Group 25-14 (EWG 25-14) advanced a multidisciplinary framework to evaluate the biological, economic, and social impacts of the EU Technical Measures Regulation for two hake mixed-fisheries case studies: Bay of Biscay and Western Mediterranean. The work built on previous STECF efforts and incorporated two ad hoc contracts that delivered reproducible data pipelines, harmonised modelling structures, and cross-regional visualisation capabilities.

The EWG integrated a set of short-term economic indicators (Gross Profit, Gross Profit Margin, Gross Value Added, and Break-Even Revenue) derived from harmonised AER and FDI datasets and assessed newly submitted social data for inclusion. Social data were found to be too heterogeneous to effectively incorporate within the time frame of the EWG. The “financial security” (average wage relative to national minimum wage) as the most suitable proxy social indicator for quantitative assessment.

Selectivity-based scenarios demonstrated consistent reductions in discards and modest biological gains, though effects remained limited when applied in isolation. The study highlights outstanding needs, including improved social data inclusion, qualitative social indicators, stakeholder engagement, expanded species-specific selectivity parameters, enhanced spatial resolution, and development of long-term forecasting. Collectively, the results represent a substantive progression toward an operational, transparent, and regionally comparable framework for evaluating technical measures in EU fisheries management.

STECF Report on EWG 25-14 Implementation of the technical measures regulation

Request to STECF

STECF is requested to evaluate the findings of the STECF Expert Working Group meeting, as well as those of the associated ad hoc reports, and make any appropriate comments and recommendations. Furthermore, the STECF is requested to make suggestions on how to integrate those findings in the TMR implementation report to be prepared this year.

STECF comments

EWG 25-14 met from 20-24 October 2025, online. The meeting was attended by 23 experts with a broad range of expertise (economics and other social science disciplines, mixed fisheries modelling, and gear technologists), including four STECF members and three JRC experts. Additionally, two observers from different backgrounds were present.

STECF considers that the EWG adequately addressed the ToRs and has the following specific comments on the ToRs addressed by EWG 25-14:

ToR 1 – Review the outputs of the two ad hoc contracts (ad hoc contract no. 2590 and 2591) to determine suitability of data, code and model runs for use by the EWG.

STECF notes that the EWG reviewed and approved the objectives of the two ad hoc contracts commissioned to advance the framework for assessing the biological and economic impact of implementing technical measures in the two case studies outlined by EWG 24-16. The contractors successfully delivered tools enabling robust data quality control, standardised data-processing pipelines, testing of selectivity scenarios, on-year forecasting, and clear visualisation of outputs. Although the two case studies utilised different models, the adoption of a common visualisation framework (BioEcon) has harmonised the presentation of results across the Mediterranean and Atlantic frameworks. Substantial effort was also invested in integrating multiple data sources, including DCF data (FDI and AER data on landings, discards, fishing effort and economic data) and results from stock assessments, improving transparency and comparability.

STECF notes that the data tools and code developed under the ad hoc contracts were updated during and after the EWG meeting to reflect the group's decisions. The results of the EWG's work are presented under the section of comments to ToR 3.

ToR 2 – Select economic and social indicators for inclusion in the framework to assess the impact of the technical measures regulation. Extract selected indicators from available databases using full reproducible methods in R. Indicators will be included in model runs and outcomes discussed.

STECF notes that the EWG selected four economic indicators (Gross Profit, Gross Profit Margin, Gross Value Added and Break- Even Revenue) from the broader set of economic indicators provided annually in the AER. These indicators were chosen for their suitability in assessing short-term economic impacts of gear-based technical measures, considering the analytical objectives, the time horizon of the analysis, calculation feasibility, and data availability in the AER.

STECF notes that, in the context of the Bay of Biscay hake mixed fisheries case study, the EWG explored the social data submitted in response to the EU Social data call for the period 2017-2023. However, the analysis of fleet performance by gear or fishery was significantly hampered due to several data limitations, including (i) the inability to link variables consistently across years, countries, or fleets without additional assumptions, (ii) records not being assignable to specific fleet segments or fishing activities, (iii) the high level of aggregation in and (iv) limited meaningful coverage for some variables and fleet segments.

STECF notes that a comparison of full-time equivalent (FTE) and employment data submitted by France and Spain under the Economic Data Call and the Social Data Call revealed some inconsistencies, with some values higher in one dataset and lower in the other.

STECF observes that the EWG identified “financial security” (average wage relative to national minimum wage, under the working conditions category of wellbeing) as the most suitable quantitative social indicator for potential model integration, with labour costs potentially serving as a reasonable proxy for wages in the fisheries sector. Financial security is one of the indicators suggested by EWG 24-05 (Social Data in EU fisheries -see ToR 5.1 of this plenary report-) for pilot studies under the Member States Work Plans. STECF observes that EWG 25-02 (Social Data in EU fisheries 1: methodology and dissemination) and EWG 25-13 (Social Data in EU fisheries 2: analysis and evaluation) explored the use of wages and labour costs. The latest describes some methodological challenges that would benefit from debates between the EWG on social data and the RCGECON. STECF notes that because qualitative social aspects (e.g. relational or subjective well-being and identity) are difficult to incorporate into modelling exercises, quantitative modelling should be complemented by qualitative research methods (e.g. interviews, questionnaires or focus groups) to capture lived experiences and local realities.

STECF observes that the EWG provided a summary of the relevant bottom otter trawl selectivity studies for hake and other key species caught in the Bay of Biscay and Mediterranean mixed trawl fisheries, including gear characteristics (mesh size of the main net) and selection device specifications (type of device used and selectivity parameters such as L50 and selectivity range). These updated selectivity parameters, building on and revising information from EWG 24-16, were used to implement selectivity changes in the modelling framework. The EWG noted that selectivity parameters are not available for all species involved; therefore, only a subset of the species caught in the mixed fisheries could be incorporated in the models.

STECF notes that based on these studies, the EWG defined gear-based scenarios for modelling. For the Bay of Biscay, two scenarios were considered: (1) the mixed OTB_DEF fishery, including a 63 mm square-mesh codend with a 77 mm square-mesh panel (3 m × 1 m) placed in the bottom panel of the trawl in an attempt to

improve hake selectivity, with overall selectivity derived by combining the characteristics of both gear components; and (2) the OTT_CRU Nephrops fishery, including an inverted selective grid with 13 mm bar spacing fitted in the top of the extension, which during selectivity trials, proved effective at excluding hake below the Minimum Conservation Reference Size (MCRS). The lowest selectivity estimates (least size-selective for hake) were applied to avoid underestimating bycatch in bottom-trawl fisheries. For the Western Mediterranean, the EWG considered increasing the square-mesh codend size from 40 mm to 45 mm, introducing a sorting grid for Norway lobster escapement, and using semi-pelagic doors to reduce fuel consumption in the OTB_DEF (demersal) and OTB_MDD/OTB_DWS (mixed and deep-water) métiers. Relative selectivity improvements for otter trawlers were calculated because combined selectivity estimates for the baseline and the most appropriate selective gear for targeting hake were not available.

ToR 3 – Identify, parameterise and run meaningful management scenarios, the finding of which will be discussed in terms of relevance to supporting future advice needs.

STECF observes that the EWG brought together the elements developed under the different ToRs by adapting the data tools and code produced under the ad hoc contracts (ToR 1) to represent the selected gear-based scenarios (ToR 2) within the modelling framework. The resulting simulations were presented using several indicators (catch, SSB, F, and recruitment), together with the economic indicators outlined under ToR 2, for the two hake demersal mixed-fisheries case studies. Social indicators were not considered due to time limitations during the meeting and the limited quality of the available data. A comprehensive summary of the scenario specifications, parametrisation, and results is provided under ToR 3 of the EWG report.

Bay of Biscay case study

STECF notes that the Bay of Biscay mixed fisheries case study, based on the ICES WGMIXFISH model, includes only four (hke.27.3a46-8abd, meg.27.7b-k8abd, hom.27.2a4a5b6a7a-ce-k8, whb.27.1-91214) of the original eight mixed-fisheries stocks, as age length keys (ALKs) were available only for those species. 19 fleets (defined by Member State and fleet segment) were identified as catching hake within the Bay of Biscay and were included in the one-year forecast projections.

STECF notes that separate selectivity assumptions were applied to each of the two gear-based scenarios for the Bay of Biscay mixed fisheries, in line with the initial model design: in scenario 1, selectivity is age-varying, reflecting the expected reduction in the capture of younger/smaller individuals while maintaining catches of older/larger fish, whereas in scenario 2 selectivity is assumed to be constant across ages as a simplifying modelling assumption.

STECF notes that an important limitation of the Bay of Biscay mixed fisheries modelling is that the métier operating within the case study do not correspond directly to the métier described in the original gear selectivity study used to parametrise the first gear-based scenario. Therefore, some assumptions on how to implement the

selectivity findings within the scenario had to be made by the EWG, which limits the comparability between the selectivity study and the scenario results. In addition, the scenario assumes that all OTB métiers in the case study use a 70–99 mm mesh size combined with the proposed selectivity device, which does not reflect actual fleet practices. Other limitations include the absence of modelled fleets representing stock catches outside the area, which partly reflects the inclusion of widely distributed stocks, as well as fleets accounting for unmodelled stock catches within the case study area.

Western Mediterranean case study

STECF notes that the Western Mediterranean mixed fisheries case study, based on BEMTOOL model, included the six species covered by the Western Mediterranean MAP, corresponding to eight stocks. 16 fleets (defined by fleet segment) were identified as catching hake within the Geographical Sub-Areas (GSAs, GFCM sensu) 9-10-11 and Effort Management Unit EMU2 and were included in the five-year forecast projections.

STECF notes that two selectivity assumptions were applied to the gear-based scenario for the Western Mediterranean mixed fisheries in line with the initial model design. Under scenario 1 (temporary selectivity), increased selectivity was assumed only for 2026, after which selectivity returned to baseline gear levels from 2027 onwards. Under scenario 2 (permanent selectivity), increased selectivity was assumed from 2026 onwards. In both cases, the compensation mechanism and the reallocation of effort from OTB_DWS/MDD to OTB_DEF were considered for 2025.

STECF notes that the Western Mediterranean mixed fisheries case study also showed a positive spillover effect, whereby improved selectivity in the trawl fleet generated indirect benefits for passive gears and polyvalent fleets, as competition for shared resources is reduced.

STECF notes that the overall results from the two case studies show only limited improvements, such as modest reductions in discards and slight increases in SSB, without any negative economic impacts. These outcomes reflect the fact that the scenarios focused on changes to a limited range of gears, which account for only a small proportion of total landings in the case study areas.

STECF notes that future work will aim to broaden the potential impact of selectivity modifications by developing scenarios that include a wider variety of gears and/or by creating more localised, regional case studies where such changes may have a stronger effect. In addition, incorporating a larger number of stocks would allow for a more complete representation of technical interactions across the fisheries. Nevertheless, the current findings help illustrate to fishers and end users the potential short term economic and biological impacts of selectivity changes, thereby reducing concerns about transitional costs and encouraging gear adoption.

ToR4 – Stakeholder engagement sessions with observers at the meeting shall be held to gather their perspectives on the utility and reality of the proposed framework to assess the biological, economic and social impact of the implementation of technical measures.

STECF notes that observer participation at the EWG was very limited, as the invitations to the Advisory Councils were sent too close to the meeting date. It was therefore decided to allow them to attend the entire meeting as observers, rather than only during the stakeholder session. The EWG noted that observers raised concerns about the short timeframe (one year prediction period) and the use of old data (2020–2022) in the economic assessments, reflecting that the work builds on the framework developed at previous EWGs.

ToR 5 – Discuss direction of future work, additional needs, stakeholder engagement, and advice needs. These discussions will include the development of longer-term forecasts; assessments on the impacts of spatial and temporal closures, and inclusion of social data.

STECF notes the need to enhance spatial resolution in future case studies to better capture local realities. The EWG suggested using the Regional DataBase and Estimation System (RDBES) data to assess the socio-economic impacts on fishing-dependent communities.

STECF notes that the EWG defined the need for the modelling to use medium- to long-term economic indicators as defined in the AER, namely Return on Fixed Tangible Assets (ROFTA) and current revenue in relation to break-even revenue (CR/BER), to evaluate long-term economic performance and capital efficiency. Future projections should also account for fleet turnover and capacity changes using Simple Capital Dynamics (SCD) models simulating vessel entry and exit. The EWG also noted a key limitation of the approach, namely its inability to account for the influence of subsidies and the incentives or disincentives they create.

STECF notes that the EWG identified 22 quantitative potential social indicators that capture aspects of quality of life and workload (days at sea per trip, hours worked per day, number of fishing trips), economic well-being (labour productivity and relative income of crew), working conditions and safety (vessel age, workplace accident rates, Minimum Required Crew per Vessel and mandatory safety training), and demographic sustainability (unionisation or cooperative membership, generational renewal index, new entrants into the sector, and level of professionalization). The spatial indicator, marine space use (competition for marine space) was identified to reflect external pressures on fishing activity and community access to resources.

STECF notes that data availability and consistency remain overarching issues for these social indicators and that most of them are suitable as outcome indicators in bioeconomic modelling scenarios, rather than as drivers within the models themselves. Some quantitative indicators related to fisher well-being, including economic conditions, quality of life, and workload, can in many cases be calculated directly from model outputs. In contrast, safety and working condition indicators, employment organisation indicators, generational renewal indicators and marine space use are generally not explicitly modelled and are most effectively used for scenario screening, evaluation, and risk assessment when interpreting model results.

STECF notes that the EWG identified the further refinement, standardisation, and integration of these social indicators as an essential next step towards a holistic management framework that better reflects the needs and dynamics of fishing communities.

STECF notes that a longer time frame in bio-economic modelling has the advantage of capturing the possible effects of capital dynamics, by allowing fleet dynamics and structural changes to be represented. However, such models are subject to higher uncertainty, as biological and economic variables can fluctuate substantially and small errors in initial conditions may accumulate over time. STECF notes that the EWG identified a five-year prediction period as an ideal balance between minimizing uncertainty and providing meaningful insights for management and policy evaluation.

STECF notes that the EWG identified the need to strengthen the stakeholder engagement and proposed organising dedicated meetings with Advisory Councils and fishers to inform social, economic, and ecological trade-offs in the short term, and likely co-benefits in the longer term. In addition, incorporating fishers' experiential knowledge can to some extent support the interpretation and validation of model results and contribute to enhancing the social and economic realism of the model by capturing local practices and operational flexibility. The EWG suggested initiating small-scale participatory modelling pilots in areas most affected by changes in key landings, to guide additional qualitative data collection.

STECF suggests integrating the outcomes of EWG 25- 14, along with previous STECF EWGs (EWG 24-16, EWG 23-15), into the upcoming 2026 review of the implementation of the Technical Measures Regulation through an ad hoc contract to prepare an initial draft of the relevant sections, ahead of the summer plenary (STECF PLEN 26- 02).

The draft will include an overview and supporting figures illustrating the progress and evolution of technical measures implementation in EU waters, providing details of catch, effort and value potentially impacted. It will also present detailed findings and insights from the hake mixed- fisheries case studies in the Bay of Biscay and the Western Mediterranean, focusing on how selectivity changes are anticipated to influence catches, stock status, and both economic and demographic indicators.

STECF conclusions

STECF endorses the outcomes of EWG 25-14 presented during STECF PLEN 26-01, including the results of the two ad hoc contracts, and concludes that all ToRs were appropriately addressed.

STECF concludes that further progress was made in the development of a decision support tool to assess and visualize the short-term bioeconomic and social impacts of technical measures. Two hake mixed fisheries case studies were finalized, demonstrating a transparent, reproducible, and regionally comparable toolset, now ready to be tested by a broader group of users to assess the clarity and usability of the result presentation.

STECF acknowledges the progress made in exploring available social data, however, concludes that their heterogeneity prevented effective integration into the model within the EWG timeframe. The indicator "financial security" (average wage relative to the national minimum wage) was identified as the most suitable quantitative social indicator for future integration, in line with what is suggested by

EWG 24-05 for pilot studies under the Member States WPs. The EWG 25-13 provides data that may inform other indicators.

STECF concludes the next steps forward are to incorporate more stocks to better represent key species and their technical interactions, and to develop more impactful selectivity scenarios beyond the currently limited fleets with robust selectivity data. Additionally, ongoing efforts should focus on establishing a permanent dissemination platform, better conversion of length-based differences into age-based selectivity changes, and the development of long-term forecasting capabilities. Furthermore, integrating quantitative and qualitative social indicators will support a more holistic management framework, while continued stakeholder feedback remains essential to ensure the validity of the results and practical feasibility of the scenarios analysed. Ultimately, the performance of any model is constrained by the completeness and quality of the data on which it relies.

STECF concludes that improved spatial resolution, including port-level information, for example as available in the RDBES for the NAO area, or (incrementally) in the ICES Ecosystem Overviews (Kraan et al. 2025) and community profiles, would further support the analysis of local socio-economic dependence and community-level effects.

STECF acknowledges that some of the methodological considerations arising from the work of this EWG are also being addressed within the EWG Methods for West Med MAP stock assessment and effort group (see ToRs 7.3 and 7.4 of this plenary report). Ensuring alignment with the work requested from that group will therefore be beneficial, both to avoid duplication of work and to promote consistency across related advice processes.

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REPORT TO THE STECF

Implementation of Technical Measure's Regulation. (EWG-25-14)

20th – 24th October 2025

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

1. INTRODUCTION

Technical measures are a broad set of rules that govern how, where, and when fishers may fish. They are established for all European sea basins, varying considerably in accordance with the regional conditions. One of the technical measures regulation's main mechanisms involves amendments to fishing gear specifications to achieve optimal exploitation patterns. Since the adoption of the Technical Measures Regulation (EU) 2019/1241, DG MARE has convened a number of Expert Working Groups (EWGs) to monitor its implementation, with the aim of optimizing the exploitation pattern of commercial fisheries by identifying the optimal catch sizes and ages for commercial species, as well as suitable fishing gear types.

While the science supporting fisheries management has generally been dominated by natural sciences, there has been a growing recognition that managing fisheries essentially means managing economic systems (Thébaud *et al.* 2023). Therefore, to enable the assessment of the sustainability and impact of management measures, such as technical measures, scientists and managers require effective tools. These tools should clearly describe the potential biological, economic, and social impacts, facilitate transparent discussions around short to long-term trade-offs, and provide assessable advice. The group of models known as Integrated Ecological Economic Fisheries Models (IEEFMs) could be used for this purpose by providing a mathematical representation of ecological and economic systems which can also integrate social dynamics (Nielsen *et al.* 2018; Prellezo, 2012). Such models would be required to assess the complex impacts of management measures such as technical measures, which can lead to reallocation of effort from one activity to another within a fleet, potentially impacting other parts of the ecosystem (see for example Abbot and Haynie, 2012).

The objectives of EWG 25-14 were to provide two finalised case studies assessing the potential impact of the implementation of technical measures in hake mixed fisheries within the Bay of Biscay (BOB) and Mediterranean (MED). The work focused on providing final outputs for these two case studies. And continued development of robust data and modelling frameworks that can manage these data in a FAIR way (Findable, Accessible, Interoperable, and Reproducible).

The STECF EWG 25-14 met from the 20–24th October 2025 online. The meeting opened at 09:00 on 20th October and was adjourned at 16:00 on 24th October 2025.

1.1 Terms of Reference

EWG 25-14 shall work on finalising the application of the proposed framework (see STECF 24-16) to assess the biological, social and economic impacts of technical measures regulation to two case studies: hake in Bay of Biscay mixed fisheries and hake in the Western Mediterranean mixed fisheries

Each case study will provide information on short term impacts regarding:

- a. the increasing of the size-selectivity of gears on the stocks caught in mixed fisheries in terms of catch, effort, fishing mortality and recruitment.

b. the likely economic and social costs or potential benefits associated with gear changes for fleets on the short-term (1 year forecast).

To achieve this the terms of reference are:

ToR 1 – Review the outputs of the two ad hoc contracts (ad hoc contract no. 2590 and 2591) to determine suitability of data, code and model runs for use by the EWG.

ToR 2 – Select economic and social indicators for inclusion in the framework to assess the impact of the technical measures regulation. Extract selected indicators from available databases using full reproducible methods in R. Indicators will be included in model runs and outcomes discussed.

ToR 3 – Identify, parameterise and run meaningful management scenarios, the finding of which will be discussed in terms of relevance to supporting future advice needs.

ToR4 – Stakeholder engagement sessions with observers at the meeting shall be held to gather their perspectives on the utility and reality of the proposed framework to assess the biological, economic and social impact of the implementation of technical measures.

ToR 5 - Discuss direction of future work, additional needs, stakeholder engagement, and advice needs. These discussions will include the development of longer-term forecasts; assessments on the impacts of spatial and temporal closures, and inclusion of social data.

2. ToR 1 - REVIEW THE OUTPUTS OF THE TWO AD HOC CONTRACTS (NO. 2590 AND 2591) TO DETERMINE SUITABILITY OF DATA, CODE AND MODEL RUNS FOR USE BY THE EWG.

The two ad hoc contracts provided the foundation on which EWG 25-14 could run finalise the results of the two case studies. The following sections provide a brief summary of the outcomes of the ad hoc contracts. The final outcomes of the models and how they were applied by EWG 25-14 are described in section 4 of this report (ToR 3).

2.1 Bay of Biscay (ad-hoc contract no. 2590)

This ad hoc contract was completed as requested. The contract was issued to advance the application of the framework applied during EWG 24-16 (STECF 2024a) to the Bay of Biscay case study using the data, code and tools provided.

After assessing the population selectivity-at-age and selectivity-at-length of relevant species in 2021 and 2022 respectively, in 2023, the EWG outlined the pathways and tools required to develop a modelling framework to assess the biological and economic impact of technical measures. The contractor was requested to advance the application of the selected framework (BioEcon, Dolder *et al.* 2021) to the Bay of Biscay hake mixed fisheries case study. This would require:

- advancing the scripts developed during EWG 24-16 to compile and quality control the data
- run model providing two different selectivity scenarios, one base line scenario and one with improved selectivity
- produce initial forecasts one year ahead
- prepare the output of the model for the Shiny App

The ad hoc contract provided a complete framework of data quality control, merging, and partitioning. This was updated during and after the EWG to account for group decisions. The results of the EWG are described in section 4.1 (ToR 3).

The following data sources were merged and prepared as part of the ad hoc:

- ICES single species stock assessment inputs and outputs including stock objects, biological reference points, age and length data.
- Fisheries Dependent Information (FDI) fleet data including landings and effort (STECF 2023a).
- Annual Economic Report (AER) fleet segment data (STECF 2025).
- Updated functions, which alter the baseline BioEcon package to conduct bio-economic analysis for the Bay of Biscay case study.

The code developed follows (where possible) the Transparent Assessment Framework (TAF) guidelines set out by ICES to ensure transparency and reproducibility and to allow for future updates. A summary of the scripts is as follows:

Table 2.1.1 Summary of scripts produced as part of ad hoc 2590

Script name	purpose
data_01_inital_processing.Rmd	Read in, explore, describe and QC data sources. Compare where possible, format data, and write out QC reporting information.
data_02_stock_objects.R	Read in, format and QC stock objects supplied by ICES
data_03_make_FLBiols.R	Transform stock objects to produce FLBiols
data_04_format_cost_data.R	Partition costs data across fleets
data_05_harbours.R	List of ports with latitude and longitude to display in the app
data_06_make_FLFleetExt.R	Create the FLFleet object
data_07_stock_conditioning.R	Conditioning with stock data
data_08_fleet_conditioning.R	Condition the fleet
data_09_Update_Econ_conditioning.R	Condition the economic data
data_10_simple_gear_relative_change.Rmd	Scripts to estimate selectivity changes for species in model from selected gear studies
data_11_advice_conditioning.R	Condition the advice
data_12_Covars.R	Set out covariate(s)
model_01_Intermediate_Year.R	Populate intermediate year assumptions
model_02_setting_up_scenarios.Rmd	Set up gear based scenarios
report_01_coastal_impacts_final.R	Calculate downstream coastal impacts
report_02_historic_stock_data.R	Prepare historic data for display in the app
report_03_code_to_run_app.R	Extract summary of Run app

Source: Own elaborations.

The final outputs include quality control visualization of input and modelled data, forecasts and summary data to parametrise and run the app. The outputs of this ad hoc and the advances made during the EWG 25-14 are detailed in section 4 of this report (ToR 3).

2.2 Western Mediterranean (ad-hoc contract no.2591)

This ad hoc contract was completed as requested. The contract was issued to advance the application of the framework applied during EWG 24-16 (STECF 2024a) to the Western Mediterranean case study using the data, code and tools provided.

The final ad hoc report focused on integrating BEMTOOL bioeconomic simulation outputs into the BioEcon visualization framework for the Mediterranean hake case study (covering GSAs 9–11), addressing a key gap identified during STECF EWG 24-16 (see complete report in Annex 1). The primary objective was to enable

standardized visualization of technical measures scenarios for Mediterranean fisheries while ensuring consistency with Atlantic case studies such as the Bay of Biscay. To achieve this, the work delivered a complete data conversion pipeline comprising 19 R scripts, a modified BioEcon Shiny application, and comprehensive documentation. Significant technical challenges were overcome, including adapting BioEcon (originally designed for Irish fisheries using FLBEIA outputs) to accommodate Mediterranean data structures, management systems, and reference points. The solution implemented an automated transformation process that converts BEMTOOL's CSV outputs into BioEcon compatible formats, harmonizes biological reference points between ICES and GFCM frameworks, and removes Atlantic-specific features such as quota swaps and choke species mechanisms. As a result, visualization parity between Mediterranean and Atlantic frameworks has been achieved, enabling scenario comparisons (status quo versus improved selectivity) across historical and forecast periods (2006–2030). While limitations remain (such as missing port-level socioeconomic indicators and approximated biological reference points) the system provides an operational tool ready for immediate use and establishes a blueprint for future integrations. Looking ahead, the report recommends developing a generic, modular visualization library (proposed as “BioEconViz”) to support multiple bioeconomic models and promote standardized evaluation methodologies across European fisheries management regions.

A detailed summary of the ad hoc can be found in Annex 1 of this report, and the outcomes of the updated analysis can be found in section 4 of this report (ToR 3).

3. TOR 2 - SELECT ECONOMIC AND SOCIAL INDICATORS FOR INCLUSION IN THE FRAMEWORK TO ASSESS THE IMPACT OF THE TECHNICAL MEASURES REGULATION. EXTRACT SELECTED INDICATORS FROM AVAILABLE DATABASES USING FULL REPRODUCIBLE METHODS IN R. INDICATORS WILL BE INCLUDED IN MODEL RUNS AND OUTCOMES DISCUSSED.

The following sections describe the rationale for selecting the economic, social and gear-related indicators chosen by EWG 25-14 to describe the short-term impact of changes to gear based technical measures. For each indicator, details are provided on the data sources used and the methodology applied for its inclusion.

3.1 Economic indicators

Economic indicators are useful for describing how changes in a fishery affect people, businesses, and the wider economy, not just focusing on the fish stock itself. The EU Fishing Fleet Economic Data Call database, whose quality is reviewed and maintained by the Annual Economic Report EWG, provides the primary source of economic and social data used for scientific advice on the performance of the EU fishing fleet (STECF 2025). Therefore, the data submitted in 2025 were used to estimate indicators for the potential economic impact of technical measures on fisheries.

STECF applies a suite of socio-economic indicators to evaluate the performance of the fishing sector, as presented annually in the AER (STECF 2025). To support the calculation of these indicators, Member States (MS) are required, under the Data Collection Framework (DCF), to report a defined set of variables to the AER. EWG

25-14 used this list of indicators and associated variables as the basis for identifying which socio-economic indicators could be incorporated into the application.

Following extensive discussions, EWG 25-14 selected four economic indicators to assess the fleet performance: gross profit (GP), gross profit margin (GPM) gross value added (GVA) and break even revenue (BER). These indicators were selected based on analytical objectives; time horizon of the analysis; and challenges in calculation. Preference was given to indicators for which data are currently available in the AER.

The selected variables can be found in the AER fleet segment table (FS_table) and have, to varying degrees, been incorporated by EWG 25-14 into the case studies and scenarios produced.

Table 3.1.1 Variables reported to the fleet segment table in the AER data call , which have been selected by EWG 25-14 for inclusion in the assessment of economic impact of technical measures.

Variable group	Variable name	Variable code	Unit
Employment	Engaged crew	totjob	Number
	Full Time Employment (FTE) national †	totnatfte	Number
	Unpaid labour	unpaidemp	Number
Fleet capacity	Number of vessels	totves	Number
	Total vessel power	totkw	kW
Effort	Days at sea	totseadays	Day
	Fishing days	totfishdays	Day
	kW days at sea †	kwseadays	kWday
	kW fishing days †	totkwfishdays	kWday
Income	Gross value of landings	totlandginc	Euro
	Other income	tototherinc	Euro
	Income from leasing out quota or other fishing rights	totrights	Euro
Energy costs	Energy costs	totenergcost	Euro
Other operating costs	Other non-variable costs	totnovarcost	Euro
	Other variable costs	totvarcost	Euro
Labour	Personnel costs	totcrewwage	Euro

Variable group	Variable name	Variable code	Unit
Repair & maintenance costs	Repair & maintenance costs	totrepcost	Euro
Employment	Unpaid labour	unpaidemp	Number
Capital value	Value of physical capital	totdeprep	Euro
	Value of unpaid labour	totunpaidlab	Euro
Capital costs	Consumption of fixed capital	totdepcost	Euro

† kW*Days at sea; kW *Fishing days – use of active gears only. GT*Days at sea; GT*Fishing days – use of passive gears only.

Source: Own elaborations.

The variables listed in Table 3.1.1 were subsequently used to calculate a set of economic indicators. EWG 25-14 concluded that these indicators represent the best available tools for application in short-term projections within the case studies.

The indicators are defined as follows:

Gross profit (GP)

GP measures the difference between total revenue and operating costs, thus excluding capital costs. Gross profit is the appropriate indicator when the purpose of the analysis is to understand short-term performance, operational efficiency, or the behaviour of fishing fleets. It captures whether a fleet can cover its running costs and thus continue operating in the short term. This is particularly relevant in bioeconomic and fleet dynamics modelling, where the decision to go fishing is determined by the expected gross margin.

Defined in terms of variable names:

$$\text{Gross Profit} = \text{Income from landings} + \text{other income} - \text{crew costs} - \text{unpaid labour} - \text{energy costs} - \text{repair and maintenance costs} - \text{other variable costs} - \text{other non-variable costs}$$

Defined in terms of variable code:

$$\text{Gross Profit} = \text{Totlandginc} + \text{tototherinc} - \text{totcrewwage} - \text{unpaidemp} - \text{totenergcost} - \text{totrepcost} - \text{totvarcost} - \text{totnovarcost}$$

Gross profit margin (GPM)

GPM is an efficiency indicator to show how a company is able to manage its production costs. It is one of three indicators STECF calculates for the evaluation of the Western Mediterranean multiannual plan (MAP) and, therefore, already available from BEMTOOL.

Defined in terms of variable names:

$$\text{GPM} = \text{Gross Profit} / \text{revenues}$$

Defined in terms of variable code:

$$\text{GPM} = \text{Gross Profit} / (\text{totlandginc} + \text{tototherinc})$$

Gross value added (GVA)

GVA complements other profitability measures by capturing not just net or gross profit, but the overall value generated by the fleet's activities, including labour and capital contributions. GVA represents the value generated by the fleet that can be distributed to labour and capital. A higher GVA indicates that the fleet is generating substantial economic value, contributing to employment and income in coastal communities. Unlike gross profit, which focuses on operational margins, or ROFTA, which measures capital efficiency, GVA captures the total value created and its distribution among stakeholders

The calculation of the indicators, reported below, is aligned with the methodology used in the AER (STECF, 2025).

Defined in terms of variable names:

$$\text{GVA} = \text{Income from landings} + \text{other income} - \text{energy costs} - \text{repair costs} - \text{other variable costs} - \text{other non-variable costs}$$

Defined in terms of variable code:

$$\text{GVA} = \text{Totlandginc} + \text{tototherinc} - \text{totenercost} - \text{totrepcost} - \text{totvarcost} - \text{totnovarcost}$$

Break even revenue (BER)

BER is the amount of revenues a business needs to cover all its costs (both fixed and variable). At this point, the business has neither a profit nor a loss, as total revenue equals total expenses.

Defined in terms of variable names:

$$\text{BER} = (\text{Fixed costs} + \text{opportunity costs of capital} + \text{depreciation}) / (1 - (\text{crew costs} + \text{unpaid labour} + \text{energy costs} + \text{repair and maintenance costs} + \text{other variable costs}))$$

Defined in terms of variable code:

$$\text{BER} = (\text{totnovarcost} + \text{totdepcost} + ((\text{totdepcost} + \text{totrights}) * 3.5)) / (1 - (\text{totcrewwage} + \text{totunpaidlab} + \text{totenercost} + \text{totrepcost} + \text{totvarcost}))$$

Both the BOB and MED case studies presented in this report utilise the methods developed by SECFISH to partition economic data (Bitetto *et al.*, 2022). SECFISH project developed a methodology to disaggregate variable costs and labour costs from the fleet segment to the metier level. This methodology uses individual vessel data on a sample of vessels, to estimate the coefficients of a Generalized Linear Model (GLM). These coefficients, in a second step, are used to disaggregate the fuel costs and other variable costs from the fleet segment (e.g. AER) to the metier level, using the effort by fleet segment and metier (e.g. from FDI data).

To enhance the reliability of economic projections carried out using bio-economic models, SEAwisE¹ project developed a methodology to estimate economic sub-

¹ <https://seawiseproject.org>

models on the basis of the data available from the DCF. The methodology, implemented in R, allows to identify (e.g. fuel costs) for each fleet, by testing a wide range of equations for each variable and estimating for each model the Root Mean Squared Error (RMSE) as a measure of the predictive capability.

The SECFISH package (Bitteto et al. 2019) is available on R Cran. More details on the equation tested in SEAwise are available in SEAwise Deliverable 2.2 (Bitteto et al. 2024); a tutorial and relevant scripts are available on the SEAwise web site².

Specifically in the MED case study the disaggregated series of fuel costs and other variable costs are used to parametrize the BEMTOOL bio-economic model in Western Mediterranean (GSAs 9-10-11), to facilitate the modelling of a different unit fuel cost by metier, allowing to take into account the difference in the distance covered by the single trip.

3.2 Social indicators and financial security index

EWG 25-14 assessed the availability and usability of the newly available social dataset to identify indicators for evaluating the implementation and impact of the Technical Measures Regulation. Descriptive data analysis was conducted to determine dataset suitability, leading to the selection of relevant indicator and the definition of an estimation method.

Exploration of social data

Under Regulation (EU) 2017/10041, the Commission requests that MS provide aggregated scientific social data to support scientific advice in EU fisheries³. In 2025 the social data submitted by MS for the period 2017 to 2023, was explored in the context of the technical measures EWG 25-14. In summary, this data included five socio-demographic variables: gender, education, age, nationality and employment status, that are available for three different metrics of labour: employment, full-time employment (FTE), and unpaid labour. These variables provide a description of the demographics of the workforce.

For the purposes of EWG 25-14, the Bay of Biscay hake mixed fisheries case study was the sole focus of this exploration. Therefore, the social data was filtered for Spanish and French fishing fleets operating in the North Atlantic Ocean (NAO) as these are the main fleets participating the Bay of Biscay hake mixed fishery. Table 3.2.1. provides an overview of the data reported for the MS after filtering to the appropriate geographical indicator and supra region. For France, all social variables are submitted for the employment metric. For Spain, however, the coverage is lower with about 15 to 30% of the variables being available for the employment. For FTE and unpaid labour, only the gender data is available for both countries.

² https://seawiseproject.org/open_online_course/modelling_social_economic_effects/

³ https://dcf.ec.europa.eu/data-calls/social_en

Table 3.2.1. Coverage of data reported to the social data call by variable for France (FRA) and Spain (ESP).

country_code	variable_code	gender	age	education	nationality	employment_status
ESP	FTE	100 %	0 %	0 %	0 %	0 %
ESP	employment	14.29 %	28.57 %	19.05 %	23.81 %	14.29 %
ESP	unpaid labour	100 %	0 %	0 %	0 %	0 %
FRA	FTE	100 %	0 %	0 %	0 %	0 %
FRA	employment	100 %	100 %	100 %	100 %	100 %
FRA	unpaid labour	100 %	0 %	0 %	0 %	0 %

Source: Own elaborations.

Table 3.2.2 provides an overview of percentage of the variables for which the information is provided as “unknown”. Note that the percentages shown are only based on the values that are not reported as NA. For France, the proportion of “unknowns” appears to be low, except for the education variable. In contrast, for Spain, the proportion of the “unknown” category is higher, ranging between 16% and 33% across all variables. The proportion of meaningful variables (i.e. values that are either NA nor “unknown”) can be obtained by combining the percentages reported in Table 3.2.1. and Table 3.2.2.

Table 3.2.2. Social data call, percentage of “unknown” categories in the data by variable for France and Spain.

country_code	variable_code	gender	age	education	nationality	employment_status
ESP	FTE	33.33 %				
ESP	employment	33.33 %	16.67 %	25 %	20 %	33.33 %
ESP	unpaid labour	33.33 %				
FRA	FTE	0 %				
FRA	employment	0 %	0 %	22.29 %	0 %	0.35 %
FRA	unpaid labour	0 %				

Source: Own elaborations.

An analysis of the available social data for 2017, 2020, and 2023 showed that the basic stratification defined for the social database was often not followed. In almost half of the submissions, data were reported for each social variable separately, with no accompanying stratification information. As a result, it was not possible to link variables across years, countries, or fleets without making additional assumptions. This indicates that the social variables are not directly connected in the submitted data and that deriving meaningful insights requires applying certain assumptions to group the data. Moreover, 43% of the records could not be classified according to any activity parameters (supra_region, fishing_tech, vessel_length, geo_indicator,

gear, fishery, activity, fishing_activity) because these were not provided. Overall, nearly 30% of the data were submitted without any disaggregation by activity parameters.

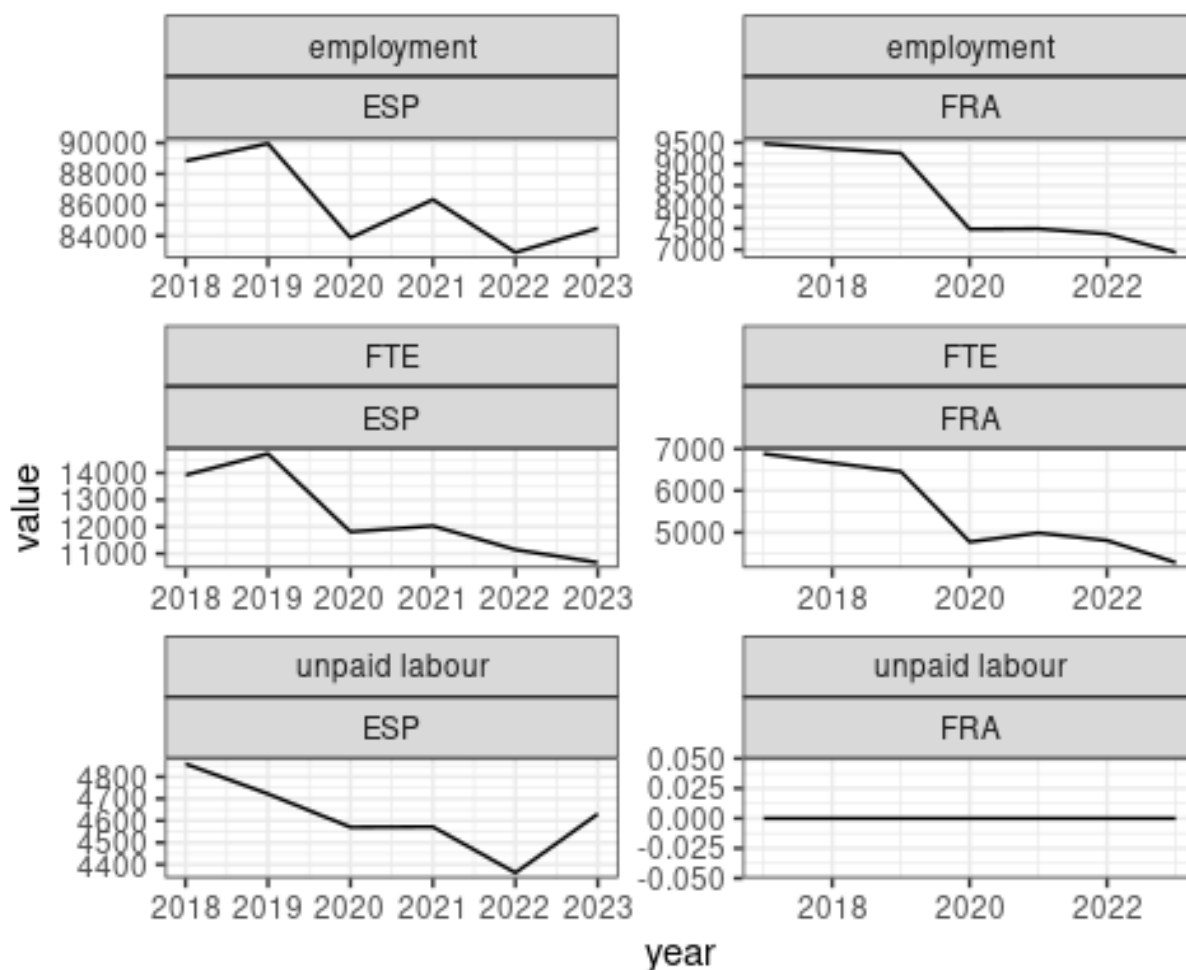
Overall trends indicate that both the employment and FTEs have decreased over the period 2018-2023 for France and Spain (Table 3.2.3, **Error! Reference source not found.**). For both MS, the main decrease occurred between 2019 and 2020. The decline was more pronounced in the FTEs than in the employment. There was also a notable difference between the ratio of the FTE to employment between France and Spain. While for France, the ratio between FTE to employment was about 0.7, while for Spain, the ratio between FTE and employment was about 0.15. France did not report unpaid labour.

Table 3.2.3. Full time employment (FTE), employment and unpaid labour for the period 2017-2023 for France and Spain as reported in the social data.

variable code	country code	2017	2018	2019	2020	2021	2022	2023
FTE	ESP		13923	14713	11808	12026	11146	10665
FTE	FRA	6881	6661	6454	4773	4987	4807	4276
employment	ESP		88840	89960	83870	86341	82924	84490
employment	FRA	9479	9359	9256	7480	7490	7370	6938
unpaid labour	ESP		4859	4722	4570	4572	4362	4631
unpaid labour	FRA	0	0	0	0	0	0	0

Source: Own elaborations.

Figure 3.2.1 Full-time employment (FTE), employment and unpaid labour for the period 2017-2023 for France and Spain as reported in the social data.



Source: Own elaborations.

Table 3.2.4 provides the employment by DCF fleet segment and year. The distribution of the employment across fleet segments by country and year is given as percentages in brackets. In France, employment tends to be more equally spread across fleet segments, while in Spain, 35 to 40% of the total employment can be allocated to two fleet segments: polyvalent mobile and passive gears (PMP0010) and dredgers (DRB0010) vessels under 10 m length.

Table 3.2.4. Employment by Data Collection Framework (DCF) fleet segment for the period 2017-2023 for France and Spain as reported in the social data. Values in brackets give the distribution of the employment within each country and year.

country code	DCF fleet segment	2017	2018	2019	2020	2021	2022	2023
ESP	NGI ESP DFN1012		2180 (2.45%)	1920 (2.13%)	1730 (2.06%)	1663.3333 (1.93%)	2141.25 (2.58%)	1645.2124 (1.95%)

country code	DCF fleet segment	2017	2018	2019	2020	2021	2022	2023
ESP	NGI ESP DFN1218		3480 (3.92%)	3185 (3.54%)	3390 (4.04%)	4216 (4.88%)	3055.0039 (3.68%)	2990.5786 (3.54%)
ESP	NGI ESP DFN1824		1330 (1.5%)	1610 (1.79%)	1230 (1.47%)	1193.85 (1.38%)	923.2 (1.11%)	2192.4416 (2.59%)
ESP	NGI ESP DRB0010		13720 (15.44%)	15180 (16.87%)	12220 (14.57%)	11933.9366 (13.82%)	10865.8302 (13.1%)	9363.7071 (11.08%)
ESP	NGI ESP DRB1012		230 (0.26%)	235 (0.26%)	265 (0.32%)	283.3334 (0.33%)	260 (0.31%)	426.25 (0.5%)
ESP	NGI ESP DRB1218		1365 (1.54%)	2030 (2.26%)	1440 (1.72%)	1545 (1.79%)	1493.8571 (1.8%)	1297.7253 (1.54%)
ESP	NGI ESP DTS1218		1400 (1.58%)	1380 (1.53%)	1580 (1.88%)	2355 (2.73%)	1341.6665 (1.62%)	1789.9568 (2.12%)
ESP	NGI ESP DTS1824		2020 (2.27%)	2130 (2.37%)	1930 (2.3%)	1911.6665 (2.21%)	2242.5 (2.7%)	2042.1343 (2.42%)
ESP	NGI ESP DTS2440		5495 (6.19%)	6295 (7%)	6200 (7.39%)	7834.8192 (9.07%)	5744.5793 (6.93%)	6959.6504 (8.24%)
ESP	NGI ESP DTS40XX		2550 (2.87%)	2080 (2.31%)	2315 (2.76%)	1791.3 (2.07%)	2081.04 (2.51%)	1719.622 (2.04%)
ESP	NGI ESP FPO1012		1355 (1.53%)	865 (0.96%)	630 (0.75%)	1463.3367 (1.69%)	1279.9999 (1.54%)	1080.8644 (1.28%)
ESP	NGI ESP FPO1218		1040 (1.17%)	845 (0.94%)	370 (0.44%)	920 (1.07%)	1300.8366 (1.57%)	1348.4612 (1.6%)
ESP	NGI ESP HOK1012		1265 (1.42%)	705 (0.78%)	950 (1.13%)	1350.83 (1.56%)	1066.6666 (1.29%)	1109.206 (1.31%)
ESP	NGI ESP HOK1218		1445 (1.63%)	1475 (1.64%)	2000 (2.38%)	1666.6601 (1.93%)	1700 (2.05%)	1581.6181 (1.87%)
ESP	NGI ESP HOK1824		1675 (1.89%)	955 (1.06%)	1040 (1.24%)	985.4246 (1.14%)	1269.5455 (1.53%)	1311.2568 (1.55%)
ESP	NGI ESP HOK2440		3185 (3.59%)	4225 (4.7%)	3210 (3.83%)	2875 (3.33%)	5382.1448 (6.49%)	6082.4443 (7.2%)
ESP	NGI ESP PG0010							170.9125 (0.2%)
ESP	NGI ESP PGP2440		5100 (5.74%)	5885 (6.54%)	5135 (6.12%)	5367.2169 (6.22%)	5706.0716 (6.88%)	5113.5549 (6.05%)
ESP	NGI ESP PMP0010		22115 (24.89%)	21825 (24.26%)	21350 (25.46%)	20456.6131 (23.69%)	21713.3237 (26.18%)	21844.8268 (25.85%)
ESP	NGI ESP PMP1012		615 (0.69%)	890 (0.99%)	1225 (1.46%)	983 (1.14%)	550 (0.66%)	149 (0.18%)
ESP	NGI ESP PMP1218		595 (0.67%)	635 (0.71%)	680 (0.81%)	539 (0.62%)	280 (0.34%)	260 (0.31%)

country code	DCF fleet segment	2017	2018	2019	2020	2021	2022	2023
ESP	NGI ESP PS1012		390 (0.44%)	335 (0.37%)	415 (0.49%)	408 (0.47%)	450 (0.54%)	452 (0.54%)
ESP	NGI ESP PS1218		4395 (4.95%)	4605 (5.12%)	3495 (4.17%)	3187 (3.69%)	3689 (4.45%)	4190 (4.96%)
ESP	NGI ESP PS1824		5530 (6.22%)	5520 (6.14%)	5475 (6.53%)	5453 (6.32%)	4980 (6.01%)	5033 (5.96%)
ESP	NGI ESP PS2440		6365 (7.16%)	5150 (5.72%)	5595 (6.67%)	5958 (6.9%)	3408 (4.11%)	4336 (5.13%)
FRA	NGI FRA DFN0010	334 (3.52%)	334 (3.57%)	329 (3.55%)	413 (5.52%)	414 (5.52%)	383 (5.2%)	375 (5.41%)
FRA	NGI FRA DFN1012	616 (6.5%)	596 (6.37%)	590 (6.37%)	417 (5.57%)	403 (5.38%)	400 (5.43%)	378 (5.45%)
FRA	NGI FRA DFN1218	440 (4.64%)	423 (4.52%)	419 (4.53%)	281 (3.75%)	263 (3.51%)	264 (3.58%)	252 (3.64%)
FRA	NGI FRA DFN1824	319 (3.37%)	319 (3.41%)	314 (3.39%)	213 (2.84%)	215 (2.87%)	201 (2.72%)	191 (2.75%)
FRA	NGI FRA DFN2440	311 (3.28%)	311 (3.32%)	309 (3.34%)	341 (4.56%)	352 (4.7%)	368 (4.99%)	368 (5.3%)
FRA	NGI FRA DRB0010	136 (1.43%)	136 (1.45%)	134 (1.45%)	104 (1.39%)	113 (1.5%)	138 (1.88%)	144 (2.07%)
FRA	NGI FRA DRB1012	252 (2.66%)	252 (2.69%)	248 (2.68%)	205 (2.74%)	223 (2.98%)	245 (3.32%)	257 (3.71%)
FRA	NGI FRA DRB1218	401 (4.23%)	385 (4.11%)	381 (4.12%)	366 (4.89%)	427 (5.7%)	465 (6.31%)	410 (5.91%)
FRA	NGI FRA DRB1824	49 (0.52%)	49 (0.52%)	48 (0.52%)				
FRA	NGI FRA DRB2440	6 (0.06%)	6 (0.06%)	6 (0.06%)				
FRA	NGI FRA DTS0010	159 (1.68%)	159 (1.7%)	157 (1.7%)	119.17 (1.59%)	106.85 (1.43%)	105.75 (1.43%)	89.98 (1.3%)
FRA	NGI FRA DTS1012	481 (5.07%)	470 (5.02%)	464 (5.01%)	356.82 (4.77%)	342.79 (4.58%)	303.34 (4.12%)	266.04 (3.83%)
FRA	NGI FRA DTS1218	681 (7.18%)	662 (7.07%)	655 (7.08%)	462.83 (6.19%)	443.57 (5.92%)	449.08 (6.09%)	385.75 (5.56%)
FRA	NGI FRA DTS1824	914 (9.64%)	886 (9.47%)	879 (9.5%)	647.32 (8.65%)	660.08 (8.81%)	563.21 (7.64%)	529.54 (7.63%)
FRA	NGI FRA DTS2440	574 (6.06%)	571 (6.1%)	566 (6.11%)	407.91 (5.45%)	439.17 (5.86%)	447.03 (6.07%)	454.06 (6.54%)
FRA	NGI FRA DTS40XX	250 (2.64%)	247 (2.64%)	244 (2.64%)	283 (3.78%)	293 (3.91%)	268 (3.64%)	268 (3.86%)

country code	DCF fleet segment	2017	2018	2019	2020	2021	2022	2023
FRA	NGI FRA FPO0010	442 (4.66%)	439 (4.69%)	434 (4.69%)	442 (5.91%)	422 (5.64%)	487 (6.61%)	411 (5.93%)
FRA	NGI FRA FPO1012	259 (2.73%)	259 (2.77%)	255 (2.75%)	274 (3.67%)	224 (3%)	225 (3.05%)	224 (3.23%)
FRA	NGI FRA FPO1218	30 (0.32%)	30 (0.32%)	30 (0.32%)				
FRA	NGI FRA FPO1824	102 (1.08%)	102 (1.09%)	101 (1.09%)	107 (1.43%)	93 (1.25%)	83 (1.12%)	54 (0.77%)
FRA	NGI FRA FPO2440	13 (0.14%)	13 (0.14%)	13 (0.14%)				
FRA	NGI FRA HOK0010	313 (3.3%)	313 (3.34%)	309 (3.34%)	282 (3.77%)	279 (3.72%)	259 (3.51%)	264 (3.81%)
FRA	NGI FRA HOK1012	134 (1.41%)	134 (1.43%)	132 (1.43%)	106 (1.42%)	95 (1.27%)	116 (1.57%)	99 (1.43%)
FRA	NGI FRA HOK1218	2 (0.02%)	2 (0.02%)	2 (0.02%)				
FRA	NGI FRA HOK1824	64 (0.68%)	64 (0.68%)	63 (0.68%)				
FRA	NGI FRA HOK2440	467 (4.93%)	467 (4.99%)	464 (5.01%)	268 (3.58%)	282 (3.77%)	245 (3.32%)	185 (2.66%)
FRA	NGI FRA MGO0010	116 (1.22%)	116 (1.24%)	115 (1.24%)	196 (2.62%)	213 (2.85%)	212 (2.88%)	208 (3%)
FRA	NGI FRA MGO1012	8 (0.08%)	8 (0.09%)	8 (0.09%)				
FRA	NGI FRA MGP0010	33 (0.35%)	33 (0.35%)	33 (0.36%)	22 (0.3%)	24 (0.32%)	21 (0.28%)	21 (0.3%)
FRA	NGI FRA MGP1012	138 (1.46%)	138 (1.47%)	136 (1.47%)	165 (2.21%)	183 (2.44%)	196 (2.66%)	171 (2.47%)
FRA	NGI FRA MGP1218	162 (1.71%)	162 (1.73%)	160 (1.73%)	207 (2.76%)	195 (2.6%)	175 (2.37%)	218 (3.14%)
FRA	NGI FRA MGP1824	25 (0.26%)	25 (0.27%)	25 (0.27%)				
FRA	NGI FRA MGP2440	29 (0.31%)	29 (0.31%)	29 (0.31%)				
FRA	NGI FRA PGO0010	118 (1.24%)	118 (1.26%)	117 (1.26%)	145.17 (1.94%)	148 (1.98%)	135 (1.84%)	145 (2.09%)
FRA	NGI FRA PGO1012	5 (0.05%)	5 (0.05%)	5 (0.05%)				
FRA	NGI FRA PGO1218	5 (0.05%)	5 (0.05%)	5 (0.05%)				

country code	DCF fleet segment	2017	2018	2019	2020	2021	2022	2023
FRA	NGI FRA PGP0010	78 (0.82%)	78 (0.83%)	77 (0.83%)	88 (1.18%)	97 (1.29%)	94 (1.28%)	81 (1.16%)
FRA	NGI FRA PGP1012	57 (0.6%)	57 (0.61%)	57 (0.62%)	45 (0.6%)	76 (1.01%)	49 (0.66%)	40 (0.57%)
FRA	NGI FRA PMP0010	101 (1.07%)	101 (1.08%)	101 (1.09%)	89 (1.19%)	68 (0.91%)	63 (0.86%)	57 (0.82%)
FRA	NGI FRA PMP1012	143 (1.51%)	143 (1.53%)	140 (1.51%)	132 (1.76%)	141 (1.88%)	145 (1.97%)	162 (2.33%)
FRA	NGI FRA PMP1218	38 (0.4%)	38 (0.41%)	38 (0.41%)				
FRA	NGI FRA PS1012	12 (0.13%)	12 (0.13%)	12 (0.13%)				
FRA	NGI FRA PS1218	191 (2.01%)	191 (2.04%)	187 (2.02%)	176 (2.36%)	178 (2.38%)	169 (2.3%)	141 (2.03%)
FRA	NGI FRA PS1824	23 (0.24%)	23 (0.25%)	23 (0.25%)				
FRA	NGI FRA TBB1012	4 (0.04%)	4 (0.04%)	4 (0.04%)				
FRA	NGI FRA TBB1218	13 (0.14%)	13 (0.14%)	13 (0.14%)				
FRA	NGI FRA TM0010	3 (0.03%)	3 (0.03%)	3 (0.03%)				
FRA	NGI FRA TM1012	25 (0.26%)	25 (0.27%)	25 (0.27%)				
FRA	NGI FRA TM1218	59 (0.62%)	59 (0.63%)	59 (0.64%)				
FRA	NGI FRA TM1824	192 (2.03%)	192 (2.05%)	189 (2.04%)	121 (1.61%)	76.09 (1.02%)	97.49 (1.32%)	89 (1.29%)
FRA	NGI FRA TM40XX	152 (1.6%)	152 (1.62%)	149 (1.61%)				

Source: Own elaborations.

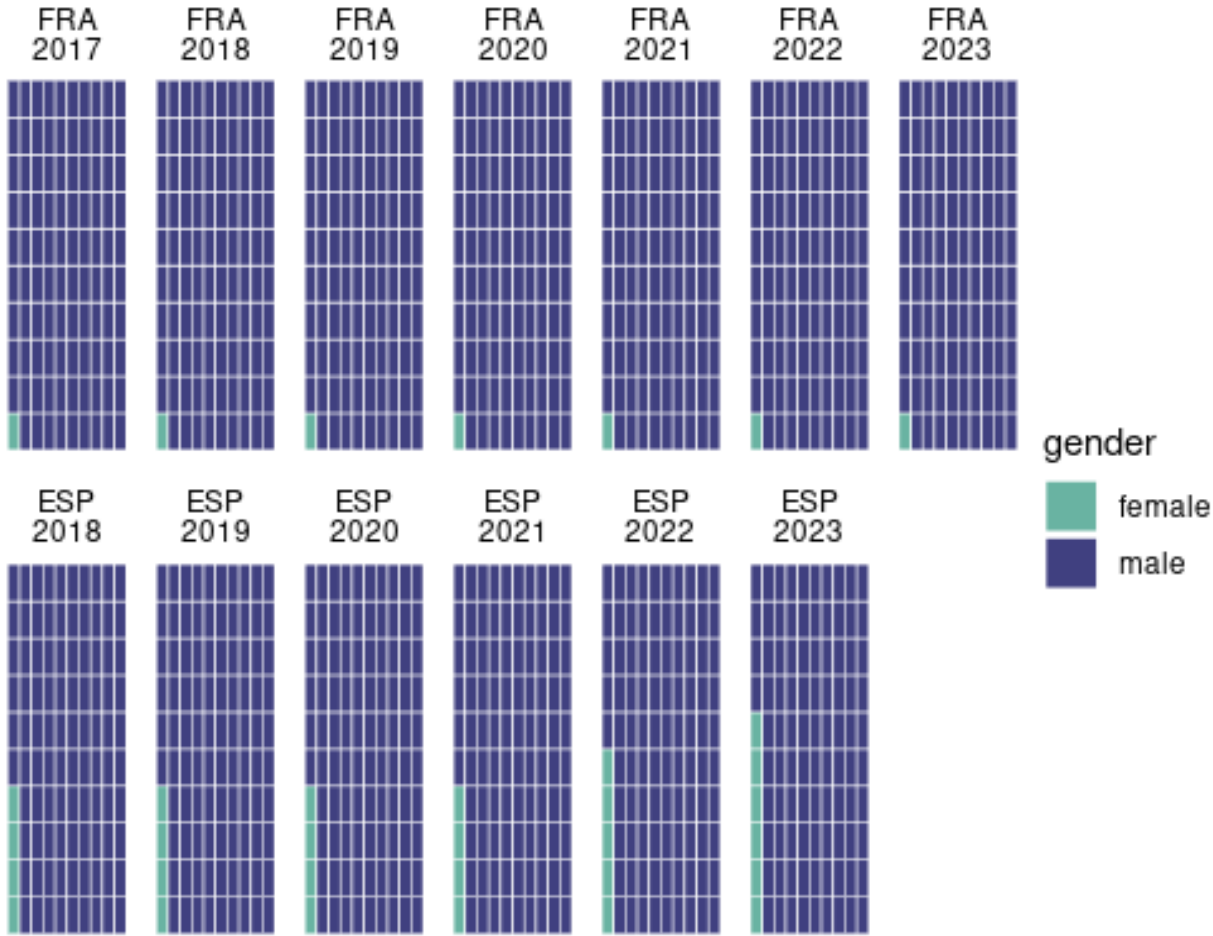
Table 3.2.5 shows the employment broken down by gender. It appears that there are more females employed in fisheries in Spain compared to France. The relative contribution of female employment tends to increase in Spain, especially over the years 2022 and 2023 (**Error! Reference source not found.**).

Table 3.2.5. Employment by gender for the period 2017-2023 for France and Spain as reported in the social data. Values between brackets give the distribution of the employment within each country and year.

variable code	country code	gender	2017	2018	2019	2020	2021	2022	2023
FTE	FRA	female	59.4379 (0.86%)	59.5588 (0.89%)	59.5588 (0.92%)	39.3 (0.82%)	36.65 (0.73%)	38.15 (0.79%)	41.37 (0.97%)
FTE	FRA	male	6822 (99.14%)	6602 (99.11%)	6395 (99.08%)	4734 (99.18%)	4950 (99.27%)	4769 (99.21%)	4236 (99.03%)
FTE	ESP	female		371 (2.66%)	459 (3.12%)	325 (2.75%)	374 (3.11%)	421 (3.78%)	416 (3.9%)
FTE	ESP	male		13553 (97.34%)	14255 (96.88%)	11484 (97.25%)	11653 (96.89%)	10725 (96.22%)	10249 (96.1%)
FTE	ESP	unknown		0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
employment	FRA	female	110 (1.16%)	110 (1.18%)	110 (1.19%)	92 (1.23%)	79 (1.05%)	85 (1.15%)	99.24 (1.43%)
employment	FRA	male	9369 (98.84%)	9249 (98.82%)	9146 (98.81%)	7388 (98.77%)	7411 (98.95%)	7285 (98.85%)	6838 (98.57%)
employment	ESP	female		640 (3.6%)	679 (3.77%)	640 (3.82%)	751 (4.35%)	729 (4.4%)	1001 (5.92%)
employment	ESP	male		17128 (96.4%)	17313 (96.23%)	16134 (96.18%)	16517 (95.65%)	15856 (95.6%)	15897 (94.08%)
employment	ESP	unknown		0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
unpaid labour	FRA	female	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)
unpaid labour	FRA	male	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)	0 (NaN%)
unpaid labour	ESP	female		309 (6.36%)	281 (5.95%)	272 (5.95%)	265 (5.8%)	258 (5.91%)	374 (8.08%)
unpaid labour	ESP	male		4550 (93.64%)	4441 (94.05%)	4298 (94.05%)	4307 (94.2%)	4104 (94.09%)	4257 (91.92%)
unpaid labour	ESP	unknown		0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: Own elaborations.

Figure 3.2.2 Relative employment by gender for the period 2017-2023 for France and Spain as reported in the social data



Source: Own elaborations.

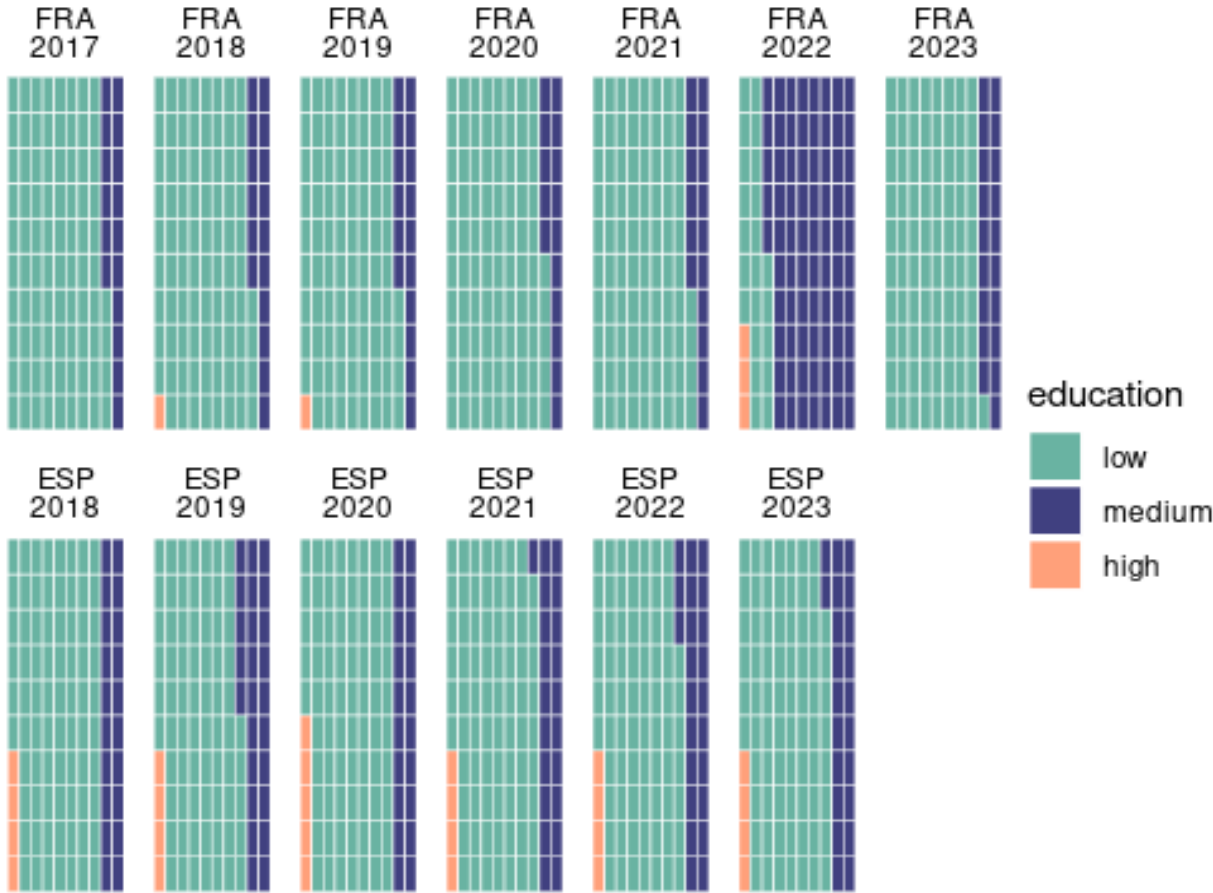
Table 3.2.6 shows the employment broken down by education level, while Figure 3.2.2. gives the relative distribution of the education level over the years. Note that these figures omit education levels which are unknown. Note that there is likely an issue with the French data in 2022 given the significant distribution of the education level compared to the other years.

Table 3.2.6 Employment by education level for the period 2017-2023 for France and Spain as reported in the social data. Values in brackets represent the distribution of the employment within each country and year.

variable code	country code	education	2017	2018	2019	2020	2021	2022	2023
employment	FRA	low	6395 (83.31%)	6275 (83.05%)	6192 (82.96%)	5224 (84.66%)	5099 (83.18%)	1304 (21.7%)	4553 (80.59%)
employment	FRA	medium	1224 (15.95%)	1224 (16.2%)	1215 (16.28%)	936 (15.16%)	1011 (16.5%)	4510 (75.05%)	1081 (19.13%)
employment	FRA	high	57 (0.74%)	57 (0.75%)	57 (0.76%)	11 (0.18%)	19 (0.32%)	196 (3.26%)	15 (0.27%)
employment	ESP	low		12271 (76.56%)	11693 (70.9%)	11156 (75.51%)	12027 (75.22%)	10886 (73.34%)	11501 (73.41%)
employment	ESP	medium		3175 (19.81%)	4086 (24.77%)	2913 (19.72%)	3324 (20.79%)	3367 (22.68%)	3491 (22.28%)
employment	ESP	high		581 (3.63%)	714 (4.33%)	706 (4.78%)	638 (3.99%)	591 (3.98%)	674 (4.3%)

Source: Own elaborations.

Figure 3.2.2. Relative employment by education level for the period 2017-2023 for France and Spain as reported in the social data.



Source: Own elaborations.

Table 3.2.7 shows the employment broken down by nationality.

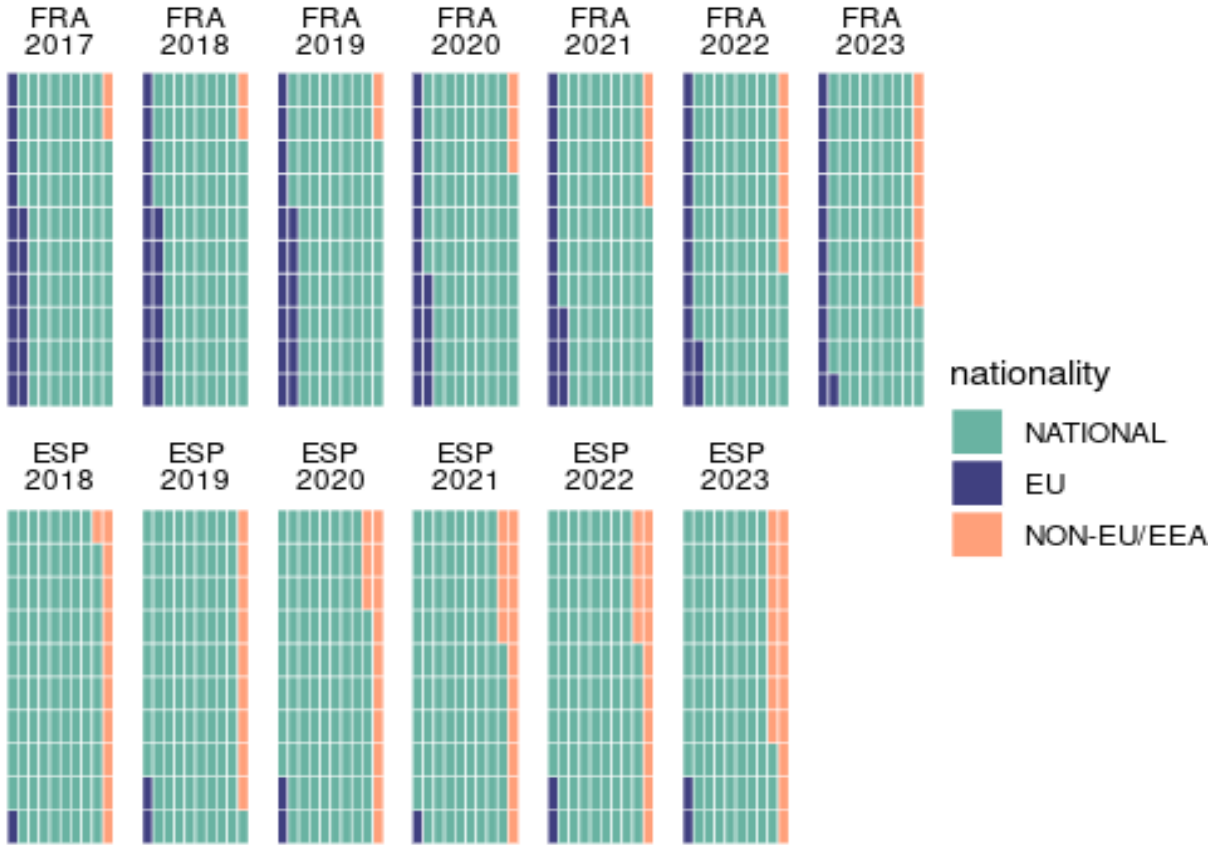
Figure 3.2.3 provides the relative distribution of the nationalities over time for both countries. Note that nationality categories reported as “unknown” are omitted. The figures indicate a higher proportion of non-European Union or European Economic Area (non-EU/EEA) workers in Spain compared to France. In France, there are more EU workers, however, there appears to be a shift over the period 2017-2023, with a decline in the relative share of EU employment and an increase in the relative importance of non-EU/EEA workers.

Table 3.2.7 Employment by nationality for the period 2017-2023 for France and Spain as reported in the social data. Values in brackets give the distribution of the employment within each country and year.

variable code	country code	nationality	2017	2018	2019	2020	2021	2022	2023
employment	FRA	NATIONAL	7820 (82.5%)	7700 (82.27%)	7609 (82.21%)	6206 (82.96%)	6197 (82.74%)	6071.61 (82.38%)	5676.32 (81.82%)
employment	FRA	EU	1481 (15.62%)	1481 (15.82%)	1469 (15.87%)	1042 (13.94%)	955 (12.75%)	879.66 (11.94%)	744.94 (10.74%)
employment	FRA	EEA	3 (0.03%)	3 (0.03%)	3 (0.03%)	2 (0.03%)	2 (0.02%)	2 (0.02%)	2 (0.03%)
employment	FRA	NON-EU/EEA	175 (1.85%)	175 (1.87%)	175 (1.89%)	230 (3.07%)	336 (4.49%)	417 (5.66%)	514 (7.41%)
employment	ESP	NATIONAL		14360 (87.61%)	14735 (89.08%)	12872 (85.39%)	14012 (85.52%)	12765 (83.92%)	13267 (81.69%)
employment	ESP	EU		224 (1.37%)	246 (1.49%)	275 (1.82%)	128 (0.78%)	343 (2.25%)	243 (1.49%)
employment	ESP	EEA		0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
employment	ESP	NON-EU/EEA		1807 (11.02%)	1561 (9.44%)	1928 (12.79%)	2245 (13.7%)	2102 (13.82%)	2732 (16.82%)

Source: Own elaborations.

Figure 3.2.3. Relative employment by nationality for the period 2017-2023 for France and Spain as reported in the social data.



Source: Own elaborations.

Table 3.2.8 shows the employment broken down by age category and Table 3.2.5 provides the relative distribution of the age groups over the years for both countries. Note that age categories reported as “unknown” are excluded from these figures. The main difference between France and Spain is found in the age group 15-24 years which contributes to about 13-15% of the French employment and only 2-3% of the Spanish employment.

Table 3.2.8. Employment by age category for the period 2017-2023 for France and Spain as reported in the social data. Values in brackets give the distribution of the employment within each country and year.

variable code	country code	age	2017	2018	2019	2020	2021	2022	2023
employment	FRA	15-24	1547 (16.32%)	1543 (16.49%)	1523 (16.45%)	1035 (13.84%)	1052 (14.05%)	1027 (13.94%)	951 (13.71%)
employment	FRA	25-39	3065 (32.33%)	3016 (32.23%)	2982 (32.22%)	2573 (34.39%)	2648 (35.35%)	2550 (34.6%)	2468 (35.57%)
employment	FRA	40-64	4788 (50.51%)	4721 (50.44%)	4672 (50.48%)	3773 (50.43%)	3704 (49.46%)	3703 (50.25%)	3410 (49.15%)
employment	FRA	65+	79 (0.83%)	79 (0.84%)	79 (0.85%)	100 (1.33%)	85 (1.13%)	90 (1.22%)	109 (1.57%)
employment	ESP	15-24		281 (1.71%)	396 (2.39%)	353 (2.33%)	482 (2.98%)	457 (3.02%)	307 (1.88%)
employment	ESP	25-39		6545 (39.85%)	6101 (36.75%)	5362 (35.35%)	4977 (30.76%)	4419 (29.18%)	4772 (29.18%)
employment	ESP	40-64		9591 (58.39%)	9968 (60.04%)	9358 (61.69%)	10636 (65.74%)	10158 (67.07%)	11220 (68.6%)
employment	ESP	65+		9 (0.05%)	136 (0.82%)	97 (0.64%)	85 (0.53%)	111 (0.73%)	56 (0.34%)

Source: Own elaborations.

Figure 3.2.4 Relative employment by age category for the period 2017-2023 for France and Spain as reported in the social data.



Source: Own elaborations.

Table 3.2.9 shows the employment broken down by employment status and

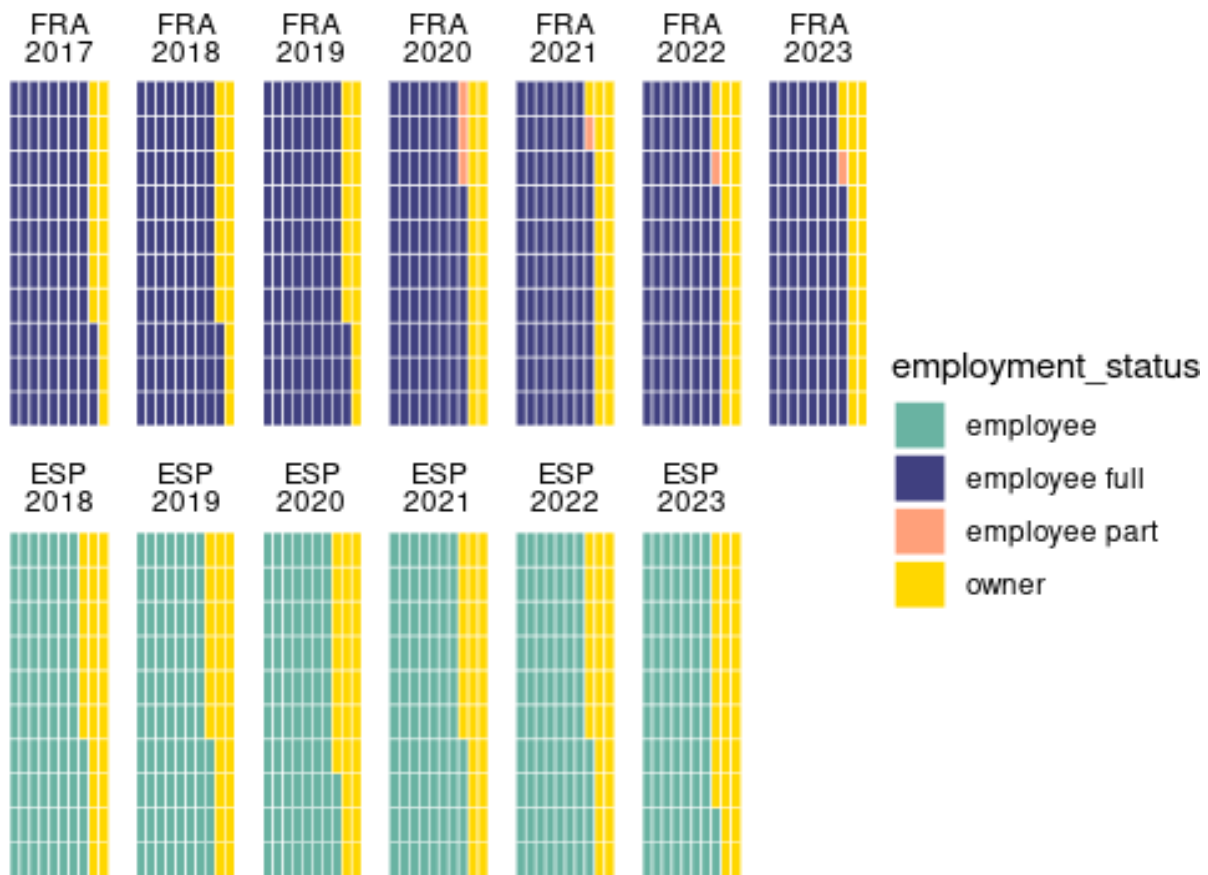
Table 3.2.6 provides the relative distribution of the employment status over the years for both countries. Note that employment status reported as “unknown” are excluded from these figures. France reports on full and part time employment, while Spain appears not to make a distinction in its reporting. Furthermore, there appear to be a higher proportion of vessel owners in Spain compared to France.

Table 3.2.9. Employment by employment status for the period 2017-2023 for France and Spain as reported in the social data. Values between brackets give the distribution of the employment within each country and year.

variable code	country code	employment status	2017	2018	2019	2020	2021	2022	2023
employment	FRA	employee full	7839 (82.7%)	7719 (82.48%)	7637 (82.51%)	5725 (76.54%)	5825 (78.11%)	5689 (77.19%)	5354 (77.18%)
employment	FRA	employee part	58 (0.61%)	58 (0.62%)	58 (0.63%)	255 (3.41%)	65 (0.87%)	70 (0.95%)	73 (1.05%)
employment	FRA	owner	1582 (16.69%)	1582 (16.9%)	1561 (16.86%)	1500 (20.05%)	1567 (21.02%)	1611 (21.86%)	1510 (21.77%)
employment	ESP	employee		12962 (73.61%)	13031 (73.83%)	12307 (73.37%)	12753 (73.85%)	12283 (74.06%)	12167 (72%)
employment	ESP	owner		4646 (26.39%)	4618 (26.17%)	4467 (26.63%)	4516 (26.15%)	4302 (25.94%)	4731 (28%)

Source: Own elaborations.

Figure 3.2.5. Relative employment by employment status for the period 2017-2023 for France and Spain as reported in the social data.



Source: Own elaborations.

Note that all these figures should be broken down to a more disaggregated level of fishing activity, vessel length, etc. This report only provides a general overview of the available data.

Comparison between AER and Social data

The established AER database provided a quality-controlled reference set by which to compare the completeness of the Social database. Table 3.2.10 shows a comparison of the FTE and employment data submitted in both the AER and social data by France and Spain. For the FTE, there is a full agreement for Spain, while for France the FTE values agree from 2020. In 2017, 2018 and 2019, the FTE values reported in the social data call where higher than those reported in the AER. For employment (totjob in the AER dataset), there is only agreement for France from 2020 to 2023. A similar deviation as for the FTE is denoted for France in the period 2017-2019. For Spain, the deviation is much larger with values in the social data call being 5 times higher than those reported in the AER data. Note that the difference appears to be consistent over time so that the underlying data source is likely the same.

Table 3.2.10. Comparison of the full-time employment (FTE) and employment between the AER and social data call

country		FTE		totjob	employment		diff
code	year	AER	SOCIAL	AER	SOCIAL	FTE	employment
ESP	2018	13923	13923	17768	88840	1.000	0.200
ESP	2019	14713	14713	17992	89960	1.000	0.200
ESP	2020	11809	11809	16774	83870	1.000	0.200
ESP	2021	12027	12027	17268	86341	1.000	0.200
ESP	2022	11146	11146	16585	82924	1.000	0.200
ESP	2023	10665	10665	16899	84490	1.000	0.200
FRA	2017	5431	6881	7675	9479	0.789	0.810
FRA	2018	5376	6661	7670	9359	0.807	0.820
FRA	2019	5191	6454	7637	9256	0.804	0.825
FRA	2020	4773	4773	7480	7480	1.000	1.000
FRA	2021	4987	4987	7490	7490	1.000	1.000
FRA	2022	4807	4807	7370	7370	1.000	1.000
FRA	2023	4277	4277	6938	6938	1.000	1.000

Source: Own elaborations.

Selected indicator

EWG 25-14 decided to use the financial position indicator (defined by EWG 25-02, STECF 2025b, under the working conditions category = wellbeing) within the modelling exercise. Also, the group recommended that the term “financial position” may lead to misinterpretation and proposed the use of financial security instead.

The financial security indicator should be calculated as the ratio of the average wage in the fisheries sector to the national minimum wage, expressed as a percentage. According to this update, the indicator was defined as:

Financial security = average wage compared to national minimum wage as per EWG 23-17 (STECF 2023b) and Tables 4.3 and 4.4 in EWG 24-05 (STECF 2024b)

This provides a standardized metric that facilitates cross-country comparison of income security within the sector.

For the BOB case study, data for national minimum wages can be obtained from Eurostat and national fisheries profiles; however, the data on minimum and average wages varies depending on the data source and year consulted. Future EWGs will to decide which source to use.

Based on Eurostat data, the below table shows the national minimum wages for Spain and France:

Table 3.2.11. National minimum wages for Spain and France

Member State (BOB)	National minimum wages (Eurostat, 2025)
France	1.801,8 €/month
Spain	1.381 €/month

Source: Own elaborations.

For the Mediterranean case study, some Mediterranean countries, such as Italy, where no minimum wage exists, national average wage data could be explored as an alternative. The financial security indicator will be calculated as the ratio of the average wage in the fisheries sector to the national minimum wage, expressed as a percentage.

In the calculation of this indicator, the variable “labour cost” provided by Member States within the DCF is used as a proxy for crew wages. In the AER labour costs are considered because the unit of analysis is the fleet and not the fishers. The use of labour costs as a proxy for wages can be considered as a limitation in data availability; nevertheless, in the fisheries sector, taxation on labour is relatively low, and other non-wage components of labour costs are minimal. Therefore, for the purpose of social indicator modelling, labour costs may be considered a reasonable proxy for crew wages.

This provides a standardized metric that facilitates cross-country comparison of income security within the sector.

Limitations

EWG 25-14 highlighted a number of limitations and challenges to the incorporation and inclusion of social data in modelling frameworks such as BioEcon.

First, outcomes are model-based and therefore indicate only the direction in which a social or economic indicator is likely to move; they are not exact measurements. However, the actual impacts will depend on the specific context. Contextual factors (e.g. regional economic structure, policy environment, cultural differences) will strongly influence the actual impacts observed (Edwards *et al.*, 1999).

Second, although some fisheries-related social data, such as employment, time away from sea, and working hours, can be represented using available official statistics, their interpretation from a social perspective remains limited (STECF 2024a, EWG 24-16). For instance, in the case of time away from sea, this quantitative indicator does not capture a range of land-based activities, including baiting, gear preparation, vessel maintenance, and other shore-based operations, which can constitute a substantial share of total labour depending on the fleet, gear type, and fishing area. Moreover, relying solely on quantitative indicators risks misinterpretation, as an observed change (e.g., a decrease in employment) could be viewed as negative

without accounting for contextual or qualitative information. Therefore, the explanatory power of these social indicators should be treated with caution, and any interpretation ought to be complemented by qualitative insights to provide a more accurate and comprehensive understanding of the fisheries' social dimension.

Third, the social indicators selected are those for which quantitative data are available and/or suitable for modelling purposes. As a result, these indicators are primarily socio-economic in nature. An example is material well-being (White, 2010), which can be measured using average wages or employment. However, qualitative social aspects, such as relational or subjective aspects of well-being (White, 2010) or identity, are more difficult to incorporate into modelling exercises, yet changes in fisheries management can have significant impacts on them. For example, if fisheries management regulations would lead to the number of fishing vessels landing in a certain fishing port decreasing below a critical mass, it is likely the local fish auction will no longer be economically viable; disappearance of the auction could then trigger a chain of events, such as the end of the fishing co-op, loss of the local shop who supplies the vessels, etc. This would, amongst others, impact on different aspects of well-being (Kraan et al., 2023). Pathway reasoning, where potential impacts of modelled socio-economic outcomes on social and cultural dimensions are qualitatively described using logical reasoning based on expert judgement and/or literature, is possible. However, as local contexts differ, there are limitations to this approach.

Looking at multidimensional outcomes through a unidimensional lens can obscure both the meaning and management implications of social-ecological phenomena (Barnett et al., 2019). To achieve a comprehensive interpretation of social and economic impacts, quantitative modelling should be complemented by qualitative research, such as interviews, questionnaires or focus group discussions, to capture lived experiences and local realities. For measuring social indicators such as material, relational and social well-being, methodologies have already been developed in the context of fisheries in Ireland (Britton et al., 2013) and The Netherlands (Kraan et al., 2023). It is advisable to draw on these as it will enable comparison. Because contextual differences play an important role, such qualitative approaches are essential for accurately interpreting social, economic, and cultural implications, and are therefore strongly recommended to ensure a more complete understanding of fisheries-related impacts.

3.3 Gear studies

Gear experts participating in EWG 25-14 compiled a summary of gear-selectivity studies relevant to the stocks and fisheries executed in the case studies selected. For each study, the summary reports the mesh size of the main net, the type and specifications of any selectivity device used, and the resulting selectivity parameters. These include the L50, defined as the fish length at which 50% of individuals are retained by the gear, and the selectivity range (SR), which measures how sharply the gear discriminates among sizes. Details of these studies can be found in the following sections.

Bay of Biscay

In the present EWG 25-14 the review on studies/selectivity estimates performed during the last EWG for the Bay of Biscay was updated, filtered for hake and checked for additional stocks, baseline selectivity parameters and potential errors in the tables for old studies. Table is included in Annex II.

Considering the reviewed studies and the information available for use in the FLBEIA model, it is suggested to select two scenarios from available gear selectivity studies:

- Cuende *et al.* (2022) absolute selectivity estimates for 2 species from Basque BOB bottom trawl fishery.
- Vogel *et al.* (2017) catch comparison selectivity indicators for 2 species from French *Nephrops* BOB trawl fishery.

Stocks incorporated in the analysis for the Bay of Biscay mixed fisheries are the following:

- Black-bellied anglerfish - 7, 8.a-b and 8.d
- Sea bass - 8.a-b
- Hake - 3.a, 4, 6, 7 and 8.a-b and 8.d
- Horse mackerel - northeast Atlantic
- Mackerel - Northeast Atlantic and adjacent waters
- Megrim - 7.b-k and 8.a-b and 8.d
- White anglerfish - 7, 8.a-b and 8.d
- Norway lobster - FU 2324
- Pollack - 8 and 9.a
- Smooth-hound - northeast Atlantic and adjacent waters
- Sole - 8.a-b
- Blue whiting - Northeast Atlantic and adjacent waters
- Whiting - 8 and 9.a

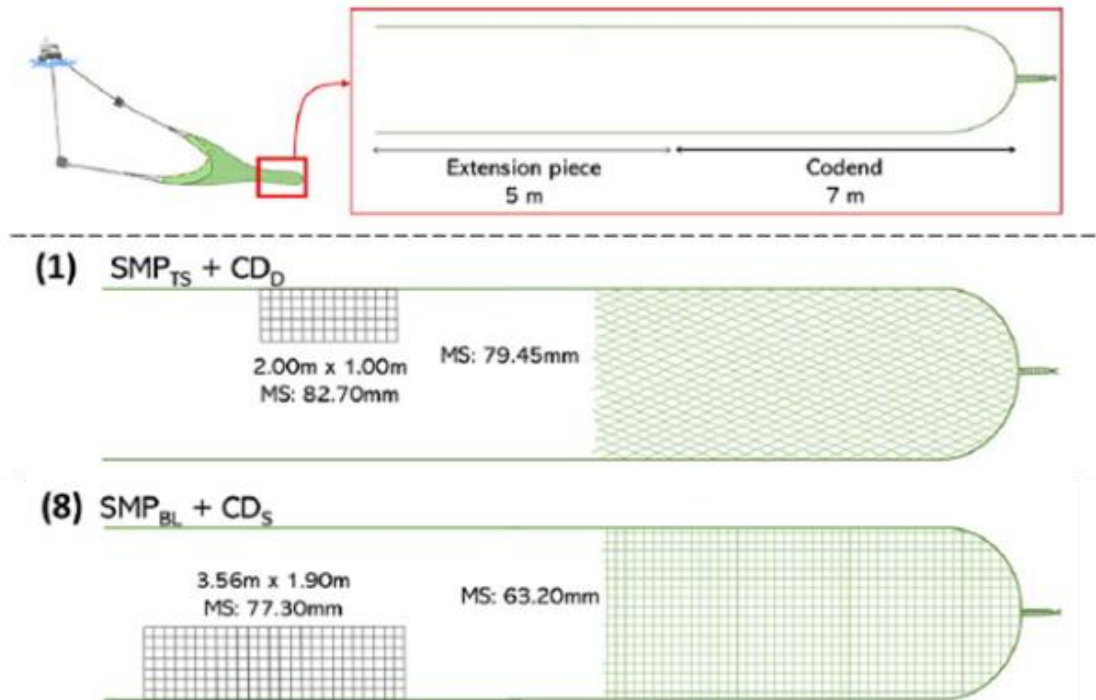
These fish stocks represent the primary target species of the bottom trawl fleets operating in the Bay of Biscay. For the purposes of this analysis, the lowest selectivity estimates associated with the mixed bottom-trawl and *Nephrops* fishery have been applied, and these are therefore the selectivity parameters used in the model. A key limitation is the lack of sufficient selectivity studies across all species involved. As a result, only the available selectivity parameters for European hake and a subset of associated species caught in this fishery can be incorporated into the modelling framework.

Scenarios are described below within the individual case studies.

Scenario 1: Selectivity parameters of technical measures tested in Basque Bay of Biscay mixed OTB_DEF fishery are provided by Cuende *et al.* (2022). The authors used codend and square mesh panel covers to provide independent selectivity estimates for codend and square mesh panel configurations. The lead author provided EWG 25-14 with combined selectivity estimates for the baseline gear and the most appropriate selective gear for targeting hake (Annex 2). The baseline gear

(SMP_{TS} + C_{DD}) configuration was a 79 mm diamond mesh codend with an 82 mm mesh size square mesh panel (2 m x 1 m) fitted in the top sheet of the extension piece (**Error! Reference source not found.**). The selective gear (SMP_{BL} + C_{DS}) consisted of a 63 mm square mesh codend and a 77 mm mesh size square mesh panel (3 m x 1 m) fitted in the bottom sheet of the extension.

Figure 3.3.1. Baseline (1: SMP_{TS} + C_{DD}) and selective (8: SMP_{BL} + C_{DS}) gear configurations included in the study that resulted from combining different SMP. Reproduced from Cuende et al. (2022). Codend designs considered. MS: mesh size.



Source: Cuende et al. (2022).

Combined selectivity parameters were only available for hake and blue whiting (**Error! Reference source not found.**). The authors consider that flatfish species are an important bycatch in the fishery. Trial results suggest that placing the square mesh panel in the bottom sheet of the trawl, as in the case of the selective gear described above, significantly increased its effectiveness for hake likely through improved contact. Blue whiting are almost exclusively size-selected by meshes in the square mesh codend.

Scenario 2:

Vogel et al. (2017) focused on technical solutions to reduce catches of undersized *Nephrops* and hake in the French OTT_CRU *Nephrops* fishery. They tested two selective devices against the baseline gear: a 70 mm square mesh cylinder (SMC) fitted in the extension (85 meshes long by 120 meshes circumference) and an inverted selective grid with 13 mm spacing fitted in the top of the extension (**Error! Reference source not found.**) The test and baseline gears included the mandatory

100 mm SMP (3m x 1m) and 70 mm diamond mesh codend. The gears were tested using the catch comparison method on board multiple commercial vessels deploying twin-rig trawls during 2010 and 2011.

Figure 3.3.2 Diagram of the square mesh cylinder (A) and inverted selective grid (B). Reproduced from Vogel et al. (2017).

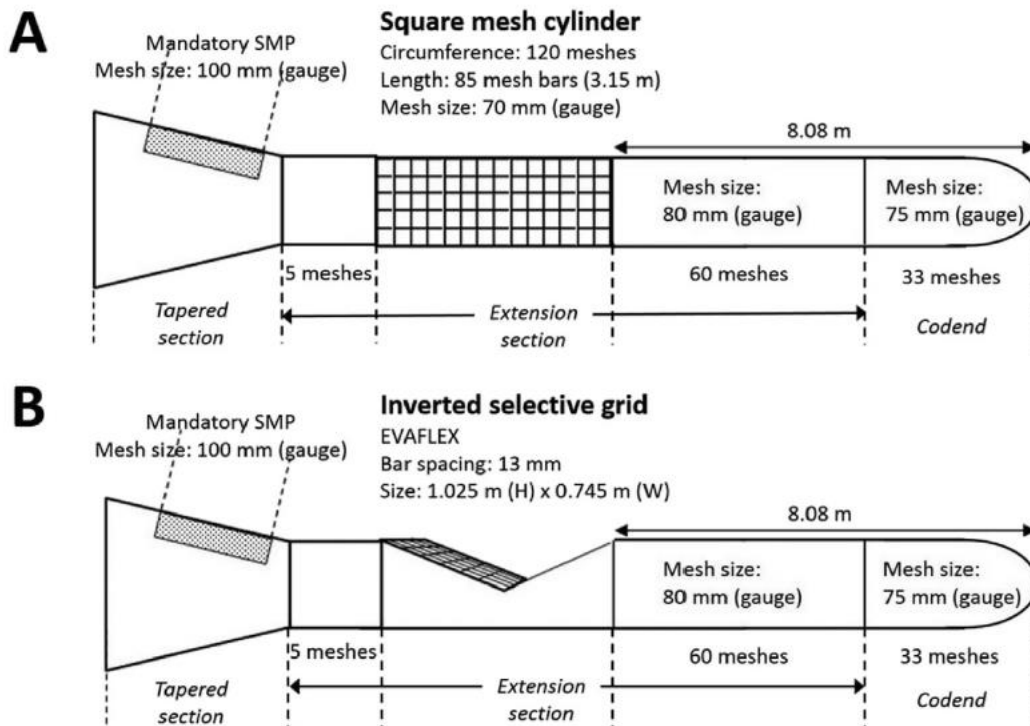


Fig. 1. Diagram of the square mesh cylinder (A) and inverted selective grid (B), with location details within the trawl body.

Source: Vogel et al. (2017).

Vogel et al. (2017) found that the two selective gears tested had similar effects on *Nephrops* < MCRS escapement while only the grid was efficient for hake < MCRS. Both test gears result in catch reductions of *Nephrops* and Hake >= MCRS. Therefore it is proposed that the grid be considered in this scenario (**Error! Reference source not found.**).

Using the results of the catch comparison presented in Vogel et al. (2017) to provide the relative selectivity change for a scenario where a grid is implemented is challenging. In a catch comparison trial, the proportional difference in catch at length between the baseline and selective gear could inform this scenario. Unfortunately, this data was not presented in the results of this trial, as is commonly the case with catch comparison trial reports, and it was not possible to obtain during the EWG. This highlights an issue with how catch comparison results are presented as the selectivity change presented in this scenario could not be modelled in this way. An author can provide this data through personal communication but this may not be possible in the case of older studies.

However, rates of escapement, discard and commercial losses are also reported in Vogel *et al.* (2017) and could potentially be used to inform a change in relative selectivity for this scenario. The authors suggest the median values are more reliable than the mean values due to the presence of extreme values which reflect variability inherent in the fishing process.

Table 3.3.1 Escapement rate and estimated reduction in discard and commercial catch rates using the grid. Reported in Vogel *et al.* (2017)

Rate	Rate description	Mean (%)	S.D.	Median
$r_{esc,NEP}$	Nephrops < MCRS escapement rate (N)	18.6	38.1	30.4
$r_{disc,NEP}$	Nephrops < MCRS discard rate reduction (wt)	12.5	42.3	21.4
$r_{cc,NEP}$	Nephrops >= MCRS catch rate reduction (wt)	10.1	19.4	9
$r_{esc,HKE}$	Hake < MCRS escapement rate (N)	19	54.9	25
$r_{disc,HKE}$	Hake < MCRS discard rate reduction (wt)	-11.5	179.1	20.6
$r_{cc,HKE}$	Hake >= MCRS catch rate reduction (wt)	-6.8	89.1	11.6

Source: Vogel *et al.* (2017).

Western Mediterranean

Annex IX of the Technical Measure Regulations (TMR) dictates the baseline mesh size for towed gears in the Mediterranean Sea, which is provisioned the 40mm square mesh codend (or 50 mm diamond mesh codend under specific requirements). In West Med, GSAs 1, 5, 6, and 7, bottom otter trawlers operate under three metiers: OTB_DEF for “coastal” demersal fishing on shelf and upper-slope grounds, and OTB_MDD/OTB_DWS for “middle-depth” and “deep-water” shrimp fishing on the middle slope. The OTB_DEF is the metier harvesting hake across West Med and OTB_MDD/OTB_DWS only affects hake indirectly via effort reallocation once deep-shrimp limits are met.

EWG 25-06 (STECF 2025c) report summarizes fishing tactics followed for hake fishery in West MED. OTB_DEF covers shallow shelf, deep shelf, and upper slope tactics, OTB_DWS is the middle-slope shrimp fishery, and OTB_MDD mixes shelf or upper-slope with middle-slope towing. These tactics are reflected in size composition of hake retained (upper slope \approx 30 cm mean, middle slope \approx 33 cm mean in the GSA 5 example), aligning OTB_DEF with the demersal fish assemblage and DWS/MDD

with deep-water crustaceans where large hake are bycatch rather than the target. By stock, OTB_DEF is the trawl activity that interacts directly with European hake across GSAs 1, 5, 6, 7. Trawling (OTB/OTT) is the main gear used for hake, with metiers varying by area, in GSA 1 hake is mainly caught from OTB, in GSA 5 hake is almost exclusively caught from OTB, in GSA 6 longlines contributed substantially to hake catches but are currently reduced, with GNS/GTR and OTB now prominent, and in GSA 7, gillnets are most important, followed by GTR, OTT and then OTB. Despite these gear differences, OTB_DEF is the main gear used for hake.

During the last two STECF EWG Western Med Multiannual Management Plan (MAP) meetings EWG 24-12 (STECF 2024c) and EWG 25-11 (STECF 2025d) BEMTOOL was used to explore selectivity scenarios involving the trawling fleets operating in GSAs 9, 10 and 11 (Ligurian, Tyrrhenian Sea and Sardinian waters).

In the present EWG 25-14 the review on studies/selectivity estimates performed during the EWG 22-19 (STECF 2022) for the whole Mediterranean Sea, was updated, filtered for hake and checked for additional stocks, baseline selectivity parameters and potential errors estimated from West and Central Mediterranean are included in Annex I.

The updated selectivity parameters were based on Bahamon *et al.* (2024) as a basis, adapted to the exploitation patterns observed in the catches in the different GSAs. The performance of square mesh codends with three different configurations was compared, including the currently enforced commercial 40-SM (baseline gear), and the experimental 45-SM and 50-SM across 154 experimental tows (2012–2021). The experimental 45-SM was tested in coastal mixed fisheries (50 – 250 m depth) targeting *Mullus barbatus*, *Merluccius merluccius*, *Parapenaeus longirostris* and *Nep hrops norvegicus*, while the experimental 50-SM was tested in highly mono-specific deep-sea fisheries (450 – 700 m depth) targeting *Aristeus antennatus*. Covered codend method were used by setting a 12 mm stretch mesh size cover to catch the individuals escaping the codend of the net. Mixed-effects logistic models are applied to derive L_{50} and selection range, run under three recruitment scenarios. Scenario 1 included all the hauls per selectivity experiment, regardless of the recruitment conditions of the species, as it would reflect the situation of the commercial fleet operating throughout the year. Scenario 2 included only the hauls carried out during recruitment conditions, characterizing the season with more impacts on selectivity when relatively small, young individuals predominate. Scenario 3 considered only the selectivity experiments carried out under no recruitment conditions. Practically, scenario 1 uses all hauls across seasons and ports, mirroring “real” fishery year-round, scenario 2 isolates recruitment peaks to test the impact on juvenile fish individuals, whereas scenario 3 (no-recruitment) is down-weighted due to few valid hauls.

Results show that square-mesh codends outperform diamond-mesh codends across species depicting higher L_{50} as the codend is increasing (Fig. 6: Bahamon *et al.*, 2024) and 45 mm of square of mesh depicts the best observed selectivity gains notably for hake, red mullet, and rose shrimp. In fact, for hake specifically, ≥ 50 mm of square mesh is needed to push L_{50} to (or above) the 20 cm MCRS (ER REG 1241/2019) in the Med, but 45 mm of square mesh is an improvement but still below

MCRS on average. For deep-sea trawl (*A. antennatus* fishery) 50 mm of square mesh exhibited the best observed selectivity. For *N. norvegicus* the 45 mm of square of mesh change did not deliver a significant selectivity benefit ($L_{50} \approx$ unchanged; SR worsened), so other measures (e.g., SMP positioning, grids, or different mesh/geometry) may be incorporated. This is because in mesh size alone was insufficient to ensure juveniles escape before capture (Bahamon et al., 2024). On the other hand, increasing mesh size of the codend could increase target size, L_{50} of hake increases to 22.2 cm (≥ 20 cm MCRS) for 50-SM and subsequently increases L_{50} for other species. However, this follows a drop in commercial yields (e.g., hake $\approx -60\%$; red mullet $\approx -30-40\%$; shortfin squid $\approx -50-55\%$). Hence, mesh-increase alone can be biologically effective but economically hardship, motivating other devices/placement/geometry to keep market fish while releasing juveniles (Sbrana et al., 2022).

Based on the above-mentioned, the selectivity were based on Bahamon et al. (2024) as a basis, adapted to the exploitation patterns observed in the catches in the different GSAs. The scenarios assumed a modification of the mesh size in the codend from 40-SM to 45-SM following the scenario 1, which serves as the reliable baseline scenario, for 40-SM and the experimental 45-SM, both for OTB_DEF (demersal) and OTB_MDD/OTB_DWS (mixed and deep-water) metier.

In the SEAwisE project (seawiseproject.org), BEMTOOL was applied to the Adriatic and western Ionian Seas to test an alternative selectivity scenario (Bitetto et al. 2025). The scenario combines a 45-mm square-mesh codend with a sorting grid and semi-pelagic doors (the latter to reduce fuel use). The gear changes were informed by recent evidence: Bahamon et al. (2024) reported increases in length at first capture for European hake, red mullet and deep-water rose shrimp when moving from a 40-SM to a 45-SM, with limited effects on Norway lobster; Gorelli et al. (2017) showed that raising codend mesh size from 40 to 50 mm increases first-capture size of blue and red shrimp. For these two shrimps we therefore applied a conversion factor to approximate the effect of a 45-SM and used the same factor for giant red shrimp.

Building on the IMPEMED project (Sbrana et al., 2022), which demonstrated that installing a sorting grid increases the length at first capture of Norway lobster with limited impacts on other species, the SEAwisE Adriatic–western Ionian case study assumes a sorting grid combined with a 45-SM to protect Norway lobster. In addition, experimental trials with semi-pelagic doors presented to the GFCM Working Group on Fishing Technology (GFCM, 2024) indicated an $\sim 18\%$ reduction in fuel consumption, so the scenarios also include semi-pelagic doors. In short, the gear-modification scenarios considered here assume: a 45-SM, a sorting grid for Norway lobster protection, and semi-pelagic doors. The selectivity scenario was also combined with catch limits of red shrimps set to reach FMSY of the two stocks (giant red shrimp and blue and red shrimp), showing that this combination consistently delivers better outcomes than the status quo, both in terms of GVA and CO_2 emissions per kg of fish. Indeed, these scenarios promote improved exploitation patterns and effort allocation, helping to stabilize economic returns and mitigate climate-induced declines. The scenario with improved selectivity for trawlers, in

particular, enhances resilience for mixed fleets in Croatia and Italy, while the reallocation of effort quotas benefits shrimp-dominated fisheries in GSAs 18 and 19.

Based on the outcomes from EWG 24-12, in GSAs 8–11, BEMTOOL provides the hake results and explicitly splits trawlers by OTB_DEF versus OTB_DWS/MDD. The baseline status for Hake is overfished ($F_{curr} \approx 0.40$ vs $F_{msy} \approx 0.25$ and $F_{reduced} \approx 0.14$; SSB ≈ 3.8 kt against $B_{pa} \approx 10.8$ kt). In fact, for GSAs 8–11, the results show that achieving HKE targets requires reductions in OTB_DEF, whereas OTB_DWS/OTB_MDD concerning for hake mainly through effort “spillover” into OTB_DEF once deep-shrimp quota limits reached. EWG 24-12 report also checks codend selectivity inputs used in the models. With 40-SM, hake juveniles are heavily retained ($L_{50} \sim 13.6$ cm), whereas a shift towards 45-SM increases L_{50} to approximately 16.8 cm, and a 50-SM shift to approximately 21 cm, slightly above to the 20-cm issued by MCRS. Meeting MSY-consistent targets requires substantial effort reduction (GSAs 8 to 11: -54% for F_{msy} or -100% for $F_{reduced}$), since 45-SM selectivity alone improves sizes, but does not reach the plan’s objectives for HKE by 2025–2027.

The application of BEMTOOL shows that, improving gear selectivity generally leads to an initial reduction in catches, revenues, and profits, followed by a gradual recovery in subsequent years as stock status improves. Higher selectivity also allows to apply less severe effort reductions and to progress toward FMSY through a combined strategy of selectivity gains and moderate cuts in effort quotas. Finally, the selectivity measure delivers immediate spillover benefits to other fleets—unless those fleets are simultaneously constrained by fleet-specific measures (e.g., catch limits on nets under the Western Med MAP).

4. TOR 3 – IDENTIFY, PARAMETERISE AND RUN MEANINGFUL MANAGEMENT SCENARIOS, THE FINDING OF WHICH WILL BE DISCUSSED IN TERMS OF RELEVANCE TO SUPPORTING FUTURE ADVICE NEEDS.

The data tools and code provided under the ad hoc contracts (Section 2, ToR 1) were adapted to represent the selected gear-based scenarios (Section 3.3, ToR 2). Where possible, the results are presented in terms of biological indicators (catch, SSB, F , and recruitment), economic indicators (Section 3.1, ToR 2), and social indicators (Section 3.2, ToR 2) for both hake demersal mixed-fisheries case studies. Scenario details, parameterisation, and outcomes can be found in the following sections.

4.1 Bay of Biscay hake mixed fisheries case study

Case study

This case study was designed to assess the impact of changes in technical measures to the Bay of Biscay (ICES divisions 8.a-b and 8.d) hake mixed fisheries in terms of biological and economic outcomes, building on the mixed fisheries model case study already applied by ICES (ICES 2023a, b). This mixed fishery targets a large range of species using gears such as otter, beam and pelagic trawls, resulting in highly mixed catches. Otter trawl is the main gear used in demersal fisheries in this

case study. The following sections detail the application of the proposed framework, achievements and outstanding work.

Although this modelling framework was designed on the original mixed fisheries advice for this region in 2023, this case study deviates from the original mixed fisheries model in a number of ways:

- This case study builds and uses age disaggregated fleet object to account for selectivity per fleet. Therefore, differences in SSB and F are to be expected between the two advice products.
- Only 4 of the original 8 mixed fisheries stocks have been included in the model (hke.27.3a46-8abd, meg.27.7b-k8abd, hom.27.2a4a5b6a7a-ce-k8, whb.27.1-91214), whereas the mixed-fisheries considerations in 2023 were presented for black-bellied anglerfish (ank.27.78abd), sea bass (bss.27.8ab), hake (hke.27.3a46-8abd), horse mackerel (hom.27.2a4a5b6a7a-ce-k8), mackerel (mac.27.nea), megrim (meg.27.7b-k8abd), white anglerfish (mon.27.78abd), Norway lobster (functional units [FUs] 23 and 24; nep.fu.2324), pollack (pol.27.89a), smooth-hound (sdv.27.nea), sole (sol.27.8ab), blue whiting (whb.27.1-91214), and whiting (whg.27.89a) in the Bay of Biscay. The reason for this deviation is due to the fact that the ad hoc author was only able to access age and length data for 4 stocks in 2023. Therefore, differing choking patterns are to be expected.

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Data sources

The following data was incorporated into the BioEcon framework:

- 1- Fleet traversal data was taken from the Fisheries Dependant Information database (STECF 2023a), this data base provided information on landings, discards (Table A) and effort (Table H).
- 2- Fleet economic data was taken from Annual Economic Report (AER) (STECF 2025a) fleet segment data (FS) table.
- 3- Single species stock assessments outputs including age and length data, advice, and stock objects were supplied by Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE, ICES 2023c) and Working Group on Widely Distributed Stocks (WGWIDE, ICES 2023d).
- 4- WGMIXFISH code, methodology and quality control processes were incorporated into the process (ICES 2023b).

Fleet groupings

This case study defines fleet groupings using clustered AER fleet segment typology, which is a combination of country, surpa region fishing technique and vessel length category. Using this typology 19 fleets were identified as catching hake within the Bay of Biscay during the period (2020-2022) (

Table 4.1.1).

Table 4.1.1 Summary of the fleets used in the Bay of Biscay case study.

Fleet	Country	Sup ra Regi on	Fishing Technique	Vessel Length Category
BEL NAO TBB2440 NGI	BEL - Belgium	NAO *	TBB - Beam trawlers	2440 - Length over all of 24 m. to shorter than 40 m
ESP NAO HOK1024 NK	ESP - Spain	NAO	HOK - Vessel using other active gears	1024 - Length over all of 10 m. to shorter than 40 m
ESP NAO PGP1024 NK	ESP - Spain	NAO	PGP - Vessels using polyvalent passive gears only	1024 - Length over all of 10 m. to shorter than 40 m
ESP NAO PGP2440 NK	ESP - Spain	NAO	PGP - Vessels using polyvalent passive gears only	2440 - Length over all of 24 m. to shorter than 40 m
FRA NAO DFN0010 NGI	FRA - France	NAO	DFN - Drift and/or fixed netters	0010 - Length over all of 0 m. to shorter than 10 m
FRA NAO DFN1024 NGI	FRA - France	NAO	DFN - Drift and/or fixed netters	1024 - Length over all of 10 m. to shorter than 40 m
FRA NAO DFN2440 NGI	FRA - France	NAO	DTS - Demersal trawlers and/or demersal seiners	2440 - Length over all of 24 m. to shorter than 40 m
FRA NAO DTS0010 NGI	FRA - France	NAO	DTS - Demersal trawlers and/or demersal seiners	0010 - Length over all of 0 m. to shorter than 10 m
FRA NAO DTS1024 NGI	FRA - France	NAO	DTS - Demersal trawlers and/or demersal seiners	1024 - Length over all of 10 m. to shorter than 40 m
FRA NAO FPO0010 NGI	FRA - France	NAO	FPO - Vessels using pots and/or traps	0010 - Length over all of 0 m. to shorter than 10 m
FRA NAO HOK0010 NGI	FRA - France	NAO	HOK - Vessel using other active gears	0010 - Length over all of 0 m. to shorter than 10 m
FRA NAO HOK1024 NGI	FRA - France	NAO	HOK - Vessel using other active gears	1024 - Length over all of 10 m. to shorter than 40 m
FRA NAO MGO0010 NGI	FRA - France	NAO	MGO - Vessel using other active gears	0010 - Length over all of 0 m. to shorter than 10 m
FRA NAO MGO1024 NGI	FRA - France	NAO	MGO - Vessel using other active gears	1024 - Length over all of 10 m. to shorter than 40 m
FRA NAO MGP1024 NGI	FRA - France	NAO	MGP - Vessels using polyvalent active gears only	1024 - Length over all of 10 m. to shorter than 40 m
FRA NAO PGP0010 NGI	FRA - France	NAO	PGP - Vessels using polyvalent passive gears only	0010 - Length over all of 0 m. to shorter than 10 m
FRA NAO PGP1024 NGI	FRA - France	NAO	PGP - Vessels using polyvalent passive gears only	1024 - Length over all of 10 m. to shorter than 40 m
FRA NAO PMP1024 NGI	FRA - France	NAO	PMP - Vessels using active and passive gears	1024 - Length over all of 10 m. to shorter than 40 m
FRA NAO TM1024 NGI	FRA - France	NAO	TM - Pelagic trawlers	1024 - Length over all of 10 m. to shorter than 40 m

Source: Own elaborations.

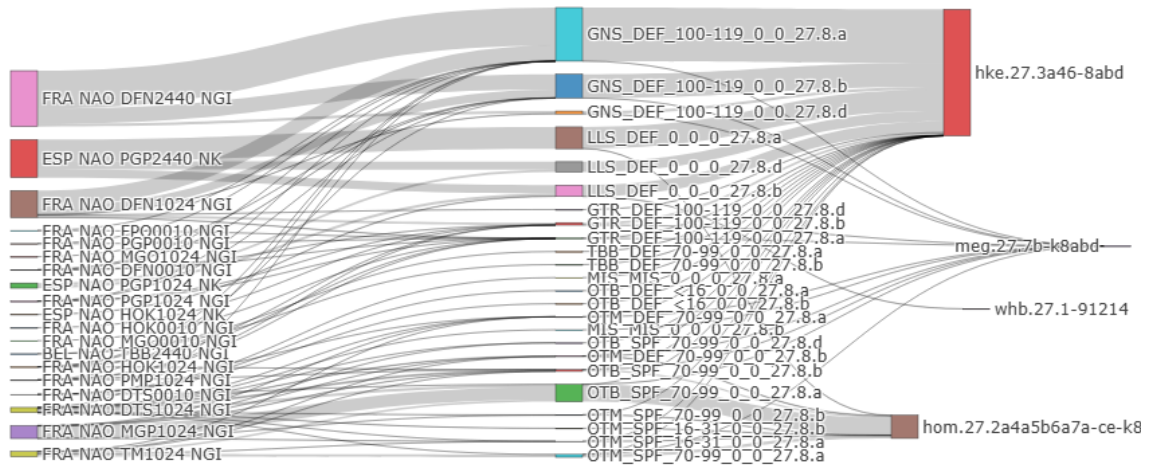
* NAO - Baltic Sea, North Sea, Eastern Arctic, North of Azores, East Greenland, NAFO, Extended North-Western waters (ICES areas V, VI and VII), Southern Western waters, CECAF areas around Madera and the Canary Islands¹⁴ (FAO areas 34.1.1, 34.1.2, 34.2.0)

These 19 fleets execute a variety of fishing behaviour, summarised by 10 métier (GNS_DEF_100-119_0_0, GTR_DEF_100-119_0_0, LLS_DEF_0_0_0, MIS_MIS_0_0_0, OTB_DEF_<16_0_0, OTB_SPF_70-99_0_0, OTM_DEF_70-99_0_0, OTM_SPF_16-31_0_0, OTM_SPF_70-99_0_0, TBB_DEF_70-99_0_0)(Figure 4.1.1). All 19 fleets catch hake to a greater or lesser extent, with one fleet also catches blue whiting, eight catching horse mackerel, and nine catching four spot megrim (Figure 4.1.2)

Due to data confidentiality requirements arising from GDPR and some MSs national legislation, some smaller fleets are clustered with larger fleets in the AER database.

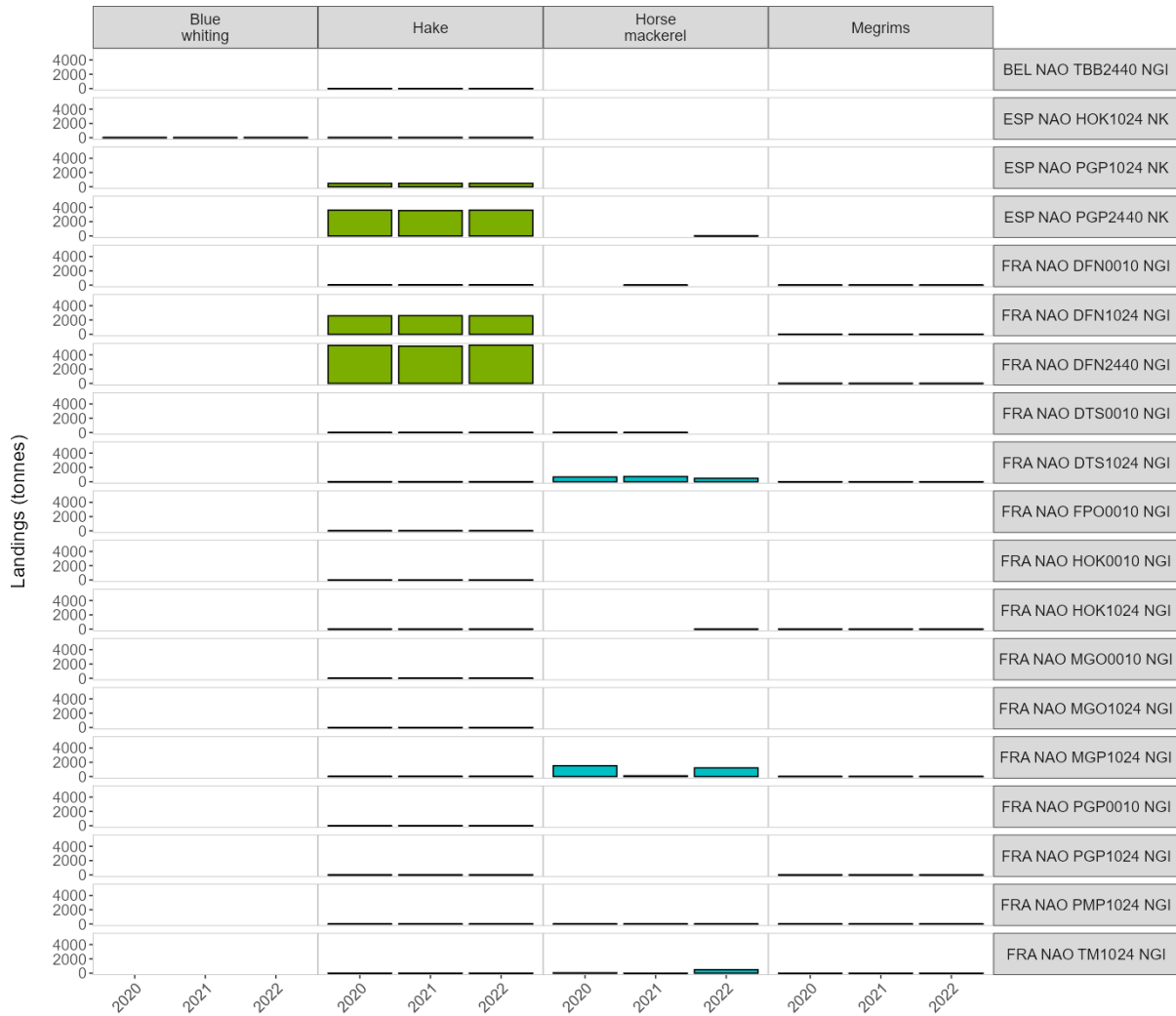
As a result, there is not always a direct link between the constructed fleet segment in FDI and the submitted clustered fleet segment in AER. However, in the case of fleets catching hake in the Bay of Biscay this does not appear to be an issue there is overall good alignment with the AER and FDI data in terms of landings declared (Figure 4.1.3).

Figure 4.1.1 Flow diagram of the fishing behaviour and stocks caught by the fleet segments modelled within the case study.



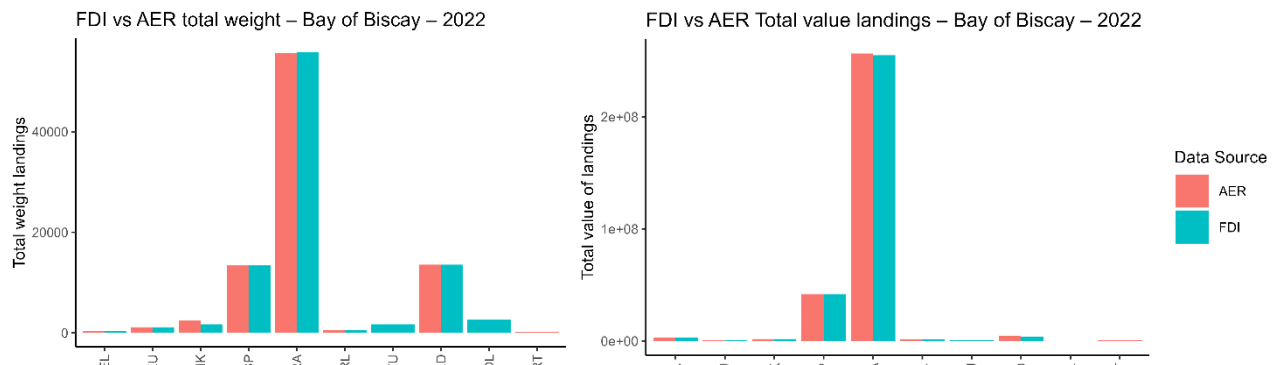
Source: Own elaborations.

Figure 4.1.2 The ‘general fleet overview’ presents the species modelled and caught by the fleets identified within this Bay of Biscay case study.



Source: Own elaborations.

Figure 4.1.3 Summary of the alignment of FDI and AER landings per country



Source: Own elaborations.

Economic indicators

All four short term economic indicators selected by EWG 25-14 and described in section 3.1 of this report, were incorporated in this case study: Gross profit; gross profit margin, gross value added; and break-even revenue.

Social indicators

There was not enough time during the EWG 25-14 to implement the selected social indicators.

Gear based scenarios

Two were produced as part of this case study, scenarios were proposed by the EWG 25-14, these are detailed below. Despite the flexibility of the BioEcon framework to apply to varying selectivity changes to multiple species and gears, it was only possible to implement these changes to hake in this instance as age length keys (ALKs) were not available for other species.

The selected gear studies are both otter trawl studies, which is a gear that makes up a small percentage of the overall hake landings in the Bay of Biscay. Although longlines and gill nets make up a large proportion of the hake landings in the Bay of Biscay. Available L50s for those gears, albeit from the Celtic Sea (STECF 2024a, STECF 24-16, Table 3.1.4.3), suggest these gears are already selective for hake. Selectivity estimates for the two selected fleets were firstly available and they use a small mesh size which L50s/ catch comparison trial results suggest the baseline gear is not selective for hake.

The two scenarios provided two different approaches to the application of selectivity changes with scenario 1 demonstrating how changes can be applied varying across age range and scenario 2 demonstrating the impact of a single selectivity change being applied across the who age range.

Scenario 1 - Age varying hake selectivity in otter trawlers (OTB)

Improved selectivity outcomes reported by Cuende *et al.* (2022) for otter trawlers targeting demersal mixed fisheries (OTB_DEF) in the Bay of Biscay was tested in this scenario. The lead author provided EWG 25-14 with combined selectivity estimates for the baseline gear and the most appropriate selective gear for targeting hake (Annex 2). EWG 25-14 noted that the essential values required to model age-varying impacts are not always published; consequently, the work depends on the availability and cooperation of the original authors.

The baseline gear configuration was a 79 mm diamond mesh codend with an 82 mm mesh size square mesh panel (2 m x 1 m) fitted in the extension piece. The gear with the improved selectivity consisted of a 63 mm square mesh codend and a 77 mm mesh size square mesh panel (3 m x 1 m) fitted in the bottom sheet of the extension. Trial results suggest that placing the square mesh panel in the bottom sheet of the trawl, as in the case of the selective gear described above, significantly increased its effectiveness for hake likely through improved contact.

As there were no fleets operating in the case study area with OTB_DEF_70-99 metier, this scenario tested what the impact on the hake catches would be if all OTB metier in the case study utilised the 70-99 mesh size with the proposed selectivity device. Therefore, within this case study these selectivity changes were applied to the fleets detailed in Table 4.1.2 when executing this following fishing behaviour (métier) also listed.

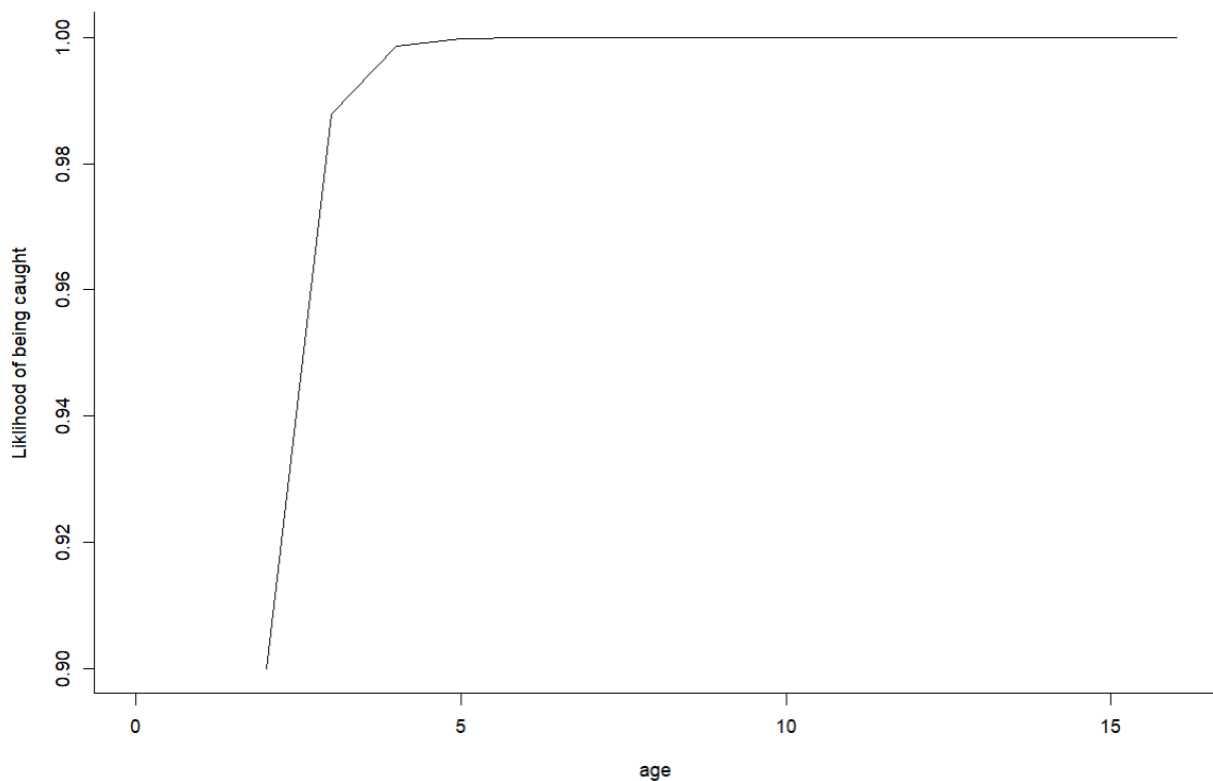
Table 4.1.2 Summary of the total landings declared by fleet, métier and ICES Division, from 2020-2022, including a summary of these values relative to the total catches of hake in the Bay of Biscay over that time period.

Fleet	Métier	ICES Division	2020	2021	2022	Total landings in tonnes (2020 - 2022)	% of total hake landings (2020-2022)
FRA NAO DTS0010 NGI	OTB_DEF_<16_0_0	27.8.a	0.063	0.063	0.063	0.189	0.000174
	OTB_DEF_<16_0_0	27.8.b	0.003	0.003	0.003	0.009	0.000008
	OTB_SPF_70-99_0_0	27.8.a	1.251	1.251	1.251	3.753	0.003455
FRA NAO DTS1024 NGI	OTB_SPF_70-99_0_0	27.8.a	19.236	19.036	19.217	57.489	0.052920
	OTB_SPF_70-99_0_0	27.8.b	5.579	5.517	5.482	16.578	0.015260
	OTB_SPF_70-99_0_0	27.8.d	0.006	0.006	0.006	0.018	0.000017
	OTB_SPF_70-99_0_0	27.8.b	0.336	0.336	0.336	1.008	0.000928
FRA NAO PMP1024 NGI	OTB_SPF_70-99_0_0	27.8.b	0.386	0.428	0.379	1.193	0.001098
FRA NAO TM1024 NGI	OTB_SPF_70-99_0_0	27.8.a	2.946	3.122	3.156	9.224	0.008491
	OTB_SPF_70-99_0_0	27.8.b	1.030	1.014	0.998	3.042	0.002801

Source: Own elaborations.

A limitation of this work is that the improved selectivity applied across ages assumes an improvement relative to the baseline in the study reported by Cuende *et al.* (2022), which does not match the baseline of the métier in the case study. Therefore, the outcomes must be treated with care and reported alongside the assumptions made. The selectivity applied at age was applied to the fishable population ages 1 to 15 (Figure 4.1.4).

Figure 4.1.4 Likelihood at age of being caught in the improved gear relative to the old gear.



Source: Own elaborations.

Scenario 2 – Age invariant hake selectivity in otter trawlers (OTB)

The improved selectivity outcomes reported by Vogel *et al.* (2017) were used to parameterise scenario two. Vogel *et al.* reported that the technical solutions used in the *Nephrops* fishery in the Bay of Biscay reduced catches of undersized *Nephrops* and hake within the French twin rig otter trawl targeting crustaceans (OTT_CRU). Within this scenario EWG 25-14 tested results of an inverted selective grid with 13 mm spacing fitted in the top of the extension. Using the results of the catch comparison presented in Vogel *et al.* (2017) it was possible to calculate the relative selectivity improvement of otter trawlers for a scenario. As the publication did not contain combined selectivity estimates for the baseline gear and the most appropriate selective gear for targeting hake

However, EWG 25-14 noted that the rates of escapement, discard and commercial losses were reported and could potentially be used to inform a change in relative selectivity for this scenario. The authors suggest the median values are more reliable than the mean values due to the presence of extreme outliers

Therefore, a selectivity improvement of 0.11 was applied to all OTB métier activity within the fleets included in the model.

Model set up

Mixed-fisheries analyses consider the implications of mixed fisheries operating under single-stock catch advice regimes, given that there are no changes in the fleet stock shares for the different stocks, in the proportion of effort per métier for each fleet, in discard rates, or catchability in the métier during the forecast period compared to the historical data years (2020–2022). Scenario assumptions for the intermediate (2025) and forecast year (2024) are listed in Table 4.1.3. These assumptions may differ from those used in the single stock forecasts.

Table 4.1.3 Assumptions made for the intermediate year (2023) and in the forecast year (2024).

Variable	description
Effort per fleet (2024)	Days at sea (kWdays): average (2020–2022)
Fishing patterns (2023–2024)	Catchability by stock and métier: average (2022–2024) Effort share by métier: average (2022–2024)
Fleet stock share allocations (2024)	Landings share by fleets: average (2022–2024)

Source: Own elaborations.

Results

All scenarios, including the baseline scenario (with no selectivity changes) resulted in an increase in landings of all four stocks, and the elimination of discarding (Figure 4.1.2).

The low level of discarding seen in the forecasted scenarios reflects the reality of the fishery where the majority of fleets and métiers modelled had limited discarding reported to InterCatch and within the FDI data. This is corroborated by the single species advice sheets for these stocks which show that the majority of discards for these stocks is low or negligible: hke.27.3a46-8abd <3% (ICES 2023e); meg.27.7b-k8abd 17% (ICES 2023f); hom.27.2a4a5b6a7a-ce-k8 <5%(ICES 2023g); and whb.27.1-91214 <1% (ICES 2023h).

This increase in landings of all stocks seen in the baseline and forecasted scenarios is not driven by selectivity changes but instead has three main drivers: incomplete technical interactions, no modelled fleet for stock catches outside of area. or a fleet for unaccounted stock catches within the case study area.

Technical interactions in mixed fisheries are defined as the competitive, technological, and unintentional interactions that occur when multiple species are caught together in the same fishing operation (by-catch) or when different fleets compete for the same resource or space. These interactions create dependencies where management measures (e.g., quotas, gear restrictions) applied to one target species or fleet directly affect the catch, mortality, and economic performance of other species or fleets. The increase in available stocks for fleets to catch within the forecast years is driven by the lack of technical interactions with other key stocks in this case study, which would typically limit the increase of catches of these stocks.

Based on the mixed fisheries advice in 2023 (ICES 2023a) hake was not a limiting species within the model (Figure 4.1.8) in fact most fleets were limited by horse mackerel (hom.27.2a4a5b6a7a–ce–k8) and pollack (pol.27.89a)(Figure 4.1.9). To avoid this artefact in future iterations of case study updates all important stocks should be included in this analysis. These stocks should be selected in line with the guidelines set out in the Methodological Framework for Mixed Fisheries Modelling (ICES 2024). This framework states that the initial points to consider when deciding which stocks to include in the models are the economic importance and mixed-fisheries relevance of the stocks in the ecoregion. Data need to be both of high quality and at a suitable level of disaggregation. The number of stocks included in the model also needs to be manageable, both computationally and in terms of the time involved in data processing and model conditioning. Finally, modelling considerations are important when deciding whether to add a new stock (Figure 4.1.5). If all key species are included then the technical interactions within the model are more likely to represent the true activity within the fishery and produce more realistic projections.

Figure 4.1.5 Considerations for stock inclusion in mixed fisheries model (ICES 2024)

Economic importance and mixed fishery relevance	Data availability	Modelling considerations
<p>Priority is given to commercially important stocks (i.e. stocks managed by a TAC; known target stocks).</p> <p>Consider stocks that account for a large proportion of catches within the region.</p> <p>Consider stocks, including non-target stocks, with substantial technical interactions with target stocks because of their ecology or the fishery in which they are caught.</p>	<p>Landings, discards, and effort data are available at suitable level of disaggregation.</p> <p>Stock assessment outputs, forecast procedure, and/or catch advice available.</p> <p>Category 1 and 2 fish stocks can be easily included with fully modelled future stock dynamics</p> <p>Additional stocks increase computational and human resource requirements.</p>	<p>There is a trade-off between adding stocks to better describe the mixed-fisheries dynamics and the validity of model results when future stock dynamics cannot be modelled (e.g. category 3+ stocks)</p> <p>Methodological differences can cause discrepancies between single-stock and mixed-fisheries forecasts, which, if large, affect the quality of the mixed-fisheries scenario results.</p>

Source: Own elaborations.

For many reasons case studies can contain stocks that have unaccounted for catches, which need to be addressed, or the result can be increases in available quote for fleets and can create artefacts in the mixed fisheries projection. Therefore, there are often “missing” catches that need to be accounted for to ensure that the total removals used as input to the mixed-fisheries model is the same as the observed catches used in the single-stock assessments. Sometimes, these “missing” catches result where fleet data either have not been submitted or are incomplete (i.e.

are missing fleet segments). Other times, these “missing” catches arise because a stock is widely distributed, with a significant portion of a stock’s catch occurring outside of the ecoregion (e.g. hake in Bay of Biscay). The magnitude of the missing catches per stock is obtained by comparing the total catches from the fleet data to the total catches used as input to the stock assessment. The approach taken to account for differences in the total catches is to allocate these catches to an additional, “residual” fleet. To account for this and avoid artefacts in the projection’s future iterations of this case study should follow the guidelines set out in the Methodological Framework for Mixed Fisheries Modelling (ICES 2024) and create a stock specific others fleet, especially for widely distributed stocks.

Finally, aside from these observed artefacts in the modelling process which effects all three projections equally, it is possible to make inferences about the potential impact of the selectivity measures on the fleets included in the model if we compare the baseline (no selectivity changes) forecast to the two selectivity scenarios it can be seen that the selectivity scenarios had limited impact on the total landings of hake, too which the selectivity impacts were applied (

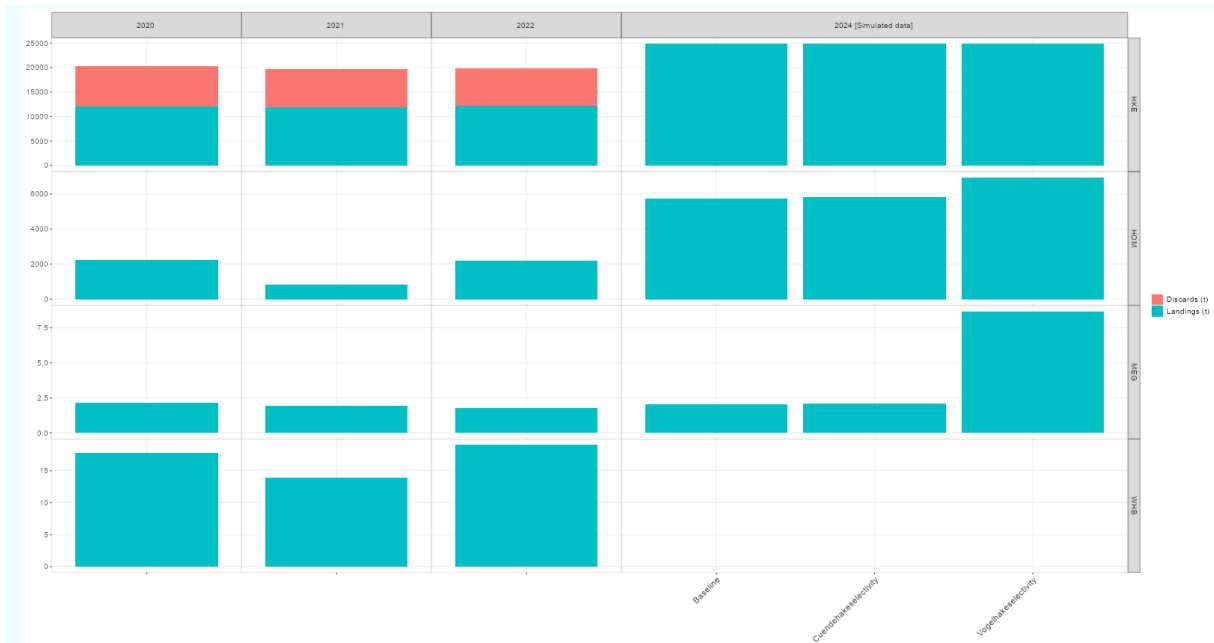
Figure 4.1.6).

The selectivity changes applied did impact the landings of the fleets to which they were applied and resulted in none or negligible hake landings in projection years (i.e. FRA NAO DTS 10 24 NGI) (Figure 4.1.7). Therefore, increases in landings all occur in fleets to which selectivity changes were not applied (i.e. BEL NAO TBB 2440 NGI) (Figure 4.1.7), increasing landings as stock shares became available.

None of the selectivity scenarios had an impact on the stock status in relation to the reference's points (Figure 4.1.10).

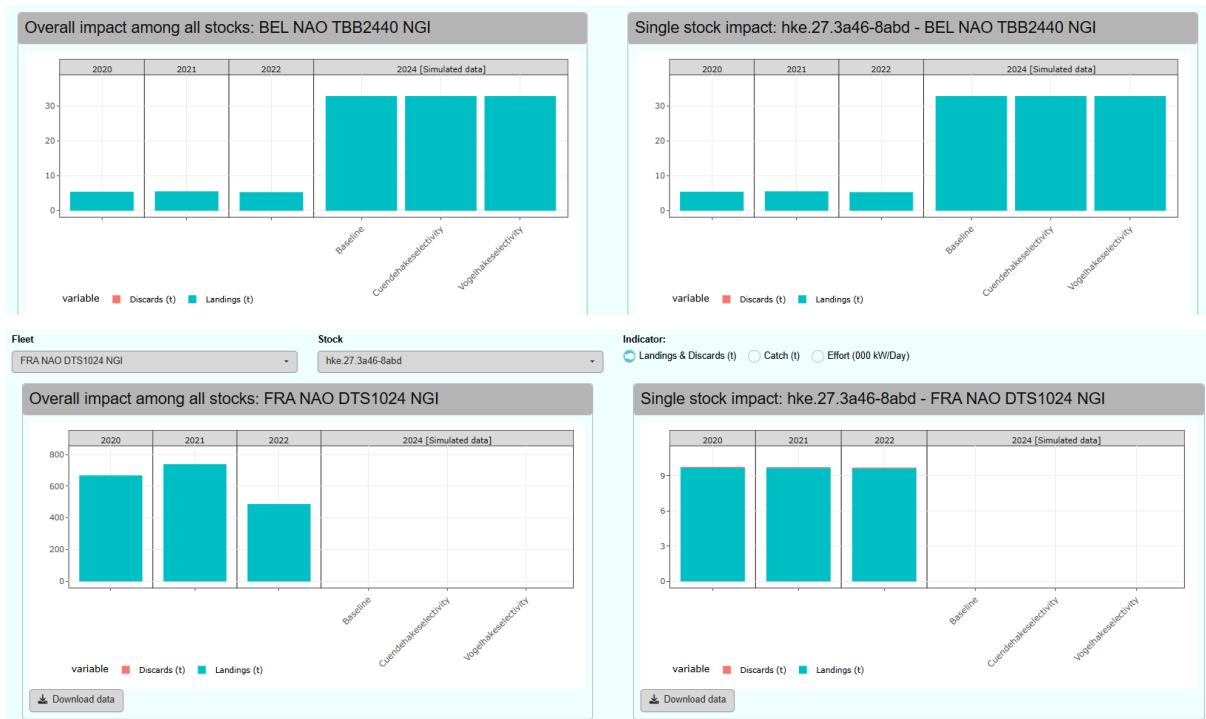
None of the selectivity scenarios indicated an economic impact to the changes in catchability implemented (Figure 4.1.11). However, the shiny app does provide a useful visualisation of the general interannual trends in these indicators. Not all fleets could be presented in the report, the shiny app should be consulted to explore all fleet changes.

Figure 4.1.6 Fleet overview of the species caught by fleets within the model are in terms of total landings and discards (tonnes). Historic fishing patterns (2020-2022) and the projected catches (2024) under each of the scenarios simulated in this model.



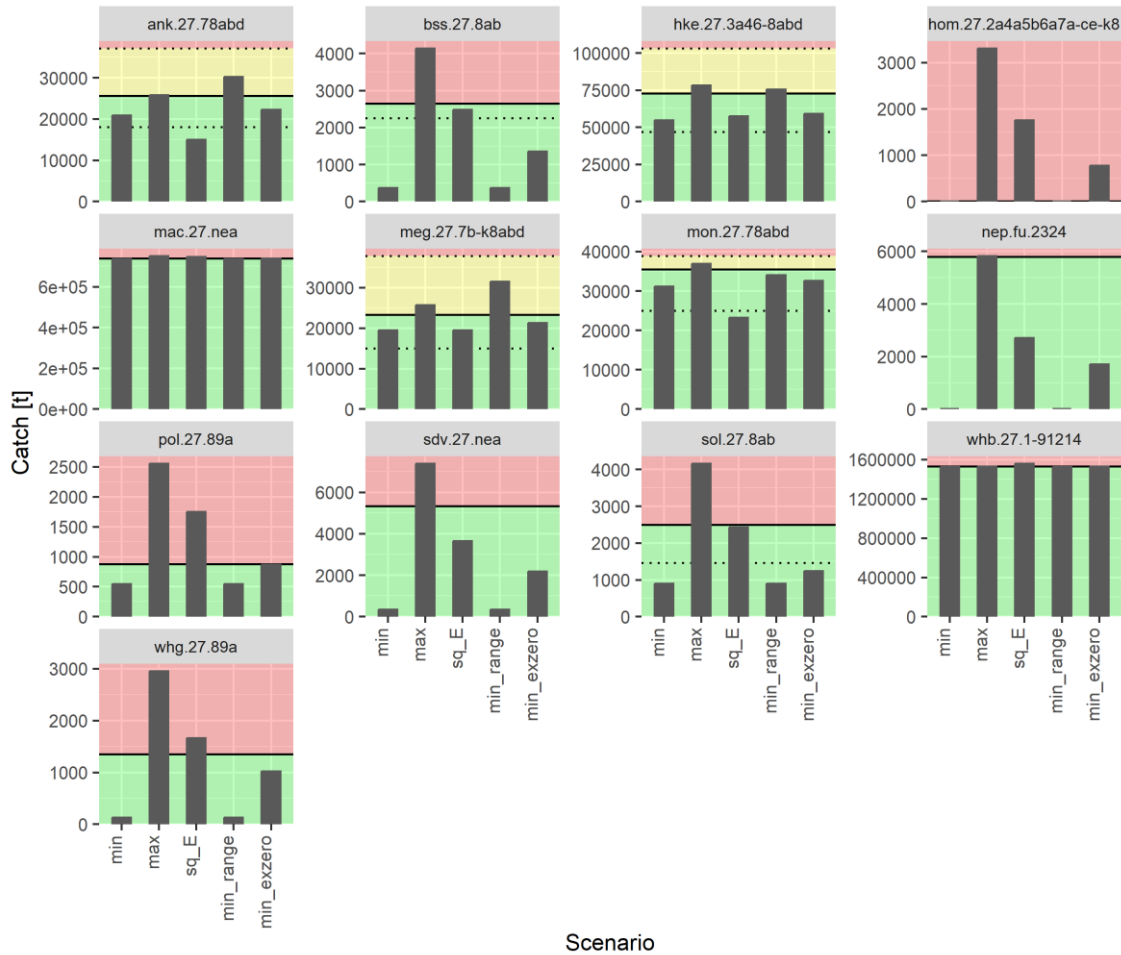
Source: Own elaborations.

Figure 4.1.7 Fleet and stock specific outcomes of each scenario can be explored in terms of landings, discards, catch and effort.



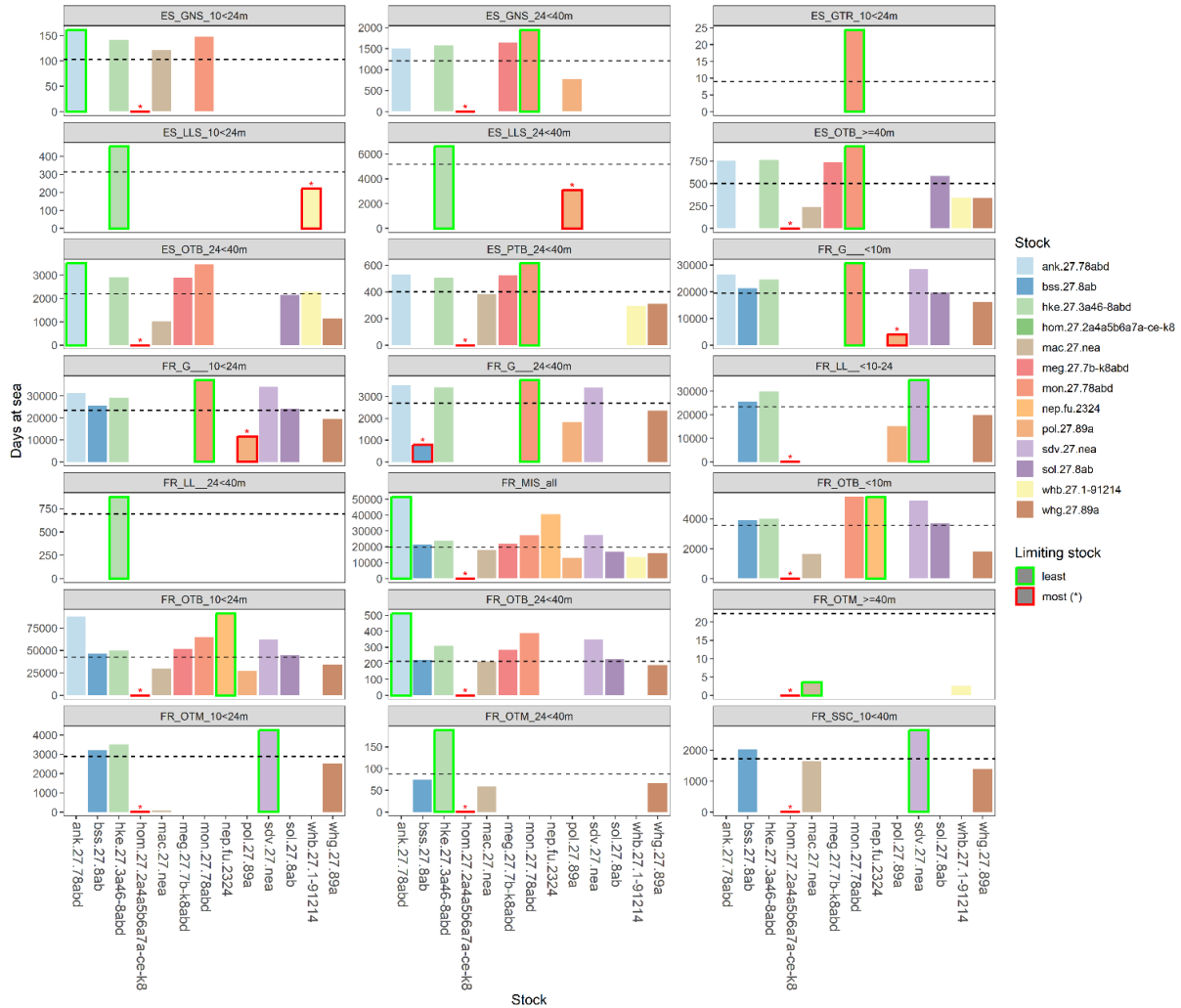
Source: Own elaborations.

Figure 4.1.8 Mixed fisheries for the Bay of Biscay. Mixed-fisheries projections. Estimates of potential 2024 catches (in tonnes) by stock and scenario (Table 1). Solid lines correspond to the single-stock catch advice. For those stocks with fishing mortality ranges defined, the lower dotted lines illustrate the catches corresponding to FMSY lower or reduced FMSY lower for stocks with defined ranges and with $SSB < MSY$ Btrigger. The upper dotted lines illustrate the catches corresponding to FMSY upper for stocks with $SSB \geq MSY$ Btrigger. (ICES 2023a)



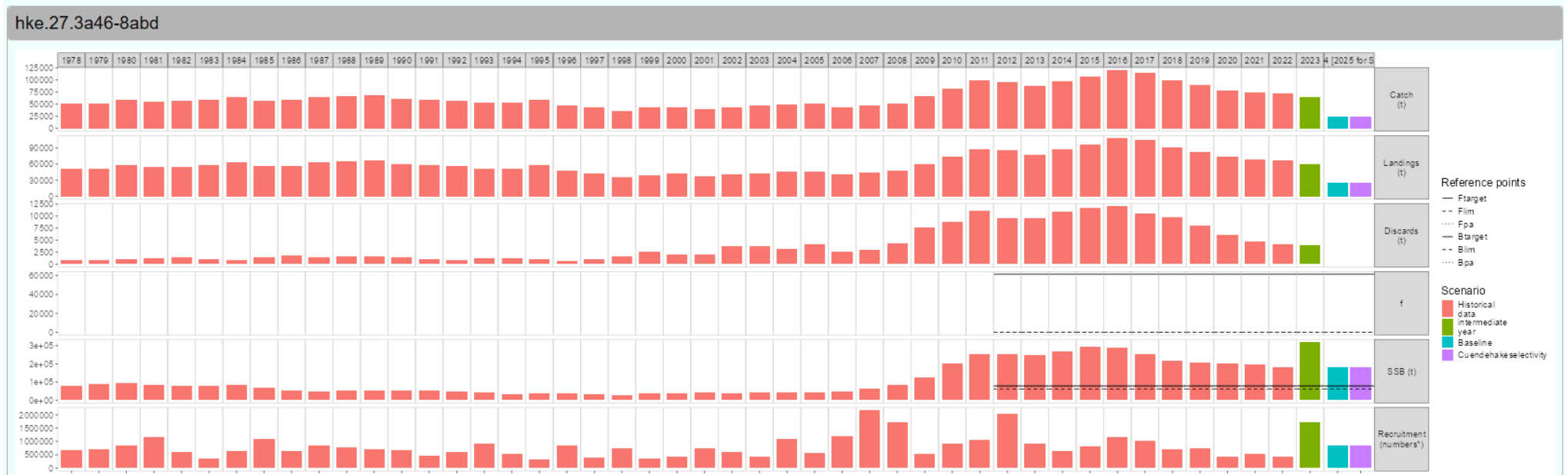
Source: Own elaborations.

Figure 4.1.9. Mixed fisheries for the Bay of Biscay. Estimates of effort by fleet needed to reach each single-stock catch advice. Stocks are coded by colour, with the bars for the most limiting stock (“choke species”) for each fleet in 2024 highlighted with a red border and asterisk and the bars for the least limiting species highlighted with a green border. Fleet names are given by country (FR = France, ES = Spain), main gear, and vessel size (m). The status quo effort for each fleet (average 2020–2022) is shown as a dashed line for reference. (ICES 2022a)



Source: Own elaborations.

Figure 4.1.10. Historical stock trends in relation to ICES biological reference points.



Source: Own elaborations.

Figure 4.1.11. Summary of economic indicators of one fleet (FRA NAO DTS 1024 NGI) in terms of historic trends (2020 – 2022) and forecasted impact (2024)



Source: Own elaborations..

Conclusion

The BioEcon framework applied to the hake mixed fisheries Bay of Biscay demonstrates the feasibility of the assessment of biological and economic impacts due to changes in selectivity in a mixed fishery.

The data merging process was completed in a clear and transparent manner with full quality control visualisations available.

The gear studies selected and tested demonstrate that the selectivity can be modelled in terms of species, age, gear and area effectively.

Despite a number of identified possible improvements to future iterations of this model and case study, the outcomes of EWG 25-14 enabled the evaluation of two selectivity studies to the Bay of Biscay otter trawlers. Although the selectivity improvements reduced the catches of hake in the selected metiers and fleets, it did not have a significant impact on the overall catches of these stocks as these metiers account for minor catches of the overall stock in the case study area. Additionally, these selectivity changes indicate no adverse economic impacts on the fleets included in the model.

To improve future iterations this analysis should be updated to:

- 1) A Quality Control narrative is required, meaning QC reports on data merging and preparation should include a summary text. Some short-term progress is expected before the March Plenary, while medium- to long-term work should continue with the best available science; this will be handled by the next ad hoc meeting and the next EWG.
- 2) Functions related to the case study still need to be unpacked, a task planned for the next ad hoc meeting with responsibility assigned to an ad hoc author.
- 3) Including more stocks is another priority, though this requires additional InterCatch data, ALKs, and stock objects; work should progress in the medium to long term under the next ad hoc and next EWG.
- 4) A more reliable method is also needed for converting length-based study outcomes into age, ideally through a length model, but the current FLEBIA approach is age-based. Improving ALK application is expected in the next ad hoc meeting, while the EWG will consider whether a better model could be developed in the longer term.
- 5) Finally, spatial information must be improved by replacing FDI data with RDBES data to allow port-of-landing inclusion. Although countries are not yet ready, testing may be possible in 2026, with practical use for advice unlikely before 2027/28; this work falls to the next EWG.

4.2 Western Mediterranean hake mixed fisheries case study

Case study

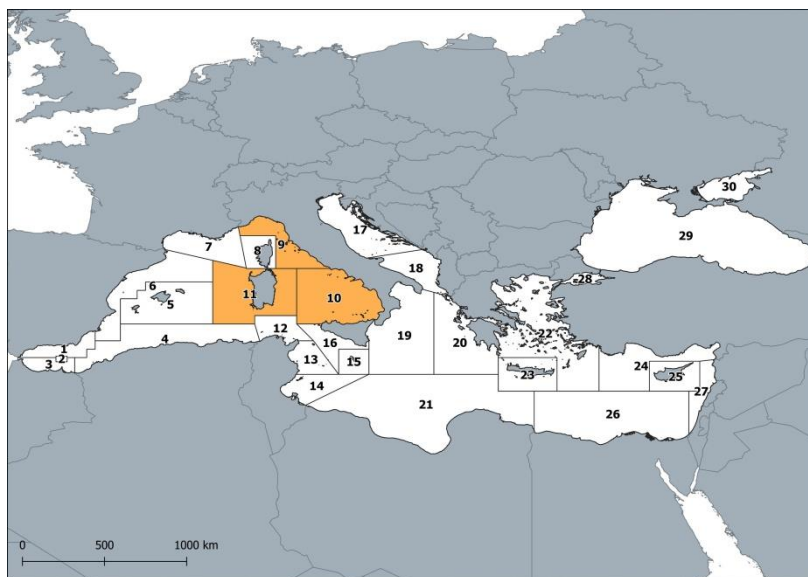
Testing selectivity scenarios with BEMTOOL model in Western Mediterranean (GSAs9-10-11). BEMTOOL bio-economic simulation model was applied to the demersal fisheries operating in the Geographical Sub-Areas (GSA, GFCM *sensu*) 9-1-11 (Effort Management Unit, EMU2, Figure 4.2.1.), in the context of the STECF

EWGs evaluating the Western Mediterranean Multi-Annual Management Plan (MAP, [Regulation \(EU\) 2019/1022](#)).

The model was parameterised using the DCF data (FDI and AER data on landings, discards, fishing effort and economic data) and results from the stock assessments carried out during the EWG 25-09 (STECF 2025e). To run the simulation in the EWG 25-14, the model version developed in EWG 25-11 (STECF 2025f) was used.

The data used for the simulations were extracted from FDI data, the outcomes of EWG 25-11 (stock objects), and the socio-economic data obtained at the GSA level through an ad hoc request to the Italian Ministry from EWG 25-11.

Figure 4.2.1. Effort Management Unit 2, GSAs 9-10-11



Source: Own elaborations.

Stocks

The model included the six species covered by the MAP, corresponding to 6 stocks:

- European hake in GSAs 9, 10 and 11 (HKE);
- Red mullet in GSA9 (MUT9);
- Red mullet in GSA10 (MUT10) (updated to 2021);
- Deep-water rose shrimp in GSAs 9, 10 and 11 (DPS) (last year assessment);
- Giant red shrimp in GSAs 9, 10 and 11 (ARS);
- Norway lobster in GSA9 (NEP9);
- Norway lobster in GSA 11 (NEP11, added this year to the model);
- Blue and red shrimp GSA9, 10 and 11 (ARA) (MEDITS data used to reconstruct the stock in BEMTOOL, being missing a quantitative assessment).

For the 8 stocks the decisions made during the EWG 25-09 on recruitment to be used for the short term forecast have been followed for the scenarios. In particular, for all the stocks the same constant recruitment level of the short term forecasts carried out by EWG 25-09 (STECF 2025e) was used for the projections, perturbed with a multiplicative log-normal error with mean 0 and standard deviation 0.3.

The relevant results of the assessment for the model parameterization, i.e. the current fishing mortality (F_{curr}) and the reference point ($F_{0.1}$) are reported in the Table 6.2.3.2, including the needed reduction to reach $F_{0.1}$ for each stock.

Considering the ratio between the current fishing mortality and the reference point ($F_{curr}/F_{0.1}$), the stock more at risk is NEP11 (ratio=2.75) and NEP9 (ratio=2.37). In Table 4.2.1 are reported, when available the biomass reference points by stock.

Table 4.2.1 Results of the assessments from EWG 25-09 relevant for BEMTOOL parameterization

Stock	F current	Fmsy	ratio F/Fmsy	B current	Bpa	Blim
HKE891011	0.49	0.41	1.195121951	4746	8604	4302
MUT10	Catch-based advice					
MUT9	0.64	0.55	1.163636364	1108	730	365
NEP9	0.336	0.142	2.366197183	343	486	243
NEP11	0.44	0.16	2.75	49.4	80	40
ARS91011	0.66	0.48	1.375	400.6	352	156
DPS891011	Catch-based advice					
ARA91011	Catch-based advice					

Source: Own elaborations.

Fleets

In the simulation and forecast scenarios 16 fleet segments have been analysed. Trawlers have been disaggregated by fishing activity at metier level (OTB_DEF, OTB_DWS and OTB_MDD) as shown in

Table 4.2.2. FDI data from 2013 to 2023 were used for the revenues by stock, number of vessels, the number of fishing days, GT and KW. STECF 18-07 EU Fleet Economic and Transversal data from 2008 to 2013 were used for the fishing effort by metier. All data include both active and passive demersal gears operated by fleet segments that rely on, and influence, some or all the stocks included in the MAP. AER data at GSA level (specifically required for the EWG) have been used for total landing and total revenues (target stocks and others).

Five fleets are allocated to GSA9, five to GSA11 and six fleets to GSA10, overall 12 fleets are trawlers and 4 fleets use passive gears (longlines, gillnets and trammel nets).

The fuel costs, the other variable costs and the labour costs have been disaggregated at metier level following the methodology to disaggregate economic variables by activity developed in SECFISH project (MARE/2016/22- SI2.768889, <https://datacollection.jrc.ec.europa.eu/docs/regional-grants>) and described in Bitetto *et al.* (2022), consistently with EWG 23-11 (STECF 2023c). This methodology allows to take into account the difference in the variable costs associated to the activity of each metier (e.g. different distance of the fishing trips from the home port).

For 2024, the fishing effort was updated using the FDI data. For 2025 the fishing effort was set equal to the fishing opportunities, amended with the adjustment of fishing opportunities for certain fish stocks and groups of stocks applicable in the Western Mediterranean Sea (D.D. n. 0415115 del 05/09/2024). This adjustment allows to the trawlers operating in EMU2 a +18% of compensation in fishing days due to a fishing ban in October and to the closure of the fishing grounds deeper than 800 m.

Socio-economic data on costs and employment at GSA level requested by the EWG to the Italian Ministry until 2023 (nominal values).

The economic data from 2024 were estimated assuming:

1. Fuel costs linearly depending on the change in total fishing days and fuel price (projections from AER for Italy by fleet segment) by fleet segment and metier;
2. Other variable costs linearly depending on the change in total fishing days by fleet segment and metier;
3. Crew (employment) per vessel, fixed and capital costs linearly depending on change in number of vessels;
4. Labour costs estimated with the crew share ratio of 2023 on the estimated difference between total revenues and total variable costs;
5. FTE were assumed varying linearly on the total fishing days;
6. Fixed costs and maintenance costs have been associated to the vessels and, thus, were assumed depending on the modified total GT respect to the 2024 FDI data, following the Decree on total GT reduction on the permanent cessation of fishing activity in accordance with Article 20 of Regulation (EU) 2021/1139.

Table 4.2.2. Combinations fleet segments-metier included in the BEMTOOL simulations and forecast scenarios by GSA, gear type, including demersal trawlers (DTS), polyvalent passive gears (PGP) and hooks (HOK), and by vessel length (VL).

GSA	Fleet segment	Metier
10	DTS_VL0612	OTB_DEF
10	DTS_VL1218	OTB_DEF and OTB_DWS/MDD
10	DTS_VL1824	OTB_DEF and OTB_DWS/MDD
10	DTS_VL2440	OTB_DEF and OTB_DWS/MDD
10	PGP_VL0018	GNS-GTR
10	PGP_VL0018	LLS
10	HOK_VL0024	GNS-GTR
10	HOK_VL0024	LLS
11	DTS_VL0612	OTB_DEF
11	DTS_VL1218	OTB_DEF and OTB_DWS/MDD
11	DTS_VL1824	OTB_DEF and OTB_DWS/MDD
11	DTS_VL2440	OTB_DEF and OTB_DWS/MDD
11	PGP_VL0018	GNS-GTR
9	DTS_VL0612	OTB_DEF
9	DTS_VL1218	OTB_DEF and OTB_DWS/MDD
9	DTS_VL1824	OTB_DEF and OTB_DWS/MDD
9	DTS_VL2440	OTB_DEF and OTB_MDD
9	PGP_VL0018	GNS-GTR
9	PGP_VL0018	LLS

Source: Own elaborations.

Economic indicators

The common list of the socio-economic indicators agreed during EWG 24-12 and confirmed during the EWG 25-11 was followed to provide the final outcomes of the simulations. The formulations of AER were used to estimate the indicators.

- Gross Value Added (GVA): Revenues-total var costs- repair costs-other fixed costs;
- Gross profit: Revenues-total var costs- repair costs-other fixed costs-labour costs;
- Gross profit margin: Gross profit/revenues;
- Full time equivalent (FTE).

Gear based scenarios

Compensation mechanism was applied by Italy in 2025 (+18%, due to closure of area deeper than 800 m and to the additional fishing ban in October), following the information provided by MARE during the EWG 25-11 meeting.

Two scenarios have been considered:

- **Status Quo with temporary selectivity:** The effort of OTB_DWS/MDD metier is driven by the catch limit of ARA and ARS of fishing opportunities 2025 (from 2026 to 2030); once that the catch limit for one fleet segment is reached, the remaining effort of OTB_DWS/MDD is re-allocated to OTB_DEF. In 2026 it was assumed that the global effort of trawlers returns at 2024 level and remains the same onwards. Compensation mechanism applied only in 2025 (+18%). Increase in selectivity with mandatory square mesh size of 45 mm in cod-end for all trawlers in 2026 was assumed, with sorting grid to protect Norway lobster. From 2027 the mesh size is again 40 mm.
- **Permanent Selectivity:** as SQ, but with selectivity improved from 2026 onward.

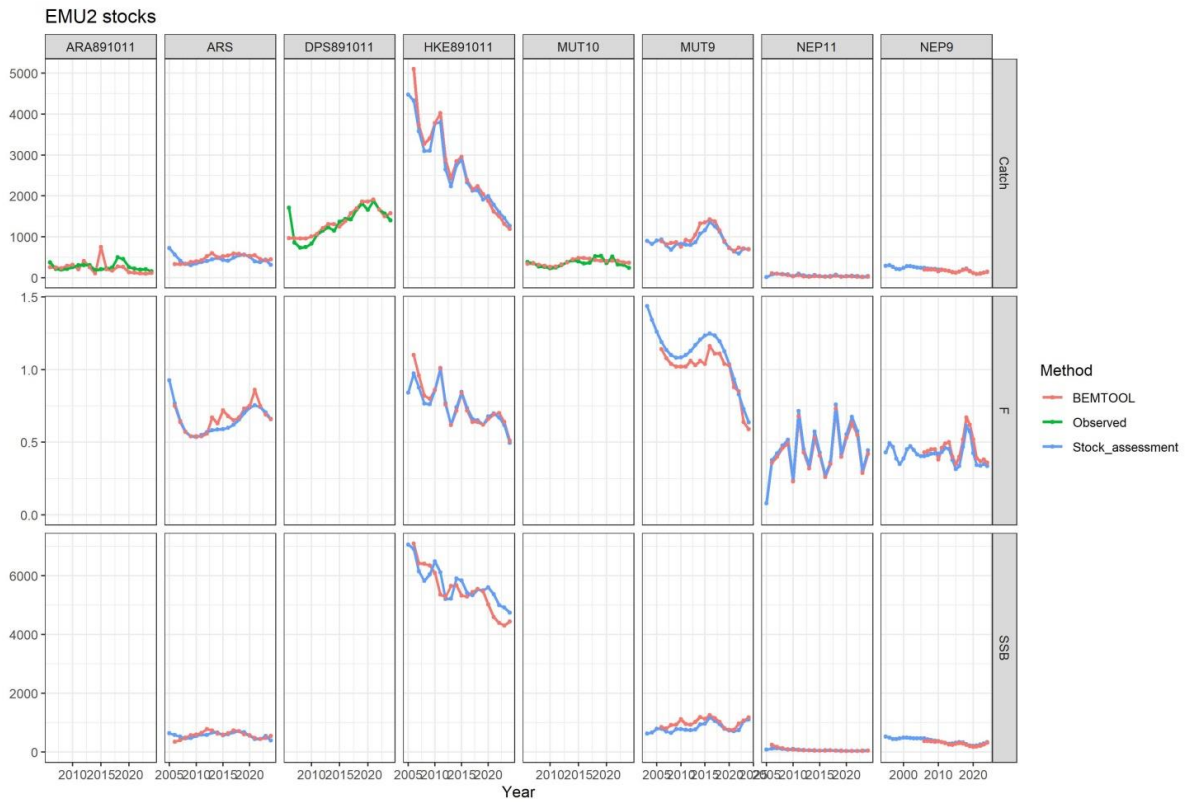
The selectivity parameters have been modified according to Bahamons *et al.* (2024) for European hake, deep-water rose shrimp and red mullet as a basis, adjusting with the LFDs of the catches in the different GSAs. For giant red shrimp and blue and red shrimp Gorelli *et al.* has been used as basis, while for Norway lobster the results of IMPLEMED project have been used.

Results

The results of the stock assessment for the 8 considered stocks have been replicated in BEMTOOL, considering the effort by metier for each fleet segment. The comparison of F, SSB and Catch showed a good level of agreement between BEMTOOL with the outcomes of the STECF EWG 25-09 (STECF 2025e), where present (

Figure 4.2.2).

Figure 4.2.2. Comparison between stock assessment results (turquoise lines) and BEMTOOL estimates (pink lines) on F, SSB and Catch for ARS 9-10-11, NEP9, NEP11, HKE 8-9-10-11 and MUT9. For MUT10, DPS8-9-10-11 and ARA9-10-11 the simulated and the observed landing is compared



Source: Own elaborations.

The projections of spawning stock biomass (SSB) across scenarios are illustrated in Figure 4.2.3.-

Figure 4.2.5. For deep-water rose shrimp the permanent change in selectivity contributes to the reduction in discard volume, with a slight reduction in F and catches and not significant improvement in SSB (Figure 4.2.1). For red mullet in GSA 9 the impact on SSB, F and discard volume is not significant (

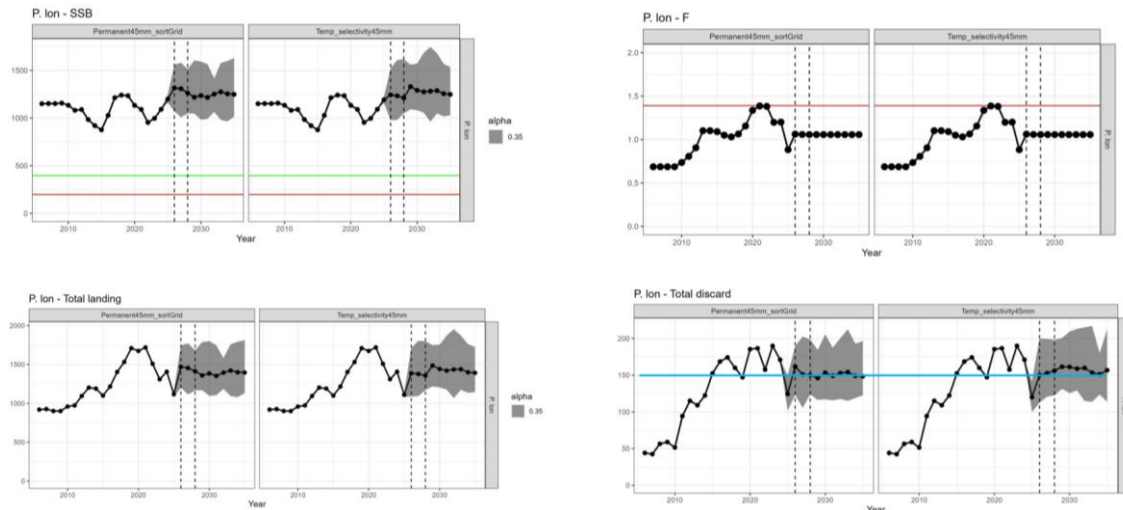
Figure 4.2.2). For Norway lobster in GSA 11, the installation of the sorting grid alone does not allow to reach the reference points for the stock (Figure 4.2.3). No substantial improvement in SSB and F, due to the very critical status of the stock (F/FMSY ratio above 2).

For European hake, the results indicate that both scenarios allow to maintain an SSB level well above Blim (Figure 4.2.6). The improvement in SSB, achieved with the permanent selectivity respect to the status quo, is around 3%. The effect on the discard ratio (D/D+L) is negligible (Figure 4.2.7). A mixed fisheries effect is observed: when trawlers increase mesh size, polyvalent and hooks benefit. For European hake the projections do not show any decrease in catch, compared to the other stocks (deep-water rose shrimp). This is mainly due to the combination of increase in recruitment and decrease in fishing mortality observed in recent years, as an effect of the Western Mediterranean EU Management Plan (Figure 4.2.2, and EWG 25-11 report). Indeed, this combination of factors completely overcompensate the short term losses in landings due to the improved selectivity, driving an exponential increase in SSB in the case study projections and, as a consequence, drives increases in landings (Figure 4.2.6). Future work should explore the sensitivity of these outcomes to alternative assumptions on recruitment (e.g. stock recruitment relationships instead of constant recruitment). What is important to highlight is that the implementation of the selectivity scenarios did not increase discarding within the fleets operating in the model (Figure 4.2.7).

In

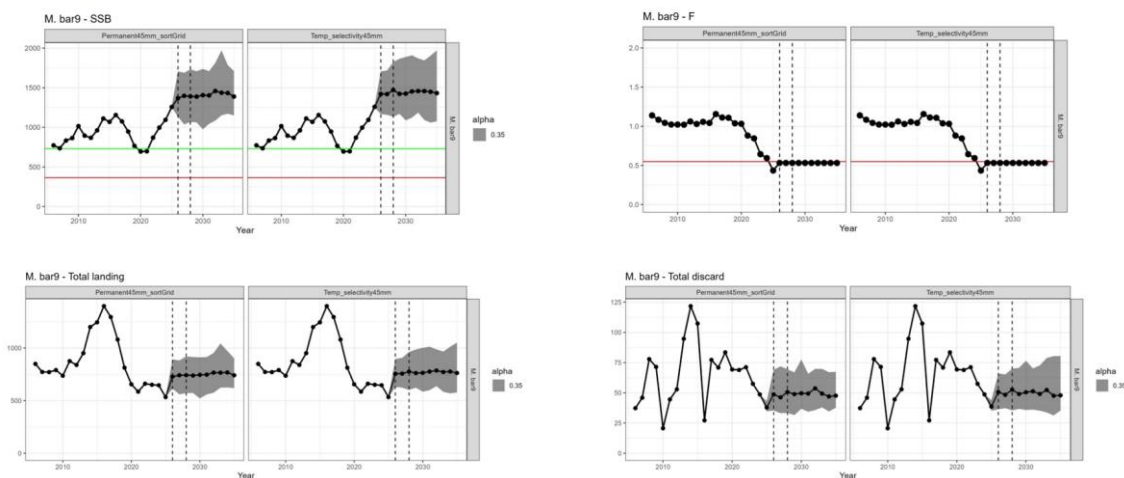
Figure 4.2.8 is reported the gross value added by fleet segment and GSA, showing a limited impact of the permanent selectivity scenario respect to the temporary one, with a 3.4 % of improvement for trawlers in 2026.

Figure 4.2.3. BEMTOOL results for deep-water rose shrimp: SSB, F, total landing and total discard.



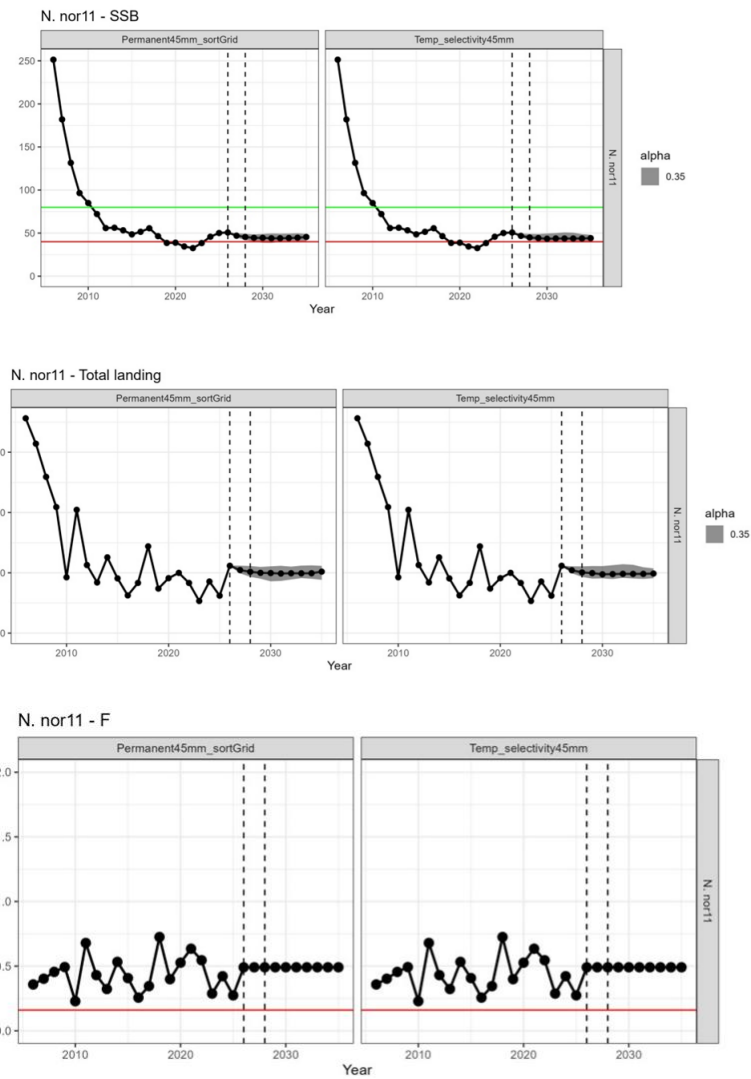
Source: Own elaborations.

Figure 4.2.4. BEMTOOL results for red mullet in GSA 9: SSB, F, total landing and total discard.



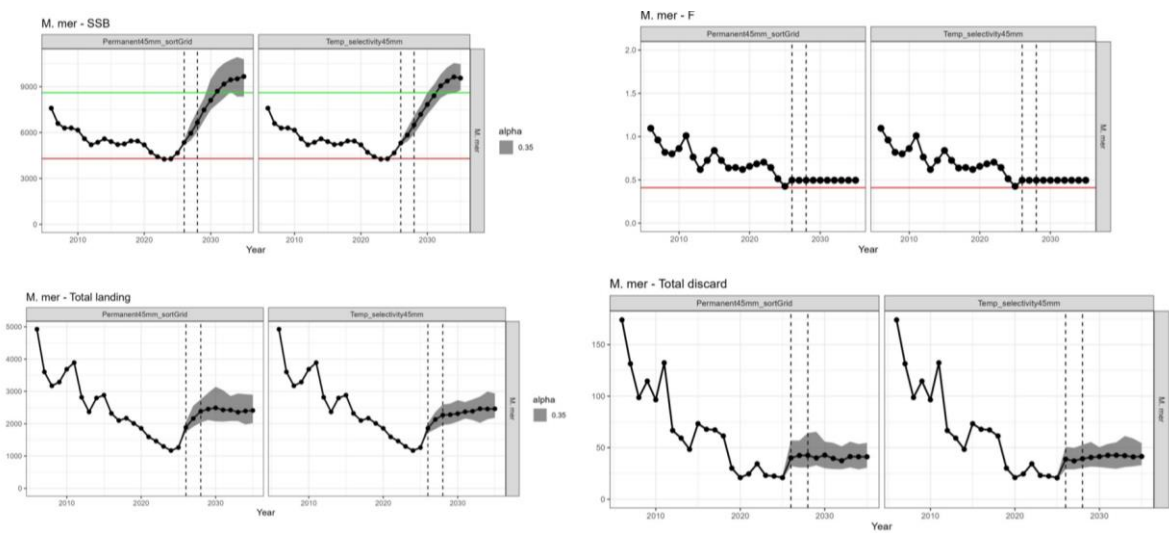
Source: Own elaborations.

Figure 4.2.5. BEMTOOL results for Norway lobster in GSA 11: SSB, F and total landing (discard is negligible).



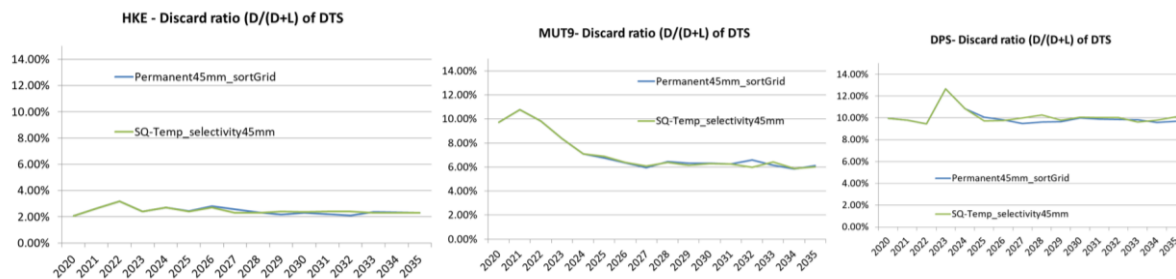
Source: Own elaborations.

Figure 4.2.6. BEMTOOL results for European hake: SSB, F, total landing and total discard.



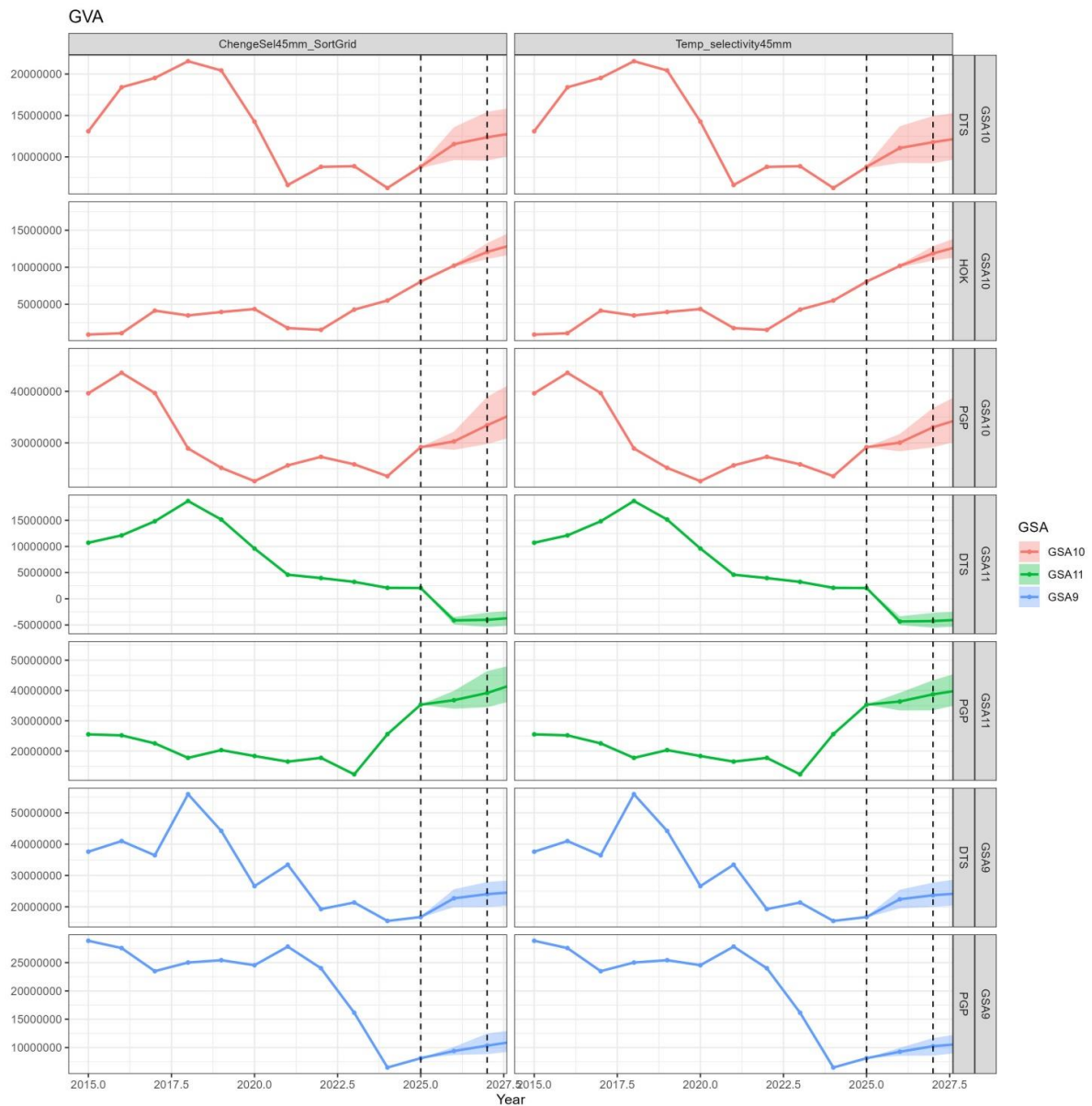
Source: Own elaborations.

Figure 4.2.7. BEMTOOL discard ratio (only DTS) for European hake, red mullet in GSA 9 and deep-water rose shrimp.



Source: Own elaborations.

Figure 4.2.8. BEMTOOL results for gross value added (GVA) by fleet segment and GSA.



Source: Own elaborations.

Conclusions

The selectivity scenarios explored during the EWG 25-14 with BEMTOOL in Western Mediterranean Sea (demersal fisheries operating in the GSAs9-10-11) allowed to evaluate the impact of a fixed improvement in selectivity for trawlers respect to the temporary selectivity change. The results show a small reduction in the discard volume, especially for deep-water rose shrimp.

Importantly, there are indirect spillover effects on other gears. By increasing selectivity in trawl fisheries, interaction pressure on shared components of the stocks is reduced, which tends to benefit passive gears and polyvalent fleets—a generally positive cross-gear effect.

Selectivity changes alone may appear only marginally effective, especially for the most pressured stocks. However, when combined with complementary measures—

such as effort management and catch limits—they can help reset the operational reference points (i.e., lower the effective F needed to meet precautionary/MSY targets) and thereby enable less severe effort reductions to achieve sustainable exploitation for the target stocks.

Future steps:

- To integrate quantitative stock assessments, if available, for the stocks relevant for the MAP (ARA, MUT10, DPS) next year;
- To test additional more impacting selectivity scenarios (e.g. T90, SM50?), possibly integrating new findings on fuel saving technologies (semi-pelagic doors).

5. ToR4 – STAKEHOLDER ENGAGEMENT SESSIONS WITH OBSERVERS AT THE MEETING SHALL BE HELD TO GATHER THEIR PERSPECTIVES ON THE UTILITY AND REALITY OF THE PROPOSED FRAMEWORK TO ASSESS THE BIOLOGICAL, ECONOMIC AND SOCIAL IMPACT OF THE IMPLEMENTATION OF TECHNICAL MEASURES.

In its PLEN 25-02 report STECF discussed the importance for stakeholder engagement in the EWG 25-14 meeting. There should be a limited possibility of stakeholders to participate in the whole EWG meeting as observers, but also the possibility to participate in a specific stakeholder meeting (preferably Wednesday afternoon). Both groups should register via the STECF website to make sure that all have signed the protocol for observers and in the meeting material from the EWG meeting could be discussed.

The original proposal, prior to EWG 25-14, was to hold a meeting with the Advisory Councils (AC), who could then inform their members and make them aware of EWG 25-14 and the possibilities to take part as observers in the whole meeting or in the special session on Wednesday. Unfortunately, an early engagement with the ACs was not possible, and ACs were contacted only 4 weeks before the EWG about the EWG meeting. At that stage only a very limited number of observers expressed their interest in participating in the EWG and it was decided to let all of them be observers to the whole meeting. During the meeting not all of the observers were able to participate the whole time and also at the specific session for stakeholders on Thursday (instead of Wednesday to have more time for having preliminary results from the meeting), there were only two observers present.

The observers were asked to present first their expectations for the EWG and their perspective regarding the technical measures regulation. MEDAC had already provided the EWG with material before the meeting and the scenarios tested in the meeting for the MED were in part based on that input. Due to the West Med Map there is an ongoing discussion to improve selectivity for hake as hake was the most vulnerable stock in most GSAs. MEDAC has provided advice on the improvement in selectivity (XXXX) which was available to the EWG. It was argued, for example, that the regulation is not clear enough to be totally sure what type of gear is permitted. There is a new fishing method, the trap line (see STECF 25-02) which is not on the gear list of the West Med Map and ICCAT in the MED but which is very promising to improve selectivity.

The main interest of the MEDAC members is regarding the costs of different options. Possible benefits of the trap line were also mentioned in the STECF PLEN 25-02

(STECF 2025g)and, therefore, it would be good to show those benefits when using the app.

As selectivity improvement is a complex issue, as we can see with the evaluation of the West Med Map (e.g. EWG 25-11, STECF 2025f) and discussions avoiding unwanted bycatch in other regions, it would be specifically interesting for the members of MEDAC and other ACs to get some results from modelling exercises to improve selectivity.

Assessing socio-economic impacts, costs and possible benefits from improvements in selectivity, would be of great importance for the ACs. In other parts of EU waters, like the Celtic Sea, there is long discussion how to reduce unwanted cod bycatch. In the North Sea there is a zero-catch advice for cod and here there is also a debate on how to deal with that probably by improving selectivity of fishing gear. Depending on what will be implemented can have substantial socio-economic impacts.

After a presentation of preliminary results of the EWG in the stakeholder meeting, especially the timeframe of the assessments was discussed. The experts participating in EWG 25-14 explained that older data (2020-2022) were used in the process because they were already available when the work on the framework started in STECF in 2024. That had not changed so that the results of the two test cases, West Med and Bay of Biscay, will rely on 'outdated' data. For the economic data the time-lag is always 2 years but, in the AER, a nowcast and forecast for the years 2024 and 2025 (in the current AER) are included. For the West Med Map modelers model the current year (this year 2025) and then applying the models to predict the development over the next year(s). A prediction for one year is also quite short and the EWG participants explained that a timeframe of 5 years was discussed in the EWG. After 5 years there is a lot more uncertainty about stock development and economic variables which makes it difficult to apply the available models.

It was additionally raised by a stakeholder that we should also look at market developments etc. as increasing catch, for example, due to improvement in selectivity after some time may influence prices negatively. The problem for STECF is that there is little data available. In the past, STECF tried to improve the data collection for the processing industry to link landings with raw material supply to the fish processing facilities but it was never possible to collect good raw material data as companies don't want to provide information about the sources.

6. ToR 5 - DISCUSS DIRECTION OF FUTURE WORK, ADDITIONAL NEEDS, STAKEHOLDER ENGAGEMENT, AND ADVICE NEEDS. THESE DISCUSSIONS WILL INCLUDE THE DEVELOPMENT OF LONGER-TERM FORECASTS; ASSESSMENTS ON THE IMPACTS OF SPATIAL AND TEMPORAL CLOSURES, AND INCLUSION OF SOCIAL DATA.

Within this section EWG 25-14 have outlined future steps and procedures which could be incorporated to expand the case studies to assess the biological, economic and social impacts of changes in technical measures. It should be noted that although the models selected are not spatially explicit the construction of the fleets and metiers could be defined to account for explicit spatial scenarios.

6.1 Data resolution

Future iterations of these case studies and models should use RDBES data to enable port level impacts to be explored. The RDBES landings table (CL) provides a port level indicator which would enable the production of a fleet object with port level information.

The BioEcon app and Bay of Biscay case study have been set up to enable easy inclusion of port level information in future case studies.

This process was tested under the SEAWISE project, for the Bay of Biscay mixed fisheries we tried to use the RDBES information to assess the ports where fish are landed to make a link with the local communities under the sociologic analysis. But the analysis was not finally included due to the inconsistencies found in catches between both sources of information (specifically MIXFISH data call and RDBES information). This was dealt in SEAWISE deliverable 2.5

(see https://data.dtu.dk/projects/Shaping_ecosystem_based_fisheries_management_SEAwise_/136112). However, the RDBES data has advanced significantly in recent years and so should be in a better state to be used by a mixed fisheries model.

6.2 Economic indicators

The EWG 25-14 discussed the calculation of medium to long-term indicators. Although these indicators can technically be calculated, the group concluded that the resulting outcomes are unlikely to be realistic or intuitive when compared with the biological forecasts from the stock assessment. They are also not expected to provide meaningful insights for stakeholders or adequately reflect the short-term impacts associated with implementing the technical measures regulation.

Additional challenges arise when attempting to implement long-term calculations of these indicators. One concern is the increased uncertainty in model parameters over extended time horizons. Over a span of 10–15 years, many vessels will need to be replaced, typically with newer and more efficient ones. This evolution in fleet composition further complicates the interpretation of long-term results. If, in future work, the time frame is extended and these uncertainties can be better addressed, the inclusion of such indicators may be reconsidered.

The EWG discussed the following medium to longer term indicators:

1) Return on Fixed Tangible Assets (ROFTA)

This indicator which may be used when the objective is to assess long-term economic performance, viability and capital efficiency. ROFTA relates profitability to the value of physical assets, and captures the capacity of a fleet to generate an adequate return on investment. Persistent low or negative ROFTA values suggest that the fleet is not covering the opportunity cost of capital and may be suffering from structural inefficiencies or overcapacity. In summary, gross profit explains operational behavior while ROFTA measures long-term sustainability.

Defined in terms of variable names:

$$RoFTA = (net\ profit + opportunity\ cost\ of\ capital) / tangible\ asset\ value\ (vessel\ depreciated\ replacement\ value)$$

Defined in terms of AER variable code:

$$RoFTA = (Net\ profit + oppcost) / totdeprep$$

$$Net\ profit = Totlandginc + tototherinc + totrightsinc - totcrewwage - unpaidemp - totenercost - totrepcost - totvarcost - totnovarcost - totrightscost - totdepcost - oppcost$$

$$oppcost = (totdeprep + totrights) * 3.5\%$$

2) Current revenue in relation to break even revenue (CR/BER)

The ratio of current revenues to break-even revenues is one of the most widely used indicators to assess whether profitability levels are sufficient to ensure the economic sustainability of a fishing activity over time. It provides a measure of a fleet's ability to generate enough income to cover all operational and capital-related expenses, thereby supporting its continued activity in the medium term.

A CR/BER ratio equal to or greater than one indicates that the fleet segment is profitable, covering variable, fixed, and capital costs, and is potentially undercapitalised, as it could generate higher returns with additional investment. A ratio significantly below one highlights a condition of insufficient financial profitability, implying that the revenues do not cover total costs. A negative ratio indicates that variable costs alone exceed current revenues, meaning that continued operation results in increasing losses. In general, the closer the ratio is to one, the closer the fleet is to economic equilibrium.

Defined in terms of variable names:

CR/BER = ratio between current revenue (CR) and break-even revenue (BER)

Where: BER = (Fixed costs + opportunity costs of capital + depreciation) / (1 - (crew costs + unpaid labour + energy costs + repair and maintenance costs + other variable costs) / Revenue)

Defined in terms of AER variable code:

$$CR/BER = totlandginc / (totnovarcost + totdepcost + ((totdepcost + totrights) * 3.5) / (1 - (totcrewwage + totunpaidlab + totenercost + totrepcost + totvarcost)))$$

6.3 Fleet turnover

Future forecasting within the selected framework should account for fleet turnover and changes to capacity. Within FLBEIA and BioEcon this would be possible with the simple capital dynamics function as currently implemented in FLBEIA

The FLBEIA (García *et al.*, 2017) Simple Capital Dynamics function (SCD) models fleet capacity changes over time by simulating vessel entry and exit decisions. It provides a coarse, heuristic mechanism for fleet adaptation to economic

performance, by linking both profitability and operational characteristics to investment or disinvestment in vessels (leading to a capacity increase or decrease, respectively).

At the end of each year, the function updates the fleet's capacity for the following year (and the number of vessels) based on profitability indicators derived from revenue and cost components, and a comparative analysis of the current operational effort relative to fleet's available capacity.

A step-by-step explanation of the function is provided below. The source code and tutorial are available at the following links:

- https://github.com/flr/FLBEIA/blob/master/R/OM_2e_CapitalDyn_SCD.R
- <https://flbeia.azti.es/wp-content/uploads/2014/01/ManualFLBEIA.pdf>

Step 1: Compute economic indicators

The following outputs are computed for each fleet yearly (at the end of the year).

Revenue

- *sum across all stocks (catch x price_per_kg)*

Costs

- *variable costs = variable costs_{per unit of effort} X effortshare_{métier} X effort_{fleet}*
- *fixed costs = number of vessels x fixed cost per vessel*
- *fuel costs = fuel cost per unit of effort x effort*
- *capital costs = number of vessels x capital costs per vessel*
- *crew costs = Revenue * crewshare + other_salaries*

From the revenue and costs, the *Break even Revenue* (BER) is computed as follows:

$$BER = \frac{crew\ costs + fixed\ costs + capital\ costs}{\left(1 - \frac{fuel\ costs}{revenue} - \frac{variable\ costs}{revenue}\right)}$$

Step 2: Compute the (dis)investment share

The potential investment share. for a specific fleet, is estimated as a proportion of the profit to the revenue multiplied with an exogenous parameter, the investment share.

$$Investment = \frac{revenue - BER}{revenue} \times investment_share$$

Note that if the revenue is lower than the BER or if revenue is negative, investment_share is multiplied by -1, so the value becomes negative (and consequently implies a capacity reduction).

Based on the *investment*, the decrease or increase in fleet capacity (Ω) is estimated. This is based on the current capacity (K) and two fleet-specific exogenous parameters $w1$ and $w2$ that define the maximum expected reduction and increase in capacity, respectively. The change in capacity is estimated as follows:

- When investment is negative:
 - If investment $< -w1$ than $\omega = \text{investment} \times K$
 - else $\omega = -w1 \times K$ (capacity decline is capped)
- When investment is positive:
 - If investment $< w2$; $\omega = \text{investment} \times K$
 - Else $\omega = w2 \times K$ (capacity increase is capped)

Following this step, a final correction to the value of the capacity change (Ω) is applied. The investment is disabled (i.e. $\omega = 0$) in case investment is positive ($\omega > 0$), if effort is not close to the maximum capacity of the fleet (specifically if effort is less than 99% of current fleet capacity). Ensuring that new vessels are only added when existing ones are fully utilised.

Finally, a fleets' capacity for the next year is updated by increasing the current seasonal capacity (by ω) taking into account the relative capacity level in each of the seasons. That is: adding the value of ω to the current fleet capacity.

$$\text{capacity}_{y+1,s} = \text{capacity}_{y,s} + \omega \times \text{capacity}_{y,s} / \text{capacity}_y$$

Finally, the updated capacity is then used to update the number of vessels in the fleet, based on the theoretical maximum number of days at sea a vessel can spent.

$$\text{number of vessels}_{y+1} = \text{capacity}_{y+1} / \text{maximum_days_at_sea}$$

Note that for this to work, the capacity should be expressed as the total number of days at sea of the fleet.

Assumptions and caveats

- Vessels can enter or leave the fleet instantly without depreciation, market friction, or transaction cost, which is considered unrealistic for real-world fleets.
- Investment decisions are immediate and proportional to profitability, assuming perfect access to capital.
- All vessels within a fleet segment are identical; consequently, heterogeneity (e.g., efficiency, age, technology) is ignored.
- Future profitability is not considered. Investment decisions are purely based on current revenue.
- Costs per unit of effort or per vessel are fixed and exogenous
- Difficulty to empirically calibrate $w1$, $w2$ and investment_share parameters

Alternatives for improvement

To improve (economic) realism of vessel exit/entry decisions, the concept of the Net Present Value (NPV) could be introduced in the FLBEIA::SCD function. The NPV framework introduces forward-looking behaviour and relate investment/disinvestment decisions to the expected future profitability over the vessel's lifetime.

Until now, the capital function has undergone very limited testing and has revealed several issues. One major problem is its conditioning, which relies on estimating several parameters. Additionally, in a tested case study, it consistently produced unrealistic results (specifically, a steady annual decline in the number of vessels, constrained by the applied threshold). One of the key shortcomings identified up to now is that the model currently fails to account for the influence of subsidies and the incentives or disincentives they create, factors which are critical to fleet evolution. Addressing this gap would require substantial work that has not yet been undertaken. Consequently, before considering its application, a thorough reassessment is needed. More importantly, it would be advisable to explore whether more robust alternatives have been published over the past decade. As FLBEIA is designed to easily accommodate new implementations, this would be feasible as long as the required inputs of the model can be estimated based on the simulated variables. If a better model can be proposed, its integration into FLBEIA would be advisable.

6.4 Social data

Social indicators stemming from EWG 24-16 (STECF 2024a) alongside “conventional” socio-economic measures such as total employment in fishing, expressed either in number of fishers or full-time equivalent (FTE) terms. In Mediterranean fisheries (as well as in BOB), core socio-economic metrics such as total employment, number of fishers and full-time equivalent (FTE) continue to be monitored as primary indicators. These baseline metrics are not new, but they remain central in data collection, for tracking job losses, fleet contraction.

Such baseline indicators provide essential context for interpreting the more targeted social variables introduced by STECF, which focus on working conditions, welfare, labour organisation and the long-term demographic sustainability of the fishing sector. The following social indicators, identified in EWG 24-16, capture key dimensions of fisher well-being, labour conditions and community resilience and are increasingly considered in fisheries assessments and policy design. Above those indicators, the STECF’s EWG 24-16 have highlighted several quantitative social indicators that capture aspects of fisher well-being (see also 3.2 under limitations), labour conditions, and sustainability of the fishing communities. These indicators, many of which can be derived from existing data (e.g. the Annual Economic Report), are defined below:

- **Days at Sea per Fishing Trip (Time Away from Home):** Measures the average trip length in days at sea, serving as an index of *quality of life* by indicating how long fishers spend away from home. A higher value suggests longer absences per trip, impacting work-life balance. This indicator is readily available from effort data and was explicitly noted as reflecting “*quality of life based on time away from home*”.
- **Hours Worked per Day:** The typical length of a working day for fishers at sea. Collected via socioeconomic data calls, this is a social indicator of workload and well-being. Longer working days may imply harsher working conditions, and this metric complements *time-away* measures in describing fisher welfare.

- **Number of Fishing Trips:** The count of trips made (often considered together with total days at sea). When combined with days at sea, it can indicate average trip duration or frequency.
- **Vessel Age:** The average age of fishing vessels, used as a proxy for *work safety*. Older vessels may lack modern safety features or be more prone to accidents. This indicator is immediately available (from vessel registers) and was highlighted as reflecting safety risks (with older fleets potentially indicating higher hazard).
- **Labour Productivity (GVA per FTE):** Gross Value Added per Full-Time Equivalent job in the fishery. This economic productivity metric is interpreted as a social indicator as higher productivity may translate to better incomes per worker. EWG 24-16 in fact listed GVA/FTE as an index describing “*quality of life*” for fishers, under the premise that more output per worker could imply greater efficiency and reflect higher wages or shorter work time for the same earnings.
- **FTE per Job (Employment Fraction):** The ratio of full-time equivalent employment per actual job position. It indicates under- or over-employment – for instance, whether fishers (and their families especially in SSF context) are working part-time or holding multiple jobs (pluriactivity). An FTE/job value significantly below 1 might mean many part-time workers, whereas above 1 could signal workers averaging overtime. EWG 24-16 identified this as “*describing under/overemployment*” in the sector.
- **Vessel Investment and Maintenance Cost per Vessel:** The average annual expenditure on vessel investments, repairs, and maintenance, per vessel. This serves as an indicator of safety and working conditions on board – higher spending may reflect better safety and living conditions (or conversely, older vessels needing more repair). EWG 24-16 noted this index as immediately available and related to safety, as under-investment in vessels could signal safety risks.
- **Unpaid Labour Ratio:** The share of labour provided by unpaid workers (e.g. family members) relative to total labour input. A high unpaid/total labour ratio indicates a reliance on family labour and may point to *family-based business resilience* or cost-saving strategies. EWG 24-16 described this indicator as reflecting a “*family business...resilience/family independence*” – essentially, the extent to which fishing operations rely on unpaid family help, which can buffer against financial shocks. It should be noted, however, that this index is not cross-country comparable, since some Member States (e.g., France) do not register any workers as unpaid labour, which drives the ratio towards zero by construction. A low or zero value in these cases signals a data artefact rather than the absence of unpaid family input.

- **Generational Renewal Index:** An age-structure indicator to assess recruitment of young fishers. One example is the ratio of the number of young fishers to older fishers, for instance, (fishers ≤ 24 years) divided by (fishers ≥ 65 years). STECF documents explicitly mention using the “*ratio of high age class to low age class*” as an index of generational renewal effectively the inverse of the example above indicating whether an ageing workforce is being replaced by youth. A lower generational index (few young per older) signals a potential future labour shortage in fishing.
- **Gender Ratio in the Workforce:** The proportion of female to male workers in the fishing sector. Although fishing in this region is traditionally male-dominated, this **gender ratio** is noted as a social variable to monitor. It reflects gender diversity and inclusion in the industry. A “gender ratio” indicator (e.g. percentage of fishers who are women) was acknowledged as part of the social data that can be collected.
- **Financial Position of Crew (Relative Income):** A measure of fishers’ earnings compared to the general workforce. One formulation is the ratio of the average wage of fishing crew to the national average (or minimum) wage for employees. For example, if crew earn on average 80% of the national mean wage, it may indicate relatively low income and potential social vulnerability. This indicator, called also *financial security* highlights whether crew incomes are on par with other jobs. In practice, data for this can be derived by dividing total crew wage costs by FTEs and comparing to official national statistics.
- **Financial Position of Vessel Owners:** A similar income comparison for owner-operators (skippers). It is defined as the fishing enterprise’s net profit per owner, compared to the average income of self-employed workers nationally. For instance, if a skipper’s annual profit is below the typical self-employed income in that country, it may signal financial precarity. This indicator is available from DCF economic data (net profit and number of vessel owners) and national income data. Notably, the RCG point out that obtaining the average self-employed income can be challenging (see discussion below).
- **Fishers in Trade Unions:** The number or proportion of fishers who are members of a trade union or professional association. This is collected per fleet and signals the level of labour organization and representation. A higher unionization rate might imply better bargaining power for workers and potentially better working conditions. This indicator was identified among the “low-hanging fruit” social variables for data collection during the EWG 24-05 (STECF 2024b).
- **Fishers in Cooperatives/Organizations:** In some cases, fishers operate through cooperative schemes (e.g. “*cofradías*” in Spain). An indicator suggested is the *number of fishers working under a cooperative agreement*.

This would measure how many fishers are engaged in such collective organizations, which can influence their social security and market power. However, as the RCG report notes, a standardized EU indicator for cooperative membership “*does not exist at EU level*” and would need Member State-specific data.

- **Minimum Required Crew per Vessel:** A work safety indicator defined by regulations – the minimum number of crew legally or operationally required on board each vessel of a given size/gear. It reflects safe manning levels. For instance, if regulations mandate at least 4 crew for a certain trawler class, compliance with this standard can be assessed. This quantitative indicator was listed by STECF/RCG as an easily collected metric (often available via national safety authorities).
- **Mandatory Safety Training (Yes/No):** Whether crew have completed required safety training courses (a qualitative binary indicator). It checks compliance with safety regulations. In data terms, this could be recorded as the percentage of fishers with up-to-date mandatory safety certificates. STECF EWG 24-05 and the RCG recommended including this as a yes/no indicator of work safety culture.
- **Workplace Accident Rates:** The number of reported **fatalities and injuries** in fishing operations, usually on a per-year basis. This indicator directly measures the safety outcome in the sector (occupational hazard rate). It has been proposed under “Work safety” to track how often fishers are hurt or killed on the job. High accident rates would signal poor safety conditions. (Data for this may come from national occupational safety reports, though it is not uniformly available in all countries.)
- **Marine Space Use (Competition for Space):** The percentage of maritime area (e.g. national EEZ or coastal waters) allocated to other uses such as aquaculture, offshore wind farms, marine protected areas, etc., versus areas designated as fishing grounds. This *spatial indicator* reflects external pressures on fishing activity and community access to resources. For example, an increasing share of sea set aside for non-fishing purposes could constrain fishing operations and affect coastal communities. RCG documents suggest using marine spatial planning data at national/ICES area level to quantify this.
- **Level of Professionalisation (Experience):** The average number of years fishers have been working in the profession. This indicator gauges the career length and expertise in the sector. A lower average tenure might indicate high turnover or difficulty retaining people in fishing, whereas a high average could indicate a stable but ageing workforce. It was proposed that this be expanded in the social data call, as it provides context on whether fishing is a lifelong career or a temporary job for most.

- **New Entrants into Fisheries:** Several related indicators measure generational flows:
 - *Enrollment in Training:* Number of people enrolled in or graduating from fisheries vocational training or mandatory safety training programs. This shows the flow of qualified new labour entering the industry pipeline.
 - *New Fishing Licences/Registrations:* Number of **new entrants in the vessel register**, i.e. new commercial fishing licences issued or new skipper entries. This reflects actual newcomers starting fishing operations.
 - *Departures/Retention:* For completeness, some reports also track those who *leave* the sector, such as entrants who are no longer in the vessel register after a certain time, to gauge retention.

Together, these indicators inform the generational status of the fishery, indicating whether young people are joining (and staying in) the profession. STECF/RCG have noted most Member States can provide data on new licence entrants. For example, Greece reported plans to collect the “*Number of New Entrants in the Vessel Register*” as a key social variable in 2025.

- **Participation in Decommissioning Schemes:** The number of fishers or vessels participating in official decommissioning (fleet retirement) programs. This indicator, under generational renewal, reflects the flip side of entry – it measures exits facilitated by policy. A high number might indicate an ageing fleet accepting buyouts or a sector contracting by design. It provides insight into how many are leaving the industry with support, and thus the potential loss of fishing livelihoods.
- **Additional Income Sources (Diversification):** The extent to which fishing households rely on income beyond fishing to sustain themselves. One way to quantify this is the *additional income to support fishing continuity as a percentage of total income or share of time*, e.g. income from other occupations or government aid. Especially in SSF, a high share of fishers indicates that fishing alone may be insufficient to make a living, and fishers must diversify their income sources (through part-time jobs, agricultural activity, etc.).

6.5 Integrating social indicators into Bioeconomic Models: Appropriateness and Challenges

Future EWGs will need to assess how the selected social indicators will be included as incorporating the social indicators into bioeconomic models can be a challenging exercise for many reasons. Bioeconomic models traditionally focus on biological stocks and economic performance; expanding them to include social dimensions is a newer endeavour encouraged by both ICES and STECF to achieve holistic fisheries management. Below, each group of indicators is assessed for its suitability in models, noting any limitations, data issues, and potential ways they could be used:

Working Time and Well-Being Indicators (Days at Sea per Trip, Hours Worked per Day, Number of Trips):

These metrics are *readily derived from effort data* and thus can be included as outputs of a bioeconomic model to evaluate scenarios. For example, if a model can project changes in total effort (days at sea) and how this is distributed among trips, it can compute whether fishers will spend more time away from home under a given management strategy. However, using them as inputs or **drivers** in the model is challenging. Current models generally do not include fisher quality-of-life preferences (e.g. a model will not normally reduce effort because fishers dislike long trips – it will reduce effort only if it's economically unprofitable or biologically constrained). Thus, these indicators often *do not feed back* into model dynamics but rather serve as social impact indicators to monitor.

One modelling challenge is that changes in these indicators may be subtle and require fine-resolution effort data. Moreover, they do not fully capture qualitative aspects of well-being (e.g. family relationships) – they are proxies. Therefore, this indicator should be interpreted with caution, because for many fishers longer trips are a rational and sometimes preferred choice that improves income, reduces fuel-intensive transits and aligns with established work culture at sea. Modern vessels, better living conditions on board and the ability to cluster work into fewer but longer trips can make extended time away acceptable or even advantageous for crews and their households. The indicator only signals a potential welfare issue when longer trips coincide with economic stress, fatigue, safety risks or shrinking home time over the year, so it must always be read alongside complementary socioeconomic and safety metrics.

Despite these caveats, their inclusion could be beneficial for *evaluating trade-offs*: managers can see, for instance, that a policy reducing allowable fishing days could improve work-life balance (shorter trips) at the cost of some economic yield. Overall, time-away-from-home indicators are straightforward to compute in projections, but incorporating fisher behaviour responses to them would need new model components (e.g. utility functions that penalize excessive time at sea).

Safety and Working Conditions Indicators (Vessel Age, Required Crew, Safety Training, Accident Rates):

Many of these indicators relate to regulatory or technological aspects that lie outside typical bioeconomic models. *Data availability* can be a limitation, e.g. accident statistics may be sparse, under-reported or only reported in voluntary basis, thus making model calibration and robustness difficult. Vessel age is a proxy for safety, but most models do not explicitly track the age distribution of the fleet over time. Including vessel age would require simulating fleet renewal (investment in new vessels or scrapping of old ones). Nonetheless, one could incorporate a scenario where older vessels are gradually replaced (thus lowering average age) and then evaluate impact on costs or accident probability. Minimum crew requirements and training are typically binary compliance measures rather than continuous variables, so a model might only flag whether a fleet segment meets these standards or not. Accident rates (fatalities/injuries) could potentially be used to adjust labour availability or insurance costs in a model (a high accident rate might reduce effective labour or increase costs). A key challenge is that improving safety (through newer vessels,

training, etc.) often requires investments or policy changes not captured by models, so their effects are hard to endogenously predict. The opportunity here is mainly in highlighting safety outcomes of management strategies e.g., if a policy “trigger” fisher to fish in riskier weather or farther offshore, an ex-post evaluation can note increased risk exposure. In summary, safety indicators are crucial socially, but integrating them into model decision-making is limited; they are best used to ensure that models’ recommended policies are screened for any safety implications.

Economic Status and Financial Indicators (Crew/Owner Income Comparisons, Financial Security):

These indicators stand in the borderline between economic and social. Bioeconomic models can already project profits, revenues, and crew wages, thus calculating relative income measures (like crew wage vs national average) from model outputs is feasible. They are appropriate to include as performance indicators for scenarios. For example, a model can forecast if crew earnings will rise to meet a national average under a certain management plan. The limitations here mostly concern data and definition consistency. National average income or minimum wage must be taken from outside the model (from socio-economic statistics), and as noted in the RCG reports, not all countries have a straightforward figure. This can complicate the comparability of the “financial position” (or financial security) indicator across countries. Even less apparent, is the figure of minimum (or average) income for owners/self-employed, if one wishes to distinguish between owners from other members of the crew.

In modelling terms, financial position indicators do not influence the model outcomes (the model cares about absolute profit and effort decisions, not how those compare to national statistics), so they again function as social outcome metrics. There is also a noted terminology issue: “Financial status/position” as used socially can overlap with economic indicators (profit, etc.), potentially causing confusion. Model practitioners need to clearly define these to avoid misinterpretation. The opportunity in including them is substantial, these indicators directly address fisher livelihoods and can signal whether a management strategy is socially sustainable (e.g. if fisher income remains far below average, you might question a policy’s long-term viability for communities). They provide a bridge between model output and broader socio-economic well-being goals, as emphasised by STECF’s push to complement economic and environmental objectives with such social metrics.

Employment and Organisation Indicators (Unionization, Social Security Coverage, Cooperative Membership):

These indicators reflect labour conditions and rights. In a modelling context, they are largely exogenous i.e., a bioeconomic model will not determine how many fishers join a union or whether they have contracts as those are institutional factors. Thus, the appropriateness of including them is mostly in descriptive reporting. For instance, one can document union membership rates in the baseline and see if policies might indirectly affect them (for example, if a policy drives many small vessels out, and if small-scale fishers were less unionized, the overall unionization rate of the sector might increase). Data collection is the biggest hurdle: as noted, statistics on things

like social security coverage or cooperative membership are not consistently available yet at the EU level. The RCG ISSG on Social Variables report indicates these need to be confirmed by each Member State, meaning models cannot rely on a unified dataset. They also often remain static over short-term simulations. In practice, these indicators would be reported alongside model outputs rather than generated by the model itself. The critical discussion around them is ensuring we gather the data in the first place, simply getting accurate counts is a challenge.

Generational Renewal and Demographic Indicators (New Entrants, Training, Decommissioning, Age Structure):

These indicators are crucial for long-term sustainability but pose significant modelling difficulties. To explicitly model new entrants or generational turnover, one would need to add a demographic component to the model – essentially, a simulation of the labour market for fishers. This requires assumptions about fisheries' sector attractiveness, recruitment rates, etc., which is something far beyond our current data collection. As such, indicators like “number of new fishers joining” or the age ratio are usually *observational, not predictive* in models. The appropriateness of including them is more in scenario evaluation and risk assessment. For example, if a policy scenario leads to very low profitability in the small-scale fleet, one can flag that it may deter new entrants (thus worsening generational renewal), even if the model itself did not calculate employment change. Some pilot studies in other regions (e.g. Greece) are beginning to collect data to make such analysis possible. Data limitations are significant here, as also noted by RCGECON reports. Additionally, small sample sizes (few new entrants per year in some fisheries) make trends hard to model statistically. Modelling challenges include how to treat decommissioning schemes; models may simulate a reduction in fleet capacity from a decommission subsidy, but translating that into social terms (how many people leave fishing) requires extra assumptions. Despite these issues, the opportunity is that by tracking these indicators, bioeconomic exercises can address the long-term viability of the fishing workforce. They open discussions on whether current management is socially sustainable; for instance, a high ratio of older fishers to young ones might prompt complementary policies for recruitment or training. In short, generational indicators are difficult to endogenize in models, but extremely valuable as flags in model results. They underscore the point that sustainability has a social dimension too: a fishery that is biologically and economically sustainable still fails if it cannot attract a next generation of fishers.

Spatial and Community Indicators (Marine Space Use Conflicts):

The percentage of area allocated to other uses is somewhat external to the typical bioeconomic model, but may be brought in through scenario parameters. For example, a model could be run under a scenario where 10% of fishing grounds are closed (simulating marine protected areas or offshore energy sites) to see the impact on catch and profits. The indicator itself, percentage of sea with competing uses, would come from spatial planning data and might be assumed or projected

externally. Limitations include the abstract nature of this metric (it doesn't capture *where* the closures are, which is often crucial) and the fact that it might overlap with fish stock considerations (closing areas could help stocks, etc., which the model might account for biologically). Another challenge is that spatial indicators are region-specific (the Mediterranean, for instance, has intense competition for coastal space), so the relevance of, say, a 5% aquaculture area is context dependent. From a modelling perspective, this indicator is appropriate to include in regional scenario analyses as it helps quantify and communicate the pressure on fishing space.

In general, data availability and consistency are overarching issues for all these indicators. As the 2025 ISSG Methodological report (Danatskos *et al.* 2025) notes, a new list of social indicators has been introduced but *whether data will be available to provide them is one of the biggest challenges*. Some indicators may not be relevant or defined uniformly in all countries (e.g. "financial security" and vocational training indicators may not apply everywhere). In practice, pilot studies in several MS are being conducted to start clarifying these issues. For instance, there are already feedbacks concerns that some of them, like safety perceptions or exact income comparisons, face low response rates or definition problems, and that roles of institutions in data collection need clarification. It has emerged that even when data exist, there can be methodological hurdles, e.g. assumptions for calculating average wage, lack of a national minimum wage that complicates the "financial security" metric. Similarly, there is a gap for *Financial Position of vessel owners* due to no public source for average self-employed income that requiring extra effort and resources to calculate homogeneously across MSs.

From a modelling perspective, an efficient inclusion of these social indicators in a robust methodological way, will provide the ability to inform more balanced policy decisions. As noted in EWG reports, integrating social data alongside biological and economic factors supports a "holistic management framework" that better reflects the needs and dynamics of fishing communities. Bioeconomic models augmented with social indicators can highlight, for example, if a technically successful management measure (one that rebuilds fish stock and economic outcomes) might fail socially because it undermines fleet renewal or worker safety. This can prompt managers to adjust or accompany measures with social programs. While many social indicators will initially play a monitoring role (tracked as outputs or contextual variables), over time they can inspire the development of new model components (such as labour dynamics or fisher behaviour models), an area of active research (e.g. ICES WGSOCIAL⁴ is exploring methodologies to incorporate well-being metrics).

In conclusion, each social indicator brings its own set of modelling challenges: some suffer from data poorness, others from lacking direct causal links in models, and some from ambiguous definitions. Nonetheless, each presents an opportunity to add a layer of insight to bioeconomic analysis. The current approach, is to start collecting and standardizing these indicators and to include them in scenario evaluations as additional criteria for success or impact. By doing so, fisheries management can move toward strategies that are not only ecologically and economically sound, but also socially sustainable and resilient. The task moving forward is to refine these indicators and incorporate them in modelling in a meaningful way, ensuring cautious

⁴ <https://www.ices.dk/community/groups/Pages/WGsocial.aspx>

interpretation and understanding of limitations, but leveraging the information they provide to guide policy that benefits both the fish stocks and the communities that depend on them.

Given the currently available social data, the group agreed that resources should be used to select appropriate case study locations. Following the approach developed by ICES to provide information on fishing communities (Kraan *et al.*, 2025) to select the landing ports for the Bay of Biscay case study. Landing ports can be used as a proxy for fishing communities, linking socio-economic indicators, such as landings value to terrestrial regions. The ICES fishing communities approach illustrates patterns in fishing activity through three key indicators: (i) fishing intensity, (ii) landings by weight, and (iii) the value of landings across ports with active fishing vessels (<10m excluded). The fishing community maps visualization uses circles of different sizes to represent the order of magnitude for each indicator, while colour denotes vessel length categories (Kraan *et al.*, 2025).

The approach can be adapted to show the distribution of hake (and other) landings in the Bay of Biscay. The impacts of management measures that affect hake (and other) landings and their value can then be illustrated. By comparing the current fishing communities map for hake in the Bay of Biscay with maps reflecting reductions or increases in hake landings resulting from management measures, the socio-economic impacts on fishing communities, in terms of landings and their value, can be visualized.

It should be noted that ICES is still in the process of developing the fishing community maps for the Bay of Biscay. The R code created for the visualisation remains to be tested and validated. Once a robust and fully functional application is available, it can be shared for use by STECF.

Time horizons in bio-economic modelling from the human dimension perspective

Example of a justification for a 5-year projection horizon in a bio-economic model for the anchovy stock in the gulf of Cádiz (ICES 9.a.S), southern European waters.

As part of the BioEcon4Fish project, an FLBEIA bio-economic model has been developed in co-creation with fishers, policy makers and an interdisciplinary scientific team. Some of the rationale for choosing a 5-year prediction period for the simulations are listed below and are the results of internal discussions within the scientific team.

1. Biological rationale

Anchovy is a short-lived species (up to 3 years), so a 5-year window covers several cohorts. This allows the model to capture at least one or two complete recruitment cycles, reflecting natural variability and stock responses to management or environmental changes.

A 5-year timeframe is also consistent with the reference period used for the stock assessments of this species and management strategy evaluations (MSEs) to assess sustainability and stock rebuilding potential under different scenarios.

2. Economic rationale

A 5-year horizon provides a reasonable period to assess market adjustments, cost structures, and fleet responses to changes in biomass, quotas, or environmental conditions. It reflects the investment and operational cycles typical in small- to medium-scale fisheries, where vessel and gear replacement, maintenance, or financial planning often occur on multi-year timescales.

Also, this time frame might allow for the evaluation of cumulative socio-economic impacts (e.g., income stability, employment trends, profitability) that may not be apparent in short-term projections.

Social and governance rationale

From a policy perspective, five years aligns with common management and funding cycles (e.g., EU multi annual management plan, national strategic plans, and derogations under regional discards plans).

It provides a meaningful yet manageable horizon for exploring adaptive capacity and well-being trends among fishers and communities without extending into speculative, long-term uncertainty. Well-being has three interrelated dimension:s (1) material well-being (e.g., income, employment, access to resources); (2) relational well-being (e.g., social networks, community cohesion, and support systems); and (3) subjective well-being (e.g., personal satisfaction, happiness, sense of fulfillment) (White, 2010; Britton *et al.*, 2013). A five-year period allows enough time for changes in income, employment, and community relationships to become measurable and meaningful. It balances capturing long-term trends without losing relevance to current social and economic conditions. It is important to note that subjective well-being can also be affected before new management measures are introduced, for example, when there is uncertainty about the future of the family business in light of proposed changes.

While individual social contexts differ (e.g., between younger and older fishers or vessel owners), a five-year span represents a collective medium-term outlook that can inform both short-term adaptation and longer-term planning discussions.

Modelling and uncertainty considerations

A 5-year horizon strikes a balance between realism and predictability: it's long enough to observe the effects of policy or environmental changes, yet short enough to limit uncertainty and model error propagation. Also, the model is live, meaning the team is planning to update it with new data as it become available, hoping to reduce uncertainty as more data become available.

Therefore, for the BioEcon4Fish case study, a five-year projection horizon was considered to be scientifically and operationally justified because it captures key biological cycles of anchovy, reflects the relevant decision-making and economic time frames of the fishery, and maintains a manageable level of uncertainty for both ecological and socio-economic indicators. ecological and socio-economic indicators. However, it should be noted that, although no purely social data were incorporated into the bioeconomic model, the implications of the management scenarios were discussed with stakeholders, including representatives from the fishing sector and local administration, from a social perspective. These discussions addressed issues

such as generational renewal, unemployment, power imbalances, and wellbeing.. The results of the project, in Spanish, are available in the website⁵ including all workshops, participatory processes undertaken, access to the posters presented to the ICES ASC (2024 and 2025) and SIMERPE3 (Lisbon, nov. 2025) are available. The team will be working to publish the results in 2026.

Time horizons in bio-economic modelling

The time span of modelling is an important issue that affects fishery bio-economics to different degrees. On the one hand, biological modelling of fish stocks is generally perceived to be long-term when projections are for one year into the future. Lengthening the time period of biological forecasts introduces significantly higher levels of uncertainty across a range of factors such as environmental variability, biological uncertainty, model limitations, human factors and data gaps (Punt & Hilborn 1997).

Fleet dynamics occur across longer time frames where vessel investments account for the life span of a fishing vessel and its components with vessel hulls potentially having a lifespan up to 30 years, engines up to 20 years, propulsion systems up to 25 years, electronic systems up to 15 years, fishing gears up to 10 years and so on (Tietze *et al.* 2005).

In terms of long-term bio-economic modelling the issue is providing realistic biological and economic parameters to allow long term modelling of fleet dynamics. Significant short-term fluctuations can occur not only in biological parameters but also in economic variables like fuel costs, labour costs and market demand among other factors (Clark 1990). Small errors in initial conditions can lead to error propagation over the longer time across these and other components of fishery systems (Punt & Hilborn 1997). The trade-off is between shorter term precision (up to 5 years) without accounting for longer-term trends (capital dynamics) and longer-term modelling with significantly higher levels of uncertainty (Clark 1990).

Alternative approaches for deriving economic indicators

While bio-economic models remain essential tools for simulating long- and short-term trajectories of fleet performance and stock dynamics, alternative analytical approaches such as cost–benefit analysis (CBA) have been employed in the IMPEMED project (Specific Contract No.EASME/EMFF/2019/1.3.2.6/01/SI2.818717 – SC04) to investigate the consequences of the implementation of T90 and selectivity devices in the trawl fisheries of the western Mediterranean and Adriatic Sea. The CBA provides a static and vessel-level perspective focusing on the immediate economic feasibility of adopting specific technical measures, such as the T90 net or the selection grid. Unlike dynamic models, CBAs do not incorporate biological feedbacks or long-term fleet adjustments but instead evaluate the direct financial implications of technological innovations in terms of profitability, gross value added (GVA), and cost structure. The approach requires the integration of DCF data with data collected through field surveys and experimental trials, which provide case-specific information on changes in catch composition, fuel consumption, and operational costs. As such, CBAs may offer complementary insights to model-based projections, particularly in contexts where management changes are implemented at

⁵ <https://bioecon4fish.ieo.csic.es/resultados>

small scales or where rapid assessment of individual or private investment decisions is required (Sbrana, 2021).

Future stakeholder involvement

As next steps towards strengthening the social dimension of fisheries for the case studies for the BOB and Mediterranean case studies, stakeholder engagement needs to be improved and approaches that integrate fishers' experiential knowledge (Stephenson *et al.* 2016 and Verschuur *et al.* 2025,) with the quantitative bio-economic models prepared by this EWG should be explored.

Stakeholder engagement in the EWG needs to be strengthened. The EWG therefore proposes to organise dedicated meetings with Advisory Councils and fishers active in the region to present the results of the past three years of work and discuss key questions that will support the further development of decision-making tools. These include questions related to stakeholders' views on the proposed socioeconomic indicators and the appropriate level of aggregation for the analysis; which economic or social aspects are most important to measure through indicators; whether any additional indicators should be included; and what scenarios (e.g., improvements in selectivity to a certain extent) would be most useful for the two case studies.

In addition to such consultative meetings, incorporating fishers' experiential knowledge is highly relevant to the quality of the models. Some information can only come from fishers (Stephenson *et al.* and Steins *et al.* 2022). It is therefore key to explore how fishers experiential knowledge can be integrated into the decision-making tools being developed by this EWG.

A first step would be to draw on fishers' experiential knowledge in the interpretation of the model results⁶. This interpretation could relate to both validation of expected ecological and direct socioeconomic outcomes as well jointly exploring potential social and economic impacts of different management scenarios on fisheries, the supply chain and fishing communities. Including fishers' expertise in this manner, is relatively easy to organise and will contribute significantly to the social, economic and ecological trade-off information required for decision-making.

A second step, which can take place in parallel, would be defining the scope and level at which fishers' experiential knowledge could be integrated in the bio-economic models to enhance their social and economic realism by capturing local operational practices, polyvalency (fishers' ability to switch between gears, métiers, or target species depending on season, regulations, or market conditions), and fishing culture. One way forward could involve combining fishers' experiential information with available data on métier activities, effort, and economic value, and representing these through GIS analysis, following methods applied in recent participatory mapping studies (Murillas-Maza *et al.*, 2023). Such an approach could help fill current data gaps, provide finer-scale insights into the spatial distribution and socio-economic relevance of métiers (e.g., targeted activities in the BOB hake fishery), and support the development of more robust social dimension indicators. The process should be iterative and co-creative, moving beyond stakeholder engagement through consultation towards participatory modelling. The EWG recommends to start a small-scale participatory modelling pilot (e.g. one or two selected communities or ports as

⁶ <https://bioecon4fish.ieo.csic.es/resultados>

case studies) to test data collection methods, validate assumptions, refine the model, and ensure fisher participation throughout these steps.

For both options in relation to incorporating fishers' experiential knowledge, it is important to keep higher level stakeholders, such as Advisory Councils and DGMARE, well-informed and also involve them in reviewing preliminary results and ensuring that key questions and perspectives from a policy and regulatory process.

More active stakeholder engagement as outlined above would foster ownership and trust in the decision-support models, enhance their credibility, and increase the legitimacy of its outcomes. Implementing this work will, depending on the approach decided on, be time- and data-intensive, with significant demands on funding, coordination, and capacity from modellers and social scientists. A realistic plan should therefore balance ambition with feasibility to avoid over-promising. To keep the work manageable and focused, pilot case studies could be selected for areas or communities that are expected to be affected the most, based on changes in landings of the key target specie(s) and landings values in the fishing ports that serve as a proxy for fishing communities. Based on these pilots, trends in selected indicators may be more informative, and best practices for additional qualitative data collection can be identified.

Conclusions on social indicators

In general, **data availability and consistency** are overarching issues for all these indicators. As the 2025 ISSG Methodological report notes, a new list of social indicators has been introduced but *whether data will be available to provide them is one of the biggest challenges*. Some indicators may not be relevant or defined uniformly in all countries (e.g. "financial security" and vocational training indicators may not apply everywhere). In practice, pilot studies in several MS are being conducted to start clarifying these issues. For instance, there are already feedbacks concerns that some of them, like safety perceptions or exact income comparisons, face low response rates or definition problems, and that roles of institutions in data collection need clarification. It has emerged that even when data exist, there can be methodological hurdles, e.g. assumptions for calculating average wage, lack of a national minimum wage that complicates the "financial security" metric. Similarly, there is a gap for *Financial Position of vessel owners* due to no public source for average self-employed income that requiring extra effort and resources to calculate homogenously across MSs.

From a **modelling perspective**, an efficient inclusion of these social indicators in a robust methodological way, will provide the ability to inform more balanced policy decisions. As noted in EWG reports, integrating social data alongside biological and economic factors supports a "holistic management framework" that better reflects the needs and dynamics of fishing communities. Bioeconomic models augmented with social indicators can highlight, for example, if a technically successful management measure (one that rebuilds fish stock and economic outcomes) might fail socially because it undermines fleet renewal or worker safety. This can prompt managers to adjust or accompany measures with social programs. While many social indicators will initially play a monitoring role (tracked as outputs or contextual variables), over time they can inspire the development of new model components (such as labour dynamics or fisher behavior models), an area of active research (e.g. ICES WGSOCIAL is exploring methodologies to incorporate well-being metrics).

In conclusion, each social indicator brings its own set of modelling challenges: some suffer from data poorness, others from lacking direct causal links in models, and some from ambiguous definitions. Nonetheless, each presents an opportunity to add a layer of insight to bioeconomic analysis. The current approach, is to start collecting and standardizing these indicators and to include them in scenario evaluations as additional criteria for success or impact. By doing so, fisheries management can move toward strategies that are not only ecologically and economically sound, but also socially sustainable and resilient. The task moving forward is to refine these indicators and incorporate them in modelling in a meaningful way, ensuring cautious interpretation and understanding of limitations, but leveraging the information they provide to guide policy that benefits both the fish stocks and the communities that depend on them.

6.6 Specification of the Technical Measures Regulation

EWG 25-14 discussed the impact of mixing terminology in Technical Measures Regulation which can impact the implementation and final impact of gears selectivity.

Discussions highlighted the possible impact of cod end length on the selectivity characteristics of the gears. The words net and mesh are not interchangeable, and lack of specification could result in the extension piece acting as a longer cod end impacting the selectivity. There is currently no scientific information available on this, EWG 25-14 suggest further investigation of impact on selectivity.

The cod end is the terminal section of a trawl net, where most size-selective processes occur, therefore most scientific investigations made in the last decades, were focused on single and combined effects of the different technical codend parameters on selectivity (mesh size and configuration, twine material, etc.), (Sala & Lucchetti, 2010; Sala & Lucchetti, 2011; Mytilineou et al., 2018; Petetta et al., 2020).

The current Mediterranean legislation providing technical indications on how codends shall be designed, constructed and connected to the rearmost part of the trawl (extension) is mostly included in the following regulations:

- COUNCIL REGULATION (EC) No 1967/2006 - *ANNEX I* - Technical conditions for attachments to and rigging of trawl nets (Med. Reg., EC, 2006)
- REGULATION (EU) 2019/1241 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL - *ANNEX IX – PART B – Mesh sizes* (EU, 2019)

The second cited regulation (EU, 2019) amended the first one (EC, 2006) even if this still includes some codend technical specifications.

The 2019/1241 for bottom trawls, (or for trawls not directed fishing for sardine and anchovy) states that:

Baseline mesh sizes for towed gear

Mesh Size ⁽¹⁾

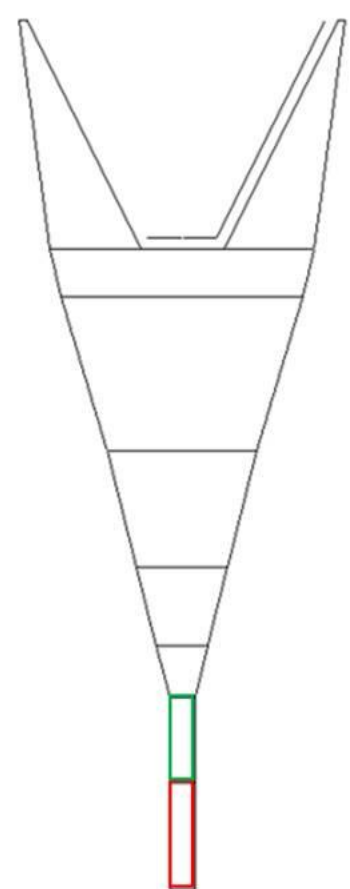
- *At least 40 mm square mesh codend ⁽²⁾*

Conditions

- *A diamond mesh codend of 50 mm² may be used as an alternative to the 40 mm square mesh cod end at the duly justified request of the vessel owner*

This section is in line with (EC, 2006), where admitted codend mesh sizes were only 40 mm square, or 50 mm diamond (Figure 1). The two footnotes ⁽¹⁾ and ⁽²⁾ refers to other conditions that will be discussed in the following section 2.

Figure 6.6.1. Graphical summary of the current Med Codend regulation 2019/1241

	Gear component	Baseline 1	Baseline 2
	Extension piece	At least 40 mm diamond mesh	At least 50 mm diamond mesh
	Codend	40 mm Square mesh	50 mm Diamond mesh

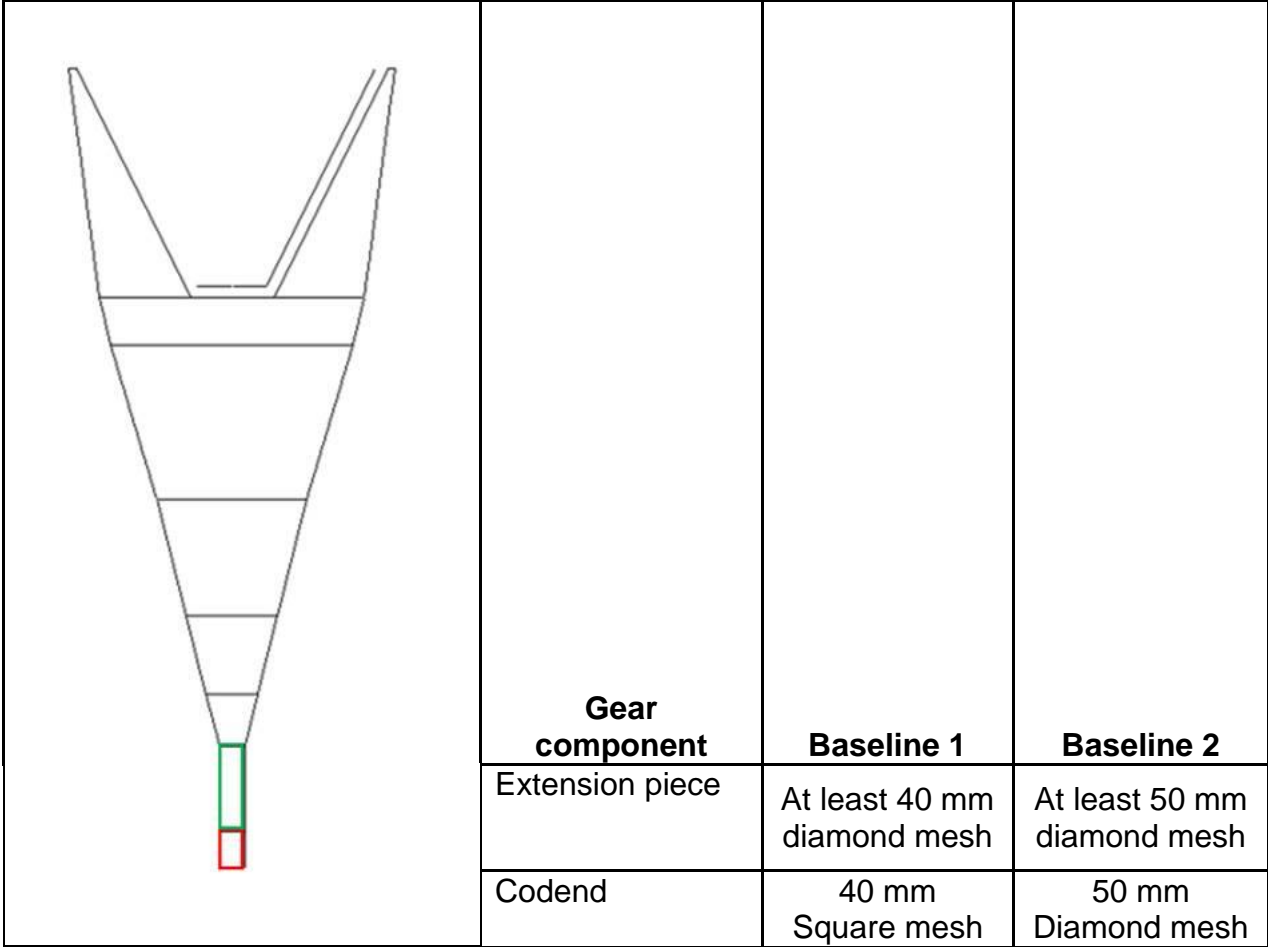
Source: Own elaborations.

When REG. 1967/2006 came into force vessel owners were obliged to take off their old codends and substitute them with one of the two above mentioned options. Baseline 1 (Figure 6.6.1) practically allowed them to continue to use the existing extension piece with at least 40 mm diamond mesh and minimizing distortions on the existing extension piece design. On the other hand, baseline 2 resulted in fishers having to make changes also in the existing extension piece diamond mesh size increasing it to “at least” 50 mm.

In this context, even if the construction of square mesh codends was a completely new practice among fishers and net manufacturers, the lack of any restrictions on the use of any minimum length for the square-mesh codend, drove ship owners to adopt the technical solution of using short 40-mm square-mesh codends in order to outwit the changing of the latter part of the net (extension) (Sala et al., 2013) Figure 6.6.2.

The codend length is a key element, since the use of short square mesh codend (red part of Figure 2) may undermine the intentions of the current legislation. The use 40mm diamond meshes in the rear section of the extension piece can deteriorate selectivity if no minimum length indications are expressed for the square mesh codend.

Figure 6.6.2. Graphical summary of the scenario, with no codend length regulation.



Source: Own elaborations.

Figure 6.6.2 shows how a shorter codend (smaller red rectangle) is still compliant with the current legislation, but in the case of Baseline 1, the contact of the catch with the red portion will be much reduced. The resulting effect could be that mostly the rear section of the extension piece with a mesh size of “at least” (in green) could effectively work as codend. Optimized trawl parameters such as, codend mesh size/configuration, rigging ratios, and overall net geometry together cod end length,

are necessary requirement for the effective management, to achieve a balance between reducing unwanted bycatch and maintaining commercial catch efficiency

EWG 25-14 highlighted requested clarification around the two footnotes reported in the regulation in particular in ANNEX IX – PART B – Mesh sizes (Figure 6.6.3).

Figure 6.6.3 Abstract of relevant regulation.

PART B
Mesh sizes

1. Baseline mesh sizes for towed gear

The following mesh sizes shall apply in the Mediterranean Sea.

Mesh Size ⁽¹⁾	Geographical Areas	Conditions
At least 40 mm square mesh codend ⁽²⁾	Whole area	A diamond mesh codend of 50 mm ² may be used as an alternative to the 40 mm square mesh cod end at the duly justified request of the vessel owner
At least 20 mm	Whole area	Directed fishing for sardine and anchovy

⁽¹⁾ It shall be prohibited to use netting with a twine thickness greater than 3 mm or with multiple twines; or netting with a twine thickness of greater than 6 mm in any part of a bottom trawl.

⁽²⁾ Only one type of net (either 40 mm square mesh or 50 mm diamond mesh) is allowed to be kept on board or deployed.

Source: Own elaborations.

In relation to footnote 1 (Figure 6.6.3):

It shall be prohibited to use netting with a twine thickness greater than 3 mm or with multiple twines; or netting with a twine thickness greater than 6 mm in any part of a bottom trawl.

EWG noted that it was not clear to the reader exactly what the 3 mm or 6 mm referred too. This has previously been noted as a typographical error by DGMARE and will be updated on the new technical measure’s regulation.

In relation to footnote 2:

Only one type of net (either 40 mm square mesh or 50 mm diamond mesh) is allowed to be kept on board or deployed.

EWG noted that considering that Article 8 of Reg EU 2019/1241 (General restrictions on the use of towed gear), point 1 states that “For the purpose of Annexes V to XI, the mesh size of a towed gear as set out in those Annexes shall mean the minimum mesh size of any codend and any extension piece found on board a fishing vessel and attached to, or suitable for attachment to, any towed net” suggests that it may be possible to have mesh size smaller than 40 mm square in other part of net. Considering that Article 8 (General restrictions on the use of towed gear), point 1 stated “For the purpose of Annexes V to XI, **the mesh size of a towed gear as set out in those Annexes shall mean the minimum mesh size of any codend and any extension piece** found on board a fishing vessel and attached to, or suitable for attachment to, any towed net”, it may be possible to assume that the provision in footnote 2 refers to the codend only and/or extension piece (as article 8 stated) and/or is referred to the whole gear. During the EWG DGMARE confirmed that this was being clarified in the draft of the technical measures which is being circulated at the moment.

CONCLUSION

EWG 25-14 successfully advanced the development and application of a multidisciplinary, data-driven framework to assess the biological, economic, and social impacts of the implementation of alternative Technical Measures. The EWG produced two case studies focused on hake mixed-fisheries: the Bay of Biscay and the Western Mediterranean. These case studies build on several years of prior STECF work and are supported by two ad hoc contracts. EWG 25-14 refined the modelling architecture, improved data processing pipelines, and generated short-term scenarios to evaluate how selectivity-based measures may influence fleets and stocks.

The case studies demonstrate that improvements in size-selectivity can produce beneficial outcomes—most consistently in the form of reduced discards, moderate increases in biomass, and small improvements in the status of key stocks. However, the findings also highlight that selectivity changes alone typically produce only marginal biological and economic effects when applied in isolation. Their effectiveness increases substantially when combined with complementary measures such as effort reductions, catch limits, or spatial/temporal adjustments. This confirms earlier STECF conclusions that technical measures can play an important supportive role but should not be viewed as the principal driver of rebuilding in heavily exploited mixed fisheries (STECF 2023 d, STECF 2017).

The economic component of the framework forecasted indicators of Gross Profit, Gross Profit Margin, Gross Value Added, and Break-Even Revenue, which proved robust and reproducible using established AER data and SECFISH methodologies. These indicators provided potential decision support tools as they provide into the short-term operational viability of fleets when implementing new technical measures. In the future this will be expanded to include a financial security indicator (average wage relative to national minimum wage), which offers a more intuitive measure of crew well-being than prior formulations. Incorporating such measures is a step forward in aligning economic modelling with the social reality of fisheries-dependent communities.

The exploration of newly available social data revealed important limitations. Although the dataset marks a significant step toward representing social dynamics, the analyses showed inconsistent reporting when compared with AER, which was not possible to explain or resolve within the time frame of EWG 25-14. As a result, the usability of social variables in quantitative models remains constrained. Moreover, the group reaffirmed that social outcomes such as well-being, identity, generational renewal, and community resilience, cannot be meaningfully captured through quantitative indicators alone. Modelled outputs can only show directional change, making qualitative, context-specific interpretation essential. EWG 25-14 therefore underscores that future assessments should explicitly combine quantitative projections with qualitative social science methods such as interviews, participatory workshops, and place-based impact evaluation.

The gear selectivity studies, reviewed and synthesised for both case studies provided essential parameters for scenario development. Nonetheless, the lack of comprehensive selectivity estimates across all species in the mixed fisheries remains a constraining factor. Additionally, EWG 25-14 noted that the essential values required to model age-varying impacts are not always published in gear selectivity studies; consequently, the work depends on the availability and cooperation of the original authors. However, EWG 25-15 is aware of the ongoing parallel work at ICES The Working Group on Innovative Fishing Gear (WGING)⁷ which will in the future provide a catalogue of gear studies which will support this work.

Overall, EWG 25-14 has delivered a substantial advancement toward an operational biological, social and economic assessment tool for evaluating technical measures. The integration of Mediterranean BEMTOOL outputs into the BioEcon environment represents a significant step forward in harmonising approaches across European sea basins, enabling comparable scenario evaluations. The group has clearly identified the remaining challenges—particularly in social data integration, stock coverage, spatial resolution, and stakeholder involvement—and laid out practical pathways for addressing them. Improving species coverage, standardising methodologies, and integrating new data streams (e.g., RDBES) will be necessary to strengthen the transparency and scientific credibility of future modelling work.

The outputs of EWG 25-14 demonstrate that effective assessment requires multidisciplinary expertise, transparent data workflows, and close engagement with stakeholders. The framework developed here provides a strong foundation for future STECF work, supporting more holistic and evidence-based advice that reflects not only biological sustainability, but also economic viability and social well-being across Europe's diverse fishing communities.

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