WORKING GROUP ON MIXED FISHERIES ADVICE METHODOLOGY (WGMIXFISH-METHODS)

VOLUME 07 | ISSUE 86

ICES SCIENTIFIC REPORTS

RAPPORTS SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

ISSN number: 2618-1371

ICES Scientific Reports

Volume 07 | Issue 86

WORKING GROUP ON MIXED FISHERIES ADVICE METHODOLOGY (WGMIXFISH-METHODS)

Recommended format for purpose of citation:

ICES. 2025. Working Group on Mixed Fisheries Advice Methodology (WGMIXFISH-METHODS). ICES Scientific Reports. 07:86. 57 pp. https://doi.org/10.17895/ices.pub.29634626

Editors

Matthew Pace • Klaas Sys

Authors

Gianfranco Anastasi • Johnathan Ball • Isabella Bitetto • Thomas Brunel • Santiago Cerviño
Chun Chen • Harriet Cole • Marta Cousido • Paul Dolder • Marta Ferraro • Dorleta Garcia
Bernhard Kühn • Luca Lamoni • Claire Macher • Hugo Mendes • Mathieu Merzéréaud • Sarah Millar
Claire Moore • Alessandro Orio • Matthew Pace • Lionel Pawlowski • Sonia Sánchez-Maroño
Klaas Sys • Marc Taylor • Vanessa Trijoulet • Evangelos Tzanatos • Youen Vermard

ICES CIEM International Council for the Exploration of the Sea Conseil International pour l'Exploration de la Mer

Contents

i Executive summary

The ICES Working Group on Mixed Fisheries Methodology (WGMIXFISH-METHODS) met to progress work on the improvement and development of the mixed fisheries considerations.

The work addressed in 2025 included improving workflows for the advice process, presenting methodological advances and responding to issues encountered during WGMIXFISH-ADVICE 2024. The group reviewed the annual data call and processing procedures and discussed improved communication of mixed fishery advice products and collaborations with other Working Groups.

The primary development affecting data workflows is the planned introduction of the Regional DataBase and Estimation System (RDBES) to support stock assessments carried out in ICES. In 2027, RDBES will replace InterCatch and the current ad hoc mixed fisheries data call, providing WGMIXFISH with data at a greater level of disaggregation than is currently possible. Whereas this presents an opportunity to improve the quality of mixed fisheries analyses carried out by the Working Group, the transition to RDBES is challenging because new processes are needed to assemble the inputs to mixed fisheries models. The Working Group identified the data requirements and steps needed to transfer workflows to using RDBES and outlined a timetable for comparing inputs derived from RDBES and current workflows in 2026.

Several methodological advances were presented, many of which address outstanding limitations of current approaches or stakeholder feedback received during mixed fisheries scoping workshops. These included improved modelling of joint harvesting in FLBEIA, an age-structured mixed fisheries model framework for the Celtic Sea case study, and analyses of métier effort-share and fleet quota-share assumptions to reduce fleet 'choking' behaviour through artificial and 'weak' technical interactions. Additionally, applications of externally developed mixed fisheries models for the Bay of Biscay and Central Mediterranean, and an analysis mixed fisheries in the Ionian Sea were presented.

Finally, each case study addressed outcomes and issues encountered during the previous year in preparation for WGMIXFISH-ADVICE 2025.

Keywords: mixed fisheries, fishing fleets, fleet definition, harvest control rule

ii Expert group information

Expert group name	Working Group on Mixed Fisheries Advice Methodology (WGMIXFISH-METHODS)
Expert group cycle	Annual
Year cycle started	2025
Reporting year in cycle	1/1
Chairs	Matthew Pace, United Kingdom
	Klaas Sys, Belgium
Meeting venue and dates	16-20 June 2025, Lisbon, Portugal, (27, hybrid)

1 Introduction

WGMIXFISH-METHODS - Working Group on Mixed Fisheries Advice Methodology

2024/AT/FRSG17 The **Working Group on Mixed Fisheries Advice Methodology** (WGMIXFISH-METHODS), chaired by Klaas Sys*, Belgium, and Matthew Pace*, UK, will hold a hybrid meeting in Lisbon, Portugal, on 16-20 June 2025, to:

a) Continue the improvement of WGMIXFISH-ADVICE data call, data processing, methodological framework, workflow, auditing, updating associated documentation and increasing transparency
b) Exploration of the RDBES data to improve fleet and métier definitions used in mixed fisheries models.
c) Continue contributing to the Fisheries Overviews and fisheriesXplorer, standardizing figures across relevant ecoregions, and ensuring data is in the correct format for use by the app;
d) Exploration of developments in methodology and advice;
e) Respond to the outcomes and issues encountered during WGMIXFISH-Advice;

WGMIXFISH-METHODS will report by 25 July 2025 for the attention of ACOM.

Only experts appointed by national Delegates or appointed in consultation with the national Delegates of the expert's country can attend this Expert Group.

Supporting information

Priority:	The work is essential to ICES to progress in the development of its capacity to provide advice on multispecies fisheries. Such advice is necessary to fulfil the requirements stipulated in the MoUs between ICES and its client commissions.
Scientific justification and relation to action plan:	The issue of providing advice for mixed fisheries remains an important one for ICES. The AFRAME project, which started on 1 April 2007 and finished on 31 March 2009 developed further methodologies for mixed fisheries forecasts. The work under this project included the development and testing of the FCube approach to modelling and forecasts. In 2008, SGMIXMAN produced an outline of a possible advisory format that included mixed fisheries forecasts. Subsequently, WKMIXFISH was tasked with investigating the application of this to North Sea advice for 2010. AGMIXNS further developed the approach when it met in November 2009 and produced a draft template for mixed fisheries advice. WGMIXFISH has continued this work since 2010.
Resource requirements:	No specific resource requirements, beyond the need for members to prepare for and participate in the meeting.
Participants:	Experts with qualifications regarding mixed fisheries aspects, fisheries management and modelling based on limited and uncertain data.
Secretariat facilities:	Meeting facilities, production of report.
Financial:	None
Linkages to advisory committee:	ACOM

Linkages to other committees or groups:	SCICOM through the WGMG. Strong link to STECF.
Linkages to other organizations:	This work serves as a mechanism in fulfilment of the MoU with EC and fisheries commissions. It is also linked with STECF work on mixed fisheries.

2 ToR A: Continue the improvement of WGMIXFISH-ADVICE data call, data processing, methodological framework, workflow, auditing, updating associated documentation and increasing transparency

2.1 Data call update/QC reports

QC of the WGMIXFISH data call

This year, there were no major issues found for the data submitted for the WGMIXFISH data call. Additionally, there was high consistency between effort and catch data files.

Full or partial resubmissions of the time series were received from France (all years), Ireland (all years), Denmark (2023 onwards), Norway (2015 onwards), Sweden (effort only, 2021 onwards), UK-England (2020 onwards) and Spain (2022 onwards).

Sweden again provided additional discard estimates for cod, sole and plaice in subdivisions 20 and 21. Not all of these discard estimates were matched to a record in the landings file submitted by Sweden. Additionally, the discard estimates were not disaggregated by fishing technique or vessel length category. Where possible, discard estimates were matched to a landings record. The North Sea subgroup should review these matches ahead of the advice meeting.

Initially, the effort data received from Spain for 2024 looked unexpectedly low compared to 2023. This was queried with the data submitter who found and corrected an error. Additionally, last year there was a change in the métiers convention naming used by Spain which affected the 2023 data. As a result, a resubmission of 2022 data using this new methodology was also requested as WGMIXFISH require 3 years of consecutive data. In response to both these issues, Spain provided a fresh resubmission of data from 2022-2024.

The new métiers submitted in 2025 are shown in Table 2.1.1.

Table 2.1.1. New métiers submitted in 2025 by ecoregion, country and ICES division/subdivision.

Ecoregion	Country	Area	Métier
IberianWaters	ES	27.8.c	GES_CAT_0_0_0
IberianWaters	PT	27.9.a	PS_SPF_>=14_0_0
IberianWaters	PT	27.9.a	PS_MPD_>0_0_0
IberianWaters	PT	27.8.c	
IberianWaters	PT	27.9.a	
IberianWaters	PT	27.9.a	GNS_MPD_>0_0_0
IberianWaters	PT	27.9.a	GNS_DEF_>100_0_0
NorthSea	NL	27.4.c	DRH_MOL_>0_0_0_all
NorthSea	UKE	27.4.b	TBB_DEF_90-99_0_0

Ecoregion	Country	Area	Métier
NorthSea	UKE	27.4.b	OTB_DWS_90-99_0_0
NorthSea	UKE	27.4.c	OTB_CEP_65-69_0_0
NorthSea	UKE	27.7.d	OTB_CEP_65-69_0_0
NorthSea	UKE	27.4.c	OTB_MOL_16-31_0_0
NorthSea	DK	27.3.a.21	FPO_CRU_>0_0_0_all_FDF
NorthSea	DK	27.3.a.21	OTB_CRU_32-69_0_0_all_FDF
IrishSea	IE	27.7.a	DRB_MOL_0-0_0_0_all
NorthSea	IE	27.6.a	OTM_SPF_32-39_0_0_all
NorthSea	NO	27.4.a	GNS_SPF_100-119_0_0
NorthSea	NO	27.4.a	OTB_CRU_100-119_0_0
NorthSea	NO	27.4.a	PS_SPF_70-89_0_0
NorthSea	UKN	27.6.b	OTB_CEP_40-54_0_0

An extra review of the whole time series of the WGMIXFISH dataset was conducted given that these data are likely to be used in plots for the mixed fisheries section of the Fisheries Overviews (see section 4.2). This review revealed a number of duplicate records. In most cases this was due to the incorrect handling of resubmissions and so was easily fixed by removing duplicate records associated with older submissions. However, in the case of Germany duplicate records arose from the way the data have been reported to WGMIXFISH. The data IDs provided by Germany indicate a Working Group allocation. This is because the métier aggregations that occur when data are provided to InterCatch vary by Working Group. Therefore, duplications take place because the same trip or vessel can be assigned to a different métier depending on the Working Group in question. These data need careful consideration by subgroups ahead of the advice meeting.

Feedback on the data call

Compared to last year, WGMIXFISH added an additional field to the data call, "fishing technique", using the same definition as the "fishing technique" field in RDBES. This would allow a comparison of the landings and effort data submitted to WGMIXFISH with the landings (CL) and effort (CE) data submitted to RDBES ensuring a better understanding, and allow an addition way to QC the RDBES data.

About half of the data submitters raised concerns about the "fishing technique" field. The main concern was that computing this field is not straightforward and would require careful testing and validation to ensure consistency between RDBES, FDI and, ultimately AER datasets. It was also flagged that the "fishing technique" field is currently an "optional" field in the RDBES data call which is left empty by some data submitters.

If WGMIXFISH includes the "fishing technique" in next year's data call, this field is ideally made "mandatory" in the RDBES data call.

2.2 Introduction of "reproduce the advice" procedure to assessment working groups

The WGMIXFISH "*reproduce the advice*" (RTA) procedure was introduced to several spring assessment working group meetings this year (WGNSSK, WGCSE) with the intention of having stock assessors include it in their suite of quality control measures. The procedure performs a deterministic forecast of the assessed stock using functions available in FLR (Fisheries Library in R, https://github.com/flr). This simple check has proved helpful in identifying inconsistencies between defined forecast assumptions and the summary statistics of the headline advice catch option scenario; e.g. reported landings, catch, fishing mortality (F), and spawning stock biomass (SSB). By including the procedure within assessment groups rather than during WGMIXFISH-ADVICE, we also hope to identify potential issues earlier in the calendar year.

The procedure is described within a new R Markdown tutorial, located within the *mixfishtools* R package repo (https://github.com/ices-tools-dev/mixfishtools, see link to html output in the README), which is broken down into five steps:

1. Start with an FLStock object with all assessment-estimated values in historical years
2. Extend FLStock into the short-term forecast years using FLasher::stf, and, if necessary, manually adjust forecast year slot values to match assessment as closely as possible
3. Create FLasher::fwdControl object to define the targets and limits of the short-term forecast years
4. Run deterministic forecast with FLasher::fwd
5. Compare resulting stock parameters with those reported by the assessment

The procedure uses the median estimated values of the stock assessment as summarized in an FLStock object and performs a deterministic forecast using the same assumptions for the future years; such as mean weights, recruitment etc. Differences are to be expected where the assessment uses a stochastic forecast that considers uncertainty. In these cases, WGMIXFISH uses a threshold of +/- 10% difference to flag potential issues. Figure 2.2.1 shows the resulting diagnostic plots used to illustrate differences in selected short-term forecast variables.

In each assessment working group, a WGMIXFISH member presented the RTA tutorial and was on hand to assist with its application. Most stock assessment coordinators were able to apply the RTA during their respective meeting, and their script and results were further reviewed by the stock assessment auditor. In all, the exercise ran fairly smoothly, and is expected to become part of the quality control tests used in the future.

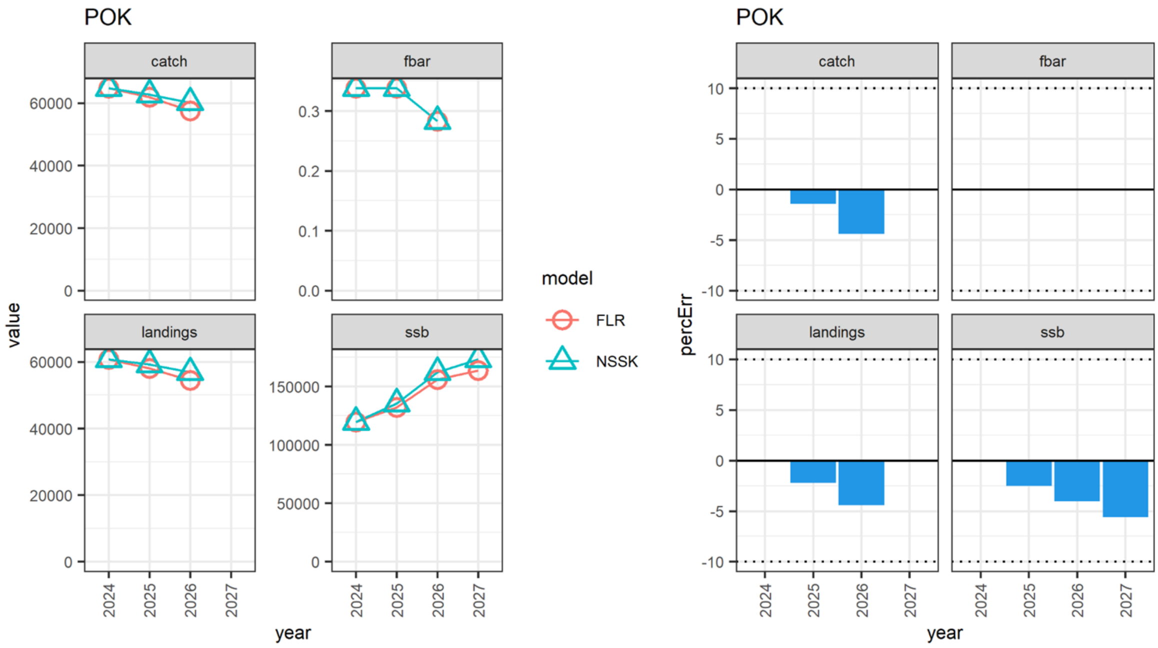


Figure 2.2.1. Example of diagnostic plots of selected short-term forecast variables as reported by the assessment (*NSSK*) and the reproduce the advice procedure (*FLR*) for North Sea saithe (pok.27.3a4), in terms of absolute values (left line plots) and percent difference (right bar plots). +/- 10% thresholds for percent difference are designated with dotted horizontal lines. Plots show values for the last data year (2024), and the 3-year forecast (2025-2027).

2.3 Identifying needs to extract WGMIXFISH data from the RDBES data model

Currently, WGMIXFISH issues an annual data call to those countries with fleets operating in at least one of the different case studies. This data call requests landings and effort data at a disaggregated métier level and is known as the *accessions* data. These accessions data, combined with extractions from the InterCatch database, comprise the input data required to condition each of the case study mixed fisheries models.

The Regional DataBase and Estimation System (RDBES) is set to replace InterCatch and the current ad hoc mixed fisheries data call. Initially, RDBES data will be available alongside InterCatch and the WGMIXFISH data call during a transition year in 2026. In 2027, RDBES will be the only data source for the development of mixed fisheries advisory products. The transition to RDBES carries several potential benefits for WGMIXFISH including:

- withdrawal of the current WGMIXFISH data call, thereby reducing the workload for data submitters,
- access to more disaggregated data which could potentially further improve fidelity and robustness of current fleet and métier definitions used in the projection models, and
- access data from areas which are currently not covered by the set of mixed-fisheries case studies, which could ease the process of building a mixed-fisheries model for a new region.

However, the RDBES data model has been developed independently from the WGMIXFISH workflow and does not include the information required by WGMIXFISH to condition fleets and métiers. Inadequate preparation for this transition could be detrimental to the quality of mixed fisheries advisory products and lead to unexplainable discrepancies in mixed fisheries projections. Therefore, WGMIXFISH has developed a roadmap which identifies the needs to recreate the *accessions* data from the RDBES CE, CL and CS tables, and a plan that allows WGMIXFISH to gradually switch to RDBES in the period 2025 - 2027.

Data needs from RDBES

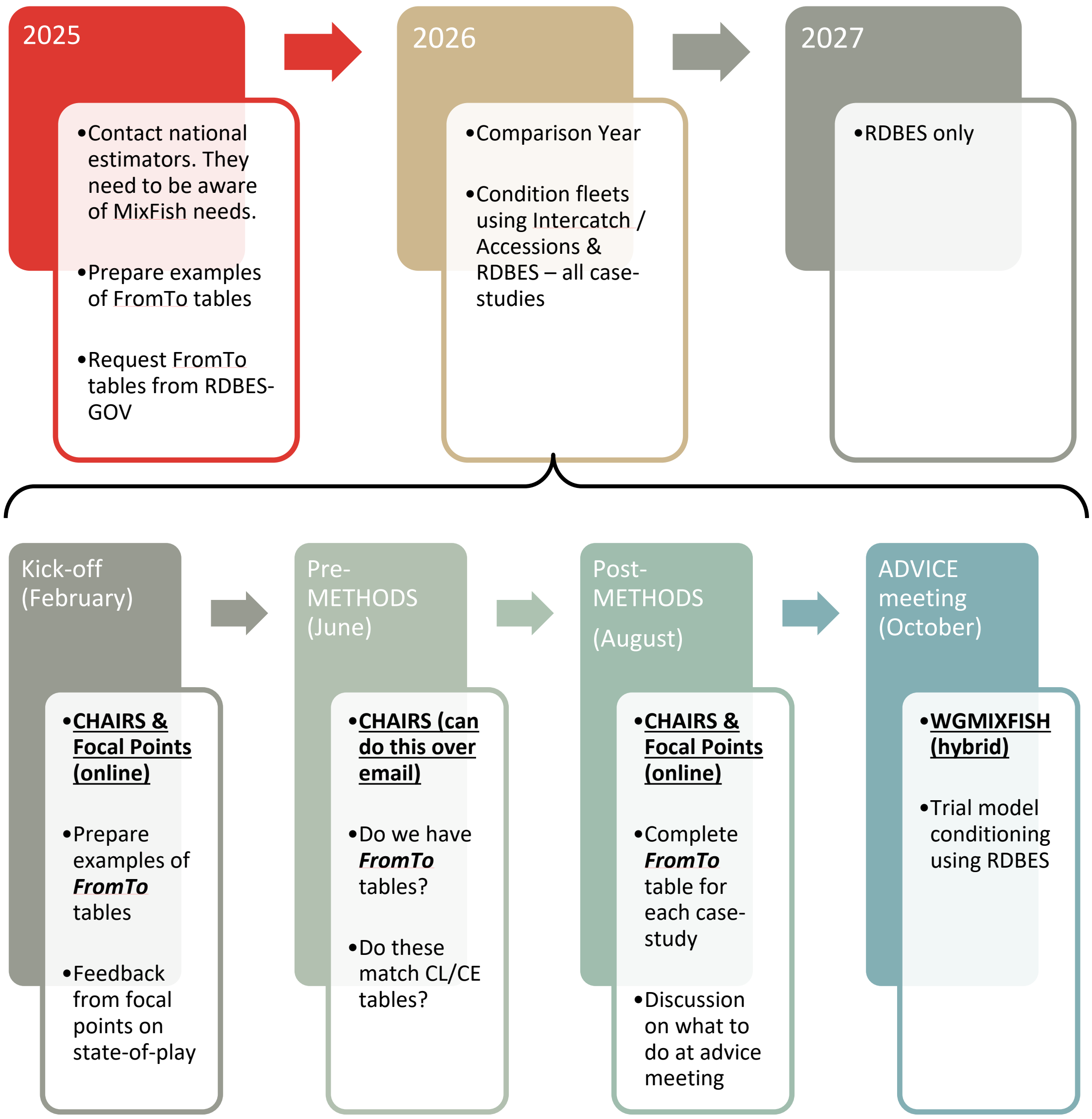
To utilise RDBES data, WGMIXFISH requires two sets of lookup tables, hereafter termed "from-to" tables, linking disaggregated sampling strata to aggregated raised estimates:

- The first set of *from-to* tables should be provided by the *national estimators* that describes how métiers, at the most disaggregated level submitted to RDBES CE and CL tables, are linked to the sampled métiers reported in the CS tables. Such a *from-to* table would allow WGMIXFISH to make use of the national expertise in aggregating the data and follow a consistent approach with national raising procedures. Such *from-to* tables can likely be generated from the Regional Catch Estimation Format (RCEF) tables which are to be used by the national estimators.
- The second set of *from-to* tables should be provided by the *stock coordinator* that allows WGMIXFISH to identify how métiers reported in the CE/CL tables are linked to the métiers reported in the CS tables.

Both "from-to" tables could be generated as a ".csv" file in the raising scripts used by the *national estimators* and *stock coordinators*. Provision of these "from-to" tables will become a mandatory reporting requirement of RDBES data submissions.

WGMIXFISH Roadmap to RDBES

The transition to RDBES would require careful coordination between *national estimators* and national *WGMIXFISH experts*, as well as *stock coordinators* and *WGMIXFISH experts*. Therefore, a Roadmap has been developed.



The Roadmap highlights 2026 as a comparison year in which to develop parallel models conditioned using Accessions and RDBES data. Work to be carried out in 2026 includes:

- January/February 2026: short online meeting to discuss the status on the generation of the "from-to" tables generated by national estimators. Identify any issues.
- Early June 2026: update on the availability of "from-to" tables to be used during the WGMIXFISH-Methods meeting in 2026
- Autumn 2026 / Spring 2027: dedicated workshop to create WGMIXFISH fleets and métiers from the RDBES data

A separate WGMIXFISH data call will be launched until 2027 as a fall-back plan.

2.4 Feedback from the WK Participatory Modelling and opportunities for WGMIXFISH

Workshop on Participatory Modelling

The presentation[1] provided feedback from a workshop on participatory modelling held in October 2024, aimed at advancing the integration of participatory approaches into ICES science and advice. The workshop reviewed various examples of participatory modelling applications in marine science, both within and outside of ICES. It also identified candidate studies or assessments within ICES that could benefit from participatory modelling—among which mixed-fisheries considerations were listed.

The workshop highlighted several major challenges for the application of participatory modelling (PM) within ICES, including the lack of structured methodologies, limited training, and the difficulty of balancing empirical scientific knowledge with experiential stakeholder input. In response, a draft framework was developed to support participatory modelling efforts within ICES and to address these challenges. This framework is designed to be modular and adaptable to different projects and sectors. It aims to offer a practical approach for guiding, evaluating, and reporting participatory engagement processes.

As part of this framework, an operational tool called the "*Onion of Engagement*"—based on Vaughn and Jacquez (2020)—was developed. This tool helps map who was, is, or should be involved in different stages of the modelling process, and to what level of engagement (ranging from informing, consulting, collaborating, to empowering). The onion tool supports ongoing PM exercises, reporting of completed exercises, and assessment of participatory engagement.

Additionally, a decision tree is being developed to guide the following questions:

- WHY: What are the motivations and expected benefits of PM (as opposed to participation or modelling alone)?
- WHO: Who should be involved, and why?
- WHAT: Which tools or models should be used?
- HOW: How should the process be structured (using the onion tool)?

Opportunities for Participatory Modelling in WGMIXFISH

The second part of the presentation explored opportunities for implementing PM within WGMIXFISH, where participatory elements have already been applied, albeit not formally recognised as such. Over the past years, three scoping workshops were held to discuss fleet segmentation, assumptions, methodologies, and outputs. The presentation proposed how PM could contribute at various stages of the modelling process and included an application of the Onion of Engagement to the Bay of Biscay case study.

The group discussed both opportunities and barriers to implementing PM in WGMIXFISH. Key challenges and risks identified from experience included:

---

[1] Presentation by Claire Macher, Marta Ballesteros, Maria Pierce, Benjamin Planque, Jacob Bentley, Stephanie Hopkins, Erasmia Kastanidi, and Irene Martins -prepared in connection to WGMIXFISH – WKMIXFISH-WGECON-WGENGAGE chairs

- Limited human resources: Existing staff are already fully engaged in model improvement, transitioning to new databases such as RDBES, and responding to increasing external demands. There is also a need for additional skills to facilitate and observe participatory processes.
- Risk of stakeholder instrumentalization: While participatory approaches hold value, there is a risk of stakeholders—honest or biased—using the process to push specific agendas. ICES' core principle of scientific impartiality must be preserved. Stakeholder inputs should be incorporated via a formalised and transparent process, with supporting evidence required when claims may alter model outputs. This process may be time-consuming but is necessary to ensure scientific credibility. Effective communication with stakeholders throughout the process is also essential for maintaining trust.
- Cross-group implications: Decisions made within WGMIXFISH (e.g., changes to intermediate year assumptions) could significantly impact stock advice and management decisions in other groups, especially those related to TACs.
- Stakeholder pressure for quick solutions: A common challenge observed (e.g., in WKMIXFLEET4) is that stakeholders often arrive with urgent short-term concerns, pressuring the group to address them immediately. Without proper guidance, this can hinder discussions on longer-term solutions.

Despite these challenges, the group expressed strong interest in developing participatory approaches within WGMIXFISH, with support from the PM workshop group, WGENGAGE, and WGECON. A follow-up workshop specifically focused on developing a PM process for WGMIXFISH was proposed and welcomed. This would allow for concrete implementation of the PM framework in WGMIXFISH and address the risks identified.

The WGMIXFISH group emphasized that substantial stakeholder engagement already exists, including with Member States' administrations. Mapping these interactions will be a crucial first step in understanding the current state in each case study (CS) and in designing future collaborative strategies. The idea is to pilot participatory modelling in one or two case studies where experts already have experience with participatory research. These efforts could be supported by colleagues—especially from WGENGAGE—to help observe and document the process. Suitable candidate case studies might include the Irish CS, the Celtic Sea, and the Bay of Biscay.

Recommendations from WGMIXFISH on Next Steps

- Potential Application: The ongoing work related to the RDBES database presents a timely opportunity to engage stakeholders in discussions on defining métiers and fleets.
- Governance: WGMIXFISH recommends establishing a governance group with balanced representation from relevant WGs (e.g., WGMIXFISH, WGENGAGE, WGECON) to oversee PM development.
- Tailored Framework: There is a need for a conceptual framework specific to WGMIXFISH methodologies, with realistic objectives based on available and potential resources. A scoping meeting involving representatives from WGMIXFISH, the PM workshop, WGENGAGE, and WGECON is proposed to co-develop this tailored framework.
- Broader Scenario Exploration: Participatory modelling offers WGMIXFISH an avenue to explore additional management tools and scenarios beyond traditional catch targets.

Wider Involvement: Several members of WGMIXFISH expressed a willingness to contribute to this participatory process and represent the WGMIXFISH perspective, both within and outside the group.

2.5 Advice plan

As per last year, an advice plan was drafted during WGMIXFISH-METHODS. This plan sets out the stocks to be included, support materials and accounts for all information learned from the single species advice production process such as the availability of stock information and benchmarking processes. The key responsibilities per advice region have been identified and allocated members of the group.

An online meeting has been scheduled (early September 2025) ahead of the WGMIXFISH-ADVICE 2025 meeting to provide an opportunity to discuss any data and model conditioning issues encountered and share developments on any intersessional work relevant to the outputs of the Advice meeting.

This year, the Advice meeting will be held in two parts. The first part (29 Sept – 3 Oct 2025) will be a hybrid meeting and form the bulk of the work needed to produce the advice. The second part (13-14 Oct 2025) will be held online and will be used to address any outstanding issues from the Advice meeting such as changes to the *Nephrops* advice following ADGNEPH (1-7 October 2025) and corrections to any single stock assessment errors found by WGMIXFISH.

Bay of Biscay

Advice 2025	**Yes**	**ank.27.78abd, bss.27.8ab, hke.27.3a46-8abd, hom.27.2a4a5b6a7a-ce-k8, mac.27.nea, meg.27.7b-k8abd, mon.27.78abd, nep.fu.2324, pol.27.89a, sdv.27.nea, sol.27.8ab, whb.27.1-91214, whg.27.89a**
TAF repo	Yes	https://github.com/ices-taf/2025_BoB_MixedFisheriesAdvice
Stock Annex	Yes	https://doi.org/10.17895/ices.pub.21517905.v1
Subgroup leader	Sonia Sanchez, ssanchez@azti.es	
Advice Meeting Participants	Sonia Sánchez-Maroño, ssanchez@azti.es Youen Vermard, youen.vermard@ifremer.fr Claire Macher, Claire.macher@ifremer.fr	

Celtic Sea

Advice 2025	**Yes**	**ank.27.78abd, cod.27.7e-k, had.27.b-k, whg.27.7b-ce-k, sol.27.7e, sol.27.7fg, nep.FU.16, nep.FU.17, nep.FU.19, nep.FU.20-21, nep.FU.22, nep.FU.27.7 outside FUs, hke.27.3a46-8abd, mon.27.78abd**
TAF repo	Yes	https://github.com/ices-taf/2025_CS_MixedFisheriesAdvice
Stock Annex	Yes	https://doi.org/10.17895/ices.pub.21517986.v1
Subgroup leader	Paul Dolder, paul.dolder@cefas.gov.uk	
Advice Meeting Participants	Claire Moore, claire.moore@marine.ie Lionel Pawlowski, Lionel.Pawlowski@ifremer.fr Paul Dolder, paul.dolder@cefas.gov.uk	

Advice 2025	**Yes**	**ank.27.78abd, cod.27.7e-k, had.27.b-k, whg.27.7b-ce-k, sol.27.7e, sol.27.7fg, nep.FU.16, nep.FU.17, nep.FU.19, nep.FU.20-21, nep.FU.22, nep.FU.27.7 outside FUs, hke.27.3a46-8abd, mon.27.78abd**
	Johnathan Ball, johnathan.ball@cefas.gov.uk Matthew Pace, matthew.pace@cefas.gov.uk	

Iberian Waters

Advice 2025	**Yes**	**ank.27.8c9a, mon.27.8c9a, ldb.27.8c9a, meg.27.8c9a, hke.27.8c9a**
TAF repo	Yes	https://github.com/ices-taf/2025_IW_MixedFisheriesAdvice
Stock Annex	Yes	https://doi.org/10.17895/ices.pub.21518010.v1
Subgroup leader	Hugo Mendes hmendes@ipma.pt	
Advice Meeting Participants	Hugo Mendes, hmendes@ipma.pt Marta Cousido, marta.cousido@ieo.csic.es	

Irish Sea

Advice 2025	**Yes**	**cod.27.7.a, had.27.7.a, whg.27.7.a, ple.27.7a, sol.27.7a, NEP.FU.15, NEP.FU.14**
TAF repo	Yes	https://github.com/ices-taf/2025_IrS_MixedFisheriesAdvice
Stock Annex	Yes	https://doi.org/10.17895/ices.pub.21518034.v1
Subgroup leader	Gianfranco Anastasi gianfranco.anastasi@cefas.gov.uk	
Advice Meeting Participants	Marta Ferraro, Marta.Ferraro@Marine.ie Gianfranco Anastasi gianfranco.anastasi@cefas.gov.uk	

North Sea

Advice 2025	**Yes**	**bll.27.3a47de, cod.27.46a7d20, had.27.46a20, ple.27.7d, ple.27.4, pok.27.3a46, sol.27.4, sol.27.7d, tur.27.4, whg.47d, wit.27.3a47d, NEP.FU. 5, NEP.FU. 6, NEP.FU. 7, NEP.FU. 8, NEP.FU. 9, NEP.FU. 10, NEP.FU. 32, NEP.FU. 33, NEP.FU. 34, NEP.FU. 4, outside Fus**
TAF repo	Yes	https://github.com/ices-taf/2025_NrS_MixedFisheriesAdvice
Stock Annex	Yes	https://doi.org/10.17895/ices.pub.21518037.v1
Subgroup leader	Thomas Brunel, thomas.brunel@wur.nl	
Advice Meeting Participants	Alessandro Orio, alessandro.orio@slu.se Harriet Cole, harriet.cole@gov.scot Klaas Sys, klaas.sys@ilvo.vlaanderen.be Marc Taylor, marc.taylor@thuenen.de	

Advice 2025	**Yes**	**bll.27.3a47de, cod.27.46a7d20, had.27.46a20, ple.27.7d, ple.27.4, pok.27.3a46, sol.27.4, sol.27.7d, tur.27.4, whg.47d, wit.27.3a47d, NEP.FU. 5, NEP.FU. 6, NEP.FU. 7, NEP.FU. 8, NEP.FU. 9, NEP.FU. 10, NEP.FU. 32, NEP.FU. 33, NEP.FU. 34, NEP.FU. 4, outside Fus**
	Thomas Brunel, thomas.brunel@wur.nl Chun Chen, chun.chen@wur.nl	

2.6 Reference list

Vaughn, L. M., & Jacquez, F. 2020. Participatory Research Methods – Choice Points in the Research Process. Journal of Participatory Research Methods, 1(1). https://doi.org/10.35844/001c.13244

3 ToR B: Exploration of the RDBES data to improve fleet and métier definitions used in mixed fisheries models

3.1 Quality control and data exploration

To date, WGMIXFISH members are unaware of any structured evaluation of the completeness and quality of the RDBES commercial effort (CE) and commercial landings (CL) tables. Therefore, WGMIXFISH has developed a report by nation similar to the quality control reports produced for the WGMIXFISH accessions data to check for completeness and errors. This report was run on the latest extraction of commercial effort and landings data from RDBES for each country covering 2021-2024.

Currently, there are 3 sections to the report:

- **Data checks:** For CE and CL, check each column for 'NA', 'NULL', 'Inf' or blank fields. Results are reported for mandatory columns first followed by the optional columns as detailed in the RDBES data model. Further checks are made to the encrypted vessel IDs to check that they are properly delimited and that each vessel ID is associated with just one fishing technique.
- **Data trends:** CE and CL data totals are plotted over time (2021-2024) aggregated by different variables covering spatial (ICES division/subdivision), temporal (month, quarter) and technical (fishing technique, métier, vessel length category) aspects.
- **Comparison with WGMIXFISH accessions data:** Effort and landings data totals from RDBES and WGMIXFISH are plotted over time aggregated by common variables covering spatial (ICES division/subdivision), temporal (quarter, year) and technical (métier, vessel length category) aspects.

These reports can be used to report issues back to the RDBES governance group (upload here: https://github.com/ices-tools-dev/RDBES/issues), to facilitate discussions with national data estimators to reproduce the WGMIXFISH data call and to advance WGMIXFISH fleet and métier definitions with the additional information available in RDBES. A summary of the quality control is provided below, while national reports are available on the WGMIXFISH-METHODS SharePoint site.

RDBES Data Completeness and Quality Summary

In general, the completeness of the RDBES data submissions was high across all contributing countries. Mandatory columns contained values as expected, encrypted vessel IDs followed the correct format, and fishing technique allocations were consistently reported with only one technique per vessel. In addition, many countries included values for fishing technique and FAO species codes—fields not mandatory under the RDBES data call but highly valuable for WGMIXFISH applications.

While some datasets lacked entries for the FAO species code, these values could typically be derived using the mandatory CLspeciesCode (AphiaID) field via national lookup tables. However, since each country may apply its own lookup table, inconsistencies in FAO code interpretation across countries may still occur.

Common Observations on Data Quality:

- Mandatory fields (e.g., CE and CL completeness) were generally well populated.
- Some gaps were identified in the fishingTechnique field, particularly for earlier years or in a few isolated datasets.
- FAO species codes were sometimes missing but could often be reconstructed via linked fields.
- A few submissions contained incorrectly formatted encrypted vessel IDs or included multiple fishing technique allocations per vessel, which is not compliant with RDBES expectations.
- Effort and landings time series were generally consistent with WGMIXFISH datasets, though some variations were noted across years, métiers, or regions.

A summary of data completeness is provided in the (anonymized) table below.

Item/field	Issue identified
CE/CL completeness (mandatory)	Mostly complete across all datasets
Fishing technique (CE/CL)	Some missing entries; occasional double allocations
FAO species code (CL)	Some missing values; may vary by lookup approach
Encrypted Vessel ID Format (CE/CL)	Some incorrect formats (e.g., wrong delimiters)
Effort Values (e.g., CEgTDaysatSea)	Some zeros or missing entries in select cases
Landings Values	Generally complete and consistent

Consistency with WGMIXFISH Data

Comparisons between RDBES and WGMIXFISH data generally revealed good alignment, especially for landings. Greater variation was seen in the effort time series, likely due to differences in the calculation methods and aggregation levels used to respond to the different data calls. Notably, effort values are more sensitive to methodological differences, such as those agreed upon in the 2nd Workshop on Transversal Variables.

Known issues were observed regarding métier grouping and renaming practices before submission to WGMIXFISH, which can introduce additional discrepancies.

General Issues Identified in Consistency Checks:

- In some cases, effort data appeared to be duplicated or inconsistently aggregated across ICES WGs, affecting comparability.
- Variability in reporting by administrative sub-entities may lead to mismatches in landing and effort figures across data calls.
- Some datasets showed improved consistency in more recent years (e.g., 2023–2024), indicating better alignment with current data call requirements.
- Minor discrepancies were found for specific ICES divisions, where landings were reported in WGMIXFISH but not represented in RDBES.

Item/field	Issue identified	Recommended action
Encrypted Vessel IDs (CE/CL)	Incorrect format (e.g., wrong delimiters, concatenations)	Report to RDBES governance
Fishing Technique (CE/CL)	Missing values in some years; occasional cases with two techniques per vessel	Non-mandatory field, but clarification or correction is helpful
Species FAO Codes (CL)	Some blank rows; likely derived from AphiaID using national lookups	Encourage harmonized lookup tables
Effort Values (CE)	Zero values reported in some metrics (e.g., days at sea, fishing days)	Mandatory field; report issues to RDBES governance
Inconsistent Time Series (Effort/Landings)	Gaps or mismatches between RDBES and WGMIXFISH for certain years or métiers	Review data generation methodology
Incomplete Year Coverage	Lower record counts for earlier years in some submissions	Validate completeness and update RDBES governance
Data Not Submitted or Missing from Extraction	Some datasets were absent or not extractable at the time of the analysis	Confirm submission obligations with RDBES governance

This general summary supports efforts to harmonize RDBES submissions and improve the interoperability of datasets across ICES groups. Continued collaboration and transparent communication with national data providers will be key to ensuring high-quality, consistent input to WGMIXFISH modelling efforts.

3.2 Exploration of RDBES Data for MIXFISH Applications in the Bay of Biscay

As part of the MIXFISH methodology group's activities, a preliminary exploration was carried out to evaluate the potential of using RDBES data to support MIXFISH applications in the Bay of Biscay. The focus was particularly on the feasibility of accessing production and effort data at the vessel level, and on leveraging the DCF fleet typology based on the combination of Main Fishing Technique and vessel length class, which is available within the RDBES framework.

This approach offers the possibility to link catch and effort data to economic data from the STECF Annual Economic Report at the same level of aggregation, supporting more integrated bio-economic analyses.

Analytical Steps

The analyses were conducted using RDBES data from France and Spain where detailed vessel-level identifiers were either directly available or could be inferred. In cases where data were aggregated over multiple vessels, a disaggregation procedure was applied based on the assumption of equal allocation of production and effort across the vessels represented in a single aggregated entry.

Due to the absence of *Main Fishing Technique* information in the Spanish dataset, an algorithm was developed to impute this variable. This allocation was based on fishing days associated with specific gear types, combined with a newly constructed correspondence table mapping gears to fishing techniques. While functional for exploratory analysis, this mapping is preliminary and requires further refinement to align with standard classifications. As such, any results relying on these imputed classifications should be interpreted with caution and are for exploratory purpose.

Vessel Activity in the Bay of Biscay

Based on the procedure outlined above, it was found that in 2024, 1341 French and 325 Spanish vessels were operating in the Bay of Biscay (Figure 3.2.1). When considering a 25% threshold with respect to the fishing effort spent in the Bay of Biscay, 1269 French and 106 Spanish vessels were identified to have spent a substantial amount of their fishing activity in the Bay of Biscay. Of these vessels, 1083 French and 62 Spanish vessels caught at least 1kg of any stock included in the MIXFISH framework.

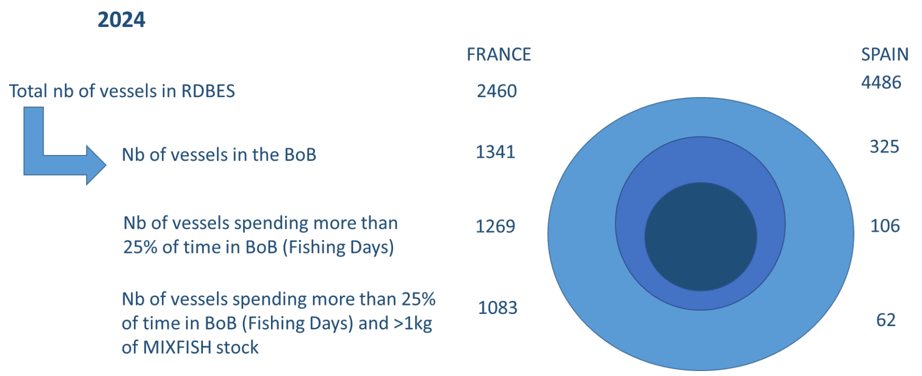


Figure 3.2.1. Exploration of the number of French and Spanish vessels operating in the Bay of Biscay mixed fisheries.

4 ToR C: Continue contributing to the Fisheries Overviews and fisheriesXplorer, standardizing figures across relevant ecoregions, and ensuring data is in the correct format for use by the app

4.1 Mixed fisheries considerations in the fisheriesXplorer app

The presentation on the ICES fisheriesXplorer app was divided into two parts. The first, more general section, outlined the app's objectives, the different levels of detail available based on the intended audience, its integration with other ICES-hosted applications, and the app's current development status.

In relation to mixed fisheries, the app primarily aims to support stakeholders in visualising fishing activities across ecoregions. It also provides an interactive tool to assist Ecosystem-Based Management by incorporating figures from the Fisheries Overviews and Mixed-Fisheries Considerations. The main target audience for the fisheriesXplorer app includes managers and policy makers. Hence, most information is provided at the ecoregion level or by mixed-fisheries case study. The data powering the mixed-fisheries section is currently retrieved from several TAF GitHub repositories maintained by WGMIXFISH.

The second part of the presentation was a live demonstration, showcasing the app's overall structure and navigation. Emphasis was placed on the mixed-fisheries section to encourage feedback from participants after the meeting.

During the presentation, the following key points were discussed:

- **Alignment of mixed fisheries case studies and Ecoregions**: The mixed fisheries case studies do not always align with ICES ecoregions. In some instances, multiple case studies exist within a single ecoregion (e.g., Celtic Sea and Irish Sea). There was a discussion on how these case studies should be labelled within the app to avoid confusion.
- **Consistency of Figures**: The app uses interactive plotting tools, which means figures displayed in the Mixed-Fisheries Considerations, and the Fisheries Overviews need to be recreated for the app. This can lead to minor differences in layout, as not all features are supported across the various plotting packages used.
- **Code Consolidation**: Currently, the code for generating figures is dispersed across multiple TAF repositories. WGMIXFISH plans to consolidate all code to generate figures into the *mixfishtools* R package to facilitate future development and standardise data input formats across different case studies.
- **Data Organisation**: Input data for figures produced by WGMIXFISH for use in the Fisheries Overviews will be stored in a dedicated "FO" subfolder within the "shiny" folder to promote findability.

Since the app is scheduled for release by the end of 2025, feedback and input are requested as soon as possible.

4.2 Planned mixed fisheries contributions to the fisheries overviews

Mixed fisheries working group contributes to the Fisheries Overviews by generating several figures that describe the major fishing patterns in an Ecoregion. Last year, the Fisheries Overviews section was reviewed for the North Sea ecoregion which resulted in some major structural changes in terms of textual context provided and figures included. Since these changes have been positively evaluated, the changes can be integrated into the Fisheries Overviews of other ecoregions.

A presentation was given that highlighted the major changes made to the North Sea Fisheries Overviews section. These include:

- Removed repetition of scenario/model results
- Focussed more on data and storytelling
- Space to provide contextual information to complement the mixed fisheries considerations
- Incorporated some WKFO2 (ICES, 2024) recommendations/developments
- General introduction text describing mixed-fisheries concepts

As these changes must be implemented in the various ecoregions and figures need to be update an annual basis, an overview of the workflow adopted for the North Sea was presented.

Inputs required:

- mixed fisheries data (accessions) and any fixes done for an ecoregion
- fleet allocation codes for a model
- refTable object for standardising stock names and colour schemes (see *mixfishtools* R package for an example)
- *mixfishtools* R package for plotting
- example code on https://github.com/ices-taf/2024_FisheriesOverview_NrS_plots

WGMIXFISH had a discussion on the output format of the Fisheries Overviews. Currently, the Fisheries Overviews chapter of the various ecoregions can be downloaded as a pdf document. However, given the developments and overlap with the fisheriesXplorer app it was agreed that these plots and the associated input data should be stored in a dedicated folder (called "shiny") for each case study. The code to generate the plots will be compiled in the mixfishtools R package before the Advice meeting in October.

The table below lists the input data file names and formats needed to generate the Fisheries Overview plots that need to be added to this folder. Following this convention will ensure that the same file names and column names are used across the ecoregions.

Plot name	Input file name	Data format/column names	Code status/function name
Figure 1 – FO landings by gearType	Figure1_FO_landingsByGearType_data.csv	year, gearType, value, dataType where,	Plot function proposed for mixfishtools: plot_FOgearType()

Plot name	Input file name	Data format/column names	Code status/function name
		gearType is broad gear categories (e.g. 'Otter trawl'); value is landings in tonnes; dataType is a character string - "landings"	
Figure 2 – FO effort by gearType	Figure2_FO_effortByGearType_data.csv	year, gearType, value, dataType where, gearType is broad gear categories (e.g. 'Otter trawl'); value is effort; dataType is a character string - "days at sea" or "KW days"	Plot function proposed for mixfishtools: plot_FOgearType()
Figure 3 – FO catch composition by country and metier	Figure3_FO_catchComp_metierCountry_data.csv	country, metCat, MIXFISHspp, landings where, country is the two-letter country code; metCat are ecoregion-defined metier categories; MIXFISHspp is the 3 letter FAO species code as listed in the MIXFISH data call; landings is the landings in tonnes	Plot function proposed for mixfishtools: plot_catchCompSpp()
Figure 4 – FO metier-stock proportions	Figure4_FO_metier-stock_proportions_data.csv	Stock, metCat, prop_stock, label where, Stock is numeric and numbers the stocks in alphabetical order; metCat is the metier category to be plots (e.g. otter_TR1_27.4.a); prop_stock is the proportion of total stock landings	Plot function proposed for mixfishtools: plot_stkMetProp() The stocks plotted here can be a wider list of stocks than those included in the mixed fisheries model

Plot name	Input file name	Data format/column names	Code status/function name	
		associated with that metier category; label is the ICES stock code		
Figure 5 – FO stock comp by fleet for datayear	Figures5-6-7_FO_catchComp_byStock-Fleet_data.csv	fleet, stock, year, landings, value where, fleet is the fleets used in the mixed fisheries models; stock is the ICES stock codes of the stocks in the model; year is the years for which data are available (whole time series); landings is the total landings by year, fleet and stock; value is the sale value of the landings	Plot function exists in mixfishtools: plot_catchCompStk() For this function you will a Also need the refTable object (see previous table).	For this plot you will also need these settings: filters = list(year=datayear) categories = ”fleet” split = ”stock” facet = NULL yvar = ”landings”
Figure 6 – FO fleet comp by stock for datayear				For this plot you will also need these settings: filters=list(year=datayear) categories = ”stock” split = ”fleet” facet = NULL yvar = ”landings”
Figure 7 – FO stock comp by fleet for all years				For this plot you will also need these settings: filters = list(year=2015:datayear) categories = "year" split = "stock" facet = "fleet" yvar = ”landings”
Figure 8 – FO relative effort by fleet and stock	Figure8_FO_relEffortByFleet-Stock_data.csv	stock, fleet, var where, stock is the ICES stock codes of the stocks used in the model; fleet is the fleet names used in the mixed fisheries models; var is the relative effort (quota effort/status quo effort) as a percentage	Plot function exists in mixfishtools: Plot_relEffortFltStk()	

4.3 Reference list

ICES. 2024. Workshop on Fisheries Overviews 2 (WKFO2; outputs from 2023 meeting). ICES Scientific Reports. 6:23. 123 pp. https://doi.org/10.17895/ices.pub.25299172

5 ToR D: Exploration of developments in methodology and advice

5.1 IAM bioeconomic mixed-fisheries application to the Bay of Biscay

The presentation provides an update on the application of the bio-economic model IAM to the Bay of Biscay (BoB) mixed fisheries. It presents the developments and the results obtained so far in support to the MIXFISH Advice.

The context of the development of this application was first reviewed. It is developed in line with WKMIXFLEET, WGMIXFISH and WGECON recommendations (with some basis and perspectives also in line with the WKPARTICIPATORY MODELLING). Bio-economic models are indeed already used and applied in different contexts to support advice and assess the biological and socio-economic impacts of management scenarios but not in the ICES context. Fostering their use in ICES requires to tackle some challenges by providing concrete operational applications within ICES groups. The potential added value of such applications to complement MIXFISH advice has been recognised for some time; however, their implementation has not yet been carried out.

In this context, an application to the BoB with the IAM model was developed to include MIXFISH issues and standards and to enable the exploration of the potential contributions to MIXFISH of a vessel/fleet-based approach linking economics and biology and accounting for socio-economic issues and short- and long-term effects. The application of this framework in the MIXFISH context tends also to develop and operationalize the capacity/methods to update annually this kind of integrated models and provide proof of concept of the feasibility of such bio-economic applications to support advice.

The IAM model (IAM- Impact Assessment Model For Fisheries Management) has been developed by Ifremer since 2009. It was initially developed in a partnership approach with stakeholders. It was already used mainly in STECF context to support impact assessment of Management plans (BoB sole, the South western Waters Multi Annual Plan and annually used for some years to support the Mediterranean Management Plan), and more occasionally in ICES context for a special request on BoB sole in 2013 and in the French national context.

It is an integrated bio-economic model which models on a yearly basis the interaction between vessels harvesting, stocks dynamics and governance accounting for the following dimensions: vessel or fleet/métier, species, age and year.

It works with parameter files developed from detailed Effort and Landings data by vessel/fleet and métier and cost structures available in the STECF - Annual Economic Report. It relies on either Baranov, a global model or constant CPUE production functions and has alternative possible behaviours implemented.

The Bay of Biscay MIXFISH IAM application developed in 2024 in WGMIXFISH has the following dimensions:

It models explicitly 945 (French) vessels[2] operating mainly in the Bay of Biscay, 23 métiers (based on Métier level 5), 24 species of which 9 species have biological dynamics (sole, sea bass, hake,

[2] The application developed this year is based on the Ifremer Fisheries Information System SACROIS database which is close to the RDBES database. It was used to parameterize the French vessels and explore the potential of an RDBES like

anglerfish, monkfish, megrims, mackerel, horse mackerel, blue whiting). Other species have catches modelled as a linear function of constant Catches per Unit of Effort.

Status quo effort (*sqE*), *min* and *max* scenarios were simulated assuming:

- adjustment of individual vessel effort accounting for the interdependency of vessels productions linked by the Baranov function;
- a quota allocation by vessel for 2024 and after calculated based on the 2023 total landings share of the vessel;
- constant allocation of effort among métier by vessel without particular reallocation behaviour at this stage (even if different options are possible to test);
- a maximum effort of 300 days at sea by vessel in the *max* scenario;
- a threshold of 100 kg of catches of a particular species to apply a quota constraint on it in the *min* scenario.

A number of MIXFISH like figures and new figures were provided as results. Results were aggregated by DCF fleet and length classes. However, the simulations allow to generate a lot of possible outputs at different level of aggregation to be compared to usual outputs. It enables to explore the heterogeneity of choke species within fleets and the economic consequences related to choke effects, highlighting positive and negative expected profit. It also highlights the short-term issues and incentives to catch the max to counterbalance with medium term results in term of biomass and thus socio-economic feedback effects.

The perspectives are to extend and continue the development of this application to be able to complement the 2026 MIXFISH ADVICE for the Bay of Biscay. An update of the model will be developed for 2025 with an effort to present the results and enable a review (to be specified) of the modelling assumptions and results to validate the use of the model in the next ICES MIXFISH ADVICE. Direct comparisons with FLBEIA outputs will not be possible given the fact that IAM is based on the Baranov catch equation and given the fact that the IAM application is based on a fleet/métier approach in line with MIXFLEET and DCF definitions of fleets and métiers. In contrast, the « métier » approach adopted in FLBEIA is based on the information available in the Accessions data.

5.2 An implementation of the Baranov catch equation in FLBEIA

The mixed fisheries models used by WGMIXFISH that use the FLBEIA software (Garcia *et al.*, 2017) rely on the Cobb-Douglas catch production function to compute the effort (E) and catches (c) of a fleet for a given set of quota constraints. This Cobb-Douglas function assumes that the fishery takes place at a single point in time during the year. This assumption implies that the effort required to catch a given amount of fish is independent from the total fishing effort (and thus fishing mortality) exerted by the entire fishery. As a consequence, a fleet's effort can be computed independent from the fishing effort of the other fleets participating in the fishery.

---

database. The Spanish data available in RDBES did not enable to connect the biology and economics. The work undertaken this year as part of the WGMIXFISH METHODS aims at extending the application to account for French and Spanish fleets by developing the paramterization methdology based on the RDBES database connected through the main vessel-length classes with the economic databases.

The Cobb-Douglas function is data driven and can take multiple forms by the alpha (α) and beta (β) parameters that control the relationship between catch and, effort and abundance (*N*), respectively. Nevertheless, as there is often too little information in the data (due to short time series and/or a lack of contrast in the data), the alpha and beta parameters are fixed to a value of 1, and only the catchability parameter (*q*, a metric expressing the catch per unit of effort and per unit of abundance) is estimated based on historical data in the FLBEIA models used for mixed-fisheries advice. Consequently, a linear relationship exists between catch and effort and catch and abundance which may result in e.g. catches exceeding abundance for high levels of fishing effort.

$$c = q\ x\ E^{\alpha} x\ N^{\beta}$$

Where c are the numbers-at-age in the catch, E the effort share by métier, N the numbers-at-age in the stock and q, α and β are the parameters of the Cobb-Douglas equation.

If the catches are taken halfway through the year, the Cobb-Douglas catch production, with scale parameters alpha and beta fixed at a value of 1, is equivalent to Pope's catch equation which approximates the Baranov catch equation. This approximation has shown to be robust, however, deviations between both catch equations exist at high levels of fishing effort/mortality as was encountered in the Celtic Sea case study during the WGMIXFISH interbenchmark (ICES, 2021a). The Cobb-Douglas catch production also differs from the catch production function used in most single species stock assessment models and forecast, which typically use the Baranov catch equation, and results in an inconsistency between the WGMIXFISH forecasts and the single-species forecasts.

The difficulty to implement the Baranov catch equation in a mixed-fisheries model (with more than one fleet), is that the fishing effort of one fleet affects the fishing effort of the other fleets. Hence, the effort required for a fleet to fully uptake a given quota allocation cannot be computed sequentially over all fleets, but an approach that allows to compute the effort levels for each fleet simultaneous is required. Such an approach was implemented in FLBEIA by solving the following set of equations:

For each fleet (*f*), which effort (E) is constrained by a quota allocation, the catch for stock (s) is subtracted by a fleets' quota allocation for the given stock ($Quota$):

$$\sum_{a\,\in\,ages\ of\ s}\left(\frac{\sum_{m\,\in\,métiers\ of\ f}(cw_{m;s;a} * q_{m;s;a} * Eshare_m * E_f)}{F_{s;a}+M_{s;a}} * N_{s;a} * e^{-(F_{s;a}+M_{s;a})}\right) - Quota_{f;s} = 0$$

Where cw are the mean weights-at-age in the catch, q is the catchability parameter of the Cobb-Douglas equation, $Eshare$ the effort share by métier, N are the numbers-at-age in the stock and F and M the fishing and natural mortalities-at-age, respectively.

As the equations rely on the Baranov catch which is nonlinear, an analytical solution cannot be computed. Therefore, a numerical method was used to find a solution for the problem. In this case, the *nleqslv* function of the *nleqslv* R package was used, this function includes tailored algorithms to solve problems of nonlinear equations.

In a mixed-fisheries context, fleets are mostly constrained by the most or least limiting stock. Therefore, for each fleet a stock needs to be found for which the fleets' effort level, required to take up the quota does not result in an overshoot (min scenario) or undershoot (max scenario) of the other (restricting) stocks caught by the fleet. Hereto, the reference stocks in the system of nonlinear equations are updated until the previous conditions are satisfied.

(1) Select a reference stock for each fleet and compute the effort for each fleet so that all quota allocated for these selected stocks is taken.
(2) Compute the catches for all the stocks with the effort identified in step (1) for each fleet.

(3) If, in a specific fleet, any catch exceeds (*min*) or is lower than the fleets' quota (*max*), replace the reference stock in step (1) by the stock with the highest/lowest quota overshoot/undershoot for *min*/*max* scenarios, respectively.
(4) Repeat steps (1) to (3) until no stocks' catch is overshot (*min*) or undershot (*max*) with respect to its quota for all fleets.

A comparison between the Cobb-Douglas and Baranov catch equations was done based on the mixed-fisheries model of the North Sea case study that was used for last years' considerations (WGMIXFISH ADVICE 2024).

The difference in catches appears to be largest under the *max* scenario which has the highest levels of fishing effort (Figure 5.2.1). For all stocks, except BLL, NEP6, NEP32 and PLE-EC, the catches under the *max* scenario are higher when the Baranov catch equation is used. In contrast, under the *min* scenario, all catches, except those for COD-NS and NEP32, are lower when the Baranov catch equation is used (Table 5.2.1). For most stocks, catches are 5 to 10% lower compared to when Cobb-Douglas equation is used.

The choke stocks that were identified under the *min* scenario were very similar, and only for one fleet a different choke stock was identified using the Baranov catch equation (Table 5.2.2). Table 5.2.3 provides a more detailed figure of the catches of COD-NS and NEP6 of the EN_OTTER10-24 fleet and indicates a high uptake of the quota for both stocks.

Under the *min* scenario, stronger effort reductions are required when the Baranov catch equation is used (Figure 5.2.2). Likewise, fishing mortalities (F_{bar}) are lower in the advice year when the Baranov catch equation is used (Table 5.2.4). In contrast, the SSB values in the year following the advice year are more similar and deviate with maximum 3%, with slightly higher SSB values when the Baranov catch equation is used.

A more in-depth comparison will be performed over the next months to better understand the reason for the discrepancies between both catch production functions.

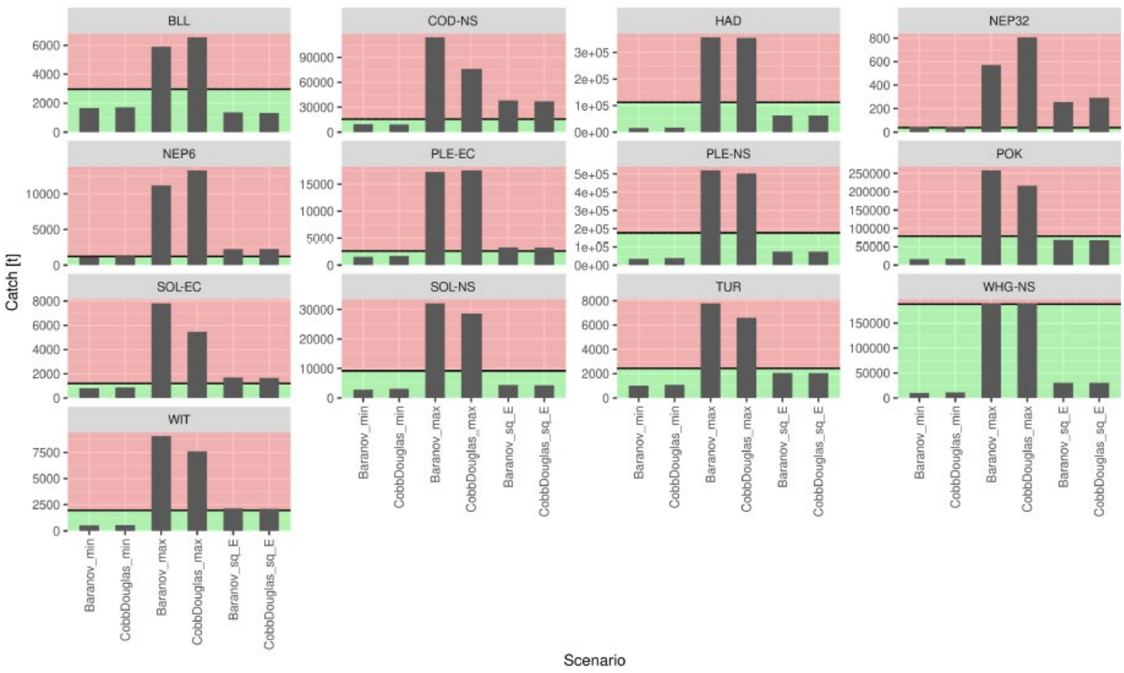


Figure 5.2.1. Headline advice plot comparing the expected catches under the *min*, *max* and *status quo* effort (*sqE*) scenarios for different stocks using the Cobb-Douglas and Baranov catch equation.

Table 5.2.1. Expected catches (tonnes) under the *min* scenario using the Cobb-Douglas and Baranov catch equations and the catch ratio (%): Baranov catch/Cobb-Douglas catch * 100.

scenario	stock	Catch– Baranov	Catch– CobbDouglas	ratio (%)
min	BLL	1595	1648	97
min	COD	8637	8312	104
min	HAD	12179	13646	89
min	NEP32	38	38	100
min	NEP6	1026	1146	90
min	PLE-EC	1400	1574	89
min	PLE-NS	29971	34328	87
min	POK	14187	15029	94
min	SOL-EC	728	802	91
min	SOL-NS	2526	2826	89
min	TUR	950	1018	93
min	WHG-NS	8106	9297	87
min	WIT	446	469	95

Table 5.2.2. Choke stocks identified under the *min* scenario. Numbers correspond to the number of fleets where each stock is being the most limiting stock.

Catch equation	BLL	COD-NS	NEP32	NEP6
Baranov	1	24	14	0
Cobb-Douglas	1	23	14	1

Table 5.2.3. Catches and quota for COD-NS and NEP6 allocated to the EN_OTTER10-24 fleet.

Catch equation	fleet	stock	catch	quota	Quota uptake
Baranov	EN_OTTER10-24	COD-NS	21.91	21.91	100
Cobb-Douglas	EN_OTTER10-24	COD-NS	21.61	21.91	99
Baranov	EN_OTTER10-24	NEP6	722.03	794.05	91
Cobb-Douglas	EN_OTTER10-24	NEP6	794.05	794.05	100

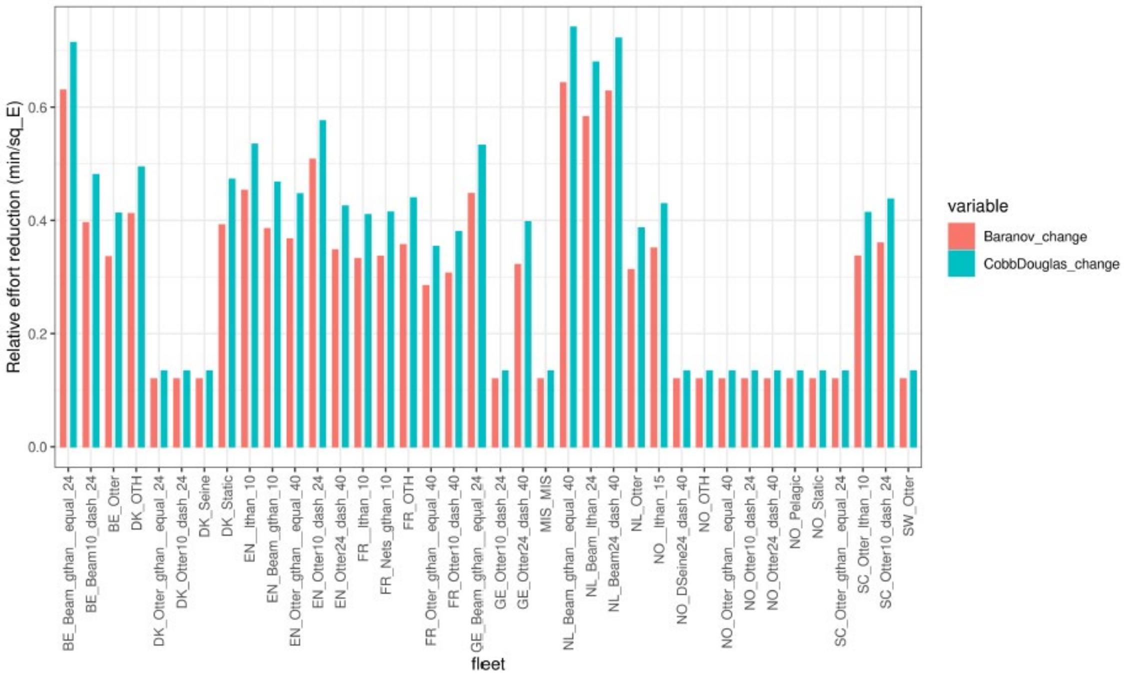


Figure 5.2.2. Relative change in effort (effort *min/sqE*) for each fleet according to the Baranov (red)and Cobb-Douglas (green) catch equations.

Table 5.2.4. Expected F_{bar} (advice year) and SSB (advice year +1) when using the Baranov and Cobb-Douglas catch equations for the different stocks included in the mixed-fisheries North Sea case study in 2024.

	stock	Baranov (a)	CobbDouglas (b)	ratio (%: a/b)
Fbar (advYr)	BLL	0.176	0.178	99
Fbar (advYr)	COD	0.045	0.049	92
Fbar (advYr)	HAD	0.013	0.015	87
Fbar (advYr)	NEP10	0.029	0.039	74
Fbar (advYr)	NEP32	0.052	0.046	113
Fbar (advYr)	NEP33	0.021	0.025	84
Fbar (advYr)	NEP34	0.024	0.032	75
Fbar (advYr)	NEP5	0.025	0.032	78
Fbar (advYr)	NEP6	0.050	0.064	78
Fbar (advYr)	NEP7	0.009	0.011	82
Fbar (advYr)	NEP8	0.043	0.053	87
Fbar (advYr)	NEP9	0.021	0.027	78
Fbar (advYr)	NEP-other NS	0.025	0.029	86
Fbar (advYr)	PLE-EC	0.079	0.092	85

	stock	Baranov (a)	CobbDouglas (b)	ratio (%: a/b)
Fbar (advYr)	PLE-NS	0.020	0.024	83
Fbar (advYr)	POK	0.043	0.045	96
Fbar (advYr)	SOL-EC	0.072	0.087	83
Fbar (advYr)	SOL-NS	0.026	0.032	81
Fbar (advYr)	TUR	0.091	0.096	95
Fbar (advYr)	WHG-NS	0.017	0.020	85
Fbar (advYr)	WIT	0.034	0.037	92
SSB (advYr+1)	BLL	9359	9461	99
SSB (advYr+1)	COD	107714	105372	102
SSB (advYr+1)	HAD	475613	472942	101
SSB (advYr+1)	NEP10	213	213	100
SSB (advYr+1)	NEP32	755	851	89
SSB (advYr+1)	NEP33	15307	15307	100
SSB (advYr+1)	NEP34	8277	8277	100
SSB (advYr+1)	NEP5	8183	8138	100
SSB (advYr+1)	NEP6	17083	17083	100
SSB (advYr+1)	NEP7	112770	112770	100
SSB (advYr+1)	NEP8	11805	11805	100
SSB (advYr+1)	NEP9	7489	7489	100
SSB (advYr+1)	NEP-other NS	8978	8978	100
SSB (advYr+1)	PLE-EC	28190	27445	103
SSB (advYr+1)	PLE-NS	1213219	1203263	101
SSB (advYr+1)	POK	239844	238573	101
SSB (advYr+1)	SOL-EC	11665	11311	103
SSB (advYr+1)	SOL-NS	54814	53727	102
SSB (advYr+1)	TUR	8733	8659	101
SSB (advYr+1)	WHG-NS	370973	369352	100
SSB (advYr+1)	WIT	6715	6592	102

5.3 How can we resolve choke effects caused by 'artificial' technical interactions?

Technical interactions occur when multiple fish stocks are caught simultaneously in a single fishing operation. When stocks are spatially independent, i.e. stock boundaries do not overlap, there should be no technical interaction between these stocks because haul-level catches cannot include both stocks. The prototypical example of this for the Celtic Sea case-study beam trawler targeting sole in division 7.e and sole in divisions 7.f and 7.g. Exhausting the quota for one of these stocks should not restrict exploitation of the other sole stock.

However, mixed fisheries models currently assume a fixed distribution of fishing effort across spatially implicit métiers, conditioned on historical observation data. Fixed métier effort distribution is a conceptually sound assumption given overlapping stock areas and in the absence of more detailed knowledge of fleet behaviour. However, when target stocks are spatially independent, fixed métier effort-share should not be assumed if the quota for one of these stocks is limiting. This can result in 'false' or 'artificial' technical interactions, where models imply choking behaviour that is not possible due to the spatial separation of stocks.

Resolving 'artificial' choking behaviour requires the reallocation of effort between métiers. However, this is not straightforward. Removing effort-share constraints on métiers requires specification of quota targets at the métier-level. This is an artificial constraint on métier activity because quotas are held at the vessel or fleet level. Moreover, the assumptions underlying quota distribution across métiers strongly determine fleet efforts and catches (Figure 5.3.1). One alternative to this is to *a priori* estimate future effort-share based on fleet targeting, quota availability and economic constraints, but this requires more detailed input data and catch outcomes depend on the activities of all other interacting fleets.

Furthermore, removing effort-share constraints risks highly unrealistic fleet behaviour when the resulting métier effort distribution leads to economically unrewarding or operationally unfeasible outcomes.

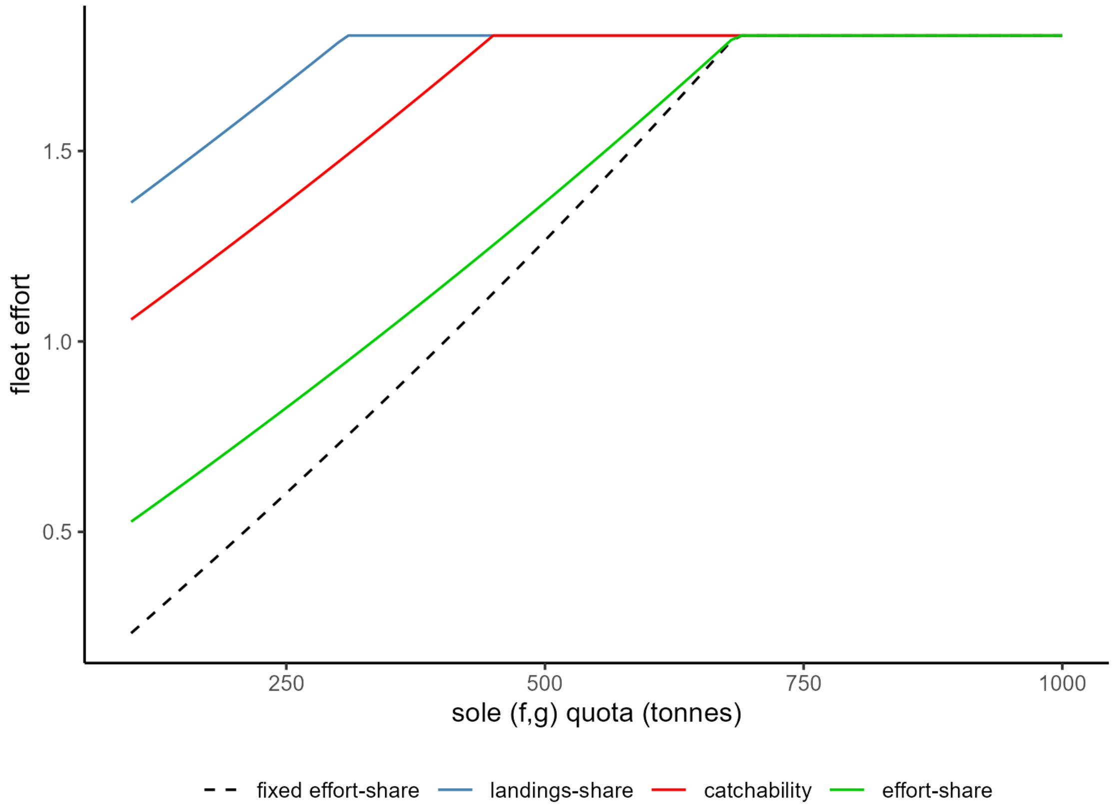


Figure 5.3.1. Total fleet effort for a simple simulated fishery comprising two métiers given dynamic (solid line) or fixed (dashed line) effort-share assumptions. Outcomes for different métier quota-share assumptions are shown; quota distributions were weighted by historical métier landings-share (blue), catchability (red) and effort-share (green). In each scenario, available quota for sole in divisions 7.f and 7.g limited effort for one métier. Quota allocations to the second métier constrained overall fleet effort and determined the tipping point between different 'choke' stocks.

Discussion within the Working Group generated ideas meriting further evaluation. One possible avenue may be the iterative optimisation of effort-share on a fleet-by-fleet basis, but the selection of optimisation target (e.g. effort, quota uptake, revenue, profit) is subjective. Alternatively, in case a fleet chokes on a spatially independent stock, that fleet could be split into two fleets (*a* and *b*), of which one "artificial" fleet (*a*) chokes on the spatially independent stock, while the effort of the remainder of the fleet is constrained by the next most limiting stock (excluding the spatially independent stock of fleet *a*) whilst accounting for the catches of the non-spatially independent stocks caught by fleet *a*. However, there was no final decision on how to address this issue.

5.4 Weak technical interactions: Can redistribution of quota allocation help?

Without further information on how total allowable catch (TAC) is distributed, mixed fisheries considerations (MFC) have relied on the assumption that future quota allocations will roughly resemble historical patterns. WGMIXFISH has compared several options in terms of accuracy in forecasts (e.g. *status quo* based on most recent data year, 3-year average, linear model, autoregressive order 1 -AR1- process) (ICES 2024), as well as whether information on quota exchanges could be used to inform more realistic quota allocations (ICES, 2021b). Despite these explorations, the use of historical patterns has remained as the most appropriate assumption.

Nevertheless, in mixed fisheries forecasts, there are cases where fleet effort is choked by stock quota allocations that are not typically limiting due to a so-called "weak technical interaction".

The presentation focused on the idea that these situations may arise in fleets that do not target a given stock and only catch a small proportion of its total catches. Under the current methodology, this fleet would receive an equally small quota allocation for the forecast years despite having a small impact to the stock. In reality, such fleets might be given a higher quota allocation of the limiting stock so that they can continue to fish their target stocks. Fleets targeting the stock may be required to give up a small percentage of their quota allocation to ensure that the others are not prematurely choked. In principle, the small adjustments should help to ensure that fleets choke on their target stocks rather than one that are incidentally caught as bycatch.

The suggested approach was to reallocate quota allocation in a regressive fashion – all fleets that catch a given stock would bank a small percentage of their quota allocation (e.g. < 5%), which would be subsequently redistributed equally among all fleets. Thus, those fleets with relatively large quota allocations would see a small decrease while those with relatively small quota allocations would see an increase. The reallocation function in R would be the following:

```
qsReallocation <- function(x, buffer = 0.05){
      idx <- which(x > 0)
      xnew <- x * 0
      xnew[idx] <- x[idx]*(1-buffer) +
      sum(x[idx]*buffer)/length(x[idx])
      return(xnew)}
```

where, *x* is a vector of initial quota allocation values (summing to 1.0), and *buffer* is the fraction to reallocate. The function then returns the adjusted vector of quota allocations, *xnew*. An example of the results of the function are shown in Figure 5.4.1. The ratio of new to old quota allocations shows the large increases experienced by fleets with small initial values, while large quota allocations experience decreases approaching the designated reallocation fraction.

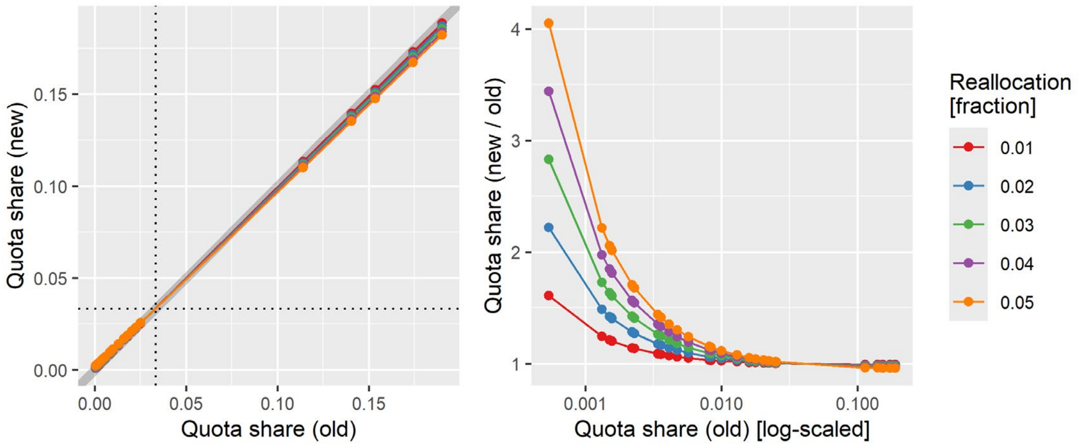


Figure 5.4.1. Example of the quota allocation reallocation procedure as applied to fleets catching a given stock. Plots are shown comparing the initial (old) versus the new values (left plot) and in terms of the relative change (new / old) (right plot). Differing levels of reallocation are indicated by colour. No change in quota allocation should occur at the mean quota allocation level (dotted lines, left plot).

Application to the North Sea case study indicates that quota allocation reallocation has the potential to relieve many weak technical interactions, resulting in higher quota uptake. Reallocation fractions of 1-5% were tested, with most gains observed even when applying a small reallocation level (1%), with gains plateauing. Applying 5% reallocation resulted in ~10-80% relative increases in catch by stock in the "min" scenario, with an average of 43% (Figure 5.4.2). Reallocation seems to have mainly helped in relieving weak technical interactions between flatfish- vs. roundfish-targeting fleets and was most affective when reallocating across all fleets at once rather than on a within-country basis. The diversity of choking stocks by fleet also increased; notably, Eastern channel flatfish (plaice, sole) and turbot became increasingly choke stocks for fleets that target them. Application to the Celtic Sea case study resulted in smaller gains in quota uptake (~0-10%), despite a large reduction of fleets being choked by cod (cod.27.7e-k) (from ~87% to ~45% with 1% reallocation). The lower gains in quota uptake may be due to more clearly distinguished fleets (based on catch composition), although further investigation of these differences is needed.

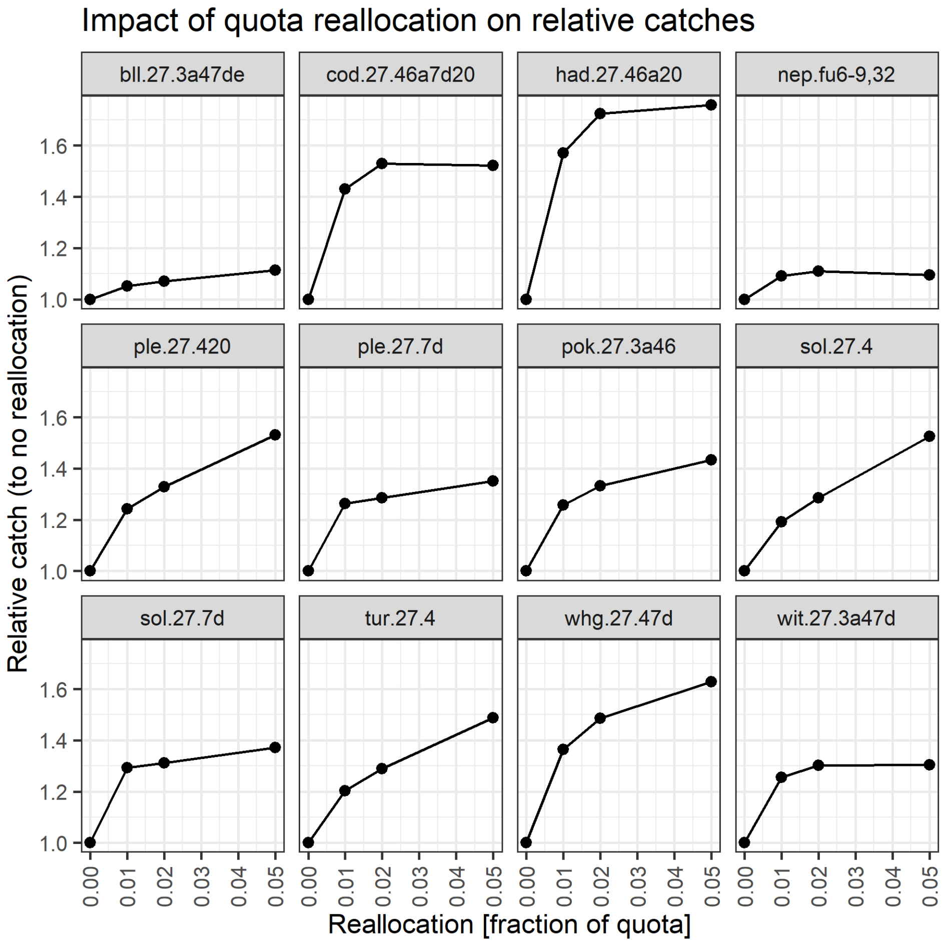
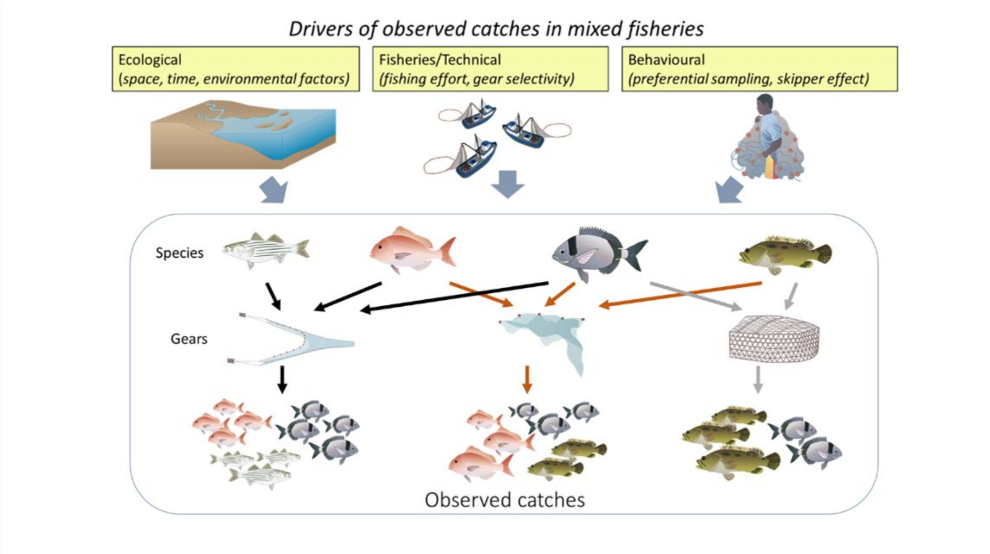


Figure 5.4.2. Relative change in catch by stock when applying different levels of quota allocation reallocation in the "min" scenario to the previous year's North Sea case study model (ICES, 2025a).

5.5 Mixed fisheries in the Ionian Sea

Multi-gear (multiple gears catching the same species) and multi-species fisheries (mixed fisheries where one gear catches various species) may be a valuable source of data concurrently spanning multiple gears, métiers and fished populations. Hence, they can be useful in providing fine-scale insights in space and time with regards to the patterns in stock distribution, abundance and even to the comparative behaviour of fishing gears. A Generalized Additive Modelling (GAM) framework to standardize catch data collected through the DCF-observer monitoring scheme was presented using a dataset from the eastern Ionian Sea (Central Mediterranean, FAO GFCM GSA20), as a case study of data-poor mixed fisheries spanning the years 2018 - 2021. The framework presented extends the usual standardization procedures by: (1) taking into account preferential sampling, (2) integrating multiple fishing gear effort metrics and (3) jointly modelling multiple species. At single stock level, the identification of the independent effect of factors used as explanatory variables (e.g. spatial, temporal, fishing intensity used as a latent approximation of effort, fishing gear, vessel-ID used as a proxy of skipper effect) can aid in fisheries monitoring and designing of management schemes. Additionally, as a result of the standardization we can estimate an objective index of either population or total fish abundance; this index can be used in order to infer inter-annual trends (more useful from more extensive time-series than the one used here). Furthermore, using standardized catches, it is possible to generate maps of species distribution (annual, seasonal or monthly) and also multiple-species persistence hotspots; this can be useful not only to inform on species distribution and ecology but also to aid in designing spatial or temporal management restrictions. The inferential process followed can also be used to identify species assemblages, i.e. groups of species based on their shared responses on environmental or fisheries-related drivers or métier assemblages (groups of fishing vessel-gear-gear technical characteristics combinations) based on their catch profiles and the apparent heterogeneity between vessels deploying common gears. These species or métier-groups can also act as units of reference for managerial purposes. Overall, the framework presented illustrates how ecological, technical and behavioural aspects of mixed fisheries can be collectively evaluated to inform both stock assessment and management (Figure 5.5.1). A more detailed explanation of the framework and an application in the eastern Ionian Sea can be found in Lazaris *et al.* (2025).



All images in this figure are courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/symbols/)

Figure 5.5.1. Conceptual framework showing the different drives of observed catch patterns in mixed-fisheries.

5.6 Integration of Economic Submodels in Mixed-Fisheries Applications: Insights from the SEAwise Project

Economic submodels can broaden the scope of mixed-fisheries analysis by incorporating socio-economic indicators and enhancing the behavioural realism of fishing activities. Within the SEAwise project—whose overarching aim was to operationalize Ecosystem-Based Fisheries Management (EBFM) in Europe—a dedicated work package focused on developing improved socio-economic submodels for use in bio-economic mixed-fisheries applications.

The presentation provided an overview of the economic submodels developed under SEAwise and shared results from their application in the Adriatic Sea using the BEMTOOL simulation platform.

Key areas of development included:

- Parametrization of métier-specific variable cost structures (e.g. fuel costs)
- Modelling of fish price dynamics, aimed at improving future price projections
- Development of alternative models of fisher behaviour
- Inclusion of socio-economic indicators, such as CO_2 emissions
- Application of bio-economic mixed-fisheries models under varying climate and socio-economic scenarios

The cost structure of fleets and métiers was parametrized using a combination of data sources: the Fisheries Dependent Information (FDI) database, the Annual Economic Report (AER), and a SEAwise-specific data call providing the socio-economic data at a finer resolution (not by Country as in AER), covering the General Fisheries Commission for the Mediterranean (GFCM) subareas (GSAs) relevant to the project.

To model fish price dynamics, multiple approaches were compared, including those that account for price elasticity as a function of supply (Bitetto et al. 2023). The model with the strongest predictive performance was selected for integration into the bio-economic modelling framework.

A novel behavioural model for fishers was introduced, distinguishing two behavioural types:

- Specialists, who aim to minimize fuel costs
- Switchers, who seek to maximize profit in response to management measures, environmental conditions, and socio-economic factors

The SEAwise framework also incorporated climate scenarios, which were linked to socio-economic projections through assumptions on future developments in fish and fuel prices. The carbon footprint of fisheries was explicitly addressed by quantifying both emissions from vessel fuel consumption and carbon removal through fish landings, by small-scale and large-scale fleets.

A case study in the Adriatic Sea, using BEMTOOL—a multi-fleet, multi-stock bio-economic simulation model—demonstrated how the integration of these economic submodels can enrich Management Strategy Evaluations (MSEs). The results illustrated the value of such integration in highlighting trade-offs between ecological and socio-economic objectives.

All underlying R code for the economic submodels has been made available to WGMIXFISH via the software folder. Additionally, links to SEAwise tutorials and the BEMTOOL source code were provided: https://github.com/ices-tools-dev/SEAwise_ecoMSE.

The SEAwise overview of the socio-economic submodels was also presented during the WGECON the 2nd October 2024.

It should be also noticed that the WGMIXFISH Celtic Sea, North Sea and Bay of Biscay case studies included the enhanced economic sub-models developed in SEAwise, and explored alternative socio-economic scenarios, specifically:

- Celtic Sea: fish price sub-models and socio-economic scenarios;
- North Sea: fish price sub-models (price elasticity & split price per age) and socio-economic scenarios;
- Bay of Biscay: fish price sub-models, behavioural sub-model and socio-economic scenarios.

5.7 An implementation of the MixME model for the Celtic Sea

Mixed-fishery Multi-stock Evaluation (MixME) is an age-structured mixed fisheries model framework with joint multi-fleet harvesting in continuous time (Pace *et al.*, 2025). Recent model developments have included support for métier structures, fixed stock populations, and zero TAC scenarios, establishing MixME as a viable candidate model for generating mixed-fisheries advice considerations in WGMIXFISH.

An application of MixME for the Celtic Sea case-study was presented using identical conditioning data as the 2024 Fcube advice model. Several challenges were encountered during model conditioning, including the provision of length-based rather than age-based estimates for anglerfish stocks and incorrect units for numbers and weight estimates for several stocks. These issues did not impact Fcube model simulations because Fcube does not resolve ages. The conditioning process was consistent with the 2024 advice model. Stock-specific 'out-of-area' fleets were defined to account for catches that were included in the stock assessment but fall outside the mixed fisheries model domain. Any remaining residual catches were accounted for by scaling fleet catches for each stock to match stock assessment estimates for the total catch biomass in each year. One key difference with the 2024 Fcube model was the omission of *Nephrops* stocks.

MixME simulations were carried out for a range of effort assumptions including status quo effort (sqE), effort constrained by the most-limiting stock quota (min), and the least-limiting stock quota (max). Outputs were evaluated against results from the 2024 advice mode.

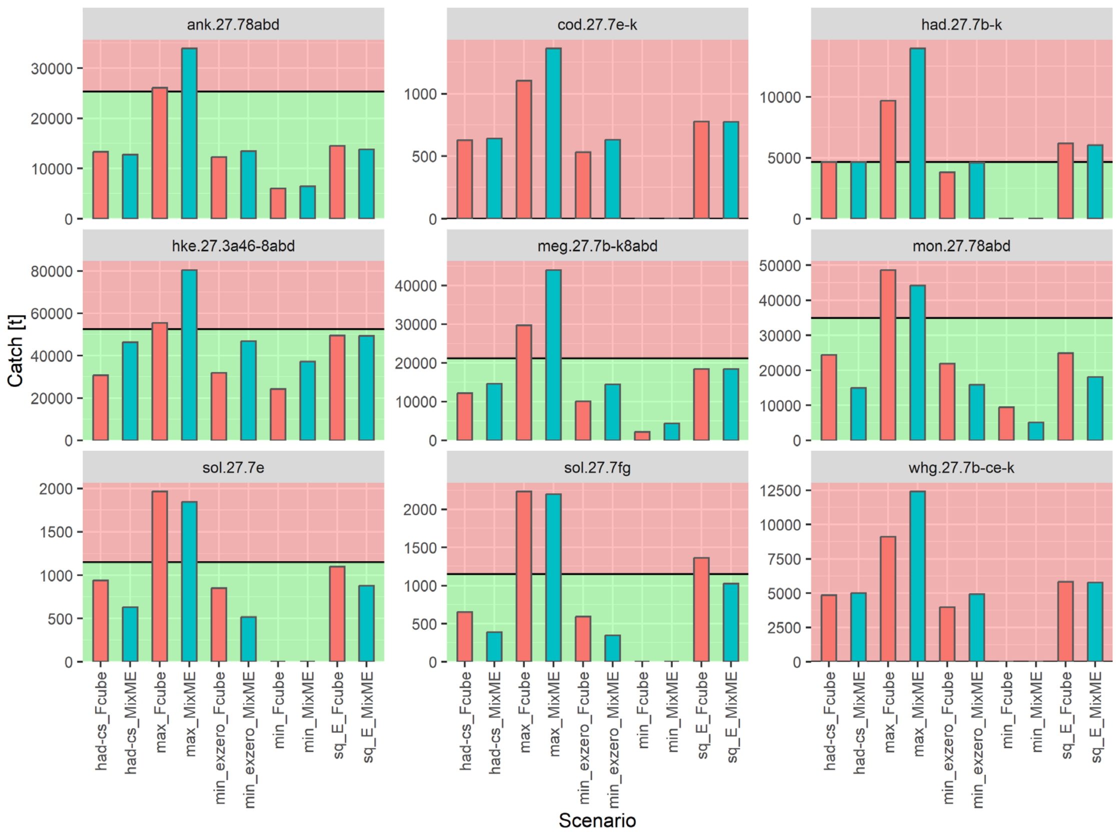


Figure 5.7.1. Mixed fisheries for the Celtic Sea for Fcube and MixME models. Mixed-fisheries projections of potential 2025 catches (in tonnes) by stock and scenario. The horizontal solid line corresponds to the single-stock catch advice. Model is denoted in the scenario name.

Results showed broadly similar outcomes between the two models (Figure 5.7.1). MixME outputs were consistent with the expectations for the relevant scenario, little to no catch under the min, high catch under the max and an effort consistent catch under the sq_E. However, catches under MixME were typically consistently somewhat higher or lower than Fcube across dynamic effort scenarios for any given stock.

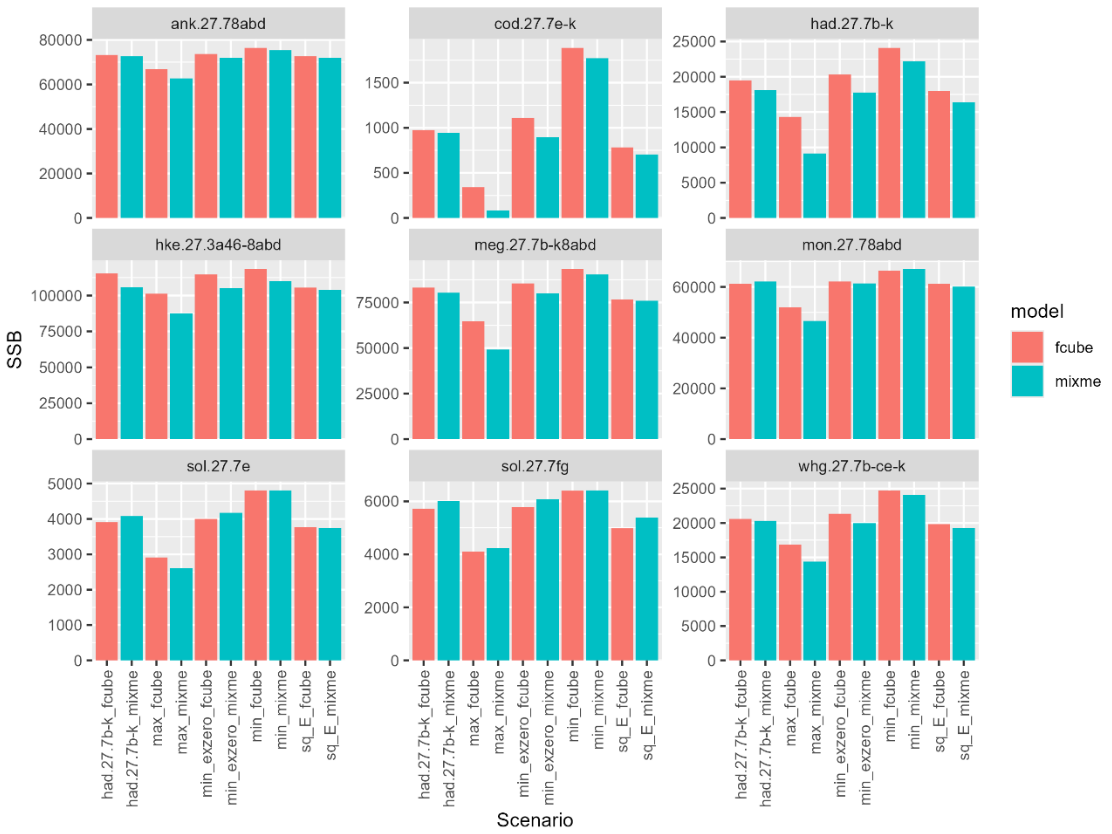


Figure 5.7.2. Projected SSB in 2026 using Fcube and MixME models for a range of stocks and effort scenarios.

Projected SSB for 2026 was very similar between the two models, mirroring the projected catch. Scenarios under the max shows the biggest differences, consistent with the high catch under the max in MixME.

The broadly consistent results are to be expected, given that the data inputs to the two models are identical. The major differences in the structuring of data between the two models are the age-disaggregation of catches and the calculation of stock-, metier- and age-specific selectivity parameters in MixME. This more detailed age structure is unlikely to substantially impact overall simulation results given that Fcube inputs are age-aggregated following age-disaggregated work-up of the data. Hence, differences in scenario outcomes are potentially primarily a result of MixME's representation of inter-fleet catch competition during the simulation. Nevertheless, the lack of Nephrops in the MixME model may a key reason for differences under the *max* scenario given that Nephrops is not the most limiting stock for any fleets under Fcube but is the least limiting for 8 fleets.

The Celtic Sea sub-group proposed transitioning to MixME as the mixed fisheries advisory model framework for the case-study starting in 2026, replacing Fcube. This will follow a process of internal documentation and review in late 2025/early 2026, and an external review of the model in 2026. The group did not support a formal benchmark process, citing several reasons: (i) ICES has not yet developed a benchmark methodology for a mixed fisheries model, (ii) no benchmark dates are available for 2026, and (iii) postponing adoption to 2027 would result in concurrent implementation of both MixME and RDBES, leading to simultaneous changes in software and data.

5.8 The *Sherwood* project: modelling Joint Harvesting of Data-Rich and Data-Limited Stocks

An ongoing research project was presented where the goal is to build upon the concept that information on fishing mortality (*F*) trends of one or more data-rich stocks can provide information to improve an assessment of data-limited stocks (so-called 'Robin Hood' approach, Punt *et al.*, 2011).

The original idea included penalties on stock and fleet specific partial fishing mortalities, so that estimates for the data-limited stocks shrink towards trends for the data-rich stocks. In this project a state-space assessment model has been developed (including an R package under development) that includes the ability to model both age-based and surplus production models where correlations in *F* trends over time among stocks (as a multivariate normal process on the random walk in *F*) can be estimated alongside the other parameters of the assessment model. This provides flexibility so that stocks can develop independently, yet if a correlation in trends in *F* are estimated, this information can improve model fits, reduce uncertainty and provide additional information that can be used for jointly forecasting the fishing mortality process that is shared among stocks.

So far, the work has demonstrated the ability for an age-structured model with joint harvesting to closely match *F* and *SSB* estimates from the single-stock assessments for cod, haddock and whiting in the Celtic Sea, with estimated positive correlations in the trends in *F* for cod and whiting and cod and haddock, and negative correlations in trends for haddock and whiting. A further test was applied to five North Sea stocks where iteratively one of the stocks was collapsed to biomass-only data (survey indices and catch series), a surplus production model fitted to the data, and the jointly fitted surplus production model (alongside the other four age-based models) compared to an individually fitted model, and the age-based estimates. This demonstrated the ability of a jointly fitted model to reduce uncertainties in some cases, but continued to struggle to estimate scale due to correlations in the *r* and *K* parameters (a common problem with surplus production model estimation) due to a lack of contrast in the data.

Future planned work includes a simulated case study to identify under what circumstances (life-history, trends in exploitation and biomass) joint fitting can improve estimates and uncertainties, and incorporating multi-fleets so that individual fleets among stock correlations can be estimated. This could provide to fleet-based forecasts that account for the correlations in *F*.

5.9 Modelling selectivity changes in Mixed Fisheries

In mixed fisheries, where multiple commercial species are caught simultaneously, management interventions such as modifying gear selectivity, can lead to complex and sometimes counterintuitive outcomes. Therefore, it is essential to model these dynamics within the mixed fishery context. Although improving selectivity for one species may seem beneficial, it can inadvertently reduce catch efficiency for others, prompting fleets to increase fishing effort. This response can negate the intended benefits and potentially intensify pressure on vulnerable non-target stocks.

The presented work tries to address this challenge by developing a comprehensive modelling framework that integrates selectivity models and Age-Length Key (ALK) models within the MixME simulation framework. The overarching aim is to evaluate how technical modifications such as changes in mesh size, affect fish population dynamics, fishing effort, and quota uptake within a mixed fishery context. This work is particularly relevant for key gadoid species like haddock and whiting, and acknowledges the role of choke species (such as cod) that can constrain overall fishery performance despite not being the primary management target.

In particular the research has three main goals: (i) assess the impact of gear selectivity on fish stocks; (ii) develop a method to translate gear selectivity trial data into population-level impacts by integrating selectivity models with Age-Length Key (ALK) models; and (iii) build a simulation framework using the MixME model (Pace et al., 2025) to explore how changes in gear selectivity, such as variations in mesh size, affect fish populations over time. The modelling framework applies ALK models to produce smooth, robust age–length distributions, even when data are sparse or missing for certain size classes. Selectivity models, based on gear trials (e.g., for haddock), show marked differences in retention probabilities when moving from 85 mm to 120 mm mesh sizes (Figure 5.9.1). These selectivity curves are then integrated into the MixME simulation framework, which in this preliminary setup was simplified to focus on three key gadoid species haddock, whiting and cod (which was excluded as a choke species). The analysis included only four demersal otter trawl (OTB) fleets from France, Ireland, Spain, and England, and applied selectivity curves derived specifically for haddock and whiting at 100 mm and 120 mm mesh sizes.

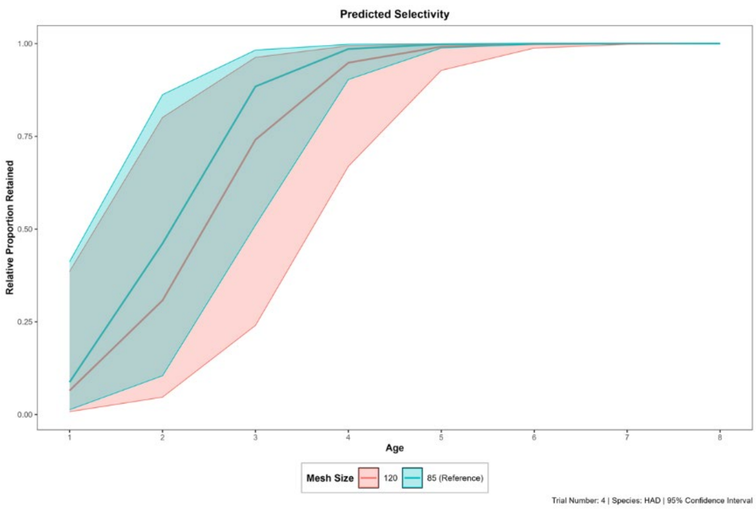


Figure 5.9.1. Example of selectivity curve for haddock from trial data cod end mesh size 85 mm (reference) and 120 mm

Preliminary results show that although selectivity curves differ noticeably between 100 mm and 120 mm mesh sizes, broader population and fleet-level indicators change only slightly between these scenarios. Specifically, spawning stock biomass, mean fishing mortality, catch, and quota uptake over time all exhibit minimal differences (Figure 5.9.2), alongside overall fishing effort (Figure 5.9.3) and choke event frequency (Figure 5.9.4).

Future work aims to refine selectivity curves by converting relative selectivity from gear trials into population-level selectivity and to integrate these with spatial fishing behaviour models (e.g., location choice dynamics described in Dolder et al., 2025). These enhancements will support a more detailed assessment of how gear changes shape fish populations and fleet behaviour over time, ensuring management decisions are informed by a more realistic, mixed-fishery dynamics.

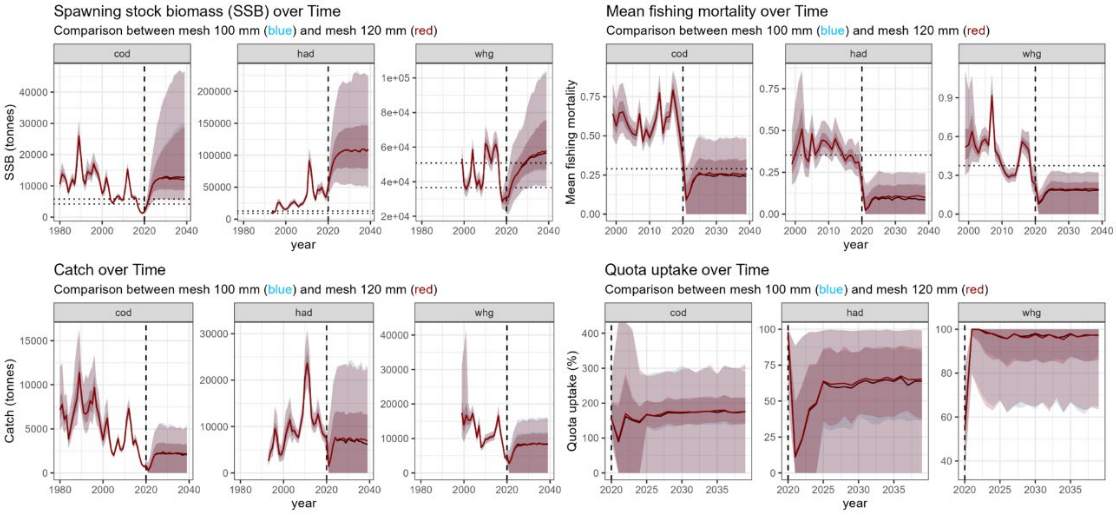


Figure 5.9.2. Simulated time-series of spawning stock biomass (SSB; tonnes), mean fishing mortality, catch (tonnes) and quota uptake for different mesh sizes (100 mm vs 120 mm) for cod, haddock and whiting. Summary quantiles are shown for SSB, fishing mortality and catch: Median value (line), 50% interval (dark ribbon) and 90% interval ranges (light ribbon). Horizontal lines represent $B_{trigger}$ and B_{lim} (SSB) and F target (mean fishing mortality). Vertical lines represent the first projection year.

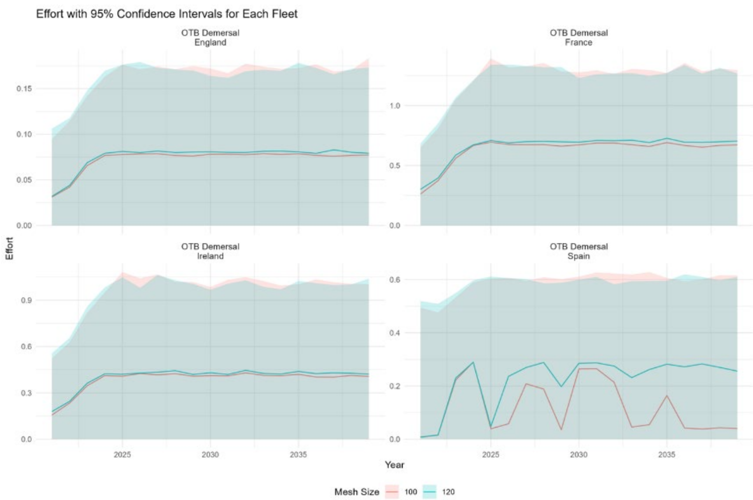


Figure 5.9.3. Projected fishing effort by fleet under different mesh sizes (100 mm vs 120 mm)

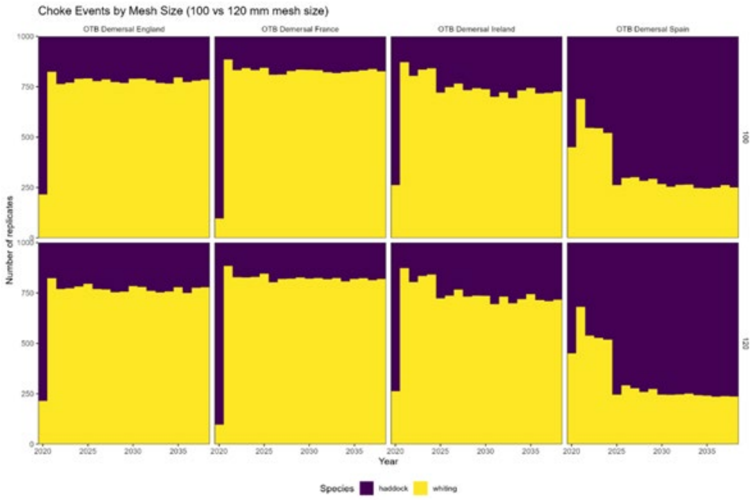


Figure 5.9.4. Effort-limiting stocks, haddock and whiting, across replicates for each simulated fleet over the simulation period.

5.10 Alternative scenarios to address the zero-catch advice technical request

There is a long-standing request from the EU that *"For stocks for which ICES is advising zero catch but that are caught in mixed fisheries, and where mixed fisheries modelling exists, ICES will provide estimates of the likely catches of stocks for which there is zero catch advice, under the assumption that TACs for the target stocks are set in line with the ICES MSY advice"*.

In the past couple of years there have been zero-catch advice for cod and whiting in the Celtic Sea, and this request has been addressed with a haddock limiting scenario from the Celtic Sea mixed fisheries model with the rationale that cod, haddock and whiting are caught together in the same fisheries. For 2026 there is a zero-catch advice for the three gadoids cod, haddock and whiting, so this approach will no longer be possible.

Alternative basis for provision of this advice needs to be explored. While in principle another target stock scenario could be chosen (e.g. *Nephrops,* sole) such a scenario is unlikely to be representative of the target fisheries for all fleets.

Using the 2024 FCube Celtic Sea advisory model alternative fleet-specific choke limiting rules were explored. These were done based on *excluding* stocks from limiting fleets under a 'min' scenario where the stock was below a given threshold for that fleet (in addition to excluding cod, haddock and whiting for all fleets). A range of thresholds were explored, from 1% to 10% and based on landings for value (Figure 5.10.1).

To give an example for Figure 5.10.1, for the fleet "IE_Otter_20<40m" you can see that initially (without exclusions) the fleet could be choked by all stocks (except cod, haddock and whiting), and is choked by Nephrops FU 19. Excluding stocks where landings (and value) are <1% results in the two sole stocks no longer limiting the fleet, nor Nephrop FU19. Nephrops FU17 becomes the new choke stock. If you jump to excluding stocks <3% of landings/value you can see the new choke stock is Nephrops outside of FUs based on landings, but this does not meet the threshold based on value, so Nephrops FU17 remain the choke stock.

As would be expected, there is a positive relationship between the threshold chosen and the catches of cod, haddock and whiting (Figure 5.10.2) as you are allowing more fishing effort by each successive exclusion. It is notable, however, that the increases in catches are relatively modest and that none of the other target stock catch limits are significantly exceeded up to around 5% (Figure 5.10.3, sole 7fg is slightly above the catch limit). This suggests that such a scenario may better reflect the choking behaviour of the fleets in the case of the zero-catch advice requests. However, it should also be noted that projected catches at a given level of fishing effort for the three stocks in question, cod, haddock and whiting, are subject to high uncertainty due to the large influence of the recruitment assumption on future catches. For example, for cod 90% of the catch is based on the recruitment assumptions for 2025 and 2026 (ICES, 2025b). Therefore, it will be important to take this uncertainty into account in addressing this request.

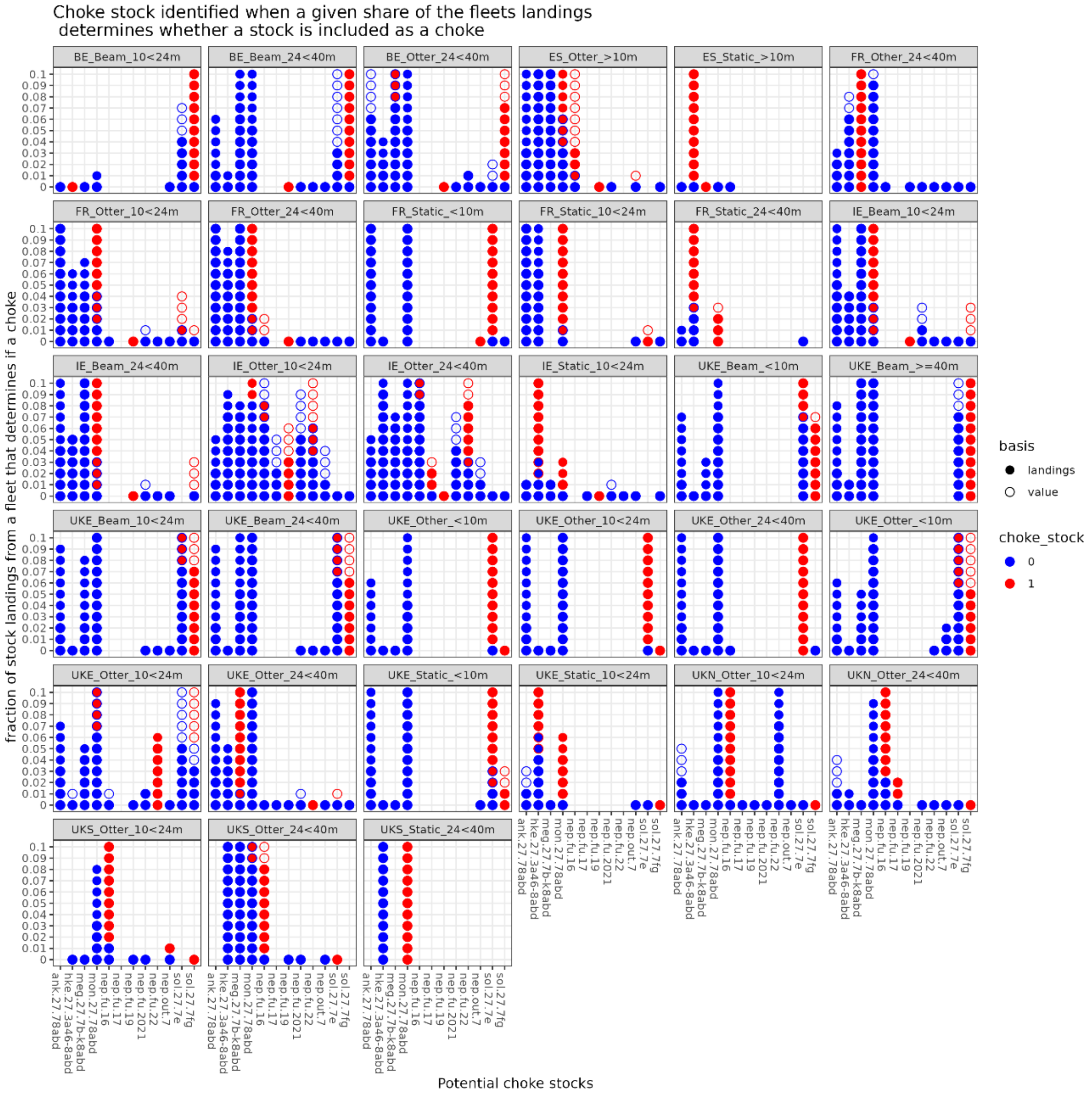


Figure 5.10.1. Setup for the different scenarios showing the threshold (y-axis) that determined which stocks (x-axis) were able to 'choke' or limit fishing effort under a 'min' scenario. Blue circles indicate the *potential* choke stocks under a given threshold, the red circles the *actual* choke stock for that threshold. Filled circles indicate that the threshold was based on the fraction of landings of the stock given the overall landings of the fleet, open circles were based on 'value' (landings x price) for the stocks. Note that cod, haddock and whiting were excluded as choke under all scenarios as zero-catch advice stocks.

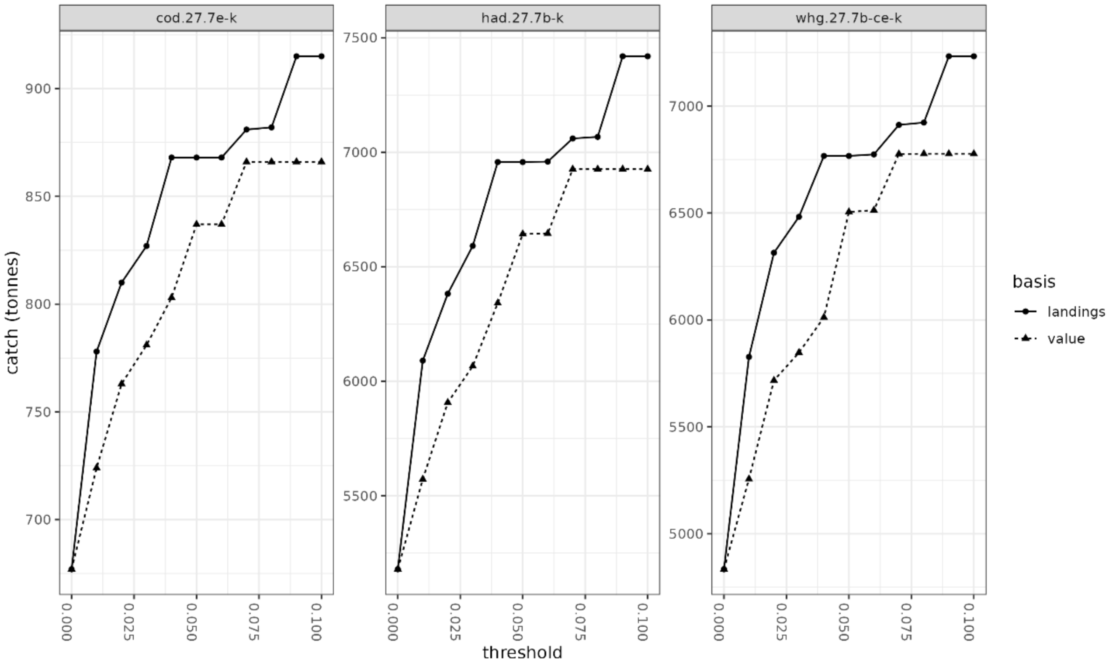


Figure 5.10.2. The projected sum of all fleets catches for the zero-catch advice stocks under different thresholds of fleet-specific choke stock limitations, where the threshold is either determined by landings (solid line) or value (dotted line).

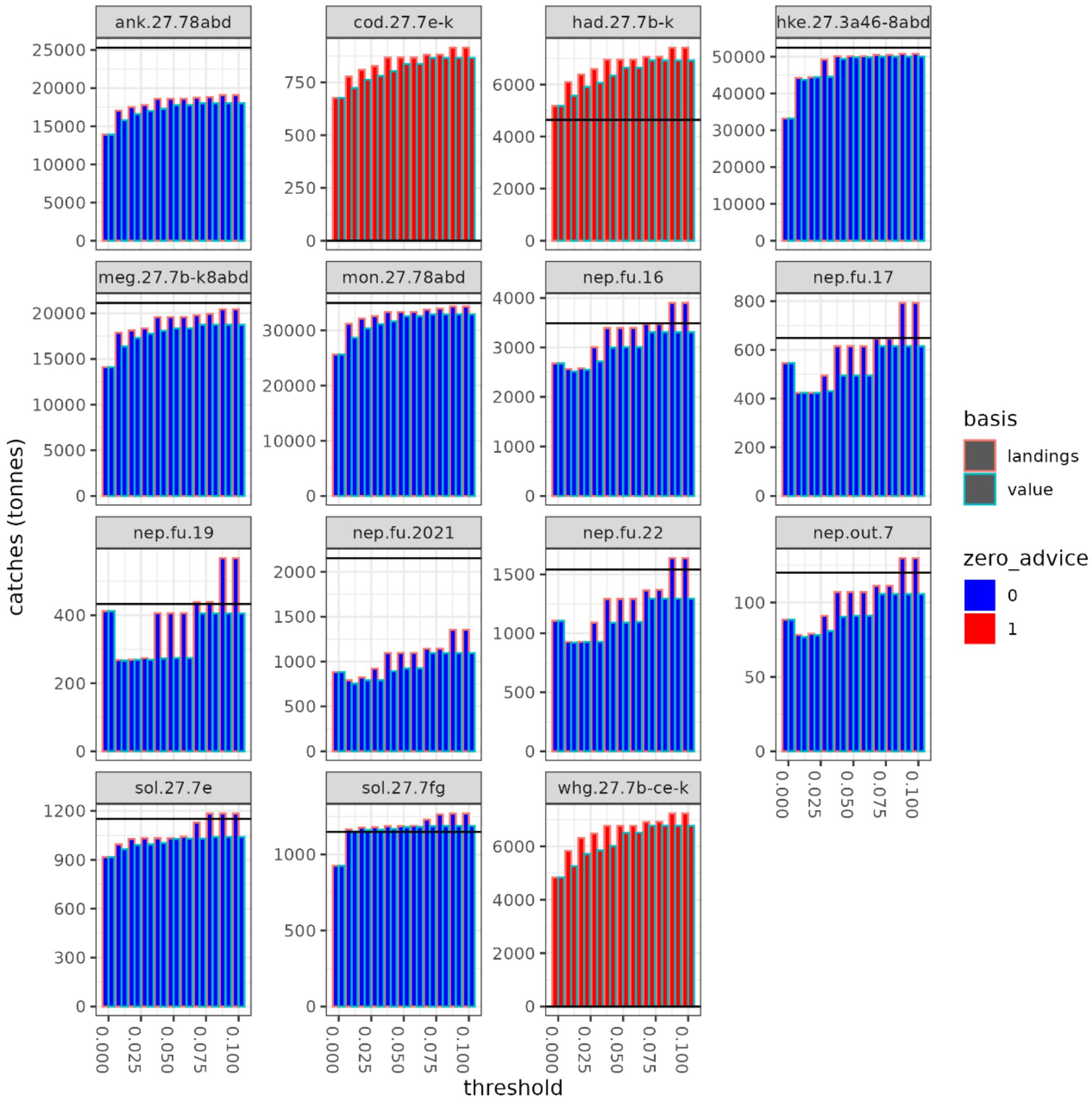


Figure 5.10.3. Projected catches of all stocks (y-axis) under the different thresholds for choke (x-axis), with the zero-catch advice stocks in filled red bars. The outline red indicates the threshold based on the landings fraction, blue based on the value fraction.

5.11 Reference list

Bitetto, I., Spedicato, M. T., Romagnoni, G., Lembo, G., Halkos, G., Plataniotis, A., Koundouri, P., Andrés, M., Sánchez, S., García, D., Ibaibarriaga, L., Voss, R., Liontakis, A., Vasilopoulou, V., Giannoulaki, M., Sgardeli, V., Tsoukali, S., Sys, K., Depestele, J., Kühn, B., Taylor, M., Kempf, A., Binch, L., and Rindorf, A. 2023. SEAwise Report on Carbon footprint, economic and social impacts of management strategies. Technical University of Denmark.

Dolder, P J., Poos, J. J., Spence, M. A., Garcia, D., Minto, C. 2025. A Comparison of Fleet Dynamics Models for Predicting Fisher Location Choice. Fish and Fisheries. https://doi.org/10.1111/faf.12886

Garcia, 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.

ICES. 2021a. Inter-Benchmark Process to evaluate a change in operating model for mixed fishery considerations in the Celtic Sea and North Sea (IBPMIXFISH). ICES Scientific Reports. 3:101. 65 pp. https://doi.org/10.17895/ices.pub.8719

ICES. 2021b. Working Group on Mixed Fisheries Advice Methodology (WGMIXFISH-METHODS). ICES Scientific Reports 3. https://doi.org/10.17895/ICES.PUB.600

ICES. 2024. EU/UK joint request regarding mixed fisheries science (Ad hoc report). ICES Scientific Reports 6, 175. https://doi.org/10.17895/ICES.PUB.25298878

ICES. 2025a. Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE; outputs from 2024 meeting). ICES Scientific Reports, *7*(1), 255. DOI: 10.17895/ices.pub.28182638

ICES. 2025b. Working Group for the Celtic Seas Ecoregion (WGCSE). ICES Scientific Reports. 7:52. 957pp. https://doi.org/10.17895/ices.pub.29401877

Lazaris, A., Tserpes, G., Kavadas, S., Tzanatos, E. 2025. Standardization of commercial catch data from multiple gears in mixed fisheries accounting for preferential sampling, catchability, and fishing effort. Fisheries Research, 284. https://doi.org/10.1016/j.fishres.2025.107305.

Pace, M. C., De Oliveira, J. A. A., Fischer, S. H., & Dolder, P. J. 2025. MixME: An R package to simulation-test fisheries management robustness to mixed-fisheries interactions. Methods in Ecology and Evolution, 16, 698–706. https://doi.org/10.1111/2041-210X.70005

Punt, A. E., Smith, D. C., & Smith, A. D. 2011. Among-stock comparisons for improving stock assessments of data-poor stocks: the “Robin Hood” approach. ICES Journal of Marine Science, 68(5), 972-981.

6 ToR E: Respond to the outcomes and issues encountered during WGMIXFISH-Advice

6.1 Bay of Biscay

The following issues were identified at WGMIXFISH-ADVICE 2024 (ICES, 2025), with progress highlighted:

Issue	Progress
Investigate discrepancy in discard estimates/change in discard mean weights in FLBEIA.	Ongoing work.
Develop a structured quality control procedure to assess quality of RDBES CL and CE data for use as WGMIXFISH data source	Roadmap to RDBES, see ToR A
Review treatment of *Nephrops* FUs in the models and presentation of results	Methodological framework for mixed-fisheries advice (ICES, 2024)
Perform a hindcast simulation using actual catches observed in 2024 to assess the prediction skill of the mixed fisheries models	Not yet tested and implemented
Consider defining maximum fleet effort as an upper limit in scenarios.	Will be implemented when agreed which should be the appropriate limit to be used. Maximum observed effort (or a multiplier) could be a potential threshold.
Continued implementation of the code, tables and figures in the ICES-taf repository (https://github.com/ices-taf) and automate the preparation of the different reports.	Ongoing work. Report, advice sheet tables and figures and input data for fisheriesXplorer app are now automatically generated. New plots/tables will be provided if necessary. For example: new figure for detailing how the raw data métiers have been aggregated in the case study area (by using Sankey plot available at the mixfishtools R package) or those that could aid communication with stakeholders (as developed under STARMIXFISH project, ICES technical service and WKMIXFISH workshops) and to allow the consistency among case studies (e.g. in the fisheries overviews plots).. Additional developments yet to be implemented in future years are: - Incorporation of RDBES information. - Retrospective analysis of intermediate year assumptions (on catchability, quota share and métier effort share). Currently it is assumed that intermediate year values are the mean of the three latest data years.
Investigate the differences obtained in the short-term forecast between that carried out for mixed fisheries advice and that of the assessment working groups, specifically for hake, horse mackerel, white anglerfish and blue whiting.	Reproducing short-term forecast for hake still presents issues to replicate the estimated discards. Problems are experienced to extract the information necessary to condition de biological model given the Stock Synthesis outputs (as, for example, currently it is not possible to correctly estimate the discards mean weights at age). Further work is ongoing for trying to solve the issue.

Issue	Progress
Improve fleet structure based on this year's fleet configuration, if considered necessary. Revise the assumptions for out of area catches for harmonisation with other case studies. Documentation and justification of the procedure.	RDBES data is being analysed and could be used to improve the fleet-métier definition if considered necessary. Use of the main fishing technique and vessel length categorisation from RDBES will improve the approach by grouping vessels with more homogeneous characteristics, strategies, fishing possibilities and behaviours. It will also enable to connect to economic data available at this level of aggregation and thus enable more integrated bio-economic approaches to mixed fisheries issues. However, changes are not planned for current year advice. Full use of this information is expected by 2027.
Analyse reported data for rays and decide on how to make assignments to the different species, given official catch data and information from surveys. Documentation and justification of the assumptions made.	This analysis is yet to be carried out, but the data reporters declare high confidence on reported information on these stocks.
Analyse the relevance of existing scenarios and identify new relevant ones. For example, include sensitivity runs to the impact of combined TACs for anglerfishes (*Lophius spp.*) and rays (in case they are included next year.	Currently existing scenarios are considered relevant for the case study and consequently will be maintained for the 2025 advice meeting. The exzero scenario was already implemented in 2023 (due to the zero TAC advice for horse mackerel) and is ready to be used in case there is any stock in this situation this year.
Analyse the option of including fleet-dependent age structure in the conditioning of the model for some stocks.	This change is yet to be implemented and it will be postponed until the transition to RDBES data is fully finalised.

6.2 Celtic Sea

The following issues were identified at WGMIXFISH-ADVICE 2024, with progress highlighted (please note that an active issues list is kept updated on the ICES TAF Issues list (https://github.com/ices-taf/2025_CS_MixedFisheriesAdvice/issues/1**)**:

Issue	Progress
Continue work on the implementation of an age-based model	The age-disaggregated 'MixME' approach that implements a fleet-based Baranov catch equation continues to be tested and compared against the current FCube model. This method is designed to address some of the issues identified at the Interbenchmark meeting (ICES, 2021) in implementing a Cobb-Douglas catch equation in the FLBEIA model, where there are inconsistencies in catches with single stock forecast methods under high fishing mortality rates (as is the case for some stocks in the Celtic Sea). Full functionality is being developed for 'MixME', with a view to its future use, following a review process. The manuscript detailing the MixME method is published (Pace *et al.*, 2025).
Perform a hindcast simulation using actual catches observed in 2024 to assess the prediction skill of the mixed fisheries models	No progress has been made to implement this procedure

Issue	Progress
Develop a structured quality control procedure to assess quality of RDBES CL and CE data for use as WGMIXFISH data source	Roadmap to RDBES, see ToRa
Review treatment of *Nephrops* FUs in the models and presentation of results.	see ICES (2025)
Consider handling of the 'out of area' catches; the fleet should have explicit quota shares based on TAC splits (as indicated by the sensitivity analysis, this fleet quota share assumption can have a large influence on overall projections for these stocks)	This was evaluated and implemented at ICES (2025), with the revised approach considered more robust.
Consider outcomes of fleet and métier sensitivity analyses, and uncertainty and sensitivity analyses and any changes that should be implemented to the model as a result	No changes implemented yet
Investigate raising procedure and "top-up" fleets: currently operating on landings and discards independently, but need to consider total catch	This was evaluated and implemented at ICES (2025), with the revised approach consistent with the best-practice guidance.
Consider whether to split the Static fleet into separate Longline and gillnet fleets to better represent differences	Current accessions data does not provide information for separately pure longliners, pure netters and mixed (polyvalent) vessels into separate fleets, but it is something that could be done should a future data call request fleet definitions *a priori*. The change is likely to be implemented when RDBES data replaces the accessions data.
Streamline code, repository and results tables and figures in TAF: much improvement was made this year in automating the report. – need to implement automated table and figure numbering. The report script still needs a few development to move redundant hard coded infos into a separate 'reference' file. Another thing that was problematic was the generation of the single advice / plot big table as the Nephrops SAG plots were not available publicly through the *icesSAG* library while available on the draft advice sheets and therefore their automated inclusion was complicated. One way forward would be a Rmd script specific to generate a word document in landscape mode just for that table, and to detect and pick the advice figures where they are available. In the end, it would be only a matter of inserting properly this file into the report section. Another thing to develop is to automatically in the text the various numbers in the description of the fleets that change from year to year	Further development on automating the report was progressed, with some of the previous issues resolved. Work will continue to improve automatic table and figure numbering.
Evaluate alternative effort scenarios based on changes implemented to allow fleet specific vectors of choking stocks,	Alternative scenarios have been tested, and an evaluation given (See Section 5.10). These are mostly likely to be relevant to the zero-catch advice technical request, and are currently not included in the advice scenarios.
Develop methods for longer term projections based on rebuilding of depleted stocks	This work is ongoing.
Others	Fixed bug in the MIS_MIS fleet where effort was not being assigned correctly due to a misnamed variable, this bug had limited impact on the 2024 mixed fisheries advice Evaluating new stocks that could be included due to upgraded assessments (e.g. pol.27.6-7)

Issue	Progress
	Consider what summary information can be provided on the impact of target fisheries on bycatch stocks (as part of Fisheries Overview). Consider how to separate choking effects for stocks that are spatially separated (e.g. sole 7e and sole 7fg, see Section 5.3)

6.3 Iberian waters

Issue	Progress
Investigate discrepancy in discard estimates/change in discard mean weights in FLBEIA.	Ongoing work.
Develop a structured quality control procedure to assess quality of RDBES CL and CE data for use as WGMIXFISH data source	Roadmap to RDBES, see ToRa
Develop criteria for selecting relevant scenarios to run. Preliminary analyses indicate that the case study species (and other key species in the area) are currently all exhibiting TAC undershoot with no fleets choking.	New scenarios could require a revised methodological framework for mixed-fisheries advice in the area and/or the inclusion of socioeconomic factors and constraints (e.g. catch limits for price stability, effort or capacity restrictions). Additional species to be included may reveal choking behaviours in the area, although this is not likely based on current data.
Perform a hindcast simulation using actual catches observed in 2024 to assess the prediction skill of the mixed fisheries models	Not yet tested and implemented
Consider other stocks in the area that are not included in the mixed fisheries methodology which are relevant for the effort allocation and technical interactions in mixed fisheries demersal métiers	Wide stocks Scomber scombrus (mac.27.nea), Micromesistius poutassou (whb.27.1-91214) and Trachurus trchurus (hom.27.2a3a4a5b6a7a-ce-k8) were identified as potential stocks. More regional stock like southern horse mackerel (hom.27.9a) are also planned to be included, unlikely they will be before WGMIXFISH ADVICE 2025. Inclusion of black-bellied anglerfish as cat 1 stock predicted to be included before WGMIXFISH ADVICE 2025. Full advice was not requested for the case study region advice.
Improvement of code structure in TAF. Continued implementation of report results, tables and figures in R markdown	Ongoing work focused on code structure, enhancing automation procedures in input data processing and including additional case study species.
Improve mixed-fisheries fleets to best reflect the technical interactions in the region. Further address the new métier classification and resolution of effort data	Although no full advice was requested for the case study, following last year changes in métier naming conventions, some adjustments were made to the MIXFISH fleet grouping for Advice. RDBES data has the potential to further enhance this work

6.4 Irish Sea

Issue	Progress
Perform a hindcast simulation using actual catches observed in 2024 to assess the prediction skill of the mixed fisheries models	No progress due to new case study participants
Review treatment of *Nephrops* FUs in the models and presentation of results	No progress due to new case study participants
Investigate of further scenarios based on alternative advice options for zero-catch stocks (e.g. cod and whiting	No progress due to new case study participants
Implement historic model validation techniques in annual workflow	No progress due to new case study participants
Further streamlining code, repository and results tables and figures	No progress due to new case study participants
Investigate the potential for implementation of an age-based model (e.g. FLBEIA/ age-based FCube model) and compare with current FCube approach	No progress due to new case study participants
Investigate differences in catch compositions of fish-stocks between Nephrops FU's if data sources allow	No progress due to new case study participants

6.5 North Sea

The following issues were identified at WGMIXFISH-ADVICE 2024, with progress highlighted:

Issue	Progress
TAF: Modify model_01 to read the BRPs (reference points) csv automatically. Better handle dataPrep scripts so they are run before running data.R. Check if the projection is needed in output.R script or if the results from model_04 can be used instead. Review on-the-fly code, and move all hidden settings to top of scripts.	These coding edits will be made while preparing for WGMIXFISH-ADVICE 2025.
Consider adding Northern Shelf anglerfish to the model	Northern Shelf anglerfish is now a category 1 stock and a FLStock object is available. Data availability in accessions will be reviewed and the potential impact on existing fleet dynamics will be examined ahead of the 2025 Advice meeting.
Consider adding Nephrops in FU 3 (and eventually in FU 4 if Kattegat also added) to the model.	Data availability in accessions has been reviewed. The impact on existing fleet dynamics was also examined (See Annex 3). Adding these FUs would result in new fleet or métiers being added to the model for Sweden and Denmark. In the case of Norway, catches from FUs 3-4 would be added to existing fleets and métiers. No further progress compared to last year. Unlikely to be implemented for WGMIXFISH ADVICE 2025.

Issue	Progress
Investigate discrepancy in discard estimates/change in discard mean weights in FLBEIA	Ongoing
Improvement of the RMarkdown report script, i.e. delete all old range code, add the Nephrops stocks to Table 4 and 5 of advice sheet, add ICES rounding rule to the outputs (notably advice sheet tables) using icesAdvice::icesRound(), add shading to Tables 4 and 5.	To progress
Investigate reason for discrepancy in reproduce the advice using FLBEIA	This issue will be investigated while preparing for WGMIXFISH-ADVICE 2025.
Investigate inconsistency in figure 2 of the advice sheet. Why is the green border for FR_NETS>10 and FR_OTTER>=40 fleets not around the highest effort bar?	This issue will be investigated while preparing for WGMIXFISH-ADVICE 2025.
Perform a hindcast simulation using actual catches observed in 2024 to assess the prediction skill of the mixed fisheries models	Not yet tested and implemented
Review treatment of *Nephrops* FUs in the models and presentation of results	see ICES (2024)
Use the results of STARMixFish project to update the methodology where relevant	No changes are being considered for 2025
Further maintenance of report section and stock annex if relevant	To progress

6.6 Fisheries Overviews

Issue	Progress
Update mixed fisheries sections in the Fisheries Overviews according to the structure of the North Sea ecoregion	These changes are planned to be made for the Celtic Sea to align with the wider review and updates being made to the Fisheries Overview for that ecoregion. Other case studies are to consider updating the sections of the relevant Fisheries Overview if possible.
Compile the code to generate mixed fisheries figures for the Fisheries Overviews in the mixfishtools package	The mixfishtools package will be updated before the WGMIXFISH ADVICE meeting (2025).
Create FO folder in the Shiny folder to store input data for FO figures	All case studies to add folder prior to/during the Advice meeting

6.7 Reference list

ICES. 2021. Inter-Benchmark Process to evaluate a change in operating model for mixed fishery considerations in the Celtic Sea and North Sea (IBPMIXFISH). ICES Scientific Reports. 3:101. 65 pp. https://doi.org/10.17895/ices.pub.8719

ICES. 2023. ICES Ecosystem Overviews Technical Guidelines. Version 4. ICES Guidelines and Policies - Advice Technical Guidelines. 24 pp. https://doi.org/10.17895/ices.pub.22059803

ICES. 2024. Methodological Framework for Mixed Fisheries Modelling. Version 01. ICES User Handbooks. 22 pp. https://doi.org/10.17895/ices.pub.28063043

ICES. 2025. Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE; outputs from 2024meeting). ICES Scientific Reports. 7:1. 255 pp. https://doi.org/10.17895/ices.pub.28182638

Pace, M. C., De Oliveira, J. A. A., Fischer, S. H., & Dolder, P. J. 2025. MixME: An R package to simulation-test fisheries management robustness to mixed-fisheries interactions. Methods in Ecology and Evolution, 16, 698–706. https://doi.org/10.1111/2041-210X.70005

Annex 1: List of participants

Name	Institute	Country (of institute)	Email
Alessandro Orio	SLU Aqua	Sweden	alessandro.orio@slu.se
Bernhard Kühn	Thünen Institute of Sea Fisheries	Germany	bernhard.kuehn@thuenen.de
Chun Chen	Wageningen Marine Research	The Netherlands	chun.chen@wur.nl
Claire Macher	Ifremer (Bretagne)	France	claire.macher@ifremer.fr
Claire Moore	Marine Institute	Ireland	claire.moore@marine.ie
Dorleta Garcia	AZTI	Spain	dgarcia@azti.es
Gianfranco Anastasi	Centre for Environment, Fisheries and Aquaculture Science	UK	gianfranco.anastasi@cefas.gov.uk
Harriet Cole	Marine Directorate of the Scottish Government	Scotland, UK	harriet.cole@gov.scot
Hugo Mendes	Portuguese Institute for Sea and Atmosphere	Portugal	hmendes@ipma.pt
Evangelos Tzanatos	University of Patras	Greece	tzanatos@upatras.gr
Isabella Bitetto	COISPA Tecnologia & Ricerca	Italy	bitetto@fondazionecoispa.org
Johnathan Ball	Centre for Environment, Fisheries and Aquaculture Science	UK	johnathan.ball@cefas.gov.uk
Klaas Sys (chair)	Flanders Research Institute for Agriculture, Fisheries and Food (ILVO)	Belgium	klaas.sys@ilvo.vlaanderen.be
Lionel Pawlowski	Ifremer (Lorient)	France	lionel.pawlowski@ifremer.fr
Luca Lamoni	ICES	Denmark	luca.lamoni@ices.dk
Marc Taylor	Thünen Institute of Sea Fisheries	Germany	marc.taylor@thuenen.de
Marta Cousido	IEO-CSIC	Spain	marta.cousido@ieo.csic.es
Marta Ferraro	Marine Institute	Ireland	marta.ferraro@marine.ie
Mathieu Merzéréaud	Ifremer (Bretagne)	France	mathieu.merzereaud@ifremer.fr
Matthew Pace (chair)	Centre for Environment, Fisheries and Aquaculture Science	UK	matthew.pace@cefas.gov.uk
Paul Dolder	Centre for Environment, Fisheries and Aquaculture Science	UK	paul.dolder@cefas.gov.uk
Santiago Cerviño	IEO	Spain	santiago.cervino@ieo.csic.es
Sarah Millar	ICES	Denmark	sarah-louise.millar@ices.dk

Name	Institute	Country (of institute)	Email
Sonia Sánchez-Maroño	AZTI	Spain	ssanchez@azti.es
Thomas Brunel	Wageningen Marine Research	The Netherlands	thomas.brunel@wur.nl
Vanessa Trijoulet	DTU-Aqua	Denmark	vtri@aqua.dtu.dk
Youen Vermard	Ifremer (Nantes)	France	yvermard@ifremer.fr

Annex 2: Resolutions

WGMIXFISH-METHODS - Working Group on Mixed Fisheries Advice Methodology

2024/AT/FRSG17 The **Working Group on Mixed Fisheries Advice Methodology** (WGMIXFISH-METHODS), chaired by Klaas Sys*, Belgium, and Matthew Pace*, UK, will hold a hybrid meeting in Lisbon, Portugal, on 16-20 June 2025, to:

a) Continue the improvement of WGMIXFISH-ADVICE data call, data processing, methodological framework, workflow, auditing, updating associated documentation and increasing transparency
b) Exploration of the RDBES data to improve fleet and métier definitions used in mixed fisheries models.
c) Continue contributing to the Fisheries Overviews and fisheriesXplorer, standardizing figures across relevant ecoregions, and ensuring data is in the correct format for use by the app;
d) Exploration of developments in methodology and advice;
e) Respond to the outcomes and issues encountered during WGMIXFISH-Advice;

WGMIXFISH-METHODS will report by 25 July 2025 for the attention of ACOM.

Only experts appointed by national Delegates or appointed in consultation with the national Delegates of the expert's country can attend this Expert Group.

Supporting information

Priority:	The work is essential to ICES to progress in the development of its capacity to provide advice on multispecies fisheries. Such advice is necessary to fulfil the requirements stipulated in the MoUs between ICES and its client commissions.
Scientific justification and relation to action plan:	The issue of providing advice for mixed fisheries remains an important one for ICES. The AFRAME project, which started on 1 April 2007 and finished on 31 March 2009 developed further methodologies for mixed fisheries forecasts. The work under this project included the development and testing of the FCube approach to modelling and forecasts. In 2008, SGMIXMAN produced an outline of a possible advisory format that included mixed fisheries forecasts. Subsequently, WKMIXFISH was tasked with investigating the application of this to North Sea advice for 2010. AGMIXNS further developed the approach when it met in November 2009 and produced a draft template for mixed fisheries advice. WGMIXFISH has continued this work since 2010.
Resource requirements:	No specific resource requirements, beyond the need for members to prepare for and participate in the meeting.
Participants:	Experts with qualifications regarding mixed fisheries aspects, fisheries management and modelling based on limited and uncertain data.
Secretariat facilities:	Meeting facilities, production of report.
Financial:	None
Linkages to advisory committee:	ACOM

Linkages to other committees or groups:	SCICOM through the WGMG. Strong link to STECF.
Linkages to other organizations:	This work serves as a mechanism in fulfilment of the MoU with EC and fisheries commissions. It is also linked with STECF work on mixed fisheries.