ISSN 2467-0715

European Commission

JRC SCIENCE FOR POLICY REPORT

Scientific Technical and Economic Committee for Fisheries (STECF) –

Implementation of the Technical Measures Regulation

(STECF 24-16)

Final report pending publication numbers for webpage release

Moore C, Döring R and Mantopoulou Palouka D. (eds.).

2025

Joint Research Centre

EUR 28359 EN

Contact information
Name: STECF secretariat
Address: Unit D.02 Ocean and Water, Via Enrico Fermi 2749, 21027 Ispra VA, Italy
Email: jrc-stecf-secretariat@ec.europa.eu
Tel.: +39 0332 789343

EU Science Hub
https://joint-research-centre.ec.europa.eu

Luxembourg: Publications Office of the European Union, 2025

How to cite this report: European Commission, Joint Research Centre, *Scientific, Technical and Economic Committee for Fisheries (STECF) – Implementation of the Technical Measures Regulation (STECF 24-16).*

CONTENTS

Authors

STECF advice:

Bastardie, Francois; Borges, Lisa; Casey, John; Daskalov, Georgi; Döring, Ralf; Drouineau, Hilaire; Goti Aralucea, Leyre; Grati, Fabio; Hamon, Katell; Ibaibarriaga, Leire; Jardim, Ernesto; Jung, Armelle; Ligas, Alessandro; Mannini, Alessandro; Martin, Paloma; Moore, Claire; Motova-Surmava, Arina; Nielsen, Rasmus; Nimmegeers, Sofie; Nord, Jenny; Pinto, Cecilia; Prellezo, Raúl; Raid, Tiit; Sabatella, Evelina Carmen; Sampedro, Paz; Somarakis, Stylianos; Stransky, Christoph; Ulrich, Clara; Uriarte, Andres; Valentinsson, Daniel; van Hoof, Luc; Velasco Guevara, Francisco; Vrgoc, Nedo

EWG-24-16 report:

EWG chairs: MOORE, Claire; DÖRING, Ralf

Experts: BITETTO, Isabella; BORGES, Lisa; BROWNE, Daragh; CURTIN, Richard; DE CARLO, Francesco; GAMAZA MÁRQUEZ, Maria; KONRAD, Christoph; KOVSARS, Maksims; LIONTAKIS, An-gelos; MANTZOUNI, Irene; ORIO, Alessandro; RINCÓN HIDALGO, Margarita; SÁNCHEZ-MAROÑO, Sonia; SYS, Klaas; VIVA, Claudio

Abstract

EWG 24-16 was tasked with the development of a bio-economic modelling framework to assess the impact of the implementation of technical measures. The EWG focused on tool preparation (data and code); framework application (two case studies); and framework development to identify additional aspects required to fully operationalise the bioeconomic and social assessment of the impact of technical measures within Western Waters and Mediterranean. This work builds on the body of research conducted in four previous working groups that focused on the review of the technical measure's regulation (EWG 20-02, EWG 21-07, EWG 22-19, EWG 23-15). The previous EWG's (20-02, 21-07, 22-19) developed several tools to translate and apply the finding of gear selectivity studies to the single species stock data to produce selectivity indications which could estimate the likely impact of selectivity measures on stocks. EWG 23-15 focused on the implemen-tation of the technical measures regulation by identifying the tools, steps and routes required to operationalise a bioeconomic (ecological, economic and social) impact assessment of the technical measures.

To assess the impact of the technical measures requires multidisciplinary expertise. This expertise was well represented at EWG 24-16 which was attended by 18 experts (biologist, economist, gear technologist, mathematicians and social scientists), including 1 JRC staff; 1 representative from the Commission; and 10 observers from diverse backgrounds including Advisory Councils.

The Terms of Reference to the EWG were all addressed and an overview of the findings in the report can be summarised as follows:

- EWG 24-16 progressed the development of a decision support tool to assess and visualise the short-term bioeconomic impact assessment of technical measures. It will take another year to fully operationalise the process of providing robust and transparent advice using this tool for short term projections.

- ToR 1 reviewed the outputs of an ad hoc contract to determine suitability of data and code provided for implementation during the EWG 24-16. The material and report provided by the ad hoc were successfully implemented during EWG 24-16

- ToR 2 documented the application of two bioeconomic case studies on hake mixed fisheries using the data and code presented in ToR1. One case study on the Bay of Biscay using the model developed by ICES WGMIXFISH advice. The second case study on EMU2 (GSAs 8, 9, 10, 11) using the model developed by the STECF West MED MAP EWG.

- ToR 3 utilised the experience of experts and observers to determine what scenarios could be tested in these specific studies, and what scenarios would be of relevance to the specific fishery and management challenges in these regions. Once operational, these decision support

tools will provide a platform by which to easily explore trade-offs to a spectrum of different scenarios.

- ToR 4 summarised the remaining steps required to fully operationalise a short-term forecast application over the next year for the two identified case studies; and what is required to operationalise a long-term forecast over the next 2 years.

STECF Report on EWG 24-16 Implementation of the Technical Measures Regulation

Request to STECF

STECF is requested to review the report of the STECF Expert Working Group meeting, evaluate the findings and make any appropriate comments and recommendations.

STECF comments

EWG 24-16 met at JRC in Ispra, Italy, 21-25 October 2024. The meeting was attended by 18 experts with a broad range of expertice (economics, mixed fisheries modelling, gear technologists and social scientists), including three STECF members and one JRC expert. Additionally, five observers from different backgrounds were present. The EWG was hold on a hybrid format to ensure active engagement and collaboration among the diverse skill set of experts.

STECF considers that the EWG adequately addressed the TORs and has the following specific comments on the ToRs addressed by EWG 24-16:

ToR 1 – Review the outputs of ad hoc contract to determine suitability of data and code for use by the EWG.

STECF notes that the EWG has reviewed and approved the objectives of the ad hoc contract, which were to collect, compile, and quality-check the data and code required to assess the biological and economic impact of technical measures implementation on the two case studies outlined in EWG 24-16. The data and code was successfully implemented during the EWG and a summary of the available case study-specific materials and existing information gaps, was provided as an annex in the report.

ToR 2 – Apply the framework identified in EWG 23-15 (STECF 2024a) to two case studies: hake in Bay of Biscay mixed fisheries and hake in the Western Mediterranean mixed fisheries. Each case study will where possible assess in the short term:

> **a. the impacts of increasing the size-selectivity of gears on the species caught in mixed fisheries in terms of catch, effort, fishing mortality and recruitment.**
>
> **b. the likely costs and potential benefits associated with gear changes for fleets on the short-term (1 year forecast).**

STECF notes that the EWG successfully applied the framework proposed by EWG 23-15 to the two case studies. The EWG provided a detailed overview of task distribution, the selected model, biological and fleet data, gear studies, economic and social data, and current and potential future scenarios, to outline the progress made during the EWG.

STECF notes that for hake in the Bay of Biscay mixed fisheries case study, the EWG used the ICES WGMIXFISH model, which employs the FLBEIA R package for a multi-stock and multi-fleet bio-economic evaluation under the MSE approach. For hake in the Western Mediterranean mixed fisheries, the EWG used BEMTOOL, a comprehensive multi-species, multi-gear bio-economic tool applied in the Western Mediterranean MAP. While both approaches support fisheries management, the Bay of Biscay case study started with a simpler, more flexible model that can be easily adapted to specific needs, whereas the Mediterranean case study employed a fully developed tool.

STECF notes that in each case study the BioEcon package identified in EWG 23-15 was adapted as the foundation for developing an interactive decision support tool to assess the potential impacts of technical measures. In case of the Bay of Biscay case study the framework summarizes the modelling approach, data inputs, and methods for simulating biological, fleet, and economic components, while also providing a 'Shiny App' for visualizing results. In case of the Mediterranean case study the model output was fed directly into the BioEcon application to standardize the output eventhough this approach offers less transparency.

STECF notes that the impact of a gear modification in the BioEcon package is evaluated through age-disaggregated catchabilities of the fleets, however, as selectivity information is collected and implemented based on length, its impact should be assessed accordingly.

STECF observes that the EWG reviewed gear selectivity estimates for hake and other key species caught in the Bay of Biscay and Mediterranean mixed fisheries. The EWG concluded that T45 or T90 mesh orientations in Bay of Biscay mixed species trawl fisheries offer the best potential for improved hake selectivity, and that post-escape mortality should be considered when evaluating the effectiveness of technical measures in achieving management goals. For hake in the Mediterranean case study, the scenarios explored during the EWG 24-12, demonstrated an improved selectivity for hake upon increase of the mesh size from 40 mm square mesh size to 45 mm square mesh size.

STECF notes that gear selectivity trials often focus on a single species rather than broader catchability changes in mixed fisheries or take place in areas with low species abundance, limiting their relevance.

STECF notes that the EWG identified the key economic variables needed to parameterise the BioEcon model for assessing the impact of technical measures and concluded that the main economic variables are available in the AER, along with the methodology for deriving them. STECF notes however, that the economic fleet segments in the AER might be too broad to assess gear changes in specific fisheries or areas.

STECF observes that the EWG conducted a thorough review of the social variables collected under the Data Collection Framework, as well as the new social indicators assessed by the latest STECF EWG on social variables (EWG 24-05). The EWG identified several social indicators currently not included in the BioEcon package and evaluated their readiness for use in future Technical Measures EWGs.

STECF notes that a context-specific approach is required to accurately estimate the socioeconomic effects of technical measures, considering factors such as income dependence on fisheries, alternative livelihoods, and the community's cultural ties to the maritime environment. STECF acknowledges the challenges in defining fisheries communities at the fleet segment level and supports the EWG's recommendation for further social analysis and engagement with the EWG 24-05 experts to request more information on the fisheries community profiles. This should include using the fisheries community profiles from EWG 24-05 or integrating economic and stock assessment data with specific ports and communities.

STECF observes that the EWG did not define or test specific scenarios which is a crucial step in ensuring the robustness and reliability of the outcomes. Stakeholder feedback is essential in this process to enhance the validity and applicability of the results.

ToR 3 – Identify meaningful management scenarios that could be produced with these models, and the additional information/data/models that would be required to produce additional scenarios.

STECF observes that the EWG addressed this ToR through a dedicated interdisciplinary discussion with experts from relevant Advisory Councils (ACs) and other observers to identify relevant management scenarios to assess the biological, social and economic impacts of technical measures regulation.

STECF highlights the need for the EWG to assess the impact of technical measures, particularly changes in gear selectivity, by comparing each scenario to its baseline rather than to other scenarios. Furtermore, both experimental and standard gear parameters should be made available to calculate differences in selectivity and to adjust for catchability, enabling the conversionn of length-based differences into age-based selectivity changes.

STECF emphasizes the need for realistic quota assumptions in models like the Bay of Biscay model. The full implementation of the landing obligation assumption often misrepresents fishing dynamics because some fleets do not tend to cease fishing once the first quota is exhausted, overestimating choking effects. Therefore, distinguishing quota- from size-based discards could improve accuracy of the results obtained with this model.

STECF notes that the EWG highlighted that mixed fisheries scenarios should explore a broader range of impacts (e.g. excluding limiting species), rather than aiming for exact predictions.

STECF notes that the selectivity improvements often lead to short-term losses, with potential long-term gains that may benefit society rather than individual fishers. Consequently, the decision to adopt more selective gears depends on how confident fishers are in future gains. Moreover not all vessels will experience the same effects as impacts vary by fleet segment and fishing area. Analysing the socio-economic impacts across different scenarios can help identify when long-term gains are likely to be realized and should also consider distributional differences, providing clearer insights for decision-making.

ToR 4 - 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 that the EWG outlined short-term and long-term steps for operationalizing the application. As a first priority, the continuation of the two case studies will focus on refining short-term projections over the next year before transitioning to the development of a medium- to long-term forecast application over the following two years. Throughout this process, the EWG considered key technical requirements, including establishing a permanent dissemination platform, ensuring BEMTOOL's compatibility with updated R versions, and coding economic data estimation in R. Additionally, efforts should be directed toward converting models to length-based data, integrating social data, extending selectivity analysis to multiple species, and addressing uncertainty.

STECF conclusions

STECF endorses the outcomes of EWG 24-16 presented during STECF PLEN 25-01 and concludes that all ToRs were appropriately addressed.

STECF acknowledges the significant progress made in developing a decision support tool to assess and visualise the short-term bioeconomic impact of technical measures. The EWG successfully integrated the data and tools into the framework proposed by EWG 23-15, and demonstrated its functionality through two case studies.

STECF emphasizes that a user-friendly decision support tool for testing scenarios via a trade-off matrix remains the goal, with accessibility and understandability for both policymakers and stakeholders being key to effective decision-making.

STECF concludes that the next step forward should be to further advance the short term forecast application for the two case studies within the next year before assessing longer-term impacts. A key aspect of this advancement is scenario testing, which is essential for defining clear objectives and ensuring the reliability of outcomes, with stakeholder feedback playing a key role in this process. Additionally, ongoing efforts should focus on establishing a permanent dissemination platform, converting models to length-based data, extending selectivity analysis to multiple species, addressing uncertainty, and integrating social data as part of a work in progress.

STECF concludes that to progress on the integration of the social data, there is a need to further explore the social data beyond the AER framework. More importantly, a thorough understanding of the social indicators is needed by establishing thresholds or identifying value changes. This process is challenging due to the absence of a time series for social data and requires the involvement of social scientists.

Contact details of STECF members

[1] - Information on STECF members' affiliations is displayed for information only. In any case, Members of the STECF shall act independently. In the context of the STECF work, the committee members do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in

relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: [How to get involved - European Commission]

Name	**Affiliation**[1]	Email
Bastardie, Francois	Technical University of Denmark, National Institute of Aquatic Resources (DTU-AQUA), Kemitorvet, 2800 Kgs. Lyngby, Denmark	fba@aqua.dtu.dk
Borges, Lisa	FishFix, Lisbon, Portugal	info@fishfix.eu
Casey, John	Independent consultant	blindlemoncasey@gmail.com
Daskalov, Georgi	Laboratory of Marine Ecology, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences	Georgi.m.daskalov@gmail.com
Döring, Ralf	Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Economic analyses Herwigstrasse 31, D-27572 Bremerhaven, Germany	ralf.doering@thuenen.de
Drouineau, Hilaire	Inrae, France	hilaire.drouineau@inrae.fr
Goti Aralucea, Leyre	Thünen Institute of Sea Fisheries - Research Unit Fisheries Economics, Herwigstrasse 31, D-27572 Bremerhaven, Germany	leyre.goti@thuenen.de
Grati, Fabio	National Research Council (CNR) – Institute for Biological Resources and Marine Biotechnologies (IRBIM), L.go Fiera della Pesca, 2, 60125, Ancona, Italy	fabio.grati@cnr.it
Hamon, Katell	Wageningen Economic Research, The Netherlands	katell.hamon@wur.nl
Ibaibarriaga, Leire	AZTI. Marine Research Unit. Txatxarramendi Ugartea z/g. E-48395 Sukarrieta, Bizkaia. Spain.	libaibarriaga@azti.es

Name	**Affiliation**[1]	Email
Jardim, Ernesto	Independent expert	ernesto.jardim@gmail.com
Jung, Armelle	DRDH, Techonopôle Brest-Iroise, BLP 15 rue Dumont d'Urville, Plouzane, France	armelle.jung@desrequinsetdeshommes.org
Ligas, Alessandro	CIBM Consorzio per il Centro Interuniversitario di Biologia Marina ed Ecologia Applicata "G. Bacci", Viale N. Sauro 4, 57128 Livorno, Italy	ligas@cibm.it; ale.ligas76@gmail.com
Mannini, Alessandro	CNR IRBIM Ancona, Largo Fiera della Pesca, 260125 Ancona ITALY	alessandro.mannini@irbim.cnr.it
Martin, Paloma	CSIC Instituto de Ciencias del Mar Passeig Marítim, 37-49, 08003 Barcelona, Spain	paloma@icm.csic.es
Motova -Surmava, Arina	Sea Fish Industry Authority, 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HS, U.K	arina.motova@seafish.co.uk
Moore, Claire	Marine Institute, Ireland	claire.moore@marine.ie
Nielsen, Rasmus	University of Copenhagen, Section for Environment and Natural Resources, Rolighedsvej 23, 1958 Frederiksberg C, Denmark	rn@ifro.ku.dk
Nimmegeers, Sofie	Flanders research institute for agriculture, fisheries and food, Belgium	Sofie.Nimmegeers@ilvo.vlaanderen.be
Nord, Jenny (chair)	Independent consultant	nordjenny@hotmail.com
Pinto, Cecilia (vice-chair)	Università di Genova, DISTAV - Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, Corso Europa 26, 16132 Genova, Italy	cecilia.pinto@edu.unige.it
Prellezo, Raúl (vice-chair)	AZTI -Unidad de Investigación Marina, Txatxarramendi Ugartea z/g 48395 Sukarrieta (Bizkaia), Spain	rprellezo@azti.es

Name	Affiliation[1]	Email
Raid, Tiit	Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallin, EE-126, Estonia	Tiit.raid@gmail.com
Sabatella, Evelina Carmen	National Research Council (CNR) – Institute for Research on Population and Social Policies (IRPPS), Corso S. Vincenzo Ferreri, 12, 84084 Fisciano, Salerno, Italy	evelina.sabatella@cnr.it
Sampedro, Paz	Spanish Institute of Oceanography, Center of A Coruña, Paseo Alcalde Francisco Vázquez, 10, 15001 A Coruña, Spain	paz.sampedro@ieo.csic.es
Somarakis, Stylianos	Institute of Marine Biological Resources and Inland Waters (IMBRIW), Hellenic Centre of Marine Research (HCMR), Thalassocosmos Gournes, P.O. Box 2214, Heraklion 71003, Crete, Greece	somarak@hcmr.gr
Stransky, Christoph	Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Herwigstrasse 31, D-27572 Bremerhaven, Germany	christoph.stransky@thuenen.de
Ulrich, Clara	IFREMER, France	Clara.Ulrich@ifremer.fr
Uriarte, Andres	Independent expert	auriartes@hotmail.com
Valentinsson, Daniel	Swedish University of Agricultural Sciences (SLU), Department of Aquatic Resources, Turistgatan 5, SE-45330, Lysekil, Sweden	daniel.valentinsson@slu.se
van Hoof, Luc	Wageningen Marine Research Haringkade 1, Ijmuiden, The Netherlands	Luc.vanhoof@wur.nl
Velasco Guevara, Francisco	Spanish Insitute of Oceanography - National Research Council, Spain	francisco.velasco@ieo.csic.es

Name	**Affiliation**[1]	Email
Vrgoc, Nedo	Institute of Oceanography and Fisheries, Split, Setaliste Ivana Mestrovica 63, 21000 Split, Croatia	vrgoc@izor.hr

REPORT TO THE STECF

EXPERT WORKING GROUP ON Implementation of the Technical Measures Regulation (EWG-24-16)

21st – 25th October 2024

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 re-gional conditions. One of the technical measures regulation's main mechanisms involves amend-ments 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 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 sci-ences, 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 re-quire 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).

To further this work, DGMARE proposed establishing EWG 24-16 which focused on the application of a framework to assess the impact of technical measures in two case studies. Case studies were selected based on three criteria:

a) A stock(s) for which technical measures could yield potential gains in terms of yield and protection of juveniles (EWG 22-19, STECF 2022a).

b) The availability of a transparent and reproducible mixed fisheries models currently used to produce advice.

c) The availability of expertise to participate in the EWG.

The two selected case studies are the hake mixed fishery in the Bay of Biscay; and a Mediterra-nean hake mixed fishery in EMU2 (GSAs 9, 10, 11). The framework applied to the two case stud-ies was identified by EWG 23-15 (STECF 2024a) as a suitable candidate IEEFMs to operationalise, explore, and visualise the impacts of operational changes in technical measures. Once operational, this framework could assess the social and bioeconomic implications at the regional level, highlight-ing trade-offs associated with management strategies. However, communicating results from these models can be challenging. Additionally, the inclusion of social data and stakeholder knowledge is crucial to understanding how policy options interact with stakeholder incentives and achieving management objectives.

The STECF EWG 24-16 met during 21–25 October 2024 in Ispra, Italy. The meeting opened at 09:00 on 21 October and was adjourned at 16:00 on 25 October 2024.

1.1 Terms of Reference for EWG-24-16

ToR 1 – Review the outputs of **ad hoc contract** to determine suitability of data and code for use by the EWG.

ToR 2 – Apply the framework identified in EWG 23-15 (STECF 2024a) to two case studies: hake in Bay of Biscay mixed fisheries and hake in the Western Mediterranean mixed fisheries. Each case study will where possible assess in the short term:

a. the impacts of increasing the size-selectivity of gears on the species caught in mixed fish-eries in terms of catch, effort, fishing mortality and recruitment.

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

ToR 3 – Identify **meaningful management scenarios** that could be produced with these models, and the additional information/data/models that would be required to produce additional scenarios.

ToR 4 - Discuss direction of **future work**, additional needs, stakeholder engagement, and advice needs. These discussions will include the development of longer-term forecasts; assess-ments on the impacts of spatial and temporal closures, and inclusion of social data.

The objective of this ad hoc contract was to collate and prepare the data and code required to develop the two proposed case studies to be used by experts attending EWG 24-16.

The ad hoc contract was successfully completed with all available material being collected and sup-plied to EWG 24-16, along with supporting documentation (Annex 1). The EWG used the infor-mation in the report as background information for the work on TOR 2.

3 TOR 2 – APPLY FRAMEWORKS TO CASE STUDIES

The focus of EWG 24-16 was to progress the application of the selected framework to assess the impact of technical measures implementation on two case studies. The case studies were selected based on three criteria:

a) A stock for which technical measures could yield potential gains in terms of yield and protection of juveniles (EWG 22-19, STECF 2022a).

b) The availability of a transparent and reproducible mixed fisheries model currently used to produce advice.

c) The availability of expertise to participate in the EWG.

The two selected case studies are the hake mixed fishery in the Bay of Biscay; and a Mediterra-nean hake mixed fishery in EMU2 (GSAs 9, 10, 11). In each case study the short-term impacts of increasing the size-selectivity of gears were assessed on the species caught in mixed fisheries in terms of catch, effort, fishing mortality and recruitment; and the likely costs and potential benefits associated with gear changes for fleets on the short-term (1 year forecast).

In each case study the BioEcon package (Dolder et al. 2021) identified in EWG 23-15 was adapted as a platform around which to develop a decision support tool to describe the potential impacts of technical measures. The BioEcon R package was originally built to simulate the impact of different Total Allowable Catch (TAC) scenarios on Irish fleets under the landing obligation. The framework and package provide a summary of the modelling approach, final data inputs and the methods for simulating the biological, fleet, and economic components. The framework also provides a ‘Shiny App’ to visualise the results, and as the report builds on the previous reports on data preparation (Moore 2020), model methodology (Dolder 2020) and economic methodology (Muench 2021).

The following sections outline the progress made to apply the framework during EWG 24-16, de-tailing information on:

- **Task distribution:** highlighting the expertise present and required to apply such a framework.

- **Model selected:** description of the selected mixed fisheries model, limitations, and ad-aptations required.

- **Biological and Fleet data:** description of data currently used in the model to account for the stock (age, length, and stock trends), fleet (métier, landings, discards, and ef-fort), and potential future needs.

- **Gear studies:** Summary of available and relevant gear studies, their outcomes and relevant baseline information.

- **Economic data:** description of data currently used, and identification and testing of po-tential additional sources and estimates.
- **Social data:** overview of available sources and future needs.
- **Scenarios:** description of scenarios currently used and those that may need to be de-veloped.

3.1 Bay of Biscay

EWG 24-16 applied the proposed framework to assess the impact of technical measures to the Bay of Biscay (ICES divisions 8.a-b and 8.d) hake mixed fisheries, building on the mixed fisheries model case study already applied by ICES (ICES 2023ab). 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.

3.1.1 Task distribution

As reflected by the multidisciplinary nature of this framework, experts with specific skill sets worked on the development of different sections. All developed code was stored in a private repository for this EWG, with location document here to support future transparent and reproducible development. Full process outlined in Table 3.1.1.1

Table 3.1.1.1 Summary of tasks. Data, code and processes required to for the BioEcon package for the Bay of Biscay, and the location of the final product.

Task	Description	Location
Stock objects	Populate stock object excel sheets	stecf_tech_measures\BOB_2024\bootstrap\data\stock_data_csv
Age data	Get age data from ices.zip, add to bob case study repo and locate where to read in to update code	stecf_tech_measures\BOB_2024\bootstrap\data\age_data_csv
Fleet data	Use WGMIXFISH data to populate template	stecf_tech_measures\BOB_2024\bootstrap\data\logbook_data
Gear studies	Identify any known gear studies on hake in this area	MS Teams
Selectivity forecasting	Code has an error in how it converts length to age but provides a great framework for how we forecast. Explore code and make plan on how to incorporate in app.	stecf_tech_measures\Selectivity_forecasting
Economics	Identify information needed to update econ data	stecf_tech_measures\BOB_2024\bootstrap\data\econ

Social	What do we want/need to display in app	MS Teams
Model Run	Full run through	stecf_tech_measures\BOB_2024
Scenario	Whole case study meet to discuss progress and possible scenarios for testing	stecf_tech_measures\BOB_2024\bootstrap\data\model_input_sheets

Source: Own elaborations.

3.1.2 Model description

Building on the tools and advice products already operational, EWG 24-16 used the mixed fisheries model already applied by ICES as the starting point for this analysis. This mixed fisheries analysis was conducted using FLBEIA (García et al., 2017), as identified in EWG 23-15 (STECF, 2024). FLBEIA is an R package that facilitates the bioeconomic evaluation of management strategies in a multi-stock and multi-fleet scheme under the FLR framework (Kell et al., 2007).

The fleets, metiers and stock modelled were the same as the ones used by ICES to give advice on mixed fisheries considerations for the Bay of Biscay (ICES, 2023ab) and are summarised in Tables: Table 3.1.2.1 and Table 3.1.2.2

Table 3.1.2.1 Stocks incorporated in the analysis for the Bay of Biscay mixed fisheries and the source of information to get the stock status, biological parameters and exploitation levels used to condition the model.

Stocks	Source
BLACK-BELLIED ANGLERFISH - 7, 8.a-b and 8.d	ICES, 2023a
SEA BASS - 8.a-b	ICES, 2023a
HAKE - 3.a, 4, 6, 7 and 8.a-b and 8.d	ICES, 2023a
HORSE MACKEREL - Northeast Atlantic	ICES, 2023c
MACKEREL - Northeast Atlantic and adjacent waters	ICES, 2023c
MEGRIM - 7.b-k and 8.a-b and 8.d	ICES, 2023a
WHITE ANGLERFISH - 7, 8.a-b and 8.d	ICES, 2023a
NORWAY LOBSTER - FU 2324	ICES, 2023a
POLLACK - 8 and 9.a	ICES, 2023a
SMOOTH-HOUND - Northeast Atlantic and adjacent waters	ICES, 2023b
SOLE - 8.a-b	ICES, 2023a
BLUE WHITING - Northeast Atlantic and adjacent waters	ICES, 2023c
WHITING - 8 and 9.a	ICES, 2023a

Source: Own elaborations.

Table 3.1.2.2 Fleets and métiers incorporated in the analysis and their correspondences with the Annual Economic Report (AER) fishing technique categories.

Fleet	Métier	Fishing technique	Vessel size category
ES_GNS_10<24m	GNS_DEF_>=100_0_0	DFN	1024
ES_GNS_10<24m	GNS_DEF_100-119_0_0_all	DFN	1024
ES_GNS_24<40m	GNS_DEF_>=100_0_0	DFN	1024
ES_GTR_10<24m	ES_GTR	DFN	1024
ES_LLS_10<24m	ES_LLS	HOK	1040
ES_LLS_24<40m	ES_LLS	HOK	1040
ES_MIS_all	ES_MIS		
ES_OTB_>=40m	OTB_DEF	DTS	40XX
ES_OTB_>=40m	OTB_MCF_>=70_0_0	DTS	40XX
ES_OTB_>=40m	OTB_MPD	DTS	40XX
ES_OTB_24<40m	OTB_DEF	DTS	2440
ES_OTB_24<40m	OTB_MCF_>=70_0_0	DTS	2440
ES_OTB_24<40m	OTB_MPD	DTS	2440
ES_PTB_24<40m	PTB_DEF	DTS	2440
FR_G___<10m	GNS_DEF_100-119_0_0_all	DFN	0010
FR_G___<10m	GTR_DEF_100-119_0_0_all	DFN	0010
FR_G___<10m	MIS_MIS_0_0_0	DFN	0010
FR_G___10<24m	GNS_DEF_100-119_0_0_all	DFN	1024
FR_G___10<24m	GTR_DEF_100-119_0_0_all	DFN	1024
FR_G___10<24m	MIS_MIS_0_0_0	DFN	1024
FR_G___24<40m	GNS_DEF_100-119_0_0_all	DFN	2440
FR_G___24<40m	GNS_DEF_all_0_0_all	DFN	2440
FR_G___24<40m	MIS_MIS_0_0_0	DFN	2440
FR_LL__<10-24	LHM_DEF	HOK	ALL
FR_LL__<10-24	LLS_DEF	HOK	0024
FR_LL__24<40m	LLS_DEF	HOK	2440
FR_MIS_all	FR_MIS		
FR_OTB_<10m	MIS_MIS_0_0_0	DTS	0010
FR_OTB_<10m	OTB_CRU_>=70_0_0	DTS	0010
FR_OTB_<10m	OTB_DEF_>=70_0_0	DTS	0010
FR_OTB_<10m	OTB_SPF_70-99_0_0_all	DTS	0010
FR_OTB_10<24m	MIS_MIS_0_0_0	DTS	1024
FR_OTB_10<24m	OTB_CRU_>=70_0_0	DTS	1024
FR_OTB_10<24m	OTB_DEF_>=70_0_0	DTS	1024

Fleet	Métier	Fishing technique	Vessel size category
FR_OTB_10<24m	OTT_CRU_>=70_0_0	PTS	1024
FR_OTB_10<24m	OTT_DEF_>=70_0_0	PTS	1024
FR_OTB_24<40m	MIS_MIS_0_0_0	DTS	1024
FR_OTB_24<40m	OTB_DEF_<16_0_0_all	DTS	1024
FR_OTB_24<40m	OTB_DEF_>=70_0_0	DTS	1024
FR_OTB_24<40m	OTT_DEF_>=70_0_0	PTS	2440
FR_OTM_>=40m	MIS_MIS_0_0_0	PTS	40XX
FR_OTM_>=40m	OTM_SPF_32-69_0_0_all	PTS	40XX
FR_OTM_10<24m	MIS_MIS_0_0_0	PTS	0010
FR_OTM_10<24m	OTM_DEF	PTS	0010
FR_OTM_10<24m	OTM_DEF_70-99_0_0_all	PTS	0010
FR_OTM_10<24m	OTM_SPF_16-31_0_0	PTS	0010
FR_OTM_10<24m	OTM_SPF_32-69_0_0_all	PTS	0010
FR_OTM_24<40m	MIS_MIS_0_0_0	PTS	2440
FR_OTM_24<40m	OTM_DEF_32-69_0_0_all	PTS	2440
FR_OTM_24<40m	OTM_DEF_70-99_0_0_all	PTS	2440
FR_OTM_24<40m	OTM_SPF_70-99_0_0_all	PTS	2440
FR_SSC_10<40m	SSC_DEF_70-99_0_0_all	DTS	1040
FR_SSC_10<40m	SSC_DEF_All_0_0_All	DTS	1040

Source: Own elaborations.

Input data was collected from different sources. Information on stock status, biological parameters and global exploitation levels has been provided by the different ICES assessment working groups (ICES, 2023abc). Catches by fleet-métier has been obtained from the Bay of Biscay model developed by the ICES Working Group on Mixed Fisheries (WGMIXFISH) Advice (ICES, 2023d) and catches at age, from the InterCatch database from ICES (https://www.ices.dk/data/data-portals/Pages/InterCatch.aspx). Economic data has been extracted from the latest Annual Economic Report (AER) (https://stecf.ec.europa.eu/data-dissemination/aer_en; STECF 2023a).

A short-term forecast is carried out assuming the same dynamics as in the most recent 3 years of data (2020-2022). Total catches in the projection year (2024) are assumed to be equal to the TACs set for this year. In the current model set up the fleet shares (assumed to be equal to the last 3 year mean), fleet effort is estimated based on the assumption that all fleets comply with the landing obligation (that is, every fleet stops fishing as soon as the first of its stocks' quota share is exhausted).

3.1.3 Fleet data

The fleet data can be broken down into:

1) **Stock data:** Information on stock status, biological information and global exploitation levels have been obtained from the ICES Working Group on Mixed Fisheries (WGMIXFISH) Advice (ICES, 2023d) and an ad-hoc code has been created to fit the input format required to be used in the BioEcon tool (Dolder *et al*. 2021).

2) **Age data:** To assess the impact of a gear modification that modifies a gear's retention curve, the catchabilities of the fleets or métiers have to be conditioned in an age/size structured way. The BioEcon package allows to condition fleets/métiers with age-disaggregated catchabilities based on the available landings and discards at age data by métier from monitoring programs. In the ICES community, such data is submitted and raised through the InterCatch database. For the Bay of Biscay case study, this data has been made available. An R script has been developed to pre-process and standardize this data to fit the required input format of the BioEcon package. As the BioEcon package relies on age-structured dynamics, the InterCatch data of hake, which is submitted by length, has been transformed to age structured data by applying an age-length key. To be able to match the IC métiers with those available in the catch and effort data, the métiers codes were standardized according to the ICES WGMIXFISH Bay of Biscay model.

3) **Fleet data:** Is a combination of declarative data (logbook and sales notes) Logbook data input folder for the BioEcon app requires three different files, each one with different columns:
    a. Logbook_Effort.csv: "YEAR" year, "Q" quarter, "METIER" metier, "VESSEL_LEN" vessel length, "ICES_DIV" ICES area, "DCF_FLEET_SEGMENT","VESSEL_REG_CO" Country, "PROJECT_FLEET" Combination of fleet and vessel length, ,"KWDAYS" Kw/day, "DAYSATSEA" Days at Sea, "NOVESSELS" Number of vessels.
    b. Logbook_Landings.csv: "YEAR" year,"Q" quarter, "METIER" metier, "VESSEL_LEN" vessel length, "PORT_LANDED", "ICES_DIV" ices area, "SPP" species, "DCF_FLEET_SEGMENT", "VESSEL_REG_CO" Country, "PROJECT_FLEET" Combination of fleet and vessel length, "LANDINGS" landings, "VALUE" revenue.
    c. vessel_numbers.csv: "YEAR" year, "bim_fleet" combination of fleet plus length vessel (the same as in PROJECT_FLEET), "vessel_no." Number of vessels, "mean", "median", "max", "min", "total".

The information needed to populate those is available for the ICES WGMIXFISH members. It is mainly based on the landings and effort data submitted by the countries to ICES through a datacall (in this case Spain and France). These data go to the "ICES Accessions database" and are pre-processed during the ICES WGMIXFISH-ADVICE annual meeting, to fix possible errors and to be in accordance with the single stock assessment performed by the different ICES groups.

For the BioEcon app, the data required for the three csv files described above are not exactly in the same format as the one available from the pre-processing described above, for that reason it was necessary to make some modifications to the pre-processing scripts. A summary of data input formats is available in Annex 5.

Modifications were made to preserve the following variables that are not reported in catch_effort_ini.Rdata file (located at bootstrap/data folder in the WGMIXFISH BoB repository for 2023) but remaining data is equivalent.

- Quarter (Q), ICES area (ICES_DIV), KiloWatts days (KWDAYS) and Number of Vessels (NOVESSELS) in Logbook_Effort.csv
- Quarter (Q), ICES area (ICES_DIV) and Landings revenue (VALUE) in Logbook_Landings.csv.
- Number of Vessels (NOVESSELS) in vessel_numbers.csv and fleet identified as the combination of fleet plus length vessel ("bim_fleet")

Currently, "DCF_FLEET_SEGMENT", "PORT_LANDED", "mean", "median", "max", "min", and "total" remain as empty cells.

The script that produces these three files is called “codetocreate_csvs.R” and it is available at “BOB_2024/bootstrap/data/logbook_data/code and files to create the files” in the repository used to run the Bioecon app together with the files created. Economic data (from AER) and crew wages (social data) is also needed.

3.1.4 Gear studies

The Bay of Biscay (ICES Divisions 8 a,b and d) is part of the Southwestern Waters Region and baseline mesh sizes are laid down in Annex VII of the technical measures regulation (TMR) (Regulation (EU) 2019/1241). The TMR defines mesh size as the longest distance between two opposite knots in the same mesh when fully extended. The mesh size of towed gears is defined as the minimum mesh size of the codend and extension piece.

The baseline mesh size for towed gears in 8a, b, c and d is at least 70 mm. Vessels engaged in directed fishery for *Nephrops* in 8a,b,d and e must also use a square mesh panel of at least 100 mm. Smaller mesh sizes (Table 3.1.4.1) are permitted in directed fisheries provided by-catches of hake do not exceed 20 % of the total catch in live weight of all marine biological resources landed after each fishing trip.

The TMR states that “other selectivity modifications may be used provided they have been assessed by STECF upon request of one or more Member States and approved by the Commission. Those selectivity modifications shall result in the same or better selectivity characteristics for hake as that of 70 mm”.

The baseline mesh size for static nets and drift nets is 100 mm but derogations exist for directed fisheries (Table 3.1.4.2)

Table 3.1.4.1 Towed gear mesh sizes for less than the baseline permitted in south western waters with associated areas and conditions.

Mesh Size	Geographical Areas	Conditions
At least 55mm	Whole area excluding ICES division 9a east of longitude 7°23′ 48″ W	Directed fishing for species not subject to catch limits and which are not covered elsewhere in the table Directed fishing for red sea bream Directed fishing for mackerel, horse mackerel and blue whiting with bottom trawls
At least 35mm	Whole area	Directed fishing for wedge sole
At least 55 mm	ICES division 9a west of longitude 7°23′ 48″ W	Directed fishing for crustaceans

Source: Regulation (EU) 2019/1241.

Table 3.1.4.2 Static net and driftnet mesh sizes less than the baseline permitted in south western waters with associated areas and conditions

Mesh Size	Geographical Areas	Conditions
At least 80 mm	Whole area except ICES division 8c and ICES sub-area 9	Directed fishing for sea bass, whiting, turbot, flounder and pollack
At least 60 mm	Whole area	Directed fishing for species not subject to catch limits and which are not covered elsewhere in the table
At least 50 mm	Whole area	Directed fishing for small pelagic species ([1]) which are not covered elsewhere in the table
At least 40 mm	Whole area	Directed fishing for red mullet, shrimps (*Penaeus* spp.), mantis shrimp, wedge sole and wrasse

([1]) A mesh size of less than 40 mm may be used for sardines.

Source: Regulation (EU) 2019/1241.

Description of Bay of Biscay fisheries

Selectivity estimates for gillnet fisheries utilising the baseline mesh size of 100 mm in the Bay of Biscay are not included in STECF 22-19. However, selectivity estimates are available from adjacent areas such as ICES Divisions 9a and 7e-k (Table 3.1.4.3). These estimates suggest that a gillnet fishery using 100 mm mesh size are likely to already be size selective for hake (Table 3.1.4.3).

Since bottom trawls are the most common gear used in the Bay of Biscay and Iberian waters ecoregion (Cuende, 2022a) the remainder of this section will focus on Bay of Biscay bottom trawl fisheries.

Table 3.1.4.3 Gear specifications and gear selectivity curve parameters by stock. SM: square mesh codend; DM: dia-mond mesh codend; SMP: square mesh panel; RFL: raised fishing line; OTB: bottom otter trawls; GNS: Set gillnets; LLS: Set longlines.

Region	Area	Stock	Gear type	Mesh size	Gear Specification	Baseline	Lg 50 (cm)	SRg (cm)	Reference
NEA	SWW	hke.27.3a46-8abd	OTB	55		Y	19.77	12.84	Valeras et al., 2014 (DESCARSEL)
NEA	SWW	hke.27.3a46-8abd	OTB	70	T90	N	22.45	8.26	Valeras et al., 2014 (DESCARSEL)
NEA	SWW	hke.27.3a46-8abd	OTB	55		Y	13.5		Anon., 2022
NEA	SWW	hke.27.3a46-8abd	OTB	70		Y	23.1		Anon., 2022
NEA	SWW	hke.27.3a46-8abd	OTB	80		N	15.68	7.92	Cuende et al., 2022
NEA	SWW	hke.27.3a46-8abd	OTB	60		N	23.49	4.36	Cuende et al., 2022
NEA	NWW	hke.27.3a46-8abd	OTB	110	110mm SMP/9-12m	N	30.6	33.96	BIM, 2009
NEA	NWW	hke.27.3a46-8abd	OTB	120	120mm SMP/9-12m	N	50.07	29.68	BIM, 2009
NEA	NWW	hke.27.3a46-8abd	OTB	100	120mm SMP/6-9m	N	37.4	21.6	BIM, 2009

NEA	NWW	hke.27.3a46-8abd	OTB	90		N	30.68	12.87	BIM, 2010
NEA	NWW	hke.27.3a46-8abd	OTB	90	120mm SMP	N	32.3	17.8	BIM, 2010
NEA	NWW	hke.27.7e-k	OTB	110		N	38.11		BIM, 2010
NEA	NWW	hke.27.7e-k	GNS	94		N	65.9		Anon., 1993
NEA	NWW	hke.27.7e-k	GNS	106		N	74.3		Anon., 1993
NEA	NWW	hke.27.7e-k	GNS	115		N	80.6		Anon., 1993
NEA	NWW	hke.27.7e-k	GNS	126		N	88.3		Anon., 1993
NEA	NWW	hke.27.7e-k	GNS	155		N	108.6		Anon., 1993
NEA	NWW	hke.27.7e-k	GNS	80		Y	56.28±9.3		BIM, 2011
NEA	NWW	hke.27.7e-k	GNS	100		Y	70.36±11.63		BIM, 2011
NEA	NWW	hke.27.7e-k	GNS	120		N	84.43±13.95		BIM, 2011
NEA	NWW	hke.27.7e-k	GNS	140		N	98±16.06		BIM, 2011
NEA	NWW	hke.27.7e-k	GNS	80		Y	54±8.2		Revill et al., 2007
NEA	NWW	hke.27.7e-k	GNS	100		Y	63±7.3		Revill et al., 2007
NEA	NWW	hke.27.7e-k	GNS	120		N	76±8.7		Revill et al., 2007
NEA	NWW	hke.27.7e-k	GNS	140		N	88±10.2		Revill et al., 2007
NEA	SWW	hke.27.8c9a	OTB	55	DM	N	15.9	3	Campos et al., 2003
NEA	SWW	hke.27.8c9a	OTB	60	DM	N	17.4	3.8	Campos et al., 2003
NEA	SWW	hke.27.9a	GNS	70		N	40.1±2.42		Dos Santos et al., 2001
NEA	SWW	hke.27.9a	GNS	80		Y	46.7±2.82		Dos Santos et al., 2001
NEA	SWW	hke.27.9a	GNS	90		N	51.1±3.08		Dos Santos et al., 2001
NEA	SWW	hke.27.9a	LLS		Hook size 10	N	45.6±4.98		Dos Santos et al., 2001
NEA	SWW	hke.27.9a	LLS		Hook size 9	N	45.6±4.71		Dos Santos et al., 2001
NEA	SWW	hke.27.9a	LLS		Hook size 7	N	44.4±4.61		Dos Santos et al., 2001
NEA	SWW	hke.27.9a	LLS		Hook size 5	N	45.3±4.97		Dos Santos et al., 2001

Source: Own elaborations and work done by EWG 22-19 (STECF 2023a).

The following paragraph summarises Bay of Biscay trawl fisheries and is can be found in Cuende et al. (2022). The majority of vessels operating in ICES 8abd are Spanish and French vessels deploying single, pair and twin trawls. Basque vessels make up 60 % of the Spanish trawl fleet operating in the Bay of Biscay. Of the vessels based in the Basque country pair trawlers target mainly hake while single trawlers target hake, megrim and monkfish. Trawlers in the Bay of Biscay typically utilise a mesh size of 70 mm combined with a 100 mm square mesh panel (SMP) (Nikolic et al., 2015; Alzorriz et al., 2016; Vogel et al., 2017; Kopp et al., 2018; Cuende et al., 2020). French vessels also catch hake as a bycatch in a directed Nephrops fishery (Nikolic et al. (2015)) using a codend mesh size of 70 mm and a 100 mm SMP. The *de minimis* request from Spain included in the 2022 south western waters joint recommendations contain the following additional information on métiers in operation in the Bay of Biscay. The *de minimis* justification includes the following Spanish fisheries in the Bay of Biscay (ICES Div. 8abd):

• 'Baka' single trawl (OTB_>70_0_0) in the Bay of Biscay (ICES Div. 8abd)

• Pair bottom trawl (PTB_DEF_>70_0_0) in the Bay of Biscay (ICES Div. 8abd)

Efficacy and selectivity of Bay of Biscay technical measures

When modelling the impacts of geat changes on a fishery it is important to not there is a difference between gear selectivity (ability to catch/exclude a size range), and realised efficncy in fish-ing operations. In 2002 a hake recovery plan was put in place to reduce the high level of hake dis-carding by Nephrops trawlers in the Bay of Biscay. Nikolic et al. (2015) assessed the efficacy of technical measures implemented since 2002 in the French Bay of Biscay Nephrops fishery. Using on-board observer data from 2003-2010 they modelled catches, discards, and landings of Nephrops and hake. During that time a range of gear options were in place including an 80 mm codend mesh size and a 70 mm codend mesh size combined with: a 100 mm dorsal square-mesh panel; a 60 mm ventral square-mesh panel and a flexible Nephrops grid (20 mm bar diameter and 13 mm bar spacing) fitted in the ventral part of the extension. They found the flexible grid was the most effective measure for Nephrops as it decreased discards by over 50 % while also in-creasing landings, though they cautioned that this was based on a relatively small number of ob-served fishing operations. None of the measures were found to effect hake catch or mean length. The 80 mm codend mesh size did not affect the catch of hake or Nephrops. The dorsal and ven-tral square-mesh panels tended to increase hake catch, but the difference was small. The grid was not included in the hake analysis. The authors found that overall, the TM regulations in the French Bay of Biscay Nephrops trawl fishery seem to have been only partly effective in reducing discards. Vogel et al. (2017) tested the effect of a square mesh cylinder (SMC) and a grid, on the escape-ment of undersized Nephrops and hake in the French mixed fishery in the Bay of Biscay. The trial was carried out in 2010 and 2011 using identical twin trawls and the catch comparison method was used to estimate the relative probability of retention in the modified gear compared with the tradi-tional gear. The traditional gear comprised an 80 mm mesh size codend, 70 mm extension piece and a 100 mm SMP located in the tapered section of the trawl. Test gears comprised: a 70 mm square mesh cylinder (SMC) fitted forward of the codend in the extension piece; and an inverted selective grid (13 mm bar spacing) fitted in the dorsal part of the extension. The two test gears reduced Nephrops catches between 15 mm and 45 mm CTL. This finding is similar to that of Ni-kolic et al. (2015) who found that a ventrally mounted grid with 13 mm bar spacing significantly reduced both discards and catches of Nephrops. The grid was more effective than the SMC at let-ting hake < 23 cm escape, with median escapement values and discard reduction equal to 25.0% and 20.6%, respectively. Vessels participating in the Basque mixed bottom trawl fishery in the Bay of Biscay usually use a 70 mm diamond mesh codend combined with a 100 mm SMP inserted in the top (dorsal) panel of the extension piece (Cuende et al., 2022). Alzorriz et al. (2016) assessed the selectivity of this gear combination and found that in practice the SMP was largely ineffective at releasing undersized individuals of hake, pouting and red mullet. This was attributed to a low probability of individuals contacting the SMP. Individuals of these species escaping the codend were found to be significantly lower than their respective minimum conservation reference size.

Kopp et al. (2018) tested a T90 (turned 90°) mesh cylinder in a French Bay of Biscay mixed fish species bottom trawl fishery. They used the covered codend method to estimate the selectivity of a 100 mm T90 mesh cylinder inserted in the extension piece. Compared with diamond mesh of an equivalent mesh size T90 meshes are reported to remain more open, improving selectivity for roundfish species and decreasing selectivity for flatfish (Kopp et al., 2018). In general diamond meshes tend to close during the catching process, reducing their size-selective properties (Herrmann et al., 2007, 2013; Wienbeck et al., 2011; Brinkhof et al., 2022). T90 mesh stabilises mesh openings along the length of the extension piece and codend and multiple studies have doc-umented improved size selectivity for roundfish, such as gadoids and Sebastes spp (Herrmann et al., 2007, 2013; Wienbeck et al., 2011; Bayse et al., 2016; Cheng et al., 2020; Brinkhof et al., 2022). Although hake are not included in the findings of Kopp et al. (2018) the authors report ob-tained selectivity estimates for six other commercial species. The T90 mesh cylinder allows the escape of small Solea solea, Trachurus trachurus and Spondyliosoma cantharus. No commercial losses of Sepia officinalis were recorded. Patterns for Dicentrarchus labrax and Mullus surmuletus require further investigation due to limited fish size ranges in the dataset.

Cuende et al. (2022) assessed the size selectivity of a range of SMP (fitted to the bottom and top of the extension) and codend designs for hake and blue whiting (Micromesistius poutassou) in IC-ES 8a and b with a view to improving size selectivity in the Basque mixed bottom trawl fishery. The effect of multiple gear modifications on the size selectivity and catch patterns of hake and blue whiting was systematically illustrated using treatment trees. Codends with diamond (T0) and square mesh (T45) orientations were tested in combination with a range of SMP configurations fitted in both the dorsal and ventral parts of the extension. The authors concluded that the hake population retained by any design with a square mesh codend (CDS) with measured mesh size of 63 mm would mostly be above MCRS (Table 3.1.4.4). They also tested a codend made of diamond meshes (CDD) with a mesh size of 79.45 mm. They suggest that all mesh bars are under tension in the CDD due to the forces acting on the gear, and that in the case of the CDS tension is present only in the two longitudinal mesh bars which favours mesh shape distortion outwards during an escape attempt. L50 of the CDs was 23.49 cm with an SR of 4.36 cm (Table 3.1.4.5) while with the CDD L50 was 15.68 cm and SR 7.92 cm. In addition, the authors found that SMP position could be a key factor to improve the release of undesired and non-target hake, since positioning the SMP in the bottom (ventral) panel could favour the escape of species that swim closer to the lower panel of the trawl.

Table 3.1.4.4 Selectivity parameters of technical measures tested in Basque Bay of Biscay mixed fishery.

	SMP$_{TS}$	SMP$_{TL}$	SMP$_{BS}$	SMP$_{BL}$	CD$_{D}$	CD$_{S}$
Hake						
L50	37.07 (21.22–37.10)	32.07 (31.04–32.10)	35.03 (0.10–35.09)	31.33 (15.02–34.73)	15.68 (12.47–17.51)	23.49 (22.82–24.46)
SR	0.10 (0.10–7.42)	0.10 (0.10–0.10)	0.10 (0.10–27.08)	6.51 (0.10–19.72)	7.92 (5.07–11.84)	4.36 (3.73–4.92)
C_{SMP}	0.01 (0.00–0.02)	0.02 (0.01–0.03)	0.05 (0.02–1.00)	0.38 (0.27–1.00)	-	-
p-Value	0.972	0.05	0.8735	0.6995	0.4420	0.8543
Dev	59.29	102.44	14.73	23.66	36.57	25.46
DOF	82	81	22	28	36	34
Blue whiting						
L50	27.62 (23.14–34.76)	32.39 (29.81–197.57)	28.97 (0.10–56.51)	0.10 (0.10–1.00)	22.88 (20.76–24.12)	27.06 (26.70–27.44)
SR	8.99 (0.10–15.73)	1.99 (0.10–48.72)	0.10 (0.10–4.60)	27.73 (0.10–40.50)	4.37 (3.60–5.61)	3.32 (2.85–3.84)
C_{SMP}	0.27 (0.21–0.38)	0.45 (0.26–0.66)	0.00 (0.00–1.00)	0.18 (0.01–1.00)	-	-
p-Value	<0.001	0.31	0.9793	0.6226	0.1159	0.3349
Dev	105.10	25.81	4.21	8.99	21.70	19.96
DOF	40	23	12	11	15	18

Selectivity parameters estimated, 95% CIs (in brackets) and fit statistics are shown. Selectivity parameters and fit statistics from trials in Cuende et al. [23, 24] are also shown.

https://doi.org/10.1371/journal.pone.0262602.t001

Source: Cuende et al., 2022.

Valeiras et al. (2021) tested a range of codend mesh sizes in T0 and T90 (turned 0 and 90°) orien-tation in the Spanish mixed bottom trawl fishery in ICES Division 8c (in the Northern Iberian waters adjacent to the Bay of Biscay). T0 is the standard mesh orientation, also known as diamond mesh. The authors report that “T90 is good for releasing small fish. T90 meshes enable the meshes in the cod end to remain more open throughout the full tow. This allows the release of small fish of all species. The actual size released depends entirely on the size of mesh used. In traditional dia-mond mesh cod ends, as the catch increases the meshes close up more and reduce water flow through the cod end, T90 helps to improve the water flow keeping the cod end more stable. this results in less damage to the catch while in the cod end due to reduced movement”.

The selectivity parameter estimates (L50 and SR) resulting from these trials are presented in Table 3.1.4.5. Results indicate increased retention of small hake, horse mackerel and blue whiting in di-amond mesh codends compared with T90 codends of equivalent mesh size. The authors caution that more trials must be carried out to identify the most suitable mesh size and shape and to study the economic loss of commercial fish in order to adapt the regulatory requirements in rela-tion to the landing obligation. The authors provide selectivity estimates for 5 species: hake (HKE), blue whiting (WHB), mackerel (MAC), horse mackerel (HOM) and four spotted megrim (LDB) (Table 3.1.4.5).

Table 3.1.4.5 Selectivity parameters for key species of a range of technical measures in Iberian waters (Ices 8c) (Valeiras et al., 2021).

Species code	Parameter	T0_55	T0_70	T90_70	T0_80	T90_80
HKE	L50	14.11	19.40	20.81	21.78	22.72
	SR	4.67	7.64	4.95	6.56	7.4
	L25	9.44	11.76	15.86	15.22	15.32
	L75	18.78	27.04	25.76	28.34	30.12

WHB	L50	17.37	22.15	22.00	34.08	na
	SR	8.84	10.87	7.18	17.60	na
	L25	8.53	11.28	14.82	16.48	na
	L75	26.20	33.02	29.18	51.68	na
MAC	L50	17.76	19.68	18.22	22.53	18.22
	SR	3.82	6.82	2.18	7.98	2.18
	L25	13.93	12.86	16.04	14.55	16.04
	L75	21.58	26.50	20.40	30.51	20.4
HOM	L50	9.04	21.71	20.31	21.08	20.91
	SR	5.93	8.27	6.47	5.67	9.04
	L25	3.11	13.44	13.84	15.41	11.87
	L75	14.97	29.98	26.78	26.75	29.95
LDB	L50	13.28	16.62	18.42	21.13	22.26
	SR	3.10	5.45	3.82	5.63	5.57
	L25	10.18	11.17	14.60	15.50	16.69
	L75	16.39	22.07	22.24	26.76	27.83

Source: Own elaborations.

Tokaç *et al*. (2018) used the FISHSELECT methodology to predict size selection of hake for a wide range of mesh configurations (mesh size and mesh opening). The FISHSELECT methodology is used to assess morphological conditions for fish to escape through meshes of different size and shape. To test the validity of the FISHSELECT predictions the authors compared them with the results of gear trials from a wide range of locations including the Skaggerak, southern coast of Portugal and the Mediterranean (Table 3.1.4.6). Live hake were collected during the course of the study and the authors report that hake appeared fragile compared with other species caught. The authors conclude that "considering the importance of hake in the European fisheries and the effort invested in describing and improving size selectivity for hake, studies describing escape mortality for hake should be conducted" (Tokac *et al*. 2018).

Table 3.1.4.6 Experimental selectivity results for Hake in diamond and square mesh codends. n denotes number of open meshes in codend circumference. fc, first cruise; sc, second cruise.

Measured mesh (mm)	Mesh orientation	L50 (cm)	SR (cm)	no. of open meshes	Study area (Sea)	References
69.40	Diamond	17	3	106	SW coast of Portugal	Campos and Fonseca (2003)
79.2	Diamond	18.3	4.2	93	SW coast of Portugal	Campos and Fonseca (2003)
55.2	Diamond	15.9	3	109	S coast of Portugal	Campos *et al*. (2003a)
60.3	Diamond	17.4	3.8	100	S coast of Portugal	Campos *et al*. (2003a)
63.5	Diamond	18	4.9	115	S coast of Portugal	Campos *et al*. (2003a)

Measured mesh (mm)	Mesh orientation	L50 (cm)	SR (cm)	no. of open meshes	Study area (Sea)	References
69.4	Diamond	20.2	3.9	106	SW coast of Portugal	Campos *et al*. (2003b)
79.2	Diamond	18.8	4.4	93	SW coast of Portugal	Campos *et al*. (2003b)
40.3	Diamond	10.1	3.1	230	Catalan Sea	Bahamon *et al*. (2006)
49.44	Diamond	11.4	4.1	400	Eastern Aegean Sea	Tosunoğlu *et al*. (2008)
92.5	Diamond	22.31	10.89	92	Skagerrak and Kattegat	Frandsen *et al*. (2009)
42.42	Diamond	11.59	4.07	300	Aegean Sea	Tokaç *et al*. (2010)
44.7	Diamond	10.4	3.1	400	Aegean Sea	Aydın and Tosunoğlu (2010)
42.2	Diamond	10.5	3.77	300	Aegean Sea	Özbilgin *et al*. (2012)
48.6	Diamond	12.81	3.67	275	Aegean Sea	Özbilgin *et al*. (2012)
75.8	Diamond	20.29	8.4	240	Bay of Biscay	Alzorriz *et al*. (2016)
42.8	Diamond	7.6	4.01	310	Adriatic Sea	Lucchetti (2008)
45.2	Diamond	8.03^{fc}	3.80^{fc}	280	Adriatic Sea	Sala and Lucchetti (2010)
45.2	Diamond	9.12^{sc}	4.72^{sc}	280	Adriatic Sea	Sala and Lucchetti (2010)
46.35	Diamond	10.84^{fc}	7.15^{fc}	326	Adriatic Sea	Sala and Lucchetti (2010)
46.35	Diamond	9.37^{sc}	5.33^{sc}	326	Adriatic Sea	Sala and Lucchetti (2010)
46.5	Diamond	11.45	5.62	280	Adriatic Sea	Sala and Lucchetti (2011)
46.5	Diamond	10.43	5.87	326	Adriatic Sea	Sala and Lucchetti (2011)
56.75	Diamond	16.25	7.56	240	Adriatic Sea	Sala and Lucchetti (2011)
56.1	Diamond	11.99	7.94	280	Adriatic Sea	Sala and Lucchetti (2011)
63.3	Square	25	5.6	64^{*}	SW coast of Portugal	Campos *et al*. (2003b)
42.8	Square	12.98	3.65	310	Adriatic Sea	Lucchetti (2008)
43.25	Square	11.97^{fc}	6.11^{fc}	70	Adriatic Sea	Sala and Lucchetti (2010)
43.25	Square	15.70^{sc}	8.68^{sc}	70	Adriatic Sea	Sala and Lucchetti (2010)

Measured mesh (mm)	Mesh orientation	L50 (cm)	SR (cm)	no. of open meshes	Study area (Sea)	References
41.7	Square	15.2	5.89	75/150^{SMP}	Aegean Sea	Tokaç *et al*. (2010)
42.4	Square	14.4	4.8	200^{*}	Aegean Sea	Aydın and Tosunoğlu (2010)
42.9	Square	15.22	4.66	150^{*}	Aegean Sea	Özbilgin *et al*. (2012)

Source: Own elaborations.

Conclusion

Various authors have reported on the ineffectiveness, in terms of reducing unwanted catches of hake,of the baseline diamond mesh codend (70 mm) and dorsal square mesh panel (100 mm) used in Bay of Biscay mixed species trawl fisheries. The most promising technical measures, in terms of improved hake selectivity, i.e. increased L50 compared with the baseline mesh size, test-ed in the Bay of Biscay or neighbouring waters comprise codends with either square (T45) or T90 mesh orientations. Both of these mesh orientations are considered to remain more open than T0 or diamond mesh codends during trawling. Suuronen (2005) suggested that mesh shape may play a more important role than mesh size in reducing the mortality of fish that escape through meshes and that many fish escape through open square meshes more easily, and apparently with less injury, than through conventional diamond meshes. The issue of post escape mortality, sometimes termed unaccounted mortality, is important to consider when assessing whether technical measures have potential to achieve management measures. This point is reinforced by Tokac et al. (2018) who concluded that the mortality of hake escaping selective gears should be better un-derstood.

The 63 mm square mesh codend tested by Cuende at al. 2022 was estimated to have an L50 of 23.49 cm with an SR of 4.36 cm for hake, these values increased when combined with ventral square mesh panel configurations (Table 3.1.4.4). In mixed fisheries it is important to consider the effect of technical measures on the range of species caught. Valeiras et al. (2021) tested a range of T0 and T90 codend mesh sizes and estimated selectivity parameters for 6 species including hake albeit in waters adjacent to the Bay of Biscay. The T90 80 mm codend tested had an L50 and SR of 22.72 cm and 7.4 cm respectively for hake.

3.1.5 Economic data

EWG 24-16 explored the utility of AER data to parameterise the model and app for the Bay of Bis-cay case study. The ICES fisheries overview for the Bay of Biscay and Iberian Waters (ICES 2023a) states that “The countries with the largest landings and effort in the ecoregion are Spain, Portugal, and France, with minor landings from Ireland, Belgium, and UK.” However, the Bay of Biscay case study only includes ICES division 8abd, and excluds 8c and 9 Iberian waters. There-fore, Portugal is not included in this assessment.

EWG 24-16 focused on populating the file structure currently used in the BioEcon app, which is five files (BioEcon_Data_V5_030621.csv, Econ_RawDataAnon_Effort_120521.csv, Econ_RawDataAnon_Effort_181220.csv, SalesNotesPrices.csv, and Port_list.csv). Three of the files (BioEcon_Data_V5_030621.csv, Econ_RawDataAnon_Effort_120521.csv and Econ_RawDataAnon_Effort_181220.csv) are all full economic survey files describing all economic variables collected under the DCF with effort data and additional fleet segmentation. EWG 24-16 found that for the purposes of assessing the impact of technical measures, these files contained more information than is currently required. EWG 24-16 proposes to reduce the number of varia-bles required in files to the following key economic variables:

Fuel costs (FuC): all costs related to powering fishing vessels including diesel, petrol, electricity and oils.

Variable costs (VaC): all costs related to fishing activity and effort including provisions, bait, ice, harbour dues etc.

Fixed costs (FxC): all costs that are fixed and not related to fishing effort such as annual memberships, insurance, adminitsartion etc.

Capital costs (CaC): all costs related to the financing and/or depreciation of the vessel including interest payments and capital repayments

Repair and maintenance costs (RmC): all costs related to the repair and maintenance of the vessel.

Crew costs (CrC): all costs related to the wages and salaries of the crew

Total investments (annual)(tot_Invest): the total value of investments carried out on the vessel in the current year

Total value of physical capital (totDepRep): The total current value of the vessel accounting for depreciation

The format costs in BioEcon model (script format_cost.R) require the following variables:

EnergyCost = totEnergyCost/kWSeaDays,

RepairCost = totRepairs/kWSeaDays,

Crewwages= totCrewWage/totLandgInc,

otherVar= (totVarOtherVariable + totVarProvisions+totVarIce+totVarfilters + totVarBait + totVarDues)/kWSeaDays,

FixedCost= (totNoVarOtherFixed + totNoVarLegalFees+ totNoVarAccountancy + totNoVarInsurance)

OpCostCap=(totNoVarLoanInterest+totDepCost)*r) %>%

EWG 24-16 concludes that the main economic variables required are available in the AER and are outlined in the following Table 3.1.5.1.

Table 3.1.5.1 Economic variables required are available in the AER

Variable	Summary	Available in AER
totEnergyCost	Total energy costs	Yes
totRepairs	Total repair and maintenance costs	Not available however totrepcosts available
totCrewWage	Total crew wages and salaries	Yes
totVarOtherVariable	All other unspecified variable costs	Not available however the sum of variable costs is available - totvarcost
totVarProvisions	Total cost of food provisions	Not available however the sum of variable costs is available - totvarcost
totVarIce	Total cost of ice	Not available however the sum of variable costs is available - totvarcost
totVarfilters	Total cost of oil filters	Not available however the sum of variable costs is available - totvarcost
totVarBait	Total cost of fish bait	Not available however the sum of variable costs is available - totvarcost
totVarDues	Total cost of harbour dues	Not available however the sum of variable costs is available - totvarcost
totNoVarLoanInterest	Total loan and interest repayments	Not available however is included within variable totDepCost
totDepCost	Total depreciation cost	Yes
totLandgInc	Total income from fish landings	Yes
totOtherInc	Total income from all other sources	Yes
plus kWSeaDays [var=14]	Effort data in terms of days at sea and engine power of vessel	Yes

AER data was found to be suitable for the purposes of parametrising the BioEcon model. A summary of how these variables were extracted from the AER data is detailed below, along with notes on the work that needs to be completed:

- May need to assess if FRA, ESP needs to be split between Med and Atl. This can be achieved by splitting the AER capacity, effort and economic data by supra region
- Effort variables may be required from FDI files; this link can be made with fishing technique variable which is now available in both data sets.
- Effort required for Bay of Biscay had to be disaggregate. AER has effort data (days at sea, fishing days, GT days at sea, kw days at sea, GT fishing days, kw fishing days) by sub_reg (ICES divisions).
- AER data compiled at fleet segment level (not individual vessel level) by supra region (NAO, MBS etc) so for selected fleet segments the average vessel cost structure could be utilised by dividing segment totals by number of vessels in segment.
- Supra region fleet segment will need to be disaggregated to Bay of Biscay
- Variable costs will be calculated by kw days at sea or kw fishing days, or by GT days at sea or GT fishing days.
- Fixed costs will be calculated by most appropriate to assess in terms of number of ves-sels fishing in area however data.

- This disaggregation can be done after the work on matching FDI with AER data is com-plete so currently create file of relevant NAO fleet segments with capacity, effort and economic variables.
- The following data variables have been extracted from the AER 'FS table' for countries Belgium, Ireland, France and Spain within supra region AREA 27 (NAO) and all fishing technologies except for inactive fleet segments;
-
    - **Variable_name** **variable_code**
    - Number of vessels totves
    - Engaged crew totjob
    - FTE national totnatfte
    - Total vessel power totkw
    - Days at sea totseadays
    - Fishing days totfishdays
    - kW days at sea kwseadays
    - kW fishing days totkwfishdays
    - Gross value of landings totlandginc
    - Other income tototherinc
    - Energy costs totenercost
    - Other non-variable costs totnovarcost
    - Other variable costs totvarcost
    - Personnel costs totcrewwage
    - Repair & maintenance costs totrepcost
    - Unpaid labour unpaidemp
    - Value of physical capital totdeprep
    - Value of unpaid labour totunpaidlab
    - Consumption of fixed capital totdepcost

Segment level file uploaded onto SharePoint 'BioEcon_Data_BoB_PreDisAgg.xls'. Utilise FS_effort by sub-region from AER file to disaggregate Bay of Biscay fleet from NAO fleets. Effort data (Days at sea, Fishing days, GT days at sea, GT fishing days, kW days at sea, kW fishing days) extracted for all segments for four EU MS (BEL, IRL, ESP, FRA) for all available years (2013-2022) for all supra regions and subregions. Extract all data for fleet segments in NAO. Make table (A) of fleet segment-year with 6 effort variables in columns for all NAO effort applied in all subregions for all years: For NAO fleet segments there are 101 fleet segments, Table (A) created for all fleet segments-years (including no data) = 1010 fleet segment-years. Make table (B) of fleet segment-year with 6 effort variables in columns for all NAO effort applied in divisions 8abd for all years. For NAO fleet segments there are 74 fleet segments. Table (B) created for all fleet segments-years (including no data) = 740 fleet segment-years. Tables merged and proportion of effort ap-plied in Bay of Biscay calculated by dividing Table B by Table A. Overall proportion of effort of se-lected fleet segments-years in NAO region applied in Bay of Biscay outlined in Table 3.1.5.1.

Table 3.1.5.2 Share of total effort of Irish, French, Belgian and Spanish fleet segments applied in divisions 8abd of total effort applied in NAO.

Share of NAO effort in 8abd					
totseadays	totfishdays	kwseadays	totkwfishdays	gtseadays	totgtfishdays
24%	17%	25%	27%	26%	27%

Source: 'FS effort by subregion' table within STECF 24-07 – EU Fleet Eco-nomic and Transversal data_fleet segment.xls.

When comparing effort variables from 'FS_effort' by sub region with the effort in 'FS data' shows some differences. Some fleet segment names differ slightly e.g. ESP NAO HOK2440 LLD in effort file while ESP NAO HOK2440 LLD * in economic file. 33 fleet segment names had this issue which requires resolution to compare data. 5 fleet segments had no effort data in NAO – these were all Irish and in the VL0010 length class. Summary of analysis of the two sources of effort within the AER file show the values and proportional coverage can be found in **Error! Reference source not found.**, where both sources of effort data within the AER economic file are compared and show that there are significant differences between the two. Totfishdays has the most consistency of the four effort variables.

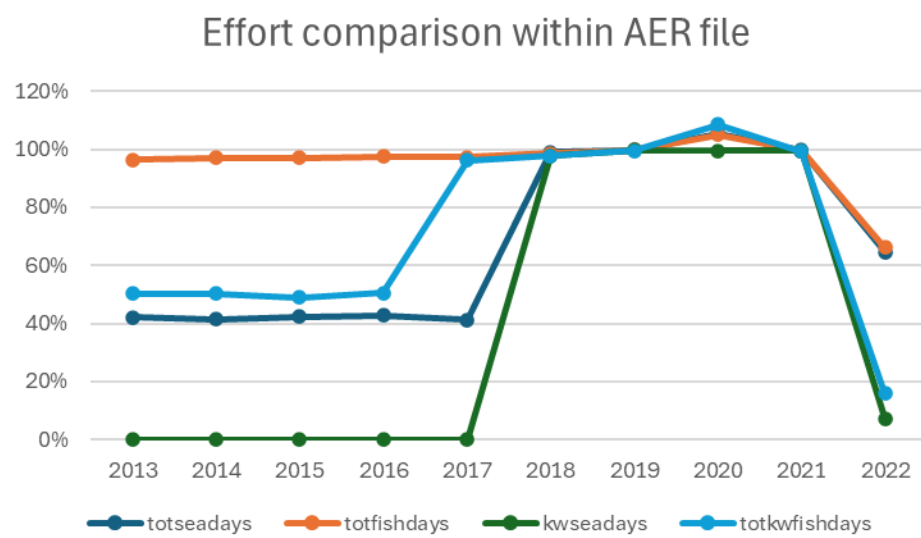
Table 3.1.5.3 Comparison of effort data variables from tables 'FS data' and 'FS_effort by sub-region' within AER eco-nomic file.

Effort Source	totseadays	totfishdays	kwseadays	totkwfishdays
FS data	10,695,390	10,283,326	737,267,997	1,509,326,208
FS_effort by sub-region	7,132,673	9,834,062	609,333,054	1,082,275,030
Share of effort by sub-region by FS data	67%	96%	83%	72%

Source: 'FS data' table and 'FS effort by subregion' table within STECF 24-07 – EU Fleet Eco-nomic and Transversal data_fleet segment.xls.

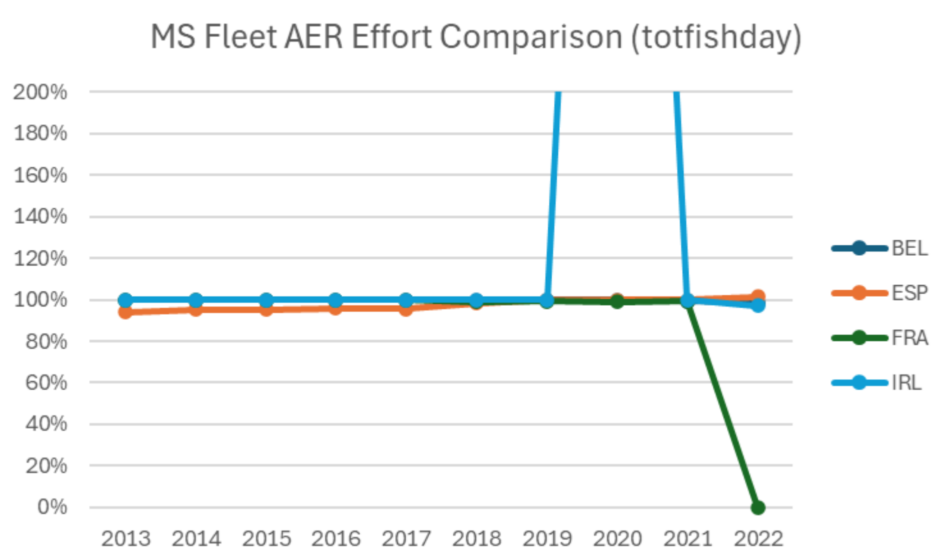
Trends over the 10-year period are as follows. In **Error! Reference source not found.** it is clear that most of the inconsistencies between both sources are for earlier years in the time series (2013-2017). For the years 2018-2021 the data sources are relatively consistent however for the year 2022 there is a significant decline again. This decline in 2022 is due to no effort data by sub-region for the French fleet. The increase in 2020 is due to significant differences for the Irish fleet in that year.

Figure 3.1.1 : comparison of effort data variables from tables ‘FS data’ and ‘FS_effort by sub-region’ within AER economic file by year for the selected fleets



Source: ‘FS data’ table and ‘FS effort by sub-region’ table within STECF 24-07 – EU Fleet Economic and Transversal data_fleet segment.xls.

Figure 3.1.2 comparison of effort data variables from tables ‘FS data’ and ‘FS_effort by sub-region’ within AER eco-nomic file by year for the selected fleets.



Source: ‘FS data’ table and ‘FS effort by sub-region’ table within STECF 24-07 – EU Fleet Economic and Transversal data_fleet segment.xls.

To parameterise and run model we only need the three most recent years of data (2020-2022). It would be required to align fleet names with those used in WGMIXFISH Bay of Biscay case study model. These fleets must be matched to the DCF segments in the economic files. Of 9 Spanish fleet segments listed in WGMIXFISH, 5 could be matched to DCF segment while 4 could not (ES_GNS_24<40m, ES_GTR_10<24m, ES_MIS_all and ES_PTB_24<40m). Of 13 French fleet seg-ments listed in WG MIXFISH, 10 could be matched with DCF segments while 3 could not (FR_MIS_all, FR_OTM_24<40m and FR_SSC_10<40m).

It would also be required to create an economic data file for fleet segments in the NAO region, all divisions, by average vessel ('BioEcon_Data_NAO.csv'), and an economic data file for fleet seg-ments in the Bay of Biscay, by average vessel, using effort Kwseadays to parse BoB fleet. 2022 effort data by subregion is not available for France so the share of effort in 2021 will be used for France for 2022 ('BioEcon_Data_BoB.csv'). Economic files will need to be tested to assess how they are functioning and if additional coding is required.

The species price file could be made from AER data. Table 'FS_landings FAO 2018-2022' contains data on landings by fleet segments with additional variables describing fishing technology, sub re-gions etc. To keep format of current price file in model 'SalesNotesPrices' the following variables are included in the current file; Species, SpeciesCode, Year, Division, Gear, Price. In Table 'FS_landings FAO 2018-2022' there is a variable for 'Gear' however this does not contain much data so 'fishing_tech' (DFN, DTS, PMP etc.) will have to be used as a proxy.

Clearly there will be differences in average price different MS fleets have for certain species how-ever as a first step all fishing_tech will be merged here so that they have the same price across MS. Further work can disaggregate this to the MS fleet level. Prices for all species caught in the Bay of Biscay subareas 8abd included. Additional price file created to account for species not caught in this are but may contribute to fleet income.

EWG 24-16 identified a number of potential socioeconomic indicators that could be considered in the model, with varying levels of availability:

a) **Days at sea & fishing trip:** this index is immediately available and describes quality of life based on time away from home (STECF, 2024b)

b) **Vessel age:** this index is immediately available and describes work safety (STECF 2024b)

c) **Labour productivity:** calculated as GVA/FTE, this index is immediately available and describes quality of life

d) **FTE per job:** this index is immediately available and describes un-der/overemployment)

e) **Asset/investment/repair and maintenance cost per vessel:** this index is im-mediately available and describes safety on board.

f) **Unpaid labour/total labour:** this index is immediately available and describes family business and an index of direct payments explicit costs / cash costs saving strategy (i.e. resilience/family independence)

g) **Hours worked per day:** Available through AER data call, this index is a social indicator for quality of life and time away from home.

h) **Number of fishing trips:** Available through AER data call, this index ratio of days at sea per fishing trip and is a social indicator for quality of life and time away from home.

Additionally, there are a number of social variables (available for reference years 2017, 2020 and soon available (early 2025) for reference year 2023). For example' ratio of high age class to low age class as an index of generational renewal: (employment at age class "<=14" + "15-24")/(employment at age class >=65) and gender ratio.

3.1.6 Social data

Integrating social data into bioeconomic assessments and models is increasingly recognized as es-sential for effective and sustainable fisheries management. Traditionally, fisheries assessments have relied heavily on biological and economic data to inform decision-making. However, incorpo-rating social dimensions—such as community dependence on fishing, employment, cultural values, and local knowledge—enables a more comprehensive understanding of how fisheries impact hu-man communities and vice versa. This approach aligns with the recommendations of the Interna-tional Council for the Exploration of the Sea (ICES) and the Scientific, Technical, and Economic Committee for Fisheries (STECF), both of which have advocated for more holistic, multi-dimensional frameworks in fisheries assessments.

Some ICES Working Groups, including the Working Group on Social Indicators (WGSOCIAL), have focused on developing robust social indicators to measure aspects like fisher well-being and the resilience of fishing communities, aiming to better capture human impacts and dependencies on marine ecosystems (ICES, 2021; ICES, 2023e). Likewise, the STECF has underscored the im-portance of social data in its bioeconomic modelling and policy recommendations to the European Commission, particularly emphasizing that social data can guide the socio-economic sustainability of European fisheries in a way that complements environmental and economic goals (STECF, 2020; STECF, 2022b).

Therefore, integrating social data into bioeconomic models offers a pathway to management strategies that reflect the values, needs, and dynamics of coastal communities. By capturing the socio-economic realities and cultural contexts of fisheries, policymakers can design more adapta-ble, equitable, and socially resilient fisheries management systems, leading to outcomes that bene-fit both marine ecosystems and the human communities reliant on them.

The STECF EWG 24-05, held in May 2024, focused on refining the collection, analysis, and integra-tion of social data within EU fisheries, aiming to advance social sustainability in line with the EU's Common Fisheries Policy (CFP). This group continued work to enhance methodologies around social indicators in fisheries, specifically looking at National Fisheries Profiles and Community Profiles. These efforts are intended to inform a broader understanding of the socioeconomic impacts within fishing communities, including metrics on labour conditions, community well-being, and economic resilience. By operationalizing these social indicators, the EWG provides a structured approach for integrating social dimensions alongside biological and economic factors in fisheries management, supporting a holistic management framework.

EWG 24-16 focused on updating the socio-economic data structures built into the bassline BioEcon package for both case studies; the Bay of Biscay (BoB) and the Mediterranean. However, EWG 24-16 have identified a number of social indicators which are not currently part of the BioEcon package which should be considered in the future. These indicators were based on the findings of EWG 24-05 (STECF 2024b) and are summarized in Table 3.1.6.1, along with a summary of their status and weather these indicators are ready to be used by future Technical Measures EWG's. This information is dependant on the availability of National Fisheries Profiles (NFPs), which are useful for centralised knowledge.

Table 3.1.6.1 Key quantitative social indicators proposed by EWG 24-05.

Social Indicators – Category	Indicator	Status
Social and Financial Status	Financial status	Available in DCF: Income, personal costs + national averages - Average wage of crew/average national income or - DCF variable net profit (€/year) / No. vessel owners and compare with average annual income of self-employed workers
	No. fishers under SER*/working under written contract	TBC by MS / fishing fleet
	No. fishers working for a cooperative under agreement	Do not exist at EU level, TBC by MS and fleets
	No. contracts with social security and working conditions specification	Do not exist at EU level, TBC by MS
	No. fisheries with contracts though employment agencies	Yes. Per nationality and fleet
	No. fishers in trade unions	Per fleet, Trade unions
	Nº fishers with no social security	Per fleet, social security agencies.
Working conditions	Work safety - Age of vessels - No. fatalities and injuries reported - Minimum required crew/vessel - Medical certificates - Mandatory training Well-being - Time away from home (days at sea/nºtrips) - Financial security (average wage vs national minimum wage)	Yes. Are these confidential data? France has the data by vessel type
	% of sea allocated to other uses (aquaculture, OWFs) / priority areas for fishing	ICES areas / MSP platforms at national level
	Level of professionalisation (nº years working as fisher)	No. Expansion of the social data call
Nº of people entering the fishing industry	- No. of people enrolled and recent graduates - No. of new entrants in the vessel register - No. of participants in decommissioning schemes - Entrants no longer in the vessel register	Yes, by most MS

Source: (STECF 2024b).

Other social data sources, recommended to be taken into account by the EWG 24-05 were the ICES WG SOCIAL, EU Project SEAWISE which is looking at dependency of fishing communities (using port of landing as a proxy) and NOAA work on indicators to assess environmental justice: https://www.fisheries.noaa.gov/national/socioeconomics/social-indicators-coastal-communities

Also, it should be noted that some social indicators could be built from the economic dimension (map of interdependencies) – WG ECON + Economic data available

Possible pathways forward

Based on a review of EWG 24-05 findings, EWG 24-16 identified a number of possible steps which could be taken to progress the integration of social indicators into the BioEcon model for the BoB:

- Both ES and FR have data to produce both **time away from home** and **financial security** (average wage vs national minimum wage) indicators, which in when combined could capture part of the socio-economic conditions of fishers ensuring their safety and well-being. EWG 24-05 suggested that these indicators data is available under existing EU data calls, however, being available does not mean to be ready for use, as noted by the group: "as next step to liaise with RCGECON to discuss how to move forward and to make sure each indicator is discussed in their context (differences by MS)". Additional indicators such working conditions category related to well-being can be approximated from *"Time away from home"*, which can be directly calculated from days at sea and number of trips is available. However, these indicators don't capture land based activities on land (baiting, repairs, etc.), which can be significant depending on the fleet, gear, and fishing zone, these activities can be significant. Furthermore, applying only the quantitative indicator implies assuming that "time away from home" is negative, which is not necessarily true and could only be confirmed with the qualitative data. Taken the above into account, great caution is needed regarding the explanatory capacity of the social indicators to be used.

- ICES WGSOCIAL develops social metrics that gauge community dependency on fisheries, socio-economic well-being, and cultural resilience. These indicators overlap with those used by STECF, which tracks similar metrics in its social and economic data reports on EU fisheries, such as those produced by EWG 24-05. Aligning these frameworks, which has been partly addressed by the work of EWG 24-05, could contribute to the development of a more standardized set of indicators that may prove useful across the EU, potentially enhancing comparability and offering better insights into regional and national fishery impacts.

- It would be possible to estimate social indicators identified **Error! Reference source not found.** by country and fleet segment using available economic data. Some of the social indicators could be extrapolated from economic indicators. For example, financial position could be estimated by Member States using data on income, personnel costs, and national averages. However, to achieve this, it would be helpful to establish a connection between data sources by fleet segment such as ongoing work at FDI EWG 23-05 (STECF 2023c), WKMIXFLEET (ICES 2024a) and WGMIXFISH-Methods (ICES 2023h). For instance, data already exists to calculate two key indicators: time away from home (days at sea) and crew wages, which could be used to assess financial security.

- Defining fisheries community and fisheries community profiles for the BoB is likely needed in order to clarify the available data. This is due to social data by fleet segment have many caveats and limitations on their own (i.e., economic differences between communities and ports might not seem evident by fleet segment); To do this, we could look at the profiles already chosen by EWG 24-05 (Figure 3.1 of the STECF 24-05 report below) as baseline or use the economic/stock assessment data available by country and fleets to relate to the ports and potential communities. However, this is not a straightforward process, and it is likely to require for social methods and approaches to analyse the operationalization of the fisheries community's concept and data availability at the proper aggregation level. To move forward on this, EWG 24-16 suggests getting in touch with EWG 24-05 chairs/experts to explain what the EWG 24-16 is trying to do, propose the BoB case study as pilot and request more information on the fisheries community profiles and National Fisheries Profiles (NFPs) for the BoB area to help understand particularities of fleet segmentation at MS level, to allow comparisons between MS. (Figure 3.1.6.1).

Figure 3.1.3 Locations of the fisheries communities identified by EWG24-05 in the Bay of Biscay (red circle) extract-ed from figure 3.1.

Source: (STECF, 2024).

- In line with the discussions held during the open EWG 24-16 plenary meetings with the observers, social and economic data to be used (in the BioEcon app or any other model) should/could benefit from further discussions with the relevant actors related to the data such as fleets representatives, advisory councils etc. These meetings would show progress and ask relevant questions such as: Does the data makes sense to them? Is that data relevant? Is there other data they might be interested in? In this regard, linking the ICES Human Dimension initiatives (e.g., the Stakeholder Engagement Strategy (ICES, 2023f) and WKParticipatory Modelling (under review) with the STECF's economic and social data efforts could be a strategic way to align fisheries science with socio-economic resilience and sustainability goals. For instance, ICES initiatives like the WKParticipatory Modelling emphasize stakeholder engagement, advocating for inclusive decision-making that incorporates the voices of fishers, local communities, and other stakeholders. This work supports STECF's efforts to interpret socio-economic data with a deeper understanding of community-specific needs and perspectives. By integrating participatory insights from ICES, STECF reports can reflect a more holistic socio-economic picture, potentially adapting policies that align better with on-the-ground realities.

With the above in mind, at this stage, integrating social indicators into the current exercise may present challenges, caveats, and limitations that should be carefully considered. Following previous recommendations, it is important to address these issues to ensure a more accurate interpretation of the socioeconomic conditions affecting fishing communities in the BoB.

3.1.7 Scenarios

To achieve the objective of applying this selected framework to assess the biological, economic and social impact of the implementation of technical measures will require the availability of multi-ple scenarios testing the possible range of impacts based on alternative technical measures and information available in gear studies.

EWG 24-16 did not define any specific scenarios for the Bay of Biscay case study. Work focused on the identification of data, and where possible the inclusion of this data in the BioEcon model. Future EWGs will need to define, test and apply scenarios.

3.1.8 App format

In order to present the simulation results in a user-friendly visual way the BioEcon application will need to be updated to describe the case study specific outcomes. The complete BioEcon app for-mat is outlined in Annex 5, but? this format does not account for the information required for the Bay of Biscay case study. The following text developed by EWG 24-16 will be used to adapt the baseline BioEcon package for the Bay of Biscay case study.

Introduction (Tab 1)

The overview tab provides a summary of the motivation for the work, the selected case study and the format and utility of the work. This tab provides an overview of the case study and what is house in the app. EWG 24-16 did not define any scenarios so only the baseline WGMIXFISH scenar-ios are currently available. Proposed text for inclusion is detailed below:

"Every year TACs are set for hundreds of fish stocks exploited by European Union fishing fleets. TACs, which are divided into Member States fishing quotas, are agreed through political process mostly annually. As a complement to the TAC regulations additional technical regulations are currently in force in order to protect the stocks. Moreover, EU Regulation 2019/1241 provides a possibility for the Commission to define additional technical measures that aid at meeting the objectives of the CFP.

Fisheries in the Bay of Biscay target a large range of species with different gears. The trawl fisheries use otter, beam and pelagic trawls. Otter trawl is the main gear used in demersal fisheries in this ecoregion, representing 52% of the landings. The species caught depends on the area and the range of depths fished, as well as on the cod-end mesh size. The main species caught in otter trawl fisheries are hake, anglerfish, megrim, Norway lobster, sole, horse mackerel, macke-rel, blue whiting, seabass, pollack, red mullet and cephalopods (cuttlefish and squid). Set net fisheries, which accounts for 27% of the catches in this ecoregion, target sole, hake, pollack, seabass, anglerfishes and crustacean species, while the longline fishery (13% of the landings) targets mainly hake. The fisheries are mainly carried out by French and Spanish vessels, but vessels from Ireland, UK and Belgium also participate in the fishery.

Here, the possible bioeconomic impact of changes in technical measures, by assuming a full compliance of the landing obligation (i.e. discard ban) can be viewed. The analysis specifically covers the economic impact on the French and Spanish demersal fleets operating in the Bay of Biscay and to the various segments within (see Fishery structure tab for further details). Given the diversity of fish stocks exploited by the fleets, different segments of the fleet can be affected to different degrees. Impacts here can also be viewed according to location within France and Spain, at the regional level, as different regions have distinct fishing vessel composition. Scenari-os on alternative technical measures are also described here."

Historical data - regional overview (Tab 2)

The regional overview tab would be populated by FDI data, with locations selected based on the communities and ports selected as most relevant to the mixed fishery identified in the case study. Providing regional summary for users to identify where they fit within the context of the case study

Historical data - fishery structure (Tab 3)

The fishery structure is defined by the fleets used in the WGMIXFISH model and the fishing technique in the AER. Another form of visualisation for diverse end users to identify the counties, fleets and gears they are interested in.

Bioeconomic model (Tab 4– 6)

This tab will provide a summary overview of all the bioeconomic modelling conducted, with all outcomes described in terms of fleets (Tab 6), fisher behaviour (Tab 7), and single species stock trends and potential mixed fisheries technical interactions and chokes (Tab 8).

Socio-Economic impact (Tab 7)

This tab will provide a summary of economic data by country, port and fleet segment (as it is already in the BioEcon app): number of jobs (employment), average crew wages (if we have this data along with average national income, we could also estimate the financial position). In future additional variable could be added, such as age of vessels and demographics such as average crew age and gender.

Social indicators by country, port and fleet segment should be included as outline by EWG 24-05 (STECF 2024b) as they are ready to use. For example, time away from home (days at sea/fishing trip) or financial security (crew average wage vs national minimum wage). Both indicators capture the socio-economic conditions of fishers ensuring their safety and well-being. However, work would have to be done on how these variables link to FDI, AER and WGMXIFISH data. For further description (limitations and challenges) of the social indicators outlined in EWG 24-05 (STECF 2024b).

Glossary (Tab 8)

This essential feature of the app provides a centralised location for all reference material, allowing users to access descriptions and supporting material quickly, therefore increase the usability of the app for diverse users.

3.1.9 Merging multi-disciplinary data sources

To support the data hungry needs of an integrated ecological and economic model a consistent link between established economic (AER), Attempts to link FDI and AER data have been made before with good results. During the EWG 24-16 meeting, the availability of raw AER and FDI data made it possible to try a different approach to linkage. It is known that, according to the FDI guidelines, the principal sub-region for each vessel is the one in which the majority of its fishing activity takes place during the year. This means that if a vessel is active in more than one sub-region, all of its effort is attributed to the sub-region in which it's most active (Table G). In order to extract the initial sub-region where the fishing activity took place, it was decided to use the FDI spatial effort Table I, as it provides information on the latitude and longitude of the activity.

This approach has been tested for the Bay of Biscay data for the corresponding sub-regions: 27.8.A, 27.8.B, 27.8.C, 27.8.D. It is likely that we will need to indicate here why we include 8.c (perhaps stock distribution).

The data provided through the FDI data call have been quality checked against the output of the STECF EWG 23-10 reference table of the allowed list of c-squares and ICES rectangles for each specified sub-region. The checks showed that only a few Member States reported effort data with incorrect coordinates for the Bay of Biscay and these were excluded from the analysis (less than 0.01% of rows).

The comparison of the effort data (fishing days) provided in the two data calls shows that there are no major differences between the two data calls, except for the data from Portugal for the years 2013-2016, when on average only about 65% of the effort in the FDI was allocated to the Bay of Biscay area. Meanwhile, the comparison between the total effort and the spatial effort re-ported in the FDI data showed that for some countries (ESP, NLD, PRT) the spatial effort in the Bay of Biscay was higher or lower than the total effort. This shows that Member States strictly follow the FDI guidelines and allocate vessel activity to the one sub-region where most fishing takes place. The comparison of landings did not reveal any major differences between the data provided in two tables of the FDI data call and the AER (difference around 0.5%).

For this approach, it was decided to test it for one year and to select only one Member State. Data were selected for France and for the year 2022. The expenditure variables by fleet from the AER data were compared with the effort specifically spent in the Bay of Biscay in order to divide the values proportionally. This makes it possible, after merging the data with FDI, to distribute the expenditure values proportionally between different areas, etc. The same exercise was carried out on the income variables in the AER data in order to obtain the proportion of fish landed in the Bay of Biscay compared with the total landings of each fleet segment.

After merging the income and expenditure data with the landing and effort data, the proportion of successful matches was calculated. On average, more than 99% of the expenditure data were successfully matched, except for one particular fleet segment where only 87% of the effort was matched. For the income data, on average around 98% of the weight and value of landings were matched after merging, except for a few specific fleets where the match was around 60%. These differences represent 0.6% of the weight of landings and 0.3% of the value of landings.

This approach showed the good result of merging the FDI and AER data. Potential differences need to be treated separately, taking into account the specificities of each fleet segment. Further inves-tigation is needed by including all Member States involved in fishing activities in the Bay of Biscay, which could reveal further difficulties and discrepancies in the data.

The R script used, the reference table for matching c-squares and ICES rectangles, and the result-ing Excel tables are available on the JRC workspace for EWG 24-16.

3.2 Mediterranean

EWG 24-16 applied the proposed framework to assess the impact of technical measures to the Western Mediterranean MAP in area EMU2 (GSAs 9, 10, 11), which is modelled using BEMTOOL, covering 19 demersal fleet segments. This mixed fishery targets a large range of demersal spe-cies using active and passive gears. The following sections detail the application of the proposed framework, achievements and outstanding work.

3.2.1 Task distribution

As reflected by the multidisciplinary nature of this framework, experts with specific skill sets worked on the development of different sections. All developed code was stored in a private re-pository for this EWG, with location document here to support future transparent and reproducible development. Full process outlined in Table 3.2.1.1.

Table 3.2.1.1 Summary of data, code and processes required to BioEcon package for the EMU 2, with location of final product.

Task	Description	Location
Fleet data	Use West MED map data (EWG 23-11, STECF 2023b)	stecf_tech_measures\ MED_2024
Gear studies	Identify any known gear studies on hake in this area	MS Teams
Economics	Use West MED map data (EWG 23-11, STECF 2023b)	stecf_tech_measures\MED_2024
Social	What do we want/need to display in app	MS Teams
Model Run	Full run through overnight	stecf_tech_measures\MED_2024
Scenario	Whole case study meet to discuss progress and possible scenarios for testing	stecf_tech_measures\MED_2024

Source: Own elaborations.

3.2.2 Model description

BEMTOOL (Rossetto et al. 2015, Russo, Bitetto et al., 2017) is a comprehensive multi-species, mul-ti-gear bioeconomic simulation model designed for Mediterranean fisheries. The model was identi-fied in the framework of EWG 23-15 and is routinely applied in the Western Mediterranean MAP EWG since 2019. Consolidating various bioeconomic models and biological modelling tools devel-oped until 2013, it comprises six operational modules: Biological, Impact, Economic, Behavioural, Policy, and Multi-Criteria Decision Analysis (MCDA). Operating on a fine time scale (month) and adopting a multi-fleet approach, the model simulates diverse management trajectories' effects on both stocks and fisheries. It considers length/age-specific selection effects, discards, economic and social performances, compliance with landing obligations, and reference points. The model includes a decision module enabling stakeholders to weigh indicators and rank management strate-gies. It can simulate scenarios involving changes in selectivity, fishing effort, fishing mortality, and Total Allowable Catch (TAC). The default output includes a range of biological, pressure, and eco-nomic indicators. Uncertainty is addressed through a Monte Carlo paradigm in line with Manage-ment Strategy Evaluation framework.

The BEMTOOL model utilised in Western Mediterranean MAP EWGs covers EMU2 (GSAs 9, 10, 11), modelling 19 demersal fleet segments, using both active and passive demersal gears that rely on, and influence, some or all the stocks included in the MAP. Six fleets are allocated to GSA9, five to GSA11 and eight fleets to GSA10, overall 12 fleets are trawlers and 7 fleets use passive gears.

3.2.3 Fleet data

The model include 7 stocks:

- European hake in GSAs 9, 10 and 11 (HKE);
- Red mullet in GSA9 (MUT9);
- Red mullet in GSA10 (MUT10);
- Deep-water rose shrimp in GSAs 9, 10 and 11 (DPS);
- Giant red shrimp in GSAs 9, 10 and 11 (ARS);
- Norway lobster in GSA9 (NEP9);
- Blue and red shrimp GSA9, 10 and 11 (ARA).

The data used for the simulations were extracted from FDI data, the outcomes of EWG 24-10 (stock objects), and the socio-economic data obtained at the GSA level through an ad hoc request to the Italian Ministry from EWG 24-12.

Assessed fishing mortality, spawning stock biomass and the observed catches were compared with the simulated ones where possible, as made also in the previous EWGs.

The results of the stock assessment for the 7 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 24-10, where present.

The model provides a number of biological, pressure and socio-economic indicators; among them, the most relevant follow:

<u>Biological</u>: SSB, total biomass, mean length in the exploited population.

<u>Pressure</u>: catch (landing, discard), F, mean length in catches (landing and discard) by fleet seg-ment.

<u>Social</u>: FTE, employment, wages.

<u>Economic</u>: Gross Value Added, Gross Profit, Gross Profit Margin, Revenues.

3.2.4 Social and economic data

Historically bioeconomic models are more focused on economic than social variables. Even though some of the utilised economic variables have also a social dimension (e.g. employment, Gross val-ue added), it is widely acknowledged that the exploitation of the social effect of technical measures using bioeconomic models is lagging behind, as those models do not yet utilize “pure” social indicators. Furthermore, apart from their usage in bioeconomic models, the development, exploitation, collection and analysis of social indicators are also necessary for the evaluation of the social dimension of the Common Fisheries Policies and of the social sustainability of the fisheries sector.

A first attempt to incorporate social variables in the Data Collection Framework, materialized with the inclusion of social pilot studies in the Data Collection Framework few years ago, which are now part of the regular Data Collection Framework (see Table 3.2.4.1). EWG 19-03 (STECF 2019) ana-lysed these variables per MS for the reference year 2017. Following Commission Implementing Decision (EU) 2016/1251, these social variables should be collected in a triennial basis. Consequent-ly, they are also available by MSs for the reference year 2020, while in the early 2025, the next AER data call will include these social variables for the reference year 2023.

Table 3.2.4.1 Social Variables for fishing and aquaculture sectors

Variable	Unit
Employment by gender	Number
FTE by gender	Number
Unpaid labour by gender	Number
Employment by age	Number
Employment by education level	Number per education level
Employment by nationality	Number from EU, EEA and Non-EU/EEA
Employment by employment status	Number
FTE National	Number

Source: Table 6 of Commission Implementing Decision (EU) 2016/1251.

These variables can shed light to important societal issues, such as the unpaid labour, the gender dimension, the education of the crew members, the share of different nationalities in the crew etc. However, they provide, by nature, demographic information on the employees and owners of fish-ing enterprises. Therefore, the need for additional social data collection has been flagged by many stakeholder groups, and lately have been informed by the policy priorities identified by the DG-MARE in 2023 and a stakeholder consultation developed in 2024. Based on the outcomes of these consultations, the top 5 priorities areas identified are:

- Current socio-economic situation of fishers
- Dependency
- Generation renewal - Number of fishers that have “dropped” or discontinued the family business
- Generation renewal - Attractiveness of the profession for the younger generation
- Assessment of management measures: Impact of EU conservation measures on fishing communities in terms of employment, working conditions and potential for social conflict

Given the above, new social indicators data collection has been examined by the last STECF EWG dedicated to the social variables (STECF 2024b). The EWG examines a list of 38 indicators, but based on the easiness of collection, it ends up to a list of 12 indicators identified as “forthcoming” (See Table 3.2.4.2).

Table 3.2.4.2 The full list of social indicators, the 12 social indicators that seem “ready to start with” following STECF EWG 24-05 and the 9 “potential” indicators according to RCG ECON ISSG on social variables.

Category	Indicator	EWG 24-05	RCG ECON ISSG
Social and Financial Status	Financial position	□	
	Nº fishers in trade unions	□	
	Social status in society/quantitative		□
	Social status in society/qualitative		□
	Nºfishers under SER*/working under written contract		
	Nºfishers working for a cooperative under agreement		
	Nº contracts with social security & working conditions specification		
	Nº fisheries with contracts though employment agencies		
	Nº fishers with no social security		
Working conditions – Work Safety	Minimum required crew/vessel	□	
	Mandatory training	□	
	Age of vessels		□
	nº fatalities and injuries reported		
	medical certificates		
Working conditions-Well Being	Time away from home (days at sea)	□	
	Time away from home (nºtrips)	□	
	Material well-being/Financial security (average vs national min. wage)	□	
	Deprivation Index (Quantitative): Proxy for security and access to services, reflecting broader socio-economic conditions.		
Assessment of Management Measures	% of sea allocated to other uses (aquaculture, OWFs)/priority areas fishing	□	
	Additional income to support fishing continuity		□
	Impact on social resilience.		
	Institutional change		
	Legitimacy		
Generational status	nº years working as fisher	□	
	Nº of people enrolled & recent graduates of mandatory safety ining	□	
	Nº of people enrolled & recent graduates of fisheries vocational ining	□	
	Nº of new entrants in the vessel register	□	
	Nº of participants in decommissioning schemes		□
	Entrants no longer in the vessel register		□
	Reduced potential for recruitment of fishers		□
	Number of new entrants in fishing insurance schemes		□
	Entrants no longer in in fishing insurance schemes		□

Source: STECF EWG 24-05.

Finally, EWG 24-05 suggested as a next step to liaise with RCGECON to discuss how to move for-ward, and to make sure each indicator is discussed in their context (differences by MS). Indeed, the social indicators identified in the EWG 24-05 were presented in the RCG ECON 2024 meeting (RCG ECON, 2024), focusing again on the indicators with data sources that can be used or easily gathered (the "forthcoming" indicators).

Following Recommendation 3 of the RCG ECON 2024, an Intersessional Subgroup (ISSG) on social aspects should be established, especially to discuss social indicators and determine the practical issues regarding data collection, availability, and the timeline for adjusting the National Work Plans (NWPs) accordingly. This meeting (ISSG Meeting: Exploring options for data collection for new so-cial variables, report pending), took place on 18-19 September 2024. The group divided the indica-tors to the three following clusters:

- "Forthcoming" indicators, which are considered ready for immediate pilot testing. The variables in this cluster are part of a larger set of 38 indicators. According to EWG 24-05, these are considered relatively easy for Member States (MSs) to develop, collect, and report in future data calls. The relative ease of implementation stems from the fact that data for most of these indicators is already being collected or can be accessed without significant additional effort from the MSs.
- "Potential" indicators, which hold significant promise but require further refinement.
- "Other" indicators, which were reviewed for future consideration.

The decision for the implementation of the pilot studies (or "test studies" following the WP template) has been already taken by MSs (deadline for the submission of the National Work Plans was on October 16th, 2024). Due to the strict timeline for the incorporation of a pilot study for addition-al social data collection, the ISSG circulated a conceptual note to the National Correspondents (NCs) to inform them on the social indicators discussed providing description of the social indicator, methodological challenge and challenges for data collection, potential data sources and potential level of disaggregation. The test studies template is provided in the Table below (Table).

Table 3.2.4.3 Template for the incorporation of various pilot/test studies, including studies for additional social data collection, under the National Work Plan.

General comment: This text box fulfils Chapter II, section 1.2 of the EU MAP Delegated Decision annex.
Name of the national test study: 2XXXXX *For national studies, specify the aim of the test study and whether it fulfils national needs, regional needs, and/or particular end-user needs, i.e. who will be using its outcomes. In the methodology, summarise risks and mitigation measures. Also describe how the study aims to inform future data collection activities.* 1. Aim of the test study 2. Duration of the test study 3. Methodology and expected outcomes of the test study *(max 900 words per study)*

Source: National Work Plan Template, based on Commission Implementing Decision (EU) 2022/39 of 12 January 2022.

The objective of test studies will be to test the definitions and data collection itself, resulting in best practices and advice to improve data collection. The WPs have been already pre-screened and will be evaluated during the EWG 24-15 (STECF, 2024b). After National WPs approval, the MSs that are planning to perform an additional social data collection as well as the specificities of these studies (e.g. specific social indicators planning to be collected and time framework will be re-vealed).

Inclusion of social (or socioeconomic) indicators in the WestMED bioeconomic models (fo-cus on BEMTOOL)

The EWG 24-16 examined the current state of play regarding the social variables, identified in the previous section. For the majority of the variables, the EWG 24-16 identifies difficulties and in-compatibilities to be included in the bioeconomic models, in their present structure. The reason is that there are no clear links on how these social indicators are affected by the implementation of technical measures (e.g., the number of fishers in trade unions, cannot directly related with the implementation of technical measures in the WestMED). Therefore, the EWG 24-16 divided social indicators in the following groups, considering also the existing state of play of the bioeconomic models (mainly BEMTOOL):

A. Social Indicators derived by EWG 24-05 and can be used “immediately”

B. Social Indicators not-derived from EWG24-05 and can be used “immediately”

C. Social Indicators stemming from the utilization of variables in the AER Data Call (available but not “immediately”)

A. Social Indicators derived by EWG 24-05 and can be used “immediately”

This group consists of the two following indicators:

a. **days at sea / fishing days**

This indicator measures the amount of time fishers spend away from home, which directly impacts their personal lives, family relationships, and overall well-being. It is quantified by calculating the total days at sea undertaken by fishers annually. This indicator helps policymakers and stakehold-ers to evaluate the social sustainability of fishing practices and to develop strategies that support the well-being of fishers and their communities.

A major challenge regarding the utilization of this variable stems from the variability across differ-ent fisheries and regions. Different fleet segments and MSs may have varying practices for re-cording days at sea and trip numbers. In Small-Scale Fisheries (SSF), trips are often shorter and more frequent. Moreover, well-being is a subjective experience, and while time away from home is a quantifiable factor, its impact may vary depending on the individual fisher's personal and fami-ly circumstances.

Days at sea is an indicator that already collected under DCF up to segment level per GSA and it is available in the FDI, allowing for analysis across different fleets, gears, and regions. The variable is utilized by all bioeconomic models, and therefore the EWG 24-16 decides to consider also the social dimension of this variable in the discussion of the bioeconomic model outcomes for the WestMED.

b. **Vessel age (work safety)**

This variable, measured in years, is described by the EWG 24-05 as an indicator in the working condition – safety group of indicators. Indeed, the presence of aged vessels with outdated equip-ment is a common structural characteristic especially for the SSF sector around the MED. In a bio-economic model, the inclusion of vessel age could potentially identify significant changes in the age distribution of vessels, due to the structural changes in the fleet segmentation and distribution of fleet segments after the implementation of a technical measure.

The are two sources of data for this indicator. The EU Fleet Register5 that provide information per vessel for the whole European fleet (including age of vessel and port of registration) and the FDI database that provide the average age of vessels per segment and GSA.

Even though this indicator is already available, EWG 24-16 decided not to utilize it, because a clear link on how it is affected by the implementation of technical measures is needed (to be integrated in the bioeconomic models).

<u>B. Social Indicators not-derived from EWG24-05 and can be used “immediately”</u>

This group consists of the two following indicators:

a. **Labour productivity (GVA/FTE)**

Labour productivity is defined as the output per unit of labour and is estimated as the ratio of GVA (measure of output) by full-time equivalent (FTE) employment (unit of labour input). An increase in labour productivity indicates that a unit of input labour is producing more output or that the same amount of output is being produced with fewer units of labour. Labour productivity can be used as a measure of economic growth, competitiveness, and living standards within a sector.

Labour productivity may also provide an indicator of fishers’ wellbeing or living standards, assum-ing that increases in productivity are matched by wage increases, a rational assumption consider-ing also the prevailing of crew shares in the WestMED area. In this sense, this indicator has a sig-nificant social dimension that is important to be considered in bioeconomic models for the West-MED area.

Considering also that the data for the estimation of this variable is already available, the EWG 24-16 decided to utilize directly this indicator in the BEMTOOL application.

b. **FTE per job (index for under/overemployment)**

This indicator can be utilized to reveal the degree of underemployment (ratio below one) or over-employment (ratio above one) of fishers among segments. This indicator has significant social di-mension and therefore its inclusion in bioeconomic models could be beneficial to reveal changes due to technical measures in the WestMED area. The level of this ratio may reflect how much time fishers spend at work versus how much time they have for family, rest, and social activities (Work-Life Balance). Underemployment may mean more free time but possibly insufficient income (Social Stability), while overemployment can lead to long working hours, stress, and exhaustion, affecting social relationships and personal well-being (Job Satisfaction). A shift towards underem-ployment could lead to a gradual loss of these traditions, as younger generations may choose oth-er occupations or move to urban areas in search of more stable work.

The data for the estimation of this indicator are already available per GSA and segment; the indicator could be potentially included in the bioeconomic models, under some assumptions on how the management measures impact on employment (e.g. stable number of employees) and FTE (e.g. linearly dependent on the fishing days). For this reason, the EWG 24-16 decided to include this indicator in the bioeconomic models after agreeing relevant assumptions, potentially for the next EWG on technical measures implementation.

c. **Unpaid labour/total labour: an index for family business and an index of direct payments explicit costs / cash costs saving strategy (resilience? /"family independence"?)**

The ratio between family and non-family labour in fisheries has both economic and social dimensions. While the economic dimension could be tied with cash costs saving strategy, the social dimension is also significant. More specifically, this indicator could be related with the identity of the family-run enterprise, that tend to have close, informal decision-making structures, often based on trust and personal relationships. This ratio can be also indicating rate of succession and legacy. In many family enterprises, labour relations aren't just economic transactions; they're tied to is-sues of succession, inheritance, and legacy. More non-family labour might indicate a shift away from a family-run operation, raising concerns about continuity across generations.

Even though the data are already available per GSA and segment, the EWG 24-05 decided not to continue with a direct inclusion of this indicator in the bioeconomic models, as this would require altering the existing assumption of the models (e.g. the unpaid labour are not considered). The potential adjustment of the assumptions will be considered for the next year's EWG.

<u>C. Social Indicators stemming from the utilization of variables in the AER Data Call (available but not "immediately")</u>

These variables are already collected and reported by the MSs at the AER data calls. However, they are not utilized in the AER report, and therefore they are not publicly available. Some of these variables could be proven significant for the identification of socially important challenges caused by the implementation of technical measures in the WestMED.

a. **Hours worked per day** (social indicator for quality of life / time away from home)

b. **Number of fishing trips** (ratio of days at sea per fishing trip as quality-of-life index / time away from home)

c. Already collected social variables that are available for reference years 2017, 2020 and soon available for reference year 2023 (early), e.g.

- **ratio of high age class to low age class** as an index of generational renewal: (employment at age class "<=14" + "15-24")/(employment at age class >=65)

3. **Fishing communities in the WestMED**

The EWG 24-05 (STECF, 2024b) agreed on the following operational definition of the fishing com-munities:

"*Fisheries communities pertain to settlements around fishing harbours where the fisheries gener-ate social and economic benefits (e.g., employment), and which enables new generations of fish-ers, due to shared norms and inter-generational links. Such norms are reflected in, for instance, resource stewardship, notions of shared materialities, cultural heritage, and interests, ways of life, and a sense of belonging. Fisheries communities are place-based but can pertain to wider geographical areas which gravitate towards the harbours and are likely to include fisheries-based organisations and ancillary industries in aquatic food value chains*".

Figure 3.2.1 and Table 3.2.4.4 present some important Fishing Communities around West MED. The following criteria were used to identify the significance:

Plurality: Communities selected are cases in multi-dimensional terms, e.g., ports presenting tech-nical and economic plurality, meaning the chosen place is used by different types of fisheries (SSF, LSF and/or DWF), fishing metiers (species landed, gears used); or ports presenting social plurality (balanced age structure; different fishers' group identities; multi-used harbours for tour-ism, fisheries, transportation, offshore wind platforms supply)

Contrast: Communities selected based on the principle of maximum contrast (Nohl, 2010; Flick, 2014) inside a MS, e.g., places with an active fleet (living fisheries communities) vs place where fisheries is disappearing ("to be lost" fisheries communities); places with a specialised fisheries community (targeting one species with a certain technique) vs. a plural fisheries community (see above).

Policy impact: Communities selected based on their capability to illustrate the answers to specific policy questions. For instance, what would be the likely impact (positive or negative) of: setting a Marine Protected Areas (MPAs) limiting access to fishing grounds and the exploitation of living aquatic resources; the deployment of Offshore Renewable Energy (OREs) (including cable routes for onshore-connection) restricting access to fishing grounds; the energy transition, etc.

The socioeconomic impact of technical measures in the WestMED region can vary significantly de-pending on the degree of dependence of these communities on the fisheries sector. Therefore, it is essential to conduct a thorough assessment of how different technical measures might affect these areas. A critical consideration is the specific socioeconomic and cultural characteristics of each fishing community, including their resilience to change and adaptability. To accurately esti-mate the socioeconomic effects of these technical measures, a context-specific approach is need-ed that considers multiple dimensions such as income dependence on fisheries, alternative liveli-hoods, and the community's cultural ties to the maritime environment.

Figure 3.2.1 Important fishing communities in the WestMED

Source: STECF EWG 24-05.

Table 3.2.4.4. Fishing communities identified by EWG 24-05.

Community	MS	Reasons (for choice)
Sète	FRA	Purse seines for bluefin tuna, small pelagic fleet, SSF mainly in laguna with prud'homies regulating the laguna fishing, mussels and oyster farming in the laguna. Tourism also is very important. In this area many anthropological studies were realized.
Grau du Roi	FRA	bigger than Sète main problems related to tourism, trawlers and SSF
Palamós	ESP	Great example of social and market innovations. Co-management. Cultural heritage
Valencia	ESP	Disappearing Community
Mallorca	ESP	Cala Ratjada Harbour. MPA of fishing interest, generational renewal.
Roses, Girona	ESP	Group of communities: Roses Cadaqués, Port de la Selva, L'Escala and L'Estartit. Impact of OWF, MPA, Natura 200. Impact of Tourism
Salerno	ITA	Salerno and Cetara host the authorized purse seine tuna fleet, coexisting with SSF and conflicting with LSF over resources. Synergies exist in processing tuna and anchovies.

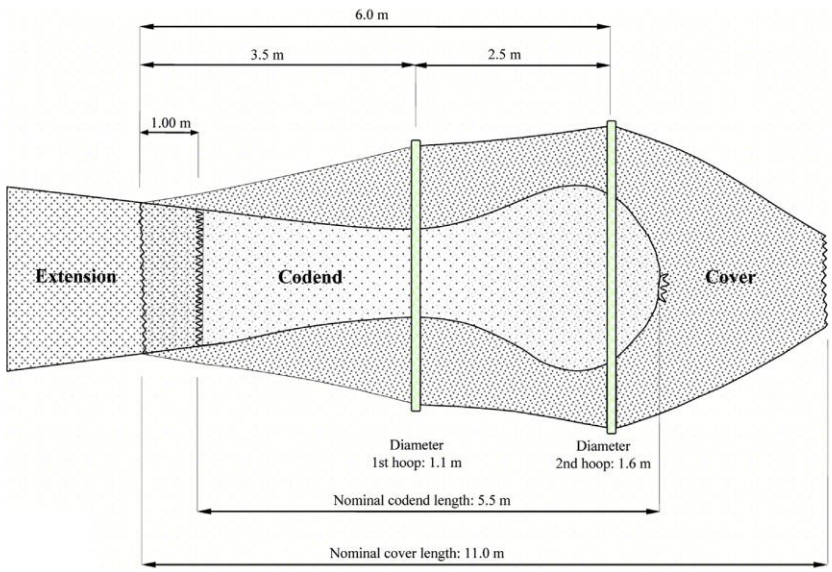
Source: STECF EWG 24-05.

3.2.5 Gear studies

During EWG 24-16 gear technologist's experts attending the meeting worked on updating and ex-panding list of available selectivity estimates from which future EWGs could use to apply in the framework for the Mediterranean case study Table 3.2.5.1. In particular, this list was expanded to account for key species occurring in these mixed fisheries. Selectivity experiment methods and parameters description

In a codend selectivity experiment measurements are required of the fish that have been retained by the codend under test and the total numbers of fish that have entered the codend. The easiest way to perform such experiments is to fit a small mesh cover around the codend under test, in order to catch the fish escaping through the meshes (Figure 3.2.5.1). The covered codend method provides the most direct results of the number and the size of fish escaped through codend mesh-es. Usually the cover is made of a nominal mesh size of 20 mm supported by circular hoops to keep it clear of the codend and minimize masking effects (Wileman et al., 1996).

Figure 3.2.2 Schematic view of the codend and “hooped” cover arrangement



Source: Sala et al. 2015.

As recommended by Stewart and Robertson (1985), to minimize the potential masking effect the cover must be approximately 1.5 times larger in circumference and longer than the codend. Traditionally, plastic or metal hoops have been used to physically expand the cover to make sure the netting of the cover is held away from the netting of the codend. Recently, to overcome handling problem, kite-assisted codend covers without the use of hoops has been developed and tested (Madsen et al., 2001; He, 2007).

For each haul, catches from trawl codend and cover are handled separately on board and weighed. Total length (TL, cm) for fishes, carapace length (CL, mm) for crustaceans are measured respectively to the nearest 0.5 cm and 1.0 mm below in randomly selected sub-samples. The subsampling ratios are then calculated by dividing the sub-sample weight by the total weight in the codend and cover separately.

Several mathematical models are available to describe the probability that a fish of a given length which enters the test codend will be retained by it.

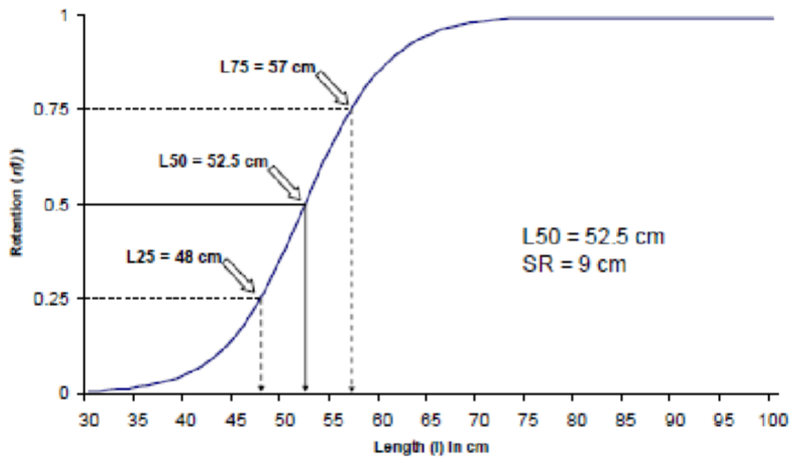
For each target species, the selectivity analysis allow to assess the ability of both Test and Control gears to catch only individuals above a certain size. The most commonly used mathematical des-cription of towed gear selection curves is the logistic curve specified by two parameters and with the following equation:

$$r(l) = \frac{exp^{(a+bl)}}{1 + exp^{(a+bl)}}$$

where r(l) is the probability that a fish of length l will be retained after entering the codend (Wileman et al., 1996). The objective of the analisys is to estimate the parameters a and b, that can be used to compute L50 = -a/b and the Selection Range (SR = (2loge(3))/b)). L50 represents the length at which the probability of a fish of a certain length l being retained is 50%, while the SR describes the steepness of the logistic curve, being the difference between the lengths of 75% and 25% retention probability. The formal modelling of between-haul variability using hierarchical mixed-effects model to explicitly model variation in selectivity parameters between hauls would be adopted (Fryer, 1991).

The results of the analysis are usually summarized by both a table of values of L50s and SRs and a graphical representation of the selection curve similar as shown in Figure 3.2.3.

Figure 3.2.3 Example of selection curve



Source: Sistiaga, 2010.

During the sampling design planning, the construction and the dimensioning of the codend to be tested is usually proportioned to the traditional codend and to the rearmost part of the extension piece. When ordering new codends from net manufacturers, the mesh size adopted is a nominal mesh size (mesh opening). During the sea trials, actual mesh sizes of the test cod end must be measured with an electronic OMEGA mesh gauge (Council Regulation (EC) No. 517/2008) while the nettings is wet.

In the present EWG 24-16 the review on studies/selectivity estimates performed during the EWG 22-19 on hake and red mullet, has been extendend to the other species listed in the West Med MAP (Regulation (EU) 2019/1022) Aristeus antennatus, Parapenaeus longirostris, Aristaeomorpha foliacea, Nephrops norvegicus.

Reviews performed in recent projects (e.g., IMPLEMED) or publications (Bahamon et al., 2024; Lucchetti et al., 2020; 2021; Sbrana, 2021) were mostly used for collecting selectivity estimates. Depending on the experimental design adopted, some studies were excluded because they were based on catch comparison analysis and then it was not possible to obtain selectivity parameters. When selectivity parameters were analyzed also for other species not included in the West Med Map list, they were however considered and included in the list in the Annex excel file, in order to include the maximum number of available species selectivity parameters.

Table 3.2.5.1 Gear specifications and gear selectivity curve parameters by stock. SM: square mesh codend; DM: dia-mond mesh codend; SM: square mesh panel; OTB: bottom otter trawls; GNS: Set gillnets; LLS: Set long-lines.

Area	Stock	Gear type	Mesh size	Gear Specification	Baseline	L50 (cm)	SR (cm)	Reference	Notes
WM	SYC.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	18.7	4.6	Massutì et al, 2009	
WM	SYC.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	21	6	Massutì et al, 2009	
WM	HKE.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	10.9	5.1	Massutì et al, 2009	
WM	HKE.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	18.9	3.4	Massutì et al, 2009	
WM	BRF.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	7.1	2.8	Massutì et al, 2009	
WM	BRF.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	8.4	2.3	Massutì et al, 2009	
WM	LDB.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	9.1	5.2	Massutì et al, 2009	
WM	LDB.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	12.1	5.6	Massutì et al, 2009	
WM	WHB.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	NA	NA	Massutì et al, 2009	
WM	WHB.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	16.1	6	Massutì et al, 2009	
WM	NEP.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	21.2	6.7	Massutì et al, 2009	
WM	NEP.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	23.8	8.6	Massutì et al, 2009	

WM	GFB.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	8.7	7.9	Massutì et al, 2009	
WM	GFB.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	10.9	5.6	Massutì et al, 2009	
WM	DPS.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	21.4	13.2	Massutì et al, 2009	
WM	DPS.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	25.7	11.4	Massutì et al, 2009	
WM	LKT.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	11.8	2.9	Massutì et al, 2009	
WM	LKT.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	13.5	3.3	Massutì et al, 2009	
WM	ARA.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	15.9	11.9	Massutì et al, 2009	
WM	ARA.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	19.6	10.4	Massutì et al, 2009	
WM	SHO.01_05_06_07	OTB	40	15 mm grid/40 mm codend	N	12.3	8.1	Massutì et al, 2009	
WM	SHO.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	14.4	5.9	Massutì et al, 2009	
WM	HKE.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	16.8	4.1	Sardà et al 2004	
WM	HKE.01_05_06_07	OTB	40	20 mm grid/40 mm codend	N	14.2	7.26	Sardà et al 2005	
WM	HKE.01_05_06_07	OTB	50	DM	Y	14.5	NA	Larraneta et al 1969	
WM	HKE.01_05_06_07	OTB	52	DM	N	15.2	NA	Larraneta et al 1969	

WM	HKE.01_05_06_07	OTB	40	SM	Y	17.64	7.4	IMPLEMED 2022	
WM	HKE.01_05_06_07	OTB	50	SM	N	22.19	5.03	IMPLEMED 2022	
WM	HKE.01_05_06_07	OTB	50	SM	N	20.9	5.1	50SELS Project D1.1_IMPLEMED	
WM	HKE.01_05_06_07	OTB	40	SM	Y	17.2	2.4	Baro et al. 2007	
WM	HKE.01_05_06_07	OTB	40	SM	Y	16	4.8	Bahamon et al 2006	
WM	HKE.08_09_10_11	OTB	40	SM	Y	17.62	6.35	Brcic et al., 2018a	
WM	HKE.08_09_10_11	OTB	50	DM	Y	13.71	3.37	Brcic et al., 2018a	
WM	HKE.08_09_10_11	OTB	60	DM	N	15.5	4.8	Lembo et al. 2002	
WM	HKE.08_09_10_11	GNS	53	DM	N	29		Sbrana et al. 2007	estimated by applying the bi-modal function SELECT method,
WM	HKE.08_09_10_11	GNS	62.5	DM	N	34		Sbrana et al. 2007	estimated by applying the bi-modal function SELECT method,
WM	HKE.08_09_10_11	GNS	70	DM	N	38		Sbrana et al. 2007	estimated by applying the bi-modal function SELECT method,
WM	HKE.08_09_10_11	GNS	82	DM	N	43		Sbrana et al. 2007	estimated by applying the bi-modal function SELECT method,
ALL	HKE.08_09_10_11	OTB	40	SM	Y*	14.88	4.5	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021

ALL	HKE.08_09_10_11	OTB	55	SM	N*	20.46	8	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
CEM	HKE.17_18	OTB	60	DM	N	16.6	4.6	Soldo, 2004	
CEM	HKE.17_18	OTB	40	SM	Y	15.7	8.68	Sala & Lucchetti 2010	
CEM	HKE.17_18	OTB	56	DM	N	16.25	7.56	Sala & Lucchetti 2011	
CEM	MAC.17_18	OTB	55.2	T0	N	21.37	3.57	Petetta et al., 2020	
CEM	MAC.17_18	OTB	55.3	T90	N	22.08	2.72	Petetta et al., 2020	
CEM	HKE.17_18	OTB	55.2	T0	N	11.26	21.33	Petetta et al., 2020	
CEM	HKE.17_18	OTB	55.3	T90	N	21.26	7.02	Petetta et al., 2020	
CEM	MUT.17_18	OTB	55.2	T0	N	16.7	2.78	Petetta et al., 2020	
CEM	MUT.17_18	OTB	55.3	T90	N	23.1	11.48	Petetta et al., 2020	
CEM	HMM.17_18	OTB	55.2	T0	N	24.99	8.03	Petetta et al., 2020	
CEM	HMM.17_18	OTB	55.3	T90	N	22.32	1.66	Petetta et al., 2020	
CEM	MTS.17_18	OTB	55.2	T0	N	13.35	8.86	Petetta et al., 2020	
CEM	MTS.17_18	OTB	55.3	T90	N	20.78	4.36	Petetta et al., 2020	
CEM	SQR.17_18	OTB	55.2	T0	N	7.88	5.67	Petetta et al., 2020	
CEM	SQR.17_18	OTB	55.3	T90	N	12.06	4.94	Petetta et al., 2020	
CEM	WHG.17_18	OTB	55.2	T0	N	23.02	12.86	Petetta et al., 2020	

CEM	WHG.17_18	OTB	55.3	T90	N	22.88	3.92	Petetta et al., 2020	
CEM	HKE.17_18	OTB	55	SM	N*	20.46	8	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
CEM	HKE.19	OTB	40	SM	Y	14.9	5.9	Aydin & Tosunoglu, 2010	L50 and SR From GSA 22 peper cited in Lucchetti et al 2021
CEM	HKE.19	OTB	50	DM	Y	14.4	6.3	Dereli & Aydin 2016	L50 and SR From GSA 22 peper cited in Lucchetti et al 2021
ALL	HKE.19	OTB	40	SM	Y*	14.88	4.5	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	HKE.19	OTB	55	SM	N*	20.46	8	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	HKE.20	OTB	40	SM	Y*	14.88	4.5	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	HKE.20	OTB	55	SM	N*	20.46	8	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	HKE.20	OTB	40	SM	Y	14.9	5.9	Aydin & Tosunoglu, 2010	L50 and SR From GSA 22 peper cited in Lucchetti et al 2021
ALL	HKE.20	OTB	50	DM	Y	14.4	6.3	Dereli & Aydin 2016	L50 and SR From GSA 22 peper cited in Lucchetti et al 2021
EM	HKE.22	OTB	50	DM	Y	11.4	4.6	Tosunoglu et al. 2008	

EM	HKE.22	OT B	50	DM	Y	14. 4	6.3	Dereli & Aydin 2016	
EM	HKE.22	OT B	40	SM	Y	15. 5	4.7	Özbilgin et al. 2012	
ALL	HKE.22	OT B	55	SM	N*	20. 46	8	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
EM	HKE.22	LLS	6	Hook VMC brand	NA	60. 09		Öztekin et al. 2020	estimated by applying the bi-modal function SELECT method,
EM	HKE.22	LLS	7	Hook VMC brand	NA	51. 45		Öztekin et al. 2020	estimated by applying the bi-modal function SELECT method,
EM	HKE.22	LLS	8	Hook VMC brand	NA	46. 43		Öztekin et al. 2020	estimated by applying the bi-modal function SELECT method,
EM	HKE.22	LLS	9	Hook VMC brand	NA	40. 11		Öztekin et al. 2020	estimated by applying the bi-modal function SELECT method,
EM	HKE.28	GN S	28	DM	N	30. 61		Deniz et al. 2020	estimated by applying the bi-modal function SELECT method,
EM	HKE.28	GN S	30	DM	N	32. 8		Deniz et al. 2020	estimated by applying the bi-modal function SELECT method,
EM	HKE.28	GN S	32	DM	N	34. 99		Deniz et al. 2020	estimated by applying the bi-modal function SELECT method,
ALL	HKE	OT B	40	DM	N*	10. 86	3	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021

ALL	HKE	OT B	40	DM	N*	10. 18		Lucchetti et al 2021	
ALL	HKE	OT B	40	SM	Y*	14. 88	4.5	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	MUT	OT B	40	SM	Y*	12. 67		Lucchetti et al 2021	
ALL	HKE	OT B	50	DM	Y*	13. 58	5	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	MUT	OT B	50	DM	Y*	12. 73		Lucchetti et al 2021	
ALL	HKE	OT B	50	SM	N*	18. 6	7	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	MUT	OT B	50	SM	N*	15. 84		Lucchetti et al 2021	
ALL	HKE	OT B	55	SM	N*	20. 46	8	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	MUT	OT B	55	SM	N*	17. 42		Lucchetti et al 2021	
ALL	HKE	OT B	60	DM	N*	16. 29	6	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	MUT	OT B	60	DM	N*	15. 27		Lucchetti et al 2021	
ALL	HKE	OT B	70	DM	N*	19. 01	6.5	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021
ALL	MUT	OT B	70	DM	N*	17. 82		Lucchetti et al 2021	
ALL	HKE	OT B	75	DM	N*	20. 36	7	Lucchetti et al 2021	SR estimated from Fig. 1 in Lucchetti et al 2021

Source: STECF 22-19 (STECF 2022a).

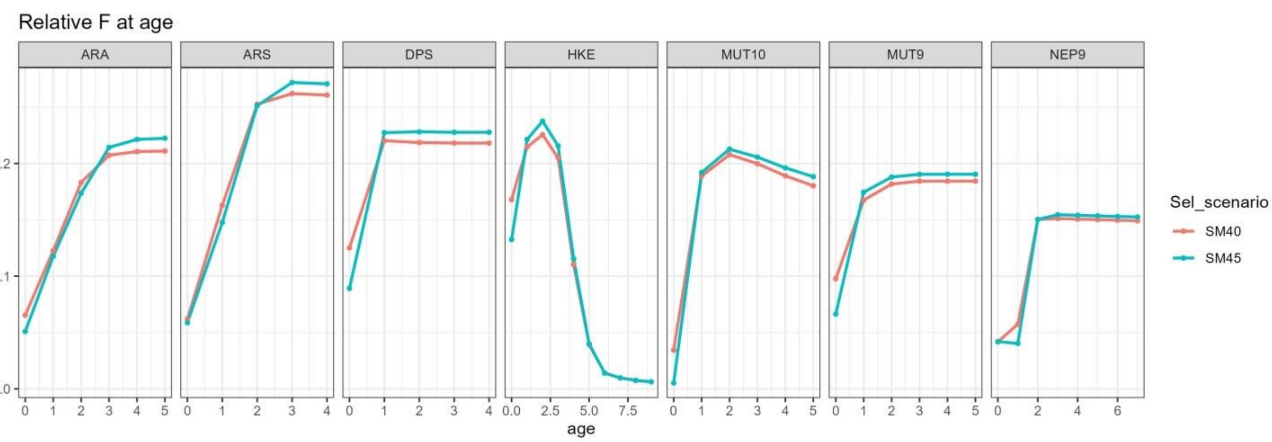
3.2.6 Scenarios

During the EWG 24-12 (STECF 2024c), scenarios including catch limits on red shrimps were explored. The model works at monthly level and the effort in the projections is assumed to be distributed among the months as in the last year of simulation (2023); the monthly ratio between each fleet segment catch to the total catch (p coefficient, used to split the total F among the fleet segments in the BEMTOOL Z formulation) in the forecast is the same of the last year of simulation. In 2024 the effort was assumed in line with regulations (e.g. effort quotas and catch limits). In the scenarios explored during the EWG 24-12, the change in selectivity from 40 mm to 45 mm of square mesh size has been applied, following the Bahamons et al. (2024). The results reported below are focused on the comparison between the Status Quo scenario (SQ) and the increase in square mesh size from 40 to 45 mm.

Results

The comparison between the two selectivity scenarios explored, namely 40 mm square mesh size (SM40) and 45 mm square mesh size (SM45) shows a shift from juveniles (0-1 years old) to older ages Figure 3.2.4). In particular, for hake the relative F applied on age 0 in scenario SM45 is about 20% less than scenario SM40 (status quo).

Figure 3.2.4 Relative F at age by stock for the two selectivity scenarios explored (40 mm square mesh size and 45 mm square mesh size).



Source: STECF EWG 24-12 (STECF 2024c).

The results on GVA, revenues and GP (Table 3.2.6.1) in the short term (2025, first forecast year) show that scenario SM45 would produce a decrease of -14% in GVA, -17.8% in GP and -4.61% in revenues for DTS fleet segments operating in GSA 10, while the economic performance of PGP and HOK fleet segments would remain quite stable. In GSA 11 the GVA of DTS fleet segments shows a 23.4% decrease, with an apparent smaller impact on GP and revenues, due to the nega-tive indicators already in the current period. In GSA 9 the impact of the increase in mesh size from 40 mm to 45 mm impacts on the DTS fleet segment of -4.5% on GVA, -4.8% on GP and -2.21% on revenues. Concerning the labour costs per FTE, the DTS fleet segment results show a -11% decrease in GSA 10, -8% in GSA 11 e 4.40 % in GSA 9, due to the decrease in revenues with the same number of FTE.

Table 3.2.6.1 Variation of economic performances (GVA, GP, revenues and labour costs per FTE) in % of SM45 re-spect to SM45 scenario in 2025.

GSA	Fishing Technique	GVA variation (%) SM45-SM40	GP variation (%) SM45-SM40	Revenues variation (%) SM45-SM40	Labour costs per FTE variation (%) SM45-SM40
10	DTS	-14.0	-17.8	-4.61	-11.02
	HOK	0.4	0.7	0.11	0.21
	PGP	1.1	1.2	0.64	0.85
11	DTS	-23.4	1.1	-1.74	-8.48
	PGP	5.2	-1.5	0.57	1.75
9	DTS	-4.5	-4.8	-2.21	-4.40
	PGP	0.7	0.7	0.49	0.57

Source: STECF EWG 24-12 (STECF 2024c).

EWG 24-16 did not define any specific scenarios for the Bay of Biscay case study. Work focused on the translation of the BEMTOOL outputs to the BioEcon visualisation format. Future EWGs will need to define, test and apply scenarios to fully explore the possible trade-offs in terms of biolo-gy, economics and social impacts.

3.2.7 App format

During EWG 24-16, experts worked on the development of code to adapt BEMTOOL outcomes to the BIM_BioEcon package. The functions fltSumBIM_BEMTOOL and fltStockSumBIM_BEMTOOL were developed to specifically translate the outcome format produced by BEMTOOL bioeconomic model in the fleet summary format required by BIM_BioEcon package.

Input:

- data frame of Economic indicators in BEMTOOL format
- years selected for the summary table

Output:

- Fleet summary table
- Fleet-stock summary table

The code was uploaded on the **stecf_tech_measures** GitHub available for the EWG: stecf_tech_measures\funcs\BMT_adaptation.

Two input files to run the function was provided in the same GitHub stecf_tech_measures\MED_2024\BIM_BioEcon\test_scenarios\scenario_runs (DF_BMT.Rdata and DF_BMT_stock.Rdata).

Three tables (scenar-io_descriptions.csv; 00_fleet_summary_Med.csv; 01_fleet_stock_summary_Med in.csv) are up-loaded on the GitHub (stecf_tech_measures\MED_2024) and can be used to verify the compatibil-ity of BEMTOOL outcomes with the BIM_BioEcon package.

BEMTOOL, in its version 2.5, available on github (https://github.com/Isabella84/BEMTOOL2.5) can simulate the following technical measures:

1. minimum landing sizes and minimum conservation sizes;
2. different gear configurations (e.g diamond meshes turned by 90°, selection grid) to reduce unwanted catches;
3. modification in mesh size;
4. fishing bans;
5. spatio -temporal closures.

The measures at points 1, 2 and 3 are modelled modifying the fleet selectivity according to regula-tions and results of selectivity experiments (e.g. IMPLEMED project, Sbrana et al., 2022 https://doi.org/10.3389/fmars.2022.1017766). The fishing ban (point 4 and point 5 no?) is mod-elled setting null effort in the months identified for the ban and assuming the same effort of the previous year in the other months. However, assumptions on a reallocation of the effort in the allowed months can be modelled. Spatial closures are implicitly modelled through a modification of fleet selectivity; this modification is derived overlapping the effort of each fleet (e.g. VMS or AIS data) with the sensitive stages (e.g. recruitment, spawners) of the stocks in the area. BEMTOOL allows also to differentiate the closures among the fleet according to how much they impact on specific stocks. An example of rotating spatio-temporal closures in Western Ionian Sea can be found in Russo, Bitetto et al., 2017 (https://doi.org/10.3389/fmars.2017.00193).

In the framework of SEAwise project (https://seawiseproject.org/), a new spatial component of BEMTOOL model has been developed and configured for Adriatic and Western Ionian Sea. This new component allows to model spatially the different fleets considering, when and where the data are available, the fishing strategy of the fishers (e.g. driven by the maximization of the profit or by the minimization of the fuel costs). Spatial closures can be modelled explicitly and effort realloca-tion is derived on the basis of historical data and fishing strategy.

Applying this new component, a wider range of spatial closures could be explored, just requiring VMS data to the data currently using to parameterize the non-spatial version of BEMTOOL (stock objects, FDI, economic data by GSA).

Text and maps to populate the app were also developed in EWG 24-16, and are available in Annex 4. As a final note, while BEMTOOL has the potential to contribute significantly to advanced bioeco-nomic analyses, its current state requires substantial updates to ensure compatibility with modern R versions and improve usability. Initial steps have been taken in EWG 24-16, as outlined in Annex 2, to address outdated dependencies and explore alternative input methods. Recommendations for further development, such as formalizing BEMTOOL as an R package and integrating a user-friendly interface, are also included in Annex 2, highlighting the tool's relevance for future case studies.

4 ToR 3 Management scenarios

This term of reference focused on the identification of meaningful management scenarios that could be produced to assess the biological, social and economic impacts of technical measures regulation. The models selected for use in each case study are used to produce scenarios annually for specific advice purposes. These scenarios are built to answer specific needs and are not de-signed to show the range of potential impacts and trade-offs of many gears. Possible manage-ment scenarios were initially discussed independently for each case study (section 3.1.7 and 3.2.6), where the capabilities of each model outlined, along with its current applications and adap-tations that would need to be made to provide additional scenarios to assess the impact of tech-nical measures. Therefore, additional information, data, and in some cases, models may be re-quired to produce such scenarios.

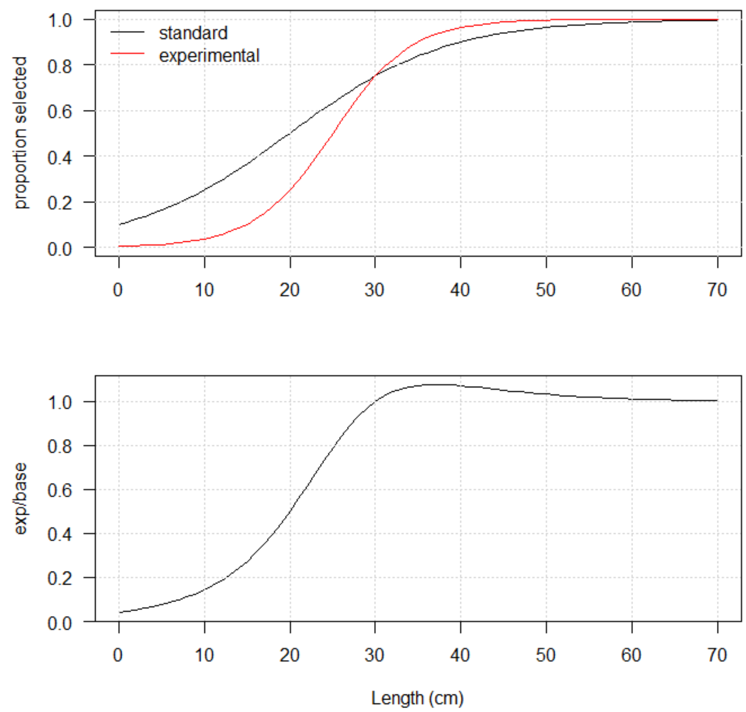
Scenario setting is an important step in the development of any advice product as it clearly defines the objectives and information required. As in the last technical measures, (EWG 23-15, STECF 2024a) there was a dedicated session with scientists and stakeholders to gather information on how these scenarios could be set. By involving stakeholders and policy makes in the design of sce-narios it ensures that the final outputs are useful decision support tools.

4.1 Scenarios in terms of selectivity

The primary goal of the EWG is to assess the impact of technical measures, in particular changes to gear selectivity. Therefore, each scenario should be compared in the first place to its baseline (no selectivity change vs selectivity change), rather than comparing scenarios with each other. Scenarios that provide higher fishing opportunities for a stock/fishery (i.e. less choking by other stocks, higher quota shares for fleets to which a technical measure is applied) for which technical measures are tested will likely strongly affect the technical measure being tested.

To adjust the catchabilities of the fleets, the parameters made available from gear selectivity studies must be transformed to a function form that allows modifying the catchability. The gear studies collected during the EWG are based on gear experiments where a cod end with small mesh size is placed over an experimental net and assumes that the fish escaping the experimental gear are all retained by the small mesh size cod end that is wrapped over the experimental net. The selectivity of the experimental gear is described by two parameters, the L50, the length at which 50% of the fish are selected by the gear, and the SR value, the slope of the selectivity curve giv-en by the difference between the L75 and L25 (Figure 3.2.3). These parameters can be used to describe a logistic function. If the parameters are also available for the standard gear, the differ-ence in selectivity at length between both gears can be calculated as the ratio of the selectivity of the experimental and standard gear and be used to modify the catchability of the standard gear, eventually after a transformation from length to age based difference in selectivity. When evaluat-ing the effect of a gear selectivity experiment in a mixed-fisheries context, it is important to con-sider all potential changes in catchability for all the species included in the model. However, for practical reasons, gear trial studies are often focused on a single species or conducted in an area with low abundance of a particular species, and therefore these studies do not always provide re-sults for all species of interest. It is important to consider these limitations when studying the effects of a gear trial study in the context of a mixed fishery.

Figure 4.1.1 Illustrative example of two gear selectivity curves (upper panel), with value of the L50 parameter 20 cm and 25 cm and value of the SR parameter 20 cm and 10 cm for standard and experimental gear, respectively. The lower panel shows the difference in selectivity at length that could be applied to modify the catchability of a given gear.



Source: Own elaborations.

4.2 Scenarios in terms of quota restrictions

EWG 24-16 discussed the impact of quota assumptions on scenario outcomes. Scenarios require limitations to be set, in the case of quota management systems, such as those implemented in the Bay of Biscay, this requires a quota limitation to be set for the fleets in the model. As fleet quota allocation cannot be known, the scenarios are currently set to assume that fleet behaviour in last year of data (total catch per fleet in tonnage) is repetitive of the quota share they are likely to catch in the forecast year in the scenario. The implications of this assumption may have the fol-lowing impacts.

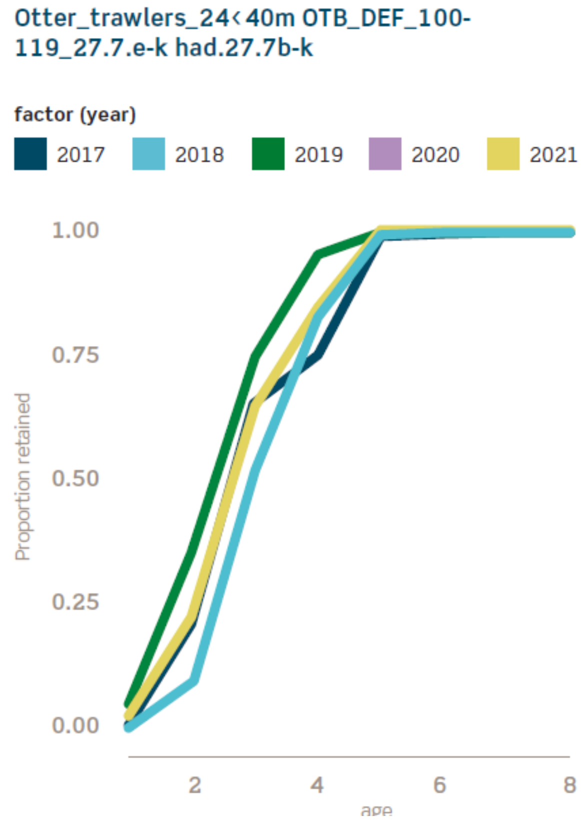
EWG 24-16 discussed that the assumptions such scenarios were that the more catch (discards from at-sea monitoring programs + landings) a fleet has, the more quota it has available, i.e. there is a linear relationship between catch and quota. However, this is not necessarily true: for example, in fleets with high observed discards the reason for discarding can be the lack of quota and, in these cases, discards are inversely related to quota availability. This is particularly im-portant considering that since the introduction of the LO, TACs include discards estimations but as the LO has minimal implementation, generalised discarding continues.

The Bay of Biscay model assumes that with full implementation of the landings obligation that fleets stop fishing once the first quota is reached. For example, in the case of the Bay of Biscay model this equates to the ‘min’ scenario in but has severe consequences in terms of choking of the fisheries, resulting in lost fishing opportunities which that may not be realistic. As highlighted by Dolder et al. (2021) this assumption also suggests that the landing of previous discarded fish may have a significant impact on price achieved (for example, from smaller fish), but would not be reflected by conditioning the model on past prices. Dolder et al. (2021) noted that assuming that all fish are landed is unlikely to be a true reflection of these changing dynamics and the impact of these changes on prices. Additionally, the assumption of ‘status quo’ fishing effort does not neces-sarily reflect the adaptation of fleets to available quotas but may better reflect the level of fishing effort observed in the fisheries. Under this scenario, discarding takes place as two components: i) the previous observed at-age proportions retained (Figure 3.2.7.1), and ii) any over-quota excess calculated in the model due to too much effort to catch the quotas Dolder et al. (2021).

EWG 24-16 suggest that in the future the suggestion of Dolder et al. (2021) is explored, this scenario would estimate future discarding dynamics by partitioning discards into under minimum size (discarded, but no value) and previously over-quota discards (retained and landed). This would require detailed analysis of the fisheries and their proportion retained in relation to the minimum conservation reference size which was outside the scope of this project, but would allow for a clear distinction between what is assumed quota-based discards and size-based discards (not ac-counting for market-based discards) in simulations (Dolder et al. 2021).

EWG 24-16 discussed that the assumption of the most limiting quota choking and stopping fleets may not be reflective of real fishing operations, as there is substantial evidence that EU fisheries chokes have rarely occurred, again associated to the generalised lack of implementation of the LO. EWG 24-16 highlighted the objective of mixed fisheries scenarios are not to produce exact point estimates, but to show the range of potential impacts on fleets. Therefore, future ranges of tested scenarios should also include those which exclude limiting species or free up the technical interactions between fleets and these limiting species. Allowing for visualisation of all impacts with-in the app (for example: ICES 2024b).

Figure 4.2.1 Example of proportion retained at age, reflecting discard patterns



Source: Dolder et al. 2021

4.3 Scenarios in terms of economics

EWG 24-16 has no specific ToR to provide a final assessments of socio-economic impacts of the implementation of the Technical Measures Regulation. The request from DG MARE is, however, to assess whether and how bioeconomic models can be applied in the future for this purpose. tBe-fore discussing about possible scenarios following, for example, a discussion with stakeholders, the EWG 24-16 want to provide some background regarding the economics of improving selectivity and what could or should play a role in the development of scenarios.

As the aim of the requests to STECF is the assessment of possible socio-economic impacts of changes in selectivity, the following aspects from an economic standpoint should/could be consid-ered and may not be all possible aspects:

- What are the costs of changing the fishing gear? Cost of new gear and costs of rigging the gear compared to status quo.
- What changes in costs occur related to the new fishing gear (e.g. reduced fuel use, re-duced sorting time, improved catch quality etc.)

- Is the species for which the measures will be implemented the target species, and the avoidance is about reducing bycatch of juveniles? If so, there may not be any economic loss as juveniles not sold on market.
- Is the species for which the measures will be implemented the target species and not only the bycatch of juveniles shall be reduced? If so, there may be economic losses due to lower landings of target species.
- Is the species a non-target species but will reduce the catch of the target species?
- Will the gear change mitigate choke species in a mixed fishery?
- What are possible avoidance strategies, e.g. the change of fishing grounds? What impact will this have on other fisheries?

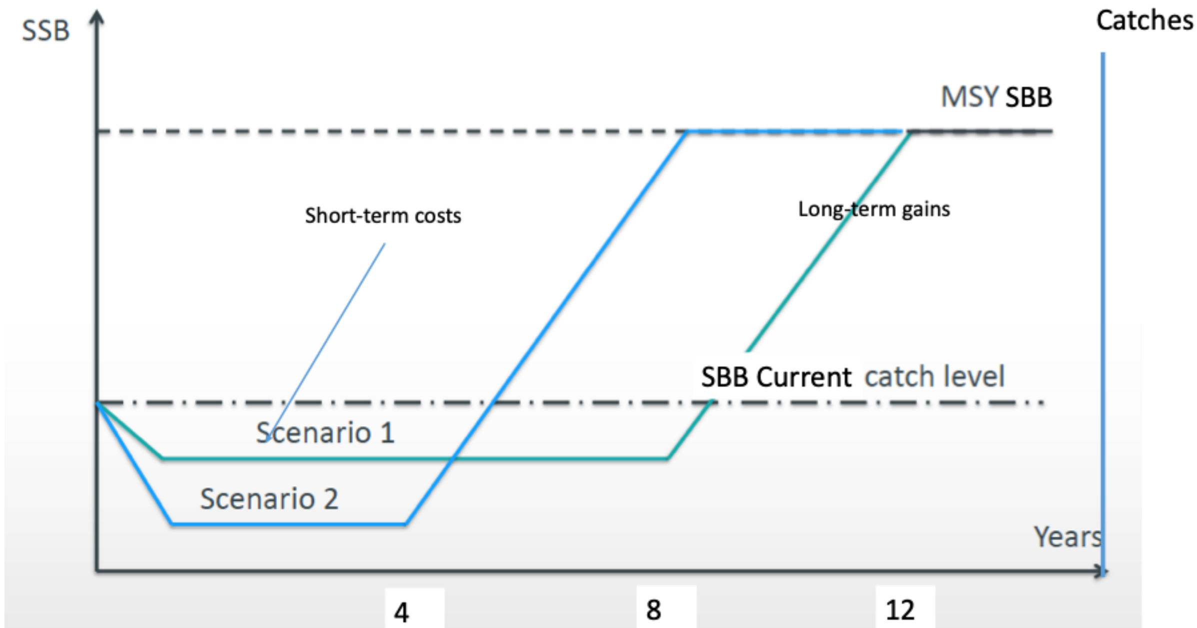
Therefore, possible scenarios and future analyses of concrete examples, should consider the an-swers to those questions. That doesn't mean that each individual scenario to be developed needs or should consider all of those questions. Each scenario developed or proposed should answer one of those questions to assess the changes compared to the status quo. In many fisheries it may not be realistic to improve selectivity by simply changing the mesh size or applying new fishing gear without additional measures like spatial measures. However, for a socio-economic impact analysis, the mixture of measures in a scenario makes it difficult to detect the reason for the changes in economic indicators. Therefore, in case a scenario with multiple measures needs to be run, it should be discussed whether additional analyses can be done with the individual measures and not only the multi-measures scenario.

From an economic standpoint it could be beneficial to analyse a wide range of scenarios with the available bio-economic models, compare the results and then hopefully be able to find an optimal solution for the improvement of selectivity, as an example. However, as time is always limited in EWGs and there may not be much preparatory work possible before the meeting the number of scenarios may be rather limited which can be run during an EWG.

As mentioned, generally fishers do not seem willing to improve selectivity voluntarily. That may have to do with the fear of increasing costs or reduced revenues or the unwillingness to change practices, among other factors (see above).

The main problem is that in nearly all or all cases there will be short-term losses for hopefully long-term gains. In case the long-term gains may not be for individual fishers but to reach a socie-tal objective, it is also the question how far that changes revenues and costs and in case fishers have increasing costs of reduced revenues governments may have to address those issues (e.g. implement mitigation measures).

Figure 4.3.1 Short-term losses vs. long-term gains



Source: Döring & Egelkraut 2008.

Figure 4.3.1. is a graphical example for rebuilding programs to MSY in the Baltic Sea cod fishery where two scenarios were compared (see Döring & Egelkraut 2008). One scenario with a lower reduction in TAC for a longer period vs. a scenario with a stronger reduction in TAC for a shorter period. This is compared with the status quo (current catch level). Without going too much into detail it can be stated that from an economic perspective it could be the case that the keeping of the current catch level (including staying on the current low level of SSB) instead of implementing scenario 1 or 2 can be the preferred option for the fishers. In this case it depends how sure the fishers are that they will receive the long-term gains. If there is very high uncertainty, they will not opt for a scenario but to keep the status quo. For the implementation of technical measures fishers may have the same question, how sure they can be to receive the long-term gains from the im-plementation of more selective gear. Therefore, the analysis of socio-economic impacts in scenarios can give indications when to expect long-term gains. Then it can be discussed how to deal with the transi-tion phase which is most likely not an issue for STECF.

Not all fishers may phase the same impacts of introducing more selective gear. The bioeconomic models provide economic indicators on a broad fleet segment level and depending on the area, vessels fish only part-time in a specific area. Therefore, negative or positive impacts of manage-ment measures may not be distributed evenly between vessels and areas. These aspects need to be considered when proposing the implementation of new technical measures.

Some of the bioeconomic models have spatial components and can provide information on distri-butional aspects like impacts of moving fishing grounds. That can lead to increasing costs and/or changes in landings. In the discussion with the observers, it was mentioned that especially regard-ing the distributional effects input from the stakeholders would be very valuable.

During the observer's session the group including the observers discussed the state of play re-garding the improvement in selectivity. There is research in the MS on improving selectivity but there is often very little economic assessment of the impact of the new fishing gear on the fishing companies. This could be one reason while many of new gear modifications/new gears are not used by the fishing sector, or among many other reasons combining social, regulatory and eco-nomic factors, and its use must be mandatory via a regulation. On the other hand, there are also examples where the fishing sector itself implemented more selective gears (e.g. AMORGORAMA (https://amorgorama.com/)). There are only very few examples for mitigation measures to lower the negative economic impacts, like Scottish Conservation Credit Scheme, or a measure in the West Med where fishers receive more fishing days in case they improve selectivity to avoid the bycatch of hake (following Regulation (EU) 2019/1022 of the European Parliament and of the Council of 20 June 2019 establishing a multiannual plan for the fisheries exploiting demersal stocks in the western Mediterranean Sea).

The Scottish Conservation Credit Scheme, however, had high publicity and political gains while it is unclear whether the objective of the Scheme of, reduction of bycatch of juveniles, has been or will be achieved.

On Thursday October 24th the EWG held a specific stakeholder/observer session regarding the management scenarios and especially the future work. It was made clear that future work of the EWG cannot be seen as ‘a socio-economic impact assessment’ in a formal sense. For specific new legislation the EC needs to provide impact assessment which must follow certain criteria. STECF work is not an IA in the sense of these requirements. There will be no assessment of a proposed regulation, for example. The study cases future EWGs may look at will be selected by DG Mare and STECF for the purpose of implementing the methodology developed by the EWGs and not to fulfil the requirement of an IA.

The TOR were presented, and an overview on socio-economic assessments (see TOR 3) was given followed by interventions from some of the stakeholders. This EWG was still on methodological development, but the next EWG in 2025 may try to assess specific measures in the regions select-ed for this EWG (Bay of Biscay, Western Mediterranean) as test cases for the methodology. For those specific cases stakeholders, will be asked to provide input, as all the information which helps to assess possible socio-economic impacts can be helpful for the future EWGs.

The stakeholders provided the EWG with some background documents which will be stored in the JRC workspace for future consideration and possible inclusion of provided examples in future as-sessments.

It was explained that in March 2025, during the spring plenary meeting of STECF, the chairs, bu-reau and DG Mare will discuss how the future process would look like including the timing of the next EWG. As concrete examples may be selected, the chairs expect that interaction with stake-holders, especially the ACs, would be beneficial in advance of the EWG. As experts will run the bioeconomic models during the meeting, every scenario needs to be defined before the EWG, eve-ry input data clarified etc. Therefore, a possibility would be that a specific feedback loop will be organised with stakeholders before the EWG.

Economic indicators and data needs

The EWG had a short discussion regarding possible economic indicators for future applications and the data needs. For the models applied in the Western Mediterranean the modelers agreed to a common list of indicators for all applied bioeconomic models:

- Gross Value Added (GVA)
- Gross profit
- Gross profit margin
- Employment: Engaged crew and FTEs
- Labour productivity (GVA/FTE)
- Average salary (Crew cost/FTE)
- CR/BER

This is a list of ‘usual’ indicators for socio-economic assessments. For the assessment of changes in technical measures especially Gross profit will be an interesting indicator as it includes revenues and costs. Changes in technical measures may have negative or positive impacts on both catego-ries, which makes gross profit (profit without taking capital costs into account) an interesting indi-cator for further consideration.

Another point for future discussion will be the assessment of long-term socio-economic impacts. Improvement in selectivity has, among other objectives like reducing negative fisheries impacts or positive impacts on biodiversity, to improve stock status for target, non-target or even prohibited species. Experience, like in the Western Mediterranean, shows that a positive response of stocks can take some time or, what could be also likely in cases where the stock status is not that far away from reaching the objective of MSY, that the improvement and possibilities to increase land-ings of the target species in the future could be small compared to the costs those changes may cause. At the same time, however, for non-target species there may be a positive impact on costs because of reduced sorting time, improvements in catch quality, the avoidance of fines for ETP catches, maintaining or obtaining sustainability certification, or generally positive impacts on the ‘environment’. Therefore, the EWG suggests that for the next meeting this topic of the assess-ment of longer-term impacts should be a prominent part of the TOR.

Data input for economic assessments

In the meantime, most if not all bioeconomic models for fisheries in EU waters are developed for the input of AER data as those data is publicly available. Therefore, as it was also discussed during the EWG, the future applications should and could be built to work with the input of AER data. The problem with the economic assessments could be afterwards that the economic fleet segments of the AER are not specific enough to analyse changes of fishing gear in a specific fishery. Economic fleet segments are quite broad and include in most cases vessels who fish in different fisheries. The EWG suggests doing some test cases during the next EWG to see how far the results answer the questions raised (e.g. what costs occur due to the change in fishing gear or what revenue changes are to be expected). Those test cases should be discussed beforehand with stakeholders, maybe the EWG can also run proposals from the ACs regarding changes in technical measures, and then the results should be also discussed with the stakeholders. In case the results are not specific enough for a certain fishery or distributional effects are not clearly visibly it can be dis-cussed how necessary information for an improvement of the analyses can be collected, e.g. from the stakeholders, and implemented.

5 ToR 4 Future work

ToR 4 captured the forward looking work of EWG 24-16. The following sections outline the current gaps and potential future needs of a fully operational model from the perspective of biologists, economics, gear technologist, social scientist, stakeholders and managers.

- **Dissemination platform**: A permanent location for the application to be housed needs to be identified. Although the code used to develop the framework has been document-ed on a private GitHub repository, a space needs to be provided to house the application for dissemination.

- **Convert models to length based**: Currently the BioEcon package is parametrised with age based data. However, the impact of selectivity should be assessed in terms of length as selectivity information is collected and implemented on length.

- **Extending selectivity to all species** – Currently the models are very much focused on the selectivity impacts at length for one species related scenario (i.e. OTB DEF 80-100 mm mesh cod selectivity change). The code would need to be adapted to provide utility to alter the outcomes of selectivity impacts for multiple species. These outcomes would require experts to describe and quality control to ensure the outcomes are logical and realistic.

- **Longer term forecast** – Longer term forecasts (>1 year) are essential to assess the medium to long term impacts of the implementation of technical measures. EWG 24-16 focused solely on the development of short-term forecasts. Code would need to be developed to facilitate for longer-term forecasts. Also, expert time would be required to describe and quality control these forecasts.

- **Accounting for uncertainty** – As with all modelling, uncertainty needs to be estimated and communicated to ensure that end users understand the limitations of the forecasts and scenarios presented.

- **Inclusion of social data** – Possible options for the inclusion of social data have been extensively discussed in this report. Future EWGs on the implementation of technical measures will need to test these options.

- **Coding of estimation of economic data** – EWG 24-16 identified the variables and sources of economic data that could potentially be used to parametrise the model. However, work is needed to produce R scripts which document this process in a transparent and reproducible manner.

- **Updating R versions** - To safely run BEMTOOL as part of this framework it is neces-sary to be able to run it in R versions >=4.4, older versions contain potential security and malware vulnerabilities. During EWG 24-16 updates were undertaken and tested (Annex 2), however future testing and integration may be required.

- **Change Management in Fisheries** – By better understanding the humans involved in the process, we will better assess transitional needs. Therefore, future work should not only focus on modelling but also on the human dimension. Pol & Eayrs (2019) suggest that fishers, scientists and managers are reluctant to change, and they identify deficits in information and motivation as the drivers of this reluctance. They suggest changing management strategies to improve voluntary uptake of fishing gears that promote sus-tainability, while mandatory implementation of selective gears was identified as one means of successfully implementing change. The TMR lays down mandatory baseline mesh sizes with the facility for alternative gears to be implemented based on equivalent or improved selectivity. Since the TMRs introduction in 2019, Member States have therefore been motivated to recommend the addition of multiple alternative gears to the TMR. This will require continued engagement with stakeholders and ensuring their continued participation in future EWGs.

6 CONCLUSION

EWG 24-16 concluded that the ad hoc contract has been completed appropriately, providing an overview of and tools currently available in establish advice frameworks, which could be applied within a framework to describe the social and bioeconomic model impacts of technical measures.

EWG 24-16 made significant progress in advancing the application of a decision-support framework to assess the bioeconomic and social impacts of technical measures in fisheries for two case stud-ies, demonstrating the potential of integrated ecological-economic models to inform sustainable fisheries management. Although challenges remain in refining the tools and addressing data gaps, the collaborative efforts of multidisciplinary experts have laid a strong foundation. Continued work will ensure the development of robust decision-support systems that balance ecological, economic, and social objectives.

EWG 24-16 concluded that the proposed framework shows promise in providing insights into the trade-offs between different management scenarios. Data from gear selectivity studies and eco-nomic records were successfully integrated to simulate possible short-term outcomes. Stakeholder engagement and interdisciplinary expertise proved essential for identifying relevant management scenarios and refining the tools.

EWG 24-16 notes that a remaining areas of work are the full inclusion of social and economic da-ta; model refinement to account for the impact of selectivity on length in mixed fisheries; the in-clusion of longer term projections; broadening collaboration with stakeholders to enhance rele-vance and applicability of scenarios; and finally a location to house the application needs to be identified.

EWG 24-16 notes that during the spring plenary meeting of STECF, the chairs, bureau and DG Mare should discuss how the future process could look like including the timing of the next EWG. As concrete examples may be selected, it would be beneficial to interact with stakeholders, espe-cially the ACs, in advance of the EWG. As experts will run the bioeconomic models during the meeting, every scenario needs to be defined before the EWG, every input data clarified etc. Therefore, a possibility would be, comparable to the work for EWG 24-09 on the assessment of socio-economic impacts of the closures of the VMEs, that a specific feedback loop will be organ-ised with stakeholders before the EWG.

References

Abbott, J.K., Haynie, A.C. 2012. What are we protecting? Fisher behaviour and the unintended consequences of spatial closures as a fishery management tool. Ecological Applications, 22: 762-777. https://doi.org/10.1890/11-1319.1

Anon., 1993. Selectivity of Fishing Gears in Irish Waters. EU Contract BIO/ECO 1993/11. 160pp + Appendices.

Anon., 2022. Annex C to SWW Joint Recommendation: De Minimis Exemption Consolidation Re-quest of 5% for several species for 2023 Onwards Proposed From Spain For Trawlers in the Bay of Biscay and Iberian Waters (ICES 8abd and 8c9a). 76pp

Bahamon N., Recasens L., Sala-Coromina J., Calero B., Garcia J.A., Rotllant G., Maurer A., Rojas A., Muth L., Quevedo J., Vigo M., Ribera-Altimir J., Company J.B., 2024. Selectivity-based man-agement for reversing overexploitation of demersal fisheries in North-western Mediterranean Sea. Marine Policy 165, 106-185. https://doi.org/10.1016/j.marpol.2024.106185.

Bayse, S.M., Herrmann, B., Lenoir, H., Depestele, J., Polet, H., Vanderperren, E., Verschueren, B., 2016. Could a T90 mesh codend improve selectivity in the Belgian

beam trawl fishery? Fish. Res. 174, 201–209

BIM, 2009. Summary report of Gear Trials in Demersal Fisheries VIa Funded under NDP Support-ing Measures for Sea Fisheries Development Project 09. SM.T1.01. Bord Iascaigh Mhara (BIM). September 2009. 18pp.

BIM, 2010. Effect of Vessel Horsepower on the Selectivity of Demersal Trawls. BIM Project Report 10.MT.01.

BIM, 2011. Gillnet selectivity trials in the hake fishery to the South and West of Ireland in ICES areas VIIb,g and j. PROJECT 11.SM.T1.01 Bord Iascaigh Mhara (BIM) April-July 2011. 12pp.

Brinkhof, J., Larsen, R.B. and Herrmann, B., 2022. Make it simpler and better: T90 codend im-proves size selectivity and catch efficiency compared with the grid-and-diamond mesh codend in the Northeast Atlantic bottom trawl fishery for gadoids. Ocean & Coastal Management, 217, p.106002.

Campos, A., Fonseca, P., Erzini, K. 2003. Size selectivity of diamond and square mesh cod ends for four by-catch species in the crustacean fishery off the Portuguese south coast. Fisheries Re-search 60, 79–97.

Cheng, Z., Winger, P.D., Bayse, S.M., Kebede, G.E., DeLouche, H., Einarsson, H.A., Pol, M.V., Kelly, D., Walsh, S.J., 2020. Out with the old and in with the new: T90 codends improve size selec-tivity in the Canadian redfish (Sebastes mentella) trawl fishery. Can. J. Fish. Aquat. Sci. 77 (10), 1711–1720

Cuende, E., Sistiaga, M., Herrmann, B. and Arregi, L., 2022. Optimizing size selectivity and catch patterns for hake (Merluccius merluccius) and blue whiting (Micromesistius poutassou) by combin-ing square mesh panel and codend designs. Plos one, 17(1), p.e0262602.

Council Regulation (EC) No. 517/2008 of 10 June 2008 laying down detailed rules for the imple-mentation of Council Regulation (EC) No. 850/98 as regards the determination of the mesh size and assessing the thickness of twine of fish- ing nets. Official Journal of the European Union L. 151.

Dolder, P., 2020. Bioeconomic model to assess the impact of the Landing Obligation (BIOE-CON:2019) Deliverable 3: Methodology report. Lowestoft, UK

Dolder, P.J., Moore, C., Curtin, R., Ball, J., Muench, A., Aristegui, M., Kalinina, O., Jackson, E., Burke, B., Lordan, C., and Rihan, D. (2021) Bioeconomic model to assess the impact of the Land-ing Obligation (BIOECON:2019) Deliverable 9 – Final methodology report. Report for Bord Iascaigh Mhara (BIM), iii + 35 pp.

Dos Santos, M.N., Erzini, K., Gaspar, M.B., Monteiro, C.C. Sá, R., Bentes, L., Gonçalves, J.M.C., Lino, P.G., Ribeiro, J. 2001. Comparison of Long-line and Monofilament Gill Net Selectivity for Hake (Merluccius merluccius) in the Algarve (Southern Portugal). NAFO SCR Doc. 01/96. Scientific Coun-cil meeting – September 2001. 7pp.

Fryer, RJ., 1991. A model of between-haul variation in selectivity. ICES Journal of Marine Science, 48 (3), 281–290. DOI: 10.1093/icesjms/48.3.281.

García, D., Sánchez, S., Prellezo, R., Urtizberea, A., and Andrés, M. 2017. FLBEIA: A simulation model to conduct Bio-Economic evaluation of fisheries management strategies. SoftwareX 6: 141-147. https://doi.org/10.1016/j.softx.2017.06.001.

Herrmann, B., Priour, D., Krag, L.A., 2007. Simulation-based study of the combined effect on cod-end size selection of turning meshes by 90 and reducing the number of meshes in the circumfer-ence for round fish. Fish. Res. 84, 222–232

Herrmann, B., Wienbeck, W., Moderhak, W., Stepputtis, D., Krag, L.A., 2013. The influence of twine thickness, twine number and netting orientation on codend selectivity. Fish. Res. 145, 22–36.

He P. 2007. Selectivity of large mesh trawl codends in the gulf of Maine: I. comparison of square and diamond mesh. fish. Res. 83, 44–59. doi: 10.1016/j.fishres.2006.08.019

ICES 2023a. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). IC-ES Scientific Reports 5 :69. 803 pp. https://doi.org/10.17895/ices.pub.23541168.

ICES 2023b. Working Group on elasmobranch fishes (WGEF). ICES Scientific Reports 5: 92. 837 pp. https://doi.org/10.17895/ices.pub.24190332

ICES 2023c. Working Group on Widely Distributed Stocks (WGWIDE). ICES Scientific Reports 5: 82. 980 pp. https://doi.org/10.17895/ices.pub.24025482.

ICES 2023d. Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE). ICES Scientific Re-ports. 5:106. 272 pp. https://doi.org/10.17895/ices.pub.24496237.

ICES 2023e. Working Group on Social Indicators (WGSOCIAL). ICES Scientific Reports. Report. Un-der review, unpublished.

ICES 2023f. Workshop on Implementation of Stakeholder Engagement Strategy (WKSTIMP). ICES Scientific Reports. 5:77. 68 pp. https://doi.org/10.17895/ices.pub.23507958

ICES 2024a. Workshop on mixed fisheries fleets (WKMIXFLEET). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.25896610.v1

ICES 2024b. EU standing request on catch scenarios for zero TAC stocks 2024: cod (Gadus morhua) in divisions 7.e–k (eastern English Channel and southern Celtic Seas). ICES Advice: Tech-nical Services. Report. https://doi.org/10.17895/ices.advice.26763922.v1

ICES 2023h. Working Group on Mixed Fisheries Methodology (WGMIXFISH-METHODS). ICES Scien-tific Reports. Report. https://doi.org/10.17895/ices.pub.24496048.v1

Kell, L.T., Mosqueira, I., Grosjean, P., Fromentin, J.-M., Garcia, D., Hillary, R., Jardim, E., et al. 2007. FLR: an open-source framework for the evaluation and development of management strat-egies. ICES Journal of Marine Science 64(4): 640-646. https://doi.org/10.1093/icesjms/fsm012.

Kopp, D., Morandeau, F., Mouchet, M., Vogel, C. and Méhault, S., 2018. What can be expected of a T90 extension piece to improve selectivity in bottom trawl multispecific fisheries in the Bay of Biscay?. Fisheries science, 84, pp.597-604.

Madsen N, Hansen KE, Moth-Poulsen T 2001. The kite cover: a new concept for covered codend selectivity studies. Fish Res 49:219–226. https://doi.org/10.1016/S0165-7836(00)00210-1

Millar, RB., 1994. Sampling from trawl gears used in size selectivity experiments. ICES Journal of Marine Science, 51 (3), 293–298. DOI: 10.1006/jmsc.1994.1030.

Millar, RB., Broadhurst, MK., Macbeth, WG., 2004. Modelling between-haul variability in the size selectivity of trawls. Fisheries Research, 67 (2), 171–181. DOI: 10.1016/j.fishres.2003.09.040.
Millar, RB., Fryer, RJ., 1999. Estimating the size-selection curves of towed gears, traps, nets and hooks. Reviews in Fish Biology and Fisheries, 9 (1), 89–116. DOI: 10.1023/A:1008838220001.

Moore, C. 2020. Bioeconomic model to assess the impact of the Landing Obligation (BIOE-CON:2019) Deliverable 1: Summary of data collected on stocks, fisheries, and economic variables, identifying any gaps or limitations. Galway, Ireland.

Muench, A., 2021. Bioeconomic model to assess the impact of the Landing Obligation (BIOE-CON:2019) Deliverable 3: Economic Methodology report. Lowestoft, UK.

Nielsen, J.R., Thunberg, E.M., Holland, D.S., Schmidt, J.O., Fulton, E.A., Bastardie, F., Punt, A.E., Allen, I., Bartelings, H., Bertignac, M., Bethke, E., Bossier, S., Buckworth, R.C., Carpenter, G.D.H., Christensen, A., Christensen, V., Da Rocha, J. M., Deng, R. A., Dichmont, C.M., . . . Wal-do, S. 2018. Integrated ecological–economic fisheries models—Evaluation, review and challenges for implementation. Fish and Fisheries, 19(1): 1–29. https://doi.org/10.1111/faf.12232

Nikolic, N., Diméet, J., Fifas, S., Salaün, M., Ravard, D., Fauconnet, L. and Rochet, M.J., 2015. Efficacy of selective devices in reducing discards in the Nephrops trawl fishery in the Bay of Bis-cay. ICES Journal of Marine Science, 72(6), pp.1869-1881.

Prellezo, Raúl & Accadia, Paolo & Andersen, Jesper L. & Andersen, Bo S. & Buisman, Erik & Little, Alyson & Nielsen, J. Rasmus & Poos, Jan Jaap & Powell, Jeff & Röckmann, Christine, 2012. "A re-view of EU bio-economic models for fisheries: The value of a diversity of models," Marine Policy, Elsevier, vol. 36(2), pages 423-431.

RCG ECON 2024. Regional Coordination Group on Economic Issues. 2024. Annual Technical Meeting Report 45 pgs. (https://www.fisheries-rcg.eu/rcg-econ/)

Revill, A., Cotter, J., Armstrong, M., Ashworth, J., Forster, R., Caslake, G., Holst, R. 2007. The selectivity of the gill-nets used to target hake (Merluccius merluccius) in the Cornish and Irish off-shore fisheries. Fisheries Research 85, 142-147.

Suuronen, P., 2005. Mortality of Fish Escaping Trawl Gears. Food and Agriculture Organization of the United Nations, Rome, pp. 72.

RCG ECON 2024. Regional Coordination Group on Economic Issues. 2024. Annual Technical Meeting Report 45 pgs. (https://www.fisheries-rcg.eu/rcg-econ/)

STECF 2019. Scientific Technical and Economic Committee for Fisheries (STECF) Social data in the EU fisheries sector (STECF-19-03), Guillen, J.(editor) and Fitzpatrick, M.(editor), Publications Of-fice, 2019, https://data.europa.eu/doi/10.2760/638363

STECF 2021a. Scientific, Technical and Economic Committee for Fisheries (STECF) – Review of the Technical Measures Regulation (STECF-21-07), Kraak, S., Winker, H. and Hekim, Z. editor(s), EUR 28359 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-45890-6, doi:10.2760/790781, JRC127718.

STECF 2022a. Scientific, Technical and Economic Committee for Fisheries (STECF) - Review of the Technical Measures Regulation (STECF-22-19), Valentinsson, D., Vasilakopoulos, P. and Gras, M. editor(s), EUR 28359 EN, Publications Office of the European Union, Luxembourg, 2023, ISBN 978-92-68-03432-3, doi:10.2760/335552, JRC133589

STECF 2023a. Scientific, Technical and Economic Committee for Fisheries (STECF) - The 2023 An-nual Economic Report on the EU Fishing Fleet (STECF 23-07), Prellezo, R., Sabatella, E., Virtanen, J., Tardy Martorell, M. and Guillen, J. editor(s), Publications Office of the European Union, Luxem-bourg, 2023, doi:10.2760/423534, JRC135182.

STECF 2023b. Evaluation of fishing effort and catch regime for demersal fisheries in the western Mediterranean Sea (Part XI) (STECF-23-11), Pinto, C., Doering, R. and Pierucci, A. editor(s), Publi-cations Office of the European Union, Luxembourg, 2023, doi:10.2760/430278, JRC136187.

STECF 2023c. Scientific, Technical and Economic Committee for Fisheries (STECF) - FDI methodol-ogy (STECF-23-05), Zanzi, A., Hekim, Z. and Motova-Surmava, A. editor(s), Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/542525, JRC134663.

STECF 2024 a. Scientific Technical and Economic Committee for Fisheries (STECF). 2024a. Imple-mentation of the Technical Measures Regulation (STECF-23-15), Moore, C., Doering, R. and Va-silakopoulos, P. editors. Publications Office of the European Union, Luxembourg, 2024, JRC137739. https://data.europa.eu/doi/10.2760/434306.

STECF 2024 b. Scientific Technical and Economic Committee for Fisheries (STECF) – Social data in fisheries (STECF-24-05), Ballesteros, M.(editor), Kraan, M.(editor), Tardy Martorell, M.(editor), Virtanen, J.(editor) and Guillen, J.(editor), Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2760/461821

STECF 2024c How to cite this report: European Commission, Joint Research Centre, Scientific Technical and Economic Committee for Fisheries (STECF) - Fishing effort regime for demersal fisheries in West Med (STECF 24-12), Pinto, C., Doring, R. and Kupschus, 5. editor(s), Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/461821, JRC138977.

Sala, A., Lucchetti, A., Perdichizzi, A., Herrmann, B., and Rinelli, P. 2015. Is square-mesh better selective than larger mesh? a perspective on the management for Mediterranean trawl fisheries. Fish. Res. 161, 182–190. doi: 10.1016/j.fishres.2014.07.011

Sistiaga, M. 2010. Selectivity studies in the Barents Sea bottom trawl gadoid fishery: Gear and methods; A dissertation for the degree of philosophiae doctor, University of Tromsø, Faculty of Biosciences, Fisheries and Economics, Norwegian College of Fishery Science

Stewart, P.A.M., Robertson, J.H.B., 1985. Small mesh covers. Scot. Fish. Res. Rep. 32,11 pages, ISSN: 0308-8022.

Thébaud, O., Nielsen, J.R., Motova, A., Curtis, H., Bastardie, F., Blomqvist, G.E., Daurès, F., Goti, L., Holzer, J., et al. 2023. Integrating economics into fisheries science and advice: progress, needs, and future opportunities, ICES Journal of Marine Science, 80: 647–663, https://doi.org/10.1093/icesjms/fsad005

Tokaç A, Herrmann B, Gökçe G, Krag LA, Nezhad DS. The influence of mesh size and shape on the size selection of European hake (Merluccius merluccius) in demersal trawl codends: An investi-gation based on fish morphology and simulation of mesh geometry. Scientia Marina. 2018 Sep 30;82(3):147-57.

Valeiras, J., Pérez, N., Araujo, H., Salinas, I., Bellido, J.M. 2014. Atlas de los descartes de la flota de arrastre y enmalle en el caladero nacional Cantábrico-Noroeste. Instituto Español de Oceano-grafía. 122pp

Valeiras, J., Carretero, M., Velasco, E.M. and Sánchez-Lizaso, J.L., 2021. Reduction of discards in the bottom trawl fishery: fishing selectivity and effect of the morphology and size of the species. Centro Oceanográfico de Vigo.

Vogel, C., Kopp, D. and Méhault, S., 2017. From discard ban to exemption: How can gear technol-ogy help reduce catches of undersized Nephrops and hake in the Bay of Biscay trawling fleet. Journal of environmental management, 186, pp.96-107.

Wienbeck, H., Herrmann, B., Moderhak, W., Stepputtis, D., 2011. Effect of netting direction and number of meshes around on size selection in the codend for Baltic cod (Gadus morhua). Fish. Res. 109, 80–88.c

Wileman, DA., Ferro, RST., Fonteyne, R., Millar, RB., 1996. Manual of methods of measuring the selectivity of towed fishing gears. International Council for the Exploration of the Sea. Cooperative Research Report, No. 215, 126pp.

CONTACT DETAILS OF EWG-24-16 PARTICIPANTS

[1] - Information on EWG participant's affiliations is displayed for information only. In any case, Members of the STECF, invited experts, and JRC experts shall act independently. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: How to get involved - European Commission

STECF members		
Name	**Affiliation[1]**	**Email**
MOORE, Claire (co – chair)	Marine Institute, Ireland	claire.moore@marine.ie
BORGES, Lisa	FishFix	lisa.fishfix@gmail.com
DÖRING, Ralf (co-chair)	Thuenen-Institute of Sea Fisheries	ralf.doering@thuenen.de

Invited experts		
Name	**Affiliation[1]**	**Email**
BITETTO, Isabella	COISPA	bitetto@fondazionecoispa.org
BROWNE, Daragh	Bord Iascaigh Mhara	daragh.browne@bim.ie
CURTIN, Richard	Bord Iascaigh Mhara	richardwcurtin@gmail.com

DE CARLO, Francesco	APLYSIA SOC. COOP. a R.L.	fradecarlo@gmail.com
GAMAZA MÁRQUEZ, Maria	Instituto Español de Oceanografía IEO CSIC	mari.gamaza@ieo.csic.es
KONRAD, Christoph	Freelance	chriskon.official@gmail.com
KOVSARS, Maksims	Institute of Food safety, Animal Health and Environment "BIOR", Fish resources research department	maksims.kovsars@bior.lv
LIONTAKIS, Angelos	Agricultural University of Athens	aliontakis@agreri.gr
MANTZOUNI, Irene	Hellenic Ministry of Rural Development	emantzo@hotmail.com
ORIO, Alessandro	Swedish University of Agricultural Sciences (SLU), Department of Aquatic Resources, Institute of Marine Research	alessandro.orio@slu.se
RINCÓN HIDALGO, Margarita	Instituto Español de Oceanografía	margarita.rincon@csic.es
SÁNCHEZ-MAROÑO, Sonia	AZTI	ssanchez@azti.es
SYS, Klaas	Research Institute of Agriculture, Fisheries and Food	klaas.sys@ilvo.vlaanderen.be
VIVA, Claudio	Freelance biologist	viva@cibm.it

JRC experts

Name	Affiliation[1]	Email
PIERUCCI, Andrea	Joint Research Centre	Andrea.PIERUCCI@ec.europa.eu

European Commission		
Name	**Affiliation[1]**	**Email**
MANTOPOULOU PALOUKA, Danai	JRC STECF secretariat	Jrc-stecf-secretariat@ec.europa.eu
MOSET MARTINEZ, Maria	DG MARE	Maria.MOSET-MARTINEZ@ec.europa.eu

7 ANNEXES

7.1 List of Annexes

- ANNEX 1 PREPARATION FOR EWG 24-16 – IMPLEMENTATION OF THE TECHNICAL MEASURES REGULATION
- ANNEX 2 UPGRADING BEMTOOL FOR COMPATIBILITY WITH CURRENT R VERSIONS
- ANNEX 3 SUMMARY OF ECONOMIC FILE FORMAT USED IN BIOECON PACKAGE
- ANNEX 4 BAY OF BISCAY CASE STUDY DATA INPUT FORMATS
- ANNEX 5 CURRENT LAYOUT OF BIOECON APP
- ANNEX 6 TEXT TO POPULATE MEDITERRANEAN APP

ANNEX 1. PREPARATION FOR EWG 24-16 – IMPLEMENTATION OF THE TECHNICAL MEASURES REGULATION

Overview

The objective of this ad hoc contract was to collate and prepare the data and code required to develop the two proposed case studies to be implemented by experts attending EWG 24-16. The ad hoc was successfully completed with all available material being collected and supplied to EWG 24-16 along with supporting documentation.

Background information

After the adoption of the EU Regulation 2019/1241, the dedicated STECF Expert Working Group (EWG) on technical measures meets regularly with the objective to propose robust scientific information to improve the management of fisheries resources using technical measures.

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 EWG 2024 should apply the proposed framework to two case studies, hake stocks (Atlantic and Mediterranean).

EWG 24-16 will be divided into three sections: tool preparation (data and code); framework application (the two case studies); and framework development to identify additional aspects required to fully operationalise the bioeconomic and social assessment of the impact of technical measures. To help in the preparations of the tools required by EWG, it is necessary to advance with the data and code as proposed in the "task" and "terms of reference" below.

Tasks:

The contractor is requested to collect, compile and quality control the data and code required for the two case studies foreseen in EWG 24-16. The requirements for each study are outlined in Table 2.1 (from PLEN 24-02, point 7.2). The expert is required to process the data, code and present a summary of the ad hoc contract work to EWG 24-16.

Table 2.1 Summary of the tools required to conduct a bioeconomic assessment of the impact of technical measures in the two proposed case studies. Details of what was collected in the final column.

Case study 1: Bay of Biscay Hake Mixed Fisheries	

Type	Description	Coverage	Owner	Purpose	Collected
Data (*)	'Accessions' Fleet data: Catch and effort	All stocks 2009 - 2023	ICES - WGMIXFISH	Describe the fishing footprint of fleet, and merge with AER data. This highly aggregated data will provide an initial tool. However, it will not facilitate alignment with AER and economic indicators as there is no vessel-based information.	Yes
	FLFleet object	All fleets 2023 advice year	ICES - WGMIXFISH	Describe selectivity	Yes
	FLStock objects (with forecast)	All stocks in model 2023 advice year	ICES – WGCSE, WGBIE,	Describe stock dynamics	Yes
	Community Profiles	4 harbours within Bay of Biscay	Individual Institutes and member states	Describe social impacts	Not yet publically available
	FDI data	All species, all tables, all years	EU	Build EU based fleet objects	Yes
	AER data	All fleets, all species, all tables, all years	EU	Build EU based fleet and economic objects	Yes
Code	WGMIXFISH advice repo	2023 advice year	ICES - WGMIXFISH	Template for modelling stock dynamics	Yes
	FLSelex code	Newest version	BIM	Plugin template for modelling selectivity	Yes
	BIOECON	Newest version	BIM	Plugin template for model visualisation and dissemination	Yes
	FDI ~ AER code to merge	FDI methodology group	EU	Template for data merging	Yes

Case study 2: Western Mediterranean Hake Mixed Fisheries					
Type	**Description**	**Coverage**	**Owner**	**Purpose**	**Collected**
Data (**)	Stock assessment outputs	All stocks in model2023 advice year	STECF	Describe stock dynamics	Only partially available

	Community Profiles (***)	4 harbours within West Med	Individual Institutes and member states	Describe social impacts	Not yet publically available
	FDI data	All species, all tables, all years	EU	Describe the fishing footprint of fleet, and merge with AER data. This highly aggregated data will provide an initial tool. However, it will not facilitate alignment with AER and economic indicators as there is no vessel-based information.	Yes
	AER data	All fleets, all species, all tables, all years	EU	Build EU based fleet and economic objects	Yes
Code	All code developed by EWG 24-01 and previous West Med map meetings to develop and apply mixed fisheries and bioeconomic models.	2023 advice year	EU	Template for modelling stock dynamics and economic inputs	Only partially available

(*) Data from ICES - WGMIXFISH will be supplied by DGMARE

(**) Data for the Mediterranean hake, will be supplied by the Joint Research Centre.

(***) To prepare the community social profiles, the expert should also take into account the templates developed by the STECF EWG on social data which will be published in the final report in the course of this month.

3. Summary of material prepared for EWG 24-16

This summary is broken down into a case study specific breakdown. The ad hoc was also used to gather, synthesis and prepare this information to present to EWG 24-16. This means presenting the packages and information, as well as preparing data and where possible completing workflows to reduce burden on the EWG, while also highlighting the gaps in formation that exist.

BioEcon

The BioEcon package was identified in EWG 23-15 as a platform around which to develop a decision support tool to describe the potential impacts of technical measures. The BioEcon R package was originally built to simulate the impact of different Total Allowable Catch (TAC) scenarios on Irish fleets under the landing obligation. The framework and package provide a summary of the modelling approach, final data inputs and the methods for simulating the biological, fleet, and economic components. The framework also provides a 'Shiny App' to visualise the results, and as the report builds on the previous reports on data preparation (Moore

2020), model methodology (Dolder 2020) and economic methodology (Muench 2021).

The ad hoc prepared a summary iterative shiny presentation to share with EWG 24-16 to support learning and understanding the app This ad hoc contract adapted the framework built for the BioEcon to better suit the data structure and needs of available data required to assess technical measures.

For the whole plenary an example of test scenarios and dissemination format was produced using the BioEcon package (Appendix 1) although this package was developed to explore chokes in terms of mixed fisheries in relation to quotas, the functionality of the model allows the users to define catchability. Much of the code collected had to be updated to comply with R version 4.4 so that there were no security or structural issues.

The ad hoc also provided a summary presentation of the framework. A summary of the packages relevant functions was prepared to present to EWG 24-16. create_scenario_template(This function creates the excel template file to set up a new scenario) and change_q (This function adjusts the fleet object to introduce a catchability change to the fleet-metier-stock in the FLeetExt object).

Code developed by Shane Murphy and Coílin Minto at ATU (Galway, Ireland) was gathered for this ad hoc contract (Appendix 7). A future aim of this work is to incorporate length based projections into the BioEcon package, which currently uses age only. Selectivity impacts of a gear are described in length, therefore length based projections are required to fully understand the impacts of selectivity.

FDI and AER alignment

The structure of the new FDI data call facilitates a link between the FDI and AER data calls. Annually the FDI group test the alignment of the FDI and the AER data calls to ensure consistency. The code developed by FDI for this purpose was collected by this ad hoc to apply during EWG 24-16 (Appendix 8). This code will provide an important quality control baseline for any future fleet information produced from merging these two data sources.

Community profiles

Finalised Community profiles have not yet been published so could not be accessed by the author of this ad hoc. However, example profiles were gathered from other areas to support the work of EWG 24-16 (Appendix 9)

Bay of Biscay hake mixed fisheries case study

In this case study example, we are focused on observed data years which run up as far as 2022, and we are focusing on the ecoregion overview as described by ICES (ICES 2022). The Bay of Biscay includes ICES 8.a and 8.b, and 8.d . The objective of EWG 24-16 was to utilise established mixed fisheries advice products to develop a decision support tool which can explore the short term implications of implementing technical measures in terms of biological, social and economic outcomes. EWG 23-15 identified ICES WGMIXFISH advice for the Bay of Biscay as an advice product which could form the basis for such a decision support tool.

Table 4.1 summarises the data, code and information collected to produce a selectivity based model to explore the bioeconomic and social impacts of selectivity measures. An objective of this ad hoc contract tested the data supplied by ICES to ensure that it was consistent with the advice produced in 2023 (reference ICES advice 2023). Once consistency was determined the ICES data, along with associated references documents such as the advice sheets, report, and stock annexes were zipped together and placed on the STECF workspace in preparation for experts attending EWG 24-16.

The framework built through the BIOECON package (reference) was edited and adapted by the author of this ad hoc to fit the needs of the Bay of Biscay case study. This rewriting also included updating a number of functions to suit the workflow and structures of the ICES WGMIXFISH workflow. Data templates were developed to guide experts attending EWG 24-16

Western Mediterranean hake mixed fisheries case study

Four models are currently applied within STECF to assess Mediterranean mixed fisheries. This ad hoc collated the available code and data for each of these models to assess their suitability for inclusion in a framework to assess the impact of technical measures. BEMTOOL was the only model for which this ad hoc could access all of the data and tools required to reproduce the mixed fisheries model. Reproducibility is key to ensuring quality control of any future scenarios tested by the technical measures EWGs.

1 BEMTOOL

BEMTOOL bioeconomic simulation model was implemented for EMU2, following the experiences gained in the previous EWGs. DCF data (FDI and MED&BS Data Call on landings, discards, fishing effort, biological and economic parameters) and results from the assessments carried out during the EWG 23-09 (STECF 2022b) were analysed, to allow the parameterization of BEMTOOL during EWG 23-11 (STECF 2022a). The model included the seven stocks covered by the Multiannual Management Plan (MAP) in the EMU2 (GSAs 9-10-11).

The author of EWG 23-11 application of BEMTOOL provided output and code for a selection of stocks, because BEMTOOL estimates a lot of biological, pressure and economic indicators.

The code to run BEMTOOL is accessible (https://github.com/Isabella84/BEMTOOL2.5), transparent and reproducible, and applied in R. Therefore, it offers the best opportunity for experts attending EWG 24-16 to incorporate in the framework. The repository also contains key information such as the user manual and useful documentation are the Western Med MAP EWG reports, where it was required to report the main equations of the model. Additional useful tools and information for the application of the model were collected (STECF 2023a, Rossetto *et al*. 2015, and Russo, Bitetto *et al*. 2017) through this ad hoc contract and supplied to EWG 24-16, along with code (Appendix 4).

2 SMART

SMART is a mixed fisheries model applied by EWG 23-11 (STECF 2023a). SMART is a spatial model that utilises the R package "smartR" (D'andrea *et al*., 2020) to configure the SMART model and suit it to the requirements of the EMU2 case study. The author of this model provided this ad hoc access to the shiny app developed for the AMARE Med to display results, along with presentation material to explain the function of the model, and associated information (Appendix 5).

3 IAM

IAM (Impact Assessment Model), a bioeconomic mixed fishery simulation model, was implemented in EMU1. The IAM model is documented in the webpage: https://ifremeriam.github.io/IAM/. The authors also supplied the output data to EWG 24-16 but not the input data (Appendix 6). Although this is produced in R and may be possible to incorporate in the framework in the future it was not possible without access to all data, input, code and output.

4 ISIS

ISIS-Fish model applied in The EMU1 ISIS-Fish model would not be easily applied in the proposed framework to test the impact of technical measures as it only describes hake stock (no mixed fisheries), is not built in R and code and data are not easily accessible.

References

D'andrea L, Parisi A, Fiorentino F *et al*. smartR: an R package for spatial modelling of fisheries and scenario simulation of management strategies. Methods Ecol Evol. 2020;11:859–68. https://doi.org/10.1111/2041-210X.13394.

Dolder, P.J., Moore, C., Curtin, R., Ball, J., Muench, A., Aristegui, M., Kalinina, O., Jackson, E., Burke, B., Lordan, C., and Rihan, D. (2021) Bioeconomic model to assess the impact of the Landing Obligation (BIOECON:2019) Deliverable 9 – Final methodology report. Report for Bord Iascaigh Mhara (BIM), iii + 35 pp.

Dolder, P., 2020. Bioeconomic model to assess the impact of the Landing Obligation (BIOECON:2019) Deliverable 3: Methodology report. Lowestoft, UK.

ICES. 2022 Bay of Biscay and the Iberian Coast ecoregion – fisheries Overview. In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, section 6.2. https://doi.org/10.17895/ices.advice.21641396

Moore, C. 2020. Bioeconomic model to assess the impact of the Landing Obligation (BIOECON:2019) Deliverable 1: Summary of data collected on stocks, fisheries, and economic variables, identifying any gaps or limitations. Galway, Ireland.

Muench, A., 2021. Bioeconomic model to assess the impact of the Landing Obligation (BIOECON:2019) Deliverable 3: Economic Methodology report. Lowestoft, UK.

Rossetto, M., Bitetto, I., Spedicato, M. T., Lembo, G., Gambino, M., Accadia, P., & Melià, P. (2015). Multi-criteria decision-making for fisheries management: A case study of Mediterranean demersal fisheries. Marine Policy, 53, 83-93.

Russo, T., Bitetto, I., Carbonara, P., Carlucci, R., D'Andrea, L., Facchini, M. T., ... & Cataudella, S. (2017). A holistic approach to fishery management: evidence and insights from a central Mediterranean case study (Western Ionian Sea). Frontiers in Marine Science, 4, 193.

STECF 2023a. Evaluation of fishing effort and catch regime for demersal fisheries in the western Mediterranean Sea (Part XI) (STECF-23-11), Pinto, C., Doering, R. and Pierucci, A. editor(s), Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/430278, JRC136187.

STECF 2023b. Stock assessments in the Western Mediterranean Sea (STECF 23-09), Mannini, A., Ligas, A. and Pierucci, A. editor(s), Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/995295, JRC135661.

García, D., Sánchez, S., Prellezo, R., Urtizberea, A., and Andrés, M. 2017. FLBEIA: A simulation model to conduct Bioeconomic evaluation of fisheries management strategies. SoftwareX 6: 141-147. https://doi.org/10.1016/j.softx.2017.06.001.

ICES. 2023a. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports 5 :69. 803 pp. https://doi.org/10.17895/ices.pub.23541168.

ICES. 2023b. Working Group on elasmobranch fishes (WGEF). ICES Scientific Reports 5: 92. 837 pp. https://doi.org/10.17895/ices.pub.24190332

ICES. 2023c. Working Group on Widely Distributed Stocks (WGWIDE). ICES Scientific Reports 5: 82. 980 pp. https://doi.org/10.17895/ices.pub.24025482.

ICES. 2023d. Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE). ICES Scientific Reports. 5:106. 272 pp. https://doi.org/10.17895/ices.pub.24496237.

Kell, L.T., Mosqueira, I., Grosjean, P., Fromentin, J.-M., Garcia, D., Hillary, R., Jardim, E., *et al*. 2007. FLR: an open-source framework for the evaluation and development of management strategies. ICES Journal of Marine Science 64(4): 640-646. https://doi.org/10.1093/icesjms/fsm012.

Scientific Technical and Economic Committee for Fisheries (STECF). 2024. Implementation of the Technical Measures Regulation (STECF-23-15), Moore, C., Doering, R. and Vasilakopoulos, P. editors. Publications Office of the European Union, Luxembourg, 2024, JRC137739. https://data.europa.eu/doi/10.2760/434306

ANNEX 2. UPGRADING BEMTOOL FOR COMPATIBILITY WITH CURRENT R VERSIONS

Introduction

BEMTOOL is a comprehensive toolkit designed for biological and ecological modeling in R. Despite its functionality, BEMTOOL presents significant challenges due to its reliance on outdated dependencies, including RGtk2 and an older version of FLCore. These dependencies not only limit compatibility with the latest R versions but also hinder the tool's performance and usability. Moreover, the package comprises over 1,000 scripts, adding complexity to any upgrade or refactoring effort.

The primary objective was to render BEMTOOL functional in a modern R environment without compromising its extensive capabilities. To achieve this, the project was split into two main tasks: upgrading dependencies and ensuring compatibility, and enhancing user interaction options for scenario execution and forecasting. This report provides a comprehensive overview of the challenges faced, solutions developed, and further recommendations for making BEMTOOL a robust and flexible package for current users.

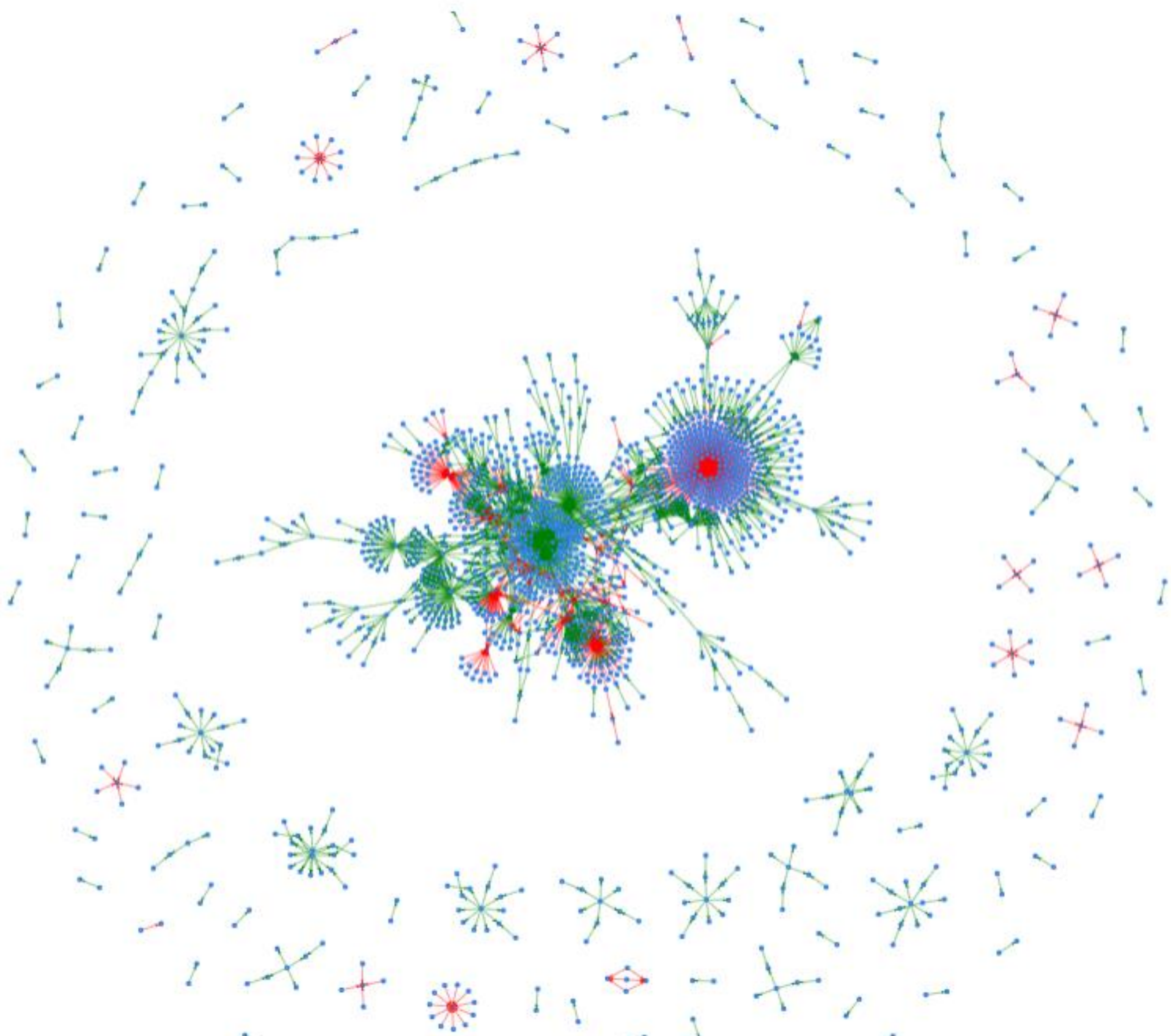


Figure 1. Visual network of BEMTOOL scripts. Green and red edges represent functions and sourced scripts respectively. Produced using the repo_connect.r and repoVisNet helper funs.

Project Goals

1. **Compatibility**: Enable BEMTOOL to work with the latest R versions, resolving issues caused by outdated dependencies.
2. **Usability**: Provide alternative input methods to replace the need for RGtk2, allowing users to work more efficiently.
3. **Management and Maintenance**: Introduce tools for easier management of BEMTOOL's large script library to support future enhancements and facilitate debugging.

Task 1: Compatibility Upgrades

Dependency Challenges

BEMTOOL's reliance on RGtk2 and older versions of FLCore posed significant barriers to compatibility with current R versions. RGtk2 is no longer actively supported, and its absence on CRAN complicates installation, especially in environments requiring R 4.0 or later. Additionally, BEMTOOL includes non-CRAN packages (ALADYM tools) built for R 3.x, further constraining compatibility.

Solutions Implemented

1. Installation of RGtk2 for Current R Versions: Modified the installation and configuration of RGtk2 to enable compatibility with the latest R environment, ensuring that users can work with this dependency where absolutely necessary. An advantage of this approach is that the GUI remains usable, maintaining functionality for users who rely on the visual interface (Appendix 1).

2. **Enhancements to FLCore-Dependent Functions:** Updated or replaced functions dependent on older versions of FLCore, effectively bridging gaps caused by deprecated functions. This included adding scripts to compensate for functionalities that have evolved in FLCore.

Helper Functions for Dependency Management

repo_connect.r:

Purpose: Analyzes and documents functions and dependencies in scripts.
Functionality: Scans a directory of R scripts to find function definitions, function calls, file read/write actions, and required packages. Outputs a structured report summarizing each script's dependencies and functionality.
Generates `script_analysis.txt` with information on function scripts, dependencies, and package requirements.

repoVisNet.R:

Purpose: Creates a visual network of script dependencies.
Functionality: Reads the `script_analysis.txt` file generated by `repo_connect.r` and visualizes script interactions with `visNetwork`. Nodes represent scripts, and edges show dependencies such as function calls or sourced files. The network can be saved as an HTML file.

add_filename_logging.R:

Purpose: Adds filename logging to track script execution, supporting tracking when scripts are run.
Functionality: Inserts a logging line at the start of each R script in a directory, printing the script's filename when sourced or executed.

add_function_call_logging.R:

Purpose: Adds logging within functions for call tracking.
Functionality: Loops through functions in R scripts, adding a print statement at the beginning of each function to log its calls.

find_lines_with_pattern.R:

Purpose: Searches scripts for specific patterns and prints matches, assisting with quick code inspection.

Functionality: Iterates through R scripts in a directory, searching for lines matching a specified pattern (e.g., function names, variables). For each match, it prints the line and line number.

replace_in_file.R:
Purpose: Replaces specific patterns (eg deprecated function) in R scripts across a directory.
Functionality: Iterates through R scripts to find and replace a given pattern while skipping commented lines. Handles encoding issues, ensuring smooth processing across different text formats.
find_scripts_with_functions_and_save.R:
Purpose: Identifies scripts that contain specified functions and saves results.
Functionality: Searches R scripts for specific functions (e.g., GTK/GDK functions used in GUI development) and lists scripts where these functions appear. Saves this information in a `.txt` file, making it easier to track dependencies and assess function usage.
find_unique_pack_functions.R:
Purpose: Detects unique functions from a package used in a repository of scripts.
Functionality: Extracts all functions from a specified package (e.g., `RGtk2`) and checks each script for occurrences of these functions. Generates a unique list of used functions, supporting compatibility checks and dependency tracking.
Rdata_content.R:
Purpose: Inspects contents of `.RData` files to list stored objects.
Functionality: Loads `.RData` files and examines their contents, identifying stored variables, data frames, or models.

Task 2: Refactoring for Enhanced Usability

In the previous BEMTOOL version, user inputs (configuration of scenarios and case studies) were entered through the RGtk2 GUI, which then exported these inputs as CSV files. In the updated version, these CSV files now serve as the primary input mechanism, eliminating the need for RGtk2, while preserving compatibility with existing user workflows. Additionally, a new function was created to accommodate user inputs that were not previously exported to CSV (configuration of forecast settings), ensuring that all necessary data can be easily supplied for scenario execution and forecasting.

Conclusion and Future Recommendations

The work completed to date has successfully adapted BEMTOOL for compatibility with the latest R versions, addressing dependency and usability issues. By removing RGtk2 dependencies, updating outdated functions, and introducing a new input system, we have established a solid foundation for further enhancements.

Recommendations for Future Development

a. Formalize BEMTOOL as an R Package: Transforming BEMTOOL into a formal R package would facilitate installation, version control, and documentation.
b. Implement a Shiny-Based User Interface: A Shiny app would offer a user-friendly, interactive interface for input and scenario configuration, similar to the one already developed through Rgtk2.
c. Maintain Alternative CSV/TXT Input Options: To accommodate all user preferences, it is recommended to maintain CSV or TXT file input options alongside the Shiny app.
d. Documentation and Tutorial Development: Detailed documentation and user tutorials are essential to support the transition to the new input systems.

In conclusion, the steps taken have modernized BEMTOOL's foundation, removing critical dependencies on outdated libraries and introducing a modular, user-centered approach to scenario management. The suite of helper functions developed in this project serves as both a toolset for future maintenance and a guide for continued improvement, positioning BEMTOOL as a more robust and accessible package for ecological and biological modeling in R.

Installing RGtk2 R package in current R versions

1. Download GTK+ dependencies (gtk+-bundle_2.22.1-20101229_win64.zip file) from GNOME
2. Unzip it to the path of your choice.
3. Set the environment variable PATH to where GTK+ was unzipped. You could use this command from within R:
   Sys.setenv(PATH = "Path\\to\\gtk+")
4. Install RGtk2 from Togaware:
   install.packages("https://access.togaware.com/RGtk2_2.20.36.2.zip", repos=NULL)
   or from Github:
   devtools::install_github("cran/RGtk2")
5. Import the library:
   library(RGtk2)
6. A dialog window may appear asking you to intall GTK+. This should install some missing parts of the GTK+ or refer RGtk2 of the GTK+ installed in step 1.
7. Restart R.
8. Import the library again

OBS: Solution valid for WINDOWS. Not tested on Linux or MAC.

ALADYMtools package should be installed afterwards, using the ALADYMTools_1.6.tar.gz provided with the BEMTOOL in the “packages required” folder.

ANNEX 3. SUMMARY OF ECONOMIC FILE FORMAT USED IN BIOECON PACKAGE

BioEcon_Data_V5_030621.csv

- Vessel ID, Unique_Vessel-ID, year, Tot Job, kWs, BIM_Fleet, kwFishDays, SeaDays, kwSeaDays, DCF_Segment, totLandgInc, totOtherInc, VNotch, totNoVarOtherFixed, totNoVarLegalFees, totNoVarAccountancy, totNoVarLoanInterest, totNoVarInsurance, totVarOtherVariable, totVarProvisions, totVarIce, totVarfilters, totRepairs, totEnergyCost, totCrewWage, totFuelDutyRefund, totSubOper, totSubInvest, totCompGovGrant, totVarBait, sundryreceipts, totDepCost, totVarDues, cashatbank, debtors, othercurrentassets, investment BS, bankfinance, bankoverdraft, shorttermloans, othercurrentliabilities, creditors, drawings, longtermloans, totDepHist, tot additions, totDepRep, totvarcost, totnovarcost, depreciation_total, insured_total, assets, debts, netprofit, totalcurrentliabilities, totalcurrentassets, netcurrentassets, netassets, netprofitperiod, closingbalance, openingbalance,

Econ_RawDataAnon_Effort_120521.csv

- Vessel ID, Unique_Vessel-ID, year, Tot Job, BIM_Fleet, kWDays, DCF_Segment, totLandgInc, totOtherInc, VNotch, totNoVarOtherFixed, totNoVarLegalFees, totNoVarAccountancy, totNoVarLoanInterest, totNoVarInsurance, totVarOtherVariable, totVarProvisions, totVarIce, totVarfilters, totRepairs, totEnergyCost, totCrewWage, totFuelDutyRefund, totSubOper, totSubInvest, totCompGovGrant, totVarBait, sundryreceipts, totDepCost, totVarDues, cashatbank, debtors, othercurrentassets, investment BS, bankfinance, bankoverdraft, shorttermloans, othercurrentliabilities, creditors, drawings, longtermloans, totInvest, totDepHist, tot_Invest, tot additions, totDepRep, totvarcost, totnovarcost, depreciation_total, netbook_total, insured_total, assets, debts, netprofit, totalcurrentliabilities, totalcurrentassets, netcurrentassets, netassets, netprofitperiod, closingbalance, openingbalance,

- Econ_RawDataAnon_Effort_181220.csv
  - Vessel ID, year, BIM_Fleet, kWDays, DCF_Segment, totLandgInc, totOtherInc, VNotch, totCrewWage, totNoVarOtherFixed, totNoVarLegalFees, totNoVarAccountancy, totNoVarLoanInterest, totNoVarInsurance, totVarOtherVariable, totVarProvisions, totVarIce, totVarfilters, totRepairs, totEnergyCost, totFuelDutyRefund, totSubOper, totSubInvest, totCompGovGrant, totVarBait, sundryreceipts, totDepCost, totVarDues, cashatbank, debtors, othercurrentassets, investment, bankfinance, bankoverdraft, shorttermloans, othercurrentliabilities, creditors, drawings, longtermloans, totInvest, totDepHist, tot_Invest, totDepRep, totvarcost, totnovarcost, depreciation_total, netbook_total, insured_total, assets, debts, netprofit, totalcurrentliabilities, totalcurrentassets, netcurrentassets, netassets, netprofitperiod, closingbalance, openingbalance,
- SalesNotesPrices.csv
  - Species
  - FAO Code
  - Year
  - Division
  - Gear
  - Price
- Port_list.csv
  - PortName
  - Country
  - IcesDivision

ANNEX 4. BAY OF BISCAY CASE STUDY DATA INPUT FORMATS

Data input identification
Christoph Lines 38-line 44

Line 38:

“scenario descriptors”?
"sce_desc.RData” --> sce_desc

- names(sce_desc)
    - "name" "description"
    - Description of scenarios (eg fixedEffort, minTAC20xx etc)
- 9 scenarios available

Line 39:

"data_for_map.RData" --> data_for_map

- names(data_for_map)
    - "Port" "year" "lon" "lat" "Landings" "Value" "jobs"
- Unsure what “jobs” precisely refers to

Line 40:

"dat_00_bind.RData" --> dat_00_bind

- names(dat_00_bind)
    - "scenario" "year" "fleet" "variable" "value"
- scenario: same as “name” in sce_desc
- year: year of data
- fleet: Fleet
- variable:
    - [1] "Discards (t)" "Landings (t)"
    - [3] "Catch (t)" "Effort (000 kW/Day)"
    - [5] "Gross profit (€)" "Net profit (€)"
    - [7] "Gross profitability (%)" "Net profitability (%)"
- value: Value of data

Line 41:

"dat_01.RData" --> dat_01

- names(dat_01)
    - [1] "scenario" "year" "fleet" "stock" "iter" "catch"
    - [7] "landings" "discards" "discRat" "price" "tacshare" "quota"
    - [13] "quotaUpt" "choke"
- choke: false/true, not sure where this is from

Line 42:

"dat_01_bind.RData" --> dat_01_bind

- names(dat_01_bind)
    - [1] "scenario" "year" "fleet" "stock" "variable" "value"
- unique(dat_01_bind[,5])
    - [1] Landings (t) Discards (t) Catch (t)

Line 43:

"dat_01_bind_general.RData" --> dat_01_bind_general

- names(dat_01_bind_general)
    - [1] "stock" "scenario" "year" "variable"
    - [5] "value" "Common name" "Scientific name" "Notes"
- stock: three letter FAO for spp
- variable: Discards (t) Landings (t) Catch (t)
- All by species, not stock abbreviation

Line 44:

"dat_01_bind_general_1.RData" --> dat_01_bind_general_1

Same as line 43

Margarita Lines 45 to 53

- Line 45

names(dat_01_bind_general_2)

Landings and discards for each scenario and stock 2017-2019 plus simulated year 2021
[1] "stock" "scenario" "year" "variable" "value" "Common name" "Scientific name"
[8] "Notes"
unique(dat_01_bind_general_2$year)
[1] "2019" "2021 [Simulated data]" "2018" "2017"
unique(dat_01_bind_general_2$variable)
[1] Discards (t) Landings (t)
Levels: Discards (t) Landings (t) Catch (t)

- Lines 46-50

load("plot_fleet_ylim.RData") load("plot_fleet_height.RData")
load("plot_fleet_height_1.RData")
load("plot_fleet_height_2.RData")

Plot specifications for fleets

plot_fleet_ylim
[1] 18985.29
plot_fleet_height
[1] "896px"
plot_fleet_height_1
[1] 816
plot_fleet_height_2
[1] 896

- Line 51

load("dat_02_bind.RData")
Effort, effort proportion, gross value (in euros) and gross value proportion by fleet metier and scenario
names(dat_02_bind)
[1] "scenario" "year" "fleet" "metier" "variable" "value"
unique(dat_02_bind$variable)
[1] Effort (000 kW/Day) Effort proportion (fraction) Gross value (€)
[4] Gross value proportion (fraction)

- Line 52

load("dat_03_bind.RData")
Landings, discards, annual revenue, catch by year, scenario, fleet, metier and stock
unique(dat_03_bind$variable)
[1] Catch (t) Landings (t) Discards (t) Revenue (€)

Levels: Catch (t) Landings (t) Discards (t) Revenue (€)
> names(dat_03_bind)
[1] "scenario" "year" "fleet" "metier" "stock" "variable" "value"

- Line 53

load("dat_04_bind.RData")
F, SSB (t), Recruitment (numbers*), Catch (t), Landings (t), Discards (t)
and Abundance\n(millions) for historical data by stock, category and year. For scenario intermediate year only data for 2020 and for the other scenarios only data for "2021 [2022 for SSB]".

unique(dat_04_bind$variable)
[1] f SSB (t) Recruitment\n(numbers*)
Catch\n(t) Landings\n(t)
[6] Discards\n(t) Abundance\n(millions)

Mari 54 to 60

- **Line 54: dat_04_lines.RData** --> Historical data on Reference points: Ftarget, Flim, Fpa, Btarget, Blim and Bpa for f, SSB and abundance/n (millions) by stock, from 2010 to 2021 (2022 for SSB)
  unique(dat_04_lines$line)
  [1] Ftarget Flim Fpa Btarget Blim Bpa
  > names(dat_04_lines)
  [1] "scenario" "year" "stock" "variable" "value" "line"
  > unique(dat_04_lines$variable)
  [1] f SSB (t) Abundance\n(millions)
  Levels: Abundance\n(millions) f SSB (t) ear" "stock" "variable" "value" "line"
  > unique(dat_04_lines$year)
  [1] "2010" "2011" "2012" "2013" "2014"
  [6] "2015" "2016" "2017" "2018" "2019"
  [11] "2020" "2021 [2022 for SSB]"

- **Line 55: dat_county_bind** --> Historical data on socio-economic variables by county for the years 2019 to 2021 (simulated data)
  names: [1] Direct full-time employment Direct gross value added (€) Downstream full-time employment
  [4] Downstream gross value added (€) Number of jobs Estimated gross value added (€)
  6 Levels: Direct full-time employment Direct gross value added (€) ... Estimated gross value added (€)
  > unique(dat_county_bind$year)
  [1] "2019" "2017" "2018" "2021 [Simulated data]"

- **Line 56: dat_port_bind.RData --> same as before, by port**

- **Line 57: dat_fleet_bind.RData --> number of jobs by fleet** for the years 2019 to 2021 (simulated data)

- **Line 58: dat_map_plot.RData** --> value of landings and number of jobs by port for the years 2017, 2018 and 2019
  unique(dat_map_plot$variable)
  [1] Landings (t) Value (€) Number of jobs
  Levels: Landings (t) Value (€) Number of jobs
  > unique(dat_map_plot$Year)
  [1] 2017 2018 2019
  Levels: 2017 2018 2019

- **Line 59: dat_glos_terms.RData** --> glossary, definitions provided for metiér, stock, fleet, fishery etc.

Term	Definition
Metiér	Homogeneous sub-division of a fishery by fleet (e.g. the Dut...
Stock	A part of a fish population usually with a particular migratio...
Fleet	A physical group of vessels sharing similar characteristics in ...
Fishery	Group of vessel voyages targeting the same (assemblage of...
Discards	Are those components of a fish stock thrown back after cap...
F Fishing mortality	Instantaneous Rate of Fishing Mortality. When fishing and n...
rec	The amount of fish added to the exploitable stock each year...
ssb	Spawning stock biomass. Total weight of all sexually mature ...
Catch	Sum components of a fish stock after capture includeing th...
Landings	Are those components of a fish stock retained after capture
Gross profit	Income from landings + other income – crew wages– energ...
Net profit	gross profit – depreciation cost – opportunity cost of capital
Cost	other variable costs – non variable costs

- **Line 60: dat_glos_spe.RData** --> scientific names and species code for 26 fish species included in the model

	Common name	Scientific name	Species code
1	Anglerfish	Lophius sp.	ANF
2	Cod	Gadus morhua	COD
3	Greater forkbeard	Phycis blennoides	GFB
4	Greenland halibut	Reinhardtius hippoglossoides	GHL
5	Haddock	Melanogrammus aeglefinus	HAD
6	Hake	Merluccius merluccius	HKE
7	Megrims	Lepidorhombus	LEZ
8	Megrims	Lepidorhombus whiffiagonis	MEG
9	Anglerfish	Lophius piscatorius	MON
10	Nephrops	Nephrops norvegicus	NEP
11	Plaice	Pleuronectes platessa	PLE
12	Saithe	Pollachius virens	POK
13	Pollack	Pollachius pollachius	POL
14	[illegible]	[illegible]	[illegible]

Klass 61 to 68

- "dat_glos_met.RData"

Glossary of métier terms

`Gear type` `Gear description` `Gear code`

```
  <chr>                    <chr>                <chr>
1 SEINES                    Scottish seines       SSC
2 TRAWLS - Bottom             Beam trawls           TBB
3 TRAWLS - Bottom             Otter trawls          OTB
4 TRAWLS - Midwater           Otter trawls          OTM
5 TRAWLS - Midwater           Pair trawls           PTM
6 DREDGES                    Boat dredges          DRB
7 GILLNETS AND ENTANGLING NETS Set gillnets (anchored) GNS
8 TRAPS                     Pots                 FPO
9 HOOKS AND LINES             Set longlines         LLS
```

- "dat_glos_tar.RData"

Glossary of target species

```
# A tibble: 7 x 2
  `Target code` `Target description`
  <chr>         <chr>
1 CRU           Crustaceans
2 PEL           Pelagic
3 DEF           Demersal
4 SPF           Small pelgic fleet
5 Other         Other species
6 MOL           Mollusc
7 MCF           Mixed crustaceans and fish
```

- "dat_glos_sto.RData"

Glossary terms of fish stocks ie

```
   Species code       Common name              Scientific
name               Stock

1          ANF        Anglerfish                 Lophius sp.         anf.27.3a46
2          ARU Greater argentine              Argentina silus         aru.27.5b6a
```

Stock description

1 Anglerfish (Lophius budegassa. Lophius piscatorius) in subareas 4 and 6. and Division 3.a (North Sea. Rockall and West of Scotland. Skagerrak and Kattegat)

2 Greater silver smelt (Argentina silus) in divisions 5.b and 6.a (Faroes grounds and west of Scotland)

- "dat_glos_fle.RData"

Glossary of fleets included in the model

```
# A tibble: 10 x 4
   `Fleet <U+200B>`                    `Fishing<U+200B> technique<U+200B>` `Vessel <U+200B>length  (m<U+200B>)`
`Description <U+200B>`
   <chr>                       <chr>              <chr>              <chr>

 1 Beam_trawlers_18<40m          TBB<U+200B>                18-40<U+200B>               Beam Trawls -<U+200B> Vessel length categories merged as considered same catch profile <U+200B>
 2 Otter_trawlers_18<24m         DTS<U+200B>                18-23<U+200B>               Demersal Trawlers<U+200B>
 3 Otter_trawlers_24<40m         DTS<U+200B>                24-40 <U+200B>              Demersal trawlers<U+200B>
```

```
 4 Otter_trawlers_Freezer_18<24m DTS-Freezer <U+200B>        18-
23<U+200B>               Freezer Trawlers  <U+200B>
 5 Otter_trawlers_Freezer_24<40m DTS-Freezer <U+200B>        24-
40 <U+200B>              NA
 6 Potting_polyvalent_all        FPO<U+200B>              >12<U+200B>              Polyvalent
Potting: <U+200B>Vessels which have 90%+crab / lobster / molluscs <U+200B>
 7 Scallopers_>10m               DRB<U+200B>              >10<U+200B>              Scallop
Fishery <U+200B>
 8 Seines_18<40m                 DTS<U+200B>              18-
40<U+200B>               Seiners<U+200B>
 9 Pelagic_polyvalent_all        TM<U+200B>               all<U+200B>              Pelagic Trawls -
<U+200B>Polyvalent General
10 Pelagic_RSW_all               TM<U+200B>               all<U+200B>              Pelagic
Trawls <U+200B>RSW (refrigerated seawater)
```

- "sankey_general_data.RData"

Input for Sankey diagram => link species landings to fleets over different years

```
year                    fleet           stock     landings
1   2017         Beam_trawlers\n18<40m        Anglerfish  530.9074801
2   2018         Beam_trawlers\n18<40m        Anglerfish  525.9998448
3   2019         Beam_trawlers\n18<40m        Anglerfish  532.7500217
4   2017                    Others        Anglerfish  375.1898883
5   2018                    Others        Anglerfish  391.4868557
```

- "sank.RData"

Input to Sankey diagram => stock to métier

- A list with elements organized according to the data years (ie 2017; 2018; 2019; full…)

```
  Stock     Metier                Fleet                       `Landings (t)`
   <fct>     <chr>                 <chr>                              <dbl>
 1 had.27.7a OTB_CRU_70-99_27.7.a   Otter_trawlers_18<24m                 10.4
 2 had.27.7a OTB_CRU_70-99_27.7.a   Otter_trawlers_24<40m                  0.27
 3 had.27.7a OTB_CRU_70-99_27.7.a   Otter_trawlers_Freezer_18<24m          7.6
```

- "sank2.RData"

Input for Sankey diagram

```
                      from                    to        data
1           Beam_trawlers_18<40m     TBB_DEF_70-99_27.7.a 4.246562e+02
2           Beam_trawlers_18<40m   TBB_DEF_70-99_27.7.e-k 1.658579e+03
3                     Others           Others_27.6.a 5.333155e+01
4                     Others           Others_27.7.a 4.676165e+02
```

- "sank3.RData"

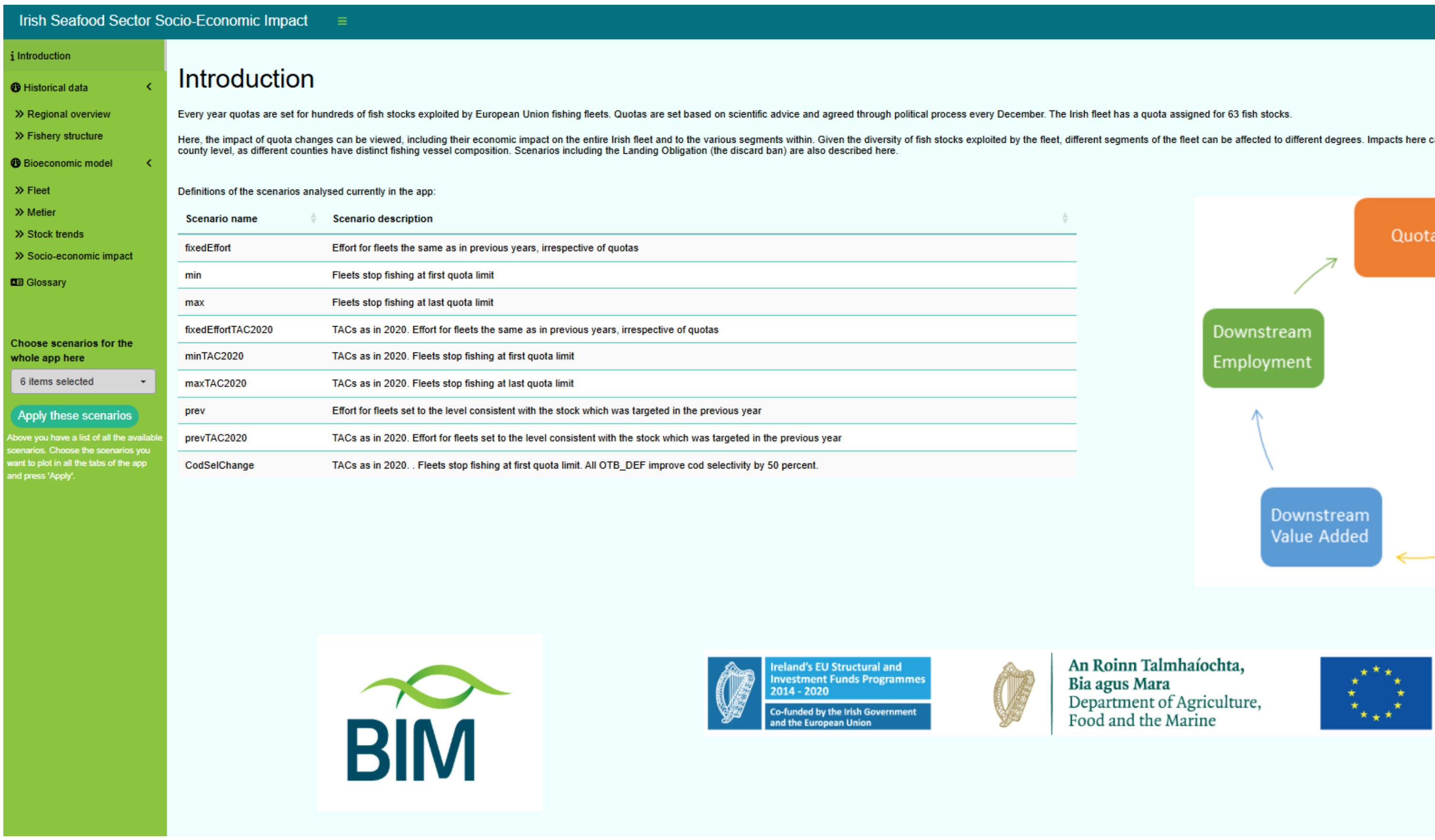
Input for Sankey diagram (same but other links)

```
              from                         to              data
1           TBB_DEF_70-99_27.7.a         Beam_trawlers_18<40m   424.656196947818
2         TBB_DEF_70-99_27.7.e-k         Beam_trawlers_18<40m   1658.57865791164
```

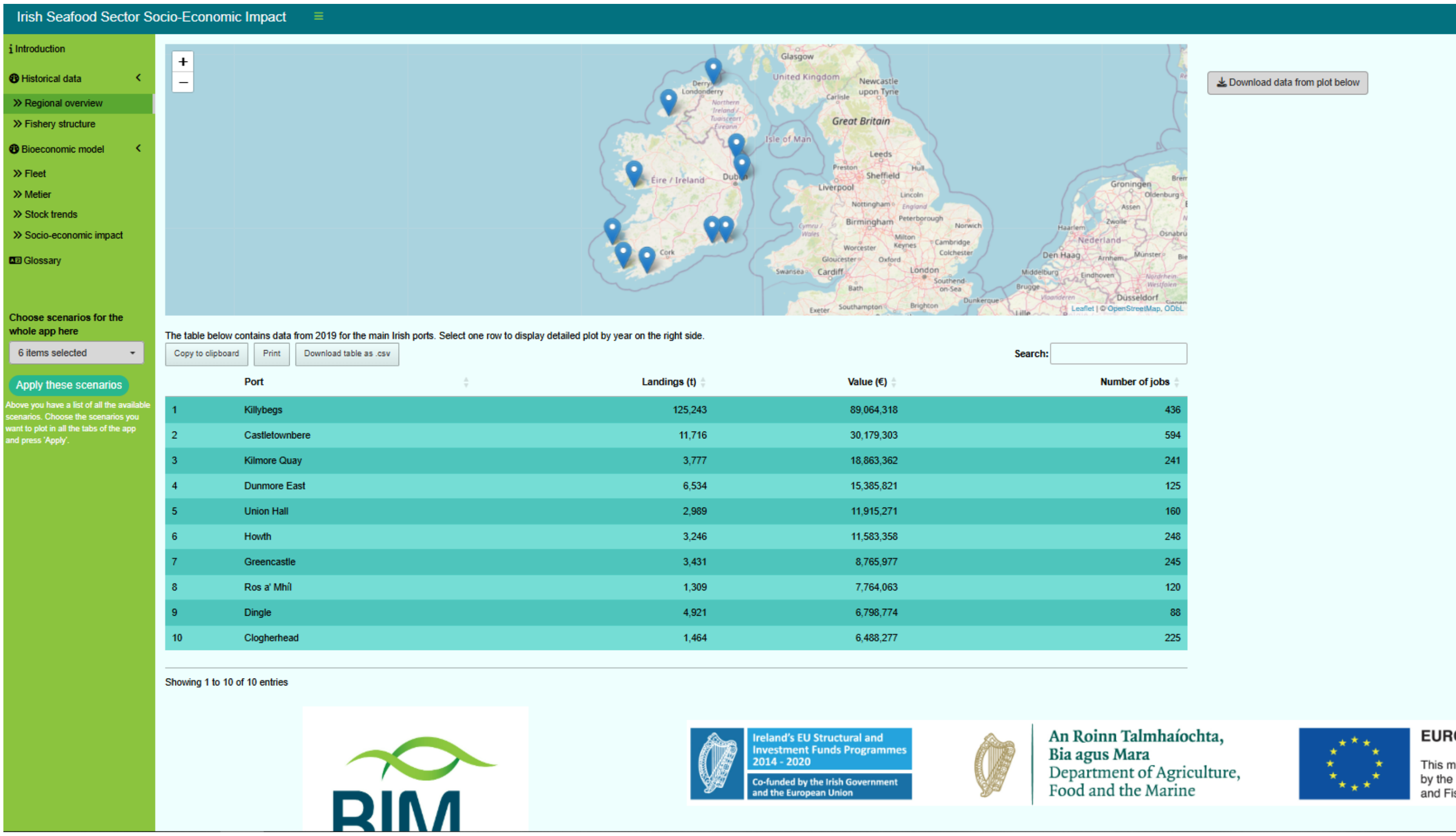
Annex 5. CURRENT LAYOUT OF BIOECON APP

The following images provide a summary of the layout and summary of the starting format of BioEcon package (Dolder *et al*. 2021), prior to updating for EWG 24-16.

Tab 1: Introduction

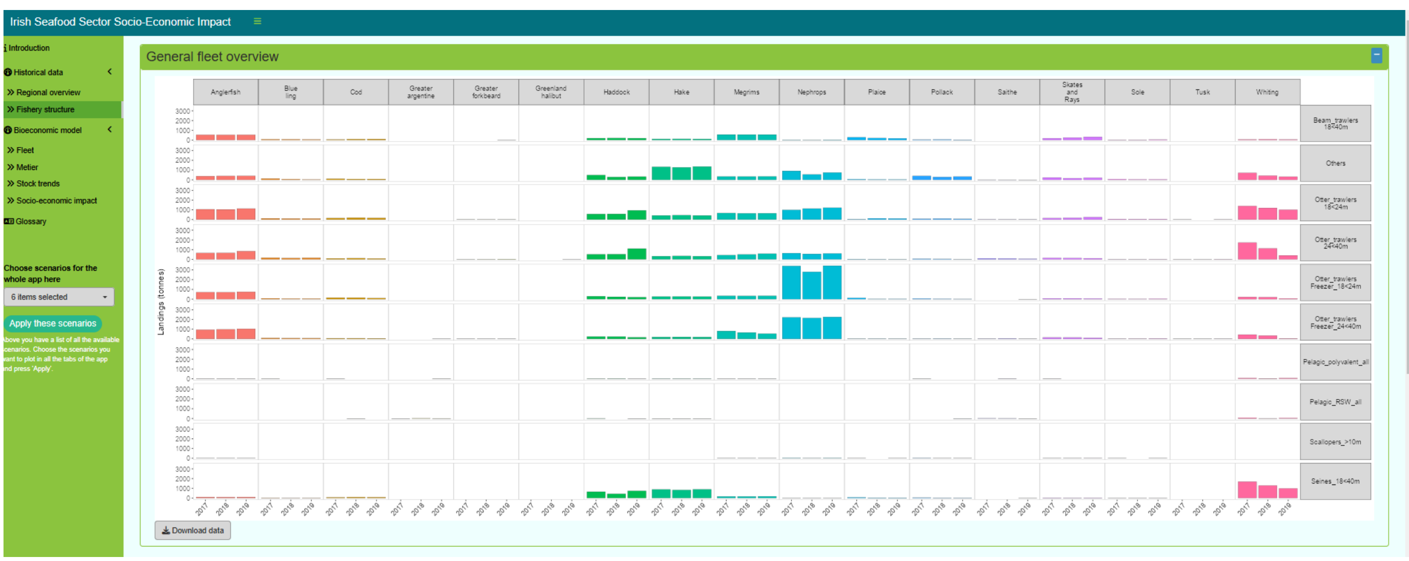


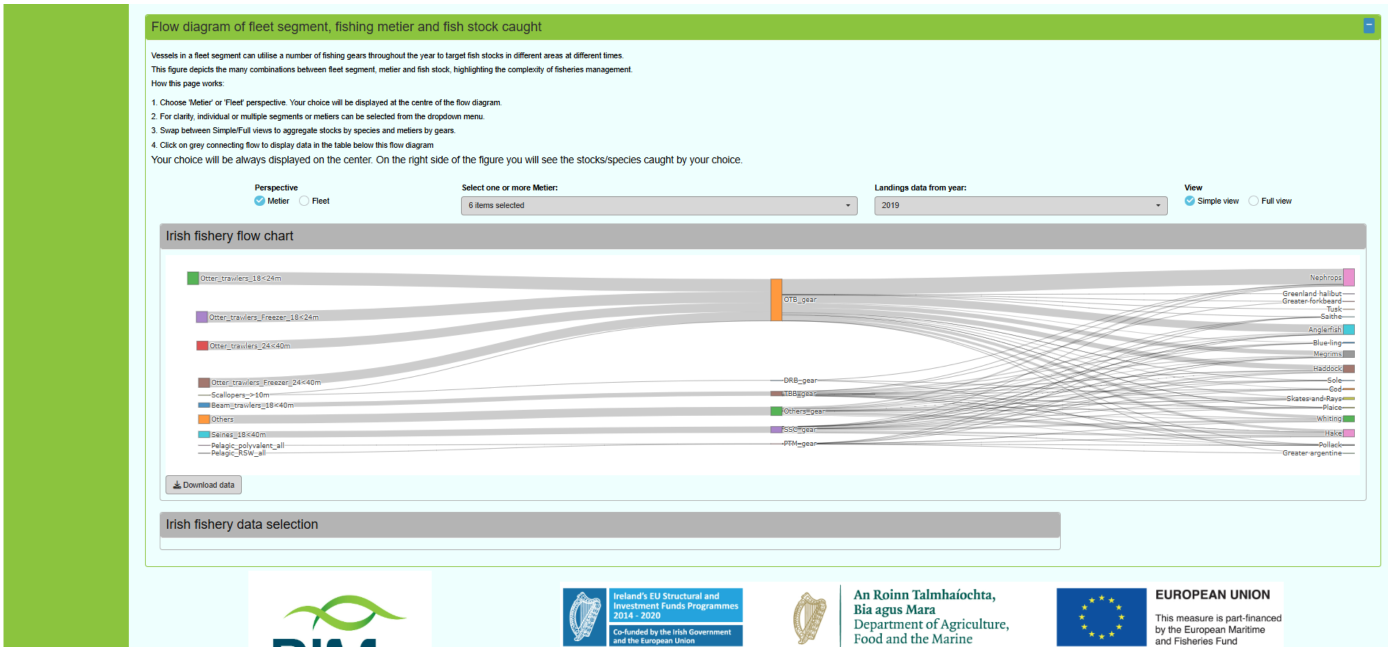
Tab 2: Historical data – regional overview



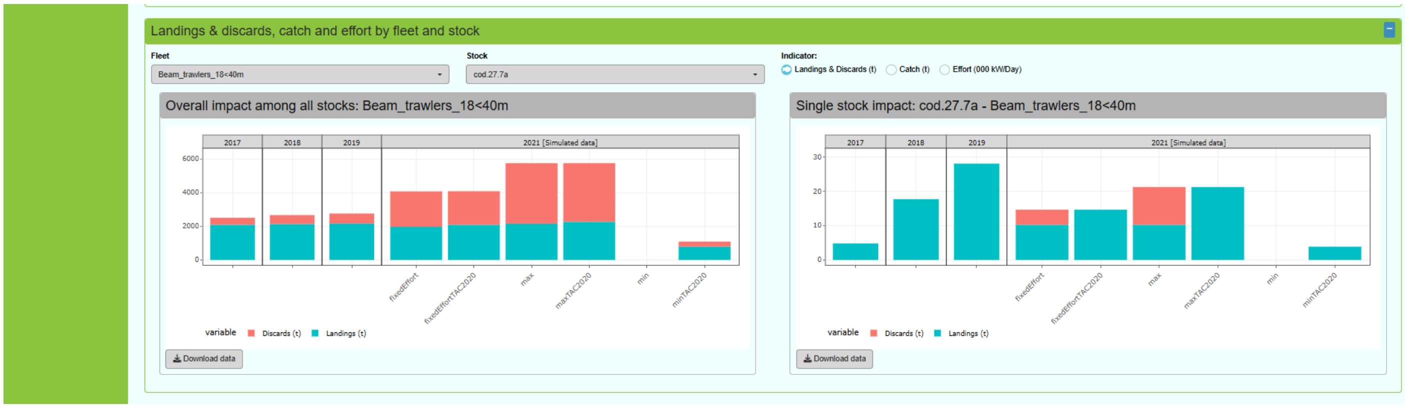
	Port	Landings (t)	Value (€)	Number of jobs
1	Killybegs	125,243	89,064,318	436
2	Castletownbere	11,716	30,179,303	594
3	Kilmore Quay	3,777	18,863,362	241
4	Dunmore East	6,534	15,385,821	125
5	Union Hall	2,989	11,915,271	160
6	Howth	3,246	11,583,358	248
7	Greencastle	3,431	8,765,977	245
8	Ros a' Mhíl	1,309	7,764,063	120
9	Dingle	4,921	6,798,774	88
10	Clogherhead	1,464	6,488,277	225

Tab 3: Historical data - fishery structure

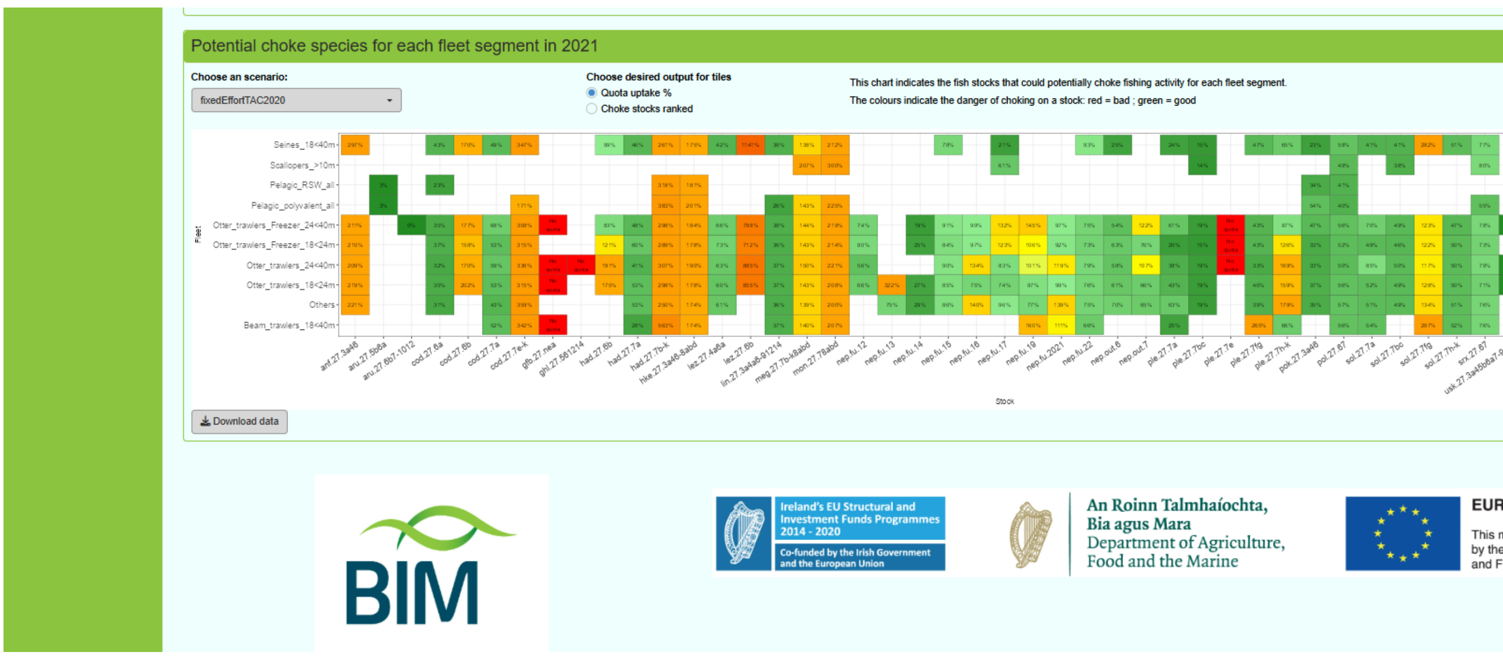




Tab 4: Bioeconomic model – fleet



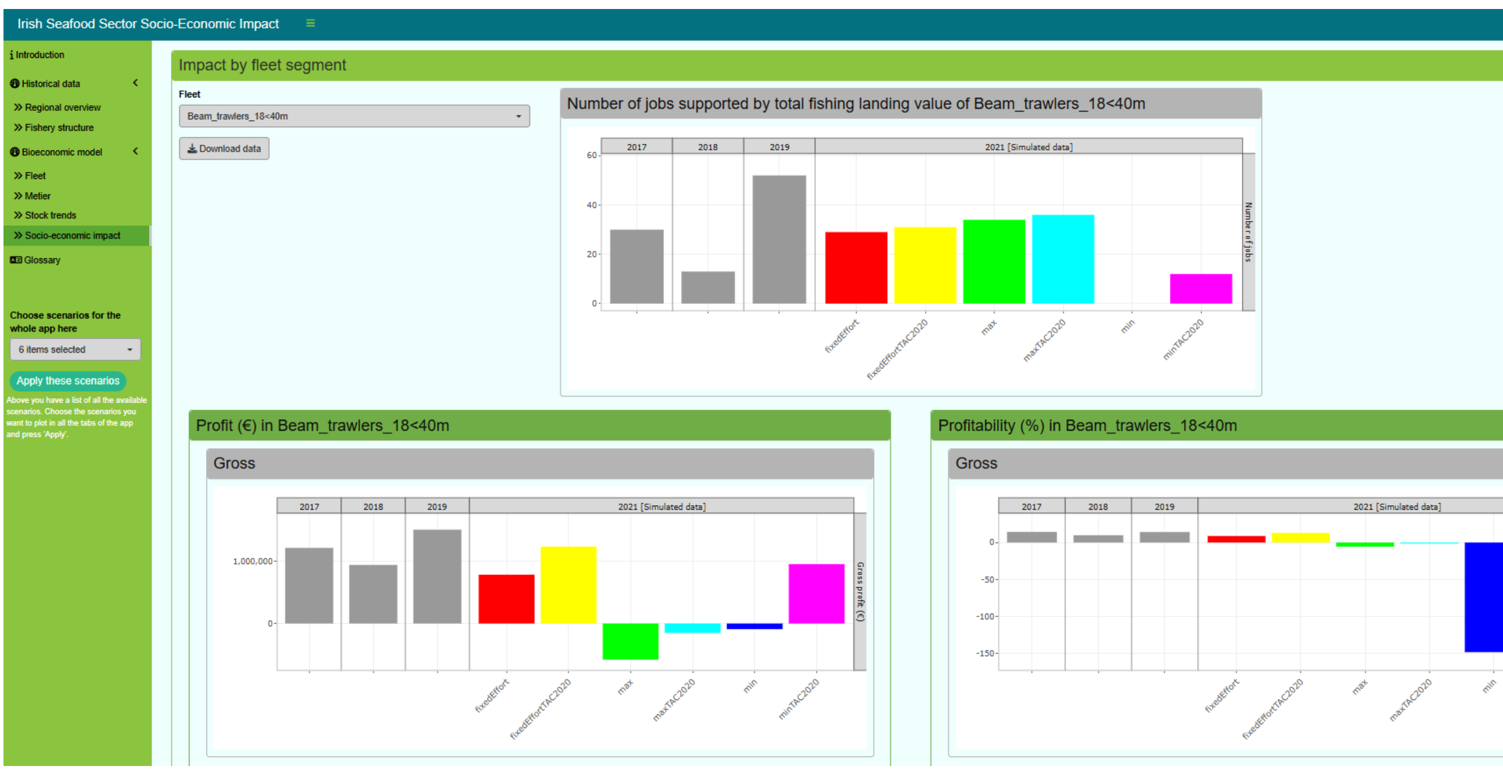
Tab 4: Bioeconomic model – fleet (continued)

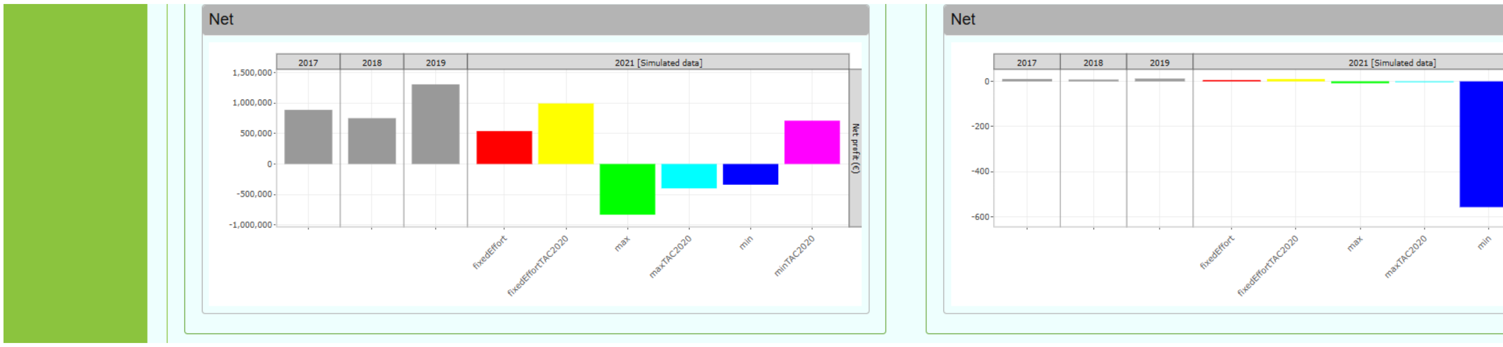


Tab 5: Bioeconomic model – métier

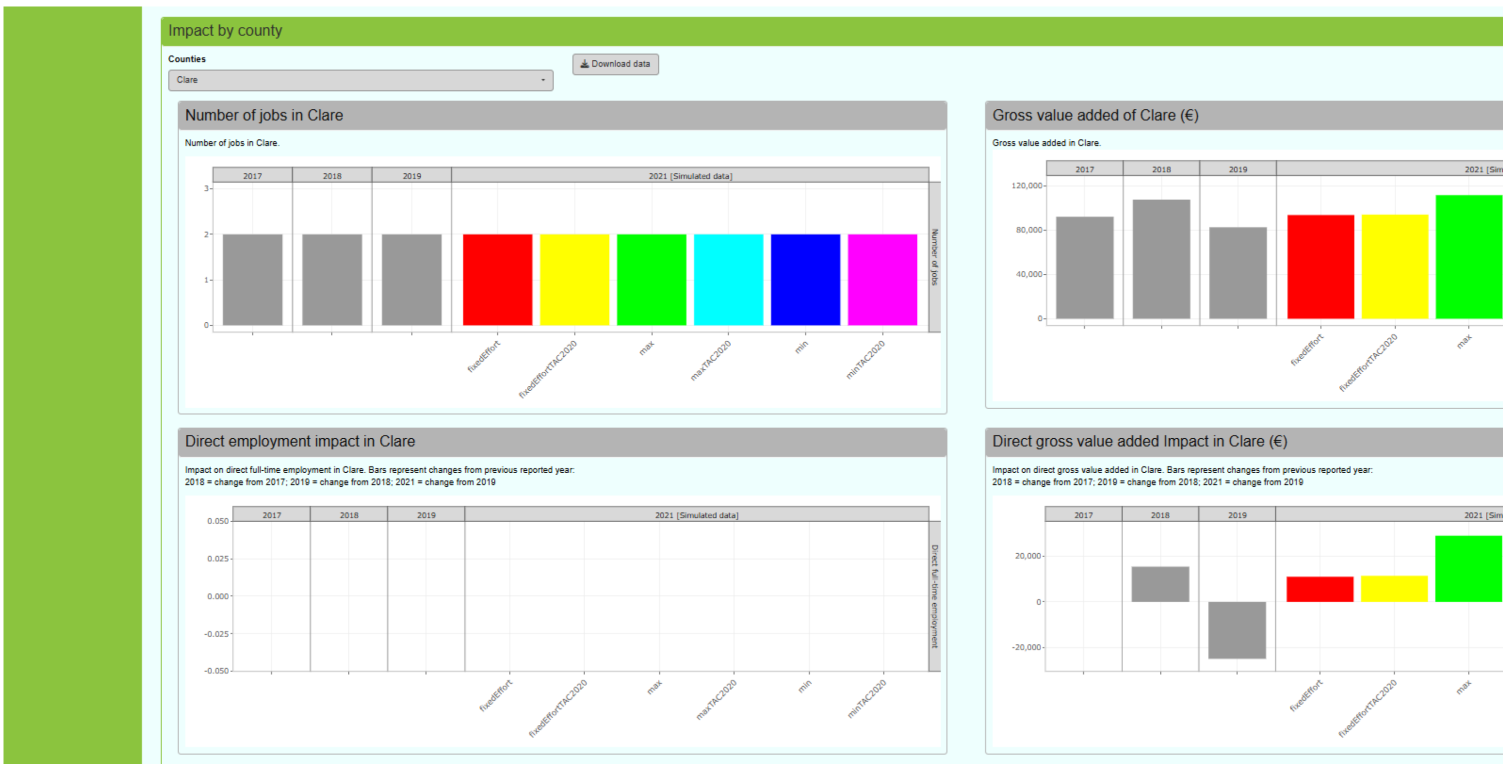
Tab 6: Bioeconomic model – stock trends

Tab 7: Bioeconomic model – socio-economic impact by fleet segment

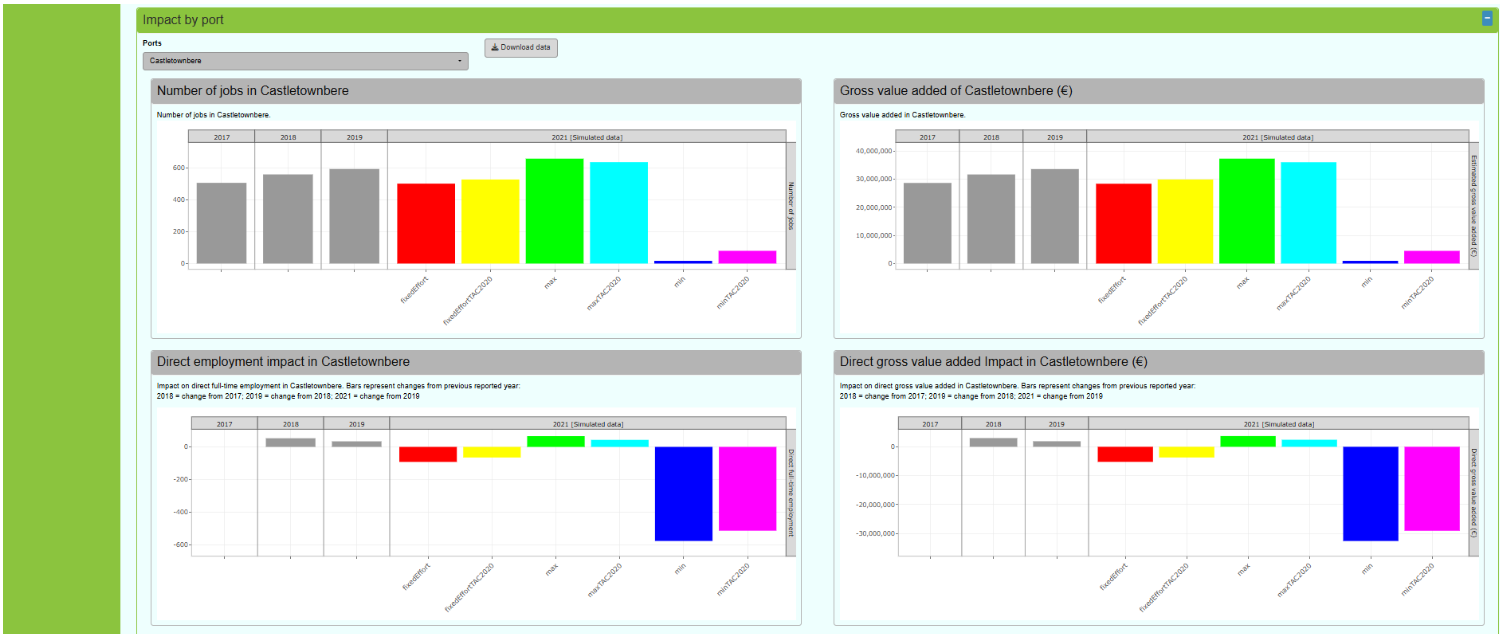


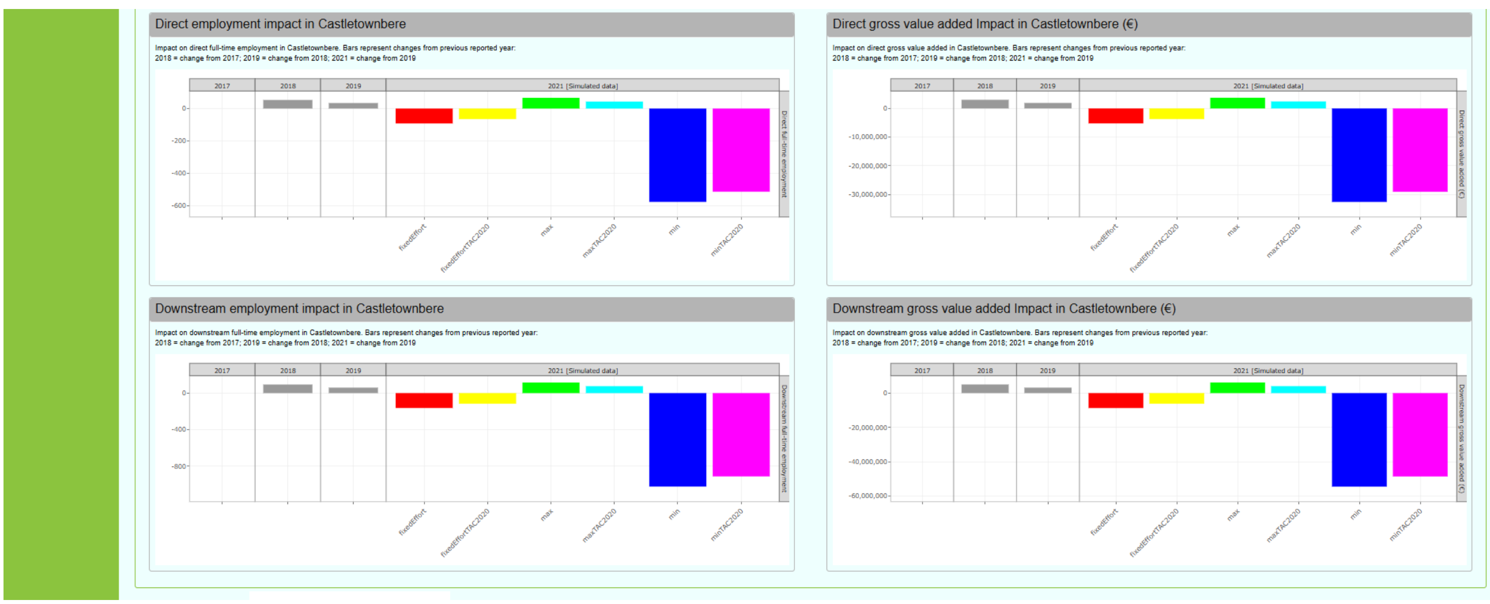


Tab 7: Bioeconomic model – socio-economic impact by county (continued)



Tab 7: Bioeconomic model – socio-economic impact by port (continued)





Tab 8: Glossary

Irish Seafood Sector Socio-Economic Impact

ℹ Introduction
Historical data
» Regional overview
» Fishery structure
Bioeconomic model
» Fleet
» Metier
» Stock trends
» Socio-economic impact
Glossary

Choose scenarios for the whole app here

6 items selected

Apply these scenarios

Above you have a list of all the available scenarios. Choose the scenarios you want to plot in all the tabs of the app and press 'Apply'.

Glossary

Definition of terms

Term	Definition
Metiér	Homogeneous sub-division of a fishery by fleet (e.g. the Dutch flatfish-directed beam trawl fishery by vessels < 300 hp in the North Sea). See also: fishery, fleet
Stock	A part of a fish population usually with a particular migration pattern, specific spawning grounds, and subject to a distinct fishery. In theory, a Unit Stock comprises all the individuals of fish in an area, which are part of the same reproductive process. It is self□contained, with no emigration or immigration of considered a 'stock' for management purposes (or a management unit), as long as the results of the assessments and management remain close enough to what they would be on the unit stock.
Fleet	A physical group of vessels sharing similar characteristics in terms of technical features and/or major activity (e.g. the Dutch beam trawler fleet < 300 hp). See also: fishery, metier.
Fishery	Group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area (e.g. the Dutch flatfish-directed beam trawl fishery in the North Sea). See also: fleet, metier.
Discards	Are those components of a fish stock thrown back after capture e.g. because they are below the minimum landing size or because quota have been exhausted for that species. Most of the discarded fish will not to survive.
F Fishing mortality	Instantaneous Rate of Fishing Mortality. When fishing and natural mortality act concurrently, F is equal to the instantaneous total mortality rate (Z), multiplied by the ratio of fishing deaths to all deaths. Expressed on an exponential scale: F=0.5 means that 1-EXP(-0.5)=39% are removed.
rec	The amount of fish added to the exploitable stock each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to the fishing gear in one year would be the recruitment to the fishable stock that year. This term mostly used in referring to the their first year are age 1 recruits
ssb	Spawning stock biomass. Total weight of all sexually mature fish in the stock.
Catch	Sum components of a fish stock after capture includeing the discarded and landed portion of the capture

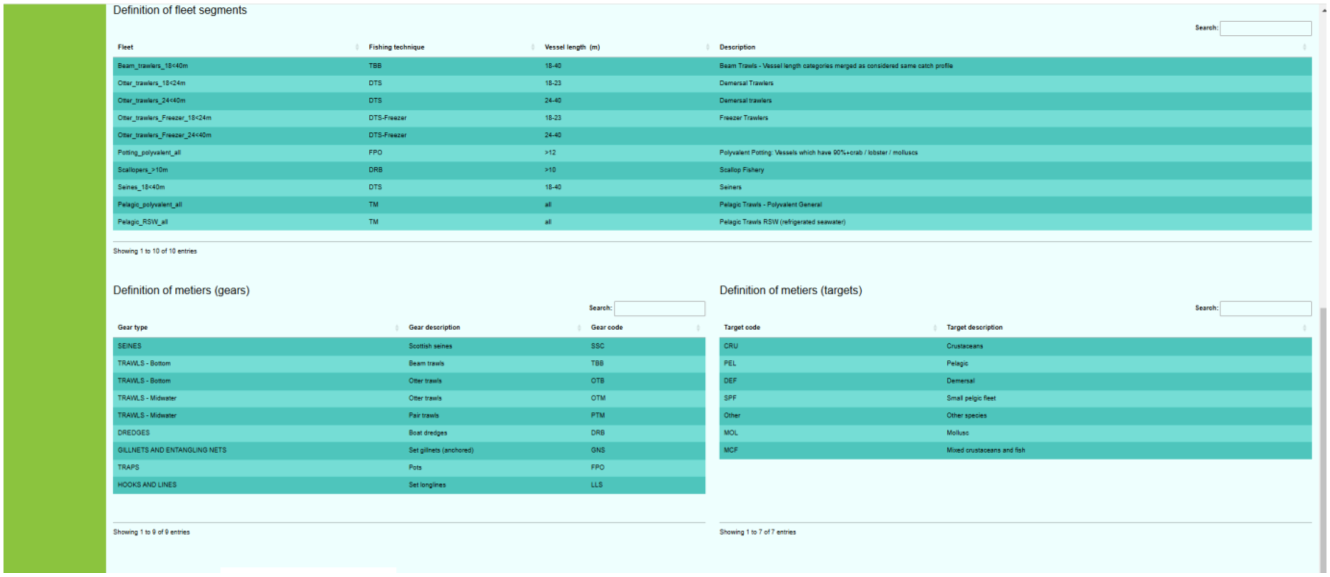
Showing 1 to 13 of 13 entries

Definition of stocks

Species code	Common name	Scientific name	Stock	Stock description
ANF	Anglerfish	Lophius sp.	anf.27.3a46	Anglerfish (Lophius budegassa. Lophius piscatorius) in subareas 4 and 6. and Division 3.a (North Sea. Rockall and West of Scotland. Skagerrak and Kattegat)
ARU	Greater argentine	Argentina silus	aru.27.5b6a	Greater silver smelt (Argentina silus) in divisions 5.b and 6.a (Faroes grounds and west of Scotland)
ARU	Greater argentine	Argentina silus	aru.27.6b7-1012	Greater silver smelt (Argentina silus) in subareas 7-10 and 12. and Division 6.b (other areas)
COD	Cod	Gadus morhua	cod.27.7a	Cod (Gadus morhua) in Division 7.a (Irish Sea)
COD	Cod	Gadus morhua	cod.27.7e-k	Cod (Gadus morhua) in divisions 7.e-k (eastern English Channel and southern Celtic Seas)
COD	Cod	Gadus morhua	cod.27.6a	Cod (Gadus morhua) in Division 6.a (West of Scotland)
COD	Cod	Gadus morhua	cod.27.6b	Cod (Gadus morhua) in Division 6.b (Rockall)
GFB	Greater forkbeard	Phycis blennoides	gfb.27.nea	Greater forkbeard (Phycis blennoides) in subareas 1-10. 12 and 14 (the Northeast Atlantic and adjacent waters)
GHL	Greenland halibut	Reinhardtius hippoglossoides	ghl.27.561214	Greenland halibut (Reinhardtius hippoglossoides) in subareas 5. 6. 12. and 14 (Iceland and Faroes grounds. West of Scotland. North of Azores. East of Greenland)
HAD	Haddock	Melanogrammus aeglefinus	had.27.6b	Haddock (Melanogrammus aeglefinus) in Division 6.b (Rockall)
HAD	Haddock	Melanogrammus aeglefinus	had.27.7a	Haddock (Melanogrammus aeglefinus) in Division 7.a (Irish Sea)

Showing 1 to 46 of 46 entries

Tab 8: Glossary continued



Definition of fleet segments

Search:

Fleet	Fishing technique	Vessel length (m)	Description
Beam_trawlers_18<40m	TBB	18-40	Beam Trawls - Vessel length categories merged as considered same catch profile
Otter_trawlers_18<24m	DTS	18-23	Demersal Trawlers
Otter_trawlers_24<40m	DTS	24-40	Demersal trawlers
Otter_trawlers_Freezer_18<24m	DTS-Freezer	18-23	Freezer Trawlers
Otter_trawlers_Freezer_24<40m	DTS-Freezer	24-40	
Potting_polyvalent_all	FPO	>12	Polyvalent Potting: Vessels which have 90%+crab / lobster / molluscs
Scallopers_>10m	DRB	>10	Scallop Fishery
Seines_18<40m	DTS	18-40	Seiners
Pelagic_polyvalent_all	TM	all	Pelagic Trawls - Polyvalent General
Pelagic_RSW_all	TM	all	Pelagic Trawls RSW (refrigerated seawater)

Showing 1 to 10 of 10 entries

Definition of metiers (gears)

Search:

Gear type	Gear description	Gear code
SEINES	Scottish seines	SSC
TRAWLS - Bottom	Beam trawls	TBB
TRAWLS - Bottom	Otter trawls	OTB
TRAWLS - Midwater	Otter trawls	OTM
TRAWLS - Midwater	Pair trawls	PTM
DREDGES	Boat dredges	DRB
GILLNETS AND ENTANGLING NETS	Set gillnets (anchored)	GNS
TRAPS	Pots	FPO
HOOKS AND LINES	Set longlines	LLS

Showing 1 to 9 of 9 entries

Definition of metiers (targets)

Search:

Target code	Target description
CRU	Crustaceans
PEL	Pelagic
DEF	Demersal
SPF	Small pelgic fleet
Other	Other species
MOL	Mollusc
MCF	Mixed crustaceans and fish

Showing 1 to 7 of 7 entries

ANNEX 6. TEXT TO POPULATE MEDITERRANEAN APP

Mediterranean Seafood Sector Socio-Economic Impact

2024-10-25

Introductions

The Western Mediterranean Sea Multi-Annual Management Plan (West Med MAP) refers to the Western Mediterranean geographical subareas (GSA) adjacent to Spain, France and Italy in GSAs 1, 2, 5, 6, 7, 8, 9, 10 and 11, grouped into two spatial EMU (Effort Management Units) - EMU1 for GSAs 1 to 7 and EMU2 for GSAs 8 to 11.

Regional overview

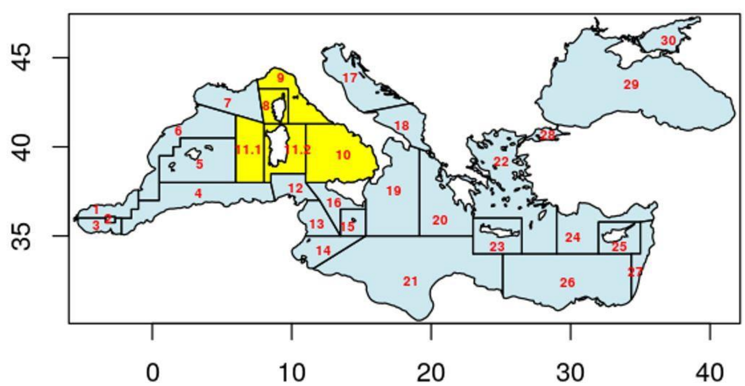


Table 1: Ports and their respective fishing data (Landings, Value, Number of Jobs).

Port	Landings (t)	Value (€)	Number of Jobs
Sanremo			
Imperia			
Albenga			
Savona			
Vado Ligure			
Genoa			
La Spezia			
Carrara			
Viareggio			
Livorno			
Piombino			
Portoferraio			
Punta Ala			
Bastia			
Ajaccio			
Propriano			
Civitavecchia			
Fiumicino			
Anzio			
Gaeta			
Porto Torres			
Alghero			
Oristano			
Arbatax			
Cagliari			
Naples			
Torre del Greco			
Castellammare di Stabia			
Salerno			
Paola			
Vibo Valentia			
Pizzo			
Gioia Tauro			
Reggio Calabria			
Trapani			
Castellammare del Golfo			
Palermo			
Termini			
Imerese Cefalù			
Milazzo			
Sant'Agata di Militello			
Messina			

Glossary

Definition of terms

Table 2: Glossary of Terms Related to Fisheries Management

Term	Definition
Metiér	Homogeneous sub-division of a fishery by fleet.
Stock	The management unite of a single, multiple or even a part of a fish population usually with a particular migration pattern, specific spawning grounds, and subject to a distinct fishery. In theory, a Unit Stock comprises all the individuals of fish in an area, which are part of the same reproductive process. It is self-contained, with no emigration or immigration of individuals from or to the stock. On practical grounds, a fraction of the unit stock is considered a 'stock' for management purposes (or a management unit), as long as the results of the assessments and management remain close enough to what they would be on the unit stock.
Fleet	A physical group of vessels sharing similar characteristics in terms of technical features and/or major activity.
Fishery	Group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area.
Discards	Components of a fish stock has damaged and cannot be sold. The Discards component plus the Landings component represent the Catches.
F (Fishing mortality)	Instantaneous Rate of Fishing Mortality. When fishing and natural mortality act concurrently, F is equal to the instantaneous total mortality rate (Z), multiplied by the ratio of fishing deaths to all deaths. Expressed on an exponential scale: F=0.5 means that 1-EXP(-0.5)=39% are removed.
rec	The amount of fish added to the exploitable stock each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to the fishing gear in one year would be the recruitment to the fishable stock that year. This term is mostly used in referring to the number of fish from a year class reaching a certain age. For example, all fish reaching their first year are age 1 recruits.
ssb (Spawning stock biomass)	Total weight of all sexually mature fish in the stock.
Catch	Sum components of a fish stock after capture, including the discarded and landed portion of the capture.
Landings	Components of a fish stock retained after capture.
Gross profit	Income from landings + other income – crew wages – energy costs – repair and maintenance.
Net profit	Gross profit – depreciation cost – opportunity cost of capital.
Cost	Other variable costs – non-variable costs.

Definition of stocks

Species code	Common name	Scientific name	Stock
HKE	European hake	*Merluccius merluccius*	HKE 9 10 11
MUT	Red mullet	*Mullus barbatus*	MUT 9
MUT	Red mullet	*Mullus barbatus*	MUT 10
DPS	Deep-water rose shrimp	*Parapenaeus longirostris*	DPS 9 10 11
ARA	Giant red shrimp	*Aristeomorpha foliacea*	ARS 9 10 11
NEP	Norway lobster	*Nephrops norvegicus*	NEP 9
ARA	Blue and red shrimp	*Aristeus antennatus*	ARA 9 10 11

Definition of fleet segments

Definition of fleet segments

Fleet	Fishing Technique	Vessel Length (m)	Description
Bottom Otter trawlers	DTS	0612	Italian trawlers operating in GSAs 9 10 and 11 below 12 m
Bottom Otter trawlers	DTS	1218	Italian trawlers operating in GSAs 9 10 and 11 between 12 and 18 m
Bottom Otter trawlers	DTS	1824	Italian trawlers operating in GSAs 9 10 and 11 between 18 and 24 m
Bottom Otter trawlers	DTS	2440	Italian trawlers operating in GSAs 9 10 and 11 between 24 and 40 m
Longlines	HOK	0624	Italian longlines operating in GSA 10 below 24 m
Polyvalents	PGP	0618	Italian polyvalents, using trammelnets, gill-nets and longlines operating in GSAs 9 10 and 11 below 18 m

Definition of Metiers

Gear Type	Gear Description	Metier
TRAWLS	Bottom Otter trawlers	OTBDEF OTBDWS OTBMDD
LONGLINERS	Vessels using hooks	GNS GTR LLS
POLYVALENTS	Vessels using polyvalent passive gears only	GNS GTR LLS

7.2 List of Background Documents

Background documents are published on the meeting's web site on:
https://stecf.ec.europa.eu/meetings-calendar/past-meetings

List of background documents:

EWG-24-16– Doc 1 - Declarations of invited and JRC experts (see also the section of this report 'Contact details of EWG-24-16 participants')