WORKING GROUP ON MIXED FISHERIES ADVICE (WGMIXFISH-ADVICE)

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

Contents

i Executive summary

The ICES Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE) held a hybrid meeting to produce mixed fisheries forecasts for the Bay of Biscay, Celtic Sea, Iberian waters, Irish Sea and the North Sea. Mixed fisheries advice highlights the potential implications of single-stock (total allowable catch and effort) management on the catches of multiple stocks caught together in mixed fisheries. It considers past fishing patterns and catchability of the different fleets, and the TAC advice produced by the single-stock advice groups, to provide a quantitative forecast of over and underexploitation of the different stocks given mixed fishery interactions. The mixed fisheries forecasts were produced using the "FCube" (Fleet and Fishery Forecasts) methodology for the Celtic Sea and Irish Sea, and the "FLBEIA" (Bio-Economic Impact Assessment using FLR) methodology for the Bay of Biscay, Iberian waters and the North Sea.

The Bay of Biscay mixed fisheries projections consider the single-species advice of 13 stocks (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, and whg.27.89a). Given the single-stock catch advice for 2024, the most limiting stock for demersal fisheries in the Bay of Biscay is horse mackerel, due to the zero-catch advice and that almost all fleets within the mixed fishery catch this stock. The least limiting stock is white anglerfish (7 of 21 fleets). However, if horse mackerel were to be excluded as a restrictive stock due to the small contribution made by the demersal fleets to the total stock landings, the most limiting stock would be pollack whose quota is first reached for 7 of 21 defined fleets.

The Celtic Sea mixed fisheries projections consider the single-species advice for 15 stocks (cod.27.7e-k, had.27.7b-k, whg.27.7b-ce-k, nep.fu.16, 17, 19, 20–21, 22, and outside FUs, sol.27.7e, sol.27.7fg, mon.27.78abd, ank.27.78abd, meg.27.7b-k8abd, and hke.27.3a46-8abd). Given the single-stock catch advice for 2024, the most limiting stocks for demersal fisheries in the Celtic Sea are cod and whiting, choking 27 of 35 fleets, with 3 further fleets choked by cod alone. This is due to the zero catch advice for cod and whiting, and almost all fisheries operating with demersal gears that catch these stocks. The least limiting stock is Norway lobster in FU 2021 (18 fleets) followed by black-bellied anglerfish (16 fleets).

The Iberian waters mixed fisheries projections consider the single-species advice for 5 stocks (ank.27.8c9a, hke.27.8c9a, lbd.27.8c9a, meg.27.8c9a and mon.27.8c9a). Given the single-stock catch advice for 2024, the most limiting stock for demersal fisheries in the Iberian waters is hake, whose advised catch for 2024 is first reached for all 11 defined fleets. The least limiting stock is black-bellied anglerfish (10 of 11 fleets).

The Irish Sea mixed fisheries projections consider the single-species advice for 7 stocks (cod.27.7a, had.27.7a, ple.27.7a, sol.27.7a, whg.27.7a, nep.fu.14, and 15). Given the single-stock catch advice for 2024, the most limiting stocks for demersal fisheries in the Irish Sea are whiting, choking all of the 12 fleets, and sole and cod chocking 11 of 12 fleets. The least limiting stock is plaice (11 of 12 fleets).

The North Sea mixed fisheries projections consider the single-species advice for 21 stocks (bll.27.3a47de, cod.27.47d20, had.27.46a20, ple.27.420, ple.27.7d, pok.27.3a46, sol.27.4, sol.27.7d, tur 27.4, whg.27.47d, wit.27.3a47d, nep.fu.5, 6, 7, 8, 9, 10, 32, 33, 34, and 4 outFU). Given the single-stock catch advice for 2024, the most limiting stock for demersal fisheries in the North Sea is cod, whose advised catch for 2024 is first reached for 35 of 43 defined fleets. The least limiting stock is whiting (36 of 43 fleets).

Additional work included contributions to six technical requests.

ii Expert group information

Expert group name	Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE)
Expert group cycle	Annual
Year cycle started	2022
Reporting year in cycle	1/1
Chairs	Harriet Cole, UK
	Marc Taylor, Germany
Meeting venue and dates	2–6 October 2023, Copenhagen, Denmark (25 participants)

1 Introduction

Working Group on Mixed Fisheries Advice 2023 report

This report documents WGMIXFISH-ADVICE 2023 meeting outputs. The ICES Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE) chaired by Marc Taylor, Germany, and Harriet Cole, UK, met on 2–6 October 2023 to apply mixed fisheries forecasts to the 2023 single-species advice for the Bay of Biscay, Celtic Sea, Iberian waters, Irish Sea, and North Sea. This working group also contributed to the fisheries overviews for a number of regions and two technical requests.

Within Europe, most fisheries management is undertaken on a stock-by-stock basis, using tools such as total allowable catch (TAC). This form of management does not reflect the reality of most mixed fisheries where multiple species are caught together. Particularly in the case of demersal fisheries where fishers have limited flexibility to discriminate between species caught during fishing operations. This mismatch between the multispecies outcomes of fishing operations and the single-species catch advice can produce a number of challenges for management, including discarding, the emergence of choke species, and missed fishing opportunities.

Within a European context, the need for mixed fisheries advice arose in 2002, when the conflicting states of the various demersal stocks in the North Sea made the limitations of the traditional, single-species approach to advice particularly apparent. These circumstances led to the introduction of management measures, such as effort restrictions and single-species multiannual management plans. The 2014 revision of the CFP-Common Fisheries Policy (EU, 2013) further highlighted the limitation of the single-species advice structure, with the introduction of two additional management measures: the landings obligation and the regional multiannual management plans for mixed fisheries. The introduction of these management measures fundamentally changed how fisheries were managed. Therefore, since 2016 the ICES advice on fishing opportunities have been provided in the context of catch, rather than landings. As mixed fisheries objectives are still under development, they cannot be incorporated in the mixed fisheries forecasts, which must build on the existing legal and management system.

The ICES Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE) produces management advice and options that consider the consequences of technical interactions in multi-stock, multi-gear fisheries. This advice is produced using two different models, depending on the advice region, namely FCube and FLBEIA. Mixed fishery advice is based on the Common Fisheries Policy (CFP) TAC regime and is consistent with relative stability.

1.1 Definitions

Two key descriptive terms form the foundation of mixed fisheries advice, the fleet (or fleet segment), and the métier. Their definition has evolved over time, but the most recent official definitions are provided by the EU Data Collection Framework (DCF; Reg. (EC) No 949/2008 and Commission Decision 2010/93/UE) and are adopted here:

- A fleet segment is a group of vessels with the same length class and predominant fishing gear during the year. Vessels may have different fishing activities during the reference period, but might be classified in only one fleet segment.
- A métier is a group of fishing operations targeting a similar (assemblage of) species, using similar gear, during the same period of the year and/or within the same area, and characterized by a similar exploitation pattern.

Since 2012, WGMIXFISH has requested catch and effort data from countries data according to aggregations based on the definitions of the EU Data Collection Framework (DCF). The data call allowed merging across DCF métiers, and as such, national data entries were sometimes not by métier in the strict sense. Merging of métiers to reduce to a manageable number going forward in the forecasts further leads to the formation of combined or 'supra-métiers.'

1.2 Terms of reference

2022/2/FRSG15 The **Working Group on Mixed Fisheries Advice (**WGMIXFISH-ADVICE), chaired by Marc Taylor, Germany, and Harriet Cole, UK, will meet at ICES Headquarters in Copenhagen, Denmark, 2–6 October 2023 to:

a) Carry out mixed fisheries projections for the Bay of Biscay taking into account the single species advice and the management measures in place for 2023 for anglerfish, megrim, sea bass, hake, sole, Norway lobster, whiting and pollack that is produced by WGBIE in May 2023; for mackerel, horse mackerel, and blue whiting produced by WGWIDE in September 2023 and smooth hound produced by WGEF in October 2023.

b) Carry out mixed demersal fisheries projections for the Celtic Sea taking into account the single species advice and the management measures in place for 2023 for cod, haddock, whiting, hake, megrim, monkfish, sole and Norway lobster that is produced by WGCSE and WGBIE in 2023.

c) Carry out mixed fisheries projections for Iberian waters taking into account the single species advice and the management measures in place for 2023 for hake, four-spot megrim, megrim and anglerfish that is produced by WGBIE in May 2023.

d) Carry out mixed demersal fisheries projections for the Irish Sea (27.7.a) taking into account the single species advice for cod, haddock, whiting, plaice, sole, and Norway lobster that is produced by WGCSE in 2023.

e) Carry out mixed demersal fisheries projections for the North Sea taking into account the single species advice and the management measures in place for 2023 for cod, haddock, whiting, saithe, plaice, sole, turbot, Norway lobster, and witch that is produced by WGNSSK in May 2023.

f) Produce draft mixed fisheries sections for the ICES advisory report 2023 that includes a dissemination of the fleet and fisheries data and forecasts for the North Sea, Celtic Sea, Irish Sea, Bay of Biscay, and Iberian waters.

WGMIXFISH-ADVICE will report by 28 October 2023 for the attention of the 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 the provision of ICES 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 ap-proach 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 and science committees	ACOM and SCICOM.
Linkages to other groups	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 Bay of Biscay

Mixed fisheries considerations

2.1 Background

2.1.1 The fisheries

The Bay of Biscay covers ICES divisions 8.a, 8.b, and 8.d. These fisheries target a large range of species with different gears and in many cases are highly mixed. The trawl fisheries use otter, beam, and pelagic trawls. Otter trawl is the main gear used in demersal fisheries in this ecoregion. The species caught depends on the area and the range of depths fished, as well as on the codend mesh size. The main species caught in these fisheries are hake, anglerfish, megrim, Norway lobster, sole, horse mackerel, mackerel, blue whiting, sea bass, pollack, red mullet, and cephalopods (cuttlefish and squid). Set-net fisheries target sole, hake, pollack, sea bass, anglerfish, and crustacean species while the longline fishery targets hake with bycatch of other deep-water species. The fisheries are mainly carried out by French and Spanish vessels with the addition of some vessels from Ireland, UK, and Belgium.

Hake caught in ICES Division 3.a and subareas 4, 6, and 7, megrim and anglerfish in Subarea 7, pollack in 8.c and 9.a, and mackerel, horse mackerel, and blue whiting outside Bay of Biscay are also included in the current analysis to account for all fishing mortality on these stocks.

2.1.2 Management measures

In the context of the new Common Fisheries Policy (CFP), the EU has developed a multiannual management plan (MAP) for the management of the Western Waters demersal mixed fisheries, which has been in force since 2019 (EU, 2019), replacing the former single-stock long-term management plans with a unique framework defining objectives and constraints for both target and bycatch demersal species. Among the stocks with analytical assessments included in the Bay of Biscay mixed fisheries analysis, several are either shared between the EU and non-EU member states (which are not involved in the EU-MAP) or not included in the EU-MAP. In those cases, ICES gives advice based on the ICES MSY approach or the precautionary approach (PA).

The EU landing obligation was introduced in 2016 (EU, 2015). This regulation prohibits the discarding of certain species on a fishery-by-fishery approach. From 1 January 2019, catches of all quota species in the Bay of Biscay are subject to the EU landing obligation rule, except if an exemption is in place.

2.2 FLBEIA

2.2.1 Software

The analysis was conducted using the FLR framework (Kell *et al.*, 2007; www.flr-pro-ject.org; FLCore 2.6; FLAssess 2.6.3; FLash 2.5.11), and was run with R version 4 (R Core Team, 2022). All forecasts were projected using the FLBEIA package (version 1.16.1; García *et al.*, 2017). FLBEIA is an FLR package that facilitates the bioeconomic evaluation of management strategies in a multistock and multifleet framework. A total of 13 stocks were considered in the present analysis.

Ten stocks are assessed as an ICES category 1 (with one Norway lobster stock assessed based on UWTV survey) and the three remaining stocks are assessed as ICES category 3.

The list of species considered, and the software used in the single-species assessments and forecasts are summarized in Table 2.1.

Table 2.1. Summary of stocks incorporated in the mixed fisheries analysis for the Bay of Biscay, the assessment model and forecast used to produce the single-species advice.

Stocks	Assessment	Forecast
Black-bellied anglerfish (*Lophius budegassa*) in Subarea 7 and divisions 8.a–b and 8.d (Celtic Seas, Bay of Biscay); ank.27.78abd	Length-based age-structured (Stock Synthesis)	FLR STF
Sea bass (*Dicentrarchus labrax*) in divisions 8.a–b (northern and central Bay of Biscay); bss.27.8ab	Age- and length-based analytical (Stock Synthesis)	*ad hoc* R code
Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay); hke.27.3a46-8abd	Length-based and sex-disaggregated (Stock Synthesis)	Stock Synthesis
Horse mackerel (*Trachurus trachurus*) in Subarea 8 and divisions 2.a, 4.a, 5.b, 6.a, 7.a–c,e–k (the Northeast Atlantic); hom.27.2a4a5b6a7a-ce-k8	Length- and age-based analytical (Stock Synthesis)	FLR STF
Mackerel (*Scomber scombrus*) in subareas 1–8 and 14 and Division 9.a (the Northeast Atlantic and adjacent waters); mac.27.nea	Age-based analytical (SAM)	FLR STF
Megrim (*Lepidorhombus whiffiagonis*) in divisions 7.b–k, 8.a–b, and 8.d (west and southwest of Ireland, Bay of Biscay); meg.27.7b-k8abd	Statistical catch-at-age (a4a)	FLR STF
White anglerfish (*Lophius piscatorius*) in Subarea 7 and divisions 8.a–b and 8.d (Celtic Seas, Bay of Biscay); mon.27.78abd	Length-based age-structured (Stock Synthesis)	FLR STF
Norway lobster (*Nephrops norvegicus*) in divisions 8.a and 8.b, Functional Units 23–24 (northern and central Bay of Biscay); nep.fu.2324	Underwater television (UWTV) survey	Ad-hoc (excel sheet)
Plaice (*Pleuronectes platessa*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters); ple.27.89a	Trends from biomass index from commercial LPUE index from French gillnet and length-based indicators (LBIs)	No
Smooth-hound (*Mustelus* spp.) in subareas 1–10, 12 and 14 (the Northeast Atlantic and adjacent waters); sdv.27.nea	Trends from combined biomass index and length-based indicator	Ad-hoc (excel sheet)
Sole (*Solea solea*) in divisions 8.a–b (northern and central Bay of Biscay); sol.27.8ab	Age-based analytical assessment (FLXSA) with only landings	FLR STF
Blue whiting (*Micromesistius poutassou*) in subareas 1–9, 12, and 14 (Northeast Atlantic and adjacent waters); whb.27.1-91214	Age-based analytical assessment (SAM)	SAM forecast (deterministic version)
Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters); whg.27.89a	Trends from biomass index from commercial LPUE (French bottom trawl) and Length Based Indicators (LBIs)	No

2.2.2 Scenarios

The basis of the model is to estimate the potential future levels of fleet fishing effort corresponding to the fishing opportunities (TACs by stock and/or effort allocations by fleet) available to that fleet, based on fleet effort distribution and catchability by métier. This level of effort was used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

The advice basis for stocks with analytical single species assessments was given in terms of the EU multiannual plan (MAP) for Western Waters when it is applicable, or alternatively, according to MSY approach (for the stocks shared with non-EU members for instance). For the stocks with no analytical assessments (Category 3), the advice was based on the precautionary approach. A total of 18 scenarios were produced:

Table 2.2. Summary of scenarios produced for the mixed fisheries analysis of the Bay of Biscay.

Scenario	Mixed Fisheries effort assumption	Basis for catch targets in 2024
Minimum (min)	For each fleet, fishing in 2024 stops when the catch for any one of the stocks meets the fleet's stock share*. This option is the most precautionary option, causing underutilization of the single-stock advice possibilities of other stocks, and can highlight some potential 'choke species' issues.	ICES catch advice
Maximum (max)	For each fleet, fishing in 2024 continues until the catches of all stocks meet the fleet's stock share*. This option illustrates the degree of overfishing of the single-stock advice if fishing is not restricted by the fleet stock shares*.	
Status quo effort (sq_E)	The effort of each fleet in 2024 is set equal to the average effort in the most recent three years (2020–2022) for which landings and discard data are available. However, for the pelagic fleets that catch the remaining quota for mackerel, horse mackerel and blue whiting we assume that they catch all their available quota.	
Minimum including ranges (min_range)	Same as min scenario.	Catches corresponding to $F_{MSY\ upper}$ for stocks in good status (SSB ≥ MSY $B_{trigger}$) and scaled F_{MSY} advice levels (F_{MSY} × SSB/MSY $B_{trigger}$) for the other stocks (including zero catch advice stocks).
Minimum excluding zero catch advice (min_exzero)	For each fleet, fishing in 2024 stops when the catch for any one of the stocks (excluding zero catch advice) meets the fleet's stock share*. Horse mackerel is a potential choke species for most of the fleets included in the analysis (due to the zero-TAC advice for 2024). However, over 2020–2022 the fleets considered here account for less than 1% of stock landings.	ICES catch advice
Stock-specific MSY or PA approach (ank/bss/hke/hom/mac/meg/mon/nep/pol/sdv/sol/whb/whg)	All fleets set their effort in 2024 corresponding to their stock-specific quota share, regardless of other catches. This option causes overfishing of some stocks, except in the case of horse mackerel (hom), which causes underutilization of some stocks.	

*** Throughout this analysis, the term 'fleet's stock share' or 'stock share' is used to describe the share of the fishing opportunities for each particular fleet, which has been calculated based on the single-stock advice for 2024 and the historical proportion of the stock landings taken by the fleet (2020–2022).**

2.3 Stock input data and recent trends

2.3.1 Stocks

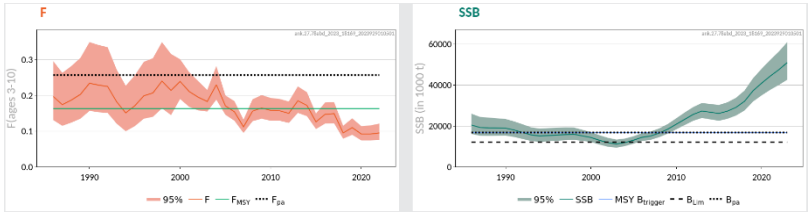
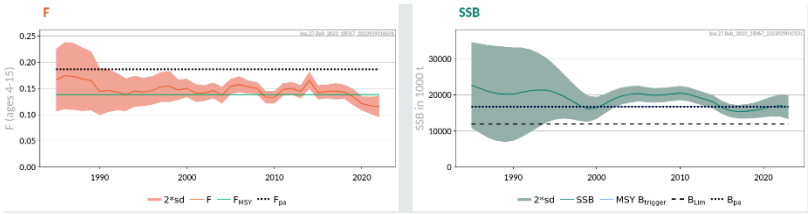
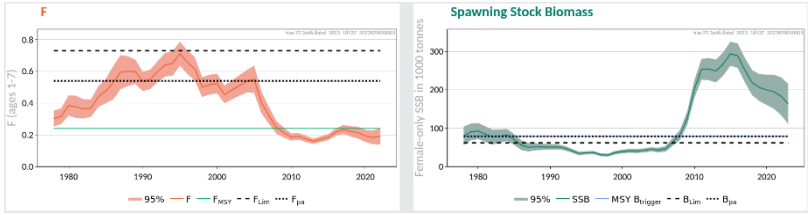
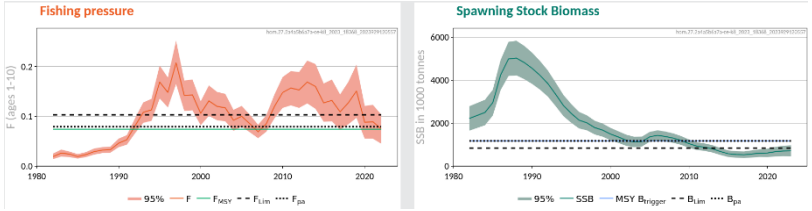
2.3.1.1 Data

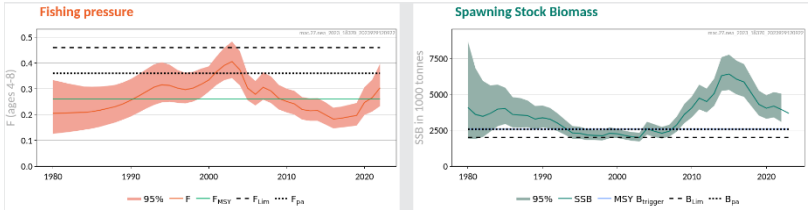
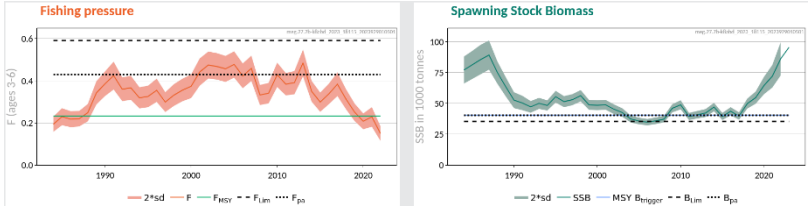
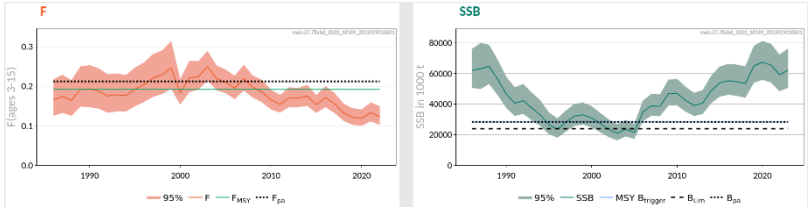
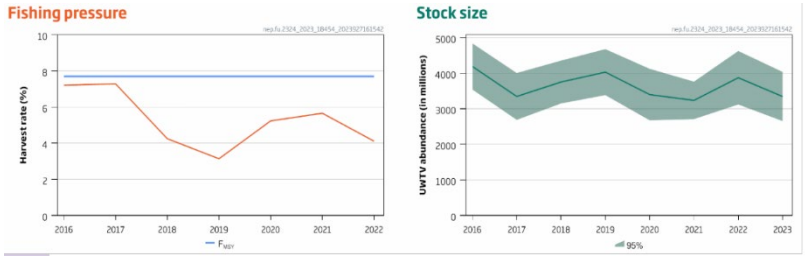
The single species assessment data for the different stocks were provided by the ICES Working Group for the Bay of Biscay and the Iberian Coast Ecoregion (WGBIE; ICES, 2023a), ICES Working Group on Elasmobranch Fishes (WGEF; ICES, 2023b) and ICES Working Group on Widely Distributed Stocks (WGWIDE; ICES, 2023c). A number of the stocks considered within this mixed fisheries analysis are being assessed using stochastic assessments. Stock Synthesis (Methot and Wetzel 2013), length-based age-structured is used for the Northern hake stock (also sex-disaggregated), the anglerfish stocks in the southern Celtic Seas and the Bay of Biscay, the Northeast Atlantic horse mackerel and northern and central Bay of Biscay sea bass. SAM (Nielsen and Berg 2014) is used for the Northeast Atlantic mackerel and blue whiting stocks. A Bayesian statistical catch-at-age model, a4a (Jardim *et al.*, 2015), is used for the stock of megrim in the west and southwest of Ireland and the Bay of Biscay. Some of those assessments are length based and/or seasonal and for some of these stocks the advice is based on stochastic projections (Table 2.3). All this cannot currently be fully replicated in the deterministic FLBEIA software. However, the projections carried out with FLBEIA are routinely compared to those carried out in the single-species assessment working group to assess the potential impact of using different approaches and results are reasonably similar (see Section 2.5.1.1 below); as such, WGMIXFISH does not consider that the difference impacts significantly on the mixed fisheries advice and the projections.

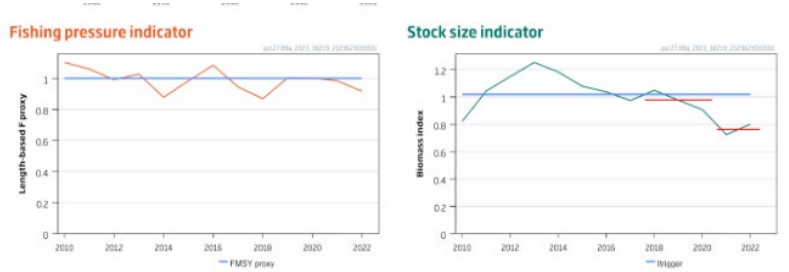
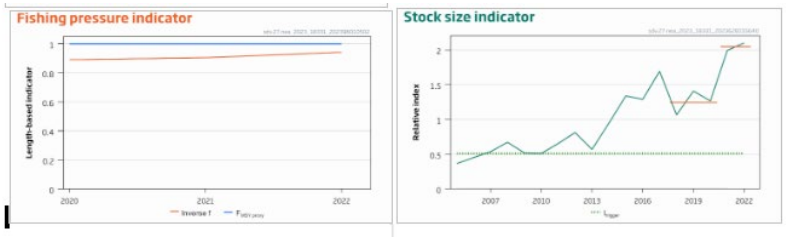
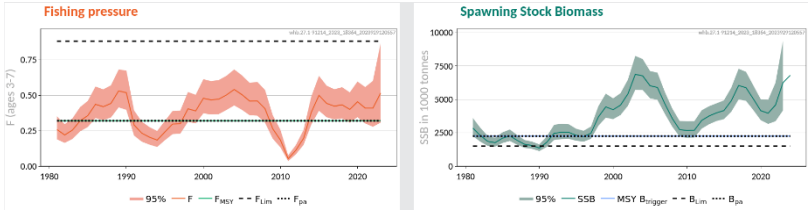
2.3.1.2 Trends and advice

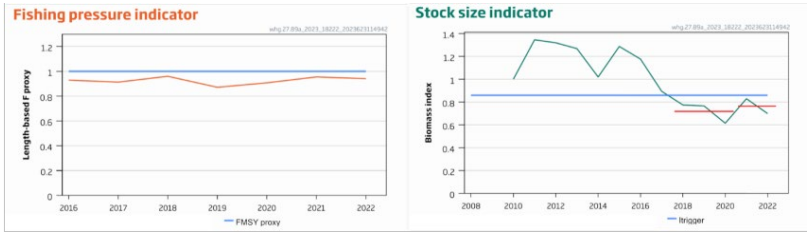
The advice for these stocks was drafted by the ICES WGBIE (ICES, 2023a), WGEF (ICES, 2023b) and WGWIDE (ICES, 2023c) under consideration by ACOM. In order to give a global overview of all Bay of Biscay demersal stocks of interest to this analysis, this information is summarized in the Table 2.3 based on the single species advice.

Table 2.3. Summary of stock status and ICES advice for the stocks included in the mixed fishery analysis.

Species	Area	Stock status	Advice 2024
ank.27.78abd (Black-bellied anglerfish)	7, 8.a–b and 8.d		ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 25 579 tonnes. ICES notes the existence of a precautionary management plan developed and adopted by one of the relevant management authorities for this stock. The use of combined species TAC for the two anglerfish species, black-bellied anglerfish (*Lophius budegassa*) and white anglerfish (*Lophius piscatorius*), prevents effective control of the single species exploitation rates and could lead to the overexploitation of either species.
bss.27.8ab (Sea bass)	8.a-b		ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, total removals* in 2024 that correspond to the F ranges in the plan are between 2249 and 2642 tonnes. This applies to the sum of the commercial and recreational catches. *Total removals include both commercial and recreational catches, taking mortality of released fish into account (estimated at 5.73%).
hke.27.3a46-8abd (Hake)	3.a, 4, 6, 7 and 8.a-b and 8.d		ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 72 839 tonnes. ICES notes the existence of a precautionary management plan developed and adopted by one of the relevant management authorities for this stock.
hom.27.2a4a5b6a7a-ce-k8 (Horse mackerel)	Northeast Atlantic		ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2024

Species	Area	Stock status	Advice 2024
mac.27.nea (Mackerel)	Northeast Atlantic and adjacent waters		ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 739 386 tonnes.
meg.27.7b-k8abd (Megrim)	7.b-k and 8.a-b and 8.d		ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 23 303 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. The use of combined species TAC for the two megrim species, megrim (*Lepidorhombus whiffiagonis*) and four-spot megrim (*Lepidorhombus boscii*), prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species.
mon.27.78abd (White anglerfish)	7, 8.a–b and 8.d		ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 35 502 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. The use of combined species TAC for the two anglerfish species, black-bellied anglerfish (*Lophius budegassa*) and white anglerfish (*Lophius piscatorius*), prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species.
nep.fu.2324 (Norway lobster)	FU 2324		ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2020–2022, catches in 2024 should be no more than 5786 tonnes. ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 8. ICES considers this plan to be precautionary when implemented at the FU level.

Species	Area	Stock status	Advice 2024
pol.27.89a (Pollack)	8 and 9.a		ICES advises that when MSY approach is applied, commercial catches should be no more than 872 tonnes in each of the years 2024 and 2025. All commercial catches are assumed to be landed. ICES cannot quantify the corresponding total catches because the recreational catches cannot be quantified.
sdv.27.nea (Smooth-hound)	Northeast Atlantic and adjacent waters		ICES advises that when the MSY approach is applied, landings should be no more than 5329 tonnes in each of the years 2024 and 2025. ICES cannot quantify the corresponding catches.
sol.27.8ab (Sole)	8.a-b		ICES advises that when the EU multiannual plan (MAP) for the Western waters and adjacent waters is applied, catches in 2024 that correspond to the F ranges in the plan are between 1454 and 2489 tonnes
whb.27.1-91214 (Blue whiting)	Northeast Atlantic and adjacent waters		ICES advises that when the long-term management strategy agreed by Norway, the European Union, the Faroe Islands, Iceland, and the UK is applied, catches in 2024 should be no more than 1 529 754 tonnes.

Species	Area	Stock status	Advice 2024
whg.27.89a (Whiting)	8 and 9.a		ICES advises that when MSY approach is applied, catches should be no more than 1347 tonnes in each of the years 2024 and 2025.

2.4 Fleets and métiers

2.4.1 Catch and effort data

The WGMIXFISH data call requests landings and effort data consistent with the definition of DCF métiers and with data submitted to InterCatch (though with additional vessel length disaggregation), disaggregated into vessel length categories. Discard data were not requested by vessel length categories, as national observer sampling programs do not distinguish between vessel lengths. Instead, discard ratios for the various métiers aggregated across all vessel lengths were extracted from InterCatch and applied to the landings of the corresponding métiers in the vessel length specific data.

Age distribution is assumed equal to the one used in the assessment for all métiers. However, the information by métier and area is now available in InterCatch and could be integrated in the MIXFISH data in future assessments. The relative size of catches of the stocks incorporated in the mixed fisheries projections is shown in Figure 2.1.

The final dataset extracted from InterCatch includes discards estimates (either imported or raised) for all stocks and métiers. These InterCatch estimates have been used to estimate a discard ratio by métier, which allows allocating discards for all WGMIXFISH fleets and métiers with matching names, such that:

$$d^* = \frac{Dl}{L}$$

Where d* is the discard value for the métier used by FLBEIA, l is the weight of landings for the métier used by FLBEIA and L and D are the weight of landings and discards entered for the (vessel length aggregated) métier in InterCatch.

The fleet segments used in the mixed fisheries analysis are defined by combining the country and the fishing gear group (Figure 2.2). These gear groupings differ to those used last year due to a change in the French data submission. Landings and effort provided this year were supplied at a more detailed métier level. This has resolved the inconsistency that resulted last year in more than half of French catch and effort being allocated to a miscellaneous fleet (FR_MIS [Figure 2.2]).

The suspected mislabelling of rays species by a number of member states is still unresolved and consequently it was not possible to include rays in this mixed fisheries analysis. These stocks are thornback ray (rjc.27.8abd), cuckoo ray (rjn.27.678abd), and undulate ray (rju.27.8ab).

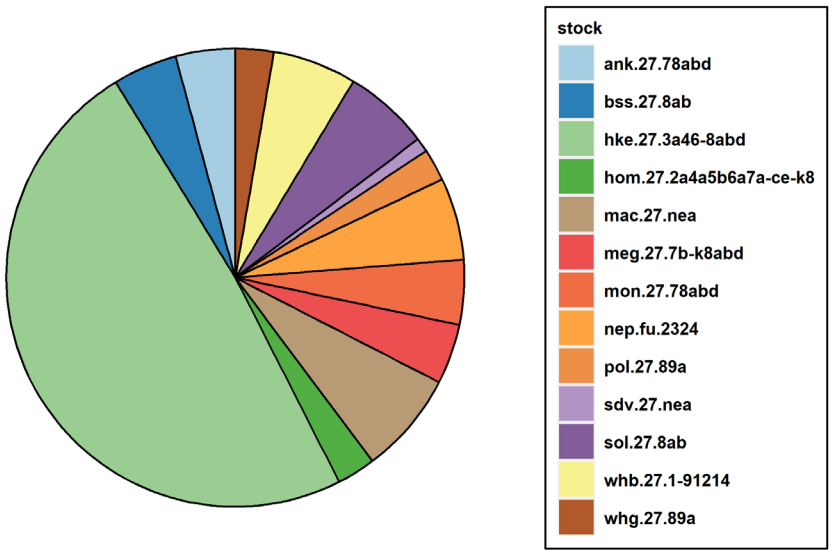


Figure 2.1. Bay of Biscay: Distribution of landings of the stocks included in the mixed fisheries projections (average 2020–2022).

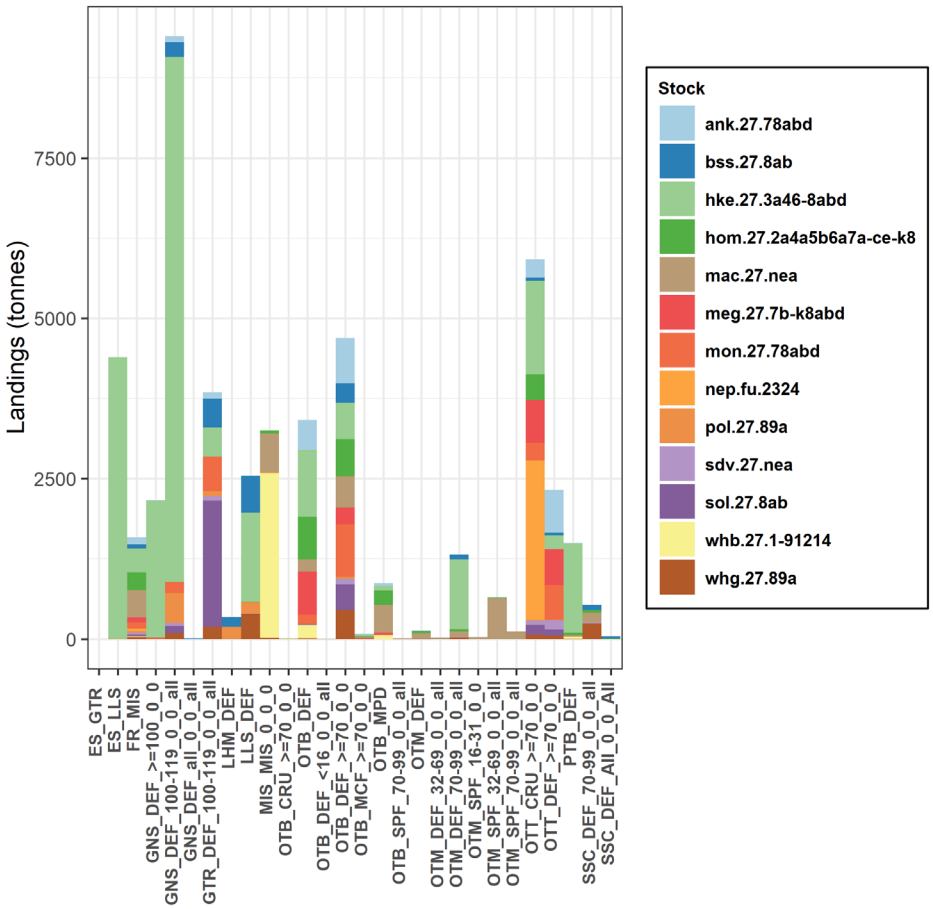


Figure 2.2. Bay of Biscay: Landings distribution of species by métier (average 2020–2022). The métiers used are described in Table 2.4. These fleets engage in one or several different métiers, among a total of 28 métiers, according to the group of target species and the technical characteristics of the fishing gear.

2.4.2 Definition of fleets and métiers

The procedure to define the fleets and métier in the model was the following:

1. Fleets were defined by aggregating landing and effort across country, gear group and vessel length (where applicable).
2. Pelagic fleets with null bycatch of demersal species (these are Spanish purse-seiners, hand and pole lines, see Figure 2.3) were removed from the analysis.
3. Fleets landing a small amount (less than 1% in last 3-year mean) of any of the stocks included in the analysis were binned into a country specific "MIS" fleet (these are "FR_MIS" and "ES_MIS").
4. Within a fleet, métiers were defined as a combination of gear, target species (e.g. demersal fish, DEF, or crustaceans, CRU) and country.
5. Métiers landing less than 2% of each stock (last 3-year mean) are aggregated under "MIS" métier category.
6. Stock catches lower than 1 t (in all the last 3 data years) are removed.
7. Effort and landing files were matched to ensure consistency. Métiers without catch of any of the modelled stocks in the last 3 data years are not retained.
8. Out of Bay of Biscay (area 8.a-b and 8.d) catches of each of the stocks are aggregated into an "OTH" fleet by stock (named as "OTH_[stock]_-9") together with the catches of the pelagic fleets in Bay of Biscay, to reduce the dimensions of the model.

Figure 2.3. Bay of Biscay: Landings distribution by fleet and species type (average 2020–2022).

The final data used contained 21 fleets, covering landing and effort inside the Bay of Biscay (8.a, 8.b, and 8.d) for the years 2020 to 2022. These fleets engage in one or several different métiers, among a total of 28 métiers (Table 2.4). Several fleets still represent a small amount of catch and could be combined in order to reduce the total number of fleets. Additionally, eight extra fleets were included to cover the landings of some stocks outside the Bay of Biscay (see Section 2.1.1).

The distribution of landings by stock and métier is presented in Figure 2.1 and Figure 2.2, respectively.

Table 2.4. Métier categories used in the Bay of Biscay mixed fisheries analysis.

Métier category	Gear and target	Mesh size
ES_GTR	Spanish trammelnet	-
ES_LLS	Spanish longline	-
FR_MIS	Other French gear types	-
GNS_DEF_>=100_0_0	Set gillnet targeting demersal fish	> 100 mm
GNS_DEF_100-119_0_0_all	Set gillnet targeting demersal fish	100–119 mm
GNS_DEF_all_0_0_all	Set gillnet targeting demersal fish	-
GTR_DEF_100-119_0_0_all	Trammelnet targeting demersal fish	100–119 mm
LHM_DEF	Handline targeting demersal fish	-
LLS_DEF	Set longline targeting demersal fish	-
MIS_MIS_0_0_0	Other gear types	-
OTB_CRU_>=70_0_0	Norway lobster bottom otter trawl	≥ 70 mm
OTB_DEF	Bottom otter trawl directed to demersal fish	-
OTB_DEF_<16_0_0_all	Bottom otter trawl directed to demersal fish	< 16 mm
OTB_DEF_>=70_0_0	Bottom otter trawl directed to demersal fish	≥ 70 mm
OTB_MCF_>=70_0_0	Bottom otter trawl directed to mixed cephalopods and demersal fish	≥ 70 mm
OTB_MPD	Bottom otter trawl directed to mixed pelagic and demersal fish	≥ 70 mm
OTB_SPF_70-99_0_0_all	Bottom otter trawl directed to pelagic fish	70–99 mm
OTM_DEF	Medium water otter trawl directed to demersal fish	-
OTM_DEF_32-69_0_0_all	Medium water otter trawl directed to demersal fish	32–69 mm
OTM_DEF_70-99_0_0_all	Medium water otter trawl directed to demersal fish	70–99 mm
OTM_SPF_16-31_0_0	Medium water otter trawl directed to pelagic fish	16–31 mm
OTM_SPF_32-69_0_0_all	Medium water otter trawl directed to pelagic fish	32–69 mm
OTM_SPF_70-99_0_0_all	Medium water otter trawl directed to pelagic fish	70–99 mm
OTT_CRU_>=70_0_0	Twin otter trawl directed to crustaceans	≥ 70 mm
OTT_DEF_>=70_0_0	Twin otter trawl directed to demersal fish	≥ 70 mm
PTB_DEF	Pairtrawlers directed to demersal fish	≥ 70 mm
SSC_DEF_70-99_0_0_all	Fly shooting seine	70–99 mm
SSC_DEF_All_0_0_All	Fly shooting seine	-

Métier category	Gear and target	Mesh size
MIS	All gears outside 8.a-b and 8.d	-

2.4.3 Trends

Analyses of trends by fleet were carried out on 2020–2022 data. A number of exploratory graphs were produced to aid quality checking of the data once compiled into the final fleets object for catches, effort and catchability. Catchability plots by stock, fleet and métier are presented in Figures 2.4 to 2.26.

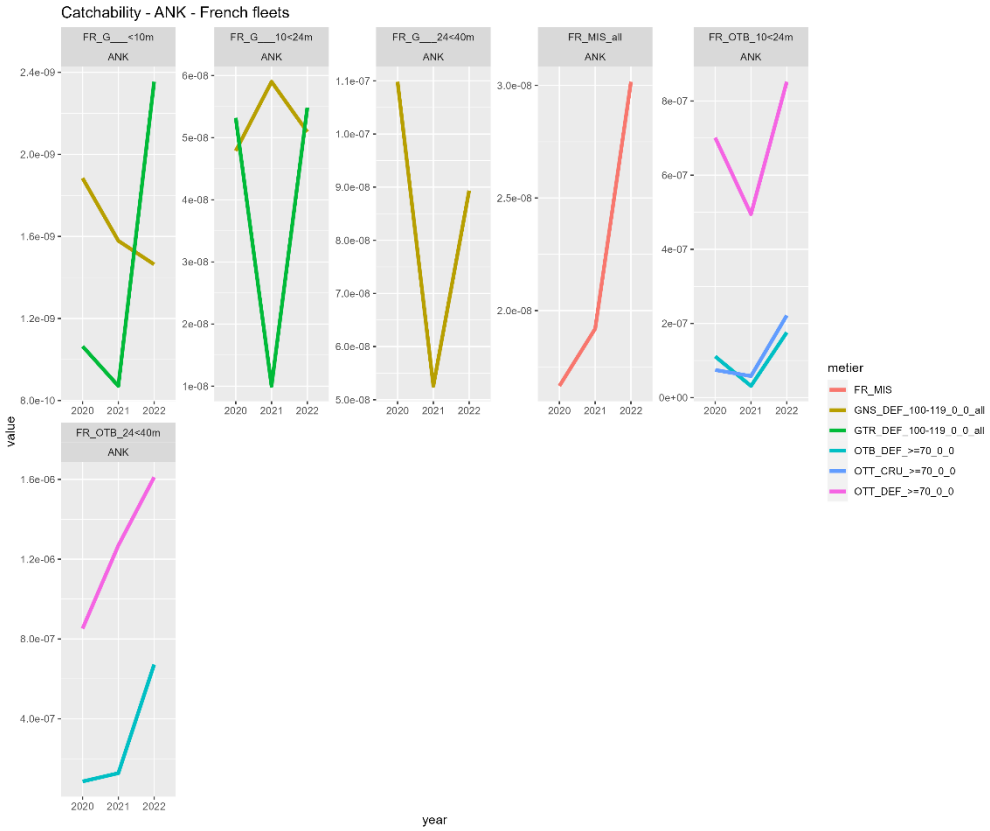


Figure 2.4. Bay of Biscay: trends of French catchability for black-bellied anglerfish (ank) by fleet and métier.

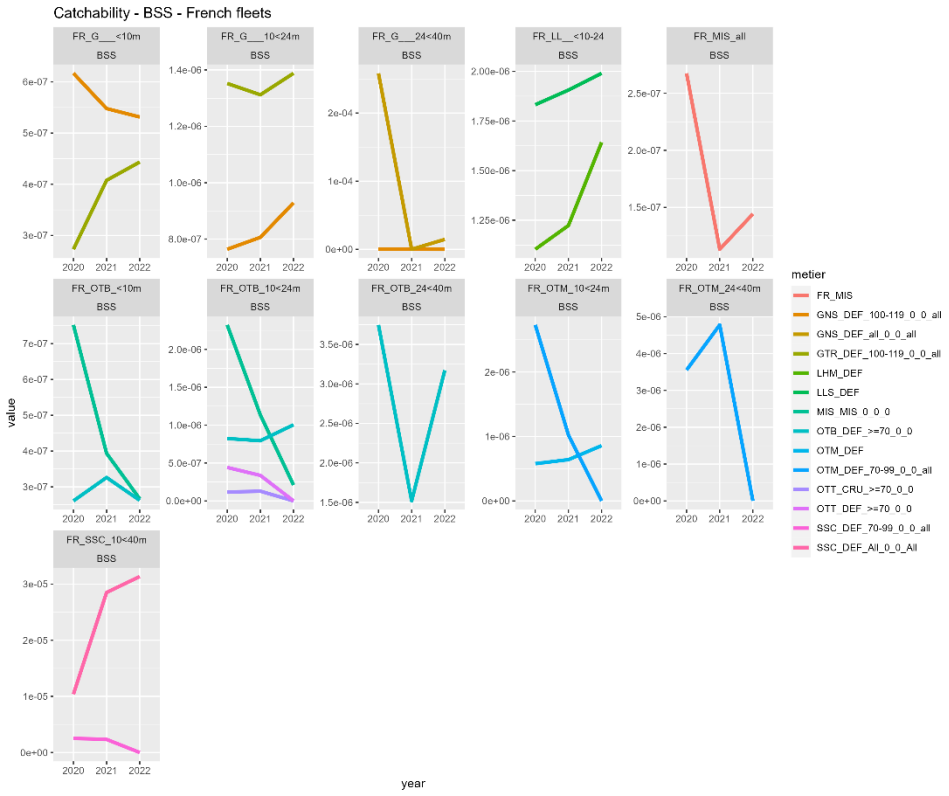


Figure 2.5. Bay of Biscay: trends of French catchability for sea bass (bss) by fleet and métier.

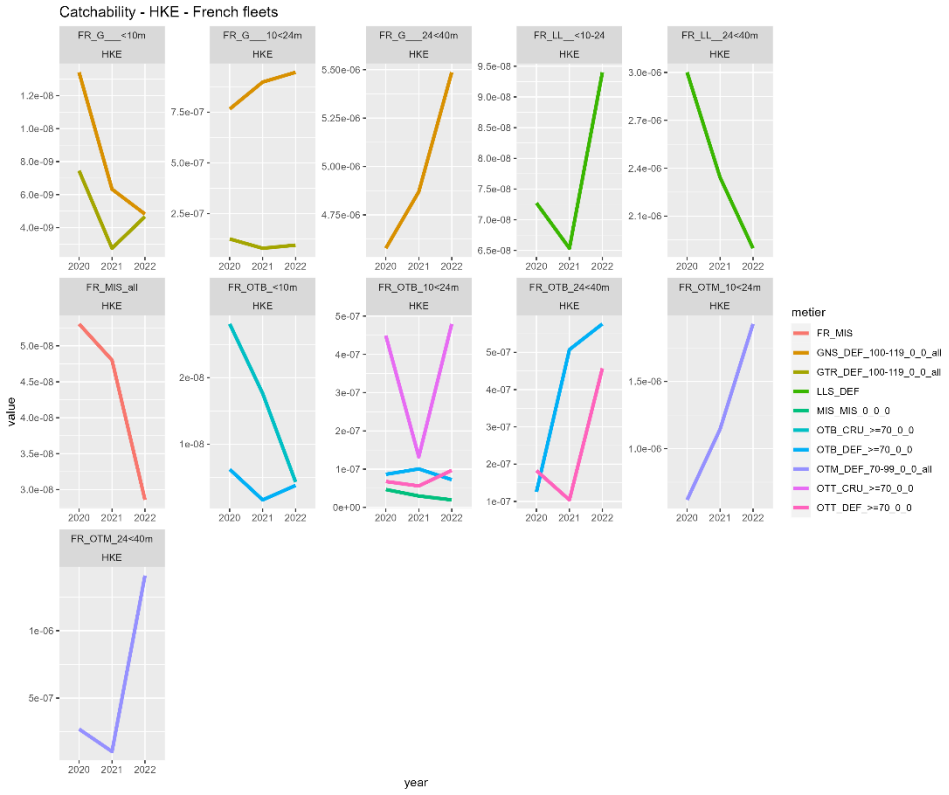


Figure 2.6. Bay of Biscay: trends of French catchability for hake (hke) by fleet and métier.

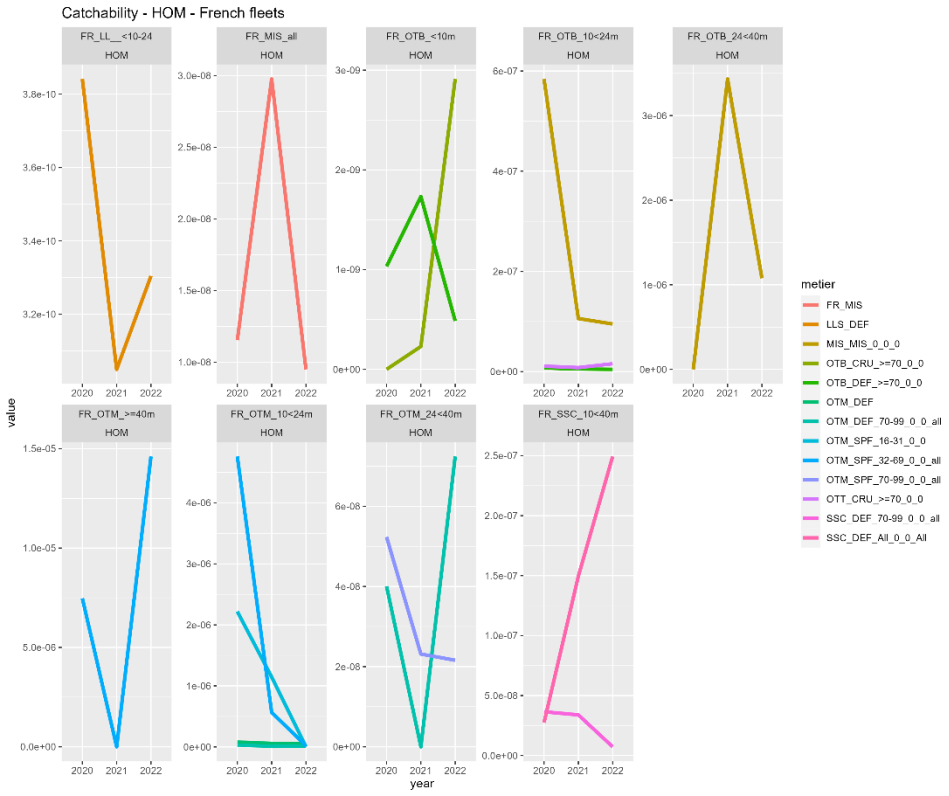


Figure 2.7. Bay of Biscay: trends of French catchability for horse mackerel (hom) by fleet and métier.

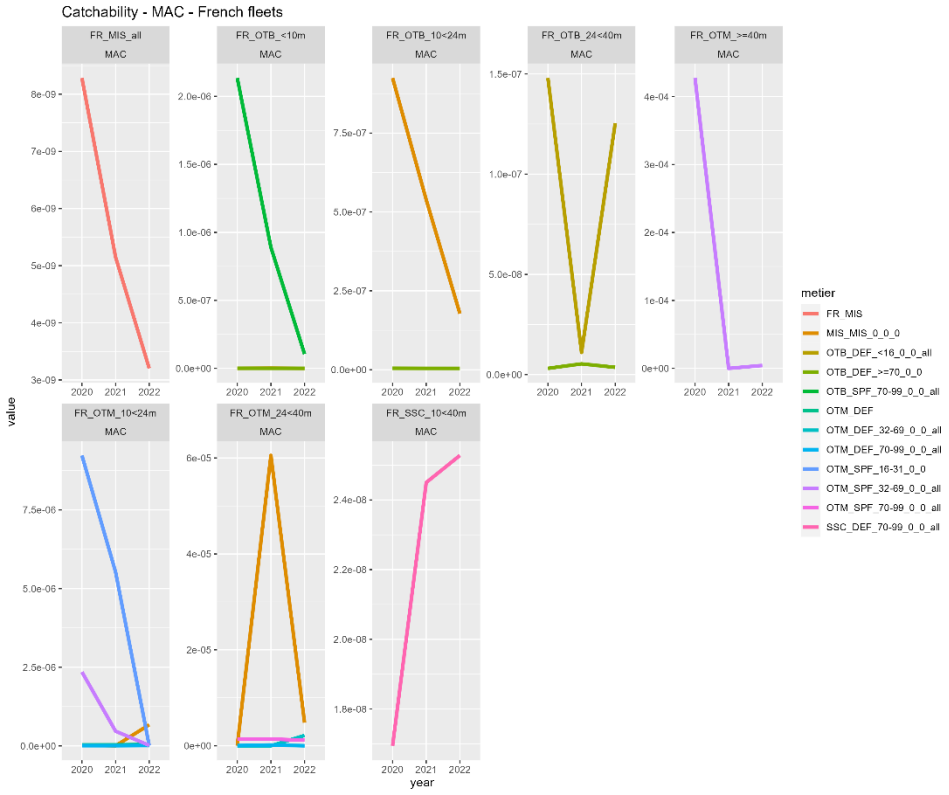


Figure 2.8. Bay of Biscay: trends of French catchability for mackerel (mac) by fleet and métier.

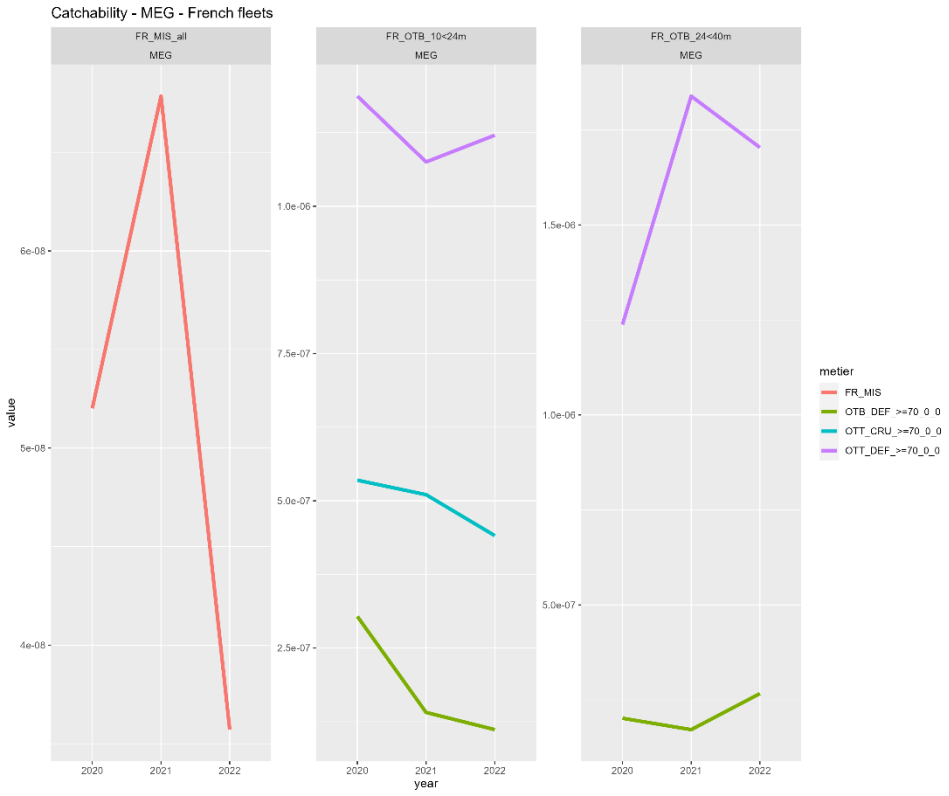


Figure 2.9. Bay of Biscay: trends of French catchability for megrim (meg) by fleet and métier.

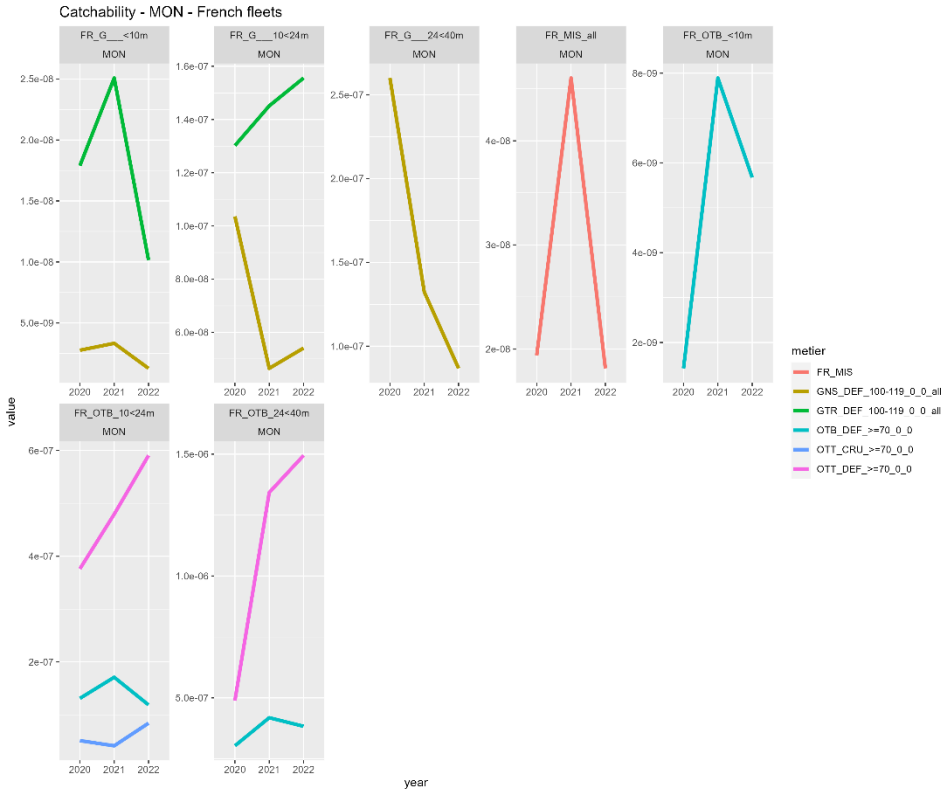


Figure 2.10. Bay of Biscay: trends of French catchability for white anglerfish (mon) by fleet and métier.

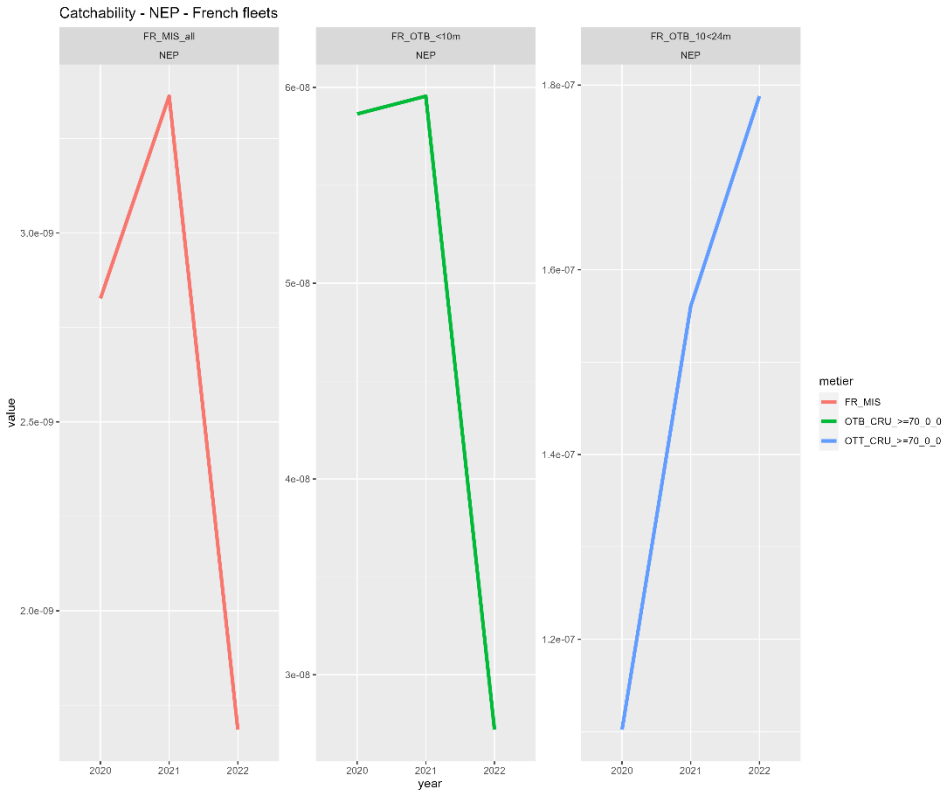


Figure 2.11. Bay of Biscay: trends of French catchability for Norway lobster (nep) by fleet and métier.

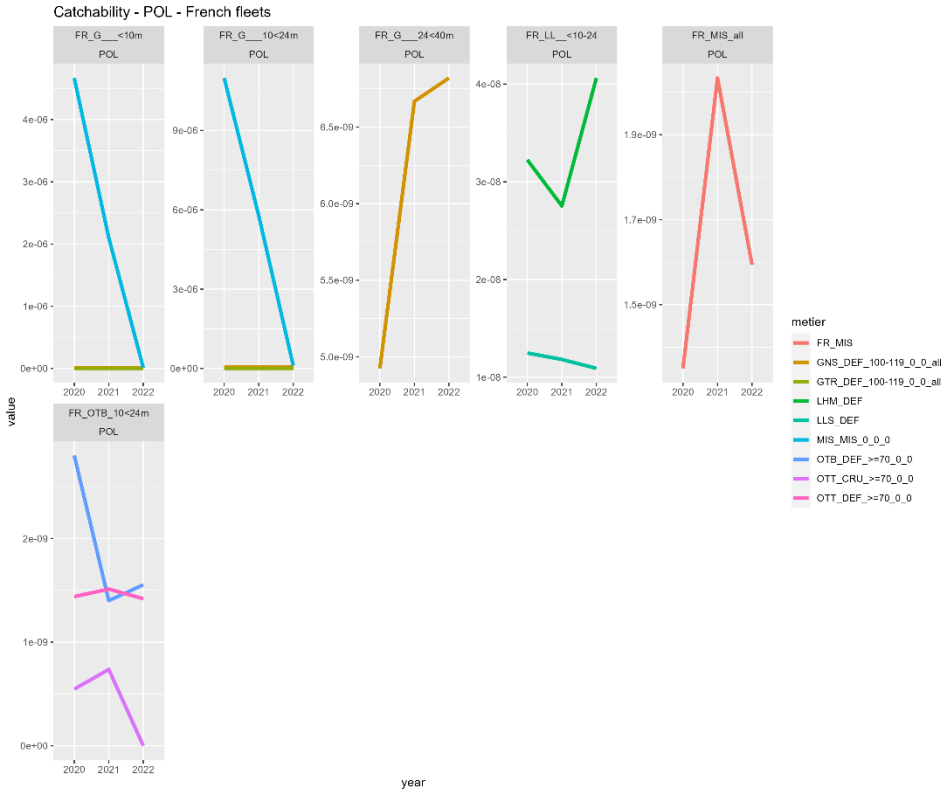


Figure 2.12. Bay of Biscay: trends of French catchability for pollack (pol) by fleet and métier.

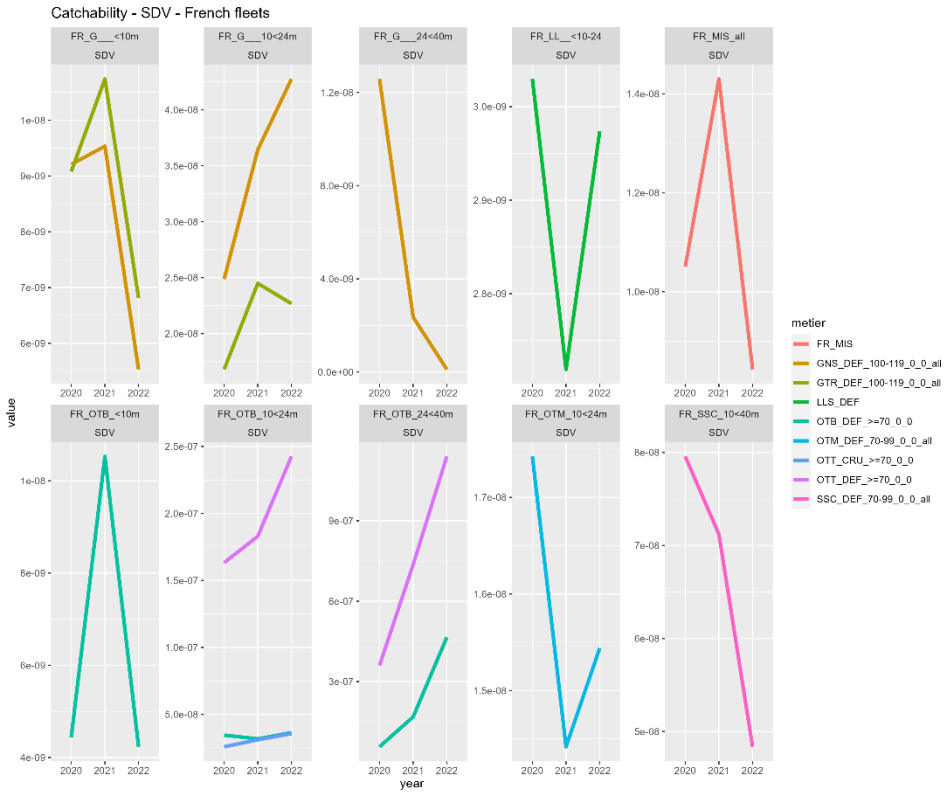


Figure 2.13. Bay of Biscay: trends of French catchability for smooth-hound (sdv) by fleet and métier.

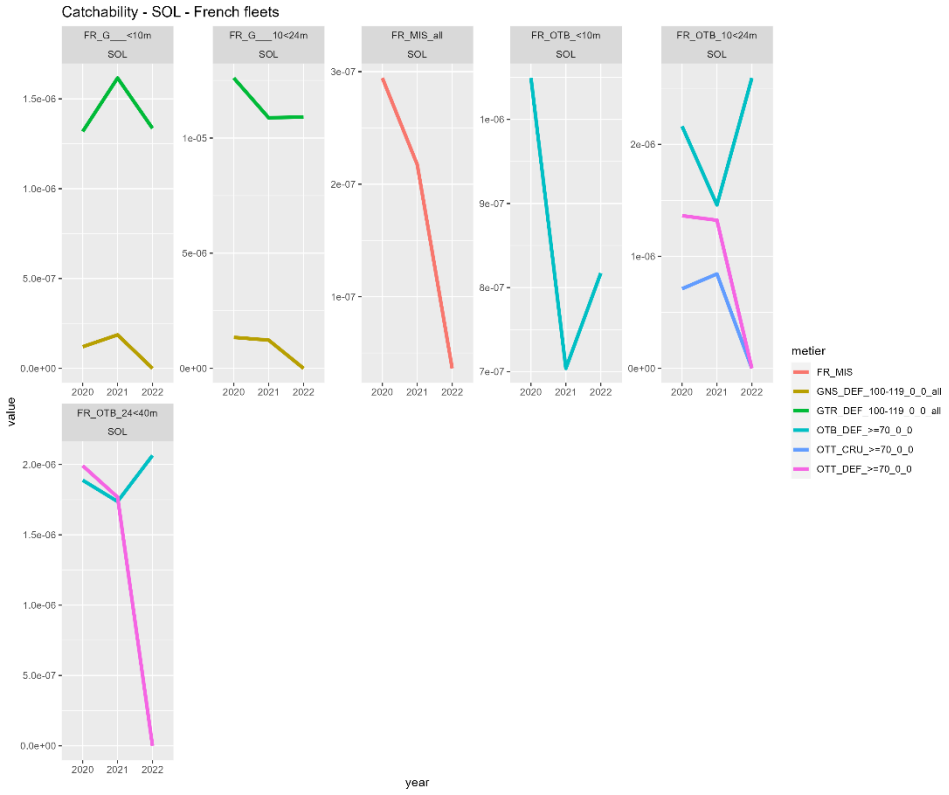


Figure 2.14. Bay of Biscay: trends of French catchability for sole (sol) by fleet and métier.

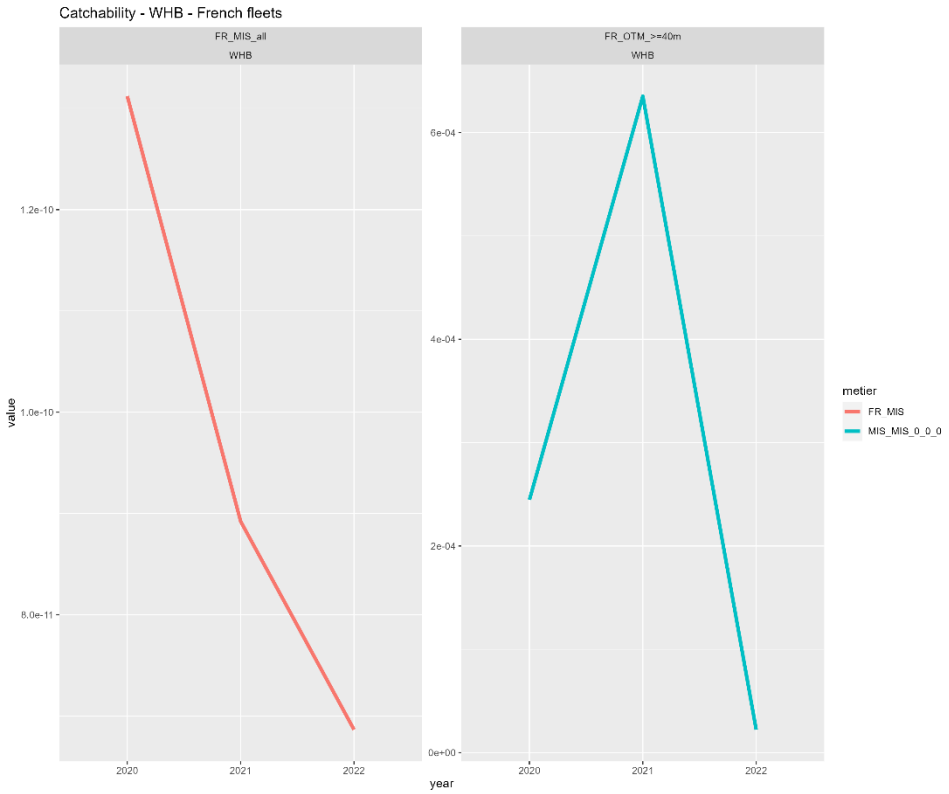


Figure 2.15. Bay of Biscay: trends of French catchability for blue whiting (whb) by fleet and métier.

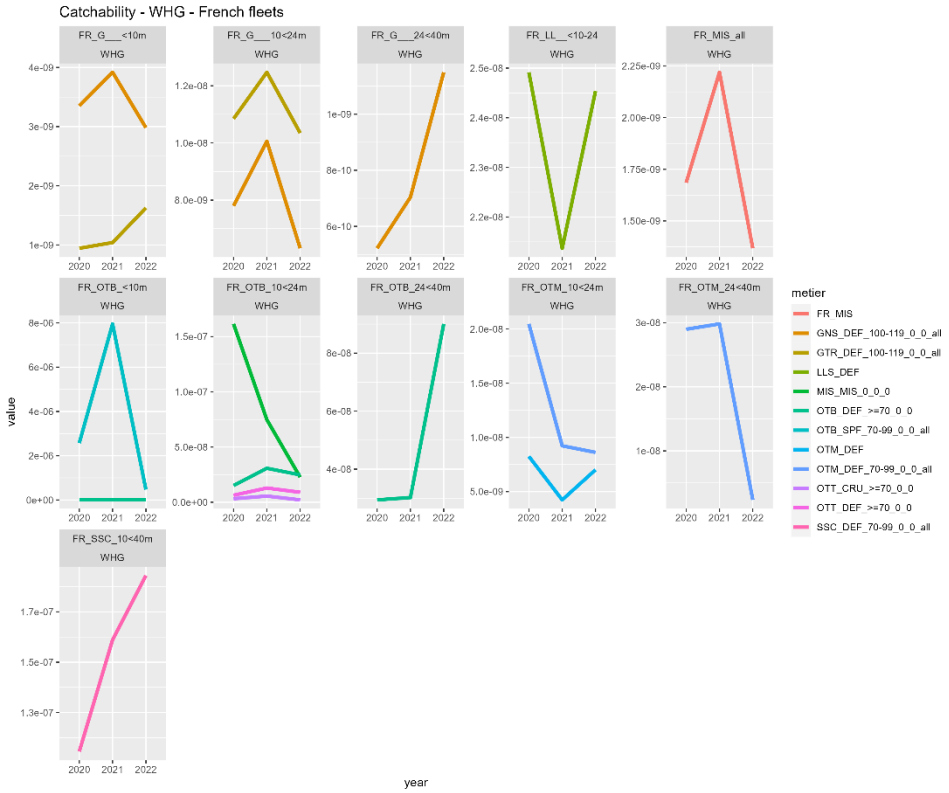


Figure 2.16. Bay of Biscay: trends of French catchability for whiting (whg) by fleet and métier.

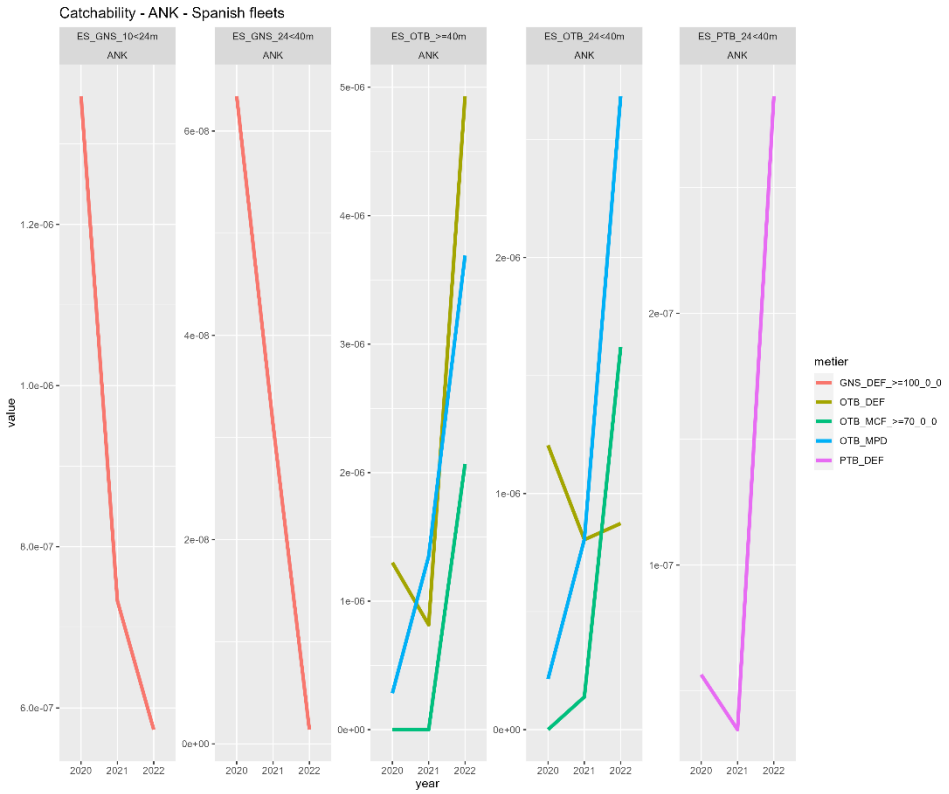


Figure 2.17. Bay of Biscay: trends of Spanish catchability for black-bellied anglerfish (ank) by fleet and métier.

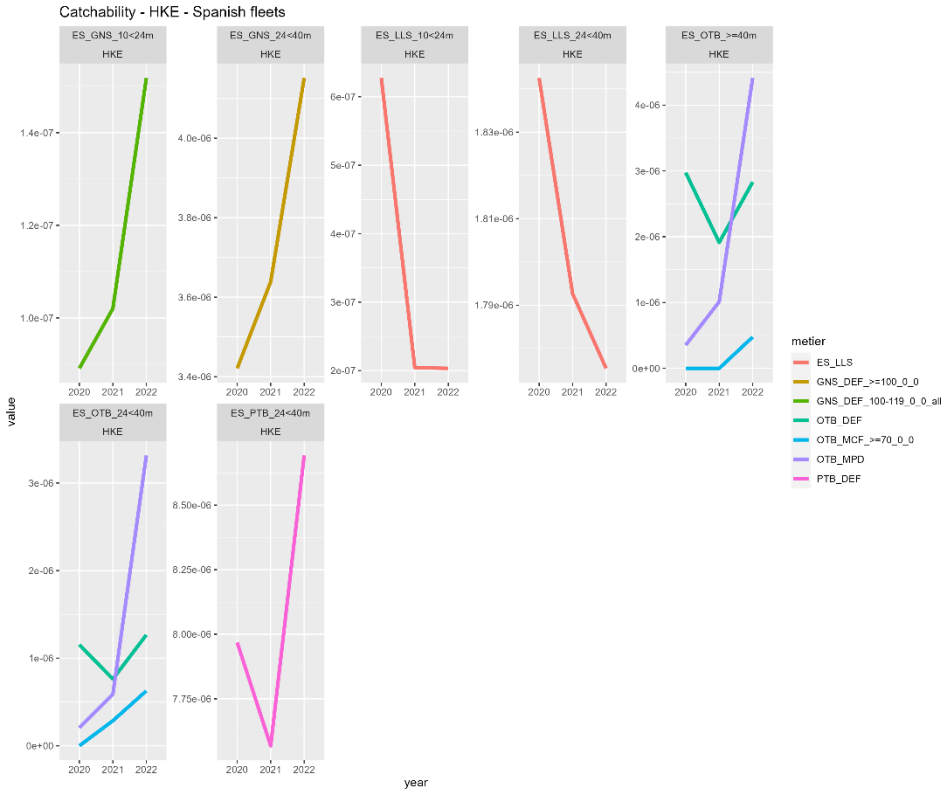


Figure 2.18. Bay of Biscay: trends of Spanish catchability for hake (hke) by fleet and métier.

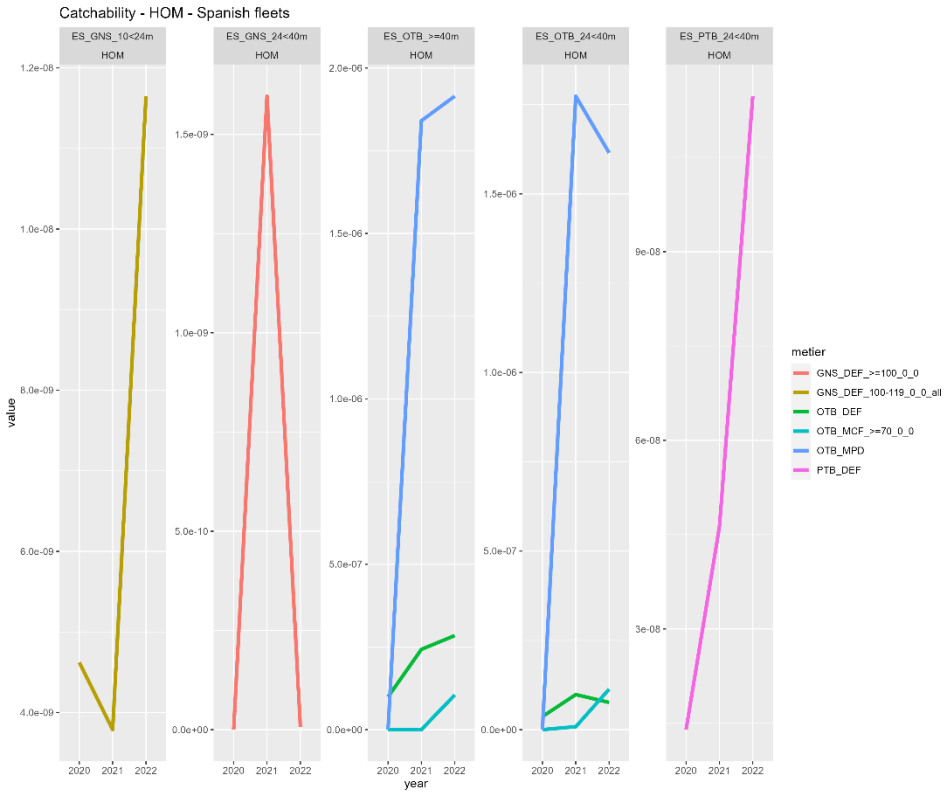


Figure 2.19. Bay of Biscay: trends of Spanish catchability for horse mackerel (hom) by fleet and métier.

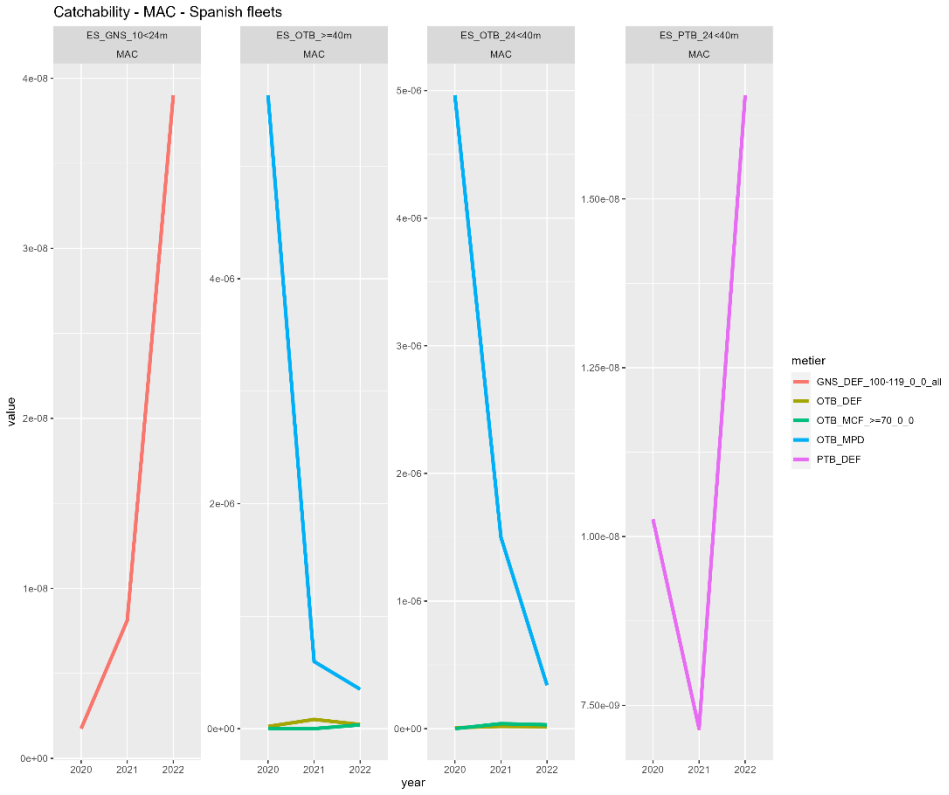


Figure 2.20. Bay of Biscay: trends of Spanish catchability for mackerel (mac) by fleet and métier.

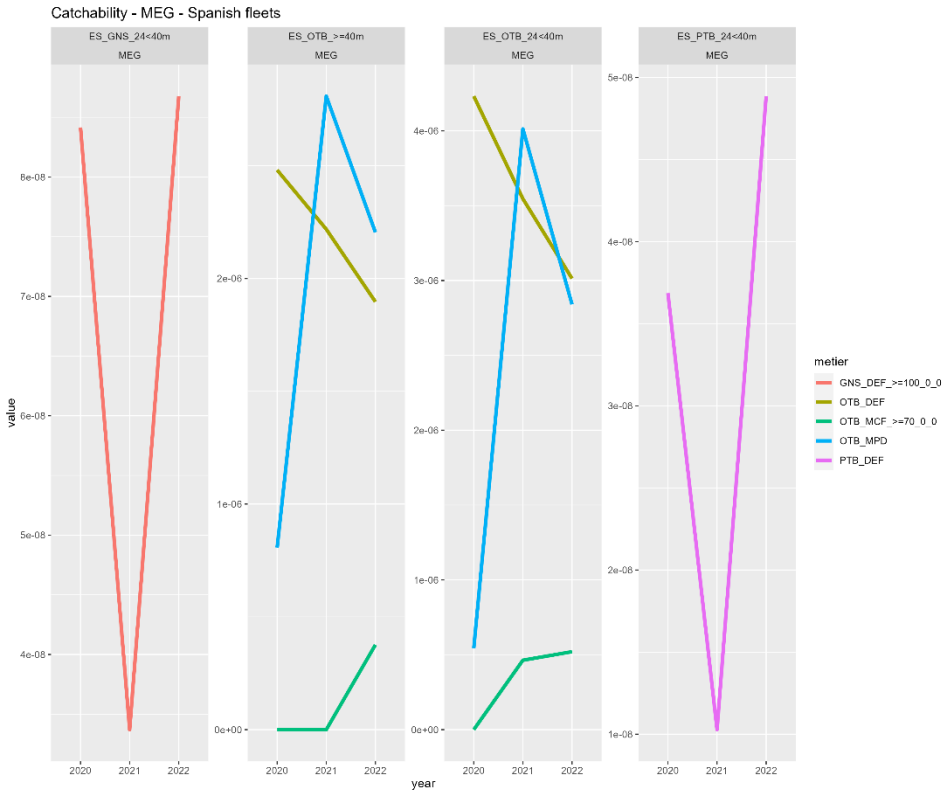


Figure 2.21. Bay of Biscay: trends of Spanish catchability for megrim (meg) by fleet and métier.

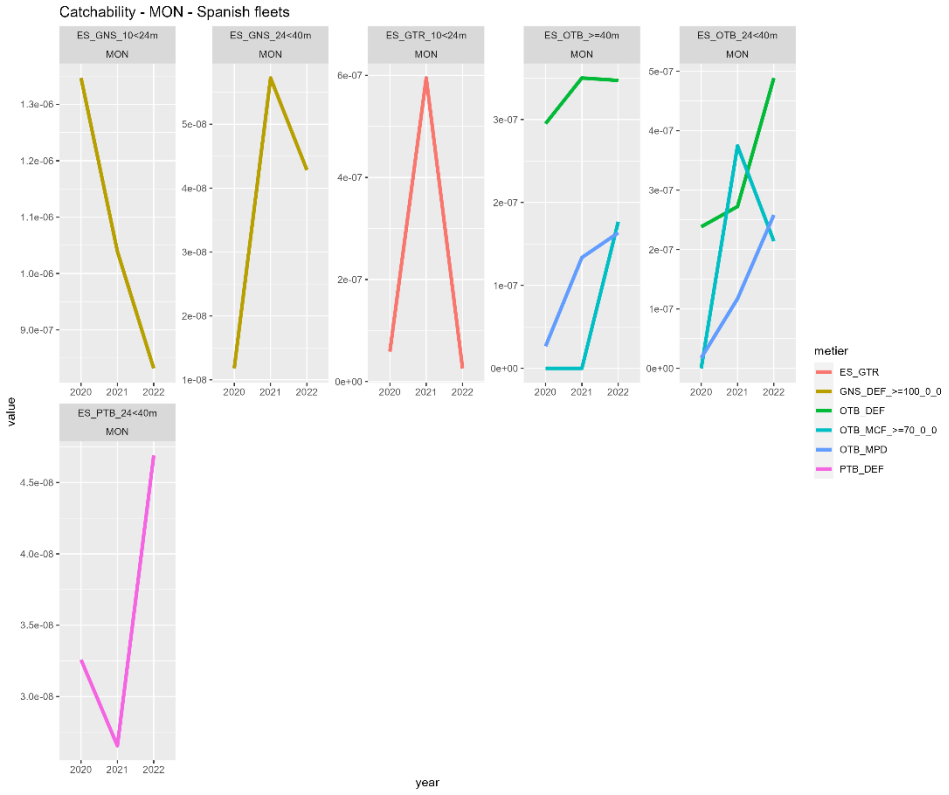


Figure 2.22. Bay of Biscay: trends of Spanish catchability for white anglerfish (mon) by fleet and métier.

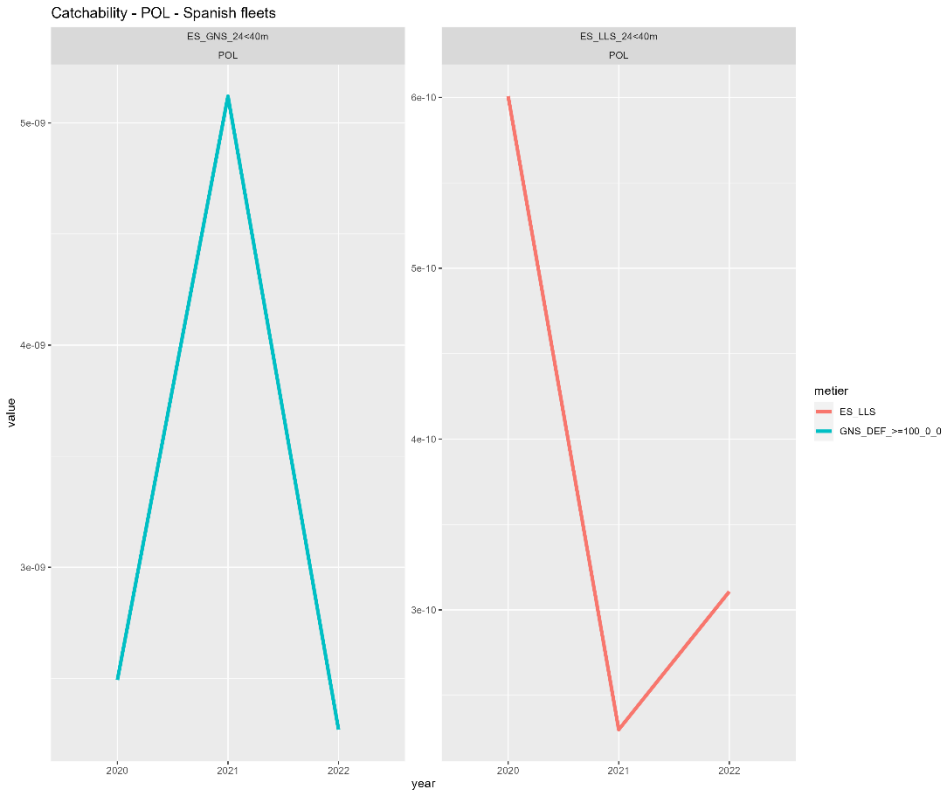


Figure 2.23. Bay of Biscay: trends of Spanish catchability for pollack (pol) by fleet and métier.

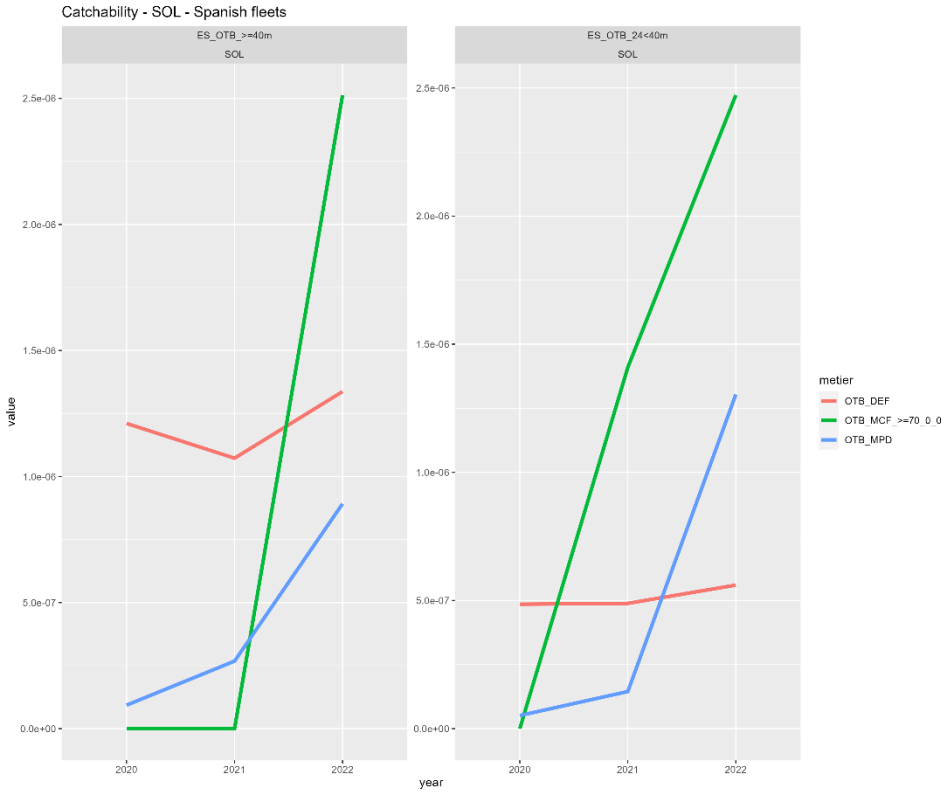


Figure 2.24. Bay of Biscay: trends of Spanish catchability for sole (sol) by fleet and métier.

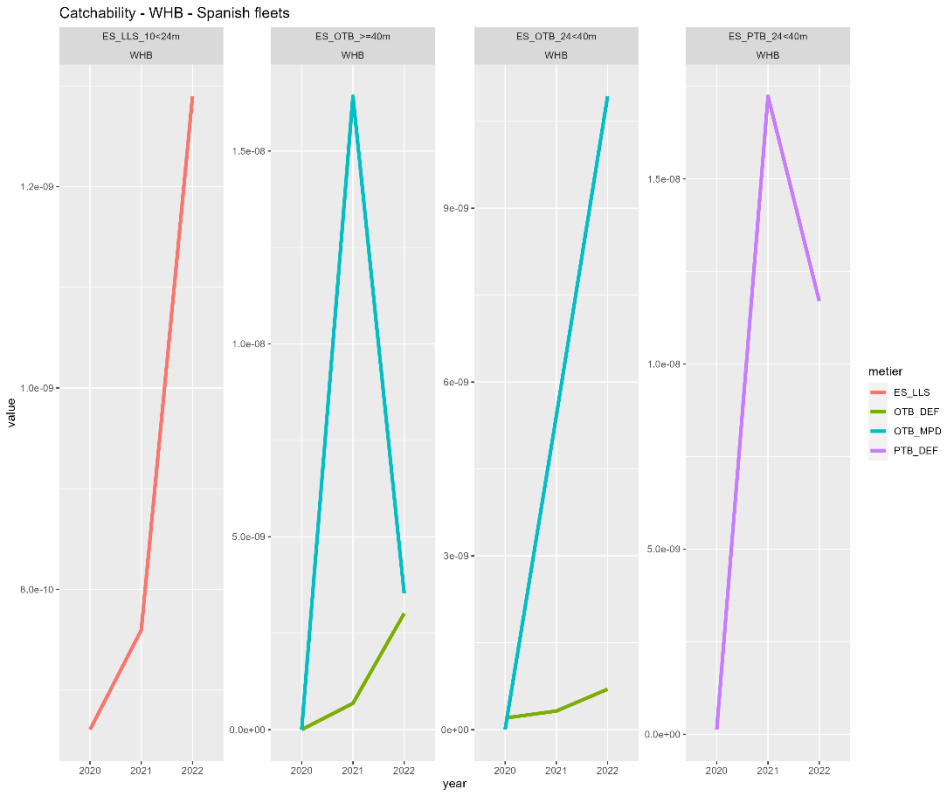


Figure 2.25. Bay of Biscay: trends of Spanish catchability for blue whiting (whb) by fleet and métier.

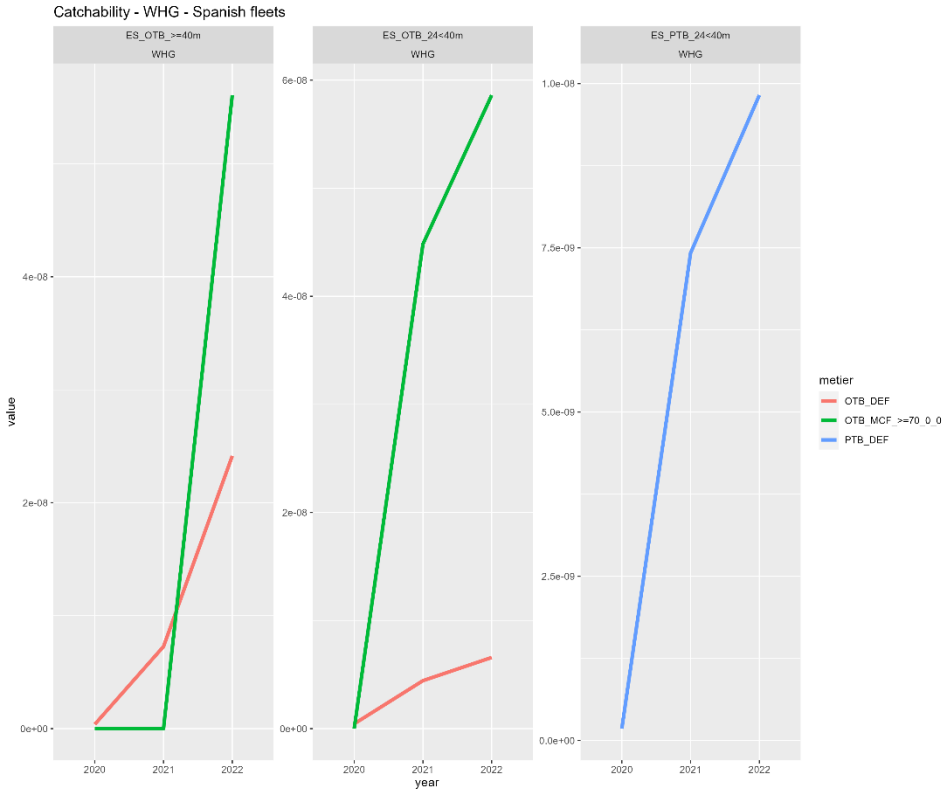


Figure 2.26. Bay of Biscay: trends of Spanish catchability for whiting (whg) by fleet and métier.

2.5 Mixed fisheries forecasts

2.5.1 Description of scenarios

2.5.1.1 Baseline runs

The objectives of the single-species stock baseline runs were to:

- reproduce as closely as possible the single-species advice produced by ACOM, and
- act as the reference scenario for subsequent mixed fisheries analyses.

The various single-stock forecasts presented by WGBIE and WGWIDE are performed using different software and setups (see Section 2.2.1, above). However, for the purposes of the mixed fisheries analyses, it is necessary to gather all forecasts into a single unified framework, which builds on the FLBEIA library (García *et al*., 2017). The same forecast settings as in the assessment working group (WGBIE or WGWIDE) are used for each stock regarding weight-at-age, selectivity and recruitment, as well as assumptions made for the intermediate year (2023) and basis for advice (MSY approach). Using these settings, and not introducing any mixed fisheries interactions, short-term forecasts are carried out at WGMIXFISH. This baseline run is then compared to the estimates provided in the ICES advice sheets (Table 2.4).

2.5.1.2 Mixed fisheries runs

Mixed fisheries analyses consider the implications of mixed fisheries operating under single-stock catch advice regimes based on the fishing patterns of the various fleets (i.e. catchability by stock and métier and effort share by métier) in recent years (2020–2022).

The mixed fishery analyses use a *status quo* effort assumption for the intermediate year (2023) for all the fleets, except for the other fleets taking up the remaining catches for a single pelagic stock ("OT_HOM_-9", "OT_MAC_-9" and "OT_WHB_-9"), which assume effort required for full quota uptake in the intermediate year. The *status quo* effort assumption for the intermediate year is considered a plausible assumption because it is in line with the standard single-stock short-term forecasting approach.

For the TAC year (2024), the FLBEIA scenarios are used for catches in the Bay of Biscay, whereas the catches outside the Bay of Biscay are associated with a single additional fleet per stock ("OT_*_-9"), assuming that they catch their full quota share.

The projections were run assuming a full and perfect implementation of a discard ban (i.e. all quota species caught must be landed, with no exemptions, *de minimis* or interspecies flexibilities).

In summary, the FLBEIA runs followed the scheme below:

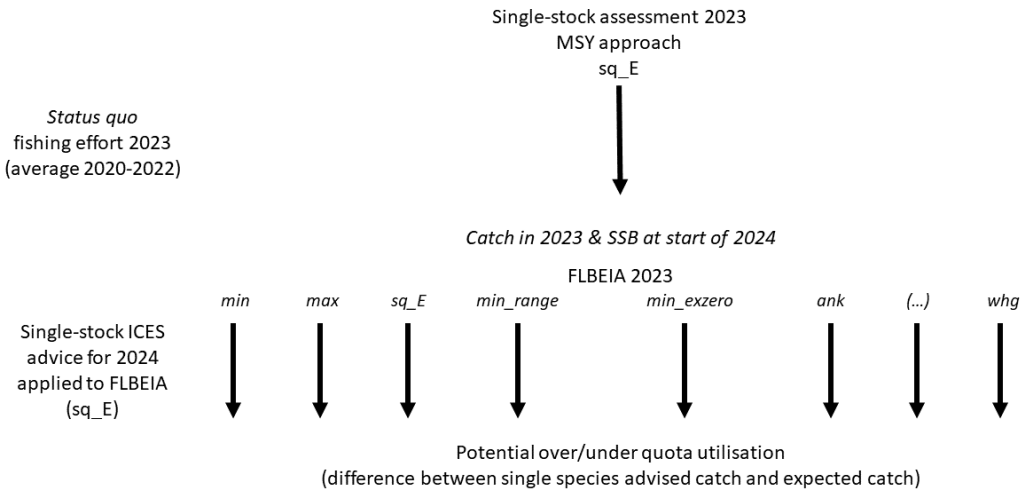


Table 2.4. Bay of Biscay: Summary of the 2024 catch advice and target Fs, resulting from the Advice Approaches considered by ICES.

Stock	Advice rational	Total catch advice 2024	F 2024	SSB 2025
Black-bellied anglerfish (*Lophius budegassa*) in Subarea 7 and divisions 8.a–b and 8.d (Celtic Seas, Bay of Biscay); ank.27.78abd	MSY	25579	0.163	60186
Sea bass (*Dicentrarchus labrax*) in divisions 8.a–b (northern and central Bay of Biscay); bss.27.8ab	MAP	2526	0.129	14509
Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay); hke.27.3a46-8abd	MSY	72839	0.24	129326
Horse mackerel (*Trachurus trachurus*) in Subarea 8 and divisions 2.a, 4.a, 5.b, 6.a, 7.a–c,e–k (the Northeast Atlantic); hom.27.2a4a5b6a7a-ce-k8	MSY	0	0.00	783126
Mackerel (*Scomber scombrus*) in subareas 1–8 and 14 and Division 9.a (the Northeast Atlantic and adjacent waters); mac.27.nea	MSY	739386	0.26	3434616
Megrim (*Lepidorhombus whiffiagonis*) in divisions 7.b–k, 8.a–b, and 8.d (west and southwest of Ireland, Bay of Biscay); meg.27.7b-k8abd	MSY	23303	0.23	89889
White anglerfish (*Lophius piscatorius*) in Subarea 7 and divisions 8.a–b and 8.d (Celtic Seas, Bay of Biscay); mon.27.78abd	MSY	35502	0.192	64669
Sole (*Solea solea*) in divisions 8.a–b (northern and central Bay of Biscay); sol.27.8ab	MAP	2435	0.29	8975
Blue whiting (*Micromesistius poutassou*) in subareas 1–9, 12, and 14 (Northeast Atlantic and adjacent waters); whb.27.1-91214	MSY	1529754	0.32	7258384

2.5.2 Results of FLBEIA runs

2.5.2.1 Baseline runs

As for some stocks, the population dynamics model used for the assessment differs from the one used in FLBEIA, some discrepancies were found between the FLBEIA baseline runs and the single-stock forecasts (Table 2.5, 2.6, and 2.7). The replicated forecast for the majority of stocks were almost identical with the single-stock advice (differences lower than 5%). Discrepancies were larger for sea bass, hake, mackerel and blue whiting (with maximum differences of 3%, 5%, 5% and 7%, respectively).

Discrepancies in fishing mortality (F) were expected for hake because the length-based, seasonal models used in the stock assessments were approximated with age-based, annual models in the mixed fisheries analysis. Differences in F for the stocks assessed using SAM (Nielsen and Berg 2014), mackerel and blue whiting, are explained by differences in the F estimation methodology. On the one hand, FBEIA estimates F by approximating values from the Baranov equation, whereas in SAM it is calculated based on the changes in numbers-at-age from one year to the following and the natural mortality. However, the reasons of discrepancies for sea bass are unknown and need to be investigated further.

Discrepancies in estimated discards were large for some stocks, specifically for hake and megrim. The discrepancies observed are probably related to the stock assessment used (Stock Synthesis), but WGMIXFISH has not been able to properly explain what is the specific factor that causes it. Nevertheless, these differences are not expected to affect the outcomes of the mixed fisheries simulations as the TAC is assumed to constrain the total catches and these are satisfactorily reproduced.

In general, the differences observed this year were small ($\leq$ 7%) for all stocks. Consequently, the WGMIXFISH deterministic forecast was considered close enough to the single-stock advice to be used as a basis for the mixed fisheries projections.

Previously observed differences in sea bass, were due to the fact that although discards are presented in the advice sheet for the stock, these are not calculated in the short-term forecast, but calculated afterwards as a fixed proportion of the landings (5.73%).

2.5.2.2 Mixed fisheries analysis

The full overview of the FLBEIA projections to 2025 is presented in Table 2.8 and Figure 2.27 to Figure 2.29. The results for 2024 can be compared to each other as in a single-species option table. For ease of comparison, the landings relative to the single-stock advice are also presented (Table 2.8 and Figure 2.28). The resulting catch by scenario in the advice year (2024) is provided in Table 2.6 along with the single-stock advice for reference (Baseline). The resulting spawning-stock biomass (SSB) at the beginning of 2025 and the fishing mortality (F) value for 2024 are shown in Table 2.7.

Mixed fisheries analyses considers the implications of mixed fisheries operating under single-stock catch limits, considering the fishing pattern and catchability of the various fleets in recent years (2020–2022). The scenarios, therefore, do not assume any amount of quota balancing through adaptation of fishing behavior. Mixed fisheries catch scenario results show that it is not possible to achieve all advised single-stock catches simultaneously under the current fishing patterns. For instance, if decreasing fishing mortality for pollack is the major objective and fleets stop fishing after exhaustion of their pollack catch advice, this would mean that the catch advice for other species in the mixed fisheries may not be fully utilized. As a consequence, scenarios that result in under- or overutilization are useful in identifying the main mismatches between the fishing opportunities for the various stocks, where limiting catch advice can create potential "choke species" effects at fleet level. Such scenarios indicate the direction in which fleets may

have to adapt to utilize these catch opportunities more fully without increasing the risk of unwanted catch.

The "min" scenario assumes that fishing stops for a fleet once one of the stock quotas is exhausted, representing a full implementation of the EU's landings obligation. For 2024, the results of the "min" scenario, indicate that horse mackerel is the most limiting stock in the Bay of Biscay mixed fisheries model due to its zero TAC advice, constraining 14 of the 21 modelled fleets.

However, the horse mackerel quota share of the stock for the demersal mixed fisheries is lower than 1% and consequently this stock was not included as a restricting stock in the "min_exzero" scenario. When excluding horse mackerel ("min_exzero" scenario), pollack becomes the most limiting stock constraining seven out of 21 fleet segments (Figure 2.30). The catch advice for this pollack stock has shown a 20% reduction in 2022–2023 relative to 2021 and an additional 4% reduction in 2024−2025.

The "max" scenario is included to demonstrate the upper bound of potential fleet effort and stock catches, because it assumes all fleets continue fishing until all their stock shares are exhausted, irrespective of economic viability, legality, or fleet capacity. For 2024, the results in none of the single-stock scenarios are similar to the "max" scenario, indicating that the least limiting stock varies from fleet to fleet. White anglerfish would be the least limiting stock for 7 out of 21 fleets, black-bellied anglerfish and hake for four fleets, smooth-hound for three fleets, Norway lobster for two fleets and mackerel for one fleet (Figure 2.30). Under this scenario, an overshoot of the advised catch is seen for the other considered stocks.

The *status quo* effort "sq_E" scenario sets the effort of each fleet in 2023 and in 2024 equal to the average of the effort in the most recently recorded three years for which data are available (2020−2022). For the pelagic fleets that catch the remaining quota for mackerel, horse mackerel and blue whiting, we assume that they catch all their available quotas. This scenario investigates the mixed fisheries outcomes if the situation remains the same in terms of total effort and effort allocation among métiers. This situation presents a potential 2024 catch advice overshoot for horse mackerel, pollack and blue whiting.

The "min_range" scenario explores how the higher catch advice associated with the $F_{MSY\ upper}$ reference point may reduce choking behaviour in mixed fisheries and increase overall quota uptake. In this scenario, the choke species per fleet are the same as for the "min" scenario. However, catches per stock in 2024 are slightly increased for megrim, black-bellied anglerfish and hake due to the increase in catch opportunities provided by the F_{MSY_upper} option for the stocks above MSY $B_{trigger}$ (Figure 2.27).

ICES single-stock catch advice for demersal stocks in 2024 is based on either existing management plans, ICES MSY approach, or ICES precautionary approach (PA). Scenario results show that it is not possible to achieve all advised single-stock catches simultaneously under current fishing patterns. However, the "min" scenario does deliver the management objectives of the single-stock advice for SSB and/or F simultaneously for all stocks. This scenario demonstrates the 'choke species' effect that may result from a strictly implemented landing obligation without adaptation of the fleets. Although there is no scenario which can achieve SSB above B_{pa} for sea bass or sole in 2025, the "min", "sq_E", "min_range" and "min_exzero" scenarios do result in SSB above B_{lim} in 2025 for both stocks and the "max" scenario only for sea bass.

Horse mackerel, mackerel, and blue whiting are included in these analyses as they are potential choke species for some demersal fleets. Catches taken by these fleets represent very small proportions of the overall catches from these stocks, so the impact of these fleets on the dynamics of the stocks of mackerel, blue whiting, and horse mackerel is negligible although they are economically important for these fleets.

Table 2.5. Bay of Biscay: Baseline run outputs from the FLBEIA package.

	ANK	BSS	HKE	HOM	MAC	MEG	MON	SOL	WHB
2023_Fbar	0.093	0.115	0.189	0.0157	0.38	0.195	0.125	0.26	0.52
2023_Fmult	1	1	1	0	1	1	1	1	1
2023_Landings	11879	2410	57704	15277	1147265	15720	20867	2190	1672375
2023_SSB	47436	16425	183432	699501	4146040	86224	59187	9288	4579983
2024_Fbar	0.163	0.129	0.24	0	0.26	0.23	0.192	0.29	0.32
2024_Fmult	2	1	1	0	1	1	2	1	1
2024_Landings	20986	2642	65472	0	739386	19312	31010	2489	1529754
2024_SSB	56741	15194	142007	743090	3514436	93419	64031	8757	6710055
2025_SSB	50941	16143	159433	707676	3865994	93038	62118	9090	6145933

Table 2.6. Bay of Biscay: Comparison between baseline run and ICES advice. Figures for 2022 compare results from the baseline run (that use the same assumptions for F in the intermediate year as the forecasts leading to ICES advice) to the ICES intermediate year results.

	ANK	BSS	HKE	HOM	MAC	MEG	MON	SOL	WHB
2023_Catch Baseline	15283	2571	63200	16698	1155274	19171	23490	2515	1691340
2023_Catch ICES	15338	2414	64096	15277	1147407	19873	24026	2190	1672378
2023_% diff catch	1	1.07	0.99	1.09	1.01	0.96	0.98	1.15	1.01
2024_Catch Baseline	25579	2642	72839	0	739386	23303	35502	2489	1529754
2024_Catch ICES	25579	2642	72839	0	739386	23303	35502	2489	1529754
2024_% diff catch	1	1	1		1	1	1	1	1
2023_Landings Baseline	11879	2410	57704	15277	1147265	15720	20867	2190	1672375
2023_Landings ICES	12148	2414	60388			16636	21198	2190	1672378
2023_% diff land	0.98	1	0.96			0.94	0.98	1	1
2024_Landings Baseline	20986	2642	65472	0	739386	19312	31010	2489	1529754
2024_Landings ICES	21175	2526	67637	0	739386	19670	31090	2435	1529754
2024_% diff land	0.99	1.05	0.97		1	0.98	1	1.02	1
2023_Discards Baseline	3404	160	5496	1421	8009	3451	2624	325	18965
2023_Discards ICES	3190	0	3707	0	0	3237	2828	0	0
2023_% diff disc	1.07	0	1.48	0	0	1.07	0.93	0	0
2024_Discards Baseline	4593	0	7367	0	0	3991	4492	0	0

	ANK	BSS	HKE	HOM	MAC	MEG	MON	SOL	WHB
2024_Discards ICES	4404	0	5202	0	0	3633	4411	0	0
2024_% diff disc	1.04		1.42			1.10	1.02		

Table 2.7. Bay of Biscay: FLBEIA baseline run outputs for SSB and F relative to ICES advice.

	SSB_2023	SSB_2024	SSB_2025	F_2022	F_2023	F_2024
ANK	1.00	1.00	1.00	1.00	1.00	1.00
BSS	0.97	0.99	1.01	1.00	0.99	1.00
HKE	0.98	0.96	0.96	0.99	1.04	1.05
HOM	1.00	1.00	1.00	1.00	1.00	
MAC	0.95	0.96	1.01	1.02	1.04	1.03
MEG	0.97	0.97	0.96	1.00	1.04	1.04
MON	1.00	0.99	0.98	1.00	1.02	1.03
SOL	0.97	0.97	0.99	1.01	1.02	1.04
WHB	0.99	1.07	0.95	0.95	1.03	1.05

Table 2.8. Results of running FLBEIA scenarios on the TAC year (2023). Comparison of the single-stock ICES advice and potential landings in the various FLBEIA scenarios.

Stock	Single-stock catch advice 2024	min	max	sq_E	min_range	min_exzero	ank	bss	hke	hom	mac	meg	mon	nep	pol	sdv	sol	whb	whg
ANK	25579	0.82	1.01	0.59	1.18	0.87	1	0.92	0.93	0.82	0.88	0.93	0.96	0.99	0.88	0.94	0.91	0.91	0.89
BSS	2642	0.141	1.56	0.94	0.141	0.51	1.27	1	1.16	0.34	0.86	0.98	1.23	1.16	0.56	1.37	0.95	0.93	0.78
HKE	72839	0.75	1.07	0.79	1.04	0.81	1.02	0.90	1	0.83	0.90	0.96	1.03	0.97	0.85	0.99	0.94	0.93	0.90
HOM	0		0	0		0	0	0	0		0	0	0	0	0	0	0	0	0
MAC	739386	1	1.01	1.01	1	1	1.01	1.01	1.01	1	1	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
MEG	23303	0.83	1.10	0.84	1.35	0.91	1.09	0.98	1	0.83	0.92	1	1.04	1.08	0.93	1.01	0.97	0.97	0.93
MON	35502	0.88	1.04	0.65	0.96	0.92	1.03	0.96	0.97	0.89	0.93	0.97	1	1.02	0.92	0.99	0.96	0.95	0.94
NEP	5786	0	1.01	0.47	0	0.30	0.97	0.51	0.55	0	0.32	0.56	0.71	1	0.30	0.68	0.49	0.47	0.37
POL	872	0.62	2.9	2	0.62	0.99	2.4	2	2.3	1.32	1.87	1.91	2.6	2	1	2.7	1.91	1.88	1.61
SDV	5329	0.062	1.38	0.69	0.062	0.41	1.29	0.75	0.81	0.144	0.53	0.79	1.03	1.24	0.42	1	0.70	0.67	0.55
SOL	2489	0.36	1.67	0.98	0.36	0.50	1.46	1.07	1.20	0.75	0.90	1.02	1.53	1.21	0.51	1.42	1	0.97	0.80
WHB	1529754	1	1	1.02	1	1	1.02	1.02	1.02	1	1	1.02	1.02	1.02	1.02	1.02	1.02	1	1.02
WHG	1347	0.096	2.2	1.24	0.096	0.76	1.83	1.36	1.46	0.22	1.04	1.34	1.63	1.78	0.84	1.81	1.26	1.23	1

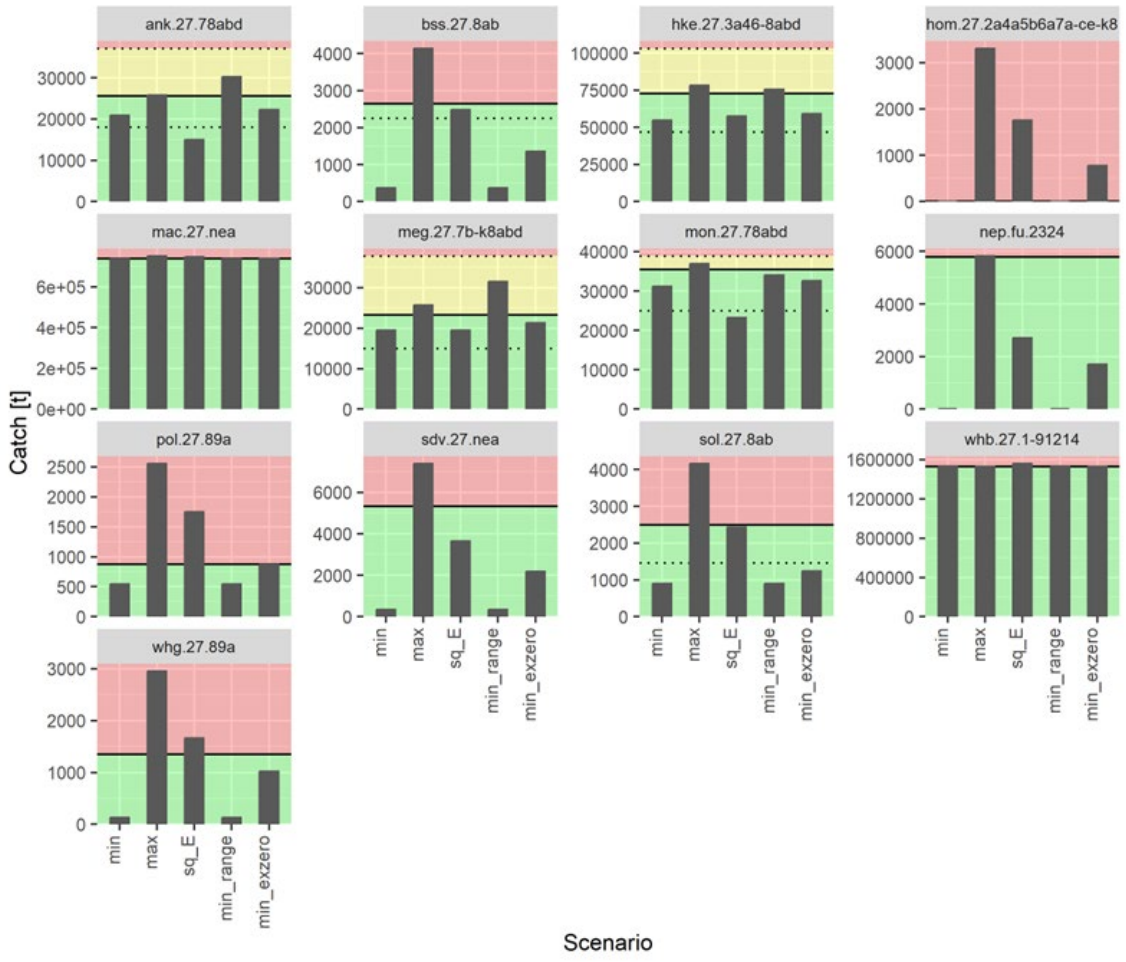


Figure 2.27. Bay of Biscay mixed fisheries forecast: Estimates of 2025 catches (in tonnes) by stock and scenario (Table 2.2). The horizontal dashed lines correspond to the single-stock catch advice, with areas above and below the line representing potential over and undershoot, respectively.

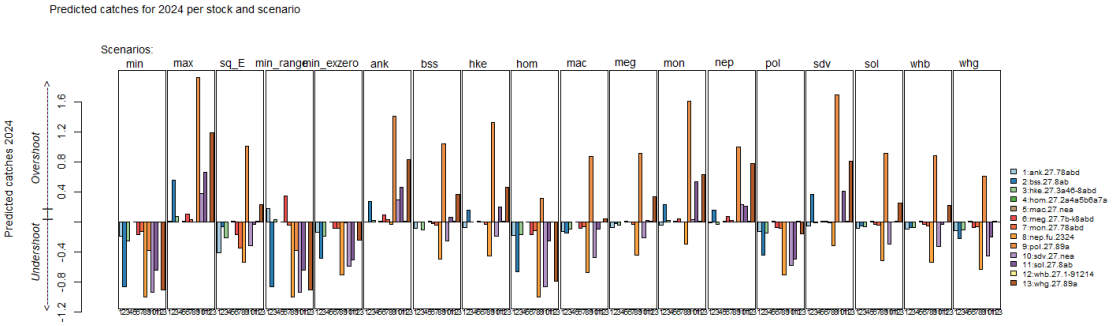


Figure 2.28. Bay of Biscay mixed fisheries forecasts: TAC year results (2024). FLBEIA estimates of potential percentage of catches change by stock (relative to the TAC advice) and scenario (Table 2.2). Horizontal line corresponds to the single-stock advice for 2024. Bars below the value of zero show the percentage of undershoot (compared to the single species catch advice) in cases where catches are predicted to be lower when applying the scenario.

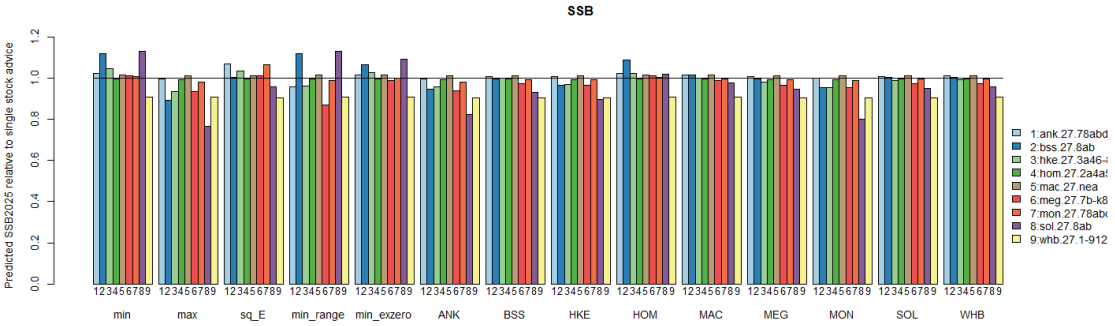


Figure 2.29. Bay of Biscay mixed fisheries forecasts: Estimates of potential SSB at the start of 2025 by stock and scenario (Table 2.2), expressed as a ratio to the single-species advice forecast (Table 2.4). Horizontal line corresponds to the SSB resulting from the single-stock advice (at the start of 2025).

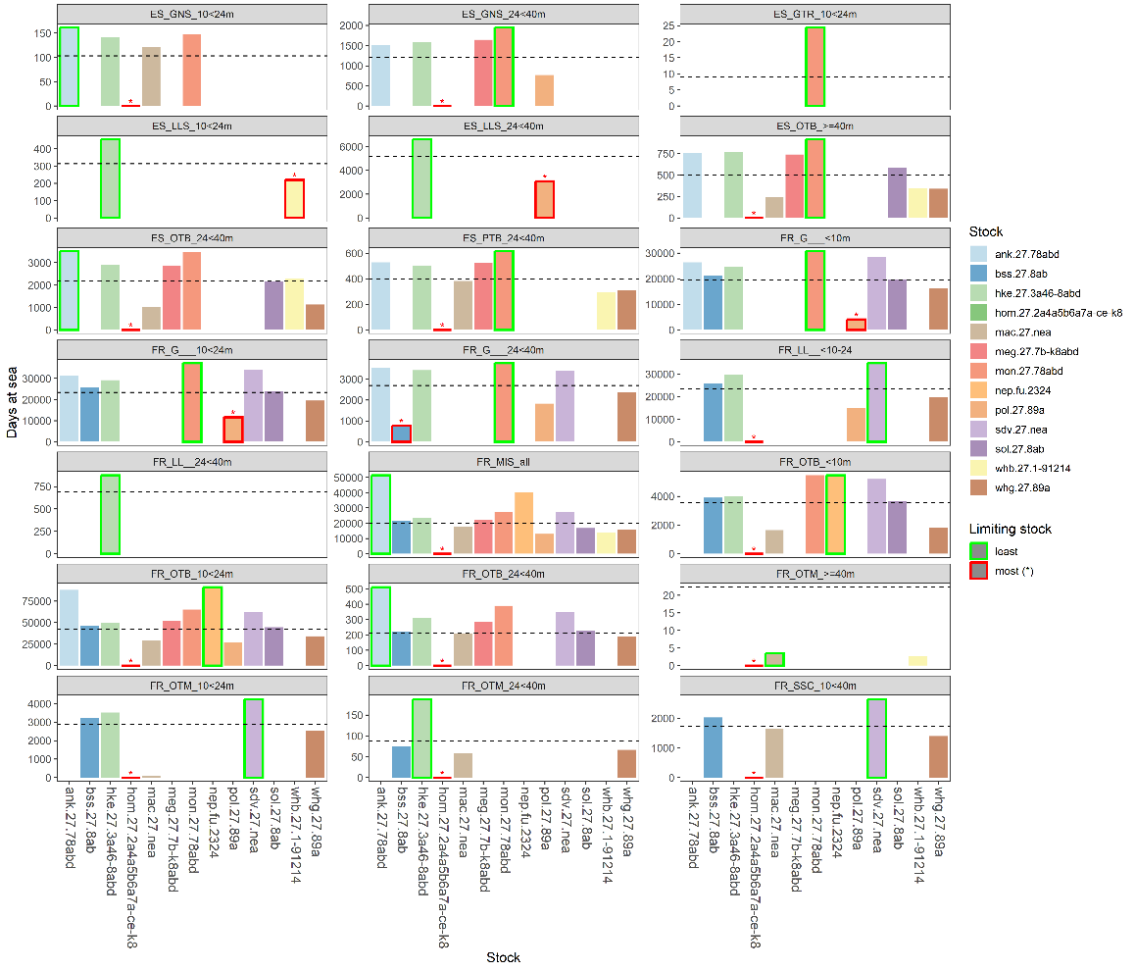


Figure 2.30. Bay of Biscay mixed fisheries forecast: Estimates of effort by fleet needed to reach the advice for the single stocks. Stocks are coded by colour, with the most limiting stock ("choke species") for each fleet in 2024 highlighted with a red border and the least limiting species highlighted with a green border. Fleet names are given by country (FR = France, ES = Spain) and by combinations of main gear and vessel size differing across countries and based on homogeneous average fishing patterns. Vessels in the various fleet segments can engage in several fisheries (métiers) over the year. The *status quo* effort for each fleet (average 2020–2022) is shown as a dashed line for reference.

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3 Celtic Seas

Mixed fisheries considerations

3.1 Background

Fisheries in the Celtic Sea are highly mixed, targeting a range of species with different gears. Otter trawl fisheries target mixed gadoids (cod, haddock, and whiting), *Nephrops*, hake, anglerfish, megrims, rays as well as cephalopods (cuttlefish and squid). Beam trawl fisheries target flatfish (plaice, sole, turbot), anglerfish, megrim, and cephalopods (cuttlefish and squid), while set-net fisheries target flatfish, hake, pollack, cod, anglerfish as well as some crustacean species. Beam trawling occurs for flatfish (in 7.e and 7.fg) and rays (7.f). The fisheries are mainly prosecuted by French, Irish, and English vessels with additional Belgian beam trawl fisheries and Spanish trawl, longline and net fisheries along the shelf edge (7.hjk).

The mixed gadoid fishery predominately takes place in ICES areas 7.f and 7.g with these areas responsible for > 75% of the landings of each cod, haddock and whiting. Landings are predominately by French and Irish vessels, though UK vessels also take significant landings of these species. Differences in stock distributions mean that spatial decoupling of catches of cod, haddock, and whiting from those of megrims, anglerfish, and sole could be achieved (Dolder *et al.*, 2018).

3.1.1 Management measures

In 2023, the ICES advice for all stocks considered in this model was given in terms of the ICES MSY approach. A multiannual management plan (MAP) for Western and adjacent waters has been adopted by the EU for stocks covered by this advice (Council Regulation (EC) 2019/472) which ICES considers to be precautionary. However, there is no agreed shared management plan with the UK for these stocks. There are two species-specific management plans for the region; a hake recovery plan (Council Regulation (EC) No 811/2004) which implements a Total Allowable Catch (TAC) annually based on a defined Harvest Control Rule (HCR) and a management plan with both an HCR and effort management elements for sole in the Western channel (7.e; Council Regulation (EC) No 509/2007). There are also effort, technical and area closure measures in place, which are summarized below. The EU western waters regulation (Council Regulation (EC) No 1954/2003) implements an effort ceiling for ≥ 15 m vessels fishing for demersal species in Subarea 7 with additional effort ceiling specifications for an area to the South and West of Ireland known as the 'Biologically Sensitive Area' for vessels ≥ 10 m.

A series of technical measures are in place for demersal trawl gears operating in various parts of the Celtic Sea. This includes maximum number of meshes in circumference, incorporation of a square mesh panel (SMP), and minimum mesh size in the codend dependent on the target composition and/or area. Technical measures for the recovery of hake stock, which includes Subarea 7, are detailed in Commission regulation (EC) No 1162/2001, Commission regulation (EC) No 2062/2001, and Commission regulation (EC) No 494/2002. More recently, the incorporation of the SMP was introduced and is detailed in Commission regulation (EU) No 737/2012 of 14 August 2012. A summary of current measures is published by BIM of Ireland[1].

[1] https://bim.ie/fisheries/advisory-services/fisheries-management-chart

Since 2005, three ICES rectangles (30E4, 31E4, and 32E3) have been closed during the first quarter (Council Regulations 27/2005, 51/2006, and 41/2007, 40/2008 and 43/2009) known as the Trevose closure, with the objective of reducing fishing mortality on cod. Another area closure was in place for EU fisheries in FU16 (the Porcupine bank) between 1 May - 31 July 2010–2012; however, the period of the EU regulatory closure was reduced to only May between 2013 and 2019 (Council Regulation 2019/124) and has not been in force since 2020 (Council Regulation 2020/123).

As of the 1 January 2016 a European landings obligation was introduced (Commission Delegated Regulation (EU) 2015/2438). This regulation prevents the discarding of certain species on a fishery-by-fishery approach. Since 1 January 2019, catches of all quota species in the Celtic Seas have been subject to the EU landings obligation rule, except where an exemption is in place, and a UK landings obligation remains in place following the exit of the UK from the EU. An overview of the exemptions of the EU landings obligation can be found below:

Exemptions to the landing obligation in 2021

Species	Exemption type	Area	Gear	Maximum de minimis exemption (% of total annual catch)
Albacore tuna	De minimis	7	Midwater pair trawls	5
Whiting	De minimis	7b -7k	Bottom trawls and seines ≥ 80 mm, Pelagic and beam trawls 80-119 mm	5
Sole	De minimis	7a, 7d -7h	Beam trawl 80-119 mm with Flemish Panel	3
Sole	De minimis	7d,e,f & g	Trammel nets and gillnets	3
Haddock	De minimis	7b,c & 7e-k	Bottom trawls and seines ≥ 100 mm, catches comprising ≤30% Nephrops	5
Haddock	De minimis	7b,c & 7e-k	Vessels using ≥ 80 mm, with catches comprising more than 30% Nephrops	5
Haddock	De minimis	7b,c & 7e-k	Beam trawls ≥ 80 mm with Flemish Panel	5
Haddock [1]	De minimis	6a	Nephrops bottom trawls using <119mm with HSG	3
Megrim [2]	De minimis	7	Beam Trawls 80-119mm & Bottom trawls	4
Horse mackerel	De minimis	6 & 7b-k	Bottom trawls, seines & beam trawls	3
Mackerel	De minimis	6 & 7b-k	Bottom trawls, seines & beam trawls	3
Boarfish	De minimis	7b,7c,7f-7k	Bottom trawls	0.5
Argentine	De minimis	EU 5b & 6	Bottom trawls ≥ 100 mm	0.6
Species	**Exemption Type**	**Area**	**Gear**	**Discard Release Notes**
Nephrops	Survivability	6 & 7	Pots, creels or traps	immediately & where caught
Nephrops	Survivability	7	Bottom trawls 70-99mm with HSG* or ≥100mm	immediately & where caught
Nephrops	Survivability	6a (<12nm)	Bottom trawls 80-110 mm	immediately & where caught
Skates & rays	Survivability	6 & 7	All gears	Released immediately
Plaice	Survivability	7d -7g	Trammel nets and otter trawls	Released immediately
Plaice	Survivability	7d -7g	Beam Trawls with flip up rope or benthic release panel (vessels > 221kW)	Released immediately
Plaice	Survivability	7a-7g	BT2 (vessels ≤221 kW or ≤24 m) inside 12 nm, tows ≤ 1:30 hour	Released immediately
All Species	Survivability	EU 5b; 6 & 7	Pots, creels and traps	Released immediately

[1] Applies ony to haddock <MCRS (30cm), [2] Applies ony to megrim <MCRS (20cm)
* See list of highly specific gears for Nephrops. ** Bottom trawls:70 to 99mm in 7f,7g, 7h North of 49.5°N & 7j East of 11°W - catches must comprise 55% whiting or anglerfish, hake & megrim combined; ≥100mm in the rest of 7

Reference: Commission Delegated Regulation (EU) 2020/2015

3.2 Model

3.2.1 Software

All analyses were conducted using the FLR framework (Kell *et al.*, 2007; FLCore 2.6.19, FLFleet 2.6.1, FLAssess 2.6.3, Flash 2.5.11) running with R4.2.2 (R Development Core Team, 2020). All forecasts were projected using the same fwd() function in the Flash Package, except where a SAM forecast procedure is used for the single-stock advice (see table below) and the stockassessment 0.12 library (Nielsen and Berg, 2014) is used instead. The FCube method was developed as a stand-alone script using FLR objects as inputs and outputs, but has been adapted to more accurately implement single-stock forecast procedures. Software used in the single-species assessments and forecasts was as outlined in the table below:

Stock	Assessment	Forecast
cod.27.7e–k	Age-based stochastic analytical assessment (SAM)	SAM
had.27.7bc,e–k	Age-based stochastic analytical assessment (SAM)	SAM

Stock	Assessment	Forecast
whg.27.7bc,e–k	Age-based stochastic analytical assessment (SAM)	SAM
meg.27.7b-k8abd	Statistical catch-at-age model (A4A)	FLR STF
mon.27.78abd	Statistical catch-at-age model (SS3)	FLR STF
ank.27.7-8abd	Length-based age-structured Stock Synthesis model (SS3)	FLR STF
sol.27.e	Age-based analytical assessment (XSA)	FLR STF
sol.27.7fg	Age-based stochastic analytical assessment (SAM)	SAM
hke.27.3a46-8abd	Length-based and sex-disaggregated model (SS3)	FLR STF
nep.fu.16	Underwater TV survey	NA
nep.fu.17	Underwater TV survey	NA
nep.fu.19	Underwater TV survey	NA
nep.fu.2021	Underwater TV survey	NA
nep.fu.22	Underwater TV survey	NA
nep.27.7outFU	Precautionary approach	NA

3.2.2 Scenarios

FCube (Ulrich *et al.*, 2008; Ulrich *et al.*, 2011) was used to forecast several mixed fisheries scenarios. The basis of the model is to estimate the potential future levels of effort by a fleet corresponding to the fishing opportunities (catches by stock and/or effort allocations by fleet) available to that fleet, based on fleet effort distribution and catchability by métier. This level of effort was used to estimate landings and catches by fleet and stock, using standard forecasting procedures. The basis for each single-stock advice was retained in the current mixed fisheries framework except for the "min-range" scenario as detailed below.

The following six options (or scenarios) were included in the advice:

Scenario code	Mixed fisheries effort assumption	Basis for catch target 2024
Minimum (*min*)	For each fleet, fishing in 2024 stops when the first stock share* of that fleet has been caught. This scenario is the most precautionary option and can highlight some potential "choke species" issues.	ICES catch advice
Maximum *(max)*	For each fleet, fishing in 2024 continues until all stock shares* of that fleet have been caught. This option illustrates the degree of overfishing of the single-stock advice if fishing is not restricted by the fleet stock shares*.	
Status quo effort (*sq_E*)	The effort of each fleet in 2024 is set equal to the average effort in the most recent three years (2020–2022) for which landings and discard data are available.	

Scenario code	Mixed fisheries effort assumption	Basis for catch target 2024
Minimum including ranges (*min_range*)	Same as min scenario.	Catches corresponding to $F_{MSY\ upper}$ for stocks in good status (SSB ≥ MSY $B_{trigger}$) and scaled F_{MSY} advice levels (F_{MSY} × SSB/MSY $B_{trigger}$) for the other stocks (including zero catch advice stocks).
Minimum excluding zero advice stocks (*min_exzero*)	For each fleet, fishing in 2024 stops when the catch for any one of the stocks meets the fleet's stock share* ignoring cod and whiting where there is zero catch advice. This scenario illustrates the effect of fishing to the next nearest non-zero advice stock.	ICES catch advice
Haddock single-stock advice (*had-cs*)	For each fleet, fishing in 2024 stops when the catch of haddock meets the fleet's stock share* for haddock, regardless of other catches. Fleets which do not catch haddock follow a *status quo* effort assumption (as described for the sq_E scenario).	

***Note that throughout this document, the term "fleet's stock share" or "stock share" is used to describe the share of the fishing opportunities for each particular fleet, calculated based on the single-stock advice for 2023 and the historical proportion of the stock landings taken by the fleet.**

A replacement scenario to the previously provided "range" scenario has been added this year. This scenario explores how the higher catch advice associated with the $F_{MSY\ upper}$ or scaled F_{MSY} reference points may reduce choking behaviour in mixed fisheries and increase overall quota uptake.

Additionally, a new scenario the "min_exzero" has been added. The scenario is consistent with a full implementation of a landing obligation given the individual single-stock advice for all stocks except cod and whiting. This aims to illustrate the potential bycatch of stocks where there is zero catch advice and if the next nearest choke becomes limiting irrespective of the catch advice for cod and whiting.

Some additional scenarios are presented here but were not presented in the mixed fisheries considerations advice sheet:

Scenario code	Mixed fisheries effort assumption	Basis for catch target 2024
cod_FARzero	For each fleet, fishing in 2024 stops when the catch of cod meets the fleet's stock share* for cod, regardless of other catches. Fleets which do not catch cod follow a *status quo* effort assumption (as described for the sq_E scenario).	For cod and whiting, catches corresponding to the scaled F_{MSY} advice levels (F_{MSY} x SSB/MSY $B_{trigger}$). ICES headline catch advice is used for other stocks.
whg_FARzero	For each fleet, fishing in 2024 stops when the catch of whiting meets the fleet's stock share* for whiting, regardless of other catches. Fleets which do not catch whiting follow a *status quo* effort assumption (as described for the sq_E scenario).	For cod and whiting, catches corresponding to the scaled F_{MSY} advice levels (F_{MSY} x SSB/MSY $B_{trigger}$). ICES headline catch advice is used for other stocks.
cod_FARcod	For each fleet, fishing in 2024 stops when the catch of cod meets the fleet's stock share* for cod, regardless of other catches. Fleets which do not catch cod follow a *status quo* effort assumption (as described for the sq_E scenario).	For cod only, catches corresponding to the scaled F_{MSY} advice levels (F_{MSY} x SSB/MSY $B_{trigger}$). ICES headline catch advice is used for other stocks.
cod-cs	For each fleet, fishing in 2024 stops when the catch of cod meets the fleet's stock share* for cod, regardless of other catches. Fleets which do not catch cod follow a *status quo* effort assumption (as described for the sq_E scenario).	ICES catch advice

Scenario code	Mixed fisheries effort assumption	Basis for catch target 2024
whg-cs	For each fleet, fishing in 2024 stops when the catch of whiting meets the fleet's stock share* for whiting, regardless of other catches. Fleets which do not catch whiting follow a *status quo* effort assumption (as described for the sq_E scenario).	

***Note that throughout this document, the term "fleet's stock share" or "stock share" is used to describe the share of the fishing opportunities for each particular fleet, calculated based on the single-stock advice for 2023 and the historical proportion of the stock landings taken by the fleet.**

3.3 Data compilation

Following IBPMIXFISH 2021 (ICES, 2021), the data compilation R scripts were significantly revised to improve workflow, readability, and reproducibility. These revisions have been thoroughly detailed in the IBP report and Stock Annex. The input data source to these scripts remains the same, bar the inclusion of standard assessment graph data retrieved directly from ICES.

Data used to produce the mixed fisheries forecasts comes from three sources:

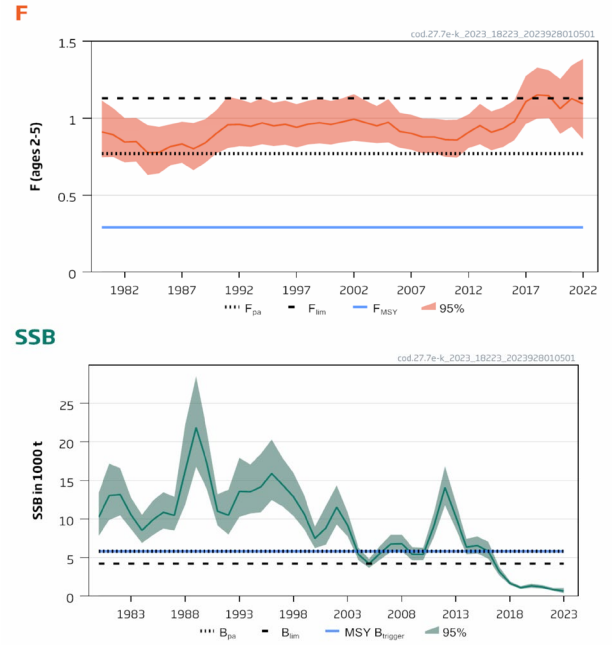
1. Stock data: Stock abundance, age-structure, reference points, catch advice, and trends. These data are supplied by the single species assessment working groups, the data are also retrieved from the ICES Standard Assessment Graph (SAG) server on a stock by stock basis and used to validate data submissions to WGMIXFISH.
2. Fisheries dependent data: fleet and métier trends in landings and effort. These data are sourced from the WGMIXFISH data call ("accessions data").
3. Discard rates: InterCatch.

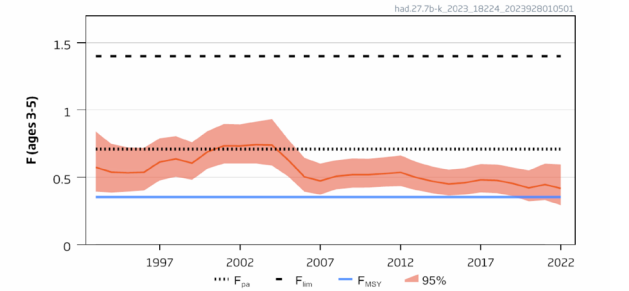
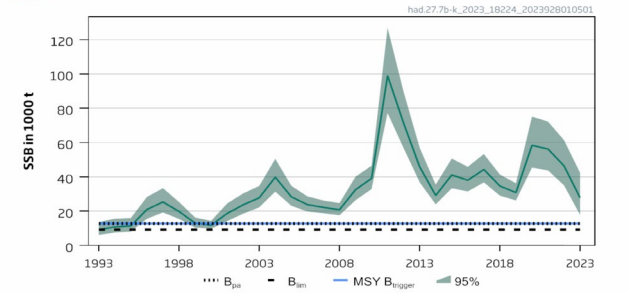
Details on the collection, structure and implementation of these data sources can be found in the Stock Annex (ICES, 2023a). Below specific details of the data sources in 2023 have been described.

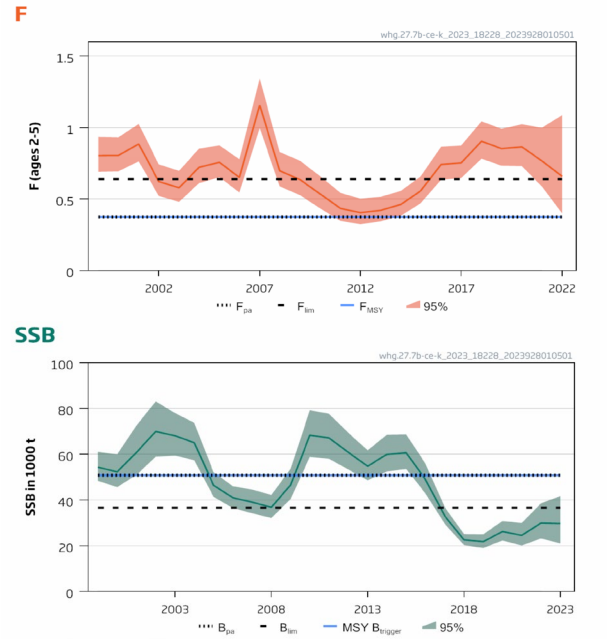
3.3.1 Stock data

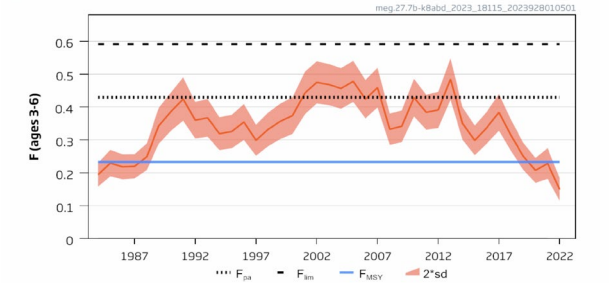
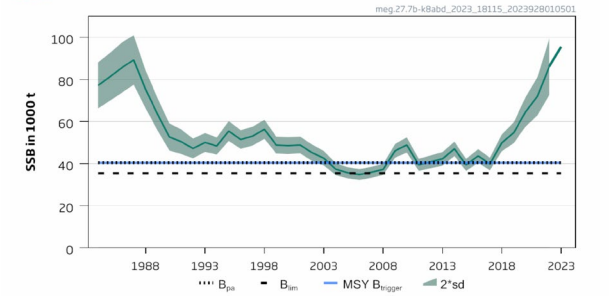
Single species stock assessment outputs including abundance, fishing mortality, biological parameters (maturity, natural mortality) and age-structure was supplied by WGCSE (ICES, 2023b) and WGBIE (ICES, 2023c) in the form of FLR stock objects. Details of reference points, advice for 2024, TAC and trends in stock status were taken from the advice sheets. The consistent support and cooperation from the chairs and single species stock assessors has greatly eased the workload of WGMIXFISH in 2023. An overview of the trends and advice for demersal stocks included in Celtic Sea mixed fisheries analysis from the single species advice for these stocks is described below (ICES, 2023b; ICES, 2023c; Table 3.1, Table 3.2).

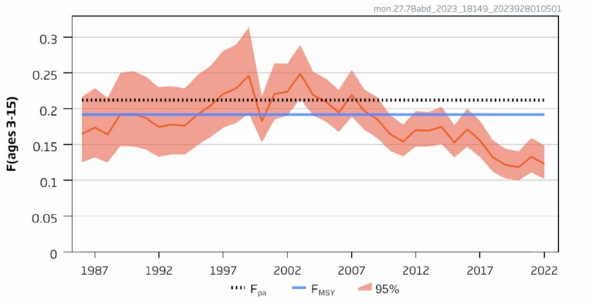
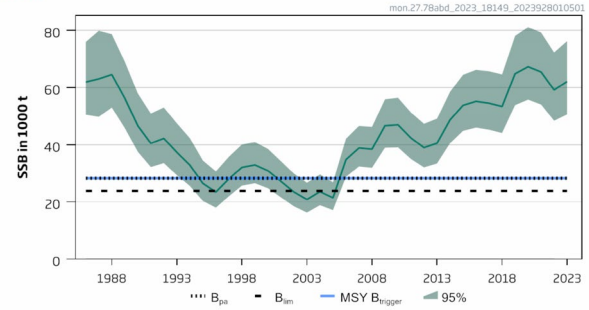
Table 3.1 Summary of advice and stock trends for the stocks included in the Celtic Sea mixed fisheries model (ICES, 2023b, 2023c)

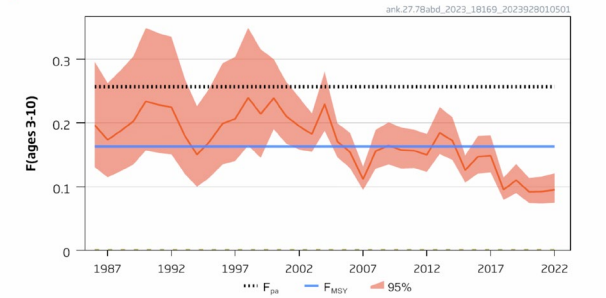
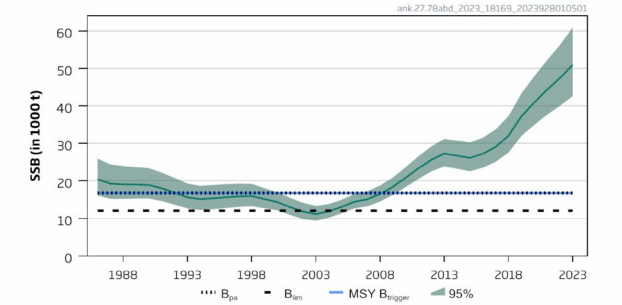
Analytical stocks			
Species	**Area**	**Stock status**	**Advice 2023**
cod.27.7e–k (Cod)	Divisions 7. e–k (western English Channel and southern Celtic Seas)	 **Summary**: Fishing pressure on the stock is above F_{MSY} and between F_{pa}, and F_{lim}, and spawning-stock size is below MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2024. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. ICES has not identified any conservation aspects.

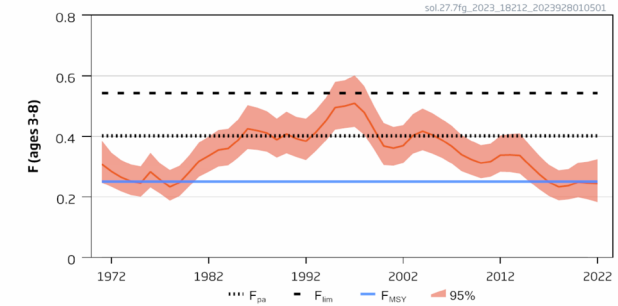
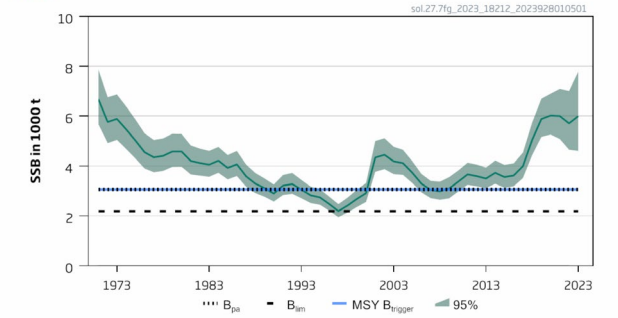
Analytical stocks			
Species	**Area**	**Stock status**	**Advice 2023**
had.27b–k (Haddock)	Divisions 7.b–k (southern Celtic Seas and English Channel)	**F**  **SSB**  **Summary**: Fishing pressure on the stock is above F_{MSY} and below F_{pa} and F_{lim}, and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 8252 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. ICES has not identified any conservation aspects.

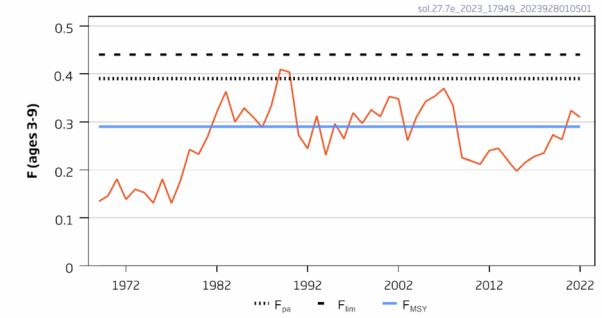
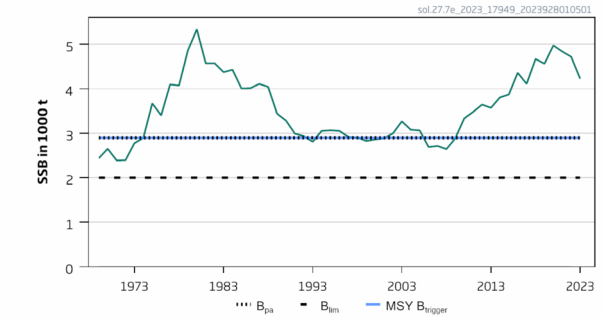
Analytical stocks			
Species	**Area**	**Stock status**	**Advice 2023**
whg.27.b–c, e–k (Whiting)	Divisions 7.b–c and 7.e–k (southern Celtic Seas and western English Channel)	 **Summary:** Fishing pressure on the stock is above F_{MSY}, F_{pa} and F_{lim}, and spawning-stock size is below MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2024. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. Management should be implemented at the stock level. ICES has not identified any conservation aspects.

Analytical stocks			
Species	**Area**	**Stock status**	**Advice 2023**
meg.27.7b-k8abd (Megrim)	Divisions 7.b–k, 8.a–b, and 8.d (west and southwest of Ireland, Bay of Biscay)	F  SSB  **Summary**: Fishing pressure on the stock is below F_{MSY}, and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 23303 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. The use of combined species TAC for the two megrim species, megrim (*Lepidorhombus whiffiagonis*) and four-spot megrim (*Lepidorhombus boscii*), prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. ICES has not identified any conservation aspects.

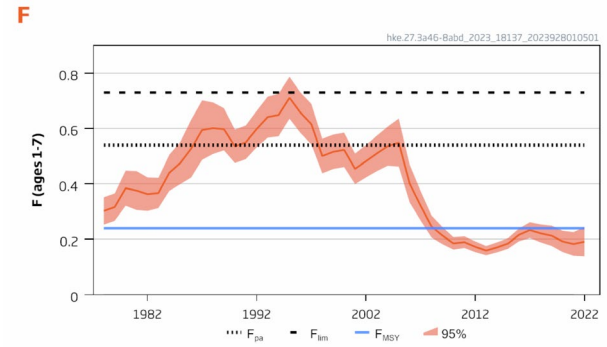
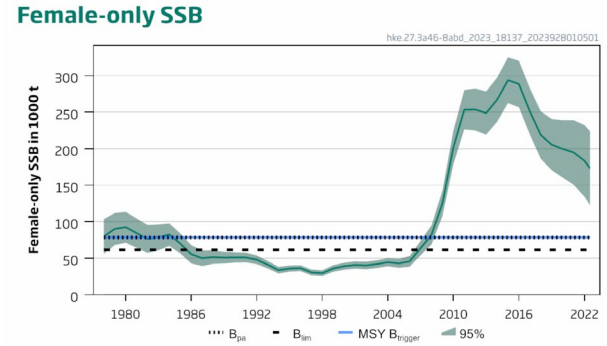
Analytical stocks			
Species	**Area**	**Stock status**	**Advice 2023**
mon.27.78abd (White anglerfish)	Subarea 7 and in divisions 8.a–b and 8.d (southern Celtic Seas, Bay of Biscay)	**F**  **SSB**  **Summary**: Fishing pressure on the stock is below F_{MSY}; spawning stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 35502 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. The use of combined species TAC for the two anglerfish species, black-bellied anglerfish (*Lophius budegassa*) and white anglerfish (*Lophius piscatorius*), prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. ICES has not identified any conservation aspects.

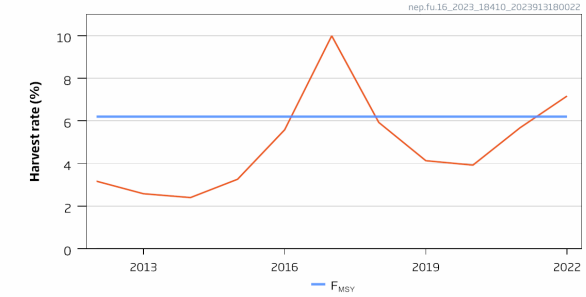
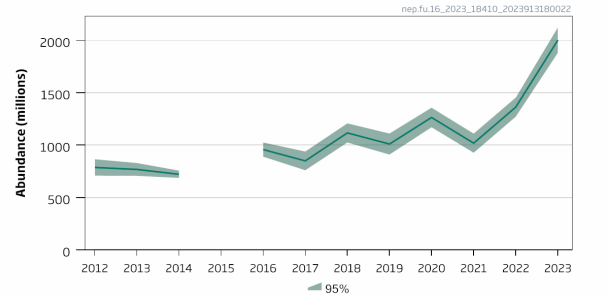
Analytical stocks			
Species	**Area**	**Stock status**	**Advice 2023**
ank.27.7-8abd (Black-bellied anglerfish)	Subarea 7 and divisions 8.a–b and 8.d (Celtic Seas, Bay of Biscay)	F  SSB  **Summary**: Fishing pressure on the stock is below F_{MSY} and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024should be no more than 25 579 tonnes. ICES notes the existence of a precautionary management plan developed and adopted by one of the relevant management authorities for this stock. The use of combined species TAC for the two anglerfish species, black-bellied anglerfish (*Lophius budegassa*) and white anglerfish (*Lophius piscatorius*), prevents effective control of the single species exploitation rates and could lead to the overexploitation of either species. ICES has not identified any conservation aspects.

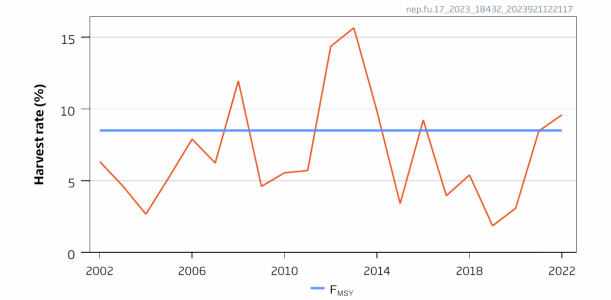
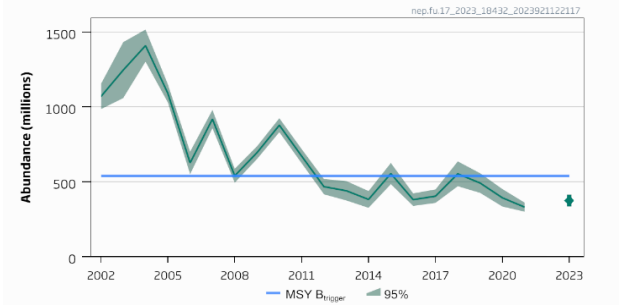
Analytical stocks			
Species	**Area**	**Stock status**	**Advice 2023**
sol.27.7fg (Sole)	Divisions 7.f and 7.g (Bristol Channel, Celtic Sea)	**F**  **SSB**  **Summary**: Fishing pressure on the stock is at F_{MSY}; spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 1267 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. ICES has not identified any conservation aspects.

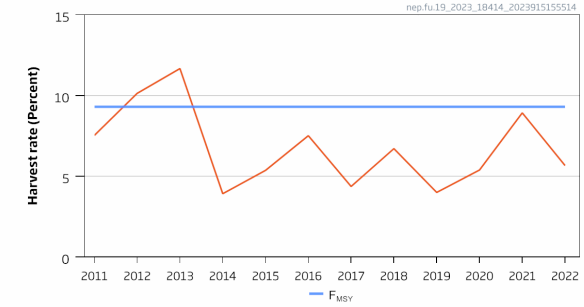
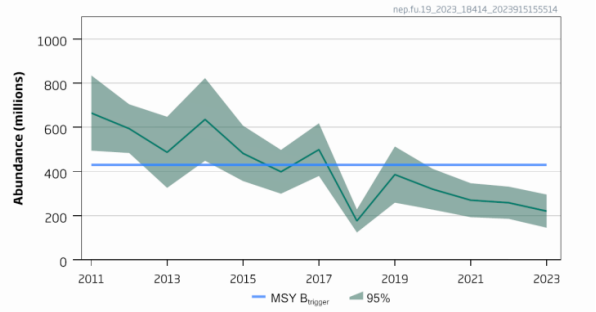
Analytical stocks			
Species	**Area**	**Stock status**	**Advice 2023**
sol.27.e (Sole)	Divisions 7.e (western English Channel)	**F**  **SSB**  **Summary**: Fishing pressure on the stock is above F_{MSY} but below F_{pa} and F_{lim}; spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 1057 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. ICES has not identified any conservation aspects.

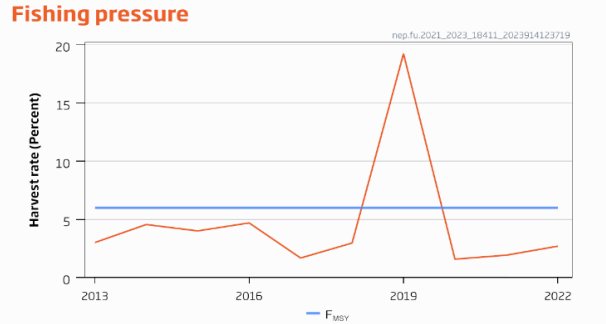
Analytical stocks

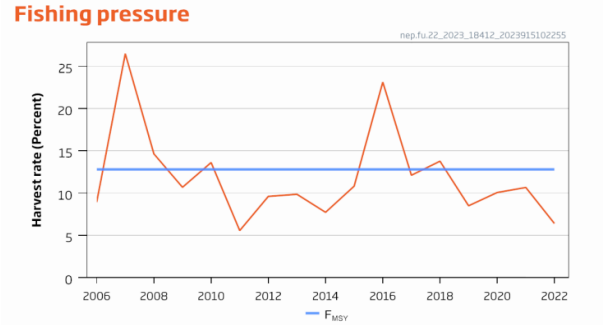
Species	Area	Stock status	Advice 2023
hke.27.3a46-8abd (Hake)	Subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay)	  **Summary**: Fishing pressure on the stock is below F_{MSY}, and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 72 839 tonnes. ICES notes the existence of a precautionary management plan developed and adopted by one of the relevant management authorities for this stock. ICES has not identified any conservation aspects.

***Nephrops* stocks**			
Species	**Area**	**Stock status**	**Advice 2023**
nep.fu.16 (*Nephrops*)	Divisions 7.b–c and 7.j–k, Functional Unit 16 (west and south-west of Ireland, Porcupine) Bank)	**Fishing pressure**  **Stock size**  **Summary:** Fishing pressure on the stock is above F_{MSY}, and no reference points for stock size have been defined for this stock.	ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, and assuming zero discards, catches in 2024 that correspond to the F ranges in the MAP are between 3677 and 4560 tonnes. The entire range is considered precautionary when applying ICES advice rule. To ensure that the stock in FU 16 is exploited sustainably, management should be continued at the FU level. ICES has not identified any conservation aspects.

***Nephrops* stocks**			
Species	**Area**	**Stock status**	**Advice 2023**
nep.fu.17 (*Nephrops*)	Division 7.b, Functional Unit 17 (west of Ireland, Aran grounds)	**Fishing pressure**  **Stock size**  **Summary:** Fishing pressure on the stock is above F_{MSY}, and stock size is below MSY $B_{trigger}$.	ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years2020–2022, catches in 2024 that correspond to the F ranges in the MAP are between 395 and 454 tonnes. To ensure that the stock in Functional Unit (FU) 17 is exploited sustainably, management should be implemented at the FU level. A transfer of advised catch from other FUs to FU 17 could lead to overexploitation. ICES has not identified any conservation aspects

***Nephrops* stocks**			
Species	**Area**	**Stock status**	**Advice 2023**
nep.fu.19 (*Nephrops*)	Divisions 7.a, 7.g, and 7.j, Functional Unit 19 (Irish Sea, Celtic Sea, eastern part of south-west of Ireland)	**Fishing pressure**  **Stock size**  **Summary:** Fishing pressure on the stock is below FMSY, and stock size is below MSY $B_{trigger}$.	ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2019–2021, catches in 2023 that correspond to the F ranges in the MAP are between 302 and 338 tonnes. To ensure that the stock in Functional Unit (FU) 19 is exploited sustainably, management should be implemented at the FU level.

***Nephrops* stocks**			
Species	**Area**	**Stock status**	**Advice 2023**
nep.fu.2021 (*Nephrops*)	Divisions 7.g and 7.h, functional units 20 - 21 (Celtic Sea)	 **Summary:** Fishing pressure on the stock is below F_{MSY}, and stock size is above MSY $B_{trigger}$.	ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2020–2022, catches in 2024 should be no more than 1865 tonnes. To ensure that the stock in functional units (FUs) 20–21 is exploited sustainably, management should be implemented at the level of the combined FU 20–21. ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 7. ICES considers this plan to be precautionary when implemented at the FU.

***Nephrops* stocks**			
Species	**Area**	**Stock status**	**Advice 2023**
nep.fu.22 (*Nephrops*)	Divisions 7.g and 7.f, Functional Unit 22 (Celtic Sea, Bristol Channel)	 **Summary:** Fishing pressure on the stock is below F_{MSY}, and stock size is below MSY $B_{trigger}$.	ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2020–2022, catches in 2024 should be no more than 1912 tonnes. To ensure that the stock in Functional Unit (FU) 22 is exploited sustainably, management should be implemented at the FU level. ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 7. ICES considers this plan to be precautionary when implemented at the FU level. ICES advice on conservation aspects ICES has not identified any conservation aspects.
nep.27.7out FU* (*Nephrops*)	Subarea 7, outside the functional units (southern Celtic Seas, southwest of Ireland)		ICES advises that when the precautionary approach is applied, landings should be no more than 120 tonnes in each of the years 2024, 2025, and 2026. ICES cannot quantify the corresponding total catches. ICES has not identified any conservation aspects.

*** Format of nep.27.7outFU differs from other stocks because the advice was published in 2023.**

3.3.2 Fisheries dependent data

Information on fisheries is supplied according to the WGMXFISH data call in the form of "accessions" data, which provides disaggregated fleet data at the level of métier which are consistent with the definitions outlined in the DCF. This includes landings (in tonnes) for defined species and fishing effort (in KW days). In 2019, there was a new data call for WGMIXFISH, which changed the format in which the data were requested.

3.3.3 Discard data

Discard ratios were calculated from InterCatch discard estimates (either raw country submission or raised) and applied to the landings data supplied by member states in the WGMIXFISH data call. All discard estimates were retrieved from InterCatch and assigned to the same métiers within the WGMIXFISH accessions files. However, this method relies on being able to match métier definitions between the two datasets. The conformity of métiers between MIXFISH and InterCatch was generally high (Figure 3.9) and is improving year after year, but it was still not possible to match a few métiers. It would be desirable for countries to keep improving the consistency between data uploaded to InterCatch and data submitted to WGMIXFISH.

3.3.4 Defining fleet and métier

The data sources described above are then combined to produce the "fleet object" which is used as an input into FCube. Within this object the fleets were defined by aggregating catch and effort across country, gear group, and vessel length (where applicable). Any fleet catching < 1% of any of the stocks included the analysis was binned into an "others" ("OTH") fleet to reduce the dimensions of the model. Effort and catch files were matched to ensure consistency and métiers with effort and no catch were aggregated to the OTH fleet.

Within a fleet, a métier was defined as a combination of gear, target species (e.g. demersal fish, DEF, or crustaceans, CRU) and ICES Division (e.g. 7b). A similar aggregating procedure as for the fleets was performed, where any métier catching < 10% of a given fleet catch of any stock was aggregated into an "OTH" métier. This results in a large number of fleets and métier due to the diversity of activity in the Celtic Sea. The data are therefore aggregated to ICES area-level groupings for the Celtics Sea (7bc; 7e; 7fg; 7hjk), this has a useful benefit of reducing run time, but also reveals the net contribution of "smaller" fleets in a manner that is more comparable for end-users. The final retained fleets accounted for most of the fishing mortality of each stock ("detailed fleets", Figure 3.1) while the OTH fleets contributed little overall ("small fleets, Figure 3.1).

The final data used contained 35 fleets (country * gear grouping * vessel length category), a "MIS_fleet" (MIS), and 14 single-stock "OTH" fleets ("megrim", "anglerfish", "monkfish" and "hake") which account for the catches of these stocks that occur outside the Celtic Sea region (i.e. the Bay of Biscay for megrim, anglerfish, monkfish and hake where there are catches West of Scotland and the North Sea as well) or where there is a mismatch between the fleet catches and the single-stock assessment catches ("small fleets, Figure 3.1). Each fleet engages in several of the 38 different métiers each catching the stocks incorporated into this model (Table 3.3, Figures 3.2–3.7). The combination of stocks landed by each métier varies greatly (Figures 3.2–3.3).

3.3.5 Quality control

As a quality control procedure, the total landings and discards across all fleets were compared to the values estimated from the single-species stock assessments (Table 3.4). Some stock

landings may not be accounted for in the fleets defined above due to issues such as landings from countries or areas not included in the Celtic Sea model or national landings with missing logbook information that cannot be allocated to a specific fleet. The landings coverage for all fish stocks is very high (above 95% of landings of each fish stock for each of the years 2020–2022 could be allocated to one of the fleets). To address the remaining small inconsistencies between fleet data used by WGMIXFISH and stock data, the differences between them were pooled into the stock specific "OTH" fleet (both landings and discards).

3.4 Mixed fisheries forecasts

3.4.1 Description of scenarios

3.4.1.1 Baseline runs

The objectives of the single-species stock baseline runs were to: 1) Reproduce as closely as possible the single-species advice produced by ICES, 2) And act as the reference scenario for subsequent mixed fisheries analyses.

The various single-stock forecasts produced by the single species working groups are performed using different software and setups (see Section 3.2.1 above). The Fcube model has been coded as a method in R 64bits (R Development Core Team, 2008), as part of the FLR framework (Kell *et al.*, 2007; http://www.flr-project.org). Input data are in the form of FLFleets and FLStocks objects from the FLCore package, and two forecast methods were used, *stf()* from the FLAssess and *fwd()* from the Flash packages. Stock objects were processed using Fla4a (version 1.8.2), FLXSA (version 2.6.4), stockassessment (version 0.12.0). As such, the input parameterization as well as the stock projections are made externally using existing methods and packages, while only 3 steps are internalised in the method, thus keeping full transparency and flexibility in the use of the model. In the mixed fisheries runs, all forecasts were done with either the FLR forecast method or the stockassessment *forecast()* method for SAM stocks. This ensured greater coherence between the single-stock and mixed fishery forecasts.

The same forecast settings as the single species assessment are used for each stock regarding weight-at-age, selectivity, and recruitment, as well as assumptions on the F in the intermediate year and basis for advice (MSY approach and precautionary approach). Some differences can occur in the forecast calculations, because of the diversity of single-stock assessment methods used, and the WG always investigates in depth the reasons for potential discrepancies. Adjustments to the Fcube forecasts are made if necessary to minimize discrepancies to the largest extent possible.

The baseline runs therefore act as a quality control procedure to ensure that the projections are set up correctly within the Fcube script. The baseline run has the additional benefit of acting as a quality control check on the projections produced by the single species stock assessors.

3.4.1.2 Mixed fisheries runs

For the mixed fisheries runs, the following assumptions/settings are used.

First, an effort based intermediate year assumption (average effort 2020–2022) is used instead of the single-stock advice assumption. This is considered more consistent with a mixed fishery fleet-based hypothesis for catch than using the divergent single-stock approaches and provides the same functional link between fishing effort and fishing mortality across all stocks.

Second, for the stock targets in the Fcube scenarios a fishing mortality consistent with the catch advice in the TAC year is used to drive the mixed fisheries scenarios rather than using the target F from the single-stock catch advice. Using the advised fishing mortality as the target in the

scenarios means that under a stock limiting scenario, it is possible to not achieve the single-stock catch advice for that stock. This is because the stock size at the beginning of the TAC year can be different from the single-stock forecast as a different intermediate year assumption is used in the mixed fisheries scenarios. Hence, a different catch in the TAC results from the advised F. Using an F consistent with the advised catch as the target in the scenario ensures that the catch advice is always achieved but it may result in a different fishing mortality to the single-stock advice. This was considered more in line with a "implementation error" type approach, given the single-stock catch advice is fixed and intermediate year uncertain and impacting the TAC year.

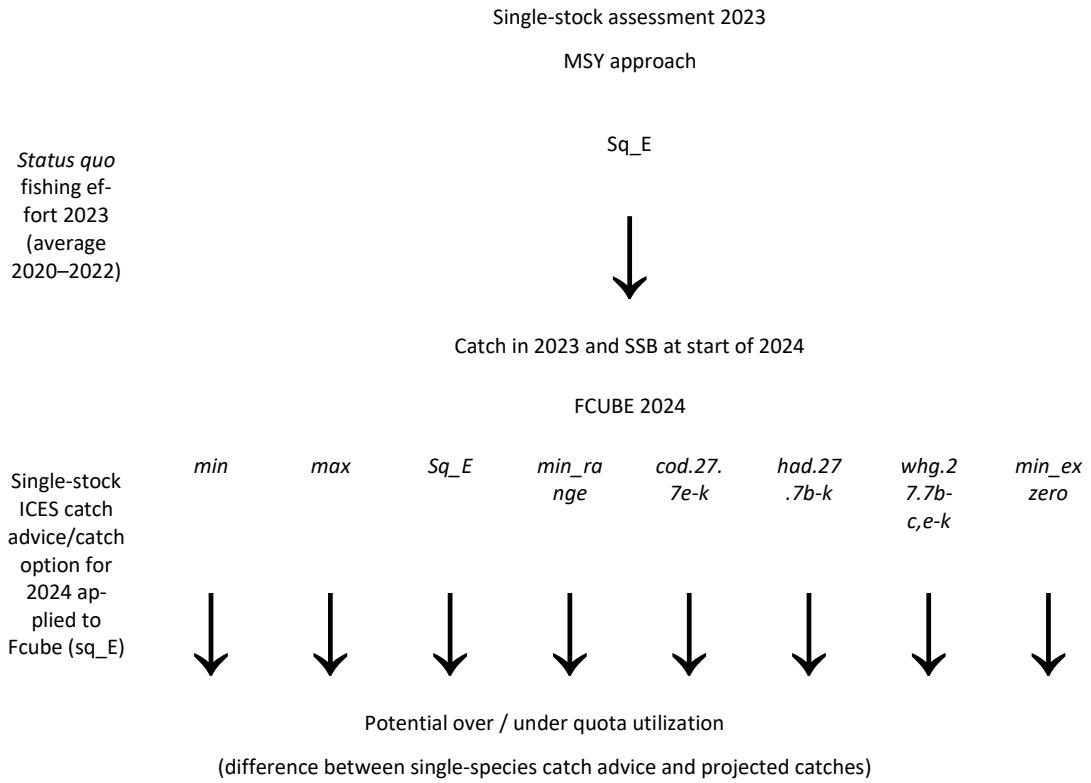
Fcube analyses of the intermediate year (2023)

- For the mixed fisheries advice, the intermediate year assumption used was *status quo* fishing effort (average 2020–2022), with Fcube scenarios applied in the TAC year.

Fcube analyses of the TAC year (2024)

- Six scenarios were run, as outlined in Section 3.2.2 above.

In summary, the Fcube runs followed the scheme below:



3.4.2 Results of Fcube runs

3.4.2.1 Baseline run

Table 3.5 summaries the result of the baseline runs for each of the stocks included in the model. Figure 3.8 shows the required change in fishing mortality for each stock. This trend shows that cod requires the biggest reduction in F, indicating that the zero catch advice would lead to a choke for all the fisheries that catch cod. Whiting also requires a reduction in F to zero, but from a lower *status quo* F than cod. No issues were encountered in replicating the single-species advice. The results from these baseline runs are compared with the results from the corresponding single-stock advice in Table 3.5 and summarized in Figure 3.9. The replicated forecast for all stocks were almost identical with the single-stock advice with a maximum deviation of −2.5% for hake

SSB in 2024. This results from the difficulty in replicating the length-based forecast procedure in the age-based Fcube framework. The SSB deviation under the same assumed F as the single-stock advice resulted in a 2% deviation, which was considered reasonable given software constraints. The only other deviation >1% (excluding rounding errors for reported precision on fishing mortality) was whiting SSB in 2025 which was a −1.9% difference.

3.4.2.2 Mixed fisheries analyses

Intermediate year

The full overview of the Fcube projections to 2024 is presented in Table 3.6–3.10, Figure 3.9–3.11. The results for 2024 can be compared to each other as in a single-species option Table 3.2. For all baseline scenarios, WGMIXFISH assumed *status quo* effort in 2023.

TAC year Fcube runs

The outcomes of the *"minimum"* and *"maximum"* scenarios are driven by which of the stocks will be most and least limiting for each individual fleet (Figure 3.11, Tables 3.6–3.7). In 2024, the "min" scenario shows that whiting and cod limits 27 of the 35 fleets and a further 3 for cod only; this is due to the zero catch advice for cod and whiting and that almost all fleets catch cod or whiting to a greater or lesser extent. The five remaining fleets had no cod landings, with the remaining fleets limited by haddock, white anglerfish (2 fleets), Celtic Sea sole and *Nephrops* outside functional units respectively.

The 'max' scenario demonstrates the upper bound of potential fleet effort and stock catches (Table 3.8, Figure 3.11), in that it assumes all fleets continue fishing until all their stock shares for all other stocks are exhausted, irrespective of the economic viability of such actions. In 2024, the *'max'* scenario indicated that fleets have different least limiting stocks which results in over-quota catches of all other stocks (Figure 3.10). Norway lobster FU 20–21 (18 fleets), Black-bellied anglerfish **(**16 fleets**)** , and western English channel sole (one fleet**)** are the least limiting stocks.

The *status quo* effort scenario (*"sq_E"*) results in a small overshoot of haddock, a large overshoot of cod and whiting, and a small undershoot of white and black-bellied anglerfish, hake, megrim, and Norway lobster.

The *min_range* scenario results in an undershoot of all stocks except cod and whiting. In this scenario, the choke species per fleet are the same as for the "min" scenario. Catches for all stocks in 2024 are slightly increased above the "min" scenario due to the increase in catch opportunity provided by the scaled F_{MSY} advice rule. However, these catches for cod and whiting are not considered precautionary.

The "min_exzero" scenario is consistent with a full implementation of a landing obligation given the individual single-stock advice for all stocks except cod and whiting. In this scenario cod and whiting were not included as effort-restricting stocks. In 2024, haddock becomes the most limiting stock constraining 11 out of 35 fleet segments for this scenario. The remaining fleets are constrained by Norway lobster (8 fleets across 3 functional units), hake (5 fleets), sole 7fg and sole 7e (4 fleets for each), white anglerfish (2 fleets) and megrim (1 fleet).

Mixed fisheries catch scenarios can take specific management priorities into account, and these results indicate that it is not possible to achieve all single-species management objectives simultaneously. ICES single-stock advice for demersal stocks is based on ICES maximum sustainable yield (MSY) approach. Any catch of cod or whiting in 2024 is not considered precautionary as both stocks are estimated to be at and remain below B_{lim} in 2025 (Table 3.9). The *'max'* scenario results in sole being fished above F_{MSY} in 2024 (Table 3.6).

Scenarios that result in under- or overutilization are useful in identifying imbalance between the fishing opportunities of the various stocks. They indicate the direction in which fleets may have to adapt to fully utilize their catch opportunities without collectively exceeding single-stock fishing opportunities. Under the scenarios presented here, the *'max'* scenario suggests that if all fleets' stock shares are to be fully utilized, catches of all other stocks would be considerably higher than advised in the single-stock advice. As all fleets catch cod and whiting to a greater or lesser extent, any fishing effort in fisheries that occur where these stocks are present is likely to result in catches of cod and/or whiting above the single-stock advice (zero catch), which is considered not precautionary. Of the presented scenarios, the *'min'* scenario meets the objective of all stocks being fished at or below F_{MSY}. In contrast to single-stock advice there is no single recommendation from this advice, instead a range of scenarios are presented. The ICES single-stock advice provides catch opportunities consistent with the ICES MSY approach. To be consistent with these objectives a scenario is necessary that delivers the SSB and/or F objectives of the single-stock advice for all stocks considered simultaneously. This is not possible in 2024 due to the SSB for cod and whiting stocks being below B_{lim} in 2025, even with a zero catch in 2024 and any fisheries for haddock likely to result in some catches of cod and/or whiting.

The *'min'* scenario assumes that fishing stops when the catch for any one of the stocks meets the fleet's stock share. This is similar to the full implementation of landing obligations. Supporting measures aimed at minimizing the misalignment between activity and stock shares for the fleets, such as changes in gear selectivity, spatio-temporal management measures, or reallocation of stock shares, may be required if fishing opportunities are to be fully taken under a fully implemented landing obligation.

Fleet level catch change

A request from stakeholders during the recent WKMIXFISH2 process (ICES, 2023d) was for a figure that showed the loss and gain in catches at the fleet level under the scenarios. One such figure was developed during the meeting, which demonstrates how for some fleets only a small share of a choke quota can result in large reductions in catches of target species (e.g. French, and Spanish static fleets (longlines and nets), Figure 3.14). The intention is to refine the figure and present it as an option that could be included in future advice sheets following feedback from stakeholders and clients.

Relative stability

Relative stability as such is not directly included as an input to the model. Instead, an assumption that the relative landings share of the fleets are constant is used as a proxy, and in the scenarios above, this input is calculated as the average (2020–2022) landing share by fleet and stock. As a crosscheck, the landings by national fleets were summed over nation for each scenario, and the share by country was compared with this initial input (Figure 3.15). The results show some deviations across all scenarios which arise because (under the assumption of a full discard ban), fleets with a small share of a stock but high discard rate have their fishing activity limited by that stock, resulting in underutilization of their target stock(s). This can translate to underutilization at the national level, as seen by the change in landings share of the stocks by EU Member States in the mixed fisheries forecasts.

3.4.2.3 EU Technical request for zero catch advice stocks

EU Technical request for zero catch advice stocks

In addition to the standard mixed fisheries scenarios ICES are asked to provide advice on potential catches of zero catch advice stocks given fishing opportunities for target stocks. For Celtic Sea cod and whiting, three additional scenarios were provided using the Celtic Sea mixed fishery model including catches:

1. Based on haddock fished at F_{MSY}.
2. Based on haddock fished at $F_{MSY\ lower}$.
3. Based on haddock fished at an intermediate level between F_{MSY} and $F_{MSY\ lower}$.

The level of catches (2024), fishing mortality (2024) and spawning-stock biomass (2025) under each of these scenarios are provided in Tables 3.11–3.13.

Table 3.2. Celtic Sea. Summary of the ICES single-species advice for 2024. Where a stock/Functional Unit does not have a management plan the landings follow ICES advice.

Species	Agreed TAC (summed TACs) 2023	Total catch advice for 2024	Projected landings advice for 2024	Ftotal/Harvest ratio for 2024	Fwanted/Harvest ratio for 2024	SSB 2024	SSB 2025	Rationale
cod.27.7e-k (Cod)	644*	0	n/a	0	0	733	2265	MSY
had.27.7b-k (haddock)	11901**	8252	6772	0.353	0.353	27904	30295	MAP
whg.27.b–c,e–k (Whiting)	9650***	0	0	0	0	26361	33995	MSY
meg.27.7b-k8abd (Megrim)	23459^	23303	19670	0.23	n/a	95693	89889	MSY
mon.27.78abd (White anglerfish)	57976^{++}	35502	31090	0.192	0.192	64207	64669	MSY
ank.27.7-8abd (Black-bellied anglerfish)	57976^{++}	25579	21175	0.163	0.163	56821	60186	MSY
sol.27.7fg (Sole)	1338	1267	1198	0.251	0.251	5850	5659	MAP
sol.27.e (Sole)	1394	1057	1052	n/a	0.29	3705	3500	MSY
hke.27.3a46-8abd (Hake)	46335	72839	67637	0.24	0.24	147052	129326	MAP
nep.fu.16 (*Nephrops*)	3787^^	4560	4560	6.2^	n/a	2002		MAP
nep.fu.17 (*Nephrops*)	18353^^^	454	375	5.9^	n/a	375		MAP
nep.fu.17 (*Nephrops*)	18353^^^	248	170	4.8^	n/a	220		MAP
nep.fu.2021 (*Nephrops*)	18353^^^	1865	1728	6^	n/a	1026		MSY
nep.fu.22 (*Nephrops*)	18353^^^	1912	1695	10^	n/a	776		MSY
nep.27.7out.FU^{+} (*Nephrops*)	18353^^^	120	120					n/a

*** TAC applies to divisions 7.b–c and 7.e–k, subareas 8–10, and EU waters of CECAF 34.1.1.**

**** TAC applies to divisions 7.b–k and subareas 8–10.**

***** TAC applies to Subarea 7 (except Division 7.a).**

^ TAC includes L. boscii and divisions 7.a and 8.e.

^^ 'of which limit' from the total Subarea 7 TAC.

^^^ TAC applies to whole of Subarea 7.

+ Harvest ratio for Projected landings + Projected dead discards.

++ applies to both Lophius species combined.

Table 3.3. Celtic Sea. Métiers consistent with DCF métier level 5 and additional métiers in the model.

Mixed fisheries métiers	Gear	Target species
LLS_DEF	Longline trawls	Demersal fish
LLS_FIF	Longline trawls	Finfish
OTB_DEF	Otter trawls	Demersal fish
OTT_DEF	Twin otter trawls	Demersal fish
OTB_CRU	Otter trawls	Crustaceans
OTT_CRU	Twin otter trawls	Crustaceans
GNS_DEF	Gillnets	Demersal fish
GTR_DEF	Trammelnets	Demersal fish
SSC_DEF	Scottish seines	Demersal fish
SDN_DEF	Danish seines	Demersal fish
TBB_DEF	Beam trawls	Demersal fish
FPO_CRU	Static pots	Crustaceans
OTH / MIS_MIS	Other miscellaneous gears	Any
Outside (of 7bc,e-k)	All gears	Any

Table 3.4. Celtic Sea. Proportion of the stocks total landings and discards (from WGCSE, WGBIE) covered by the MIXFISH fleets. A ratio >1 means that the catch information collated by MIXFISH is higher than the information used by WGCSE, WGBIE.

Year	Stock	Working Group Landings (WGCSE, WGBIE)	Working Group Discards (WGCSE, WGBIE)	Ratio of Landings	Ratio of Discards	WGMIXFISH Landings	WGMIXFISH Discards
2020	ank.27.78abd	8556	3172	1	1	8556	3172
2021	ank.27.78abd	8963	5959	1	1	8963	5959
2022	ank.27.78abd	10145	5849	1	1	10145	5849
2020	cod.27.7e-k	922	231	0.976	1	944	231
2021	cod.27.7e-k	914	580	1	1	914	580
2022	cod.27.7e-k	630	42	1	0.612	630	69
2020	hke.27.3a46-8abd	72800	6043	1	1	72800	6043
2021	hke.27.3a46-8abd	68747	4686	1	1	68747	4686

Year	Stock	Working Group Landings (WGCSE, WGBIE)	Working Group Discards (WGCSE, WGBIE)	Ratio of Landings	Ratio of Discards	WGMIXFISH Landings	WGMIXFISH Discards
2022	hke.27.3a46-8abd	67327	4179	1	1	67327	4179
2020	meg.27.7b-k8abd	12093	2532	1	1	12093	2532
2021	meg.27.7b-k8abd	13765	3385	1	1	13765	3385
2022	meg.27.7b-k8abd	11436	2419	1	1	11436	2419
2020	mon.27.78abd	19134	3183	1	1	19134	3183
2021	mon.27.78abd	22573	3861	1	1	22573	3861
2022	mon.27.78abd	21290	2455	1	1	21290	2455
2020	sol.27.7fg	1523	106	0.999	1	1524	106
2021	sol.27.7fg	1343	62	1	1	1343	62
2022	sol.27.7fg	1299	72	1	1	1300	72
2020	whg.27.7b-ce-k	5931	1266	0.999	0.987	5939	1282
2021	whg.27.7b-ce-k	6154	1223	1	0.977	6154	1251
2022	whg.27.7b-ce-k	5113	2463	0.998	1	5123	2463
2020	had.27.7b-k	7859	4260	0.996	0.846	7888	5035
2021	had.27.7b-k	9259	2281	0.996	0.941	9292	2425
2022	had.27.7b-k	8895	2773	1	0.954	8895	2906
2020	sol.27.7e	1219	0	1	NA	1219	0
2021	sol.27.7e	1392	0	1	NA	1392	0
2022	sol.27.7e	1409	0	0.998	NA	1412	0
2020	nep.out.7	304	0	1	NA	304	0
2021	nep.out.7	346	0	1	NA	346	0
2022	nep.out.7	440	0	1	NA	440	0
2020	nep.fu.22	1518	288	0.999	0.999	1520	289
2021	nep.fu.22	1616	149	1	1	1616	149
2022	nep.fu.22	1271	141	0.985	0.985	1291	143
2020	nep.fu.2021	413	34	1	1	413	34
2021	nep.fu.2021	697	47	1	1	697	47

Year	Stock	Working Group Landings (WGCSE, WGBIE)	Working Group Discards (WGCSE, WGBIE)	Ratio of Landings	Ratio of Discards	WGMIXFISH Landings	WGMIXFISH Discards
2022	nep.fu.2021	795	70	1	1	795	70
2020	nep.fu.19	249	136	1	1	249	136
2021	nep.fu.19	415	173	0.999	0.999	416	173
2022	nep.fu.19	247	107	0.996	0.996	248	107
2020	nep.fu.16	1899	0	0.976	NA	1945	0
2021	nep.fu.16	2476	0	1	NA	2476	0
2022	nep.fu.16	2846	0	1	NA	2846	0
2020	nep.fu.17	222	54	0.996	0.996	223	54
2021	nep.fu.17	498	88	0.999	0.999	498	88
2022	nep.fu.17	452	122	0.964	0.964	469	127

Table 3.5. Celtic Sea. Comparison between the outputs from the reproduction of the advice and ICES advice. Values for 2023 compare results from the baseline run to the ICES intermediate year results. For relevant stocks, the baseline run uses the same assumptions for F in the intermediate year as the forecasts leading to ICES advice.

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	% difference
2023	ank.27.78abd	catch	15313	15338	−0.2
2023	ank.27.78abd	discards	3165	3190	−0.8
2023	ank.27.78abd	Fbar	0.093	0.093	0
2023	ank.27.78abd	landings	12148	12148	0
2023	ank.27.78abd	Recruitment	147781	147781	0
2023	ank.27.78abd	ssb	50976	50975	0
2023	cod.27.7e-k	catch	812	812	0
2023	cod.27.7e-k	discards	134	-	-
2023	cod.27.7e-k	Fbar	1.094	1.09	0.4
2023	cod.27.7e-k	landings	678	-	-
2023	cod.27.7e-k	Recruitment	1108	1108	0
2023	cod.27.7e-k	ssb	645	645	0
2023	had.27.7b-k	catch	12118	12100	0.1
2023	had.27.7b-k	discards	1573	1560	0.8

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	% difference
2023	had.27.7b-k	Fbar	0.417	0.417	0
2023	had.27.7b-k	landings	10545	10540	0
2023	had.27.7b-k	Recruitment	224539	224539	0
2023	had.27.7b-k	ssb	42660	42660	0
2023	hke.27.3a46-8abd	catch	63778	64096	−0.5
2023	hke.27.3a46-8abd	discards	3901	3707	5.2
2023	hke.27.3a46-8abd	Fbar	0.188	0.189	−0.5
2023	hke.27.3a46-8abd	landings	59872	60388	−0.9
2023	hke.27.3a46-8abd	Recruitment	862134	862134	0
2023	hke.27.3a46-8abd	ssb	159977	163204	−2
2023	meg.27.7b-k8abd	catch	19944	19873	0.4
2023	meg.27.7b-k8abd	discards	3237	3237	0
2023	meg.27.7b-k8abd	Fbar	0.195	0.195	0
2023	meg.27.7b-k8abd	landings	16636	16636	0
2023	meg.27.7b-k8abd	Recruitment	217477	217477	0
2023	meg.27.7b-k8abd	ssb	95559	95559	0
2023	mon.27.78abd	catch	23935	24026	−0.4
2023	mon.27.78abd	discards	2814	2828	−0.5
2023	mon.27.78abd	Fbar	0.125	0.125	0
2023	mon.27.78abd	landings	21133	21198	−0.3
2023	mon.27.78abd	Recruitment	111245	111245	0
2023	mon.27.78abd	ssb	62214	62159	0.1
2023	sol.27.7e	catch	1394	1394	0
2023	sol.27.7e	discards	6	6	0
2023	sol.27.7e	Fbar	0.344	0.34	1.2
2023	sol.27.7e	landings	1388	1388	0
2023	sol.27.7e	Recruitment	4036	4036	0
2023	sol.27.7e	ssb	4226	4226	0
2023	sol.27.7fg	catch	1338	1338	0

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	% difference
2023	sol.27.7fg	discards	76	75	1.3
2023	sol.27.7fg	Fbar	0.264	0.264	0
2023	sol.27.7fg	landings	1262	1263	−0.1
2023	sol.27.7fg	Recruitment	5156	5156	0
2023	sol.27.7fg	ssb	6006	6002	0.1
2023	whg.27.7b-ce-k	catch	9854	9817	0.4
2023	whg.27.7b-ce-k	discards	1635	1637	−0.1
2023	whg.27.7b-ce-k	Fbar	0.763	0.763	0
2023	whg.27.7b-ce-k	landings	8219	8180	0.5
2023	whg.27.7b-ce-k	Recruitment	387753	387753	0
2023	whg.27.7b-ce-k	ssb	29740	29740	0
2024	ank.27.78abd	catch	25523	25579	−0.2
2024	ank.27.78abd	discards	4364	4404	−0.9
2024	ank.27.78abd	Fbar	0.163	0.163	0
2024	ank.27.78abd	landings	21159	21175	−0.1
2024	ank.27.78abd	Recruitment	148368	148368	0
2024	ank.27.78abd	ssb	56821	56821	0
2024	cod.27.7e-k	catch	0	0	-
2024	cod.27.7e-k	discards	0	-	-
2024	cod.27.7e-k	Fbar	0	0	-
2024	cod.27.7e-k	landings	0	-	-
2024	cod.27.7e-k	Recruitment	1102	1102	0
2024	cod.27.7e-k	ssb	734	733	0.1
2024	had.27.7b-k	catch	8247	8252	−0.1
2024	had.27.7b-k	discards	1450	1480	−2
2024	had.27.7b-k	Fbar	0.353	0.353	0
2024	had.27.7b-k	landings	6797	6772	0.4
2024	had.27.7b-k	Recruitment	224539	224539	0
2024	had.27.7b-k	ssb	27823	27781	0.2

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	% difference
2024	hke.27.3a46-8abd	catch	72486	72839	−0.5
2024	hke.27.3a46-8abd	discards	5573	5202	7.1
2024	hke.27.3a46-8abd	Fbar	0.24	0.24	0
2024	hke.27.3a46-8abd	landings	66908	67637	−1.1
2024	hke.27.3a46-8abd	Recruitment	855364	855364	0
2024	hke.27.3a46-8abd	ssb	143408	147052	−2.5
2024	meg.27.7b-k8abd	catch	23647	23303	1.5
2024	meg.27.7b-k8abd	discards	3675	3633	1.2
2024	meg.27.7b-k8abd	Fbar	0.233	0.23	1.3
2024	meg.27.7b-k8abd	landings	19893	19670	1.1
2024	meg.27.7b-k8abd	Recruitment	217477	217477	0
2024	meg.27.7b-k8abd	ssb	95693	95693	0
2024	mon.27.78abd	catch	35366	35502	−0.4
2024	mon.27.78abd	discards	4390	4411	−0.5
2024	mon.27.78abd	Fbar	0.192	0.192	0
2024	mon.27.78abd	landings	30994	31090	−0.3
2024	mon.27.78abd	Recruitment	111482	111482	0
2024	mon.27.78abd	ssb	64227	64207	0
2024	nep.fu.16	catch	4560	4560	0
2024	nep.fu.16	discards	0	0	-
2024	nep.fu.16	discards.dead	0	0	-
2024	nep.fu.16	discards.surviving	0	0	-
2024	nep.fu.16	Fbar	0.062	0.062	0
2024	nep.fu.16	landings	4560	4560	0
2024	nep.fu.16	Recruitment	-	-	-
2024	nep.fu.16	ssb	-	2002	-
2024	nep.fu.17	catch	454	454	0
2024	nep.fu.17	discards	79	79	0
2024	nep.fu.17	discards.dead	59	59	0

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	% difference
2024	nep.fu.17	discards.surviving	20	20	0
2024	nep.fu.17	Fbar	0.059	0.059	0
2024	nep.fu.17	landings	375	375	0
2024	nep.fu.17	Recruitment	-	-	-
2024	nep.fu.17	ssb	-	375	-
2024	nep.fu.19	catch	248	248	0
2024	nep.fu.19	discards	78	79	−1.3
2024	nep.fu.19	discards.dead	59	59	0
2024	nep.fu.19	discards.surviving	20	20	0
2024	nep.fu.19	Fbar	0.048	0.048	0
2024	nep.fu.19	landings	170	170	0
2024	nep.fu.19	Recruitment	-	-	-
2024	nep.fu.19	ssb	-	220	-
2024	nep.fu.2021	catch	1865	1865	0
2024	nep.fu.2021	discards	137	136	0.7
2024	nep.fu.2021	discards.dead	102	102	0
2024	nep.fu.2021	discards.surviving	34	34	0
2024	nep.fu.2021	Fbar	0.06	0.06	0
2024	nep.fu.2021	landings	1728	1728	0
2024	nep.fu.2021	Recruitment	-	-	-
2024	nep.fu.2021	ssb	-	1026	-
2024	nep.fu.22	catch	1912	1912	0
2024	nep.fu.22	discards	217	217	0
2024	nep.fu.22	discards.dead	163	163	0
2024	nep.fu.22	discards.surviving	54	54	0
2024	nep.fu.22	Fbar	0.1	0.1	0
2024	nep.fu.22	landings	1695	1695	0
2024	nep.fu.22	Recruitment	-	-	-
2024	nep.fu.22	ssb	-	776	-

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	% difference
2024	nep.out.7	catch	120	120	0
2024	nep.out.7	discards	0	-	-
2024	nep.out.7	discards.dead	-	-	-
2024	nep.out.7	discards.surviving	-	-	-
2024	nep.out.7	Fbar	NA	NA	-
2024	nep.out.7	landings	120	120	0
2024	nep.out.7	Recruitment	-	-	-
2024	nep.out.7	ssb	-	-	-
2024	sol.27.7e	catch	1057	1057	0
2024	sol.27.7e	discards	4	4	0
2024	sol.27.7e	Fbar	0.29	0.29	0
2024	sol.27.7e	landings	1052	1052	0
2024	sol.27.7e	Recruitment	4036	4036	0
2024	sol.27.7e	ssb	3705	3705	0
2024	sol.27.7fg	catch	1267	1267	0
2024	sol.27.7fg	discards	68	69	−1.4
2024	sol.27.7fg	Fbar	0.251	0.251	0
2024	sol.27.7fg	landings	1199	1198	0.1
2024	sol.27.7fg	Recruitment	5156	5140	0.3
2024	sol.27.7fg	ssb	5852	5850	0
2024	whg.27.7b-ce-k	catch	0	0	-
2024	whg.27.7b-ce-k	discards	0	0	-
2024	whg.27.7b-ce-k	Fbar	0	0	-
2024	whg.27.7b-ce-k	landings	0	0	-
2024	whg.27.7b-ce-k	Recruitment	387753	387753	0
2024	whg.27.7b-ce-k	ssb	26179	26361	−0.7
2025	ank.27.78abd	Recruitment	-	148368	-
2025	ank.27.78abd	ssb	60180	60186	0
2025	cod.27.7e-k	Recruitment	-	-	-

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	% difference
2025	cod.27.7e-k	ssb	2267	2265	0.1
2025	had.27.7b-k	Recruitment	-	-	-
2025	had.27.7b-k	ssb	30358	30295	0.2
2025	hke.27.3a46-8abd	Recruitment	-	-	-
2025	hke.27.3a46-8abd	ssb	128653	129326	−0.5
2025	meg.27.7b-k8abd	Recruitment	-	-	-
2025	meg.27.7b-k8abd	ssb	89613	89889	−0.3
2025	mon.27.78abd	Recruitment	-	-	-
2025	mon.27.78abd	ssb	64691	64669	0
2025	sol.27.7e	Recruitment	-	-	-
2025	sol.27.7e	ssb	3500	3500	0
2025	sol.27.7fg	Recruitment	-	-	-
2025	sol.27.7fg	ssb	5670	5659	0.2
2025	whg.27.7b-ce-k	Recruitment	-	-	-
2025	whg.27.7b-ce-k	ssb	33353	33995	−1.9

Table 3.6. Celtic Sea. The "most" limiting stocks, "least" limiting stocks and stocks that are neither most or last limiting ("intermediate") under the single-stocks advice. Note that totals can sum to greater than number of fleets where two stocks are equally limiting (in this case, cod and whiting which both have zero catch advice).

	intermediate	least	most
ank.27.78abd	19	16	0
cod.27.7e-k	5	0	30
had.27.7b-k	34	0	1
hke.27.3a46-8abd	35	0	0
meg.27.7b-k8abd	35	0	0
mon.27.78abd	33	0	2
sol.27.7e	34	1	0
sol.27.7fg	34	0	1
whg.27.7b-ce-k	8	0	27
nep.fu.16	35	0	0
nep.fu.17	35	0	0

	intermediate	least	most
nep.fu.19	35	0	0
nep.fu.2021	17	18	0
nep.fu.22	35	0	0
nep.out.7	34	0	1

Table 3.7. Celtic Sea. The "most" limiting stocks, "least" limiting stocks and stocks that are neither most or last limiting ("intermediate") under the single-stock advice excluding cod and whiting.

	intermediate	least	most
ank.27.78abd	19	16	0
had.27.7b-k	24	0	11
hke.27.3a46-8abd	30	0	5
meg.27.7b-k8abd	34	0	1
mon.27.78abd	33	0	2
sol.27.7e	30	1	4
sol.27.7fg	31	0	4
nep.fu.16	35	0	0
nep.fu.17	35	0	0
nep.fu.19	29	0	6
nep.fu.2021	17	18	0
nep.fu.22	34	0	1
nep.out.7	34	0	1

Table 3.8. Celtic Sea. Mixed fisheries advice in the Celtic Sea. Catch (in tonnes) per mixed fisheries scenario 2024, in absolute values.

Stock	Single-stock catch advice (2024)^	min	max	Sq_E	min_range	had-cs	min_exzero	cod_FAR-zero	whg_FAR-zero	cod_FARcod	cod-cs	whg-cs
ank.27.78abd	25579	5513	39753	14884	5787	12311	11434	5665	7751	5665	5390	6081
cod.27.7e-k	0	0	1267	944	47	799	714	47	305	47	0	15
had.27.7b-k	8252	4	20858	9763	363	8217	6398	363	2761	363	4	4
hke.27.3a46-8abd	72839	42269	102604	57131	43107	59301	61906	43317	53126	43317	42480	49943
meg.27.7b-k8abd	23303	5006	45587	20119	5517	16423	14845	5518	8338	5518	5006	5006
mon.27.78abd	35502	4098	85844	23380	4702	19048	17400	4122	9064	4122	3516	5219
sol.27.7e	1057	14	2593	1085	55	998	826	60	289	60	19	81
sol.27.7fg	1267	2	5179	1262	46	730	646	46	236	46	2	2
whg.27.7b-ce-k	0	0	16265	8912	370	8033	6266	370	2824	370	0	0
nep.fu.16	4560	367	10912	3980	480	3519	2336	480	1449	480	367	367
nep.fu.17	454	0	1236	452	15	403	241	15	143	15	0	0
nep.fu.19	248	5	762	278	14	245	150	14	86	14	5	5
nep.fu.2021	1865	77	1672	609	95	586	392	95	247	95	77	77
nep.fu.22	1912	1	4348	1597	54	1405	858	54	492	54	1	1
nep.27.7outFU	120	6	266	97	9	87	56	9	34	9	6	6

^ Advised catches of no more than the indicated value.

Table 3.9. Celtic Sea. Mixed fisheries advice in the Celtic Sea. Fishing mortality per mixed fisheries scenario 2023, in absolute values.

Stock	Single-stock catch advice (2024)^	min	max	Sq_E	min_range	had-cs	min_exzero	cod_FAR	whg_FAR	cod_FAR	cod-cs	whg-cs
ank.27.78abd	0.163	0.033	0.266	0.092	0.035	0.075	0.07	0.034	0.047	0.034	0.032	0.037
cod.27.7e-k	0	0	2	1.117	0.036	0.861	0.733	0.036	0.258	0.036	0	0.011
had.27.7b-k	0.353	0	1.335	0.445	0.014	0.361	0.27	0.014	0.108	0.014	0	0
hke.27.3a46-8abd	0.24	0.131	0.36	0.182	0.134	0.19	0.199	0.134	0.168	0.134	0.132	0.157
meg.27.7b-k8abd	0.23	0.044	0.522	0.194	0.049	0.155	0.139	0.049	0.075	0.049	0.044	0.044
mon.27.78abd	0.192	0.02	0.553	0.122	0.023	0.098	0.089	0.02	0.046	0.02	0.017	0.026
sol.27.7e	0.29	0.003	0.868	0.28	0.012	0.254	0.206	0.013	0.067	0.013	0.004	0.018
sol.27.7fg	0.251	0	2	0.246	0.008	0.135	0.119	0.008	0.042	0.008	0	0
whg.27.7b-ce-k	0	0	2	0.75	0.023	0.652	0.474	0.023	0.189	0.023	0	0
nep.fu.16	0.062	0.005	0.148	0.054	0.007	0.048	0.032	0.007	0.02	0.007	0.005	0.005
nep.fu.17	0.059	0	0.21	0.077	0.003	0.068	0.041	0.003	0.024	0.003	0	0
nep.fu.19	0.048	0.002	0.243	0.088	0.004	0.078	0.048	0.004	0.028	0.004	0.002	0.002
nep.fu.2021	0.06	0.003	0.06	0.022	0.003	0.021	0.014	0.003	0.009	0.003	0.003	0.003
nep.fu.22	0.1	0	0.271	0.1	0.003	0.088	0.053	0.003	0.031	0.003	0	0

Legend:	Fish stocks	Norway lobster FUs	Notes:
	$F_{2024} \leq F_{MSY}$	$F_{2024} \leq F_{MSY}$	* ank.27.78abd and mon.27.78abd have no F_{lim}.
	$F_{MSY} < F_{2024} \leq F_{pa}$	-	** Norway lobster stocks have no F_{pa} or F_{lim} limits, and so colours relate to above (black) or below (white) F_{MSY} harvest rates.
	$F_{pa} < F_{2024} \leq F_{lim}$	-	
	$F_{pa} < F_{2024}$, no F_{lim}	-	
	$F_{2024} > F_{lim}$	$F_{2024} > F_{MSY}$	

Table 3.10. Celtic Sea. Mixed fisheries advice in the Celtic Sea. Spawning-stock biomass per mixed fisheries scenario 2025, in absolute values.

Stock	Single-stock catch advice SSB(2025)^	min	max	Sq_E	min_range	had-cs	min_exzero	cod_FAR	whg_FAR	cod_FAR	cod-cs	whg-cs
ank.27.78abd	60186	68614	54383	64697	68499	65771	66137	68550	67677	68550	68665	68376
cod.27.7e-k	2265	2237	387	817	2164	1024	1147	2164	1763	2164	2237	2214
had.27.7b-k	30295	38390	17664	28524	38031	30062	31883	38030	35594	38030	38390	38390
hke.27.3a46-8abd	129326	144809	114432	137270	144383	136172	134855	144277	139298	144277	144702	140912
meg.27.7b-k8abd	89889	109212	67200	93429	108675	97276	98922	108675	105721	108675	109211	109211
mon.27.78abd	64669	77634	44513	69782	77387	71545	72216	77624	75610	77624	77871	77177
sol.27.7e	3500	4745	2251	3700	4705	3785	3952	4700	4475	4700	4740	4679
sol.27.7fg	5659	7063	1684	5756	7016	6299	6389	7016	6815	7016	7063	7063
whg.27.7b-ce-k	33995	33516	19524	25580	33181	26336	27888	33181	30954	33181	33516	33516

Legend

- $SSB_{2025} \geq B_{pa}$ or MSY $B_{trigger}$
- $SSB_{2025} \geq B_{lim}$; no B_{pa} defined
- $B_{lim} \leq SSB_{2025} < B_{pa}$
- $SSB_{2025} < B_{lim}$

*Female SSB

Table 3.11. Mixed fisheries advice in the Celtic Sea (Technical request). Catch (in tonnes) per mixed fisheries scenario 2024, in absolute values.

Stock	Single-stock catch advice (2024)	Haddock F_{MSY}	Haddock F_{MSY_int}	Haddock F_{MSY_lower}
ank.27.78abd	25579	12311	11121	10008
cod.27.7e-k	0	799	688	571
had.27.7b-k	8252	8217	6832	5468
hke.27.3a46-8abd	72839	59301	57451	55721
meg.27.7b-k8abd	23303	16423	14322	12323
mon.27.78abd	35502	19048	16447	13998
nep.27.7outFU	120	87	71	57
nep.fu.16	4560	3519	2907	2340
nep.fu.17	454	449	364	284
nep.fu.19	248	245	199	155
nep.fu.2021	1865	765	632	508
nep.fu.22	1912	1405	1132	880
sol.27.7e	1057	998	836	680
sol.27.7fg	1267	730	596	469
whg.27.7b-ce-k	0	8033	6803	5545

Table 3.12. Mixed fisheries advice in the Celtic Sea (Technical request). TAC year (2024) fishing mortality per mixed fisheries scenario 2024, in absolute values.

Stock	Single-stock F advice (2024)	Haddock F_{MSY}	Haddock F_{MSY_int}	Haddock F_{MSY_lower}
ank.27.78abd	0.163	0.075	0.068	0.061
cod.27.7e-k	0	0.861	0.696	0.543
had.27.7b-k	0.353	0.361	0.291	0.226
hke.27.3a46-8abd	0.24	0.19	0.183	0.177
meg.27.7b-k8abd	0.23	0.155	0.133	0.113
mon.27.78abd	0.192	0.098	0.084	0.071
nep.27.7outFU	NA	NA	NA	NA
nep.fu.16	0.062	0.048	0.04	0.032
nep.fu.17	0.059	0.068	0.055	0.043

Stock	Single-stock F advice (2024)	Haddock F_{MSY}	Haddock F_{MSY_int}	Haddock F_{MSY_lower}
nep.fu.19	0.048	0.078	0.063	0.05
nep.fu.2021	0.06	0.021	0.017	0.014
nep.fu.22	0.1	0.088	0.071	0.055
sol.27.7e	0.29	0.254	0.209	0.166
sol.27.7fg	0.251	0.135	0.109	0.085
whg.27.7b-ce-k	0	0.652	0.526	0.408

Table 3.13. Mixed fisheries advice in the Celtic Sea (Technical request). TAC year + 1 (2025) SSB per mixed fisheries scenario 2024, in absolute values.

Stock	Single-stock SSB advice (2025)	Haddock F_{MSY}	Haddock F_{MSY_int}	Haddock F_{MSY_lower}
ank.27.78abd	60186	65771	66268	66733
cod.27.7e-k	2265	1024	1186	1361
had.27.7b-k	30295	30062	31442	32810
hke.27.3a46-8abd	129326	136172	137108	137983
meg.27.7b-k8abd	89889	97276	99468	101554
mon.27.78abd	64669	71545	72604	73601
sol.27.7e	3500	3785	3942	4094
sol.27.7fg	5659	6299	6442	6575
whg.27.7b-ce-k	33995	26336	27412	28520

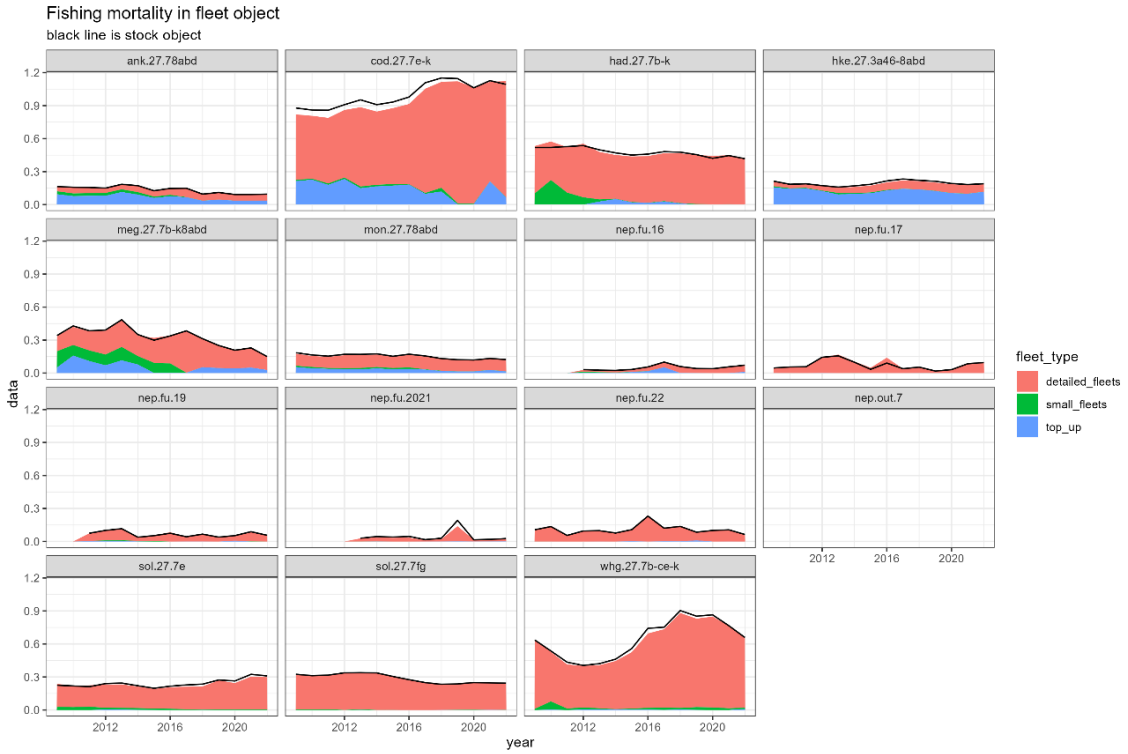


Figure 3.1. Celtic Sea. Time-series of partial fishing mortality accounted for by those fleets explicitly represented in the model ("detailed fleets"), the fleets that were aggregated together due to having only a small share of any stock catches ("small fleets") and where there is a mismatch between the fleets and the total catches in the stock object, due to catches outside the model domain or other reasons ("top up").

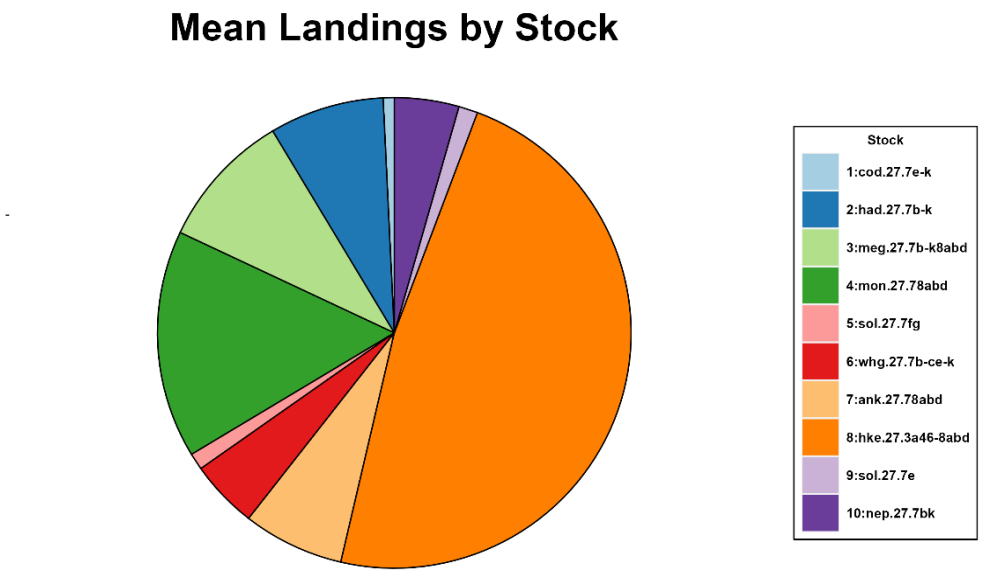


Figure 3.2. Celtic Sea. Distribution of landings (average 2022–2022) of those stocks included in the mixed fisheries projections.

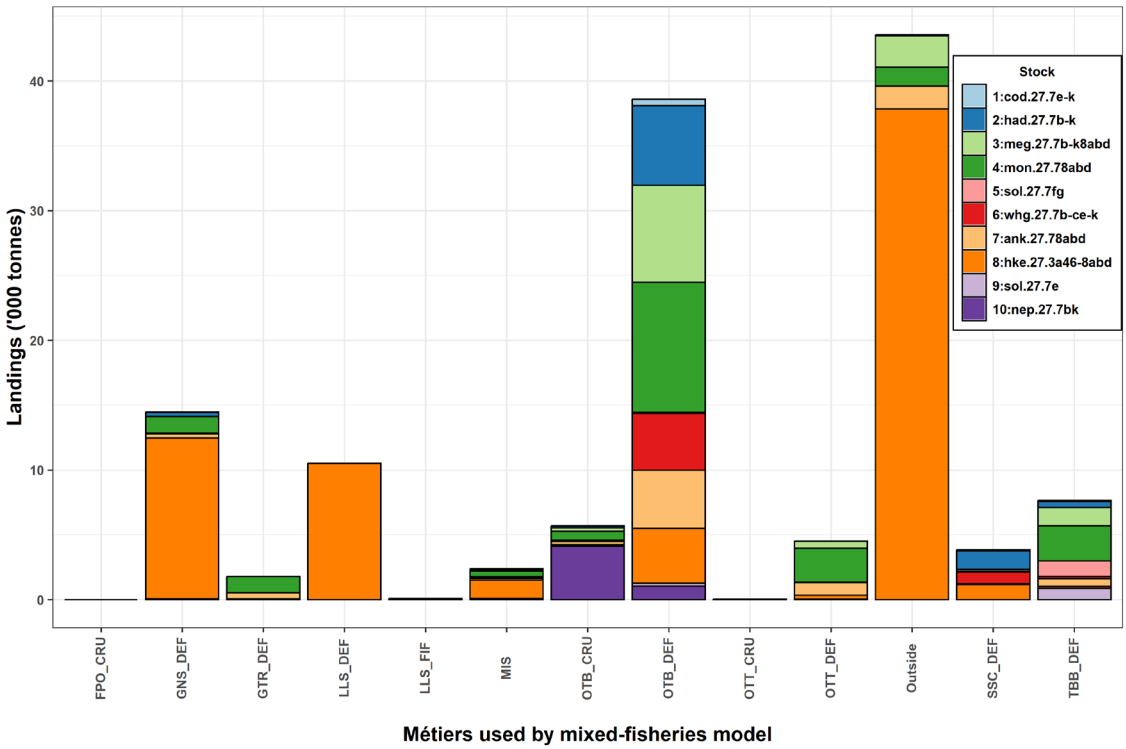


Figure 3.3. Celtic Sea. Landings distribution of species by métier with landings consisting of more than 1% of any of the stocks (1–7; average from 2020–2022) Note: The "other" (OTH) displayed here is a mixed category consisting of (i) landings without corresponding effort and (ii) landings of any combination of fleet and métier with landings of more than 1% of any of the stocks 1–7 ; average from 2020–2022

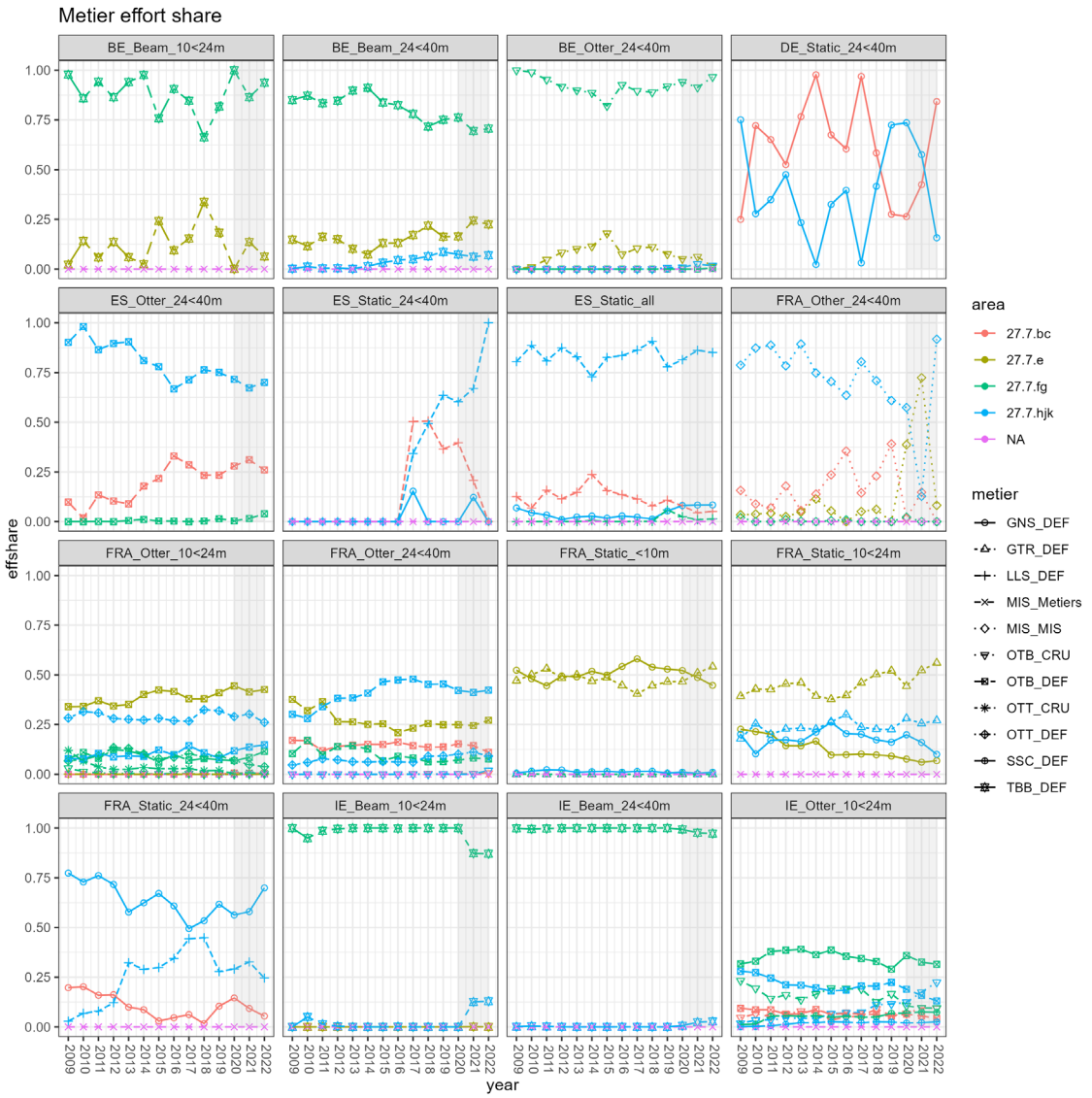


Figure 3.4. Celtic Sea. Effort share (in proportion) by métier and by year for each fleet (part 1). The average years used for forecasting the effort share in the scenarios are shaded in grey.

Figure 3.5. Celtic Sea. Effort share (in proportion) by métier and by year for each fleet (part 2). The average years used for forecasting the effort share in the scenarios are shaded in grey.

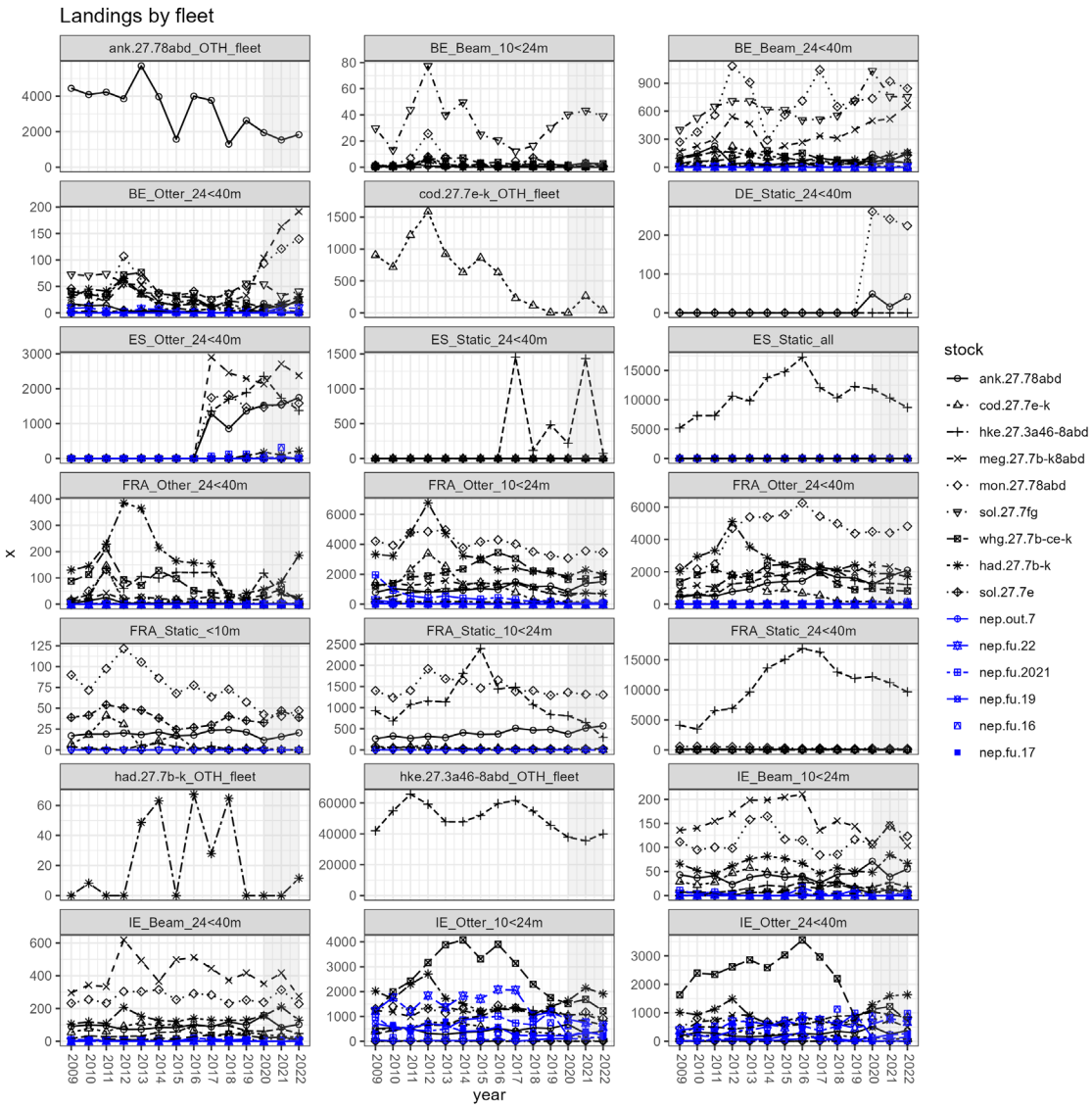


Figure 3.6. Celtic Sea. Landings by fleet, stock and year (part 1). Note: different scales on the y-axis.

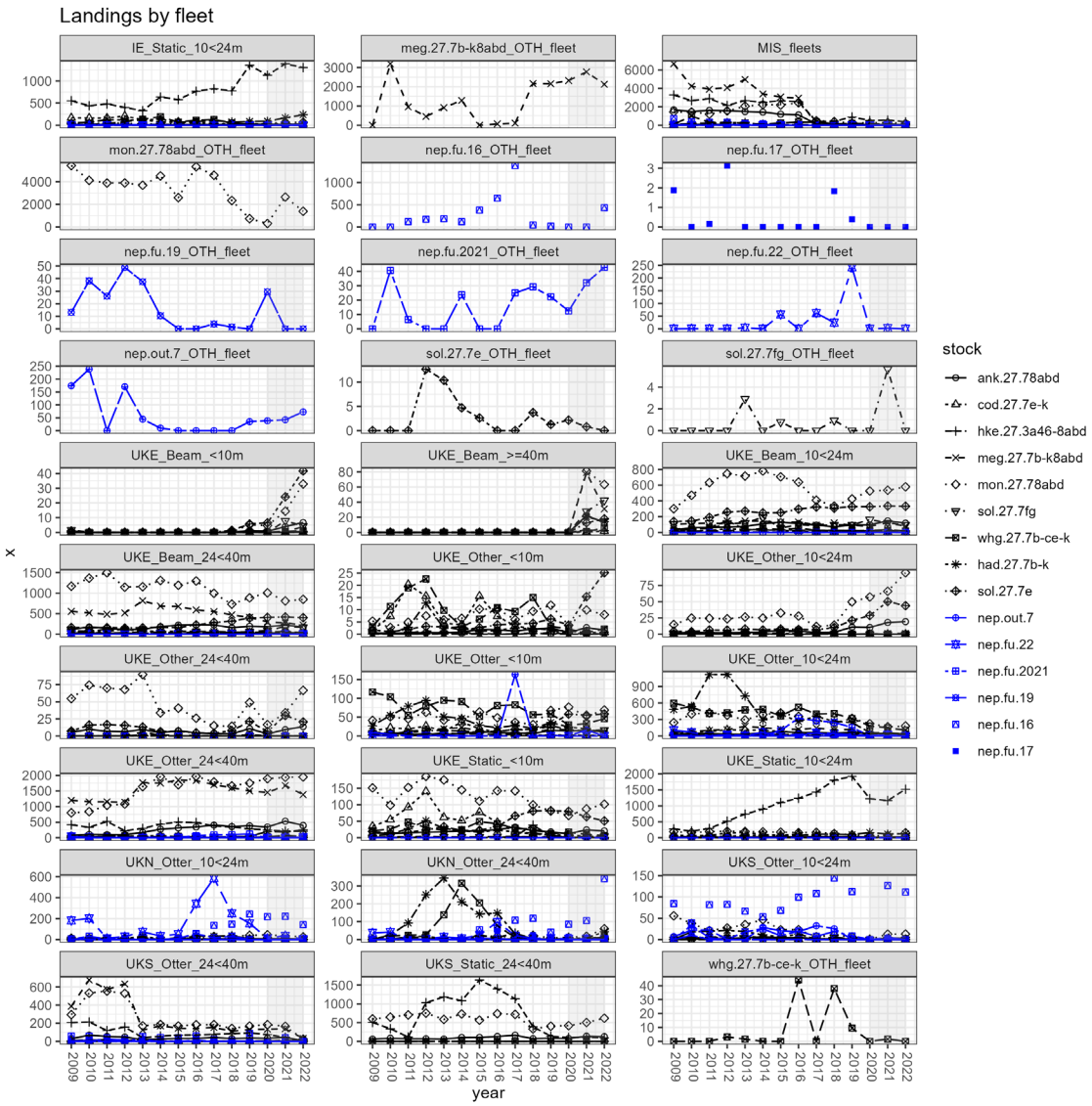


Figure 3.7. Celtic Sea. Landings by fleet, stock and year (part 2). Note: different scales on the y-axis.

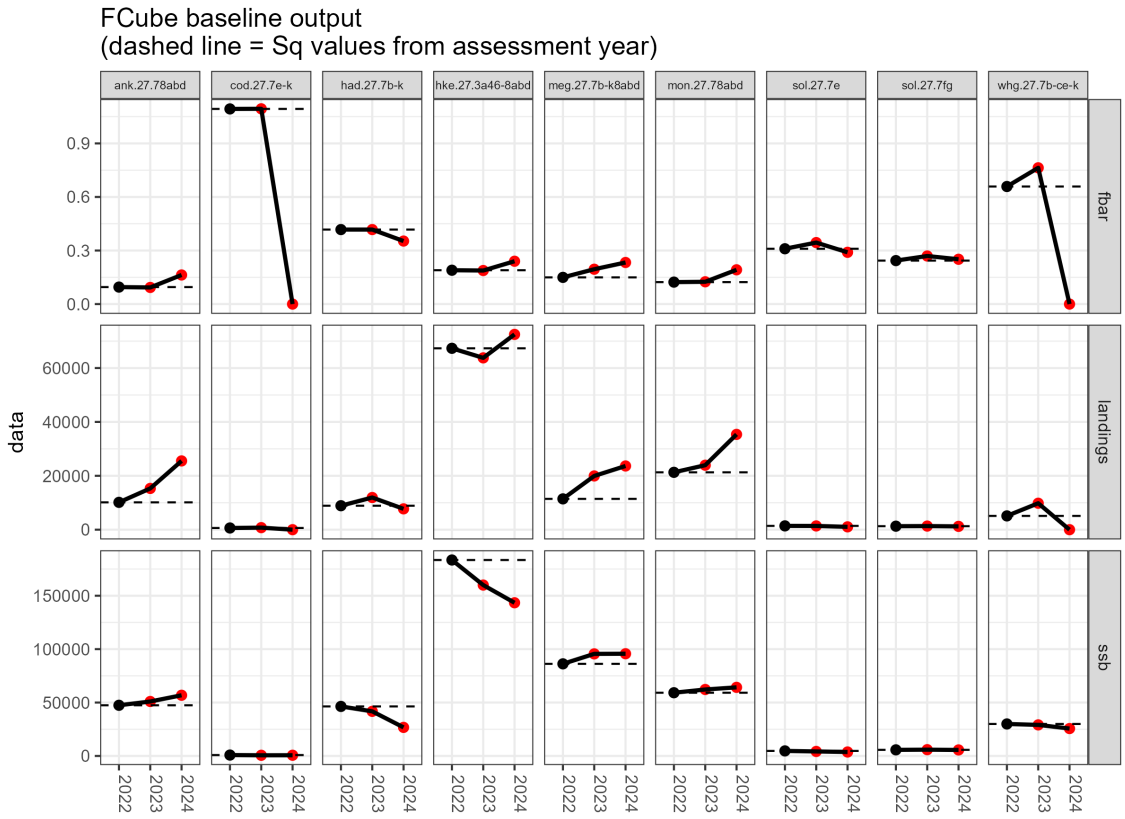


Figure 3.8. Celtic Sea. Change in fishing mortality (Fbar), landings (tonnes) and SSB (tonnes) assumed in the intermediate year (2023) and required for the TAC year (2024) under the single-stock forecast assumptions consistent with the MSY approach.

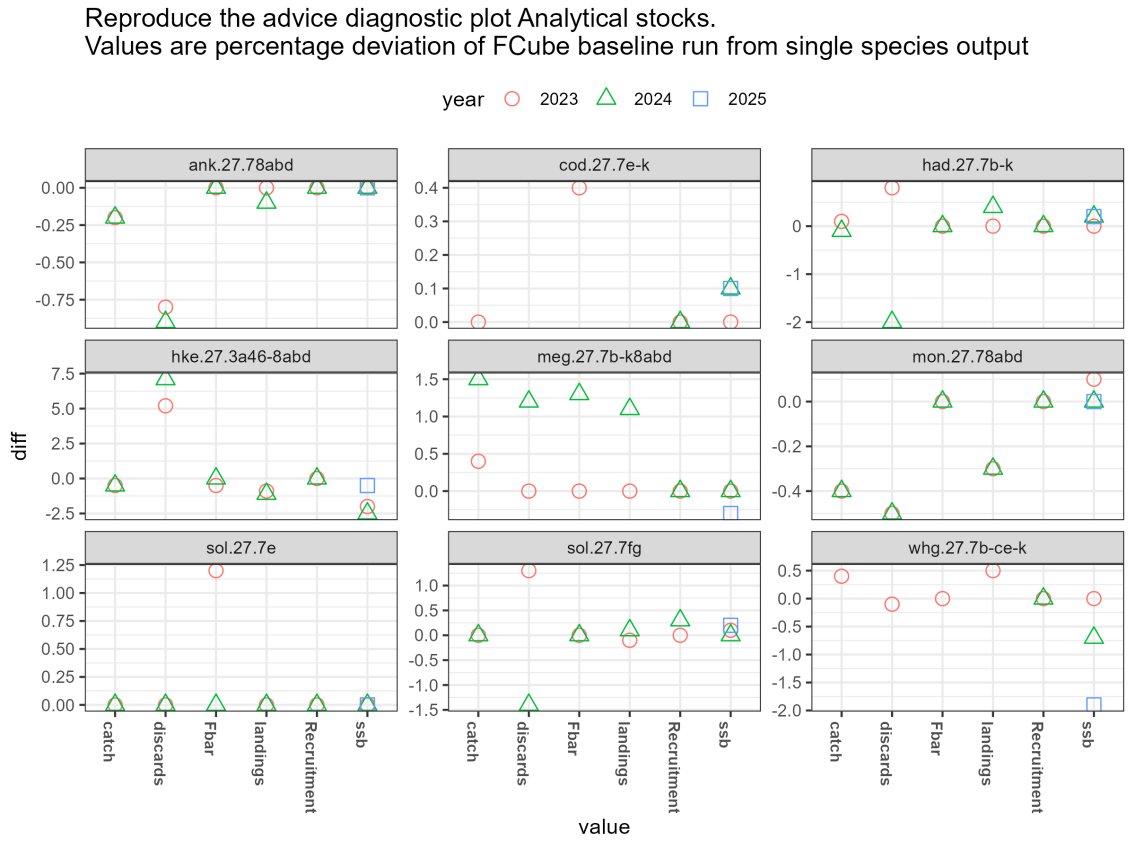


Figure 3.9. Celtic Sea. Percentage difference between FCube baseline run and single-species advice for finfish stocks, showing Fbar (2023–2024), catch, discards and landings (2023–2024) and SSB (2022–2025).

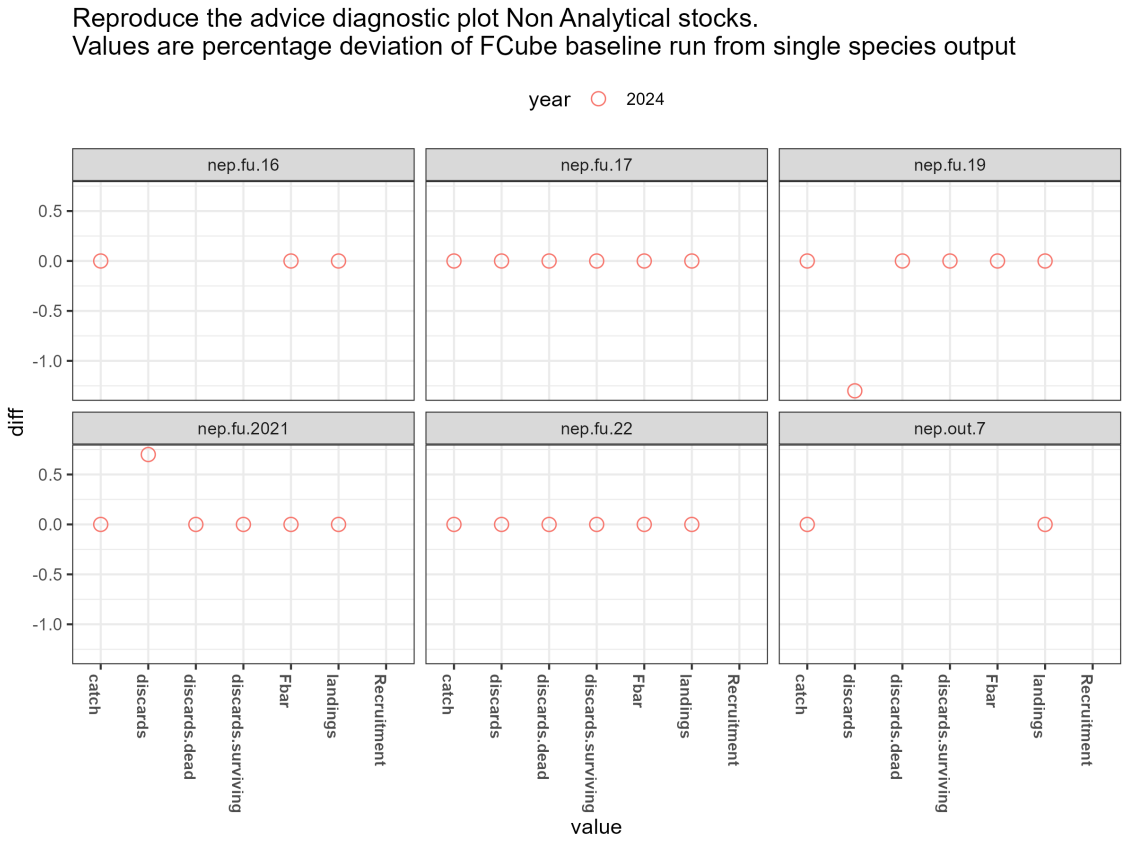


Figure 3.10. Celtic Sea. Percentage difference between FCube baseline run and single-species advice for *Nephrops* stocks, showing harvest ratio, catch, discards and landings (2024).

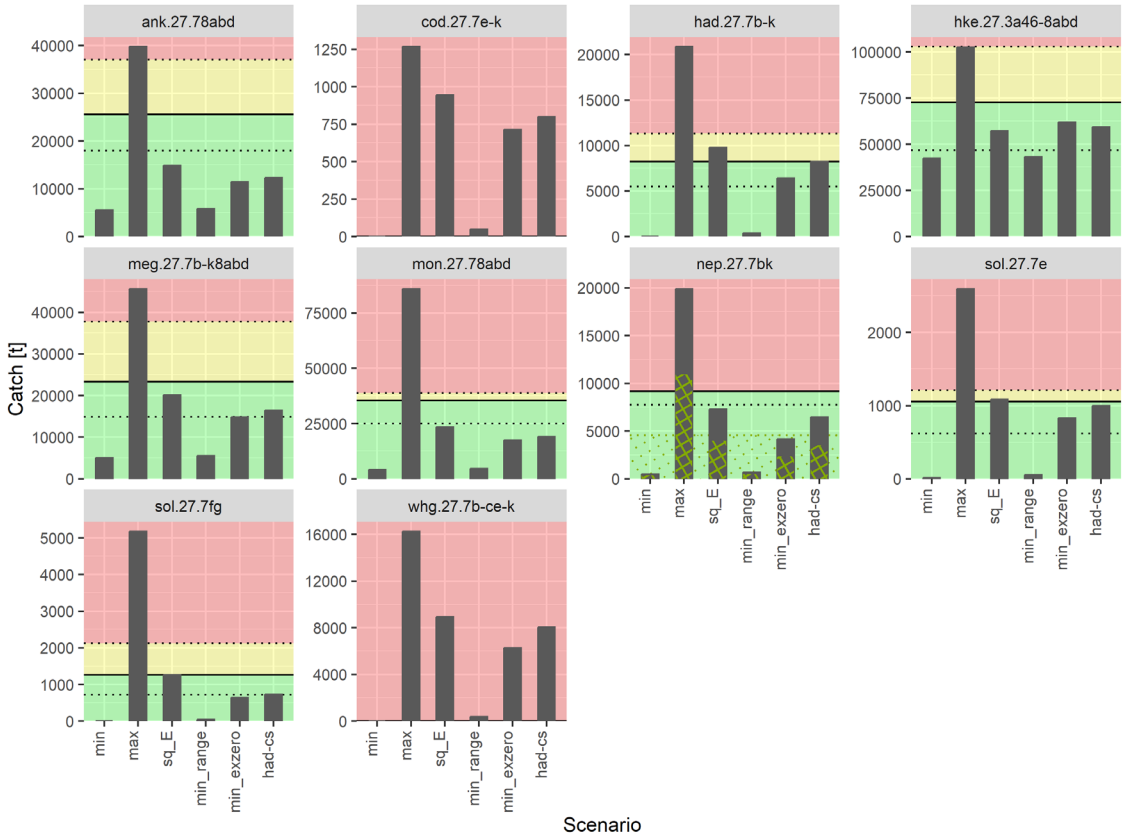


Figure 3.11. Celtic Sea. TAC year results (2024). FCube estimates of potential landings by stock after applying the *status quo* effort scenario to all stocks in the intermediate year followed by the FCube scenarios. Horizontal lines correspond to the single-stock advice. Bars below the value of zero show the scale of undershoot (compared to the single-species advice) in cases where landings are predicted to be lower when applying the scenario.

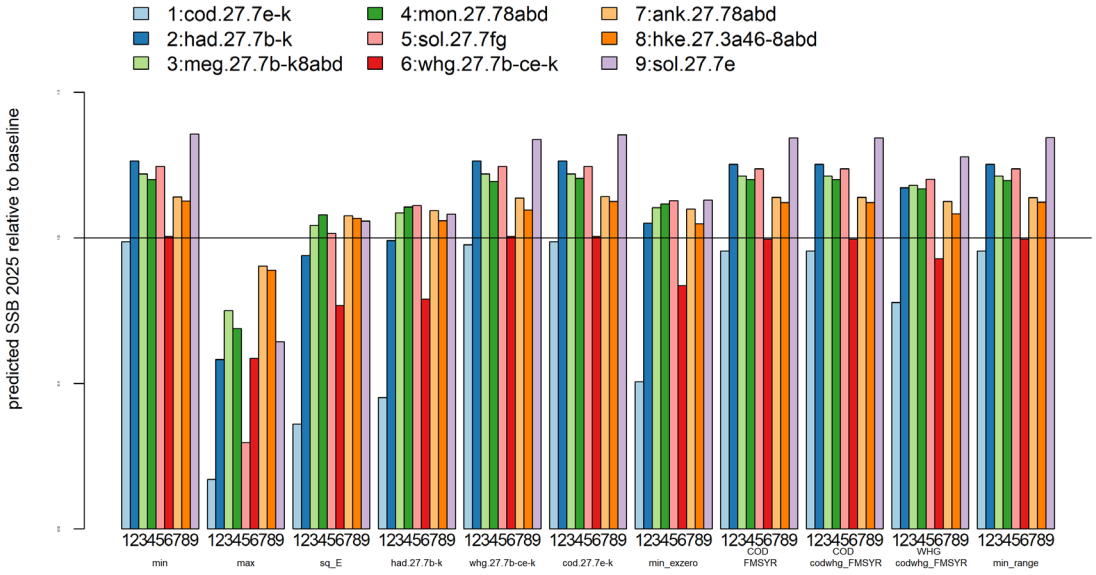


Figure 3.12. Celtic Sea. Mixed fisheries advice for divisions 7.b–c and 7.e–k. Estimates of potential SSB at the start of 2025 by stock after applying the mixed fisheries scenarios (indicated along the x-axis), relative to SSB resulting from the single-stock advice forecast (the horizontal line). Note: scenario names in this plot are slightly different from those named in Section 3.2.2 but are as follows: had.27.7b-k = "had-cs", whg.27.7b-ce-k = "whg-cs", cod.27.7e-k = "cod-cs", COD FMSYR = "cod_FARcod", COD codwhg_FMSYR = "cod_FARzero", WHG codwhg_FMSYR = "whg_FARzero".

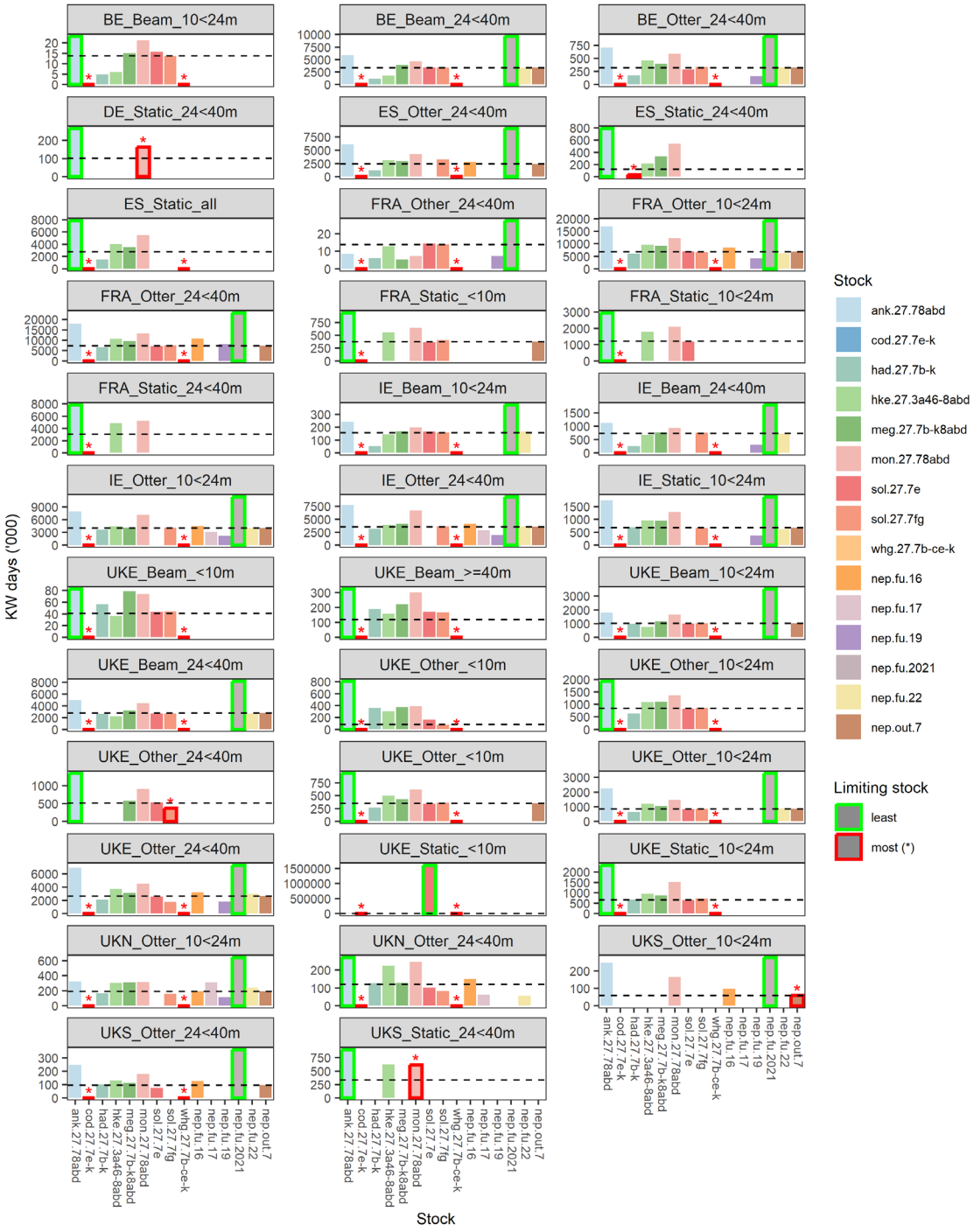


Figure 3.13. Mixed fisheries for the Celtic Sea. Estimates of effort by fleet needed to reach each single-stock advice. The stocks are coded by colour, with the bar for the most limiting stock ("choke species") for each fleet in 2024 highlighted with a red border and the bar for the least limiting species highlighted with a green border. Fleet names are given by country, main gear, and vessel length (m). The *status quo* effort for each fleet (average 2020–2022) is shown as a dashed line for reference.

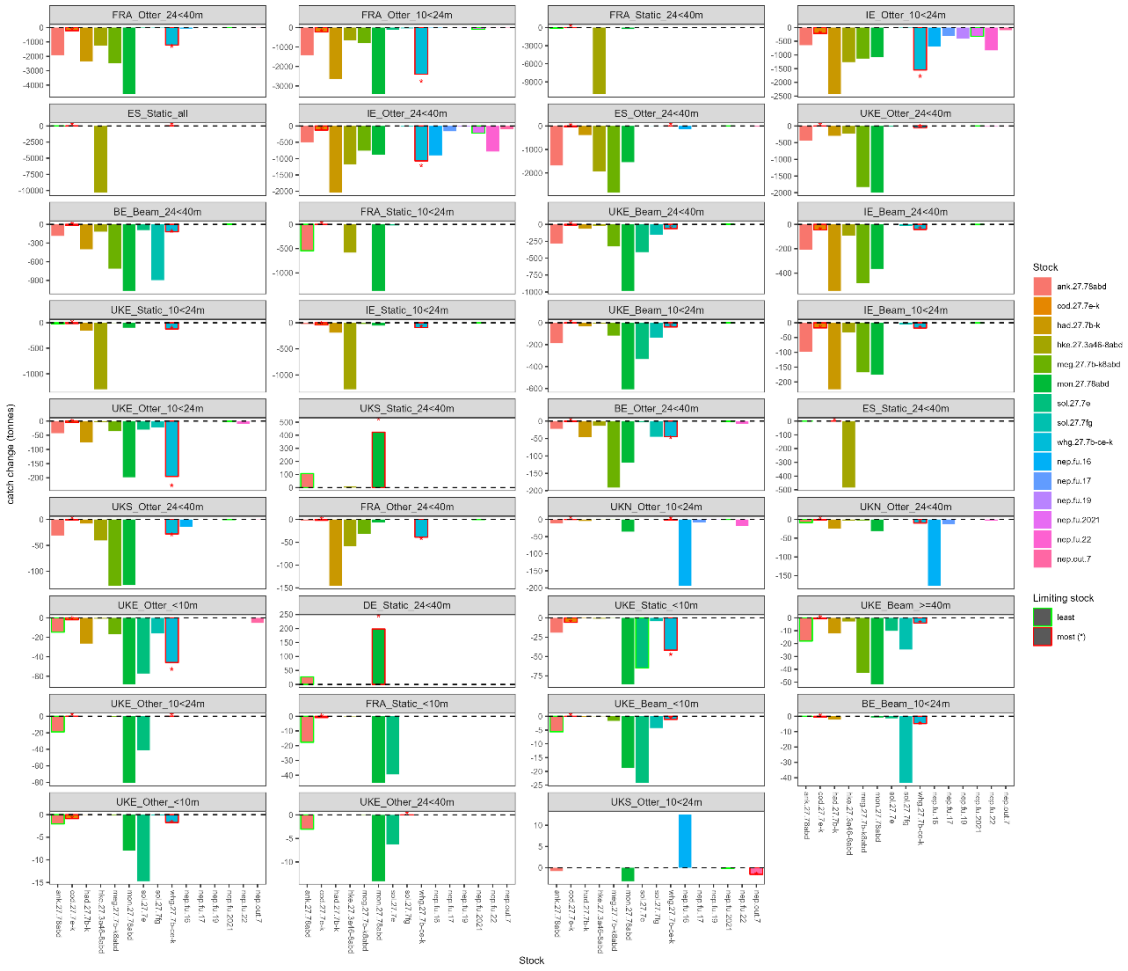
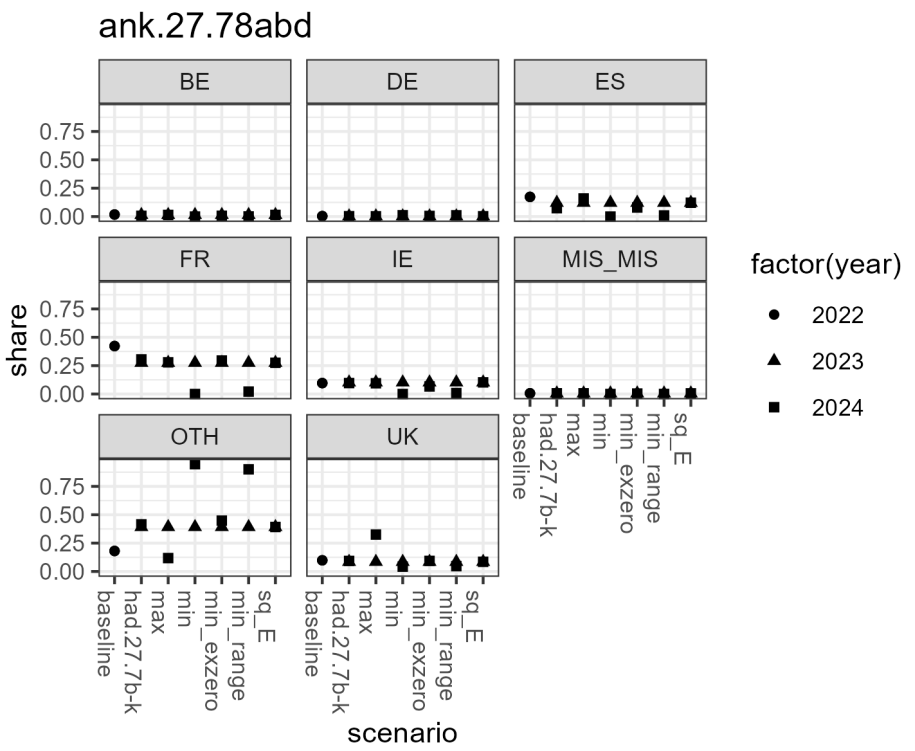


Figure 3.14. Mixed fisheries for the Celtic Sea. Estimates of change in catch by fleet under the "min" scenario. The stocks are coded by colour, with the bar for the most limiting stock ("choke species") for each fleet in 2024 highlighted with a red border and the bar for the least limiting species highlighted with a green border. Fleet names are given by country, main gear, and vessel length (m). Fleets are ordered by those with the largest catches to the smallest.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ES
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IE
MIS_MIS
OTH
UK
share
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baseline
had.27.7b-k
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min_range
sq_E
scenario
factor(year)
2022
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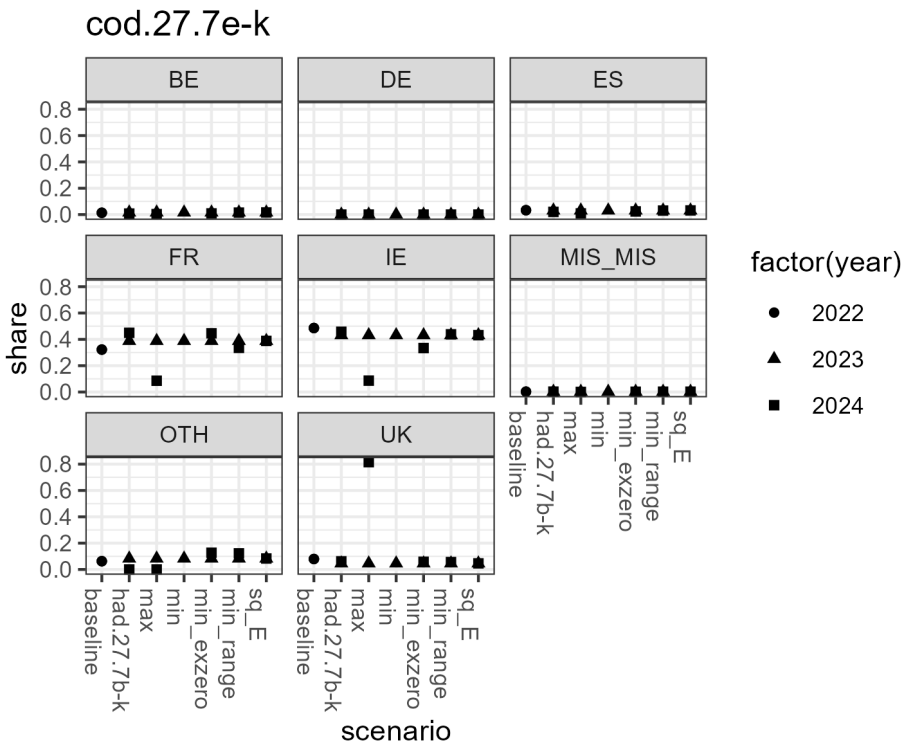
2024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2023
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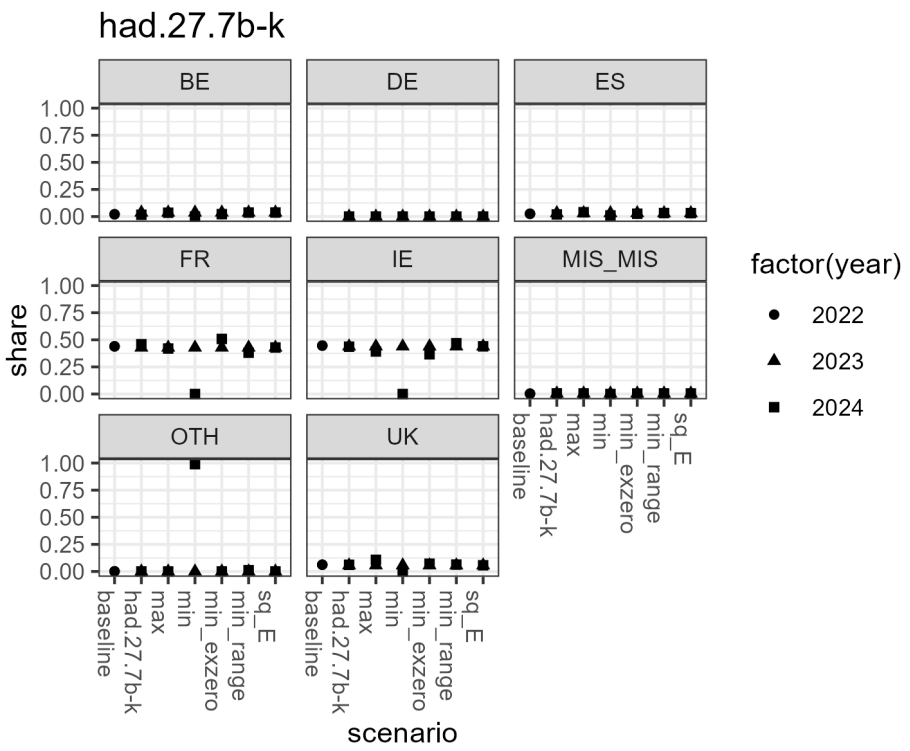
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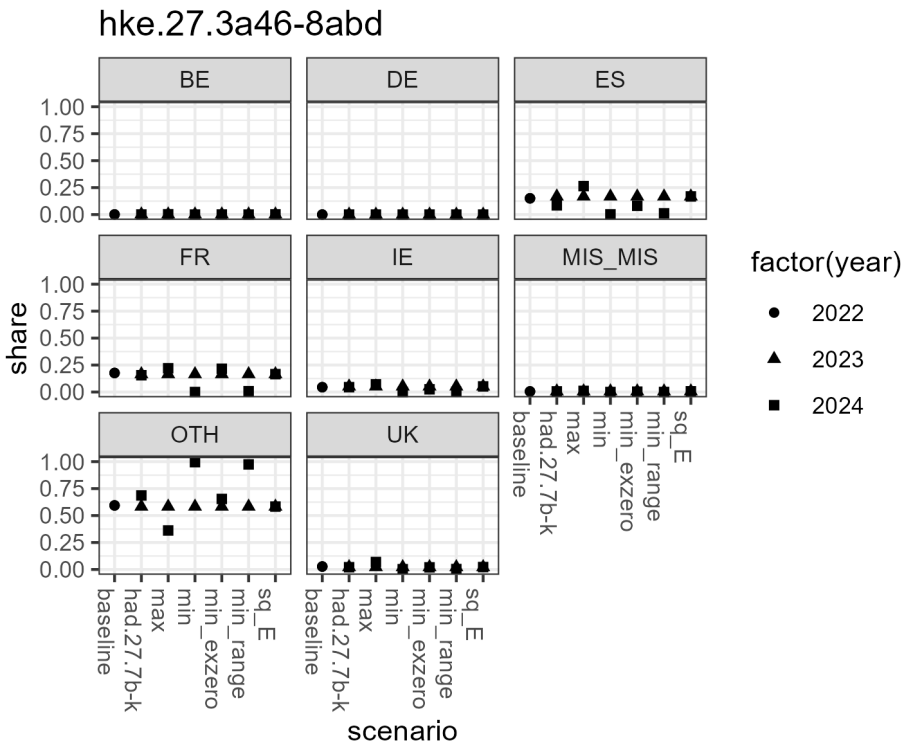
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scenario
factor(year)
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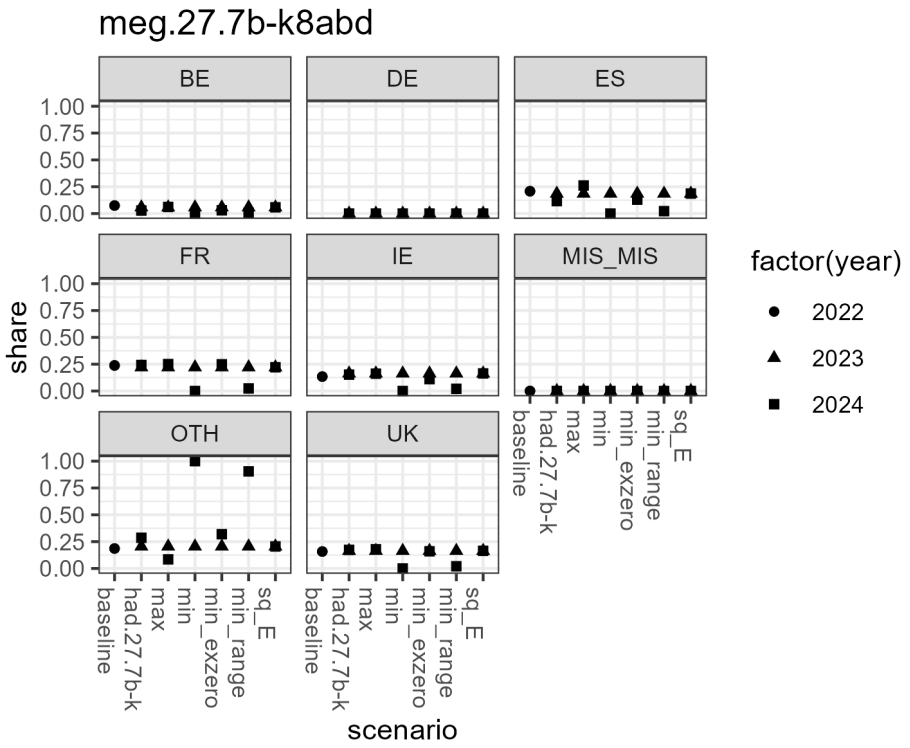
2023
2024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factor(year)
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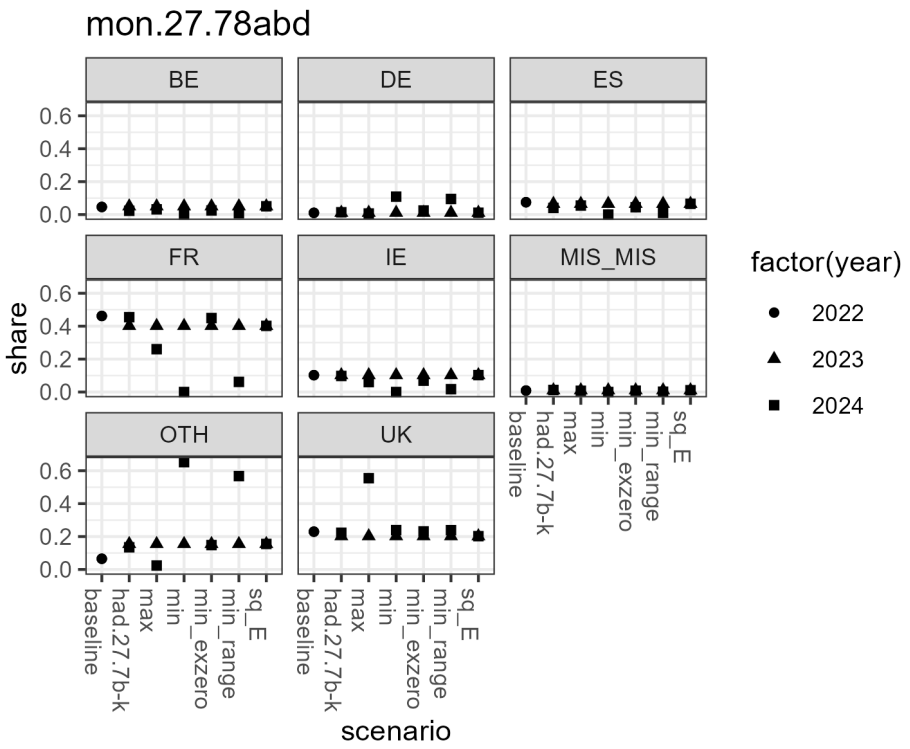
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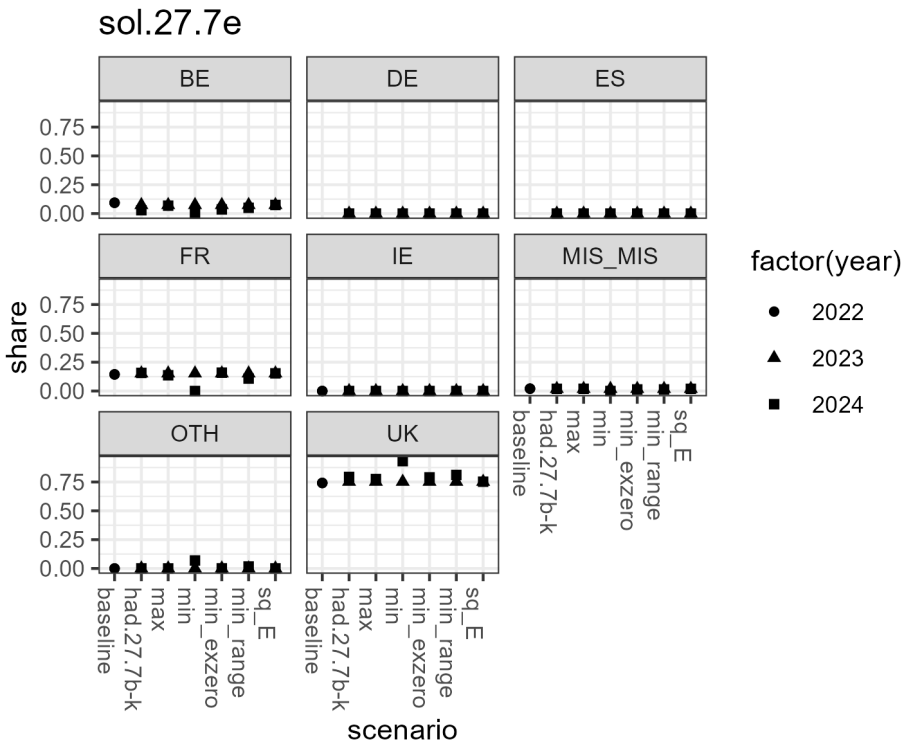
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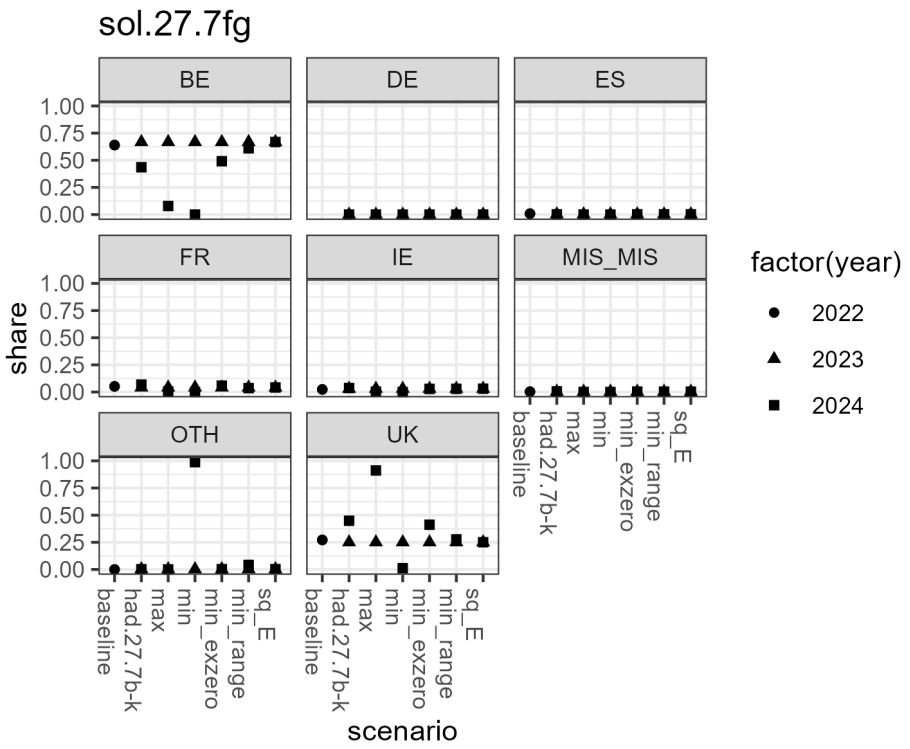
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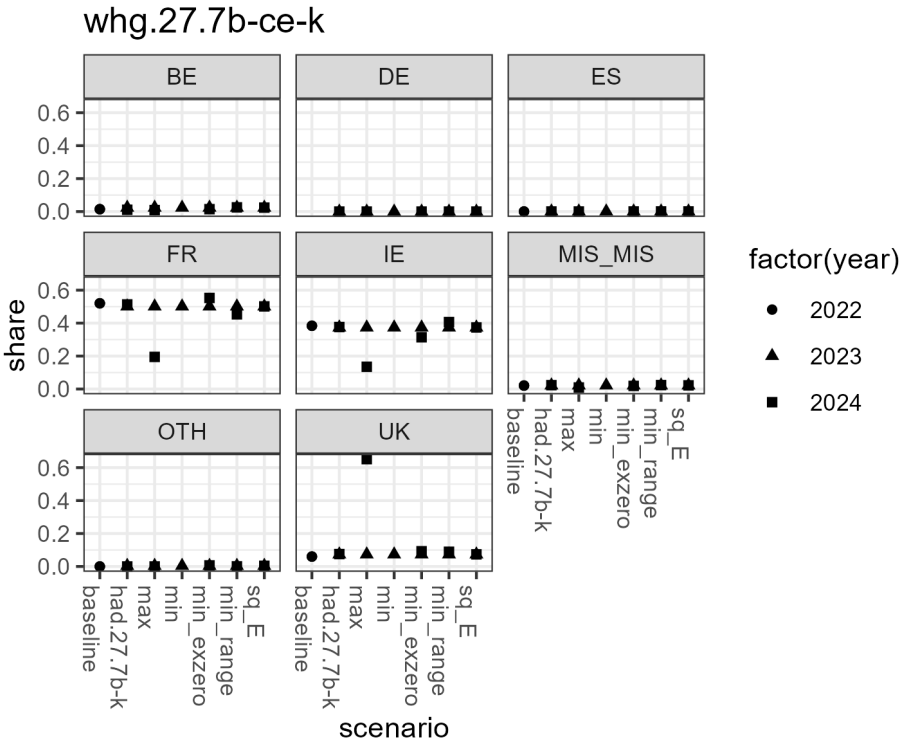

Figure 3.15. Test for relative stability. Changes of relative share of species' landings by country in 2023 and 2024 compared to the 2022 share, for the 'baseline' and six FCube scenarios.

3.5 References

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4 Iberian waters

Mixed fisheries considerations

4.1 Background

Fisheries operating within the Atlantic Iberian Coast Ecoregion catch a wide range of different species, including those considered to be demersal, pelagic, wide-ranging, and deep-sea. Various elasmobranch species are also caught.

Portuguese and Spanish demersal fisheries are typically mixed, catching a wide variety of species, reflecting the biological diversity of the areas they exploit. These fisheries are executed using a number of different gear types. Trawl fisheries (using otter or pair trawls) land *Nephrops*, hake, anglerfish, megrims, blue whiting, mackerel, horse mackerel as well as cephalopods (cuttlefish and squid). Gillnet fisheries target sole, hake, pollack and anglerfish, while a longline fishery targets mainly hake. Analyses of the Spanish demersal fleets in divisions 8.c and 9.a show that the main target species are blue whiting, mackerel, hake, horse mackerel, anglerfish and megrims. Three pelagic/semi-pelagic species (blue whiting, mackerel, and horse mackerel) constitute 61% of the total landings in these demersal métiers. In the Portuguese demersal métiers the most important species caught by the demersal fish trawlers are horse mackerel, mackerel, hake and blue whiting. The three pelagic/semi-pelagic species (blue whiting, mackerel, and horse mackerel) constitute 41% of the total landings in these demersal métiers. The Portuguese crustacean trawlers target mainly Norway lobster, rose shrimp, and blue whiting. Hake, anglerfish, sole, and rays are present in trawl catches, but they are mainly caught by artisanal métiers using gill- and trammelnets.

There is a large small-scale multi-gear fleet operating in the area which uses a diversity of gears that allow exploitation of ecological communities in different habitat types, depths, and substrata. The composition of the landings depends largely on the fishing gear used and on the ecological community of the fishing grounds visited, which may change seasonally. Fleet segmentation of this large small-scale fleets presents a challenge in the area.

The fisheries are mainly carried out by Portuguese and Spanish vessels, with a small participation of French vessels

This mixed fisheries analysis will consider finfish species in the ICES divisions 8.c (Bay of Biscay-South) and 9.a (Portuguese waters-East). The species considered are part of the demersal mixed fisheries of the Atlantic Iberian waters, and include hake (hke.27.8c9a), four-spot megrim (ldb.27.8c9a), megrim (meg.27.8c9a), black-bellied anglerfish (ank.27.8c9a) and white anglerfish (mon.27.8c9a). As mentioned above there are other stocks in the area that could be relevant to describe the effort allocation and technical interactions in the area. The introduction of new species will improve the scope and relevance of this mixed fisheries analysis.

4.1.1 Management measures

Total allowable catch (TAC) is the main fishery management tool in this region. These were introduced for most stocks in the 1980s, but the TACs (and quotas) were generally not restrictive until the early 1990s. The 2013 reform of the Common Fisheries Policy aimed to eliminate discarding through the introduction of the EU landing obligation (LO). The LO was introduced for pelagic species in 2015 and has been phased in for demersal TAC species since 2016. From 2019

the LO will apply to all TAC species, although there are some exemptions. Delegated Regulation (EU) 2019/2237 included a *de minimis* exemption for hake caught with trawls and seines, megrims caught with gillnets, trawls, and seines and anglerfish caught with gillnets, trawls and seines in ICES subareas 8 and 9. A large number of technical measures are in place. These include measures to improve the selectivity of towed gears (partly in order to reduce bycatch) and gear restrictions (ICES, 2022).

Spatial management also occurs, both for fisheries and for ecosystem reasons. Closed areas/seasons are used to protect spawning and juvenile fish, for example. Protected areas have also been designated for habitats and species listed by EU Nature Directives (ICES, 2022). Fishery regulations are in place to restrict certain fisheries that may affect vulnerable habitats

The Regulation (EU) 2019/472 of the European Parliament and of the Council, published on 19 March 2019, has established a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, repealing the Southern hake and Norway lobster recovery (EC Nº 2166/2005) which set effort reduction measures. Fishing opportunities for 2020 were presented in EU Reg. 2020/123. The new multiannual management plan (MAP, EU Regulation 2019/472) includes 36 demersal and deep-sea stocks including 15 Norway lobster FUs in Western Waters, 7 of those stocks (FUs) are caught in ICES division 8c and 9a. The five stocks considered in the mixed fisheries analysis of Iberian waters; hake (hke.27.8c9a), megrim (meg.27.8c9a), four-spot megrim (ldb.27.8c9a), black-bellied (ank.27.8c9a) and white anglerfish (mon.27.8c9a) are included in this new multiannual management.

4.2 FLBEIA

4.2.1 Software

All analyses were conducted using the FLR framework (Kell *et al.,* 2007); www.flr-pro-ject.org; FLCore 2.6.15; FLAssess 2.6.3;) running with R 4.0.1 (R Development Core Team, 2020). All forecasts were projected using the FLBEIA Package (v1.15.5; García *et al.,* 2017). FLBEIA is an FLR package that facilitates the bioeconomic evaluation of management strategies in a multistock and multifleet framework. It can be used to produce both short and long-term simulations. Table 4.1 summarizes the assessment models and forecast methods used for each of the species included in the mixed fisheries framework.

Table 4.1. Software used in the single-species assessments and forecasts

Stocks	Assessment	Forecast
Black-bellied anglerfish (*Lophius budegassa*) in divisions 8.c and 9.a (Cantabrian Sea, Atlantic Iberian waters); ank.27.8c9a	Surplus Production model (SPiCT)	NA
Hake (*Merluccius merluccius*) in divisions 8.c and 9.a, Southern stock (Cantabrian Sea and Atlantic Iberian waters); hke.27.8c9a	Length-based age-structured Stock Synthesis model (SS3)	SS3
Four-spot megrim (*Lepidorhombus boscii*) in divisions 8.c and 9.a (southern Bay of Biscay and Atlantic Iberian waters East); ldb.27.8c9a	Statistical catch-at-age model (a4a)	FLR STF
Megrim (*Lepidorhombus whiffiagonis*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters); meg.27.8c9a	Statistical catch-at-age model (a4a)	FLR STF
White anglerfish (Lophius piscatorius) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters); mon.27.8c9a	Length-based age-structured Stock Synthesis model (SS3)	SS3 (*ad hoc* R code)

4.2.2 Scenarios

The basis of the model is to estimate the potential future levels of effort by a fleet corresponding to the fishing opportunities (TACs by stock and/or effort allocations by fleet) available to that fleet, based on fleet effort distribution and catchability by métier. This level of effort was used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

In 2023, ICES single-stock catch advice was given according to the EU MAP for the Western Waters and adjacent waters (MSY level) for hake, megrims and white anglerfish and the MSY approach for black-bellied anglerfish. The same basis was retained in the current mixed fisheries framework, in which the following nine scenarios are considered in the advice (Table 4.2).

Table 4.2. Mixed fisheries for the Iberian waters. Mixed fisheries scenarios.

Scenario code	Scenarios
max	**"Maximum":** For each fleet, fishing stops when all stocks have been caught up to the fleet stock shares*. This option causes overfishing of the single-stock advice possibilities of all stocks.
min	**"Minimum":** For each fleet, fishing stops when the catch for any one of the stocks meets the fleet stock shares*. This option is the most precautionary option, causing underutilization of the single-stock advice possibilities of other stocks.
sq_E	***"Status quo* effort":** The effort of each fleet in the catch advice year (2023) is set equal to the average effort in the most recent three years (2019–2021) for which catch and effort data are available.
min_range	Same as min scenarios but with catches corresponding to $F_{MSY\ upper}$ for stocks in good status (SSB ≥ MSY $B_{trigger}$) and scaled F_{MSY} advice levels (F_{MSY} × SSB/MSY $B_{trigger}$) for the other stocks (including zero catch advice).
ank	**"Black-bellied anglerfish":** All fleets set their effort corresponding to that required to catch their black-bellied anglerfish stock share*, regardless of other catches.
hke	**"Hake":** All fleets set their effort corresponding to that required to catch their hake stock share*, regardless of other catches.
ldb	**"Four-spot megrim":** All fleets set their effort corresponding to that required to catch their four-spot megrim stock share*, regardless of other catches.
meg	**"Megrim":** All fleets set their effort corresponding to that required to catch their megrim stock share*, regardless of other catches.
mon	**"White anglerfish":** All fleets set their effort corresponding to that required to catch their white anglerfish stock share*, regardless of other catches.

*** Throughout this section, the term "fleet stock share" or "stock share" is used to describe the share of the fishing opportunities for each particular fleet. These are calculated based on the single-stock advice for 2024 and the historical proportion of the stock landed by the fleet (2020–2022).**

4.3 Stock input data and recent trends

4.3.1 Stock data

The assessment data for the different stocks is taken each year from the ICES Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE; ICES, 2023a). For hake and both megrims, total catches (landings and discards) are included in the single-stock assessment. The assessment of white anglerfish and black-bellied anglerfish just include landings, as discards are almost negligible for these species.

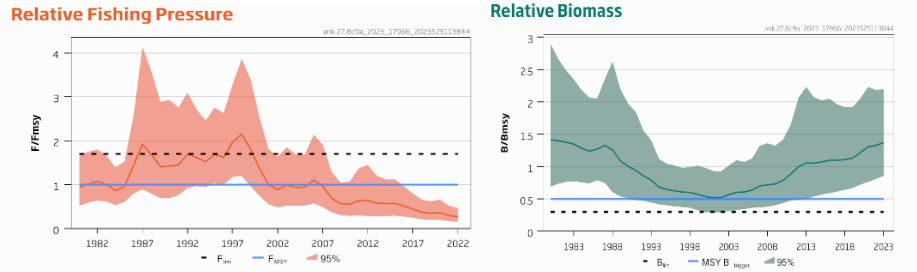
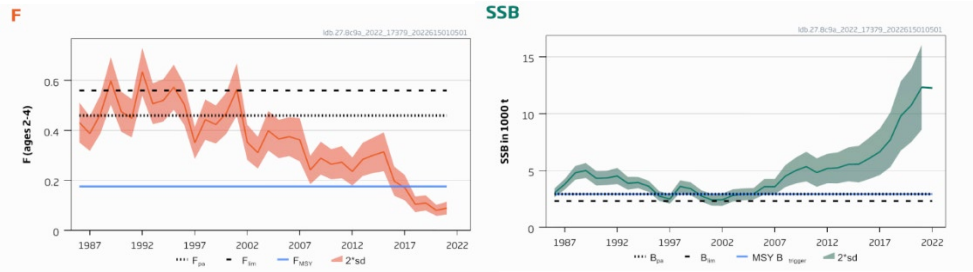
The assessment data for the stocks with analytical assessment were directly provided by the respective stock coordinators, as an FLStock object for white anglerfish, megrims and hake. White anglerfish and hake are being assessed using a Stock Synthesis length and/or seasonal based statistical assessment. However, the implementation of FLBEIA requires age-based dynamics and the assumption made in the assessment model for these two species cannot be fully replicated. This can lead to differences in the projections carried out with both approaches mainly due to the difference between the length-based model used for this stock and the age-based model applied in the mixed fisheries analysis. The projections carried out with FLBEIA are routinely compared to those carried out in the single-species assessment working group to assess the potential impact of using different approaches. The black-bellied anglerfish stock is assessed with a surplus production model (SPiCT). The single-stock advice for black-bellied anglerfish is provided following the ICES guidelines for category 2 stocks.

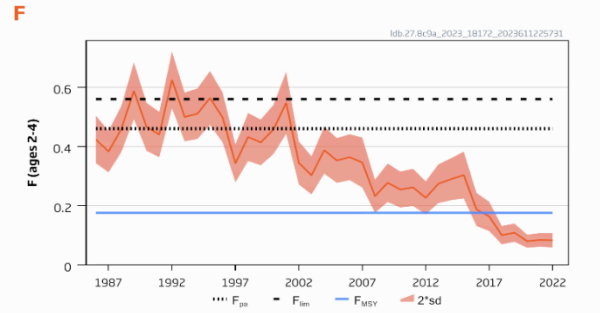
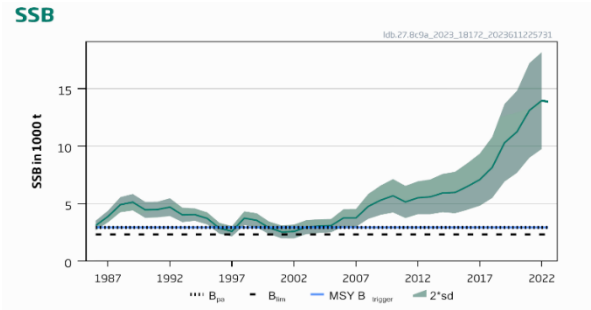
This year, hake and megrim stocks were benchmarked and assessment models and forecast methodologies changed. The updated single-species assessment and forecast methods are outlined in Section 4.5.1.1.

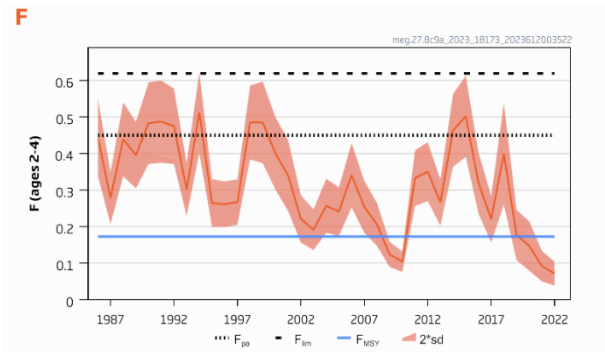
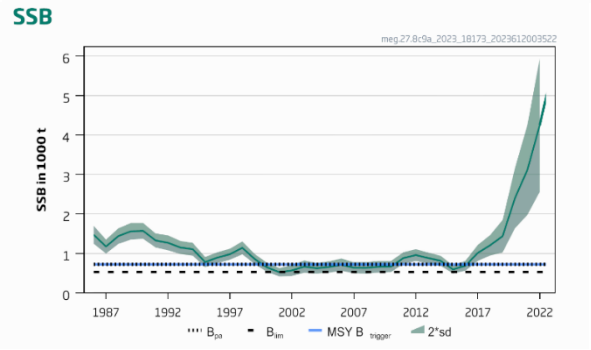
4.3.2 Stock trends and advice

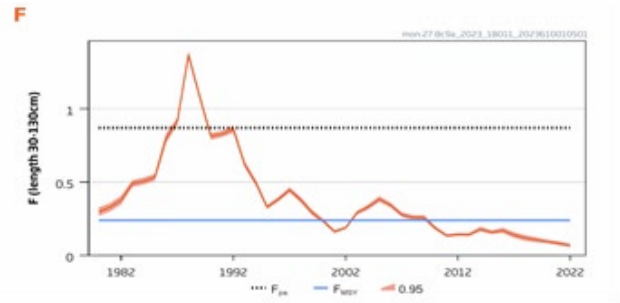
Recent trends in SSB, F and recruitment are described on a stock-by-stock basis in ICES (2023), and latest advice for 2024 by stock is available on the ICES website. In order to give a global overview of the Iberian demersal stocks included in this analysis, this information is summarized below. Table 4.3 provides an overview of the F and SSB trends for the stocks included in the mixed fisheries advice and summarizes the advice, SSB and target Fs.

Table 4.3 Summary of stocks included in the mixed fisheries advice

Species	Area	Stock status	Advice 2024
ank.27.8c-9a (black-bellied anglerfish)	Divisions 8.c and 9.a (Cantabrian Sea, Atlantic Iberian waters)		Summary: Fishing pressure on the stock is below F_{MSY}, and biomass is above MSY $B_{trigger}$ and B_{lim}. Advice: ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 2111 tonnes.
hke.27.8c-9a (Hake)	Divisions 8.c and 9.a (Cantabrian Sea, Atlantic Iberian waters)		Summary: Fishing pressure on the stock is below F_{MSY}, and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim} Advice: ICES advises that when the EU multiannual plan (MAP) for the Western Waters and adjacent waters is applied, catches in 2024 that correspond to the F ranges in the plan are between 9119 tonnes and 17 445 tonnes. According to the MAP, catches higher than those corresponding to F_{MSY} (12919 tonnes) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying ICES advice rule.

Species	Area	Stock status	Advice 2024
ldb.27.8c-9a (Four-spot Megrim)	Divisions 8.c and 9.a (Cantabrian Sea, Atlantic Iberian waters)	 	Summary: The fishing pressure on the stock is below F_{MSY}; spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}. Advice: ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2024 that correspond to the F ranges in the plan are between 1640 and 3537 tonnes. According to the MAP, catches higher than those corresponding to F_{MSY} (2351 tonnes) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying the ICES advice rule

Species	Area	Stock status	Advice 2024
meg.27.8c-9a (Megrim)	Divisions 8.c and 9.a (Cantabrian Sea, Atlantic Iberian waters)	 	Summary: Fishing pressure on the stock is below F_{MSY}; spawning stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}. Advice: ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2024 that correspond to the F ranges in the plan are between 859 and 1915 tonnes. According to the MAP, catches higher than those corresponding to F_{MSY} (1271 tonnes) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying the ICES advice rule.

Species	Area	Stock status	Advice 2024
mon.27.8c-9a (white anglerfish)	Divisions 8.c and 9.a (Cantabrian Sea, Atlantic Iberian waters)		Summary: Fishing pressure on the stock is below F_{MSY}, and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}. Advice: ICES advises that when the EU multiannual plan (MAP) for Western waters and adjacent waters is applied, catches in 2024 that correspond to the F ranges in the plan are between 1805 tonnes and 3334 tonnes. According to the MAP, catches higher than those corresponding to F_{MSY} (2539 tonnes) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying the ICES advice rule

4.4 Fleets and métiers

4.4.1 Catch and effort data

The mixed fisheries assessment is based on catch and effort data provided by the National laboratories and administrations to the annual ICES data calls (InterCatch database: discards and landings by stock, area and métier, consistent with the DCF definition of métiers), and data collected by STECF for the evaluation of the effort regime (Accessions data, that contains information on landings and fishing effort by area, quarter and métier). These fishery data, structured by DCF fleet segments and métiers, are used as inputs together with ICES single-stock data and advice, in the integrated FLBEIA framework.

The final dataset extracted from InterCatch for use by WGBIE includes discards estimates for all stocks and some métiers, which are used to estimate the discard ratio for the mixed fisheries fleets in the assessment of hake and both megrims (anglerfish stocks discards are considered negligible). InterCatch files also provided non-reported landings (ICES WGBIE estimates) besides the official landings. The fleet information specifically required by the WGMIXFISH, needed to split landings by fleet segment and métier, were provided by Spain and Portugal with official landings and economic value. France only provides landings that are considered negligible (less than 1% of the total catch) and not considered for WGMIXFISH analysis in this area. Discards and non-reported landings are added from the respective InterCatch files.

Métier-based landings and effort files requested by the WGMIXFISH data call were provided by the three countries with fleets operating in Atlantic Iberian waters, i.e. Spain, Portugal and France.

Portugal provides a series of effort and landings for the period 2015–2022, using an updated algorithm for métier classification since 2019. Some outdated métiers who had no catches in the last years were removed in the new series. The two megrims are not usually landed separately for the majority of the commercial categories, being recorded together. In the case of anglerfish species, despite recent improvements, there are still some degree of misidentification in landings (ICES, 2023a). Therefore, estimates of species-specific landings for these species are derived from their relative proportions in market samples and applied to correct Portuguese landings at the species level.

For the period 2009–2016, Spain sent effort and official landings as a unique series. Data for the period 2017–2022 are provided by two laboratories, IEO and AZTI, independently. Landings for anglerfish and megrim were not at the species level for the period 2009–2016. Time-series of landings and discards are checked between single-stock assessment and the data compiled by WGMIXFISH from ICES Data Accessions and InterCatch.

Proportion of landings in 2020–2022 for stocks considered in the mixed fisheries projections is presented in Figure 4.1 (hke.27.8c9a) is the dominant species, comprising of 78% of total landings, followed by black-bellied anglerfish (ank.27.8c9a, 7%), four spot megrim (ldb.27.8c9a ,6%), white anglerfish (mon.27.8c9a, 7%) and megrim (meg.27.8c9a, 2%).

Southern hake stock provides the highest catches in almost all fisheries operating in the area with demersal gears. Megrims are mainly caught by the bottom otter trawl targeting demersal fish and anglerfish by several bottom otter trawl and gillnets (Figure 4.2)

4.4.2 Definition of fleets and métiers

Fleet and métier categories used in the mixed fisheries analysis are based on the EU Data Collection Framework (DCF) level 6 categories provided by Spain, Portugal and France. Since.

In 2022, 58 métiers were reported through the ICES Data Accessions. InterCatch data included 25 fleet categories with catches on the species considered in the mixed fisheries analysis. 14 fleet segments are aggregated based on their relevance for the Portuguese and Spanish fisheries, gear group and on the species catchability considered in mixed fisheries advice (Table 4.5). The classification of fleet segments did not include vessel size for Spanish trawlers as the disaggregation by métier already captures this information. In the case of Portugal, the contribution of the small vessels was minor, and their catch profile was similar to the largest vessels profile, hence a single fleet is used for the three trawl size categories. National fleets with minor landings in the mixed fisheries stocks are aggregated to a miscellaneous fleet. Mixed fisheries multigear fleets use a diversity of gears that allow exploitation of different fish assemblages in different habitats and depths.

Within the fleet segments, métiers are defined by combining the country, fishing gear and mesh size of both Portuguese and Spanish fleets. The "MIS" métier represents the artisanal multi-gear fleet occurring in the area. The "MIS" miscellaneous métier represents the Portuguese and Spanish miscellaneous fleet occurring in the area. The "FR-MIS" fleet is a mixed category consisting of landings without corresponding effort data and small métiers of the French fleet which account for <1% of catches (average 2020–2022). Table 4.6 describes the main gear, country, mesh size and target assemblage of the final métier categories used in the mixed fisheries analysis.

The procedure for defining fleets and métiers was not revised in 2022, and has therefore been the same in the last few years. In order to improve harmonization between the Portuguese and Spanish fleets, which have different technical characteristics in both active and static gears, further analysis should be done on the method for matching and aggregating the métiers used for mixed fisheries analysis.

4.4.3 Trends

Analyses of trends by fleet is carried out for 2020–2022 data. A number of exploratory graphs are produced to aid quality checking of the data once compiled into the final fleets object for catches, effort and catchability. The catchability plots by stock, fleet and métier for the Spanish and Portuguese fleet segments are presented in Figure 4.3 and 4.4, respectively. The key assumption in the projections is that catchability by stock and métier and effort distribution (share) in the intermediate year (2023) and forecast year (2024) is the average of the last three years (2020–2022). In reality, fishing patterns may have slight changes over time but the scenarios presented do not assume any adaptation of fishing behaviour.

4.5 Mixed fisheries forecasts

4.5.1 Description of scenarios

4.5.1.1 Baseline runs

The objectives of the single-species stock baseline runs were to:

1. reproduce as closely as possible the single-species advice produced by ACOM, and
2. act as the reference scenario for subsequent mixed fisheries analyses.

The various single-stock forecasts presented by WGBIE are performed using different software and setups. For the purposes of the mixed fisheries analyses, it is necessary to gather all forecasts into a single unified framework, which builds on the "FLBEIA" library (García *et al*., 2017). Some of the assessments are length based and/or seasonal and this cannot be fully replicated in the

deterministic FLBEIA software. The same forecast settings as in the Stock Annex for each category 1 stock regarding weight-at-age, selectivity and recruitment, as well as assumptions on the F in the intermediate year and basis for advice (MSY approach). For category 2 black-bellied anglerfish, assessed with surplus production model (SPiCT), the catch estimates in the ICES advice sheet under *status quo* F/F_{MSY} was used. The Fsq estimates provided in the ICES advice sheets were used for the stocks with analytical assessment.

The same forecast settings as in the Stock Annex for each stock with dynamics (i.e. not including the fixed dynamics used for category 2 black-bellied anglerfish) is outlined in the Table 4.4.

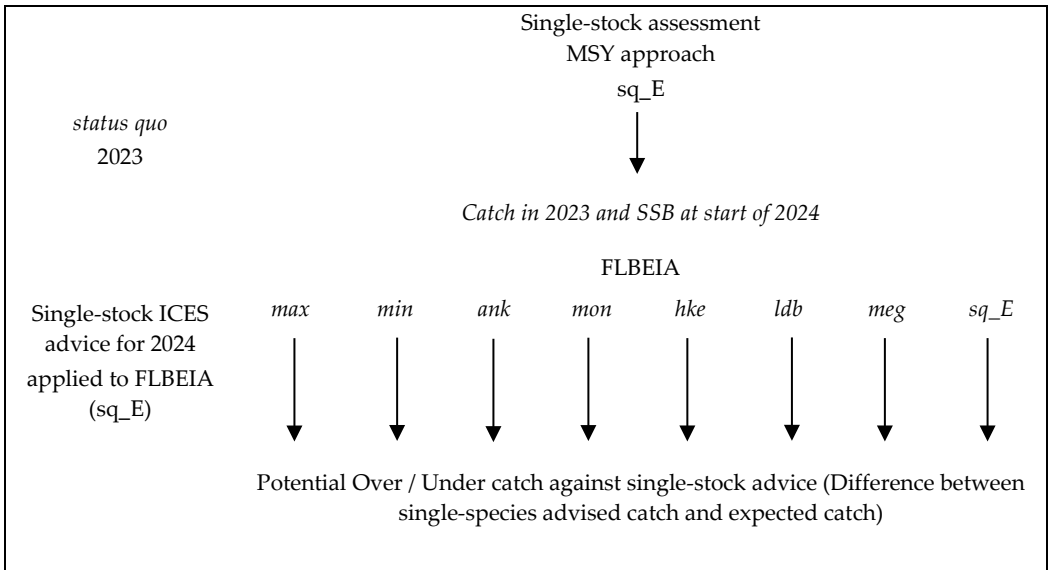
Table 4.4. Mixed fisheries for the Iberian waters. Forecast settings for stocks with dynamics.

Stocks	Assess-ment	Forecast	Fbar(range)	Fsq	Weight-at-age	Recruitment	Discards proportion
Hake; hke.27.8c9a	(SS3)	SS3	age1-age7	Average F (2020–2022)	Time invariant	Estimated BevHolt in SS3	Estimated (fixed)
Four-spot megrim; ldb.27.8c9a	(a4a)	FLR STF	age2-age4	Average F (2020–2022)	Average (2018–2022)	GeoMean (1990–2020)	Average (2018–2022)
Megrim; meg.27.8c9a	(a4a)	FLR STF	age2-age4	Average F (2020–2022)	Average (2018–2022)	GeoMean (1998–2020)	Average (2018–2022)
White anglerfish; mon.27.8c9a	(SS3)	SS3	30–130cm	Average F (2020–2022)	Time invariant	GeoMean (2003–2022)	Discards negligible

4.5.1.2 Mixed fisheries runs

The mixed fishery analysis used a *status quo* effort assumption for the intermediate year (2023), with the FLBEIA scenarios used for the advice year (2024). The *status quo* effort assumption for the intermediate year is considered a plausible assumption because is in line with the standard single-stock short-term forecasting approach. As last year, the projections were run assuming a full and perfect implementation of a discard ban (i.e. all quota species caught must be landed, with no exemptions, *de minimis* or interspecies flexibilities).

In summary, the FLBEIA runs followed the scheme below:



4.5.2 Results of FLBEIA runs

4.5.2.1 Baseline runs

The rationale behind the single-species baseline runs is given in the previous Section 4.5.2.1. The ICES single-stock advice for category 2 black-bellied anglerfish is based on the MSY approach and for hake, megrims and white anglerfish in 2023 (ICES, 2023a) is based on F ranges in accordance with the EU multiannual plan (MAP) for demersal stocks in the western waters (EU, 2019). The results from baseline runs (Table 4.7) are compared with the results from the corresponding ICES runs in Table 4.8 (Catch differences) and Table 4.9 (SSB and F differences).

Due to methodological differences between the forecasts conducted in single-species assessments and the deterministic forecast done within WGMIXFISH (Section 4.5.1.1), some discrepancies are to be expected between the baseline run reproducing the assessments. Despite these methodological differences, the differences observed this year were small (< 5%) The WGMIXFISH deterministic forecast was considered close enough to the single-stock advice to be used as a basis for the mixed fisheries projections. The issues and problems encountered in replicating the single-species advice for each species are identified below.

- **White anglerfish**: Assessment with length-based SS3 model. The Fsq (30–130 cm) use in the assessment forecast was defined in FLBEIA as Fsq (age1-age10) based on age–length analysis. Discrepancies of 1% in the final assessment year and < 2% in the SSB end advice year 2024. F differences of 1–2% in the final assessment, interim and advice year.
- **Hake**: Assessment with multi season, sex separated, length-based SS3 model. The approach used is summarized in Table 4.12. Discrepancies for SSB and F in the final assessment year was < 1% and SSB differences in the forecast years and the F´s < 3%.
- **Four-spot megrim:** Assessment with a4a. Discrepancies in SSB were below 2% and 5% in F between FLBEIA run and single-stock advice forecast years.
- **Megrim**: Assessment with a4a. < 2% discrepancies in the SSB in the forecast years and < 4% in F´s in 2023 between FLBEIA runs and single-stock advice forecast.
- **Black-bellied anglerfish**: category 2 stock, assessment with surplus production model. F and biomass projections are relative to F_{MSY} and B_{MSY}. 1% differences in catch 2023 and no discrepancies in catch 2024.

The outputs of the scenarios at the start of the advice year were all consistent with the single-stock forecasts with minor differences considering the adjusted methods used for the FLBEIA unified framework and each single-species stock methodology. The differences were considered acceptable for modelling the technical interactions between stocks and fleets in the mixed fisheries scenarios.

4.5.2.2 Mixed fisheries analyses

The full overview of the FLBEIA scenarios catch and SSB projections is presented in Tables 4.10 and 4.11 and Figure 4.5–Figure 4.7. Figure 4.5 illustrates trade-offs in catches and the potential for quota overshoot and undershoot linked to the most and the least restrictive single-stock fishing opportunities for 2024, for ease of comparison, the landings relative to the single-stock advice are also presented. Figure 4.6 is very similar and shows the estimates of potential 2024 catches by stock and by scenario, the horizontal dashed line corresponds to the single-stock catch advice, with areas above and below the line representing potential over- and undershoot respectively. Figure 4.7 illustrates the estimates of potential SSB by stock in the mixed fisheries scenarios, for ease of comparison, the SSB is expressed as a ratio to the single-stock advice forecast.

The **"min"** scenario is based on the assumption that the fishery stops for a fleet when any of the stock quotas is exhausted, representing a full implementation of the landing obligation. This scenario reflects the constraints that result from a strictly implemented discard ban. For 2024, the **"min"** scenario results are very similar to those of the **"hke"** scenario, indicating that hake is the most limiting stock for all fleets. This scenario shows potential loss of fishing opportunities for black-bellied and white anglerfish and, to a lesser extent, the two megrims stocks (Figure 4.5–4.6, Table 4.10).

The **"max"** scenario is included to demonstrate the upper bound of potential fleet effort and stock catches because it assumes that all fleets continue fishing until all the stock shares are exhausted, irrespective of the economic viability of such actions. In 2024, the "max" scenario results in over-quota catches for hake, megrim stocks and white anglerfish. The "max" scenario shows that black-bellied anglerfish stocks is the least limiting for most fleets. In this scenario, the F estimates in 2024 are above the F_{MSY} levels for white anglerfish, hake, megrim and four-spot megrim (Table 4.12).

The *status quo* **"sq_E"** scenario sets the effort of each fleet in the forecast years equal to the average of the effort in the most recently recorded three years for which data are available (2020–2022). This scenario investigates the mixed fisheries outcomes if the situation remains the same in terms of total effort and effort allocation among métiers. For 2024, this scenario shows an undershoot for the advised catches of all stocks (Figure 4.5–4.6), unlike in previous years. These results are consistent with the observed ratio of catch to TAC in recent years for the considered stocks with the exception of hake. In October 2022, a significant upward revision of the TAC occurred for this stock which prevented fishing fleets from fully utilizing their available quota in 2022, reflected in this mixed fisheries scenario.

In the **"min_range"** scenario, the choke species per fleet are the same as for the "min" scenario. However, catches per stock in 2024 are increased due to the increase in catch opportunities provided by the F_{MSY_upper} option for stocks above MSY $B_{trigger}$.

Within the scenarios based on each of the stocks, the results of **"ank"** is similar to those of the **"max"** SSB is estimated to be lower than the single-stock advice because of large TAC overshoot (Table 4.11). The reduction of SSB is more noticeable in hake stock because of the increased effort in these scenarios and technical interaction between this species in all fleets. The **"mon"** scenario estimates effort levels slightly lower to those in **"ank"** and **"max"** scenarios. Black-bellied anglerfish is the least limiting stock in 10 fleets of the 11 considered in this analysis. The **"hke"** scenario gives the same result as the **"min**" scenario, showing hake as the choke species in this group and across all fleets considered in mixed fisheries analysis (Figure 4.5–4.6).

The **"ldb**" and **"meg"** scenarios provide a similar perspective, increasing the fishing opportunities of both stocks compared with the **"hke"** scenario. The **"meg"** scenario, by definition, is also in agreement with the observed average ratio of catch to TAC for this species, very close to 1 in recent years. This scenario estimates an undershoot for four-spot megrim and anglerfish stocks very similar to the observed 2016–2021 average ratio of catch to TAC in these species. This could be a consequence of megrims and anglerfish being caught by the same bottom otter trawl gears, while hake occurs in the catches of almost all the Iberian métiers.

All scenarios result in SSB above MSY $B_{trigger}$ for all stocks except for hake in the "mon" scenario with SSB below MSY $B_{trigger}$ and SSB below B_{lim} in the "max" and "ank" scenarios (Table 4.11).

The estimates of effort by fleet are presented in Figure 4.8 showing the most limiting stock ('choke species') and the least limiting species for each fleet in 2023. The *status quo* effort for each fleet (average 2020–2022) is shown as a dashed line for reference. As expected hake is the most limiting stock for all 11 fleets considered in mixed fisheries analysis and the black-bellied anglerfish is the least limiting stock in 10 fleets and the four-spot megrim in 1 fleet (SP_MIS).

4.6 References

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Table 4.5. Detailed description of the fleet categories with relevant catches in the species considered in the Iberian waters mixed fisheries analysis and final mixed fisheries métier group. Fleets with minor landings in the mixed fisheries stocks are aggregated to a miscellaneous fleet.

Acronym	DCF definition	Description	Mixed fisheries métier
GNS_DEF_>=100_0_0	Set gillnet targeting demersal fish with mesh sizes larger than 100 mm	Spanish set gillnet ("rasco") targeting white anglerfish in ICES Division 8c with mesh size of 280 mm	GN1
GNS_DEF_0_0_0	Set gillnet targeting demersal fish	Artisanal Portuguese fleet using set gillnets	GN_GT_LL
GNS_DEF_60-79_0_0	Set gillnet targeting demersal fish with mesh sizes within the range 60–79 mm	Spanish small set gillnet ("beta") targeting a variety of demersal fish in northwestern Spanish waters	GN_GT
GNS_DEF_80-99_0_0	Set gillnet targeting demersal fish with mesh sizes within the range 80–99 mm	Spanish set gillnet ("volanta") targeting hake with nets of 90 mm mesh size in northwestern Spanish waters	GN2
GTR_DEF_0_0_0	Trammelnet targeting demersal fish	Artisanal Portuguese fleet using trammelnets	GN_GT_LL
GTR_DEF_60-79_0_0	Trammelnet targeting demersal fish with mesh sizes within the range 60–79 mm	Spanish trammelnet targeting a variety of demersal species in northwestern Spanish waters	GN_GT
LLS_DEF_0_0_0	Set longline targeting demersal fish	Spanish set longline targeting a variety of demersal fish in Spanish Iberian waters	GN_GT_LLS
MIS_MIS_0_0_0_HC	Miscellaneous	Portuguese and Spanish artisanal fleet not covered by other métiers	MIS
OTB_CRU_>=55_0_0	Bottom otter trawl targeting crustaceans using mesh sizes larger than 55 mm	Portuguese bottom otter trawl targeting *Nephrops* and rose shrimp	OT_CRU
OTB_DEF_>=55_0_0	Bottom otter trawl targeting demersal fish using mesh sizes larger than 55 mm	Spanish bottom otter trawl targeting hake, anglerfish, and megrim using "baca" nets of 70 mm mesh size in Divisions 8c and 9a	OT_DEF
OTB_DEF_>=65_0_0	Bottom otter trawl targeting demersal fish using mesh sizes larger than 65 mm	Portuguese bottom otter trawl targeting demersal fish in Division 9a	OT_DEF
OTB_ MCD_>=55_0_0	Bottom otter trawl targeting mixed crustaceans and demersal fish using mesh sizes larger than 55 mm	Spanish bottom otter trawl targeting a variety of fish and crustaceans using nets of 55 mm mesh size in southwestern Iberian waters (Gulf of Cadiz and Southern Portuguese waters)	OT_MCD
OTB_MPD_>=55_0_0	Bottom otter trawl targeting mixed pelagic and demersal fish using mesh sizes larger than 55 mm	Spanish bottom otter trawl targeting pelagic (horse mackerel, mackerel…) and demersal fish (hake) by using "jurelera" nets of 55 mm mesh size in northwestern Spanish waters	OT_PT_MPD
PTB_ MPD _>=55_0_0	Bottom pair trawl targeting mixed pelagic and demersal fish using mesh sizes larger than 55 mm	Bottom pair trawl targeting pelagic (blue whiting, mackerel…) and demersal fish (hake) by using nets of 55 and 70 mm mesh size in northwestern Spanish waters	OT_PT_MPD

Table 4.6. Final métier categories description used in mixed fisheries analysis (PT- Portugal; SP-Spain; FR-France).

Acronym	Gear / country	Mesh size / main target assemblage
GN1	Gillnets / SP	≥ 100 mm / demersal fish
GN2	Gillnets / SP	≥ 80 mm and < 99 mm / demersal fish
GN_GT	Gillnets, trammelnets / SP	≥ 60 mm and < 79 mm / demersal fish
LL_GN_GT	Longlines, gillnets, trammelnets / PT; SP	Any / demersal fish
OT_CRU	Otter trawls / PT	≥ 55 mm / crustaceans
OT_DEF	Otter trawls / PT ; SP	≥ 65 mm / demersal fish
OT_MCD	Otter trawls / SP	≥ 55 mm / crustacean; demersal fish
OT_PT_MPD	Otter and pair trawls / SP	≥ 55 mm / pelagic; demersal fish
MIS	Miscellaneous / PT ; SP	Any
FR_MIS	Miscellaneous / FR	Any

Table 4.7. Baseline run outputs from the FLBEIA package.

	ANK* ank.27.8c9a	HKE hke.27.8c9a	LDB ldb.27.8c9a	MEG meg.27.8c9a	MON mon.27.8c9a
2023_Fbar	NA	0.21	0.083	0.104	0.081
2023_Landings	621	7070	1120	320	574
2023_SSB	NA	21703	13572	5578	11584
2024_Fbar	NA	0.22	0.176	0.173	0.24
2024_Landings	2111	11106	2148	1214	2539
2024_SSB	NA	23659	12924	6124	12541
2025_SSB	NA	25982	11121	5464	11768

***Category 2 stock with fixed dynamics in FLBEIA**

Table 4.8. Comparison between baseline run and ICES estimated catches for intermediate and advice years. Figures for 2023 compare results from the baseline run - that use the same forecast assumptions in the intermediate year as the forecasts leading to ICES advice.

	ANK* ank.27.8c9a	HKE hke.27.8c9a	LDB ldb.27.8c9a	MEG meg.27.8c9a	MON mon.27.8c9a
2023_catches Baseline	712	10793	1220	699	827
2023_ catches ICES	622	10793	1220	699	827
2023_ratio FLBEIA/ICES	1.14	1	1	1	1
2024_ catches Baseline	2111	12919	2351	1271	2539

	ANK* ank.27.8c9a	HKE hke.27.8c9a	LDB ldb.27.8c9a	MEG meg.27.8c9a	MON mon.27.8c9a
2024_ catches ICES	2111	12919	2351	1271	2359
2024_ ratio FLBEIA/ICES	1	1	1	1	1.08

*Category 2 stock with fixed dynamics in FLBEIA

Table 4.9. Comparison of SSB and F forecasts between FLBEIA baseline run outputs and single-stock assessment (ratio FLBEIA / ICES).

	SSB_2023	SSB_2024	SSB_2025	F_2023	F_2024
ank.27.8c9a*	NA	NA	NA	NA	NA
hke.27.8c9a	0.99	0.97	0.97	1.01	1.03
ldb.27.8c9a	0.99	0.98	0.98	1.04	1.05
meg.27.8c9a	0.99	0.99	0.98	1.04	1.03
mon.27.8c9a	1.02	1.02	1.01	1.01	0.99

*Category 2 stock with fixed dynamics in FLBEIA

Table 4.10. Results of running FLBEIA scenarios on the advice year (2024). Comparison of the single-stock ICES advice and potential catches in the various FLBEIA scenarios (test for details).

	Single-stock Catch (2024)	min	max	sq_E	min-range	Ank	hke	ldb	meg	mon
ank.27.8c9a	2111	756	2113	712	1021	2111	759	1411	1132	1792
hke.27.8c9a	12919	12775	26967	12293	17250	26967	12919	24100	17673	25832
ldb.27.8c9a	2351	1230	3429	1148	1661	3429	1230	2351	1857	2933
meg.27.8c9a	1271	843	2339	783	1139	2339	843	1611	1271	2004
mon.27.8c9a	2359	1005	2773	935	1358	2772	1014	1932	1435	2359

Table 4.11. Results of running FLBEIA scenarios on the advice year. Comparison of the Spawning-stock biomass (SSB) results in 2025 (end 2024) from single-stock advice. Weights are in tonnes.

	Single-stock SSB (2025)	min	max	sq_E	min-range	Ank	hke	ldb	meg	mon
ank.27.8c9a*	26726	25775	4861	25924	23538	4864	25705	8805	18644	6326
hke.27.8c9a	11371	12354	7883	12444	11886	7883	12354	11136	11672	9381
ldb.27.8c9a	5574	6001	3137	6075	5641	3137	6001	4734	5480	3872
meg.27.8c9a	11607	13426	11513	13502	13045	11514	13417	12423	12962	11961
mon.27.8c9a	26726	25775	4861	25924	23538	4864	25705	8805	18644	6326

*Category 2 stock with fixed dynamics in FLBEIA

Table 4.12. Results of running FLBEIA scenarios on the advice year. Comparison of the Fishing mortality levels results in 2024 from single-stock advice.

	Single-stock F (2024)	min	max	sq_E	min-range	Ank	hke	ldb	meg	mon
ank.27.8c9a*	0.221	0.225	1.684	0.220	0.317	1.684	0.228	1.449	0.586	1.590
hke.27.8c9a	0.176	0.092	0.311	0.085	0.126	0.311	0.092	0.184	0.142	0.250
ldb.27.8c9a	0.173	0.114	0.457	0.106	0.158	0.457	0.114	0.258	0.178	0.360
meg.27.8c9a	0.240	0.088	0.267	0.082	0.121	0.267	0.089	0.178	0.129	0.222
mon.27.8c9a	0.221	0.225	1.684	0.220	0.317	1.684	0.228	1.449	0.586	1.590

*Category 2 stock with fixed dynamics in FLBEIA

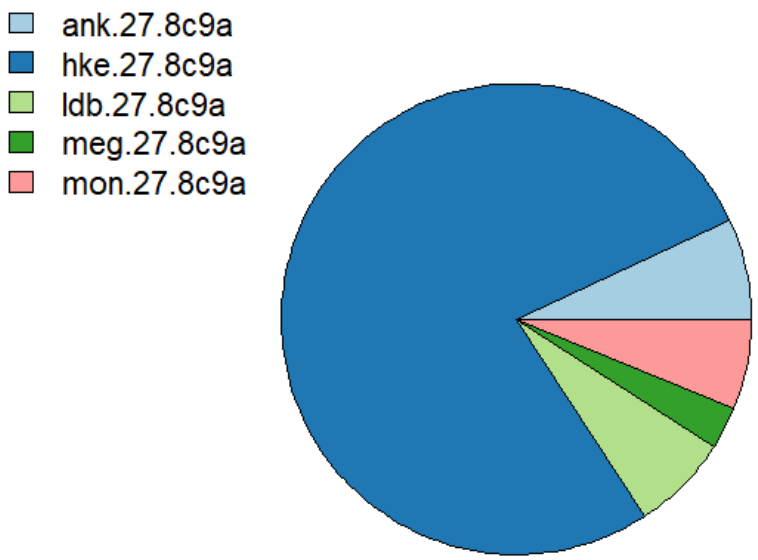


Figure 4.1. Catch distribution in 2020–2022 by the stocks included in the mixed fisheries projections: Hake (78%), black-bellied anglerfish (7%), white anglerfish (6%), four spot megrim (7%) and megrim (2%).

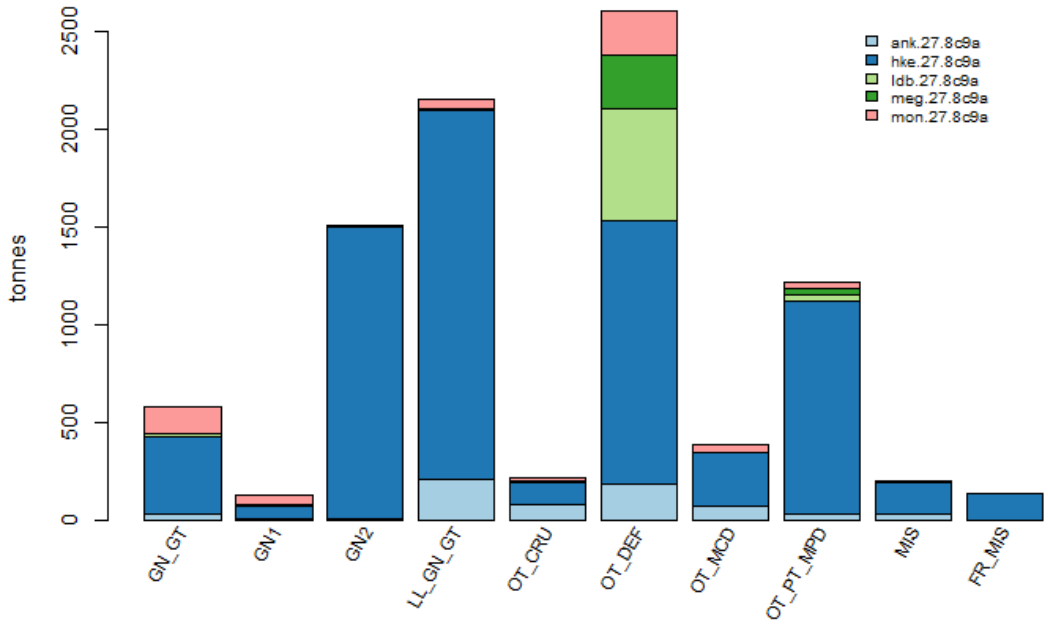


Figure 4.2. Landings distribution of species by mixfish gear group in 2020–2022. (see Table 4.6 for description of the technical characteristics of each gear group).

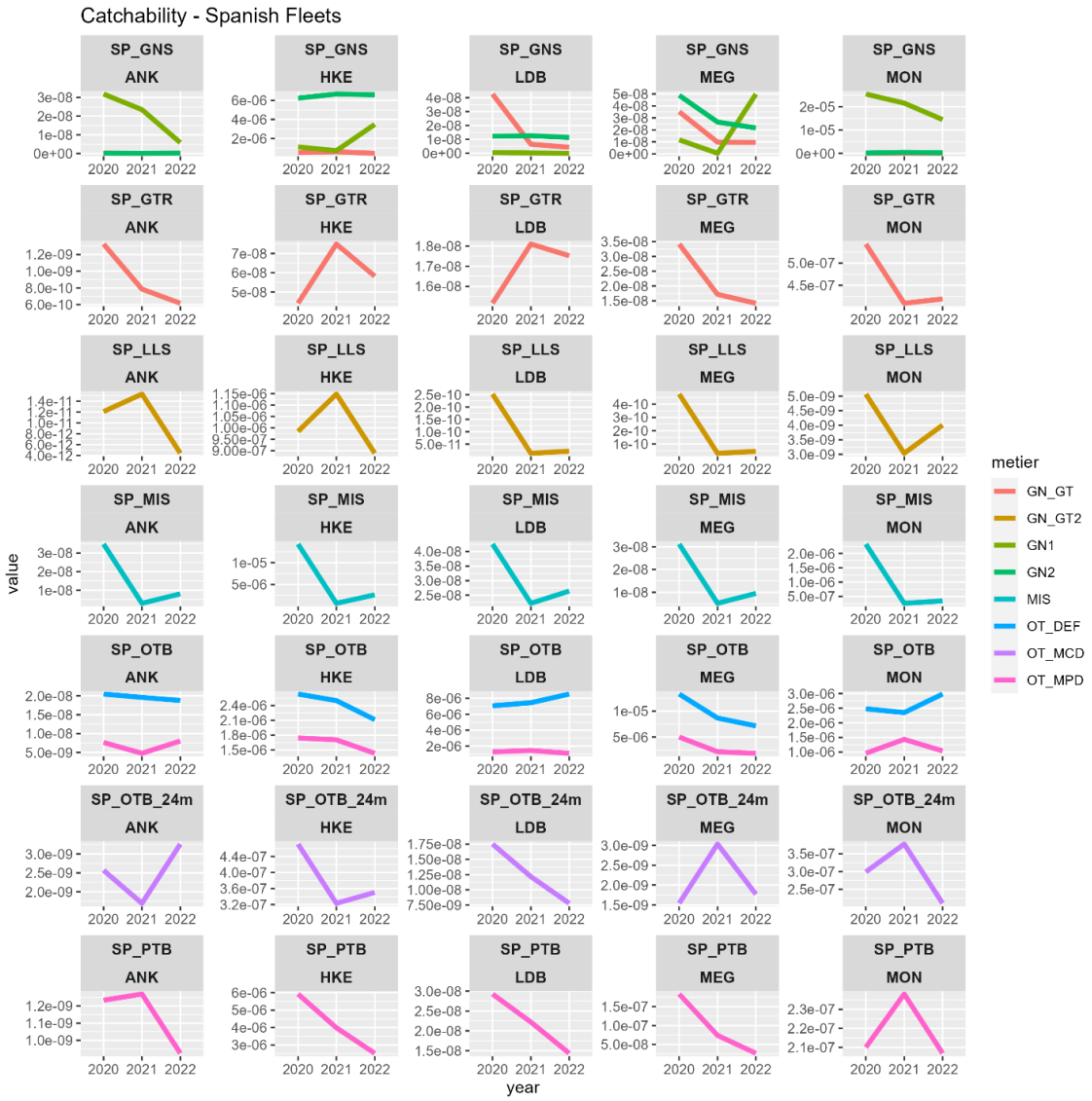


Figure 4.3. Trends of Spanish catchability by stock, fleet and métier from 2020–2022.

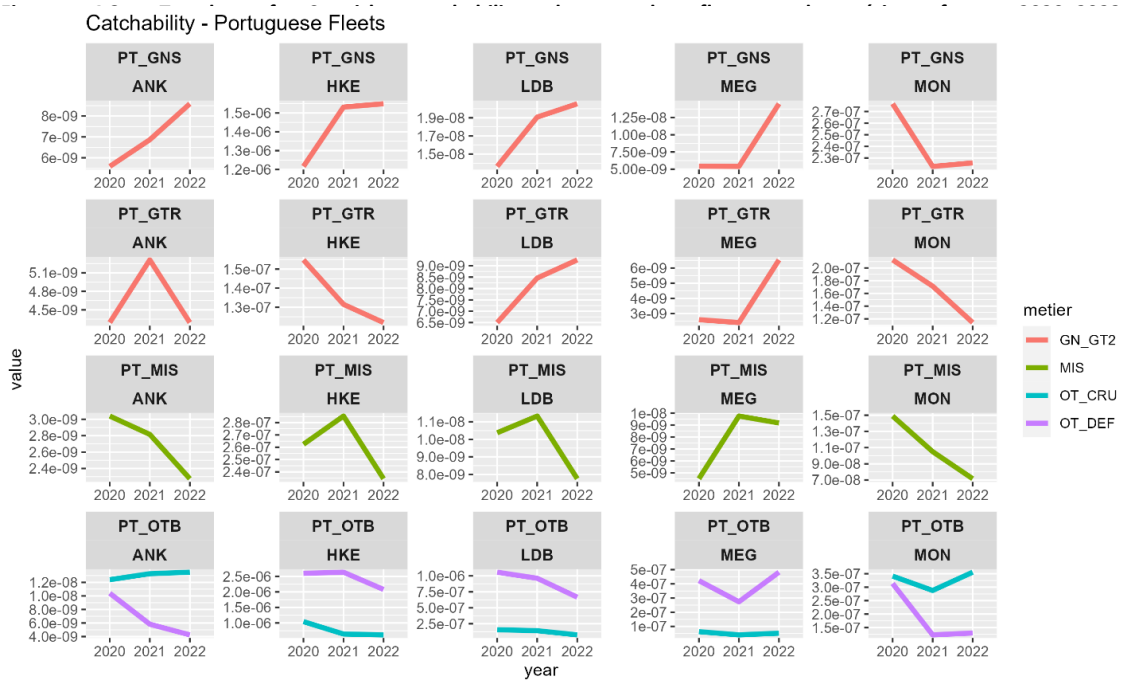


Figure 4.4. Trends of Portuguese catchability by stock, fleet and métier from 2020–2022.

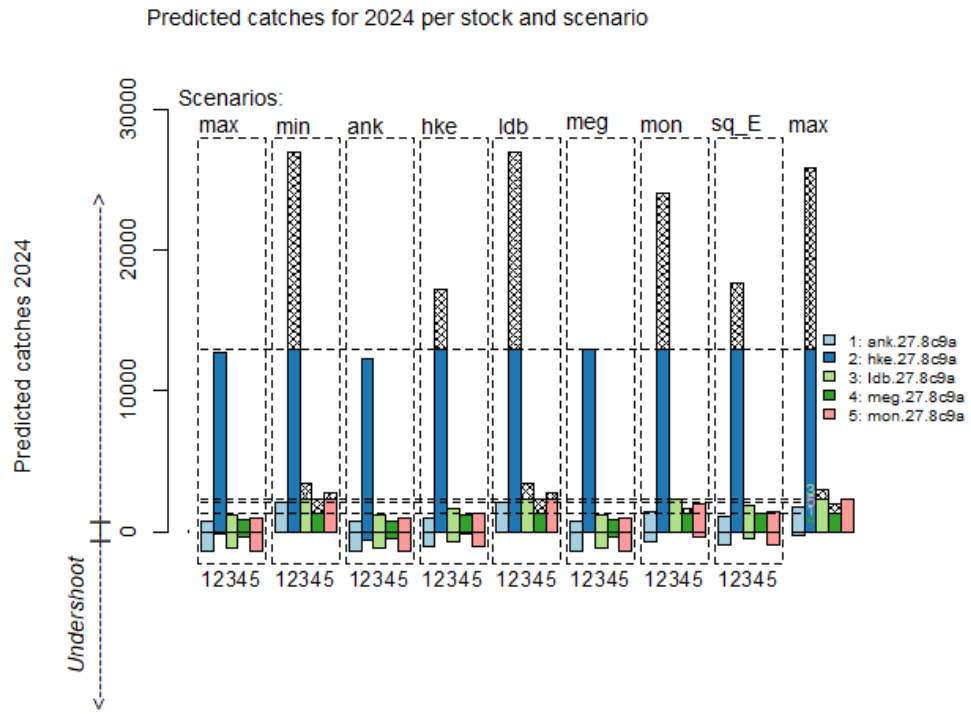


Figure 4.5. Mixed fisheries forecasts for catches in 2024. FLBEIA estimates of potential catches by stock after applying the status-quo effort scenario to all stocks in the intermediate year 2023, followed by the FLBEIA scenarios. Horizontal lines correspond to the catch set by the single-stock advice. Bars below the value of zero show the scale of undershoot (compared to the single-species catch advice) in cases where catches are predicted to be lower when applying the scenario.

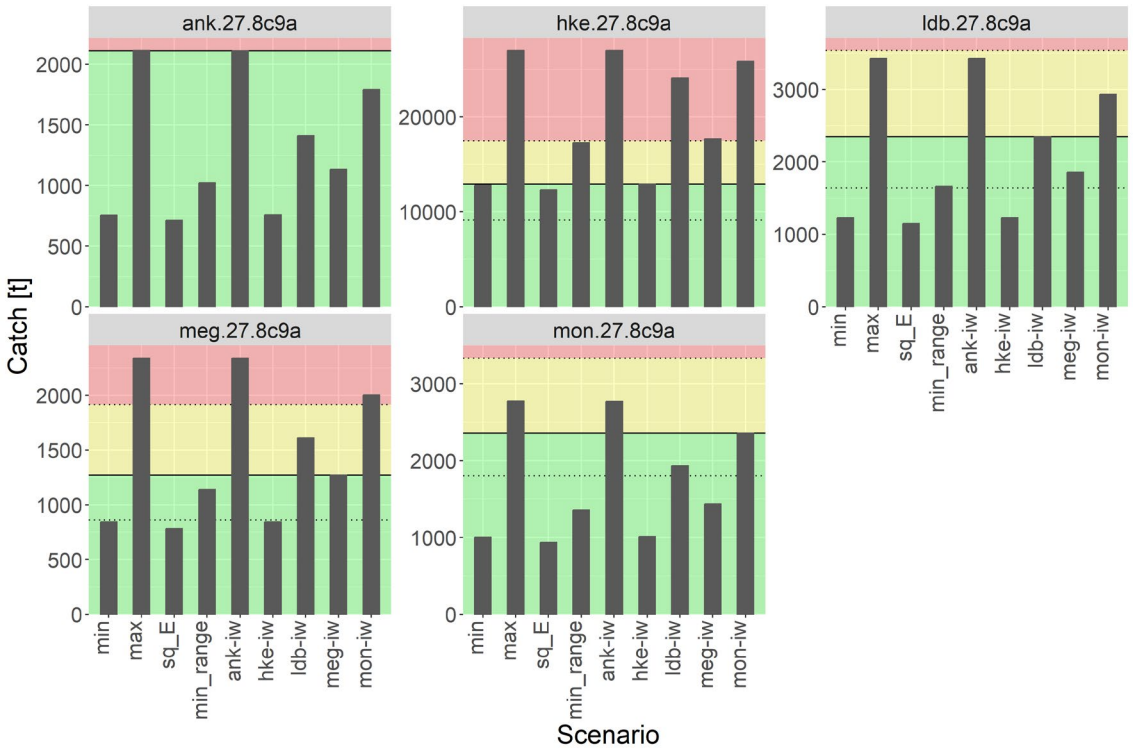


Figure 4.6. Estimates of potential 2024 catches (in tonnes) by stock and scenario. Solid lines correspond to the single-stock catch advice. Lower dotted lines illustrate the catches corresponding to $F_{MSY\ lower}$ or reduced $F_{MSY\ lower}$ for stocks with SSB < MSY $B_{trigger}$. Upper dotted lines illustrate the catches corresponding to $F_{MSY\ upper}$ and only appears for stocks with SSB ≥ MSY $B_{trigger}$.

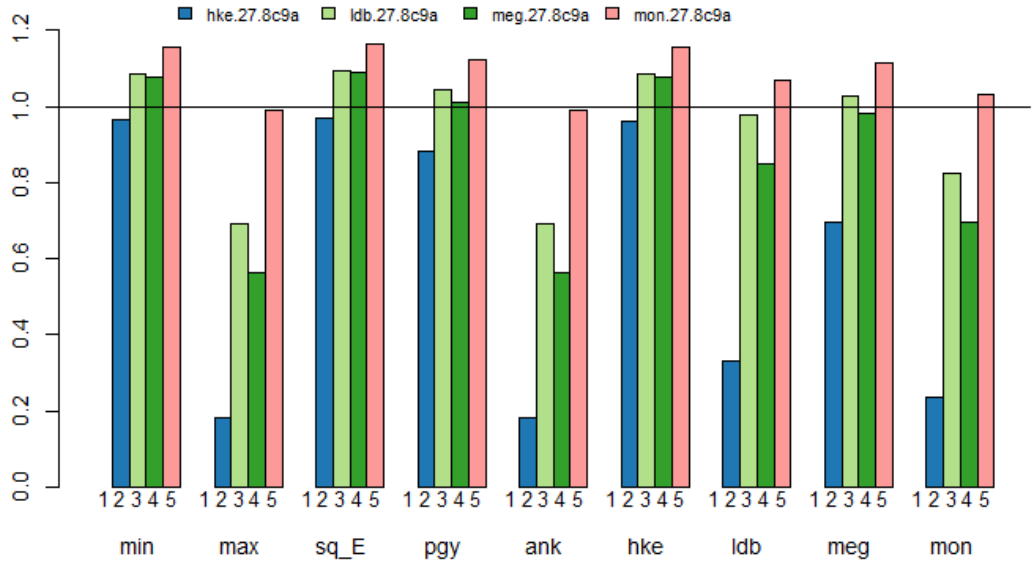


Figure 4.7. Mixed fisheries forecasts for estimates of potential SSB at the start of 2025 by stock after applying the mixed fisheries scenarios, expressed as a ratio to the single-species advice forecast. Horizontal line corresponds to the SSB resulting from the single-stock advice (at the start of 2025).

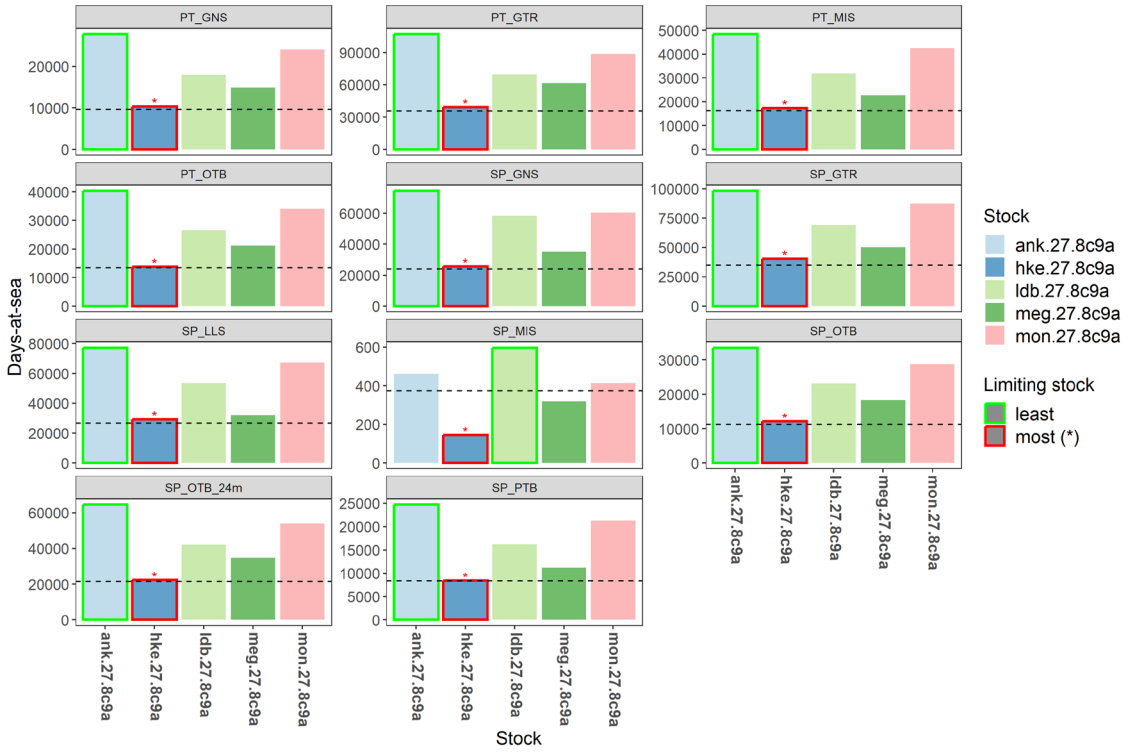


Figure 4.8. Estimates of effort by fleet needed to reach the single-stock advice catches. The bar for the most limiting stock ('choke species') for each fleet in 2024 highlighted with a red border and the bar for the least limiting species highlighted with a green border. The *status quo* effort for each fleet (average 2020–2022) are shown as a dashed line for reference.

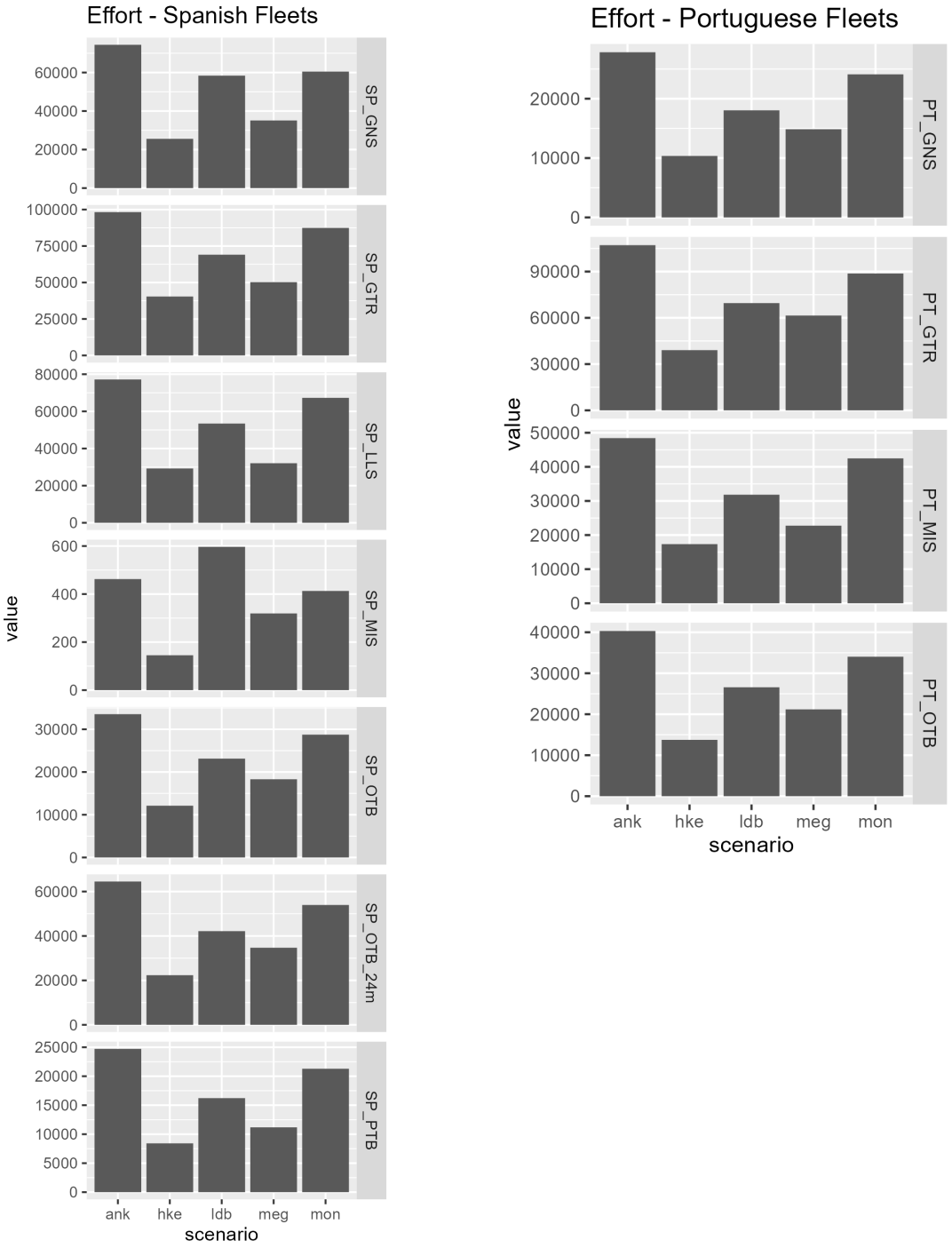


Figure 4.9. FLBEIA estimates of effort by national fleet corresponding to the individual "quota share" (or partial target F) by stock in 2024 (baseline run).

5 Irish Sea

Mixed fisheries considerations

5.1 Background

The Irish Sea, ICES Division 7.a, is a relativity enclosed sea basin situated between Ireland/Northern Ireland and Great Britain. It is connected to the Celtic Sea (7.g) in the south by St George's Channel, and in the north, it is linked to the West of Scotland (6.a) by the Northern Channel. Within the Irish Sea there are distinct habitat patches formed from a combination of bathymetry, topographical features and hydrography. The area contains a deeper channel in the west with a maximum depth exceeding 275 m, and eastern bays have depths less than 50 m. A large, well-defined, deep-water mud basin is located in the northwestern region close to the Northern Irish and Irish coastline. There is another distinct mud habitat in the east of the division. These two mud habitats are identified as two separate *Nephrops* functional units (FU14 and FU15; Figure 5.1).

Norway lobster (*Nephrops*) is the main demersal species landed by Irish Sea fisheries. *Nephrops* is mainly targeted using otter trawls (OTB) with mesh size in the range 70–99 mm. This fishery is primarily focused on the northwest of the Irish Sea, with > 95% of landings in 2022 caught in FU 15. Of demersal species haddock accounts for the second highest landings and is mainly caught in otter trawls (OTB) and midwater otter trawls (OTM). Sole accounts for the third highest landings in the Irish Sea, and is mainly targeted by beam trawls (TBB).

In addition to demersal fisheries, a seasonal pelagic herring fishery operates in late summer to early autumn in the pre- and post-spawning period. Dredge fisheries target king and queen scallops, with king scallops in coastal areas and the queen scallop fishery operating in the central area south of the Isle of Man. To a lesser extent queen scallops are also targeted using trawlnets during the late summer when swimming activity is most pronounced.

Four nations carry out most of fishing activity in the Irish Sea, namely: Northern Ireland, Republic of Ireland, England and Belgium. There is variation in the landings profiles of each country reflecting different fishing patterns, practices, and quota shares (Figure 5.2 and 5.3).

5.1.1 Management measures

Fishing opportunities Irish Sea (ICES Division 7.a) are managed by TACs for six demersal species: cod, haddock, plaice, sole, whiting, and *Nephrops.* Single species advice for these stocks is issued annually by the ICES Working Group for the Celtic Seas Ecoregion (WGCSE). Category 1 analytical assessments are conducted for all fish stocks. *Nephrops* stocks are assessed using UWTV based stock assessment models at the FU level.

A multiannual management plan (MAP) for Western and adjacent waters has been adopted by the EU for cod, haddock and whiting in the Irish Sea, and *Nephrops* in FU's 14 and 15 (Council Regulation (EC) 2019/472) which ICES considers to be precautionary. Plaice in the Irish Sea is taken into account under the EU multiannual plan (MAP) as a bycatch species. However, there is no agreed shared management plan with UK for these stocks. ICES is not aware of any agreed precautionary management plan for sole in this area. A single *Nephrops* TAC is issued for Subarea 7 (with an 'of which' provision for FU16). ICES notes that to ensure that each stock is exploited sustainably, management should be implemented at the FU level.

Cod and whiting are managed as bycatch only in the Irish Sea, with no directed fishery of either species permitted in the area. As such they are likely to have considerable mixed fisheries implications, and catches may be impacted by adjusting the fishing opportunities permitted for other species in addition to technical measures such as area closures and technical devices such as highly selective gears. For a summary of current technical measures in the region see: https://bim.ie/fisheries/advisory-services/fisheries-management-chart. Catches of whiting are primarily observed in *Nephrops* directed otter trawl fisheries, with a smaller proportion from finfish directed otter trawls and other gears. Catches of cod are primarily observed in demersal fish directed otter trawl fisheries (both OTB and OTM), with significant proportions from *Nephrops* directed otter trawls and beam trawls. Council Regulation (EC) No. 304/2000 and Regulation (EC) No. 2549/2000 introduced area closures on the cod spawning grounds for ten weeks from mid-February till the end of April. These area closures now occur annually, although there are some derogations in place for gears not targeting cod.

As of the 1 January 2016 a European demersal species landings obligation was introduced (Commission Delegated Regulation (EU) 2015/2438). This regulation prevents the discarding at sea of certain species on a fishery-by-fishery approach. This regulation prevents the discarding of certain species on a fishery-by-fishery approach. Since 1 January 2019, catches of all quota species in the Celtic Seas have been subject to the EU landings obligation rule, except where an exemption is in place, and a UK landings obligation remains in place following the exit of the UK from the EU. An overview of the exemptions of the EU landings obligation can be found below:

Exemptions to the landing obligation in 2022

Species	Exemption type	Area	Gear	Maximum de minimis exemption (% of total annual catch)
Albacore tuna	De minimis	7	Midwater pair trawls	5
Whiting	De minimis	7b -7k	Bottom trawls and seines ≥ 80 mm, Pelagic trawls and beam trawls 80-119 mm	5
Sole	De minimis	7a, 7d - 7g	Beam trawl 80-119 mm with Flemish Panel	3
Sole	De minimis	7d,e,f & g	Trammel nets and gill nets	3
Haddock	De minimis	7b,c & 7e-k	Bottom trawls and seines ≥ 100 mm with catches comprising ≤30% Nephrops	5
Haddock	De minimis	7b,c & 7e-k	Vessels using ≥ 80 mm, with catches comprising more than 30% Nephrops	5
Haddock	De minimis	7b,c & 7e-k	Beam trawls ≥ 80 mm with Flemish Panel	5
Haddock [1]	De minimis	6a	Nephrops bottom trawls using <119mm with HSG*	3
Megrim [2]	De minimis	7	Beam Trawls 80-119mm & Bottom trawls**	4
Horse mackerel	De minimis	6 & 7b-k	DMF [3] using bottom trawls, seines & beam trawls	3
Mackerel	De minimis	6 & 7b-k	DMF [3] using bottom trawls, seines & beam trawls	3
Boarfish	De minimis	7b,7c,7f-7k	Bottom trawls	0.5
Argentine	De minimis	EU 5b & 6	Bottom trawls ≥ 100 mm	0.6
Species	**Exemption**	**Area**	**Gear**	**Discard Release Notes**
Nephrops	Survivability	6 & 7	Pots, creels or traps	immediately whole & where caught
Nephrops	Survivability	7	Bottom trawls 70-99mm with HSG* or ≥100mm	immediately whole & where caught
Nephrops	Survivability	6a (<12nm)	Bottom trawls 80-110 mm	immediately whole & where caught
Skates & rays	Survivability	6 & 7	All gears	Released immediately
Plaice	Survivability	7b -7k	Seines (SSC)	Released immediately
Plaice	Survivability	7d -7g	Trammel nets and otter trawls	Released immediately
Plaice	Survivability	7d -7g	Beam Trawls with flip up rope or benthic release panel (vessels > 221kW)	Released immediately
Plaice	Survivability	7a-7g	BT2 (vessels ≤221 kW or ≤24 m) inside 12 nm, tows ≤ 1:30 hour	Released immediately
All Species	Survivability	EU 5b; 6 & 7	Pots, creels and traps	Released immediately

[1] Applies ony to haddock <MCRS (30cm), [2] Applies ony to megrim <MCRS (20cm), [3] Demersal Mixed Fisheries

* See list of area-specific highly selective gears for Nephrops in table

** Bottom trawls: 70 to 99mm in 7f, 7g, 7h North of 49.5°N & 7j East of 11°W - catches must comprise 55% whiting or anglerfish, hake & megrim combined; ≥100mm in the rest of 7

Reference: Commission Delegated Regulations (EU) 2020/2015 (Consolidated)

5.2 Model

5.2.1 Software

The FCube model has been coded as a method in R 64bits (R Development Core Team, 2008), using the FLR framework (Kell *et al.*, 2007; www.flr-project.org). Input data are in the form of FLFleets and FLStocks objects from the FLCore 2.6.19 and FLFleet 2.6.1 packages. Stock objects were created using outputs from single-stock assessment for each fish stock: FLa4a (version 1.8.2)

and FLXSA (version 2.6.1). Forecasts for fish stocks with analytical assessments were projected using the fwd() function in the Flash package (version 2.5.11). *Nephrops* catch forecasts were calculated based on a combined FU14 and FU15 stock, with the same R approach used for individual FU's in the single-stock advice. As such, the input parameterization as well as the stock projections are made externally using existing methods and packages, while only the FCube specific steps are internalised in the method, thus keeping full transparency and flexibility in the use of the model.

All code and data are stored at: https://github.com/ices-taf/2023_IrS_MixedFisheriesAdvice

Table 5.1. Software used by WGCSE in the single-species assessments and forecasts

Stock	Assessment	Forecast
cod.27.7a	Stock synthesis (SS3)	FLR STF
had.27.7a	ASAP (Age-Structured Assessment Programme; NOAA)	FLR STF
nep.fu.14	Underwater TV survey	NA
nep.fu.15	Underwater TV survey	NA
ple.27.7a	Age-based stochastic analytical assessment (SAM)	SAM
sol.27.7a	Age-based analytical assessment (XSA)	FLR STF
whg.27.7a	ASAP (Age-Structured Assessment Programme; NOAA)	FLR STF

5.2.2 Scenarios

FCube (Ulrich *et al.*, 2008; Ulrich *et al.*, 2011) was used to forecast seven mixed fisheries scenarios (Table 5.2). The basis of the model is to estimate the future levels of effort for each fleet corresponding to the fishing opportunities available to that fleet, based on recent fleet effort distribution and catchability by stock and métier. This level of effort is then used to estimate the corresponding summed *F* of all fleets per stock, and catches are then forecast using the standard forecast procedures from the single-species assessment (with the exception of plaice which was forecast using FLR rather than SAM). The basis for each single-stock advice is retained in the current mixed fisheries framework.

The mixed fisheries model includes cod, haddock, plaice, sole, whiting and *Nephrops* FU14 and FU15. For fish stocks the stock objects used in the model were received directly from the single-stock coordinators and match those used in the single-stock advice (ICES, 2023a). *Nephrops* stocks in FU14 and FU15 were merged in the mixed fisheries model (see Section 5.3.1 below for technical details), and a single scenario representing the sum of the advice for both FU14 and FU15 was used to represent the Irish Sea *Nephrops* fishing advice. Following model testing this was selected as the best approach, because the landings and discards data in MIXFISH accessions and InterCatch for fish stocks is at the level of ICES division (7.a). Therefore, it is not currently possible to allocate catch compositions of fish stocks at the individual FU level. Furthermore, *Nephrops* targeting fleets move between FU's using the same métiers depending on fishing opportunities and conditions. Therefore, while *Nephrops* stocks are best assessed as separate FU's the behaviour and catch compositions of the fishery within the mixed fishery model (given the available data) are best captured by merging FU14 and FU15 stocks and advice within the model. Out of FU and FU19 catches are excluded from the model, as these are unlikely to reflect the main target areas of the Irish Sea *Nephrops* fishery and represent <1% of the landings.

A retrospective analysis highlighted difficulties in predicting catches of sole based on Norway lobster and gadoid catches under previous model assumptions (ICES, 2023b). This is due to differences in the fleet behaviour of fleets predominantly targeting sole (beam trawl fleets and Belgian otter trawls), which are largely unrelated to other fisheries in the region. Therefore, this year, the stock-specific scenarios (Table 5.2) additionally restrict the effort of fleets targeting sole in the region, based on the zero-catch advice for sole in 2024. This affects the interpretation of these scenarios, particularly for Norway lobster and haddock ("nep-is" and "had-is"), where projected catch, *F* and SSB (including those of sole and plaice) do not include any contribution from fleets which have targeted sole in the recent past.

A new scenario has been added this year, the "min_range" scenario (see Table 5.2). The "min_range" scenario explores how the higher catch options associated with the $F_{MSY\ upper}$ or scaled F_{MSY} reference points (for stocks where ranges are defined) may reduce choking behaviour in mixed fisheries and increase overall quota uptake. Under this scenario scaled F_{MSY} catch options are applied in the case of stocks with headline zero-catch advice based on precautionary principles in the single-stock advice. As such the "min_range" scenario cannot be considered precautionary for these stocks. The "min_range" scenario makes use of the multiannual plan (MAP) F_{MSY} ranges defined for demersal stocks under the EU MAP for the western waters (EU, 2019). There is no agreement with the UK regarding this plan, and it is not used as the basis of the advice for these shared stocks.

The following scenarios are included in the mixed fisheries considerations:

Table 5.2. Mixed fisheries scenarios considered for the Irish Sea

Scenario code	Mixed fisheries effort assumption	Basis for catch target 2024
Minimum (*min*)	For each fleet, fishing in 2024 stops when the first stock share* of that fleet has been caught. This scenario is the most precautionary option and can highlight some potential "choke species" issues.	ICES catch advice
Maximum (*max*)	For each fleet, fishing in 2024 continues until all stock shares* of that fleet have been caught. This option illustrates the degree of overfishing of the single-stock advice if fishing is not restricted by the fleet stock shares*.	
Status quo effort (*sq_E*)	The effort of each fleet in 2024 is set equal to the average effort in the most recent three years (2020–2022) for which landings and discard data are available.	
Minimum including ranges (*min_range*)	Same as min scenario.	Catches corresponding to $F_{MSY\ upper}$ for stocks in good status (SSB ≥ MSY $B_{trigger}$) and scaled F_{MSY} advice levels (F_{MSY} × SSB/MSY $B_{trigger}$) for the other stocks (including zero catch advice stocks).
Single-stock advice for cod (*cod-is*), haddock (*had-is*), Norway lobster (*nep-is*), sole (*sol-is*), and whiting (*whg-is*)	For each fleet, fishing in 2024 stops when the catch of the focus stock meets the fleet's stock share*. Fleets which do not catch the focus stock follow a *status quo* effort assumption (as described for the sq_E scenario). In all of these single-stock advice scenarios, fleets that target sole (all beam trawls and Belgium otter trawls) are limited by their stock share of sole rather than by the scenario focus stock.	ICES catch advice

*** Throughout this document, the term "stock share" is used to describe the share of the fishing opportunities for each fleet, calculated based on the single-stock advice for 2024 and the historical proportion of the catches of that stock taken by the fleet (average 2020–2022).**

5.3 Data compilation

Data used to produce the mixed fisheries forecasts comes from three sources:

1. Stock data: stock abundance, structure, reference points and advice (ICES, 2023a).
2. Fisheries dependent data: fleet and métier trends in landings and effort (2020–2022), are from the WGMIXFISH data call.
3. Discard data: from the ICES InterCatch database, and WGCSE stock coordinators.

5.3.1 Stock data

Single species stock assessment outputs including biomass, fishing mortality, biological parameters (maturity, natural mortality) and age-structure for demersal fish stocks were supplied by WGCSE stock co-ordinators in the form of FLR stock objects (with the exception of plaice which was supplied as a SAM object). FLR stock objects for *Nephrops* FU14 and FU 15 were created based on landings, discard and stock numbers, mean weights and harvest rates in the WGCSE advice meeting report (ICES, 2023a). *Nephrops* stock objects were merged by summing their respective stock objects using the R package FLCore, to create a single Irish Sea *Nephrops* stock object within the mixed fisheries model (see Section 5.2.2 above). This results in the annual landings, discards, catches and stock (tonnes and number) being the sum of those in the individual stocks. The individual weights in landings, discards, stock and catches, are calculated as the mean individual weight per year weighted by the numbers of each FU14 and FU15 in each year. The annual harvest rates of the merged stock object were calculated as the catch numbers divided by the stock numbers per year. The forecast harvest rate based on *Nephrops* advice was calculated based on the sum of the advice for both FU's. Specifically, the advised harvest rate for catch in the advice year is calculated as:

$$Adviced\ catch\ numbers = \frac{Advised\ catch\ FU14\ (t) + Advised\ catch\ FU15\ (t)}{Mean\ catch\ weight\ (g)}$$

$$Harvest\ rate = \frac{Advised\ catch\ numbers}{Stock\ numbers}$$

Reference points, advice for 2023, TAC in 2022 and trends in stock status were from WGCSE advice sheets. The consistent support and cooperation from the chairs and single species stock assessors has greatly eased the workload of WGMIXFISH. An overview of the trends and advice for stocks included in Irish Sea mixed fisheries analysis from the single species advice sheets for these stocks is described below (ICES, 2023a; Table 5.3).

5.3.2 Fisheries dependent data

Information on fisheries is supplied according to the WGMIXFISH data call in the form of "accessions" data, this provides disaggregated fleet data at the level of métier which are consistent with the definitions outlined in the DCF. This includes landings (in tonnes) for defined species and fishing effort (in KW days). Landings and effort métiers for the model stocks were checked for consistency within countries and years, and effort data were available for all of the métiers

for which landings were reported. For comparison of accessions data and other data sources see Section 5.3.5 on Quality Control.

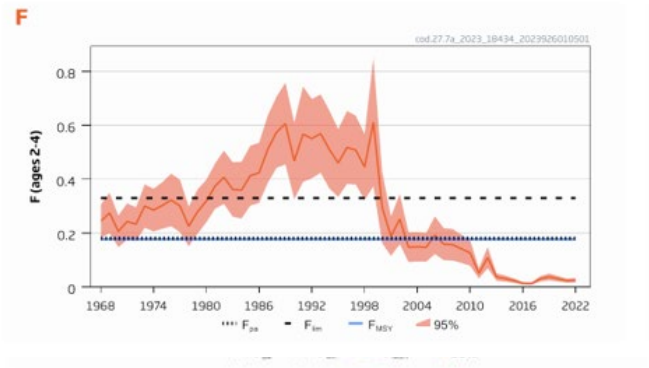
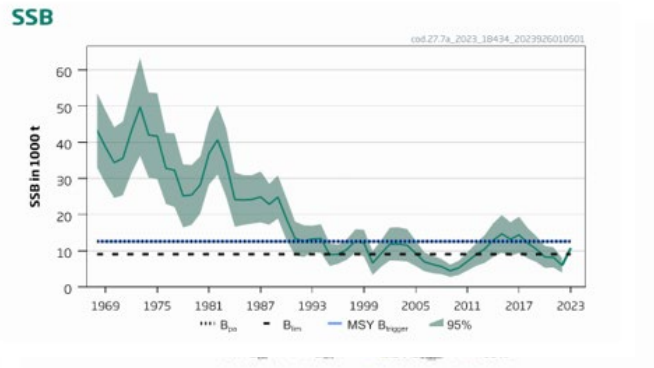
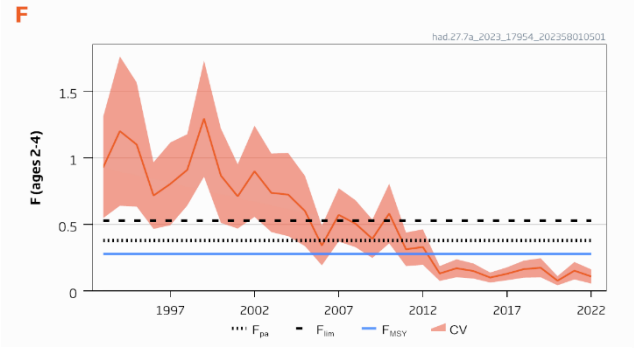
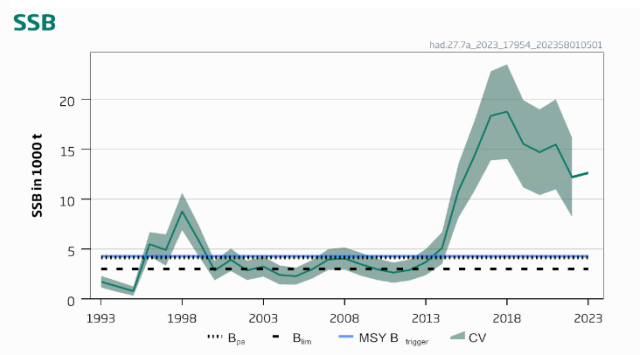
5.3.3 Discard data

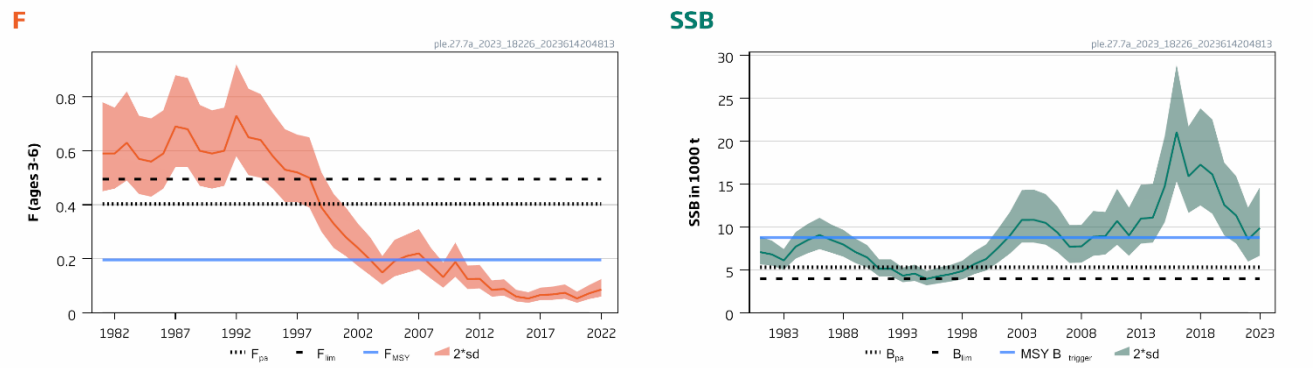
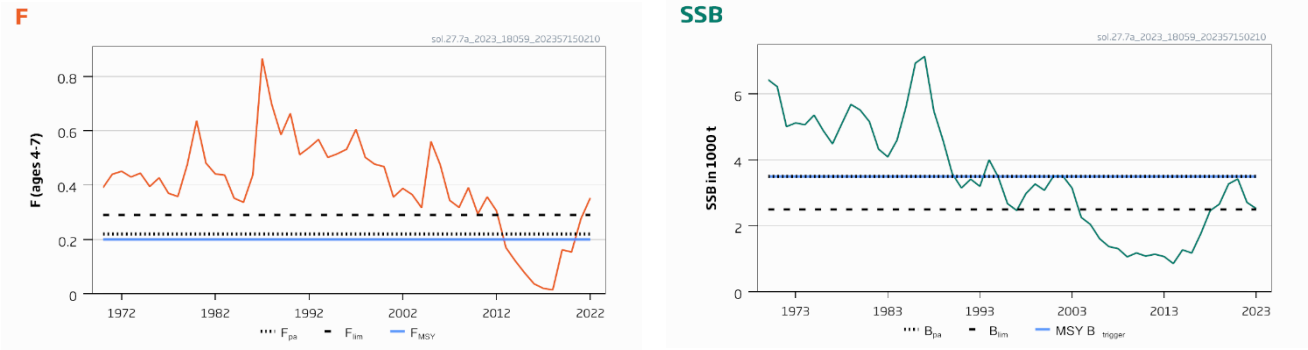
Discard ratios were calculated per stock, country, year and métier (DCF level 6 where possible e.g. OTB_CRU_70-99_0_0_all) from InterCatch data used in single-stock assessments. These ratios were applied to the landings data supplied in the WGMIXFISH accessions data call to calculate corresponding discard weights for the submitted landings.

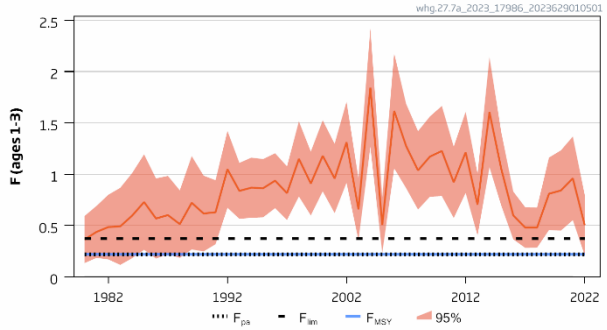
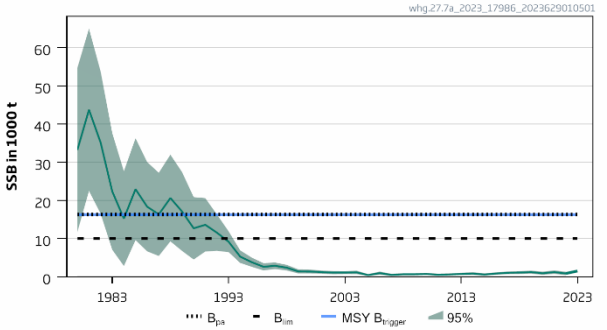
For some 7.a stocks discard data are estimated by WGCSE single-stock assessors outside the ICES InterCatch system prior to the single-stock assessment (e.g. sol.27.7.a and whg.27.7.a), and in these cases discard data in InterCatch formats were sourced directly from the stock coordinators of these stocks. In the case of sol.27.7a this is standard practice, while in the case of whg.27.7a this related to changes in data processing to accommodate incorporation of other sampling sources following disruptions to sampling programmes. In *Nephrops* FU14 there was no discard data available in 2020 due to the Covid-19 pandemic. Therefore, discard rates were estimated as the mean value of the three preceding years (per country and métier), as per the WGCSE single-stock assessment for this stock. An adjustment was made to the discard estimate of ple.27.7a for the English OTB_CRU_70_99_0_0_all in 2021 to match the single-stock assessment as the discard raising for this fleet was conducted outside InterCatch for that year. Haddock discards for 2022 from some Irish fleets were also estimated separately due to low sampling and were therefore received directly from the WGCSE stock assessor.

Overall, the conformity of métiers in MIXFISH and InterCatch was high, however, it would be desirable for countries to continue improving the consistency between data uploaded to InterCatch and data submitted to WGMIXFISH (for details see 5.3.7 Quality Control).

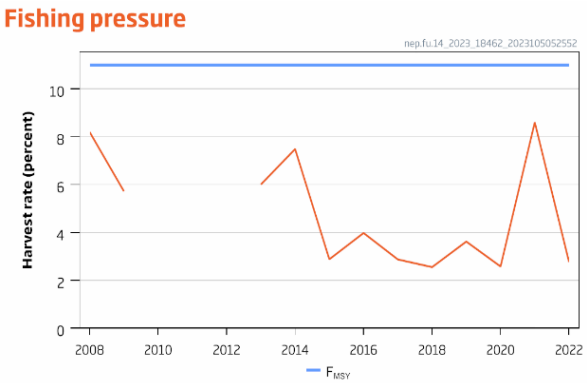
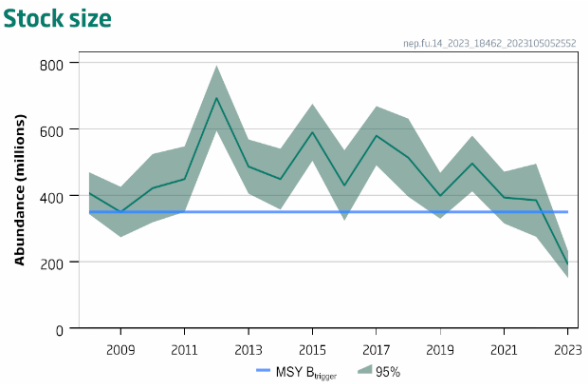
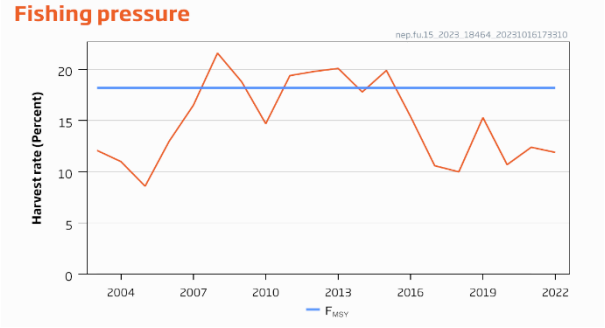
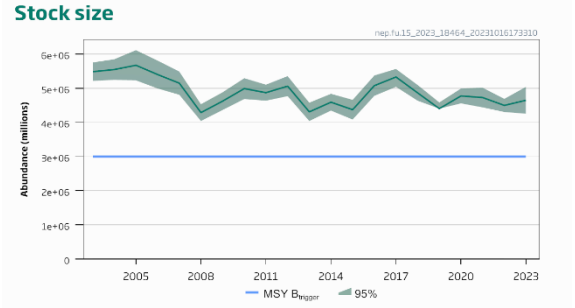
Table 5.3. Summary of advice, fishing pressure/harvest rate and stock trends for the stocks included in the Irish Sea mixed fisheries model (ICES, 2023a).

Fish stocks			
Species	**Area**	**Stock status**	**Advice**
cod.27.7.a	Irish Sea – Division 7a (excluding rectangles 33E2 and 33E3)	  **Summary:** Fishing pressure on the stock is below F_{MSY} and spawning-stock size is below MSY $B_{trigger}$ and between B_{pa} and B_{lim}.	ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2024. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock.
had.27.7a (Haddock)	Irish Sea – Division 7a (excluding rectangles 33E2 and 33E3)	  **Summary:** Fishing pressure on the stock is below F_{MSY}, and spawning stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 2263 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock.

Fish stocks			
Species	**Area**	**Stock status**	**Advice**
ple.27.7a (Plaice)	Irish Sea – Division 7a		ICES advises that when the MSY approach is applied catches in 2024 should be no more than 1902 tonnes.
Summary: Fishing pressure on the stock is below F_{MSY}, and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.			
sol.27.7a (Sole)	Irish Sea – Division 7a		ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2024.
Summary: Fishing pressure on the stock is above F_{MSY}, F_{pa} and Flim; spawning-stock size is below MSY $B_{trigger}$ and B_{pa}, but above B_{lim}.			

Fish stocks			
Species	**Area**	**Stock status**	**Advice**
Whg.27.7a	Irish Sea – Division 7a (excluding rectangles 33E2 and 33E3)	**F**  **SSB** 	ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catches in 2024 and 2025.

Summary: Fishing pressure on the stock is above F_{MSY}, F_{pa}, and F_{lim}; spawning-stock size is below MSY $B_{trigger}$, B_{pa}, and B_{lim}.

Nephrops stocks			
Species	**Area**	**Stock status**	**Advice**
nep.fu.14 (*Nephrops*)	Divisions 7.a, Functional Unit 14 (Irish Sea, West)	  **Summary:** Fishing pressure on the stock is above F_{MSY}, F_{pa}, and F_{lim}; spawning-stock size is below MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2016–2022, catches in 2024 should be no more than 222 tonnes.
nep.fu.15 (*Nephrops*)	Divisions 7.a, Functional Unit 15 (Irish Sea, West)	  **Summary:** Fishing pressure on the stock is below F_{MSY}, and stock size is above MSY $B_{trigger}$.	ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2020–2022, catches in 2024 should be no more than 12 008 tonnes. To ensure that the stock in Functional Unit (FU) 15 is exploited sustainably, management should be implemented at the FU level.

5.3.4 Building the fleet

The above data sources are then combined to produce the "fleet object" which is used as an input for the FCube model. Fleet objects were created using the FLCore 2.6.19 and FLFleet 2.6.1 packages, fleets were defined by their country and predominant fishing gear and target fishery based on mesh-size. Vessel lengths have not been used in the categorization of fleets, due to the relatively small size of the fishery operating in the Irish Sea. Fleet categories are not necessarily exclusive, and individual boats may contribute to the effort of multiple fleets if they change their fishing gear (i.e. boats may be polyvalent). Within countries fleets were split based on the following categories:

- Beam trawls (all sizes)
- Otter trawls crustaceans (mesh-size 70–99 mm)
- Otter trawls demersal fish (mesh-size ≥ 100 mm)
- Pelagic gears (32–69 mm)
- Seines

Any fleets which did not land > 1% of any stock in the model were then grouped into an 'MIS_MIS' fleet to reduce model complexity.

Métiers were based on the Technical Regulation (TR) classes methodology outlined in the long-term plan for cod stocks, with an added category to describe gears targeting pelagic fish (OTM/PTM mesh-size 32–69 mm). Midwater otter trawls with a mesh-size >100 mm were included in the TR1 category. Specifically:

Gear groupings and assigned métiers in the FCube fleets:

a) Bottom trawls and seines (OTB, OTT, PTB, SDN, SSC, SPR, OTM) of mesh:
   1. TR1 equal to or larger than 100 mm,
   2. TR2 equal to or larger than 70 mm and less than 100 mm,
   3. TR3 equal to or larger than 16 mm and less than 32 mm;

b) Beam trawls (TBB) of mesh:
   1. BT1 equal to or larger than 120 mm
   2. BT2 equal to or larger than 80 mm and less than 120 mm;

c) Gillnets, entangling nets (GN);
d) Trammelnets (GT);
e) Longlines (LL)
f) Pelagic – Otter or pelagic trawls with mesh sizes 32–69 mm

Métiers accounting for < 1% of landings of any stock within a fleet were grouped as 'MIS'. This process resulted in 12 fleets, with 1 métier per fleet for all fleets except pelagic fleets which include 2 métiers (Figure 5.4). Six separate métier classes were included in the final fleet objects: TR1, TR2, BT2, PTM_SPF, OTM_SPF and MIS. Métiers are described according their DCF level 5 métiers in the advice sheet for consistency with DCF, WGMIXFISH accessions and Celtic Seas Ecoregion terminology.

Table 5.4 Fleets and métiers used in the Irish Sea mixed fisheries model.

FCube Fleet name	Country	FCube métier name	DCF métier	Gear	Target species
Beam_all_BE	Belgium	BT2	TBB_DEF	Beam trawls	Demersal fish
Beam_all_EN	England (UK)	BT2	TBB_DEF	Beam trawls	Demersal fish
Beam_IE	Ireland	BT2	TBB_DEF	Beam trawls	Demersal fish
DSeine_IE	Ireland	TR1	SSC_DEF	Scottish seines	Demersal fish
Otter_CRU_EN	England (UK)	TR2	OTB_CRU	Otter trawls	Crustaceans
Otter_CRU_IE	Ireland	TR2	OTB_CRU	Otter trawls	Crustaceans
Otter_CRU_NI	Northern Ireland (UK)	TR2	OTB_CRU	Otter trawls	Crustaceans
Otter_DEF_BE	Belguim	TR1	OTB/OTM_DEF	Otter trawls	Demersal fish
Otter_DEF_IE	Ireland	TR1	OTB/OTM_DEF	Otter trawls	Demersal fish
Otter_DEF_NI	Northern Ireland (UK)	TR1	OTB/OTM_DEF	Otter trawls	Demersal fish
Pelagic_NI	Northern Ireland (UK)	Pelagic	OTM/PTM_SPF	Pelagic/midwater trawls	Pelagic fish
*MIS_MIS	Any	MIS	OTHER	Other gears, including dredges, pots, gillnets, trammelnets, long-line trawls and gears reported as miscellaneous	Any

*** Fleets and métiers with landings < 1% of any of the stocks in the model (average 2020 to 2022)**

Alternative configurations for fleets in the Irish Sea model were discussed at the WGMIXFISH 2022 Irish Sea Mixed Fisheries Model Review meeting, and at the WGMIXFISH-Methods meeting 2022 (see ICES 2022b, pp 63–65 for details). Both of these meetings upheld the view that the separation of fleets into separate groupings relating to *Nephrops* (CRU) and demersal (DEF) fisheries produced more realistic model behaviour than previous model versions which grouped these métiers within national 'otter trawl fleets'. Specifically, disaggregating these métiers allows the model to simulate the behaviour where boats may continue fishing with a different métier (e.g. OTB_CRU instead of OTB_DEF), even after the one of these métiers has reached its limit for a particular stock. For example, under the current configuration, if a nation has reached its landings quota (stock share) of cod for its OTB_DEF fleet, that nation would be able continue fishing with its OTB_CRU fleet, if either a) there was still landings quota for cod available to the OTB_CRU fleet, or b) if the OTB_CRU fleet for that nation did not catch any cod in the model.

5.3.5 Quality control

5.3.5.1 Métier coding; WGMIXFISH vs. InterCatch

Where possible discard estimates were retrieved from InterCatch and assigned to the same métiers within the WGMIXFISH accessions files. This method relies on being able to match métier definitions between the two datasets. Where an exact match was not possible, expert knowledge

was used to apply discard rates from similar InterCatch métiers (see Table 5.5). These métier year combinations accounted for < 1% of the total accessions landings for the stocks in the model.

5.3.5.2 Matching accessions; InterCatch and ICES landings

The initial match between the accessions landings, InterCatch landings and official landings was good (Figure 5.6). However, some small discrepancies remained between the WGMIXFISH accessions landings for gadoid stocks (cod, haddock and whiting) for some fleets. Therefore, WGMIXFISH accession landings data were rescaled per country, métier and gadoid stock to exactly match those used in the single-stock assessment prior to further analyses. Following the matching of landings data described above, discard rates from InterCatch were applied to the WGMIXFISH accessions landings to estimate discards. There was a good match between the accessions calculated discards, InterCatch discards and ICES advice discards for all stocks.

In the case of two stocks, ple.27.7a and sol.27.7a, discards are treated differently in the single-stock assessment stock objects. For plaice, discards are adjusted by an estimated 40% dead discard rate in the assessment to represent survivability of discarded catch (i.e. total discards x 0.6 = dead discards; ICES, 2023a). For sole, no discards are included in the assessment or FLR forecast of the stock, but instead discards are added to the forecast *post hoc* based on an estimated 12.5% discard rate (ICES, 2023a). Therefore, the dead discard rate was applied to plaice discards on the country, year, métier level within the mixed fishery fleet objects, and the discards of sole were therefore set to zero in the mixed fisheries fleet objects to match the single-stock assessment procedures. After the FCube mixed fisheries forecast, the dead discards of plaice and the discards of sole were added onto the forecast catch estimates as per the single-stock assessment process for each stock. These procedures are intended to maximize consistency between the single-stock assessment and mixed fisheries model.

5.4 Mixed fisheries forecasts

5.4.1 Description of scenarios

5.4.1.1 Baseline runs

The objectives of the single-species stock baseline runs were to:

1. reproduce as closely as possible the single-species advice,
2. act as the reference scenario for subsequent mixed fisheries analyses.

The various single-stock forecasts produced by the single species assessment Working Groups are performed using different software and setups (Table xx). The FCube model has been coded as a method in R 64bit (R Development Core Team, 2008), as part of the FLR framework (Kell *et al*., 2007; www.flr-project.org). Input data are in the form of FLFleets and FLStocks objects from the FLCore 2.6.16 package, and two forecast methods were used, stf() from the FLAssess (version 2.6.3) and fwd() from the Flash (version 2.5.11) packages. Stock objects were processed using FLa4a (version 1.8.2), FLXSA (version 2.6.5). As such, the input parameterization as well as the stock projections are made externally using existing methods and packages, while only 3 steps are internalised in the method, thus keeping full transparency and flexibility in the use of the model (see Stock Annex for details). In the mixed fisheries baseline run, all forecasts for analytical fish stocks were calculated using the FLR forecast method.

Nephrops in the Irish Sea mixed fishery model represent the sum of FU14 and FU15 *Nephrops* stocks (see sections 5.2.2 and 5.3.1 for details). Therefore, in the baseline run forecasts for this stock are compared to the sum of the advice for FU14 + FU15. Only catches and landings can be compared with the single-stock advice, as there is no comparable harvest rate for the combined

stocks calculated in the single-stock advice. Future catches and landings of *Nephrops* are estimated following the single-stock procedures.

The same forecast settings as the single species assessment are used for each stock regarding weight-at-age, selectivity, and recruitment, as well as assumptions on the F in the intermediate year and basis for advice as the single-stock forecasts for the baseline run. This ensured greater coherence between the single-stock and mixed fishery forecasts. Some differences can occur in the forecast calculations, (because of the diversity of single-stock assessment methods used) and WGMIXFISH always investigates in depth the reasons for potential discrepancies. Adjustments to the FCube forecast methods are made if necessary to minimize discrepancies.

The baseline run acts as a quality control procedure to ensure that the stock objects and projection methods closely match those used in the single-stock assessment. The baseline run has the additional benefit of acting as a quality control check on the projections produced by the single-stock assessments.

5.4.1.2 Mixed fisheries runs

FCube intermediate and forecast year assumptions

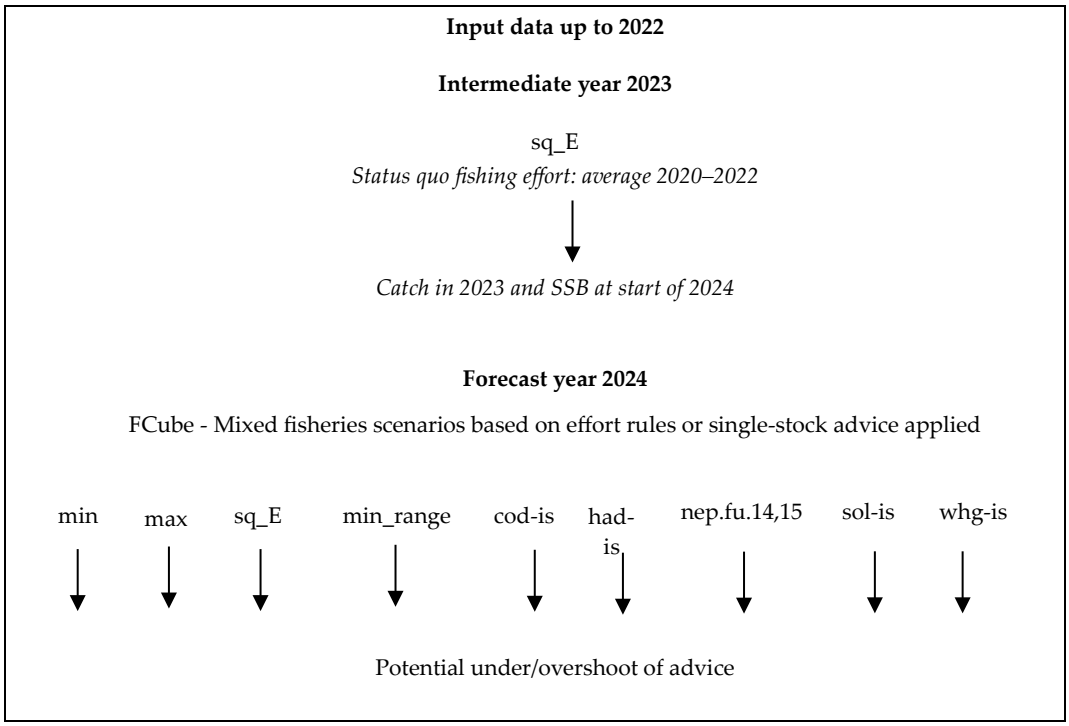
In all FCube scenarios, the effort of fleets and métiers in the intermediate year was the average of the three preceding data years (2020–2022). This is similar to an intermediate year assumption of mean F of the preceding three years commonly used in single-stock assessments, but individual single-stock assessments may differ in their intermediate year assumptions. These differences in assumptions may produce small differences in intermediate year forecasts between mixed fisheries and single-stock assessments. FCube catchabilities are the mean of last three data years per métier. Stock shares of fleets and métiers are calculated as the average proportion of catches reported by each fleet and métier in the preceding three data years.

No landings to discards split is presented for forecast years in the mixed fisheries model projections. Internally, the model assumes all catch of cod, haddock and sole in the intermediate and forecast years to be landed, concordant with a full application of a landings obligation in future years. Plaice and sole discards are treated within the stock objects in the same manner in the single-stock assessment, and discards are added to the forecast values projected by FCube as per the single-stock advice process.

FCube analyses for the TAC year (2024)

Nine mixed fisheries scenarios were run as outlined in Section 5.2.2 above. A 'min', 'max', *status quo*, and 'min_range' scenario, and stock-specific scenarios with a fishing mortality consistent with the F in the single-stock headline advice for cod, haddock, *Nephrops*, sole and whiting. A scenario for plaice was not run as plaice is primarily a bycatch stock of other fisheries in the region, and the current ICES catch advice for plaice in 7.a. is unlikely to be limiting in 2024 based on recent observed catches. A retrospective analysis highlighted difficulties in predicting catches of sole based on Norway lobster and gadoid catches under previous model assumptions (ICES, 2023b). This is due to differences in the fleet behaviour of fleets predominantly targeting sole (beam trawl fleets and Belgian otter trawls), which are largely unrelated to other fisheries in the region. Therefore, this year, the stock-specific scenarios (Table 5.2.2) additionally restrict the effort of fleets targeting sole in the region, based on the zero-catch advice for sole in 2024.

In summary, the FCube runs followed the scheme below:



5.4.2 Results of FCube runs

5.4.2.1 Baseline run – reproducing the single-stock advice

Overall consistency of results between single species stock assessments and FCube baseline runs was achieved, based on comparisons of predicted catches, landings, SSB and Fbar in 2023 and 2024 for analytical stocks (Table 5.6, Figures 5.7 and 5.8), and landings and catch in 2024 for *Nephrops* stocks (Table 5.7). For demersal fish stocks the differences between the baseline runs ('reproduce the advice') forecasts and those of WGCSE were small (≤ 3.9% in all cases). The largest deviations were seen for plaice and likely result from the difference in the forecast method used (i.e. FLR in the mixed fisheries forecast rather than SAM which is used in the single-stock assessment). However, these differences were low at ≤ 3.3% for SSB and ≤ 3.9% for catches, and therefore FLR was considered to be an appropriate method for reproducing this stock forecast in the Irish Sea FCube model this year. *Nephrops*, comparisons between the forecast in 2023, and the sum of the advice targets for NEP14 and NEP15 from the WGCSE showed very small differences (≤ 2.3%). Hence, the process of merging the stocks in the mixed fisheries model is considered an adequate match for the advice forecasts conducted at the functional unit level by WGCSE. For all model stocks, the deviation from the in single-stock advice was well below the acceptable deviation threshold of 10%, applied in other advice regions.

Figure 5.9 shows the required change in fishing mortality for each fish stock if the intermediate year assumptions (2023) and advice targets (2024) of the single-stock advice are to be met. A large reduction in Fbar would be required to meet the advice target of zero catch for whiting and sole in 2023, with a small reductions in the Fbar of cod also required. Meanwhile, an increase in Fbar would be required to catch up to the advice of haddock and plaice. *Nephrops* catches in recent years are also considerably below current single-stock advice.

5.4.2.2 Mixed fisheries analyses

The overview of the FCube catch projections for each scenario is shown in Tables 5.9–5.11 and Figures 5.10–5.11. In contrast to single-stock advice there is no single advised catch level based

on the mixed fishery approach, instead a range of scenarios are presented. Scenarios that result in under- or overshoot of single-stock advice are useful in identifying imbalances between the fishing advice for the various stocks. They indicate the direction in which fleets may have to adapt to fully utilize their catch opportunities without collectively exceeding single-stock fishing opportunities. ICES single-stock advice for the stocks considered here are based on a combination of the MSY approach and precautionary considerations. The MSY approach is used for haddock, plaice and *Nephrops*. Scenarios for cod, sole and whiting are based on ICES zero-catch advice, based on precautionary considerations.

The "min" scenario is consistent with a full implementation of a landing obligation given the individual single-stock advice (Table 5.9, Figure 5.10). In 2024, the "min" scenario shows that whiting limits all 12 fleets. This is due to the zero catch advice for whiting and that all fleets catch whiting. Secondarily, cod and sole are also very limiting due to the zero-catch advice for these stocks. Cod and sole are caught by 11 of the 12 fleets (Figure 5.11).

The "max" scenario shows the upper bound of potential fleet effort and stock catches (Table 5.9, Figure 5.10), in that it assumes all fleets continue fishing until all their stock shares for all stocks are exhausted irrespective of economic viability, legality, or fleet capacity. In 2024, the "max" scenario, shows that plaice would be the least limiting stock for 11 out of 12 fleets (Figure 5.11).

The *status quo* effort "sq_E" scenario sets the effort of each fleet in the forecast years equal to the average of the effort in the most recent three years for which data are available (2020–2022). This scenario investigates the mixed fisheries outcomes if the situation remains the same in terms of total effort and effort allocation among métiers. For 2024, this scenario shows advised catch overshoots for cod and whiting, and undershoots of haddock and Norway lobster (Table 5.9, Figure 5.10).

The "min_range" scenario explores how the higher catch options associated with the $F_{MSY\ upper}$ or scaled F_{MSY} reference points (for stocks where ranges are defined) may reduce choking behaviour in mixed fisheries and increase overall quota uptake. Catches for all stocks in 2024 are marginally increased above the "min" scenario due to the increase in catch opportunity provided by the scaled F_{MSY} advice rule (Table 5.9, Figure 5.10).

In addition, five stock-specific scenarios are presented to further explore the consequences of individual stock catch advice on the catches of other stocks. In all stock-specific scenarios, fleets which target sole (all beam trawls and Belgian otter trawls) are assumed to be restricted by the zero-catch advice for sole in 2024 rather than the scenario-specified stock. Therefore, the sole and plaice results for catches, F and SSB under these 'nep-is' and 'had-is' scenarios should be interpreted as resulting from the likely bycatch of those stocks only by fleets which do not primarily target sole.

The "nep-is" scenario results in an overshoot for cod, sole and whiting and an undershoot for haddock and plaice. The "had-is" scenario would result in overshoot of the catch advice for other stocks, except plaice. Catches in both the "nep-is" and "had-is" advice scenarios are considerably above those of the "sq_E" scenario, indicating that the fishing effort required to achieve the 2024 catch advice for Norway lobster and haddock is higher than that observed in recent years (Table 5.9, Figure 5.10).

The "cod-is", "sol-is" and "whg-is" scenarios are presented to explore the consequences of the zero catch advice for these stocks. The "whg-is" scenario implies that catches of the other Irish Sea stocks would also be zero (equal to the "min" scenario). However, the "cod-is" and "sol-is" scenarios suggest that there would be some small catches of whiting by a single fleet which is not restricted by the zero catch advice for these two stocks (Figure 5.11).

Taken together these results indicate that it is unlikely to be possible to achieve all single-species management objectives simultaneously. ICES single-stock advice for demersal stocks is based on

ICES maximum sustainable yield (MSY) approach. However, only the 'min' scenario can be considered in keeping with the precautionary principle, due to zero catch advice for cod, sole and whiting in the region. Here, whiting SSB is projected to remain below B_{lim} in 2025, and cod between B_{lim} and $B_{trigger}$ under all scenarios. Sole remains below B_{lim} in the 'max' and 'sq_E' scenarios, and between B_{lim} and $B_{trigger}$ under all other scenarios.

The current mixed fisheries scenarios illustrate the implications of the single-species advice for cod, haddock, Norway lobster, plaice, sole and whiting stocks. Additional scenarios for zero catch advice stocks (cod, sole, and whiting) are provided in ICES (2023c; 2023d; 2023e).

5.5 References

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Table 5.5 Mismatch between accessions and InterCatch métiers. Table shows the accessions métiers (WGMIXFISH) for which no matching métier was available from that country and year. InterCatch métiers from corresponding countries and years were used to apply discard rates to these accessions métiers. Total landings, indicates total landings for that country, year and métier in the accessions data.

Country	Accessions métier	Year	Tonnes in accession	InterCatch métier
EN	OTB_DEF_100-119_0_0_all	2020	2.328	OTB_DEF_>=120_0_0_all
EN	TBB_CRU_16-31_0_0_all	2021	0.002	OTB_CRU_16-31_0_0_all
EN	FPO_CRU_0_0_0_all	2022	0.255	MIS_MIS_0_0_0_all
EN	TBB_CRU_16-31_0_0_all	2022	0.082	OTB_CRU_16-31_0_0_all
IE	OTB_DEF_>=120_0_0_all	2020	140.692	OTB_DEF_100-119_0_0_all
IE	OTB_DEF_70-99_0_0_all	2020	12.200	OTB_CRU_70-99_0_0_all
IE	TBB_DEF_100-119_0_0_all	2020	0.86	TBB_DEF_70_99_0_0_all
IE	OTB_DEF_70-99_0_0_all	2021	12.79	OTB_CRU_70_99_0_0_all
IE	DRB_MOL_0_0_0_all	2022	0.310	MIS_MIS_0_0_0
IE	OTB_DEF_70-99_0_0_all	2022	25	TBB_DEF_70-99_0_0_all
NI	TBB_CRU_16-31_0_0_all	2020	5.093	OTB_CRU_70-99_0_0_all
NI	TBB_CRU_16-31_0_0_all	2021	1.152	OTB_CRU_70-99_0_0_all

Table 5.6 Irish Sea. Summary of the 2023 ICES single-species advice. Target Fs are left justified; harvest ratios are right justified.

Species	Agreed TAC 2022	Total Catch-advice for 2023	Projected landings-advice for 2023	Ftotal/Harvest ratio for 2023	Fwanted/ Harvest ratio for 2023	SSB 2023	SSB 2024
cod.27.7a	206	0	0	0	0	4842	5930
had.27.7a	3038	2648	2107	0.28	0.171	11817	9321
nep.FU.14	17038*	789	735	11**	n/a	386***	n/a
nep.FU.15	17038*	11069	9271	18.2**	n/a	4498***	n/a
ple.27.7a	2747	2039	967	0.196	0.061	13514	12629
sol.27.7a	787	605	435	n/a	0.189^	3299	3129
whg.27.7a	721	0	0	0	0	1223^^	2211^^

*** TAC applies to all FU's of Subarea 7, of which no more than 2804 t may be caught in FU16.**

**** Harvest ratio for projected landings + projected dead discards.**

***** Stock abundance in millions of individuals.**

^ F-target in the single-stock forecast for Sole 7a is based on the landings (Fwanted).

^^ Single-stock advice for whg.27.7a was last issued in 2021. SSB values for 2023 and 2024 are from the 2022 WGCSE update assessment (ICES, 2022a).

Table 5.7 Comparison between the outputs from the baseline run (reproduction of advice) and ICES advice. Figures for 2023 compare results from the baseline run (FLR forecasts) to the ICES single-stock intermediate year results. The baseline run uses the same assumptions for F in the intermediate year as the forecasts leading to ICES advice.

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	Difference
2023	cod.27.7a	Catch	291	288	1.0
2023	cod.27.7a	Fbar	0.028	0.028	0.0
2023	cod.27.7a	Landings	265	262	1.1
2023	cod.27.7a	SSB	10870	10919	−0.4
2024	cod.27.7a	Catch	0.00	0.00	0.0
2024	cod.27.7a	Fbar	0.00	0.00	0.0
2024	cod.27.7a	Landings	0.00	0.00	0.0
2024	cod.27.7a	SSB	11765	11815	−0.4
2025	cod.27.7a	Catch	NA	NA	NA
2025	cod.27.7a	SSB	10609	10645	−0.3
2023	had.27.7a	Catch	1485	1496	−0.7
2023	had.27.7a	Fbar	0.148	0.148	0.0
2023	had.27.7a	Landings	1233	1235	−0.2
2023	had.27.7a	SSB	12714	12539	1.4
2024	had.27.7a	Catch	2246	2263	−0.8
2024	had.27.7a	Fbar	0.28	0.28	0.0
2024	had.27.7a	Landings	1808	1807	0.1
2024	had.27.7a	SSB	10059	9888	1.7
2025	had.27.7a	Catch	NA	NA	NA
2025	had.27.7a	SSB	7174	7073	1.4
2023	ple.27.7a	Catch	656	664	−1.2
2023	ple.27.7a	Fbar	0.071	0.071	0.0
2023	ple.27.7a	Landings	265	269	−1.3
2023	ple.27.7a	SSB	9739	9877	−1.4
2024	ple.27.7a	Catch	1829	1902	−3.9
2024	ple.27.7a	Fbar	0.196	0.196	0.0
2024	ple.27.7a	Landings	40	769	−3.8
2024	ple.27.7a	SSB	10233	10583	−3.3

Year	Stock	Value	Fcube.baseline	Single.Spp.Advice	Difference
2025	ple.27.7a	Catch	NA	NA	NA
2025	ple.27.7a	SSB	9843	10054	−2.1
2023	sol.27.7a	Catch	666	667	−0.1
2023	sol.27.7a	Fbar	0.261	0.261	0.0
2023	sol.27.7a	Landings	584	584	0.0
2023	sol.27.7a	SSB	2525	2525	0.0
2024	sol.27.7a	Catch	0.00	0.00	0.0
2024	sol.27.7a	Fbar	0.00	0.00	0.0
2024	sol.27.7a	Landings	0.00	0.00	0.0
2024	sol.27.7a	SSB	2340	2340	0.0
2025	sol.27.7a	Catch	NA	NA	NA
2025	sol.27.7a	SSB	2677	2677	0.0
2023	whg.27.7a	Catch	1447	1445	0.1
2023	whg.27.7a	Fbar	0.77	0.77	0.0
2023	whg.27.7a	Landings	275	275	0.0
2023	whg.27.7a	SSB	1517	1517	0.0
2024	whg.27.7a	Catch	0.00	0.00	0.0
2024	whg.27.7a	Fbar	0.00	0.00	0.0
2024	whg.27.7a	Landings	0.00	0.00	0.0
2024	whg.27.7a	SSB	1094	1096	−0.2
2025	whg.27.7a	Catch	NA	NA	NA
2025	whg.27.7a	SSB	2108	2111	−0.1

Table 5.8 Comparison between WGMIXFISH baseline run (reproduction of advice) and ICES advice for *Nephrops* in the Irish Sea. FU14 and FU15 *Nephrops* stocks are merged in the mixed fisheries model, thus catches and landings are compared to the sum of those for FU14 and FU15 in the single-stock advice. NA values in 'single-stock' column in 2022 indicate values which are not calculated in the single-stock advice process for the intermediate year. Similarly, there is no equivalent merged harvest rate for both FU's given in the single-stock advice.

Year	Stock	Value	Fcube Baseline	Single-stock	% difference
2023	nep (FU14 + FU15)	Catch	10297	NA	NA
2023	nep (FU14 + FU15)	hr	0.15	NA	NA
2023	nep (FU14 + FU15)	Landings	8527	NA	NA
2024	nep (FU14 + FU15)	Catch	12420	12230	1.6
2024	nep (FU14 + FU15)	hr	0.18	NA	NA
2024	nep (FU14 + FU15)	Landings	10486	10255	2.3

Table 5.9 FCube scenarios for the in Irish Sea. Forecast catch (in tonnes) for mixed fisheries scenario in 2024.

Stock	Single-stock advice	Catch per mixed fisheries scenario (2024)								
	Catch (2024)*	min	max	sq_E	min_ range	cod-is	had-is	nep-is	sol-is	whg-is
cod.27.7a	0	0	583	194	4	0	389	261	0	0
had.27.7a	2263	0	2875	1030	21	0	2271	1582	0	0
nep.fu.14,15	12230	0	23551	7819	148	0	19278	12229	0	0
ple.27.7a	1902	0	1832	664	14	0	616	421	0	0
sol.27.7a	0	0	1352	584	13	0	144	93	0	0
whg.27.7a	0	0	2347	1318	33	46	2259	1749	46	0

Table 5.10 Mixed fisheries for the Irish Sea. Fishing mortality (F) resulting from single-stock advice and different mixed fisheries scenarios for demersal fish species. The colour gradients of the legend show the forecast F under each scenario in relation to reference points (detailed in legend).

Stock	Single-stock advice	F (2024) resulting from mixed fisheries scenario (2024)								
	F (2024)	min	max	sq_E	min_range	cod-is	had-is	nep-is	sol-is	whg-is
cod.27.7a	0	0	0.079	0.026	0.0005	0	0.052	0.035	0	0
had.27.7a	0.28	0	0.36	0.117	0.0022	0	0.27	0.184	0	0
ple.27.7a	0.196	0	0.196	0.068	0.00142	0	0.063	0.043	0	0
sol.27.7a*	0	0	0.74	0.26	0.0052	0	0.058	0.037	0	0
whg.27.7a	0	0	2.0	0.78	0.0147	0.021	1.85	1.18	0.021	0

***F values and reference points for sol.27.7a are Fprojected landings as discards are not included in the single-stock assessment.**

Legend:

$F_{2024} \leq F_{MSY}$

$F_{MSY} < F_{2024} \leq F_{pa}$

$F_{pa} < F_{2024} \leq F_{lim}$

$F_{2024} > F_{lim}$

Table 5.11 Mixed fisheries for the Irish Sea. Spawning-stock biomass SSB results from single-stock advice and different mixed fisheries scenarios. All weights are in tonnes. The colour gradients of the legend show the forecast SSB under each scenario in relation to reference points (detailed in legend).

Stock	Single-stock advice	SSB per mixed fisheries scenario (2025)								
	SSB (2025)	min	max	sq_E	min_range	cod-is	had-is	nep-is	sol-is	whg-is
cod.27.7a	10645	10635	10003	10424	10631	10635	10213	10352	10096	10635
had.27.7a	7073	9538	6835	8560	9519	9538	7396	8041	6874	9538
ple.27.7a	10054	11246	9864	10744	11235	11246	10780	10927	10680	11246
sol.27.7a	2677	2679	1503	2169	2668	2679	2553	2598	2527	2679
whg.27.7a	2111	2094	305	982	2064	2052	351	668	305	2052

Legend:

$SSB_{2025} \geq B_{pa}$ or MSY $B_{trigger}$

$SSB_{2025} \geq B_{lim}$, no B_{pa} defined

$B_{lim} \leq SSB_{2025} < B_{pa}$

$SSB_{2025} < B_{lim}$

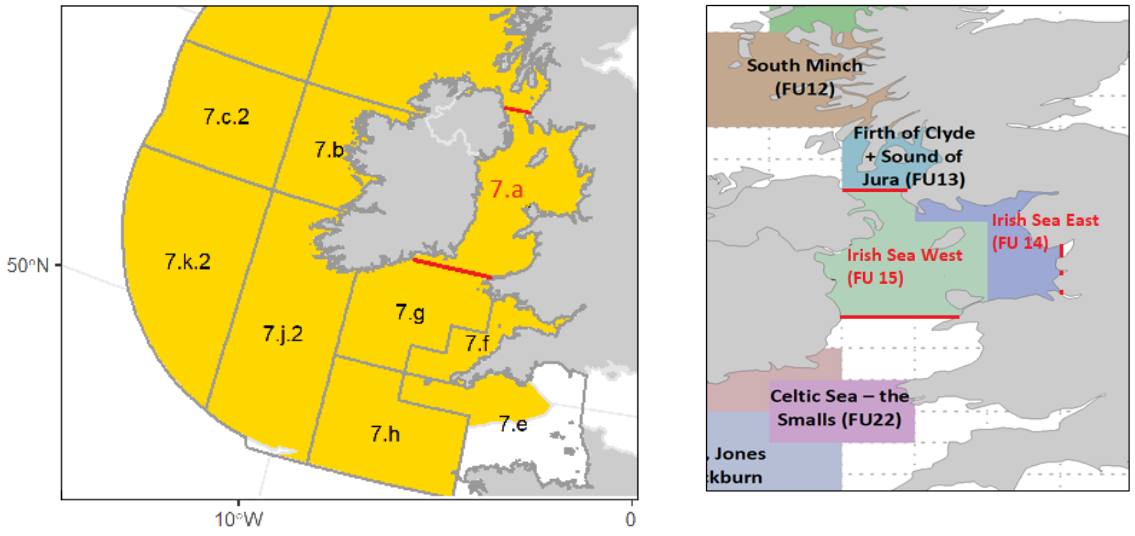


Figure 5.1 ICES Area description for fish (7a) and *Nephrops* Functional Units (FU) in the Irish Sea region.

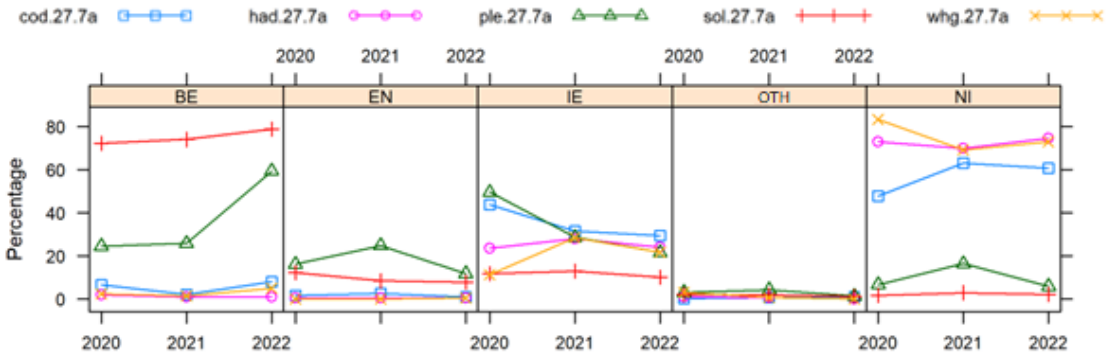


Figure 5.2 Percentage of total catches by country per fish stock 2020–2022. BE = Belgium, EN = England (UK), IE = Ireland, NI = Northern Ireland (UK). OTH = fleets of any nationality landing < 1% of any stocks.

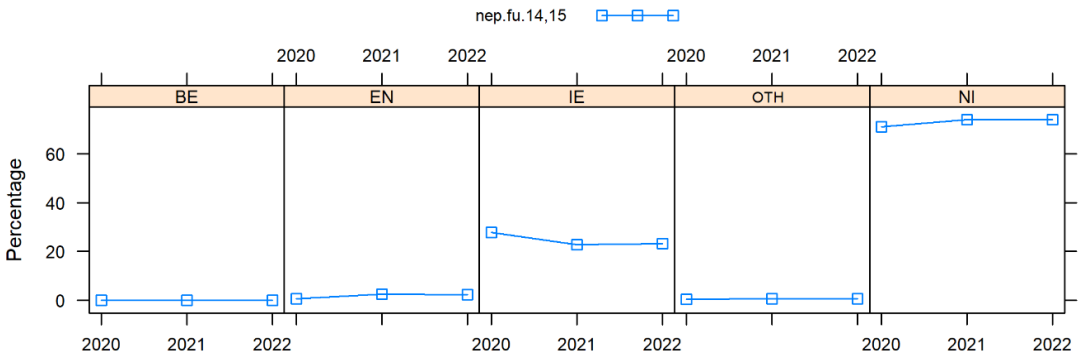


Figure 5.3 Percentage of total catches of *Nephrops* by country 2020–2022, BE = Belgium, EN = England (UK), IE = Ireland, NI = Northern Ireland (UK). OTH = fleets of any nationality landing < 1% of any stocks.

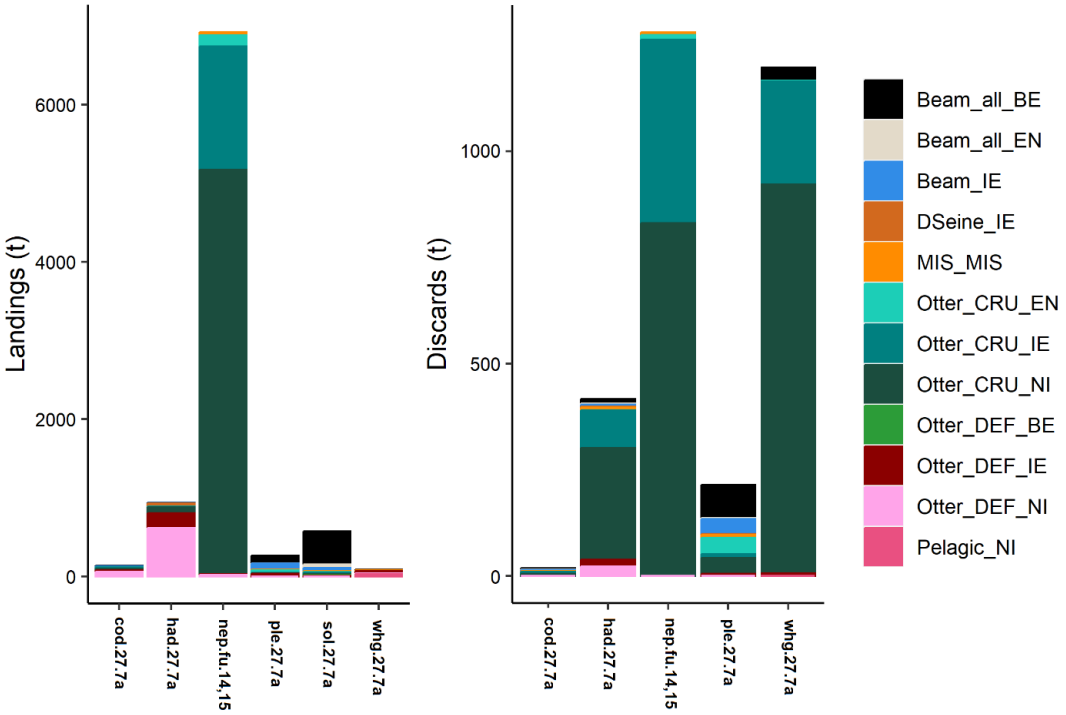


Figure 5.4 Landings and discards of stocks included in the FCube model by fleet (average 2020–2022). *Y*-axis scale differs between landings and discards plots. Colours indicate fleets used in the FCube model. Plaice discards are 'dead discards' only, calculated at the 40% survival rate as per the single species assessment. Sole discards are not included as these are not included in the FCube model as per single species stock assessment, instead they are calculated as 12.5% of catch by weight after the model forecast. Other fleets catching less than <1% of any stock are omitted from figure for visualization reasons.

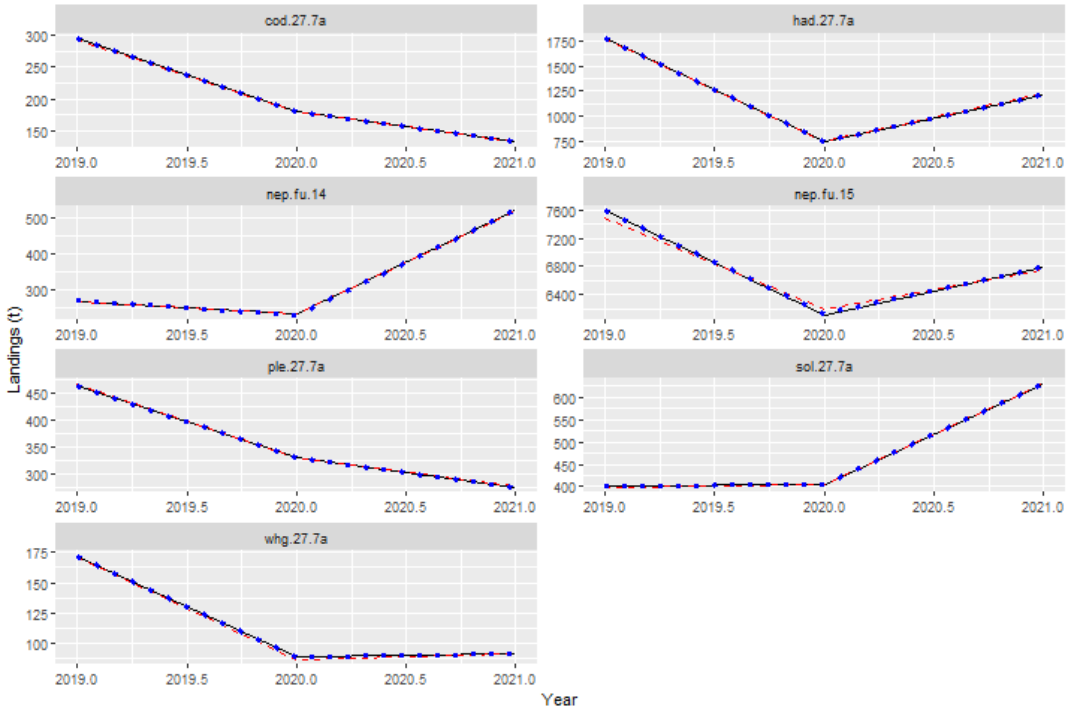


Figure 5.5 Quality control comparison of different sources of landings data. Blue dotted lines show ICES landings from WGCSE advice sheets, dashed red line shows WGMIXFISH accessions landings data and solid black lines show landings reported in InterCatch data. Note differing scales on y-axes per stock.

Figure 5.6 Quality control comparison of different sources of discards data. Blue dotted lines show ICES assessment discards from WGCSE advice sheets, dashed red line shows WGMIXFISH discards by applying the discards rate from InterCatch per métier, country and year to accessions landings. Solid black lines show discards reported in InterCatch data. Note differing scales on y-axes per stock. Discards for sol.27.7a are not used directly in either the in single-stock assessment or WGMIXFISH FCube model.

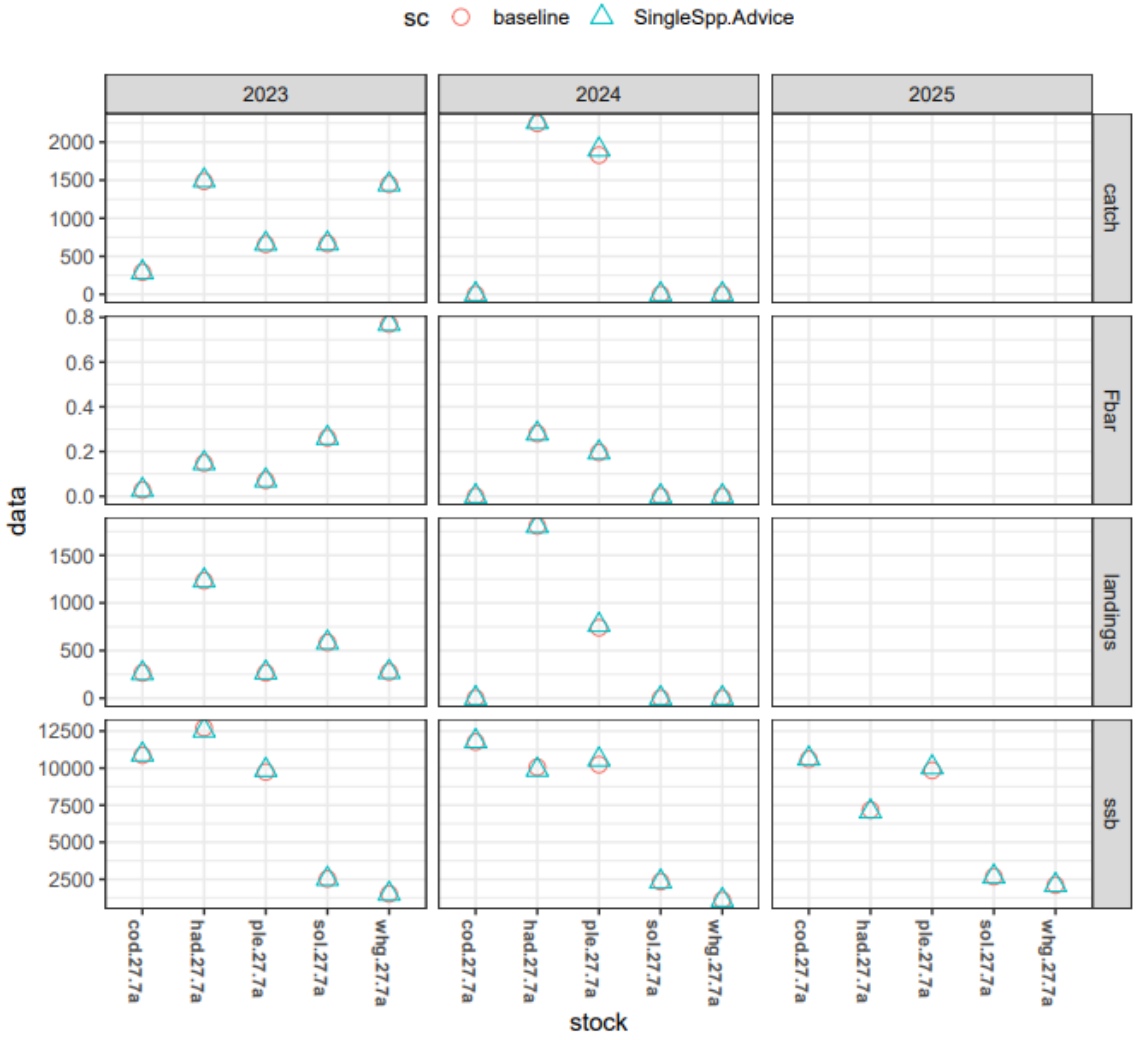


Figure 5.7 Irish Sea. Difference in absolute values between mixed fisheries baseline run (reproduction of advice) and single-stock advice for demersal fish stocks, showing catch, Fbar and landings (2023–2024) and SSB (2023–2025).

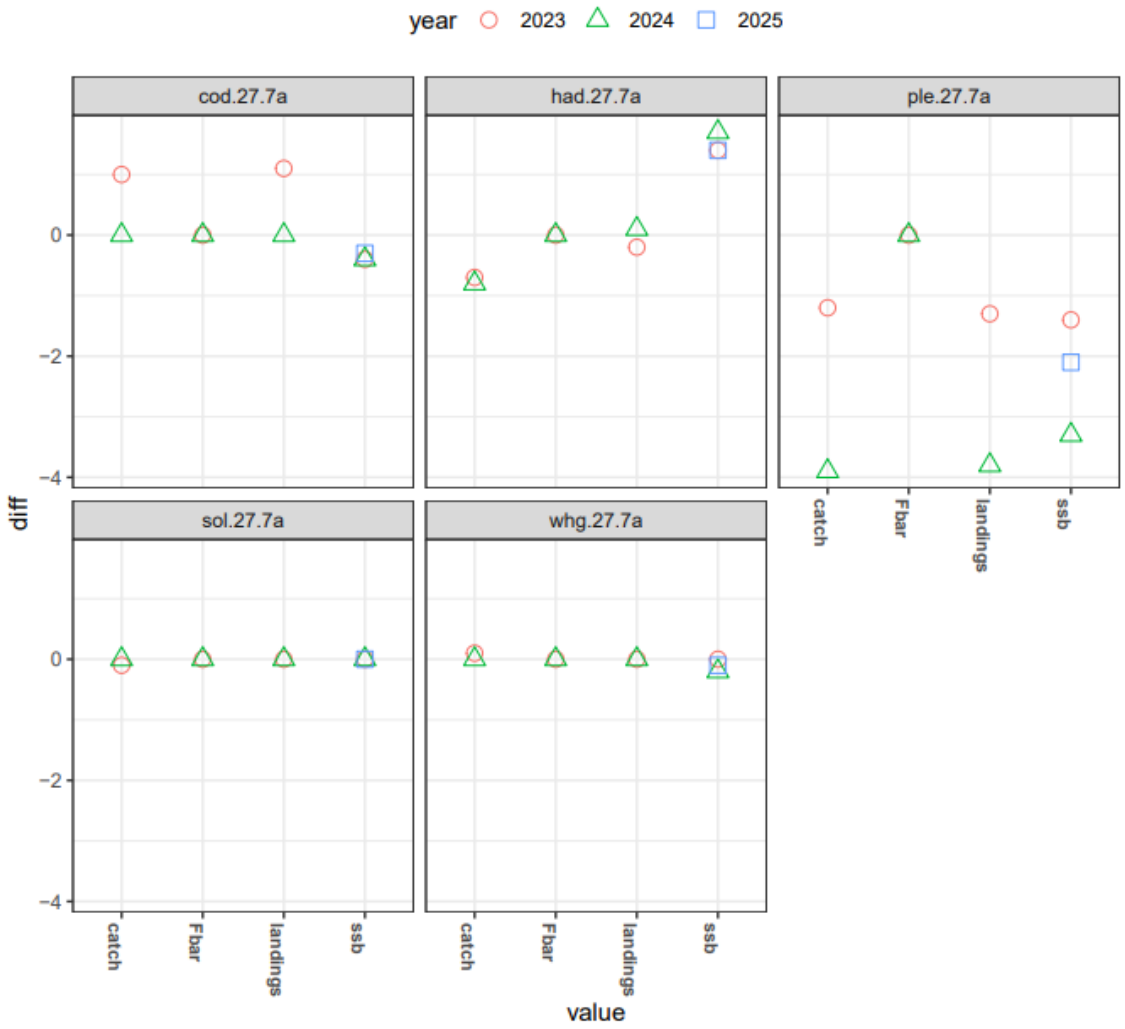


Figure 5.8 Irish Sea. Proportional difference between mixed fisheries baseline run (reproduction of advice) and single-species advice for finfish stocks, showing catch (tonnes), Fbar and landings (tonnes; 2023–2024) and SSB (tonnes; 2023–2025).

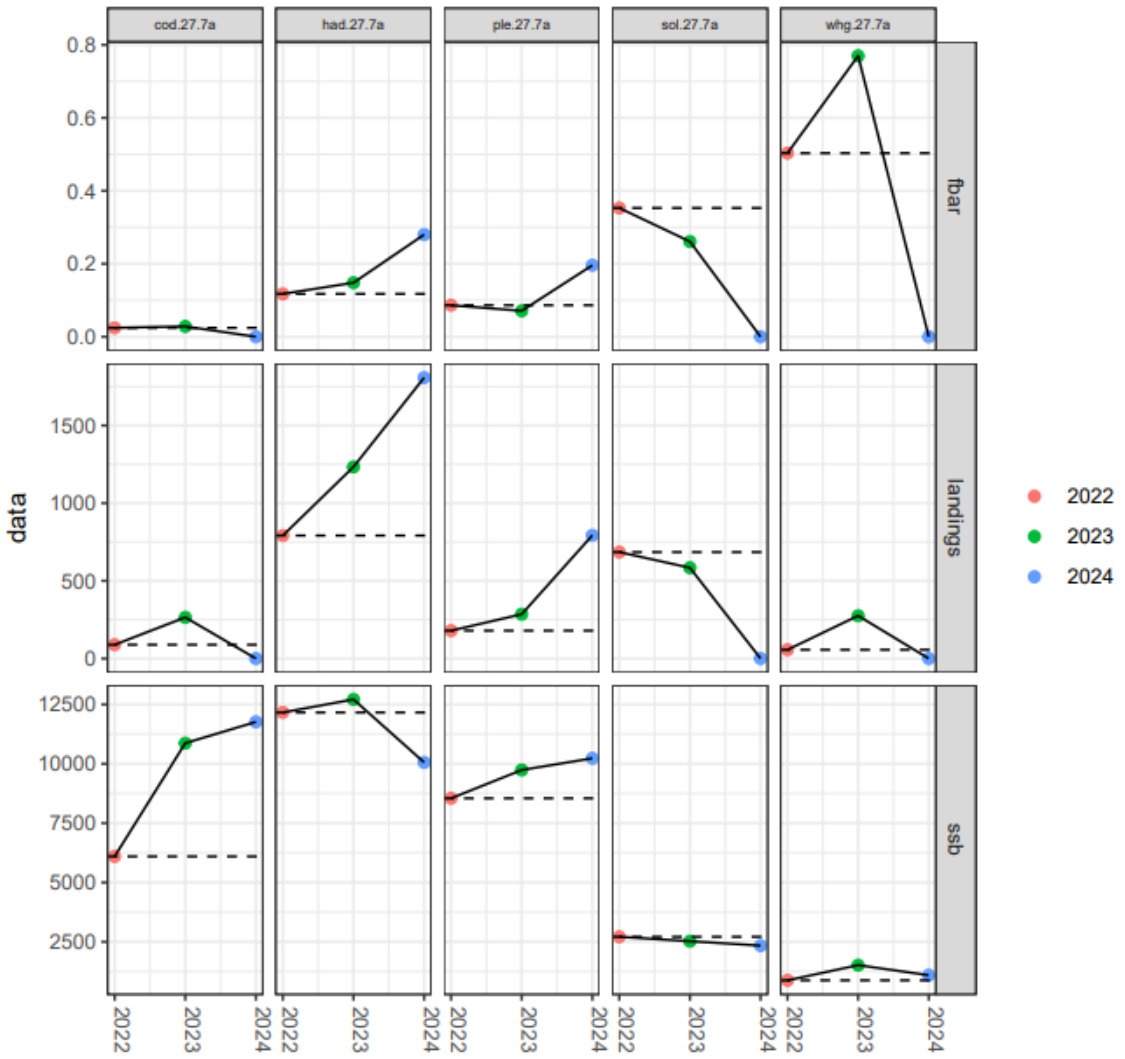


Figure 5.9 Change in fishing mortality (Fbar), landings (tonnes) and SSB (tonnes) assumed in the intermediate year (2023) and required for the advice year (2024) under the single-stock forecast assumptions. Dashed line represents value in the most recent data year (2022).

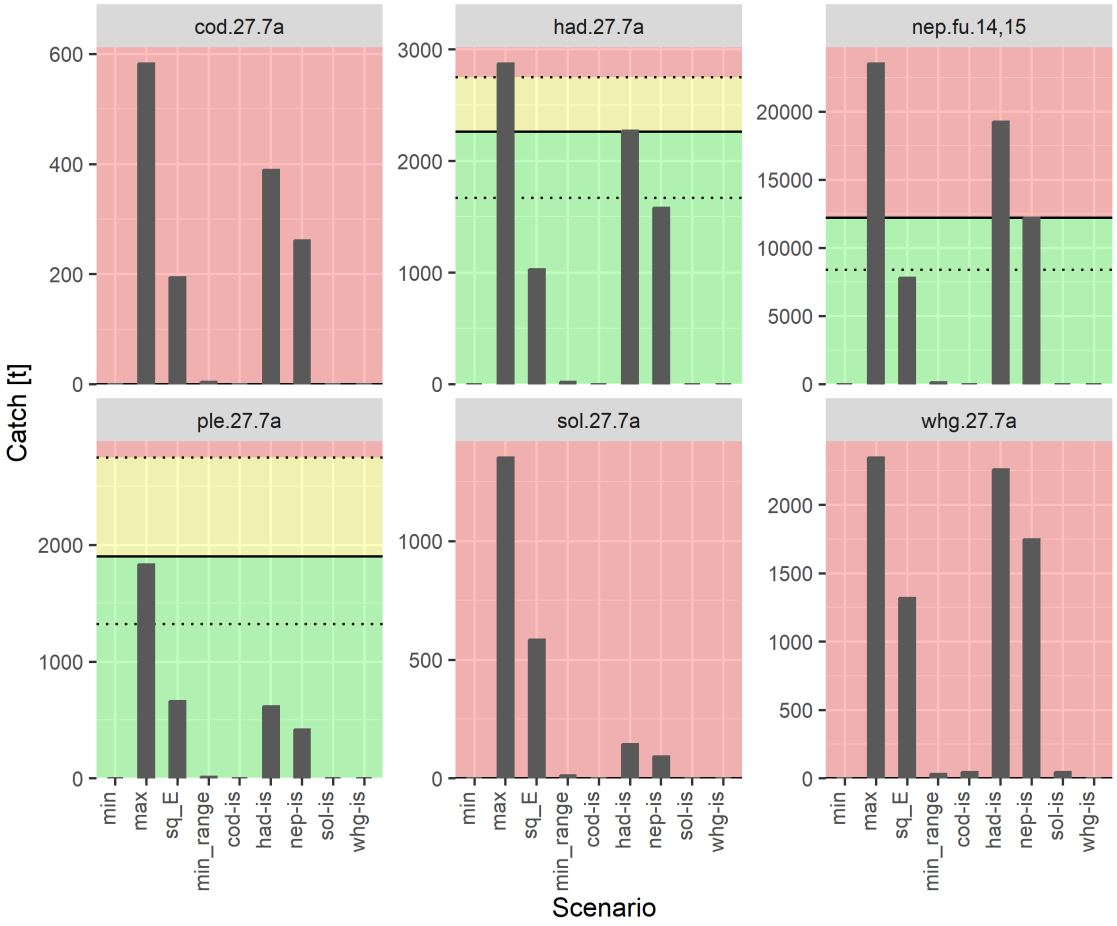


Figure 5.10 Mixed fisheries for the Irish Sea. Mixed fisheries projections. Estimates of potential 2024 catches (in tonnes) by stock and scenario. The horizontal solid line corresponds to the single-stock catch advice. For those stocks with fishing mortality ranges defined, lower dotted lines illustrate the catches corresponding to $F_{MSY\ lower}$ or reduced $F_{MSY\ lower}$ for stocks with SSB < MSY $B_{trigger}$. Upper dotted lines illustrate the catches corresponding to $F_{MSY\ upper}$ and only appears for stocks with defined ranges and with SSB ≥ MSY $B_{trigger}$.

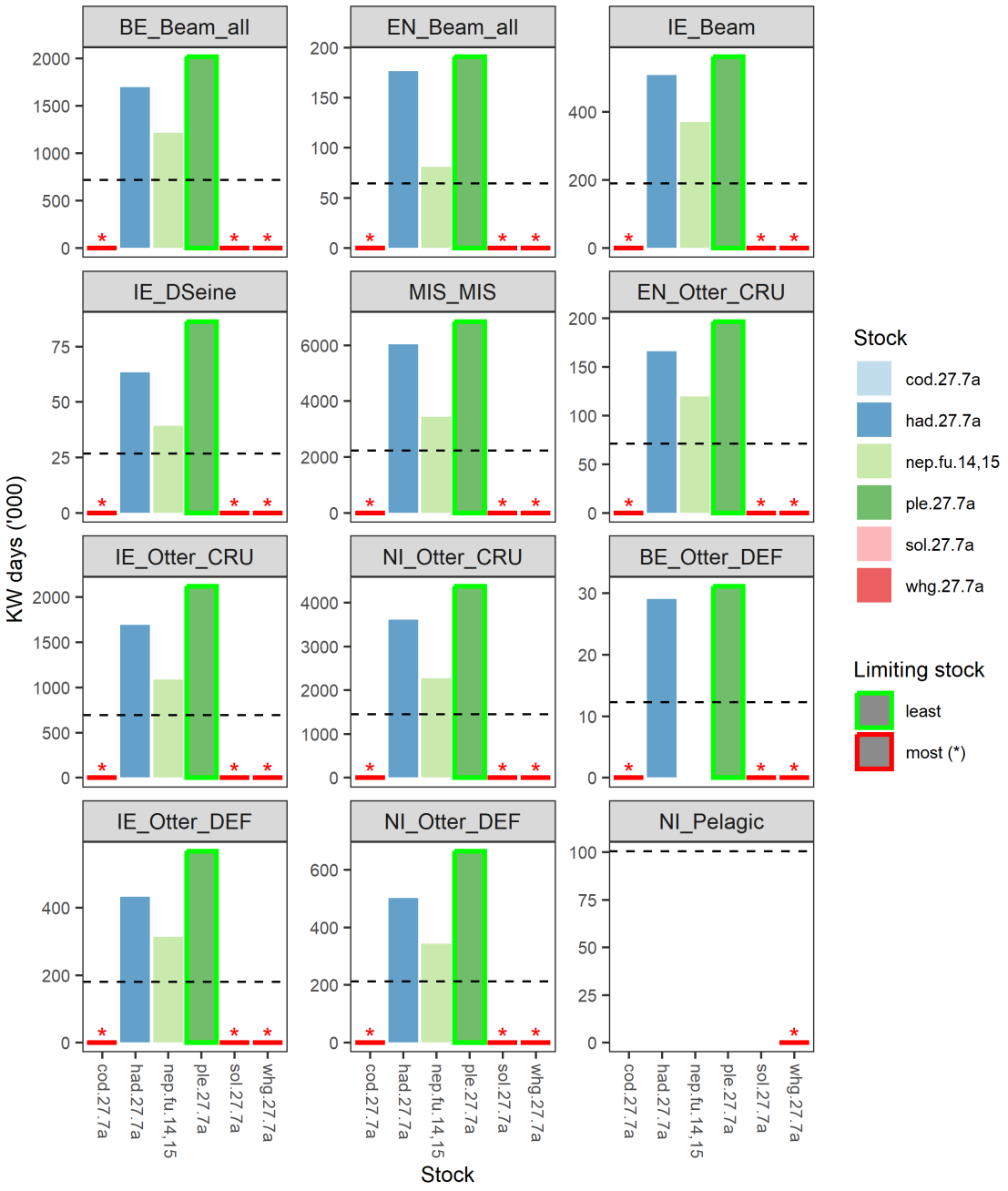


Figure 5.11 Mixed fisheries for the Irish Sea. Estimates of effort by fleet needed to reach each single-stock catch advice. Stocks are coded by colour, with the most limiting stock ("choke species") for each fleet in 2024 highlighted with a red border with asterisk and the least limiting species highlighted with a green border. Fleet names are given by country, main gear and target species assemblage. The "MIS_MIS" fleet combines all small fleets and métier with landings < 1% for any stock in the model (average 2020–2022). The *status quo* effort for each fleet (average 2020–2022) is shown as a dashed line for reference.

6 North Sea

Mixed fisheries considerations

6.1 Background

Please refer to the North Sea Mixed Fisheries Stock Annex for a full description of the geographical area and the fishery.

6.1.1 Effort limitations

In previous years, WGMIXFISH advice has considered restrictions to effort in line with legislation related to the cod recovery plan (Council Regulation (EC) 1342/2008). Since 2018, in preparation with the full implementation of the landing obligation for all stocks in 2019, new legislation was issued that removed these restrictions (Council Regulation (EU 2019 amending EU 2018/973). Some limitations now exist in terms of fleet capacity rather than effort, but these are not considered in the current WGMIXFISH scenarios.

6.1.2 Stock-based management plans

In the context of the new CFP, the EU has developed a Multiannual management plan (MAP) for the management of the North Sea demersal mixed fisheries, which has been in force since 2018 (EU, 2018), and replacing the former single-stock long-term management plans with a unique framework defining objectives and constraints for both target and bycatch demersal species. The majority of the stocks included in the North Sea demersal mixed fisheries analysis are shared between the EU, UK and Norway. As there is no agreement with Norway and the UK regarding the EU MAP, ICES gives advice based on the ICES MSY approach. Some of the stocks included in the mixed fisheries analysis are considered as bycatch under the MAP (North Sea turbot and witch). However, now these stocks have category 1 assessments, and since they are stocks shared with UK and Norway, ICES also gives advice for the stocks on the basis of the ICES MSY framework (while according to the MAP, they should be managed according to the precautionary approach).

In the mixed fisheries simulations, it is assumed that TACs for 2023 will be based on the ICES advice and may therefore not correspond for all stocks to the application of the EU MAP. In practice, the TACs for shared stocks are agreed during EU/UK/Norway negotiations, and may deviate from the ICES advice.

6.2 FLBEIA

6.2.1 Software

All analyses were conducted using the FLBEIA model (v1.15.5; García *et al*., 2017), coded as a method in R (R Core Team, 2022), as part of the FLR framework (Kell *et al*., 2007; www.flr-project.org). Input data are in the form of FLFleetsExt and FLBiols objects inherited from the FLCore 2.6.19 package objects, and two forecast methods were used, stf() from the FLAssess (version 2.6.3) and fwd() from the Flash (version 2.5.11) packages. Both input parameterization as well as the stock projections are made using FLBEIA functions and methods (version 1.16.0.0), that are

flexible enough to allow covering different alternatives. FLBEIA source code is available at GitHub (https://github.com/flr/FLBEIA). The code, software and versions are part of the ICES Transparent Assessment Framework (TAF) and can be fully reproduced from this repository (see https://github.com/ices-taf/2023_NrS_MixedFisheriesAdvice).

The baseline run is performed with the objective of reproducing as closely as possible the single-species advice produced by ACOM, and act as the reference scenario for subsequent mixed fisheries analyses. Models used for single-species assessments and forecasts are listed in Table 6.1) The single-stock forecast is performed using the 'fwd()' method in FLR (FLash R add-on package). The same forecast settings as in WGNSSK are used for each stock regarding weight-at-age, selectivity and recruitment, as well as assumptions on the F in the intermediate year and basis for advice. Some stock assessments (e.g. cod 4, 6a, 7d and 20; haddock 4, 6a and 20; whiting 4 and 7d) use data from the current year (intermediate year) and therefore produce stock abundance estimates for this year, which are used as the starting numbers for the short-term forecasts. The FLash fwd() function is not designed to use stock abundances provided in the first year of the projections and overwrites any existing values with the outcome of the survival equation, using numbers and mortality rates from the previous year. Therefore the FLash fwd() function was modified so that, if stock abundances-at-age are provided for the first year in the short-term forecast, they are effectively used as starting values and not replaced.

Table 6.1. Software and models used in the single-species assessments and forecasts. For the *Nephrops* stocks, the assessment methods are simpler and conducted on excel spreadsheets.

Species	Assessment	Forecast
Brill (*Scophthalmus rhombus*) in Subarea 4 and divisions 3.a and 7.d-e (North Sea, Skagerrak and Kattegat, English Channel); bll.27.3a47de	SPiCT	SPiCT
Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20 (North Sea, West of Scotland, eastern English Channel and Skagerrak); cod.27.46a7d20	Multistock SAM	Multistock SAM
Haddock (*Melanogrammus aeglefinus*) in Subarea 4, Division 6.a, and Subdivision 20 (North Sea, West of Scotland, Skagerrak); had.27.46a20	SAM	SAM
Plaice (*Pleuronectes platessa*) in Subarea 4 (North Sea)	SAM	SAM
Saithe (*Pollachius virens*) in Subareas 4, 6 and Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat); pok.27.3a46	SAM	SAM
Sole (*Solea solea*) in Subarea 4 (North Sea); sol.27.4	AAP	FLR
Whiting (*Merlangius merlangus*) in Subarea 4 and Division 7.d (North Sea and eastern English Channel); whg.27.47d	SAM	MFDP
Plaice (*Pleuronectes platessa*) in Division 7.d (eastern English Channel); ple.27.7d	AAP	FLR
Sole (*Solea solea*) in Division 7.d (eastern English Channel); sol.27.7d	SAM	SAM
Turbot (*Scophthalmus maximus*) in Subarea 4 (North Sea); tur.27.4	SAM	FLR
Witch (*Glyptocephalus cynoglossus*) in Subarea 4 and divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, eastern English Channel); wit.27.3a47d	SAM	SAM

6.2.2 Scenarios

Single-species ICES advice for North Sea stocks of interest is given according to specific single-species options, existing management plan, ICES maximum sustainable yield (MSY) approach, or precautionary approach (PA). The basis for each single-stock advice is retained in the current mixed fisheries framework. Given fishing opportunities available for each fleet (e.g. TACs by stock or effort allocation by fleet), FLBEIA estimates the potential future levels of effort for each fleet, based on fleet effort distribution and catchability by métier. Based on this effort level, landings and discards (i.e. catches) by fleet are estimated using standard forecasting procedures. For the catch advice year FLBEIA is used to run the scenarios (Table 6.2).

Table 6.2. Mixed fisheries for the Greater North Sea. Mixed fisheries scenarios.

Scenario	Mixed Fisheries effort assumption	Basis for catch targets in 2024
Minimum (min)	For each fleet, fishing in 2024 stops when the catch for any one of the stocks meets the fleet's stock share*. This scenario is the most precautionary option and can highlight some potential "choke species" issues.	ICES catch advice
Maximum (max)	For each fleet, fishing in 2024 continues until the catches of all stocks meet the fleet stock share*. This option illustrates the degree of overfishing of the single-stock advice if fishing is not restricted by the fleet stock shares*.	
Status quo effort (sq_E)	The effort of each fleet in 2024 is set equal to the effort in the most recent year (2022) for which landings and discard data are available.	
Minimum including ranges (min_range)	Same as min scenario.	Catches corresponding to $F_{MSY\ upper}$ for stocks in good status (SSB ≥ MSY $B_{trigger}$) and scaled F_{MSY} advice levels (F_{MSY} × SSB/MSY $B_{trigger}$) for the other stocks (including zero catch advice). Applies only to stocks with ranges defined.
Cod single-stock advice (cod-ns)	For each fleet, fishing in 2024 stops when the catch of cod meets the fleet's stock share* for cod, regardless of other catches. Fleets which do not catch cod follow a *status quo* effort assumption (as described for the sq_E scenario).	ICES catch advice

*** Throughout this document, the term "fleet's stock share" or "stock share" is used to describe the share of the fishing opportunities for each particular fleet. These are calculated based on the single-stock advice for 2024 and the historical proportion of the stock landings taken by the fleet (2022).**

Incorporating *Nephrops* into the mixed fisheries advice produces a number of complicating factors: for example, *Nephrops* are fished in distinct geographic areas or functional units (FU), only some of which receive an abundance estimate (necessary to calculate a catchability). This WG followed the approach adopted by ICES (2009) which is to perform the normal FLBEIA prediction for those FUs with absolute abundance estimates, then to calculate a ratio of change from the current yields to the ICES advice for the same FUs. For those FUs without absolute abundance estimates, landings resulting from the FLBEIA run were simply taken to be the most recently recorded landings multiplied by the same ratio R. To do this, landings for each métier had to be apportioned across the FUs. This was facilitated by the supply of effort and catch data by FU.

6.3 Stock input data and recent trends

6.3.1 Stock input data

The assessment data for the different stocks were supplied by ICES WGNSSK (ICES, 2023). Similar to last year, all stock inputs formatted as FLR stock objects were directly provided to WGMIXFISH by the respective stock coordinators, and this eased greatly the quality of the process of collecting stock data.

An increasing number of WGNSSK stocks are being assessed using stochastic assessments (multistock SAM model for Northern Shelf cod, SAM model for haddock, plaice in the North Sea, saithe, sole in the Eastern English channel, turbot, whiting and witch). An AAP assessment was used for the plaice stock in the English Channel and for North Sea sole, and a SPiCT assessment for Brill. Therefore, for some of these stocks the advice is based on stochastic forecasts, which cannot be fully replicated in the deterministic FCube software. FLBEIA is applied for the third year in a row, FCube projections were not run but in previous years the output from these projections were routinely compared to the median projections of the single-species stochastic forecasts on which single-stock advice is based and results are very similar (see Section 6.5); as such, WGMIXFISH does not consider the difference in models to have a significant impact on the mixed fisheries considerations.

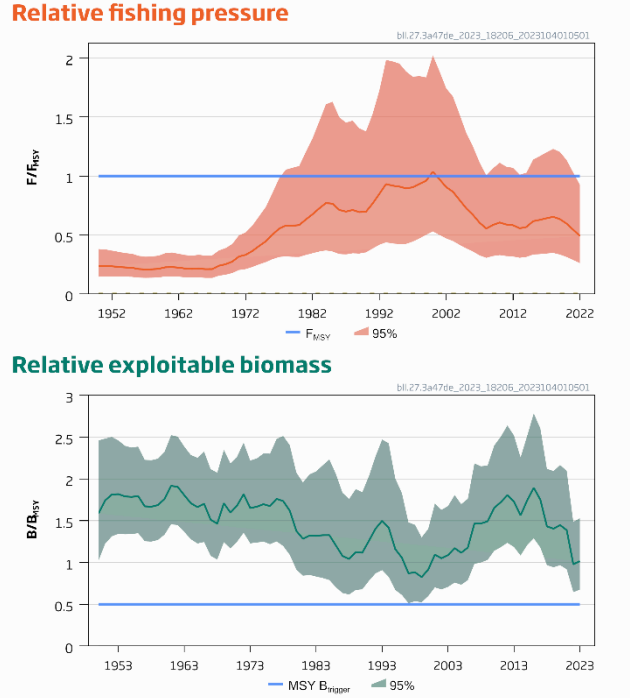
Following the benchmark that took place in 2023, the model now includes the Northern Self stock-complex, which replaces the former North Sea and West of Scotland cod stocks. The Northern Self cod is composed of three substocks, assessed as separate entities in a multistock assessment model. The distribution of the three substocks overlap to a large extent for 3 quarters of the year, and there is currently no method to separate the substocks in the catch samples. Therefore, the data available to WGMIFISH on catches per fleets and métiers is provided at the combined stocks level, which makes it impossible to model the individual substocks for the mixed fisheries projections. Therefore, in the mixed fisheries model, the three substocks are combined in a single FLStock object, and are modelled as if there were a single population.

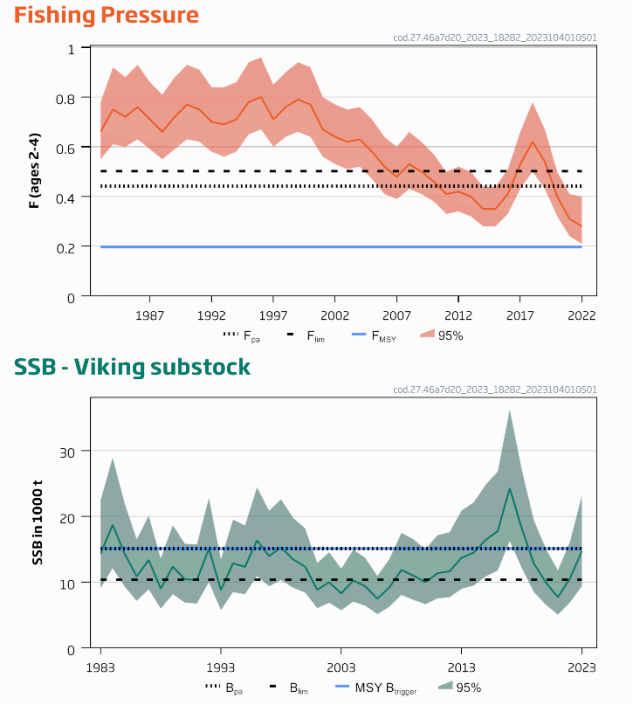
Nephrops stocks were incorporated in the evaluation by functional unit (although they are managed under a single TAC). The functional units with stock indices from underwater surveys and harvest rates (FU6, FU7, FU8 and FU9) have an advice based on the F_{MSY} approach. These FUs are explicitly modelled in the projections, and they can act as most or least limited stocks. For the five other functional units (FUs 5, 10, 32, 33 and 34 and *Nephrops* outside FUs) no quantification of stock size is available, and the advice is based on the precautionary approach. The future dynamics of these FUs is not modelled in the projections (cannot be choke stocks) but catch projections can be made based on the effort resulting from the different scenarios, and assuming constant CPUEs for these FUs.

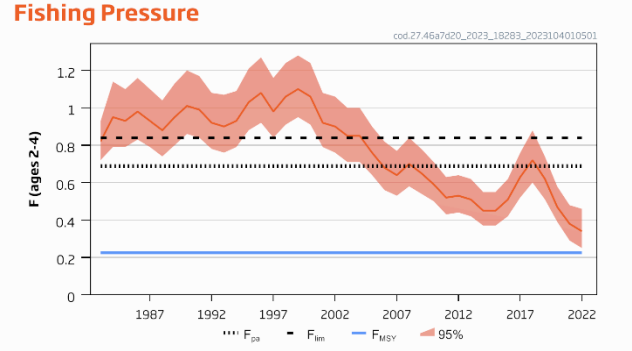
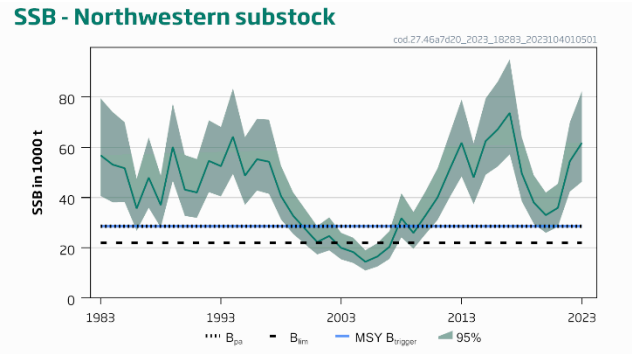
6.3.2 Recent trends and advice

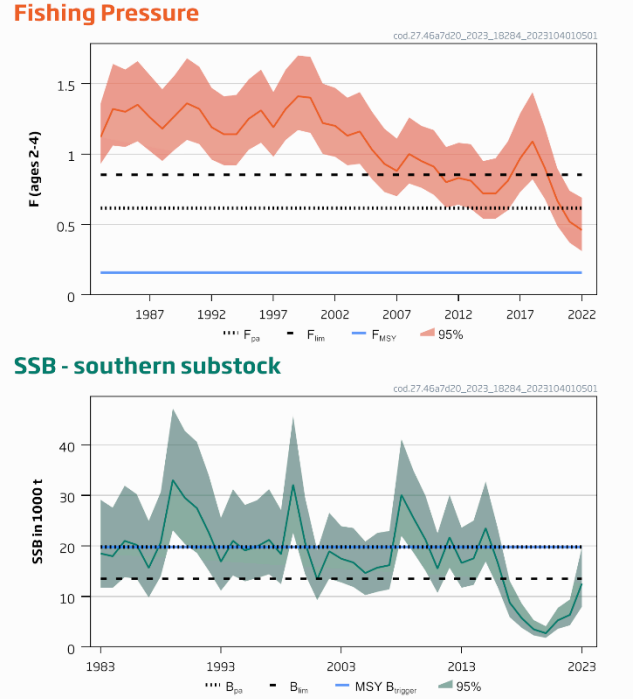
The advice for these stocks is drafted by the WGNSSK (ICES, 2023) under considerations by ACOM. Recent trends are described on a stock-by-stock basis, and latest advice by stock is available on the ICES website. An overview of mixed fisheries North Sea demersal stocks advice and trends are summarized below (Table 6.3). It should be noted that although there is only one advice, additional management considerations are also listed in each single-species advice document.

Table 6.3 Summary of stocks included in the mixed fisheries advice.

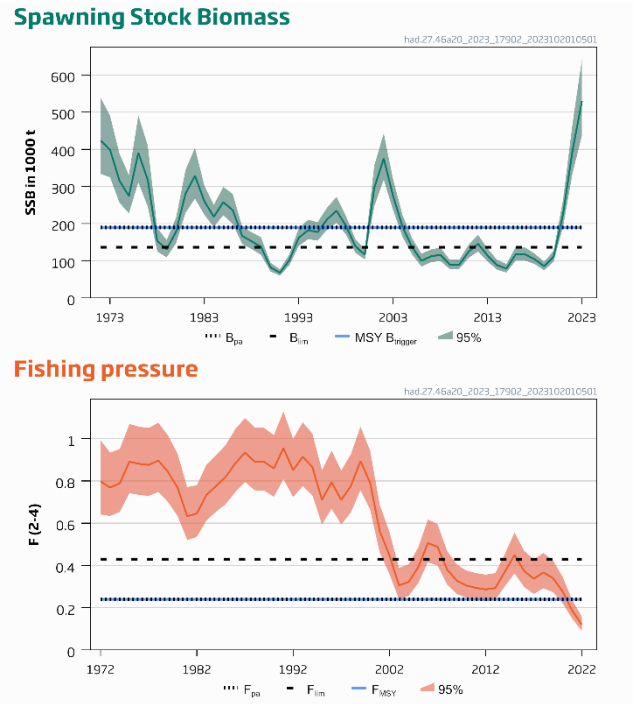
Species	Area	Stock status	Advice 2023
bll.27.3a47de (brill)	Subarea 4 and divisions 3.a and 7.d–e (North Sea, Skagerrak and Kattegat, English Channel)	 Summary: Relative fishing pressure on the stock is estimated to be below F_{MSY}; Relative exploitable biomass size is estimated to be above MSY $B_{trigger}$.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 2456 tonnes. The use of a combined species TAC for brill and turbot prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. ICES advises that management should be implemented at the species level and cover the entire stock distribution area (Subarea 4 and divisions 3.a and 7.d–e).

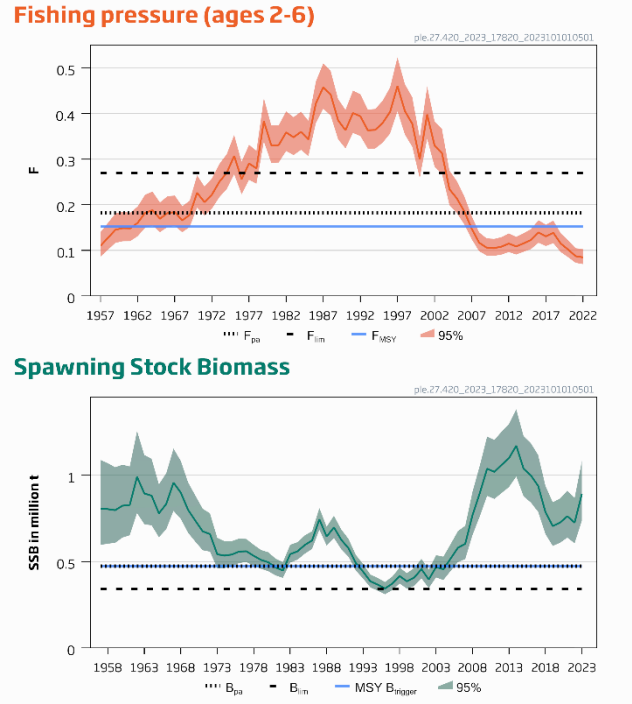
Species	Area	Stock status	Advice 2023
cod.27.46a7d20 (cod)	Subarea 4, division 6.a and 7.d, and Subdivision 20 (North Sea, West of Scotland, eastern English Channel, Skagerrak)	 Summary: Fishing pressure on the substock is above F_{MSY}, but below F_{pa} and Flim; spawning-stock size is below MSY $B_{trigger}$ and between B_{pa} and Blim.	ICES advises that when the MSY approach is applied for the southern substock and precautionary considerations to protect the southern substock are applied for the northwestern and Viking substocks, catches in 2024 should be no more than 22 691 tonnes, which corresponds to 13 529 tonnes from the northwestern substock, 5240 tonnes from the Viking substock, and 3922 tonnes from the southern substock. These catches by substock should not be taken as area-specific advice.

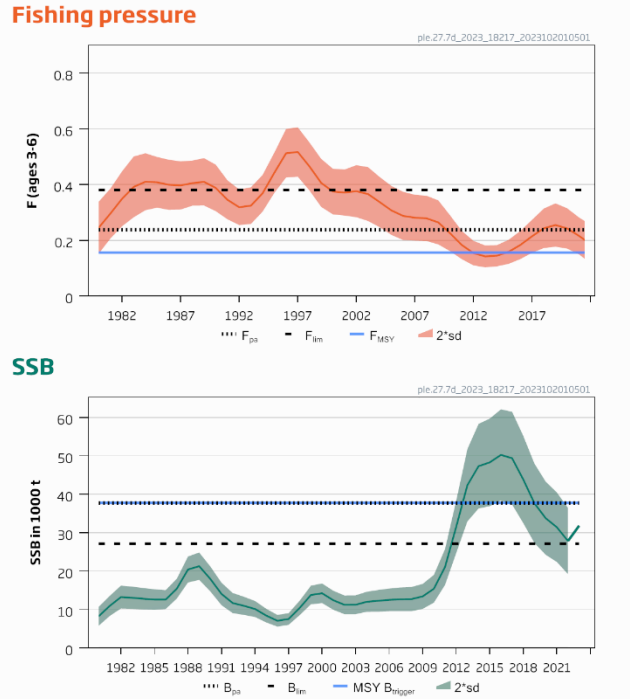
Species	Area	Stock status	Advice 2023
		  Summary: Fishing pressure on the substock is above F_{MSY}, but below F_{pa} and Flim; spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	

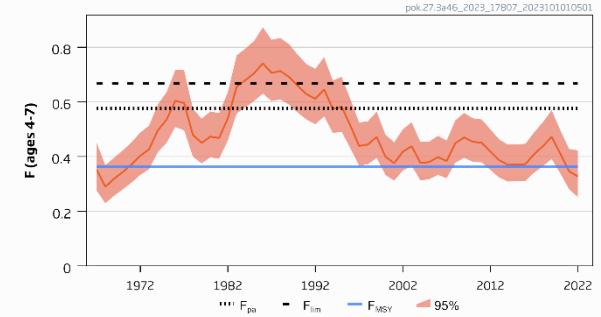
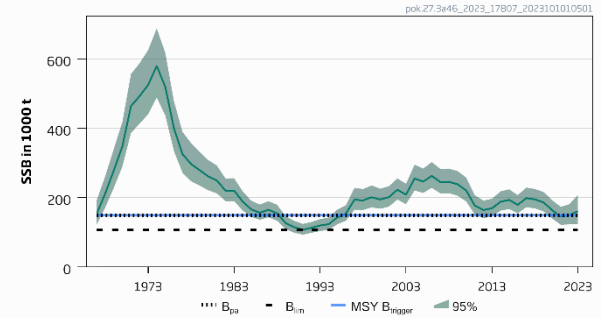
Species	Area	Stock status	Advice 2023
			

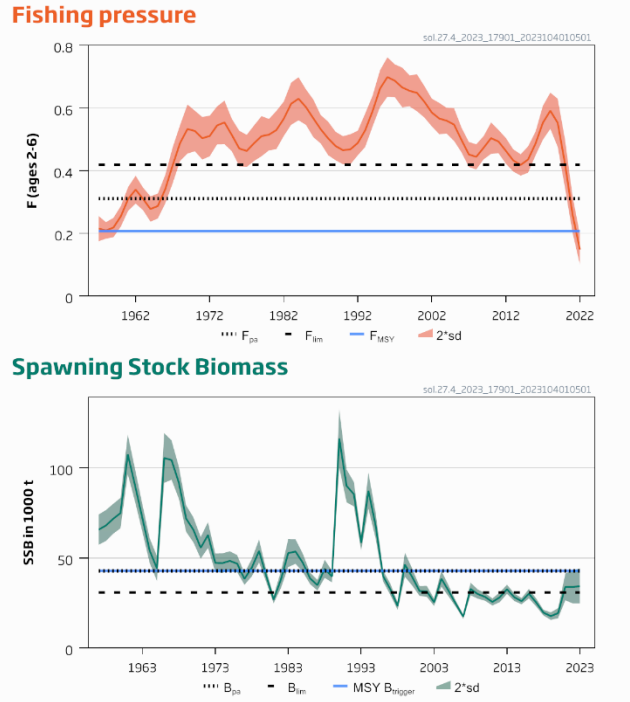
Summary: Fishing pressure on the substock is above F_{MSY}, but below F_{pa} and Flim; spawning-stock size is below MSY $B_{trigger}$, B_{pa}, and B_{lim}.

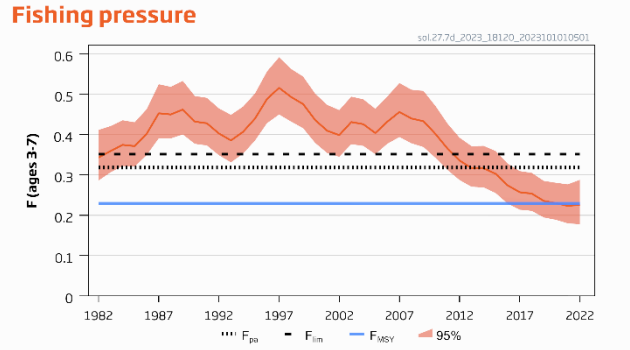
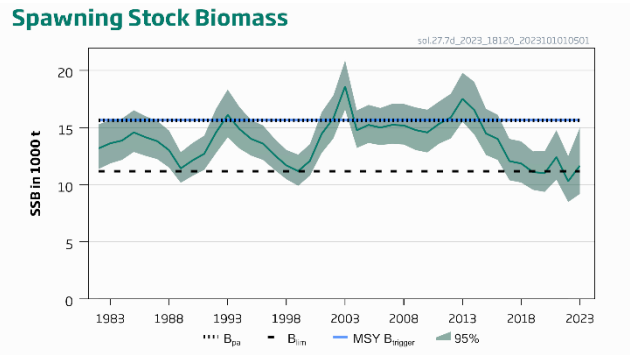
Species	Area	Stock status	Advice 2023
had.27.46a20 (haddock)	Subarea 4, Division 6.a, and Subdivision 20 (North Sea, West of Scotland, Skagerrak)	 Summary: Fishing pressure on the stock is below F_{MSY} and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, total catches in 2024 should be no more than 149 024 tonnes.

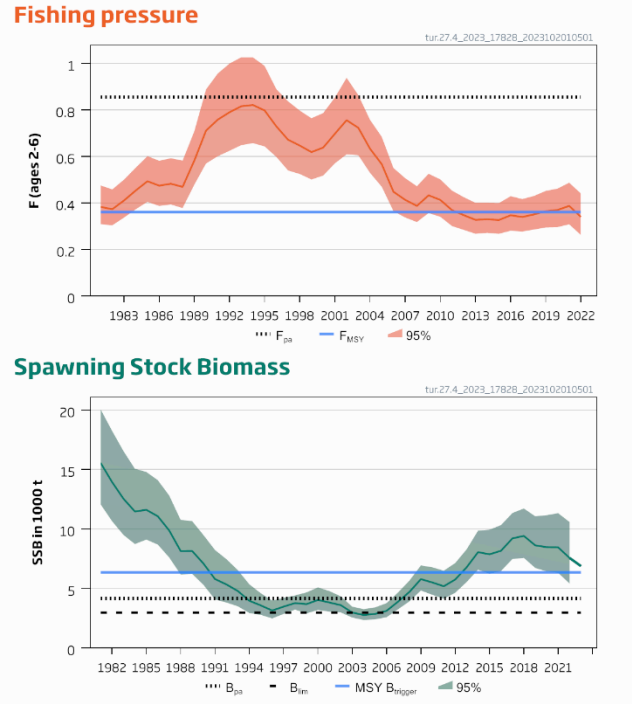
Species	Area	Stock status	Advice 2023
ple.27.420 (Plaice)	Subarea 4 (North Sea) and Subdivision 20 (Skagerrak)	 Summary: Fishing pressure on the stock is below F_{MSY} and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 155 015 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock.

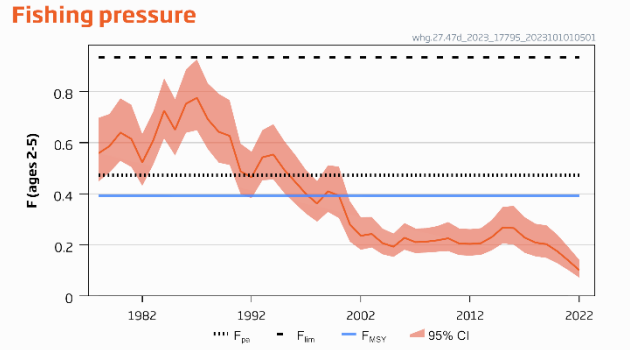
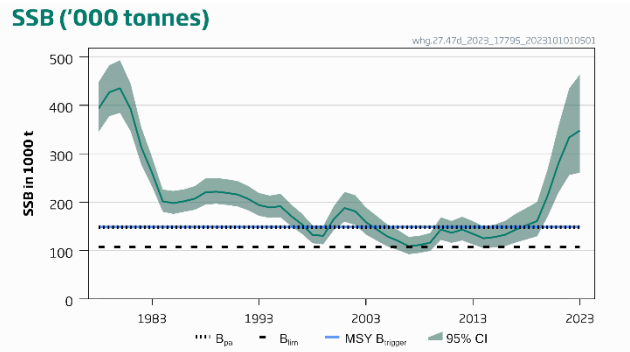
Species	Area	Stock status	Advice 2023
ple.27.7d (plaice)	Division 7.d (eastern English Channel)	 Summary: Fishing pressure on the stock is above F_{MSY} but below F_{pa} and F_{lim} and spawning-stock size is below MSY $B_{trigger}$ and between B_{pa} and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 2367 tonnes. The use of a combined TAC for plaice in divisions 7.d and 7.e prevents effective control of single-stock exploitation rates and could lead to the overexploitation of either stock. ICES advises that management should be implemented at the stock area level. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock.

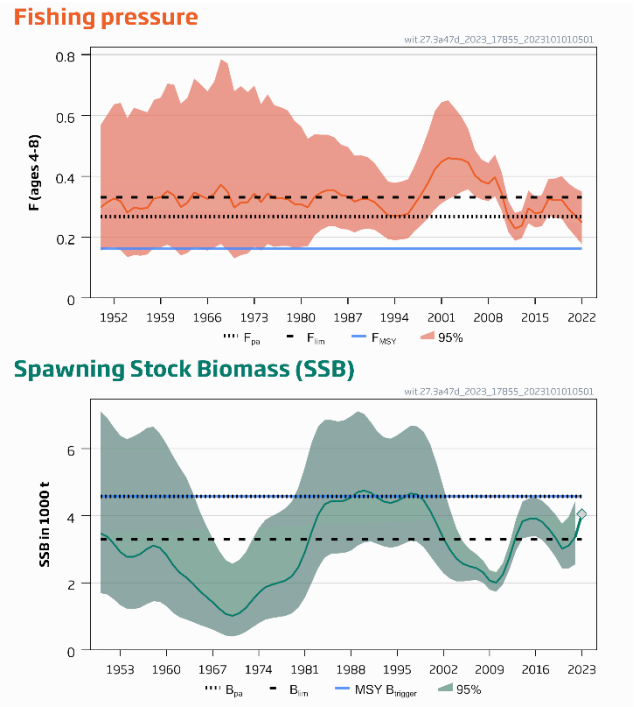
Species	Area	Stock status	Advice 2023
pok.27.3a46 (saithe)	Subareas 4 and 6, and in Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)	**Fishing pressure**  **Spawning Stock Biomass**  Summary: Fishing pressure on the stock is below F_{MSY}, F_{pa} and Flim; spawning-stock size is above MSY $B_{trigger}$ and between B_{pa} and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 73 815 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock.

Species	Area	Stock status	Advice 2023
Sol.27.4 (sole)	Subarea 4 (North Sea)	 Summary: Fishing pressure on the stock is below F_{MSY}, F_{pa} and Flim; spawning-stock size is below MSY $B_{trigger}$ and between B_{pa} and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 3588 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock

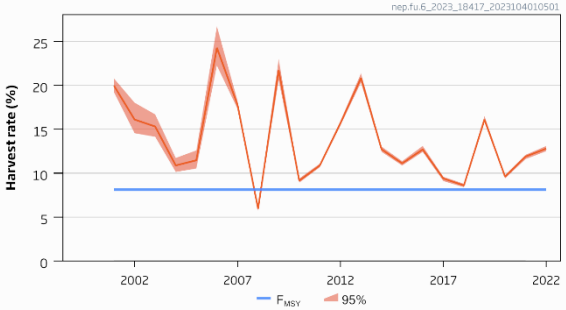
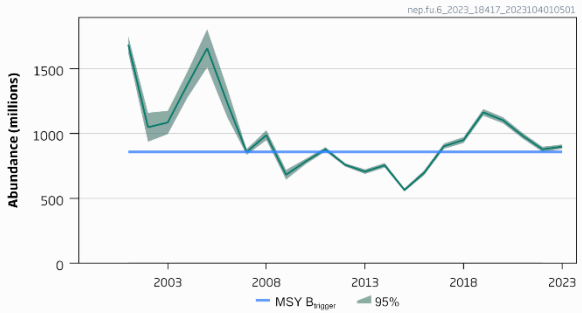
Species	Area	Stock status	Advice 2023
sol.27.7d (sole)	Division 7.d (eastern English Channel)	  Summary: Fishing pressure on the stock is above F_{MSY} but below F_{pa} and Flim; spawning-stock size is below MSY $B_{trigger}$ and between B_{pa} and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 1504 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock.

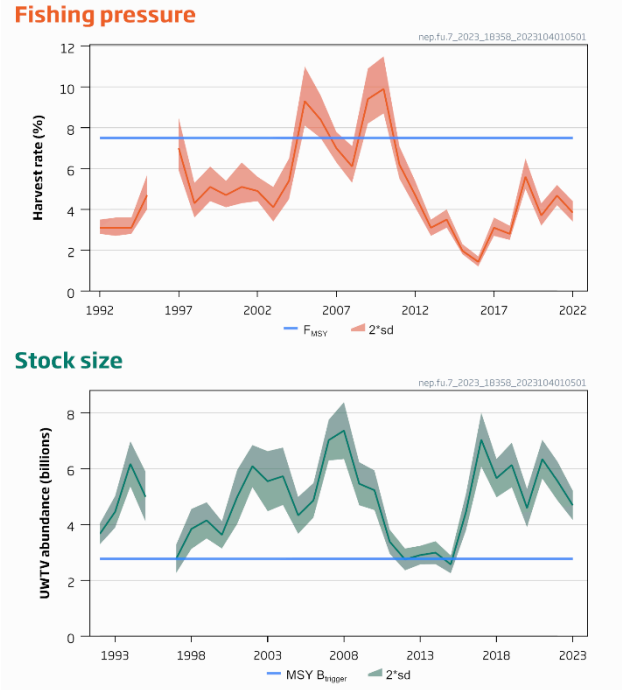
Species	Area	Stock status	Advice 2023
tur.27.4 (turbot)	Subarea 4 (North Sea)	 Summary: Fishing pressure on the stock is below F_{MSY}; spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 2052 tonnes. The use of a combined species TAC for brill and turbot prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. ICES advises that management should be implemented at the species level.

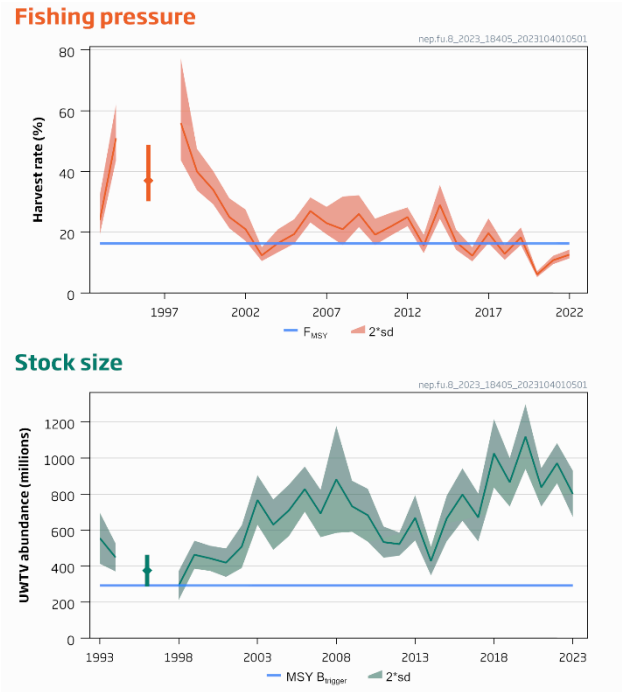
Species	Area	Stock status	Advice 2023
whg.27.47d (whiting)	Subarea 4 (North Sea) and Division 7.d (Eastern Channel)	  Summary: Fishing pressure on the stock is below F_{MSY} and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.	ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 128 290 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. Management should be implemented at the stock level

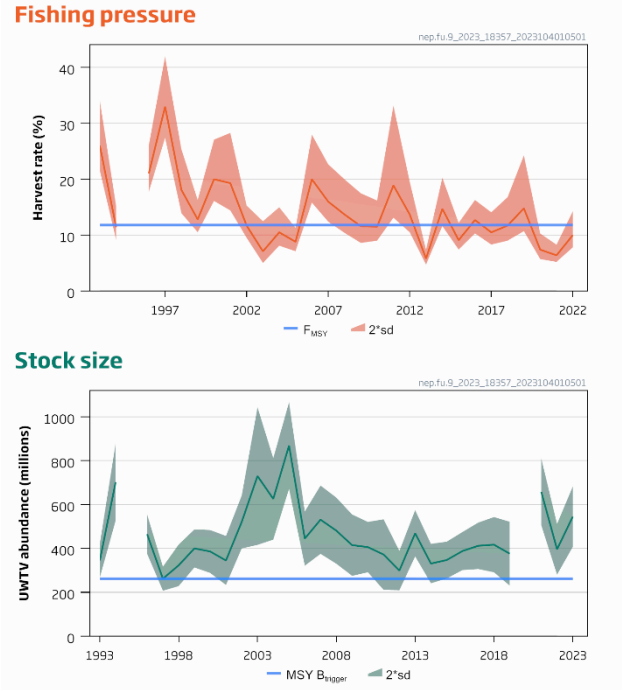
Species	Area	Stock status	Advice 2023
wit.27.3a47d (witch)	(North Sea, Skagerrak and Kattegat, eastern English Channel	 Summary: Fishing pressure on the stock is above F_{MSY} but below F_{pa} and Flim; spawning-stock size is below MSY $B_{trigger}$ and between B_{pa} and B_{lim}.	CES advises that when the MSY approach is applied, catches in 2024 should be no more than 1579 tonnes. The use of a combined species TAC for witch and lemon sole prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. ICES advises that management should be implemented at the species level and cover the entire stock distribution area (Subarea 4 and divisions 3.a and 7.d).

Species	Area	Stock status	Advice 2023
Nephrops nep.27.4outFU	Subarea 4, outside the functional units (North Sea)	ICES cannot assess the stock and exploitation status relative to maximum sustainable yield (MSY) and precautionary approach (PA) reference points because the reference points are undefined.	ICES advises that when the precautionary approach is applied, landings should be no more than 301 tonnes in each of the years 2023 and 2024. ICES cannot quantify the corresponding total catches
Nephrops nep.fu.5	Botney Gut-Silver Pit (FU 5)	ICES cannot assess the stock and exploitation status relative to maximum sustainable yield (MSY) and precautionary approach (PA) reference points because the reference points are undefined.	ICES advises that when the precautionary approach is applied, catches in each of the years 2023 and 2024 should be no more than 1256 tonnes. To protect the stock in this functional unit (FU) from continued overexploitation, management should be implemented at the functional unit level.

Species	Area	Stock status	Advice 2023
Nephrops nep.fu.6	Farn Deeps (FU 6)	**Fishing pressure**  **Stock size**  Summary: Fishing pressure on the stock is above F_{MSY}, and the stock size is above MSY $B_{trigger}$.	ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2020–2022, catches in 2024 should be no more than 1607 tonnes. To ensure that the stock in Functional Unit (FU) 6 is exploited sustainably, management should be implemented at the functional unit level. Transfer of advised catch from other FUs to FU 6 could lead to overexploitation. ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 4. ICES considers this plan to be precautionary when implemented at the functional unit level.

Species	Area	Stock status	Advice 2023
Nephrops nep.fu.7	Fladen Ground (FU 7)	 Summary: Fishing pressure on the stock is below F_{MSY} and stock size is above MSY $B_{trigger}$.	ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2020–2022, catches in 2024 should be no more than 12 302 tonnes. To ensure that the stock in Functional Unit (FU) 7 is exploited sustainably, management should be implemented at the functional unit level. The catch in FU 7 has been lower than advised in recent years, and if the difference is transferred to other FUs, this could result in non-precautionary exploitation of those FUs. ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 4. ICES considers this plan to be precautionary when implemented at the functional unit level.

Species	Area	Stock status	Advice 2023
Nephrops nep.fu.8	Firth of Forth (FU 8)	 Summary: Fishing pressure on the stock is below F_{MSY}, and stock size is above MSY $B_{trigger}$.	ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2020–2022, catches in 2024 should be no more than 3129 tonnes. To ensure that the stock in Functional Unit (FU) 8 is exploited sustainably, management should be implemented at the functional unit level. Transfer of advised catch from other FUs to FU 8 could lead to overexploitation. ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 4. ICES considers this plan to be precautionary when implemented at the functional unit level.

Species	Area	Stock status	Advice 2023
Nephrops nep.fu.9	Moray Firth (FU 9)	 Summary: Fishing pressure on the stock is below F_{MSY}, and stock size is above MSY $B_{trigger}$.	ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2020–2022, catches in 2024 should be no more than 1770 tonnes. To ensure that the stock in Functional Unit (FU) 9 is exploited sustainably, management should be implemented at the functional unit level. A transfer of advised catch from other FUs to FU 9 could lead to overexploitation. ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 4. ICES considers this plan to be precautionary when implemented at the functional unit level.

Species	Area	Stock status	Advice 2023
Nephrops	Noup (FU 10)	ICES cannot assess the stock and exploitation status relative to maximum sustainable yield (MSY) and precautionary approach (PA) reference points because the reference points are undefined.	ICES advises that when the precautionary approach is applied, catches in each of the years 2023 and 2024 should not exceed 55 tonnes, assuming discard rates. In order to ensure the stock in this FU 10 is exploited sustainably, management should be implemented at the functional unit level.
Nephrops	Norwegian Deep (FU 32)	ICES cannot assess the stock and exploitation status relative to MSY and precautionary approach (PA) reference points because the reference points are undefined	ICES advises that when the precautionary approach is applied, catches in each of the years 2023 and 2024 should not exceed 304 tonnes. This stock is under the Norwegian discard ban since 2022.
Nephrops	Horns Reef (FU 33)	ICES cannot assess the stock and exploitation status relative to MSY and PA reference points, because the reference points are undefined	ICES advises that when the precautionary approach (PA) is applied landings in each of the years 2023 and 2024 should not exceed 918 tonnes. ICES cannot quantify the corresponding total catches. To ensure that the stock in Functional Unit (FU) 33 is exploited sustainably, management should be implemented at the functional unit level.

Species	Area	Stock status	Advice 2023
Nephrops	Devils Hole (FU 34)	ICES cannot assess the stock and exploitation status relative to maximum sustainable yield (MSY) and precautionary approach (PA) reference points because the reference points are undefined.	ICES advises that when the precautionary approach is applied, catches in each of the years 2023 and 2024 should not exceed 652 tonnes. In order to ensure the stock in this functional unit (FU) is exploited sustainably, management should be implemented at the functional unit level.

6.4 Fleets and métiers

6.4.1 Catch and effort data

Prior to 2012, catch (landings and discards) and effort data were submitted to WGMIXFISH as comma separated files structured around the distinction of gear, mesh size and vessel length categories (based to a large extent on the format used by the STECF for the evaluation of effort management). From 2012 to 2014 a joint WGNSSK/WGMIXFISH data call has been issued, with age and discards data by métier (consistent with the DCF definition of métiers) to be submitted to InterCatch, and landings and effort data by métier and vessel length class to be submitted as .csv files. Since 2015, ICES generalized the data call to most stocks and regions. The process and the quality of data have thus continuously improved over time.

Noticeably, although the data collation process has become smoother, it remains a very tedious and time-demanding task. The processes developed to automate the various steps of merging different datasets from different countries and different data sources together have increased the amount of checks and graphical visualization of the data. Starting from 2019, data submissions have been evaluated with the aid of newly developed quality control routines, which are summarized in a report. This process has aided both data submitters and participants of WGMIXFISH in terms of identifying problematics entries and has greatly eased the model conditioning process.

Norway began to submit data to WGMIXFISH in 2022 covering the period from 2015 to 2022. However, due to data quality issues, Norway are only able to provide effort and landings data for vessels over 15 m. The provision of data on vessels under 15 m are expected within a few years. Previously, these missing Norwegian catches were implicitly included in the OTH-OTH fleet which includes any difference in total catches between the fleet data and the single-stock assessments. However, this year the catches associated with Norwegian vessels under 15 m were estimated through comparisons with the catches reported to InterCatch and accounted for in an additional fleet called "NO_<15".

A significant proportion of catches of brill are taken outside the North Sea model area in division 7.3 and subdivision 3.a.21. Similar to catches from Norwegian vessels < 15 m, these out of area catches are encapsulated in an addition fleet, "BLL_OTH", to account for all sources of removals in the North Sea model for brill. Any remaining missing catches are included in the OTH-OTH fleet and are derived from the difference in total catches between the fleet data and the single-stock assessments. In total, these additional fleets, NO_<15, BLL_OTH and OTH_OTH account for approximately 6% of all landings in the North Sea model.

The final dataset extracted from InterCatch for use by WGNSSK includes discards estimates (either imported or raised) for all stocks and métiers. These InterCatch estimates have been used to estimate a discard ratio for each country/métier/stock combination, which allows allocating discards for all WGMIXFISH métiers with matching names, such that:

$$d^* = \left(\frac{D}{L}\right) l$$

Where d* is the discard value for the métier used by FLBEIA, l is the weight of landings for the métier used by FLBEIA and L and D are the weight of landings and discards entered for the (vessel length aggregated by métier in InterCatch). For age-based stocks, discard rates are estimated for each age class. Similarly, proportions at age in the landing and discards from InterCatch are used to allocate age distributions to all WGMIXFISH métiers with matching names for age based stocks. This matching process became automated in 2023 and begins with allocations made where exact matches for stock, year, area and métier (gear, target assemblage, mesh size)

exist between the datasets. Where no exact match exists, the variables are dropped in turn (mesh size > target assemblage > gear > area) and allocations of the mean value from matching data records are made. Any remaining unmatched WGMIXFISH fleet data records are then allocated stock level values as reported in the stock assessment

The relative size of landings of the stocks incorporated in the mixed fisheries projections is shown in Figure .

6.4.2 Definitions of fleets and métiers

Minor revisions were made in 2023 to the procedure for defining fleets and métiers, however, the majority of the process has been the same since 2012. Nevertheless, as the procedure is applied to the last data year, the number of fleets and métiers can vary slightly from one WGMIXFISH report to the next.

In summary, the procedure follows a number of steps:

- Initial fleet allocations are made using country, gear type and, when necessary, vessel length group. Initial métier category allocations are made using the definitions used in the cod long-term management plan.
- Within a fleet, small métiers are defined as those that fail to catch at least 5% of the fleets total landings of at least one stock. These métiers are aggregated to a "MIS" métier category.
- Small fleets are defined as fleets that fail to catch at least 1% of the total landings of at least one stock. These fleets are aggregated to a "MIS_MIS" fleet.
- Métiers without catch of any of the modelled stocks in the last data year are not retained.

A full list of the métiers reported to WGMIXFISH and the final fleet and métier category allocation following these processing steps can be found in Annex 6.

Despite the data now being available according to DCF categorization, WGMIXFISH is of the opinion to continue using the categorization following the EU Cod management plan as used in previous years, both in order to maintain the consistency of the MIXFISH time-series and in order to continue addressing management-oriented scenarios and issues. WGMIXFISH métiers are thus defined as combinations of gear, mesh size and area (North Sea (Subarea 4), Skagerrak (Subdivision 3.a.20), West of Scotland (Division 6.a) or Eastern Channel (Division 7.d), see Table 6.4 and Figure 6.2.

The consistency between DCF and EU Cod plan categories had been investigated by WGMIXFISH 2011 and during the pilot data call performed in autumn 2011. It was determined that most DCF métiers as sampled by individual nations could automatically be allocated to a corresponding EU Cod plan métier, with two exceptions: the TBB_DEF_70-99_0_0 métier in the North Sea (as the corresponding BT2 métier is only defined for the mesh sizes 80–99) and the OTB_DEF (or CRU)_90-119_0_0 métier in the Skagerrak, which straddles over the TR1 (>=100 mm) and TR2 (70–99 mm) categories. As in previous years, the TBB_DEF_70-99_0_0 métier was assumed equivalent to BT2, and the Skagerrak 90-119_0_0 was assumed as TR2, to maintain consistency with previous data. Since 2012 the Swedish *Nephrops* fishery with an escapement grid, OTB_CRU_70-89_2_35 has been kept distinct from the other DCF métiers. Since 2020, fleets are conditioned as age-disaggregated fleets, this means that catchability at age is considered for each métier rather than having catchability at the fleet level (see Stock Annex).

In 2023, the final data used contained 44 national fleets (including the NO_<15, BLL_OTH and OTH_OTH fleets). These fleets engage in 1 to 10 different métiers each, resulting in 182 combinations of country*fleet*métier*area catching fish and *Nephrops* stocks considered this year (Table 6.4). The balance of landings of the stocks across gear categories is shown in Figure .

Diagnostics were produced to check the fleet conditioning in FLBEIA. The fishing mortality-at-age and averaged as well as age-disaggregated and total catch, landings and discards across all fleets was compared to the values estimated from the single-species stock assessments (Figure to Figure and Table 6.5 to Table 6.8). Some discrepancies exist although most are minor. These discrepancies are due to the fact that weight at age and age distributions for each stock is now given at the fleet level rather than the stock which induces some differences between the Inter-Catch data and the ones used in the single species assessment.

6.4.3 Trends

A number of overview graphs (using the Lattice and ggplot package in R) were produced to aid quality checking of the data once compiled into the final fleets object. Some are useful to show the relative importance of the fleets chosen and trends in their effort and catches. Effort by fleet in absolute levels (Figure) and relative trends (Figure 6.), and landings by fleet and stock (Figure 6.9) are included in this report.

6.5 Mixed fisheries forecasts

6.5.1 Description of scenarios

6.5.1.1 Baseline run

The various single-stock forecasts presented by WGNSSK are performed using different software and setups (see Section 6.2.1). For the purpose of the mixed fisheries analyses, it is necessary to gather all stock assessment output and forecasts settings into a single unified framework in FLR, which builds on the "FLBEIA" package (García *et al*., 2017). The same forecast settings as in WGNSSK are used for each stock regarding weight-at-age, selectivity and recruitment, as well as the assumptions made for the intermediate year (2022) and the basis for advice (ICES MSY advice rule). Using these settings, and not introducing any mixed fisheries interactions, short-term forecasts are carried out at WGMIXFISH. This baseline run is then compared to the estimates provided in the ICES advice sheets.

For a number of stocks (COD-NS, HAD, WHG-NS) the stock assessment produces abundances-at-age estimates until the current year (while for the other stocks, the assessment goes until one year before the current year). For these stocks, the forecasts conducted at WGMIXFISH use these abundances-at-age estimates as starting number for 2023. For the other stocks, starting number for 2023 are calculated as the survivors from 2022.

In the case of the HAD stock, the WGNSSK forecast starts one year earlier than for the other stocks (i.e. first forecast year is 2022 whereas it is 2023 for most stocks). Instead of reproducing this in the WGMIXFISH framework, which would have required too many modifications of the existing code, the SAM estimates of the numbers-at-age for 2023 were replaced in the FLStock object by the median of the abundances-at-age from the SAM forecast for 2023.

BLL is added to the WGMIXFISH model for the first time this year. This stock is assessed using a surplus production model. The FLR framework used to produce this baseline run cannot accommodate stocks using a biomass dynamics model. For this reason, BLL is not included in the baseline run.

For a number of stocks, it is not expected that the single-stock advice can be exactly reproduced within the FLR environment. There are data and model related differences between the framework used at WGMIXFISH and the different single-stock forecasts conducted at WGNSSK:

- For a number of stocks assessed using SAM (cod, haddock, saithe, sole 7d and witch), the single-stock advice is based on stochastic forecasts (in which the forecast result is the median of a number of iterations, carried out with different starting conditions and process variance realization), which cannot be reproduced using FLR.
- In the case of cod, the single-stock advice is based on stochastic forecasts conducted separately using SAM for each of the three substocks. At WGMIXFISH, the FLR forecast is conducted on the sum of the three substocks, applying the same assumption for the intermediate years (*status quo* F) and using the same rate of changes in fishing mortality between 2023 and 2024 as applied for the single-stock advice (Fbar2024 = 0.40Fbar2023, same rate applied for all substocks).
- For whiting, the single-stock forecast uses the Multi Fleet Deterministic Projection (MFDP) forecast software, which models separately fleets fishing for human consumption and the industrial fishery, which is a different fleet specification that in FLBEIA and can also not be reproduced with the FLR function used to project the stocks.

In addition to that, the FLBEIA framework has some specificities of its own which depart from the way most stock assessment and forecast methods operate:

- Although assumption used for conditioning the forecast are the same, in FLBEIA, future assumptions regarding biology and exploitation pattern are derived from fleet-disaggregated data, while at WGNSSK they are derived from stock-level assessment input and output
- The catch process is modelled using a different equation (Baranov equation for single-stock advice and for Cobb Douglas equation in FLBEIA)

In order to assess the impact of the change in modelling framework on the quantities produced in short-term projections for the various stocks considered, two different baseline runs are produced using the WGMIXFISH FLR environment:

- WGMIXFISH FLR baseline: a simple FLR deterministic forecast using the fwd() function that uses exactly the same input (starting abundances, future biology and fisheries selectivity) and the same production function (Baranov) as the forecast methods used in the WGNSSK. This run is used as a quality check that is mainly aimed at checking that all stock data and future assumptions are transferred correctly into the FLR/FLBEIA environment. Discrepancies with the WGNSSK forecast should be minimal, and only results from method used in WGNSSK not being fully reproducible in FLR (e.g. SAM stochastic forecasts).
- WGMIXFISH-FLBEIA baseline: a FLBEIA baseline run in which stocks are projected forward independently from each other (no mixed fisheries interactions). In addition to the discrepancies observed for the simple FLR run, this WGMIXFISH-FLBEIA baseline run may deviate further from the WGNSSK single-stock advice as they are carried out with mean weight, discard rate and selectivity at age based on the mixed fisheries data, and using the Cobb Douglas production function. The aim of this baseline run is to assess the impact of changing from a modelling framework not considering fleets, to a fleet-explicit one.

These two baseline runs are compared with the single-stock advice forecast from WGNSSK.

6.5.1.2 Mixed fisheries runs

Prior to 2013, projections were run applying the mixed fisheries scenarios two years in a row, i.e. both for the intermediate year and the TAC year. This allowed WGMIXFISH to analyse why management plans often did not deliver their expected results and why some short-term forecasts had been over-optimistic in the past (Kraak *et al.*, 2013), by evaluating the impact of the assumptions in the intermediate year.

However, since 2013, the working group adopted a forecast approach for the intermediate year on the basis of *status quo* effort (Table 6.9). The *status quo* effort assumption is considered a plausible assumption and is more in line with the standard single-stock short-term forecasting approach (which apply a *status quo* F unless a TAC constraint is used).

An important change to the projections was implemented in 2015, to account for the landing obligation. Historically, the mixed fisheries projections have been presented in terms of landings and overshoots or undershoots of the retained portion of the catch, assuming fishing fleets would discard as observed in past years and that only the landings counted against the fleets' stock shares.

This year, the projections were run assuming a full and perfect implementation of the discard ban (i.e. all quota species caught must be landed, with no exemptions, *de minimis* or interspecies flexibilities) for species under landing obligation, i.e. all catches are assumed to be landed and to count against the quota.

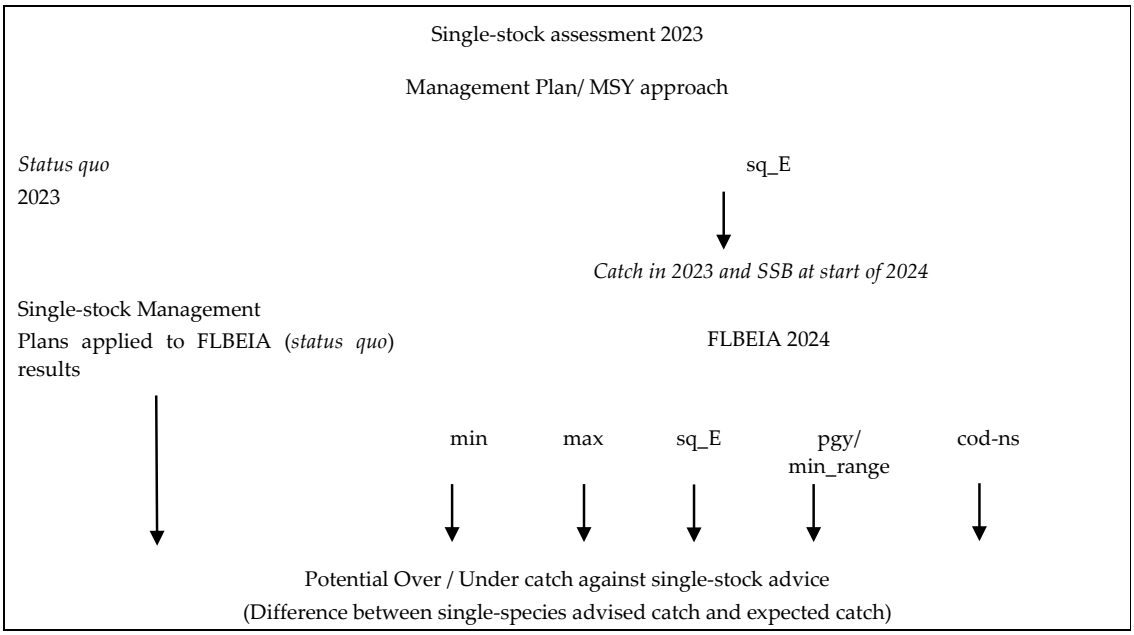
While WGMIXFISH is aware that the landing obligation may not be enforced for all stocks in 2023, and that discards will not disappear overnight, it was considered that this option would bring new insights to where the choke effects will lie. The main implication of this change in the results would be that stocks for which some fleets had high discards in the past may become more limiting for those fleets, due to the mismatch between their catches (which now all count against the fleets' stock shares) and their stock shares based on historical landings.

Since 2021, projections are performed with age-disaggregated data at the métier level. This change does not affect the total catch that can be taken in the advice year of the alternative scenarios. However, for some stocks it affects the age-composition of the catch and associated Fbar values, and may provide additional insights into discard and landing quantities at the métier, fleet and stock level.

To increase the similarity between the mixed fisheries and single species projections, the population dynamics in the intermediate year have been changed to fixed population dynamics since 2022. This forces the mixed fisheries projection models to use the same stock numbers as single species forecasts at the start of the projection.

Since 2023, the range scenario, which presented a "min" scenario using fishing mortality values that minimized the difference between catches realized under a "min" and "max" scenario by exploring F values between the lower and upper F_{MSY} ranges for each stock where applicable, was replace by the pgy scenario. This scenario is an alternative "min" scenario in which F_{MSY} target values in the advice year are replace by target fishing mortalities corresponding to $F_{MSY\ upper}$ where applicable ($SSB > B_{trigger}$).

In summary, the FLBEIA runs followed the scheme below:



6.5.2 Results

6.5.2.1 Baseline run

WGMIXFISH-FLR baseline run

The Figure 6. summarizes the trends in single-stocks advice between the last data year (2022) and the two forecast years (2023 and 2024). The advised catch for 2024 for COD-NS corresponds to a 60% decrease in Fbar compared to 2023. This decrease corresponds to the implementation of the MSY advice rule for the Southern substock, and the implementation of a decrease of the same proportion for the other two substocks, as a precautionary measure. Such a decrease in Fbar implies that the effort corresponding to this advice for all fleets catching this stock would be much lower than the current effort. Other stocks also have a catch advice for 2024 that imply a substantial decrease in Fbar compared to 2023 (around −42% for WIT and −37% for PLE-EC , −30% for SOL-NS). On the other hand, the advice catch for whiting (WHG-NS), haddock (HAD) and North Sea plaice (PLE-NS) correspond to a strong increase in Fbar compared to 2022 (by 290%, 116% and 90% respectively).

The comparison between the WGMIXFISH-FLR baseline run and the ICES single-stock advice is summarized in Table 6.10 for the *Nephrops* stocks and in Figure 6. for the fish stocks. The issues encountered in replicating the single-species advice in FLR are detailed below.

- **Cod:** The Northern Shelf cod forecast is a stochastic projection, conducted separately for the three substocks. For each substock, the forecast produced internally in SAM by generating 1000 replications within the confidence interval of the F-at-age, N-at-age and catch multiplier estimates. The short-term forecast conducted at WGMIXFISH does not use SAM, but a simple deterministic forecast conducted on the combined stock (sum of the three substock). Despite these noticeable differences in the projection methodology, only small differences were observed (−3.6% for the catch in 2024 and 5.2% for SSB in 2024) between the FLR forecast and the single-stock advice.
- **Haddock:** The haddock assessment and forecast are also conducted using SAM. The SAM forecast is run with 2022 as a starting year. This was not reproduced in the FLR forecast, which started in 2023, using the stock abundances from the SAM forecast as

starting numbers for 2023. The single-stock forecast also uses weight-at-age in the forecasted period produced by a growth model instead of the commonly used assumption of constant weights equal to the average over the recent years. Those specific values could not be reproduced in the forecasting procedure of FLR and were therefore entered manually. Some small discrepancies were also observed for this stock. The −6.0% difference in SSB for 2023 is explained by the fact that the HAD advice sheet report the stock assessment estimate (SAM) for this year, which is different from the value obtained by the SAM forecast. Differences for the advice year, 2024, are smaller (maximum −2.7% for the catches). The FLR forecast was considered sufficiently close for use in the mixed fisheries projection.

- **Whiting:** Although whiting is assessed using SAM, the WGNSSK forecast is deterministic, conducted using MFDP. The WGNSSK forecast treats the industrial bycatch separately from the landings for human consumption, with specific future weights-at-age and selectivity and assumes a *status quo* F value for this fishery, independent from the value of target F for the human consumption fishery. The FLR forecast used at WGMIXFISH does not allow for multiple fleets and therefore the industrial bycatch is included in the discards component, which means that its F is scaled to the overall F. The future landings selectivity and weights-at-age were recalculated as the weighted means of the values in the landings for human consumption and industrial bycatch. There is an 8.3% difference in the 2023 landings (while catch are equal) which come from the fact that part of the industrial bycatch is ascribed to landings in the WGNSSK forecast, while industrial bycatch were all ascribed to the discards in the FLR forecast. Given the strong increase in Fbar between the current year and the advice year (+290%), the difference in the treatment of the industrial fishery bycatch (*status quo* and modelled separately in MFDP vs. incorporated in discards and therefore scaled to the overall F) leads to −9.0% and −8.1% differences in the 2024 catch and landings, respectively. This is considered close enough for use in the mixed fisheries projection.
- **Saithe:** As for cod and haddock, the 2023 saithe assessment and forecast were carried out using the SAM assessment model. The difference in forecast procedure compared to WGMIXFISH resulted in differences in the output of −2.4% in the 2023 SSB and −3.8% in the 2024 catches and -−4.9% in 2025 for SSB. The FLR forecast was considered sufficiently close for use in the mixed fisheries projection.
- **North Sea Plaice:** the assessment and forecast are also conducted using SAM, which explain the small differences with the FLR deterministic forecast (maximum −1.7% on the 2024 catch).
- **English Channel Plaice:** Significant migrations of plaice occur between the North Sea, Eastern Channel and Western Channel. As a result, only a proportion of the plaice TAC defined in Subdivision 7.d corresponds to the Eastern Channel plaice. The forecast takes account of the expected quantity of plaice caught in the eastern channel adjusting for these migrations. The single-stock advice is based on a deterministic forecast run in FLR, which was reproduced almost identically by WGMIXFISH.
- **North Sea Sole:** Although the single-stock forecast and the WGMIXFISH-FLR forecast are both deterministic, carried out in FLR, the libraries used were different (Flasher and Flash, respectively). The library used at WGNSSK recomputes future weight-at-age in the catches, based on assumed future landings and discards weights-at-age, and the forecasted proportions of landings and discards in future catches (this ensure consistency in the projected catch, landings and discards amounts). The library used at WGMIXFISH uses a 3 year average for mean weight-at-age in the catches, landings and discards. This methodological difference results in a small discrepancy in the forecast catch values (0.8% in 2024).

- **English Channel Sole:** The 2021 English Channel Sole assessment and forecast were carried out using the SAM assessment model. As for the other stocks with a SAM stochastic forecast, some small differences were observed between the single-stock and the FLR forecasts (−4.5% and −4.3% for the 2023 and 2034 SSB values).
- **Turbot:** The turbot assessment is conducted with SAM, but the WGNSSK forecast procedure is deterministic using the FLR package. These results were reproduced identically at WGMIXFISH. The turbot assessment does not include discard information (for lack of accurate discard-at-age data), and therefore the landings (in the assessment and in the short-term projections) are equal to the catches. WGNSSK applies a correction of the projected landings to take into account the discard rate in weight (4.5% in 2023). This has not been reproduced in the WGMIXFISH baseline run and explains the difference in the 2023 and 2024 catch between the single-stock advice and the WGMIXFISH baseline run.
- **Witch:** As for other stock where SAM is used to run a stochastic forecast, small differences with the single species advice were encountered, of less than 2% for all forecasted quantities.
- ***Nephrops*:** The forecasts applied the recommended harvest rates to the most recent abundance estimates available for the FUs considered at category 1 stocks (FU 6, 7 8 and 9). The ICES advice for 2024 is given assuming that the landing obligation is applied in 2023 for all FUs, with an exemption of high survival for catches with pots (FPO), and for catches with bottom trawls (OTB, TBN) with a mesh size of at least 80 mm equipped with a netgrid selectivity device. The WGNSSK procedure was reproduced as closely as possible in FLR and the differences in the forecasted 2024 landings were in all cases under 1%.

WGMIXFISH-FLBEIA baseline run

The forecast conducted using FLBEIA without mixed fisheries interactions is compared to the WGMIXFISH-FLR baseline run and the single-stock advice on Figure 6.. In FLBEIA, the stocks are projected forward based on catches. In order to configure the FLBEIA runs, the catches in 2023 and 2024 from the single-stock advice were used as constraints. This differs from the method applied for the single-stock advice and the WGMIXFISH-FLR baseline run, for which the constraint in the intermediate year can be either a Fbar or a catch constraint (depending on the stocks) and the calculation in the advice year is based on a Fbar value. As a result, the forecasted catches for 2023 and 2024 in the WGMIXFISH-FLBEIA baseline run are the same as the single-stock advice (blue curve on the black line on Figure 6.), while small differences can be observed for the WGMIXFISH-FLR baseline (as detailed above). The only exception is for TUR, for which the assessment (and the FLR objects used a WGMIXFISH) do not contain discards while in the single-stock advice, discards are added as an assumed proportion of the landings.

Differences are observed for the catches for 2022, the last data year. The 2022 catches in FLBEIA are the sum across métiers of the landings and discards-at-age multiplied by the corresponding weight-at-age which are obtained by WGMIXFISH from the InterCatch data combined with the accession data. These sums of catches are generally close to the ICES estimates provided on the single-stock advice. The stock assessment output provided by WGNSSK, however, contain catches estimated by the stock assessment model (which differ from the observed catches) for part of the stock. This explains the differences for 2022 catch for HAD and SOL-NS on figure 6.12.

In general, the WGMIXFISH-FLBEIA forecast reproduced the single-stock forecasts well for the SSB (differences with single-stock advice generally under 5%) although larger discrepancies are often observed for the 3rd projection year (2025). The large discrepancies found for WIT are due to the fact that FLBEIA is not able to compute accurately the SSB for stocks not spawning at the start of the year, which is the case for WIT. Computing manually the SSB using the output of

FLBEIA gave values close to the single-stock advice. For most stocks, the FLBEIA forecast leads to similar differences as obtained with the FLR forecast, indicating that the main cause for the difference is the impossibility to reproduce in a deterministic FLR forecast some of the specificities of the forecast done in WGNSSK (e.g. stochasticity).

Large discrepancies were observed for the landings and discards for most stocks, with higher discards and lower landings in the WGMIXFISH-FLBEIA projections. The most extreme example is for SOL-NS, for which the discards in the WGMIXFISH-FLBEIA baseline are more than two times larger than the single-stock advice (while landings are around 15% lower), and PLE-EC, for which the landings are less than 50% of those from the single-stock advice (while the discards are 50% higher). The cause of these discrepancies could not be fully understood at WGMIXFISH. A potential reason could be that the proportions of discards vs. landings in the stock objects provided by WGNSSK may be different from those resulting of the use of fleet and métier disaggregated data that is used in FLBEIA. Further investigations are required to ascertain that this is indeed the cause.

Large differences are also observed for the Fbar values calculated by FLBEIA (projections done based on catches and fishing mortality calculated a posteriori).

In conclusion, using the mixed fisheries model for the projections leads to some differences in forecasted quantities, which are related both to the difference in methodologies (projections based on F or catches, using the Baranov equation vs. projection based on catch only, using the Cobb-Douglas equation), and to the underlying data (stock-aggregated selectivity, weights and discard ratios, vs. fleet specific values).

The WGMIXFISH-FLBEIA baseline produces similar population dynamics as the WGMIXFISH-FLR baseline since forecasted SSB values (and therefore underlying population numbers-at-age) are broadly similar, and catches are, by default, equal to single-stock (since that is the constraint used for the projection). This indicates that, when the mixed fisheries interactions are introduced in the model, the model should represent population dynamics and catches (resulting from the choice of a most or least limiting effort) in an appropriate manner. These quantities are the main quantities relevant to the mixed fisheries advice. There could be some concern with the landingsvs.discards values produced, as well as with the Fbar values, but these quantities are not relevant to the mixed fisheries advice.

Mixed fisheries analyses

The full overview of the FLBEIA projections are presented in Table 6.11 and in Figure 6. to Figure . Figure 6. displays the catch by scenario for each of the species. Potential overshoot/undershoot on this figure are calculated by comparing the single-species catch advice for 2024 with the mixed fisheries catch estimates. The anticipated SSBs in 2025 of the mixed fisheries scenarios compared to the baseline are shown in Figure , and Figure shows the effort needed to reach the single-stock advice and highlights the most and least limiting stock per fleet. Figure shows the relative quota uptake by fleet in case of the min scenario. A summary of catches by scenario, including the single-stock advice values for reference, is presented in Table 6.12. Finally, Figure 6.18 summarizes all the mixed fisheries projections and compares them to the single-species advice projections.

The outcomes of the “min” and “max” scenarios are driven by the stocks that will be most and least limiting for each individual fleet. Cod was estimated to be the most limiting stock in the “min” scenario. The “min” scenario assumes that fleets would stop fishing when their first quota share is exhausted, regardless of the actual importance of this quota share, thus leading to a distorted perception of plausible fleet behaviour. While this can be considered an unlikely scenario as long as discarding is allowed, this scenario reflects the constraints that result from a strictly implemented discard ban. Assuming a strictly implemented landings obligation (i.e. a

discard ban where all catches of quota species must be counted against quota, with no flexibilities such as exemptions, *de minimis* allowed discards or interspecies flexibility, as the "min" scenario represents), cod would be the most limiting stock, constraining 35 of the 43 fleet segments (not considering the BLL_OTH fleet; Figure and Figure). Eastern English Channel plaice constrains five fleet segments, while saithe, witch flounder, and Norway lobster (FU6) limit each one fleet. This would result on undershooting the advised catches for 2024 provided by the single species advices for all stocks except cod in 2024 (Figure 6. and Figure 6.).

Conversely, in the "max" scenario, North Sea whiting would be the least limiting stock for 36 out of 43 fleets. This is similar to the previous year. Haddock, North Sea plaice and Norway lobster (FU7) are the other stocks identified as least limiting for each one fleet (Figure and Figure). Under the "max" scenario all stocks are overshot except whiting (Figure 6. and Figure 6.).

The "cod_ns" scenario reflects the fishing mortality corresponding to the single-species advice for cod.27.47d20 (based on the ICES MSY approach), and the results present fishing opportunities for other stocks in a mixed fisheries context. It is very similar to the "min" scenario as most fleets are choked by cod in the "min" scenario. Similar scenarios based on the single-stock advice for the other finfish stocks could be provided by ICES, but the "cod_ns" scenario is considered here because it was requested by managers in the past.

Mixed fisheries results for Norway lobster are displayed after combining functional units 6–9 (FUs 6–9) in one plot, but stock status and fishing opportunities differ widely across FUs. In particular, FU7 (Fladen Ground) is exploited well below the MSY target, and acts as a least limiting stock for 1 fleet. In order to ensure Norway lobster stocks are exploited sustainably in the different FUs, management should therefore be implemented at the FU level. Potential undershoot of catch opportunities for FU7 should not be transferred to other FUs.

The "pgy" scenario is almost identical with the "min" scenario. Fishing at $F_{MSY\ upper}$, where applicable, would relax choking for a single fleet, the NL_Pelagic would be choked by whiting instead of saithe), whereas all other fleets are choked by stocks with SSB < $B_{trigger}$ that cannot be considered to be fished at $F_{MSY\ upper}$.

6.6 References

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Table 6.4. Final fleet and métier categories used in the mixed fishery analysis. 4, 3AN and 7D refer to ICES area. Effort is in kWdays and catch is in tonnes, and both figures are for the year 2022.

Fleet	Métier	Effort	Catch	Fleet2	Métier3	Effort4	Catch5
BE_Beam<24	beam_oth.4	553	65	FR_Otter10-40	TR1.7D	100	49
BE_Beam<24	BT2.4	108	167	FR_Otter10-40	TR2.4	408	804
BE_Beam<24	BT2.7D	169	938	FR_Otter10-40	TR2.7D	3843	3661
BE_Beam>=24	BT1.4	475	1302	GE_Beam>=24	BT1.4	28	18
BE_Beam>=24	BT2.4	243	321	GE_Beam>=24	BT2.4	1497	1394
BE_Beam>=24	BT2.7D	1918	2007	GE_Otter<24	TR1.3AN	8	11
BE_Otter	OTB32-69.4	94	22	GE_Otter<24	TR1.4	64	60
BE_Otter	OTB32-69.7D	9	2	GE_Otter<24	TR2.4	926	3443
BE_Otter	TR1.4	286	539	GE_Otter24-40	TR1.3AN	82	496
BE_Otter	TR1.7D	2	1	GE_Otter24-40	TR1.4	5430	5027
BE_Otter	TR2.4	397	2735	GE_Otter24-40	TR2.4	944	2277
BE_Otter	TR2.7D	13	17	GE_Otter24-40	TR2.7D	133	26
BLL_OTH	OTH	1000	454	MIS_MIS	MIS	29254	4180
DK_OTH	OTH.3AN	502	118	NL_Beam<24	beam_oth.4	3160	154
DK_OTH	OTH.4	5047	1440	NL_Beam<24	BT1.4	1	175
DK_Otter<24	MIS	152	38	NL_Beam<24	BT2.4	156	2279
DK_Otter<24	TR1.3AN	183	437	NL_Beam>=40	BT1.4	1716	4157
DK_Otter<24	TR1.4	426	913	NL_Beam>=40	BT2.4	11947	37461
DK_Otter<24	TR2.3AN	2723	4019	NL_Beam24-40	beam_oth.4	534	17
DK_Otter<24	TR2.4	28	191	NL_Beam24-40	BT1.4	245	982
DK_Otter>=24	MIS	16	0	NL_Beam24-40	BT2.4	1348	4372
DK_Otter>=24	OTB32-69.3AN	1086	233	NL_OTH	OTH.4	1428	3575
DK_Otter>=24	OTB32-69.4	161	28	NL_OTH	OTH.7D	18	5
DK_Otter>=24	TR1.3AN	111	310	NL_Otter	MIS	16	12
DK_Otter>=24	TR1.4	2122	4132	NL_Otter	otter_oth.4	747	3765
DK_Otter>=24	TR2.3AN	961	1398	NL_Otter	otter_oth.7D	1097	500
DK_Otter>=24	TR2.4	373	2460	NL_Otter	TR1.4	378	2998
DK_Pelagic	pelagic.4	2299	559	NL_Otter	TR1.7D	36	15

Fleet	Métier	Effort	Catch	Fleet2	Métier3	Effort4	Catch5
DK_Pelagic	pelagic.6A	429	11	NL_Pelagic	pelagic.4	3365	2065
DK_Seine	TR1.3AN	512	3954	NL_Pelagic	pelagic.6A	1326	5
DK_Seine	TR1.4	665	1847	NL_Pelagic	pelagic.7D	413	1
DK_Static	GN1.3AN	395	717	NO_<15	OTH	1000	4108
DK_Static	GN1.4	991	2460	NO_DSeine24-40	MIS	0	32
DK_Static	LL1.3AN	14	26	NO_DSeine24-40	otter_oth.4	24	388
DK_Static	LL1.4	1	12	NO_DSeine24-40	TR1.3AN	9	85
EN_<10	GN1.4	152	42	NO_DSeine24-40	TR1.4	337	1433
EN_<10	GN1.7D	0	254	NO_OTH	OTH.3AN	117	3
EN_<10	GT1.4	26	11	NO_OTH	OTH.4	516	3780
EN_<10	GT1.7D	136	100	NO_Otter	OTB32-69.3AN	27	2
EN_<10	MIS	394	36	NO_Otter	OTB32-69.4	2329	952
EN_<10	pots.4	1284	23	NO_Otter	otter_oth.4	937	516
EN_<10	pots.7D	481	3	NO_Otter	TR1.3AN	34	117
EN_<10	TR1.4	31	63	NO_Otter	TR1.4	4088	7056
EN_<10	TR2.4	379	903	NO_Otter	TR3.4	4188	1067
EN_<10	TR2.7D	109	311	NO_Otter10-24	OTB32-69.3AN	1260	54
EN_Beam	beam_oth.4	133	0	NO_Otter10-24	OTB32-69.4	889	70
EN_Beam	beam_oth.7D	1	2	NO_Otter10-24	otter_oth.3AN	135	4
EN_Beam	BT1.4	237	582	NO_Otter10-24	otter_oth.4	126	2
EN_Beam	BT2.4	705	1601	NO_Otter10-24	TR1.3AN	125	61
EN_Beam	BT2.7D	69	482	NO_Otter10-24	TR1.4	273	80
EN_Otter<24	MIS	19	16	NO_Otter10-24	TR3.3AN	397	23
EN_Otter<24	otter_oth.4	23	13	NO_Otter10-24	TR3.4	1	0
EN_Otter<24	otter_oth.7D	52	55	NO_Otter24-40	OTB32-69.3AN	1404	99
EN_Otter<24	TR1.4	228	584	NO_Otter24-40	OTB32-69.4	2965	192
EN_Otter<24	TR2.4	931	2450	NO_Otter24-40	otter_oth.3AN	18	0
EN_Otter<24	TR2.7D	94	89	NO_Otter24-40	otter_oth.4	152	20
EN_Otter>=40	OTB32-69.4	31	20	NO_Otter24-40	TR1.3AN	125	137

Fleet	Métier	Effort	Catch	Fleet2	Métier3	Effort4	Catch5
EN_Otter>=40	TR1.4	256	1805	NO_Otter24-40	TR1.4	2171	1349
EN_Otter>=40	TR1.6A	30	238	NO_Otter24-40	TR3.3AN	162	8
EN_Otter>=40	TR2.4	263	548	NO_Otter24-40	TR3.4	693	299
EN_Otter>=40	TR3.4	112	10	NO_Pelagicall	pelagic.3AN	4	1
EN_Otter24-40	MIS	6	5	NO_Pelagicall	pelagic.4	3886	1713
EN_Otter24-40	otter_oth.4	1099	456	NO_Static	GN1.3AN	30	8
EN_Otter24-40	otter_oth.7D	590	234	NO_Static	GN1.4	1927	3940
EN_Otter24-40	TR1.4	344	841	NO_Static	LL1.3AN	0	0
EN_Otter24-40	TR1.6A	3	0	NO_Static	LL1.4	2244	738
FR_<10	GT1.4	15	3	NO_Static	LL1.6A	631	3
FR_<10	GT1.7D	251	53	NO_Static	pots.3AN	3	0
FR_<10	MIS	68	1	NO_Static	pots.4	12	2
FR_<10	OTH.4	0	0	OTH_OTH	OTH	1000	6408
FR_<10	OTH.7D	193	40	SC_Otter<10	TR1.4	34	79
FR_<10	otter_oth.7D	16	66	SC_Otter<10	TR2.4	291	905
FR_<10	TR2.4	2	0	SC_Otter<24	MIS	6	196
FR_<10	TR2.7D	51	215	SC_Otter<24	TR1.4	5899	17911
FR_Nets	GT1.4	56	22	SC_Otter<24	TR1.6A	759	673
FR_Nets	GT1.7D	593	407	SC_Otter<24	TR2.4	1068	10390
FR_Nets	MIS	19	2	SC_Otter<24	TR2.6A	2154	511
FR_OTH	OTH.4	52	190	SC_Otter>=24	TR1.4	8610	54976
FR_OTH	OTH.6A	3	150	SC_Otter>=24	TR1.6A	1661	5851
FR_OTH	OTH.7D	5484	442	SC_Otter>=24	TR2.4	228	1223
FR_OTH	otter_oth.7D	44	60	SC_Otter>=24	TR2.7D	213	478
FR_OTH	pelagic.4	1221	106	SC_Static<10	GN1.4	3	7
FR_OTH	pelagic.7D	769	92	SC_Static<10	GN1.7D	0	0
FR_OTH	TR2.4	80	198	SC_Static<10	LL1.4	279	311
FR_OTH	TR2.7D	652	1229	SC_Static<10	LL1.6A	4	0
FR_Otter>=40	TR1.4	2033	9928	SC_Static<10	pots.4	2106	26

Fleet	Métier	Effort	Catch	Fleet2	Métier3	Effort4	Catch5
FR_Otter>=40	TR1.6A	1431	1301	SW_Otter	OTB32-69.3AN	1186	156
FR_Otter10-40	MIS	30	6	SW_Otter	OTB32-69.4	143	25
FR_Otter10-40	OTB32-69.4	4	36	SW_Otter	TR1.4	257	1481
FR_Otter10-40	OTB32-69.7D	124	80	SW_Otter	TR2.3AN	849	866
FR_Otter10-40	TR1.6A	482	124	SW_Otter	TR2_grid.3AN	850	141

Table 6.5. Average fishing mortality (Fbar) in 2022 between the single-stock assessment (SSA) and FLBEIA.

	FLBEIA	SSA	Diff_FLBEIA/SSA
BLL	0.171	0.172	-0.008
COD-NS	0.306	0.322	-0.052
HAD	0.115	0.119	-0.036
PLE-EC	0.216	0.187	0.156
PLE-NS	0.095	0.085	0.121
POK	0.343	0.327	0.050
SOL-EC	0.223	0.226	-0.015
SOL-NS	0.126	0.148	-0.149
TUR	0.293	0.340	-0.140
WHG-NS	0.109	0.101	0.082
WIT	0.272	0.248	0.098

Table 6.6. Total catch in 2022 between the single-stock assessment (SSA) and FLBEIA.

	FLBEIA	SSA	Diff_FLBEIA/SSA
BLL	1082.417	1082.417	0.000
COD-NS	32525.071	34177.363	-0.048
HAD	57766.537	53554.243	0.079
PLE-EC	5293.387	4704.543	0.125
PLE-NS	73629.429	64878.986	0.135
POK	54924.910	54912.633	0.000
SOL-EC	1984.616	1924.708	0.031
SOL-NS	4342.247	5011.773	-0.134
TUR	1788.085	1800.222	-0.007

	FLBEIA	SSA	Diff_FLBEIA/SSA
WHG-NS	27709.534	27891.358	-0.007
WIT	1853.320	1861.610	-0.004

Table 6.7. Total landings in 2022 between the single-stock assessment (SSA) and FLBEIA.

	FLBEIA	SSA	Diff_FLBEIA/SSA
BLL	1082.417	1082.417	0.000
COD-NS	23449.506	23892.085	-0.019
HAD	38216.379	33856.809	0.129
PLE-EC	1296.494	1153.330	0.124
PLE-NS	28251.337	25543.240	0.106
POK	50705.550	50346.234	0.007
SOL-EC	1693.913	1632.826	0.037
SOL-NS	3712.694	4476.225	-0.171
TUR	1788.085	1800.222	-0.007
WHG-NS	15247.783	15669.772	-0.027
WIT	1666.267	1697.144	-0.018

Table 6.8. Total discards in 2022 between the single-stock assessment (SSA) and FLBEIA.

	SSA	FLBEIA	Diff_FLBEIA/SSA
BLL	0.000	0.000	
COD-NS	10279.693	9075.565	−0.117
HAD	19672.629	19550.159	−0.006
PLE-EC	3551.213	3996.893	0.126
PLE-NS	39353.428	45378.092	0.153
POK	4566.350	4219.360	−0.076
SOL-EC	291.882	290.703	−0.004
SOL-NS	535.549	629.552	0.176
TUR	0.000	0.000	
WHG-NS	12242.804	12461.751	0.018
WIT	189.850	187.052	−0.015

Table 6.9. Intermediate year assumption in the baseline and mixed fisheries projections.

	Fbar in 2023	Landings in 2023	Discards in 2023	Catches in 2023	SSB in 2024
bll.27.3a47de	0.141	927	0	927	7973
cod.27.46a7d20	0.323	29090	13078	42168	112296
had.27.46a20	0.120	47164	23809	70973	511860
ple.27.7d	0.234	662	3710	4372	27857
ple.27.420	0.100	23272	58684	81957	895353
pok.27.3a46	0.341	54708	5799	60507	170313
sol.27.7d	0.235	1292	453	1745	11063
sol.27.4	0.141	2952	801	3753	25449
tur.27.4	0.296	1726	97	1824	6849
whg.27.47d	0.111	18796	14314	33110	347289
wit.27.3a47d	0.272	1860	271	2131	5235
nep.fu.5	0.003	1029	613	1642	16360
nep.fu.6	0.008	1920	855	2775	18896
nep.fu.7	0.001	5676	271	5946	162837
nep.fu.8	0.006	1790	263	2053	18597
nep.fu.9	0.005	1075	415	1489	14898
nep.fu.10	0.003	1	0	1	10
nep.fu.32	0.001	214	3	217	2169
nep.fu.33	0.002	1094	0	1094	10940
nep.fu.34	0.003	881	0	881	8810
nep.27.4outFU	0.002	824	232	1056	10560

Table 6.10. Comparison between WGMIXFISH-FLR baseline run and ICES advice for *Nephrops in the TAC year (2024). The values for *Nephrops* FUs that do not receive an absolute ICES abundance estimate are set according to the ICES approach for data-limited *Nephrops* stocks. No 'ICES advice' values are given for *Nephrops* in the intermediate year because the baseline run uses values based on recorded landings in the previous year which can vary significantly from the advice for each FU.**

year	value	scenario	NEP5	NEP6	NEP7	NEP8	NEP9	NEP10	NEP32	NEP33	NEP34	NEPOTH-NS
2024	landings	ICES_advice	1005	1375.0	12195	2985.0	1753.0	37	303	918	615	301
2024	landings	MIXFISH_baseline	1005	1397.0	12198	2991.0	1756.0	37	303	918	615	301
2024	landings	difference (%)	0	1.6	0	0.2	0.2	0	0	0	0	0

***These numbers are landings values; ICES advice does not provide total catch.**

Table 6.11. Results of Final FLBEIA runs.

4	year	indicator	BLL	COD-NS	HAD	PLE-EC	PLE-NS	POK	SOL-EC	SOL-NS	TUR	WHG-NS	WIT	NEP10	NEP32	NEP33	NEP34	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH-NS
baseline	2023	landings		35210.000	56049.000	1594.000	38169.000	57156.000	1530.000	3842.000	1781.000	23819.000	2096.000	1	213.859	1094	881	1028.8	1920.285	5675.514	1789.735	1074.524	824
baseline	2024	landings		18866.000	123837.000	1058.000	73181.000	67620.000	1295.000	3278.000	1982.000	82419.000	1485.000	0.498	102.037	534.828	433.216	507.591	1037.192	2756.044	881.645	713.608	234.871
baseline	2023	catch		42258.000	68498.000	3714.000	82190.000	60169.000	1747.000	4289.000	1781.000	34976.000	2292.000	0.38	76.671	405.698	328.435	384.845	734.065	2082.908	670.378	536.952	234.871
baseline	2024	catch		21871.000	144927.000	2368.000	152346.000	71026.000	1494.000	3706.000	1982.000	116796.000	1587.000	0	3.141	0	0	613.2	854.533	270.63	263.497	414.592	232
baseline	2023	Fbar		0.322	0.112	0.187	0.085	0.327	0.204	0.171	0.340	0.101	0.248	0	1.499	0	0	307.991	426.198	131.425	129.932	4.965	288.174
baseline	2024	Fbar		0.129	0.240	0.119	0.152	0.363	0.174	0.122	0.361	0.393	0.144	0	1.126	0	0	234.5	301.874	99.334	98.8	3.736	161.65
baseline	2023	ssb		95161.000	497597.000	29502.000	885884.000	157291.000	11315.000	21619.000	6941.000	348137.000	4013.000	0.003	0.001	0.002	0.003	0.003	0.008	0.001	0.006	0.005	0.002
baseline	2024	ssb		114528.000	519185.000	28864.000	903878.000	170986.000	11313.000	24998.000	6549.000	347814.000	4904.000	0.011	0.008	0.02	0.021	0.019	0.067	0.007	0.03	0.029	0.01
baseline	2025	ssb		157943.000	444165.000	29594.000	963392.000	174491.000	11854.000	33225.000	6530.000	278612.000	5814.000	0.017	0.016	0.032	0.035	0.027	0.087	0.014	0.051	0.049	0.015
min	2023	Fbar	0.141	0.323	0.120	0.234	0.100	0.341	0.235	0.141	0.296	0.111	0.272	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
min	2024	Fbar	0.185	0.144	0.054	0.116	0.053	0.142	0.121	0.080	0.146	0.054	0.121	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560

4	year	indicator	BLL	COD-NS	HAD	PLE-EC	PLE-NS	POK	SOL-EC	SOL-NS	TUR	WHG-NS	WIT	NEP10	NEP32	NEP33	NEP34	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH-NS
min	2025	Fbar	0.161	0.106	0.040	0.092	0.041	0.103	0.100	0.062	0.111	0.041	0.087	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
min	2023	ssb	6591.547	95161.393	497596.703	29501.944	885883.978	157291.473	11314.504	21618.903	6940.891	348136.680	4540.042	1	217	1094	881	1642	2774.818	5946.144	2053.233	1489.116	1056
min	2024	ssb	7972.631	112296.101	511860.325	27857.291	895352.812	170312.686	11062.982	25448.691	6848.986	347288.817	5235.126	3.494	717.342	4365.296	3133.212	6888.394	13260.078	20577.487	7660.587	5774.578	4328.345
min	2025	ssb	8718.461	151636.217	533681.551	28492.430	1036521.913	210980.817	12098.409	34761.577	7853.776	354128.552	6444.339	5.635	1188.828	6515.166	4987.262	10020.238	17006.198	33162.698	12096.466	9040.089	6391.778
min	2023	catch	926.754	42168.464	70973.245	4372.182	81956.582	60506.652	1744.614	3752.824	1823.670	33110.355	2130.739	1	213.859	1094	881	1028.8	1920.285	5675.514	1789.735	1074.524	824
min	2024	catch	1477.634	22681.563	34155.643	2180.823	46317.479	30098.743	951.312	2758.940	1116.830	17020.659	1186.812	3.494	299.6	918	652	786.95	1138.708	11742.092	2727.446	1757.771	234.871
min	2025	catch	1399.79	22377.430	25094.915	1768.713	36079.642	26792.020	874.672	3048.710	1044.759	12410.292	1144.478	5.635	299.6	918	652	786.95	1053.468	11742.092	2727.446	1757.771	234.871
min	2023	landings	926.754	29090.315	47164.390	661.779	23272.270	54707.998	1292.068	2952.275	1726.488	18796.269	1860.164	0	3.141	0	0	613.2	854.533	270.63	263.497	414.592	232
min	2024	landings	1477.634	16506.988	28503.531	398.062	13714.233	27271.274	725.154	2164.123	1116.830	10567.640	1056.157	0	417.743	3447.296	2481.212	6101.444	12121.37	8835.395	4933.141	4016.807	4093.474
min	2025	landings	1399.79	17476.246	21212.147	337.572	11702.921	24467.753	663.771	2446.365	1044.759	7726.362	1038.166	0	889.229	5597.166	4335.262	9233.288	15952.73	21420.606	9369.02	7282.318	6156.907
min	2023	discards	0	13078.149	23808.854	3710.403	58684.312	5798.654	452.546	800.549	97.183	14314.086	270.576	0.003	0.001	0.002	0.003	0.003	0.008	0.001	0.006	0.005	0.002
min	2024	discards	0	6174.575	5652.111	1782.761	32603.247	2827.469	226.158	594.817	0.000	6453.019	130.654	0.003	0.001	0.003	0.004	0.004	0.011	0.001	0.006	0.004	0.002
min	2025	discards	0	4901.184	3882.768	1431.141	24376.721	2324.267	210.901	602.344	0.000	4683.930	106.312	0.003	0.001	0.003	0.004	0.004	0.011	0.001	0.006	0.004	0.002
max	2023	Fbar	0.141	0.323	0.120	0.234	0.100	0.341	0.235	0.141	0.296	0.111	0.272	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
max	2024	Fbar	0.604	1.842	0.568	1.975	0.620	1.888	2.161	1.982	1.670	0.529	1.531	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
max	2025	Fbar	0.94	1.842	1.264	1.975	1.072	2.044	2.161	2.161	1.781	1.019	1.905	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
max	2023	ssb	6591.547	95161.393	497596.703	29501.944	885883.978	157291.473	11314.504	21618.903	6940.891	348136.680	4540.042	1	217	1094	881	1642	2774.818	5946.144	2053.233	1489.116	1056
max	2024	ssb	7972.631	112296.101	511860.325	27857.291	895352.812	170312.686	11062.982	25448.691	6848.986	347288.817	5235.126	1	217	1094	881	1642	2774.818	5946.144	2053.233	1489.116	1056
max	2025	ssb	5378.781	25909.084	319147.426	6004.890	657628.821	57517.944	2231.946	5958.393	3796.988	260143.409	2171.859	1	217	1094	881	1642	2774.818	5946.144	2053.233	1489.116	1056

4	year	indicator	BLL	COD-NS	HAD	PLE-EC	PLE-NS	POK	SOL-EC	SOL-NS	TUR	WHG-NS	WIT	NEP10	NEP32	NEP33	NEP34	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH-NS
max	2023	catch	926.754	42168.464	70973.245	4372.182	81956.582	60506.652	1744.614	3752.824	1823.670	33110.355	2130.739	1	213.859	1094	881	1028.8	1920.285	5675.514	1789.735	1074.524	824
max	2024	catch	4817.314	100118.652	245321.962	17366.909	376411.024	177583.356	5506.206	17465.872	5328.331	128575.530	6892.027	1	213.859	918	652	786.95	1138.708	5675.514	1789.735	1478.828	234.871
max	2025	catch	5055.393	41672.102	221051.414	9647.348	352054.530	105754.993	2143.762	9757.510	2870.810	128520.177	4756.946	1	213.859	918	652	786.95	1138.708	5675.514	1789.735	1478.828	234.871
max	2023	landings	926.754	29090.315	47164.390	661.779	23272.270	54707.998	1292.068	2952.275	1726.488	18796.269	1860.164	0	3.141	0	0	613.2	854.533	270.63	263.497	414.592	232
max	2024	landings	2456	9125.890	120961.278	405.890	46860.615	59425.796	808.547	2098.469	1176.343	78051.214	1071.136	0	3.141	176	229	855.05	1636.11	270.63	263.497	10.288	821.129
max	2025	landings	2456	4880.532	109966.700	223.135	47654.368	48583.021	681.722	1654.136	1139.128	74483.461	934.993	0	3.141	176	229	855.05	1636.11	270.63	263.497	10.288	821.129
max	2023	discards	0	13078.149	23808.854	3710.403	58684.312	5798.654	452.546	800.549	97.183	14314.086	270.576	0.003	0.001	0.002	0.003	0.003	0.008	0.001	0.006	0.005	0.002
max	2024	discards	2361.314	90992.762	124360.684	16961.019	329550.409	118157.560	4697.659	15367.403	4151.987	50524.317	5820.890	0.002	0.001	0.001	0.001	0.002	0.004	0.001	0.003	0.002	0.001
max	2025	discards	2599.393	36791.570	111084.715	9424.213	304400.162	57171.973	1462.041	8103.374	1731.682	54036.715	3821.953	0.001	0	0.001	0.001	0.001	0.003	0	0.002	0.001	0.001
sq_E	2023	Fbar	0.141	0.323	0.120	0.234	0.100	0.341	0.235	0.141	0.296	0.111	0.272	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
sq_E	2024	Fbar	0.18	0.418	0.117	0.243	0.099	0.341	0.256	0.165	0.298	0.110	0.334	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
sq_E	2025	Fbar	0.174	0.416	0.117	0.241	0.099	0.341	0.252	0.190	0.301	0.110	0.348	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
sq_E	2023	ssb	6591.547	95161.393	497596.703	29501.944	885883.978	157291.473	11314.504	21618.903	6940.891	348136.680	4540.042	1	217	1094	881	1642	2774.818	5946.144	2053.233	1489.116	1056
sq_E	2024	ssb	7972.631	112296.101	511860.325	27857.291	895352.812	170312.686	11062.982	25448.691	6848.986	347288.817	5235.126	0.498	103.535	534.828	434.328	816.487	1523.113	2887.633	1012.499	718.615	524.59
sq_E	2025	ssb	8762.551	110631.677	501876.357	25562.931	997359.703	178459.254	10919.539	31757.124	7096.873	340406.386	5559.902	0.381	80.186	409.128	331.591	623.899	1213.65	2185.678	772.608	541.466	401.916
sq_E	2023	catch	926.754	42168.464	70973.245	4372.182	81956.582	60506.652	1744.614	3752.824	1823.670	33110.355	2130.739	1	213.859	1094	881	1028.8	1920.285	5675.514	1789.735	1074.524	824
sq_E	2024	catch	1433.544	47631.921	71843.103	4058.197	85905.036	65730.758	1691.486	4637.227	2032.072	33928.344	2399.204	0.498	102.037	534.828	434.328	508.247	1070.128	2756.201	882.397	713.649	234.871
sq_E	2025	catch	1525.384	47230.160	66748.534	3767.721	83517.767	68648.366	1668.704	6095.497	2168.228	31097.123	2717.701	0.381	79.026	409.128	331.591	387.989	860.396	2086.189	673.245	537.725	234.871
sq_E	2023	landings	926.754	29090.315	47164.390	661.779	23272.270	54707.998	1292.068	2952.275	1726.488	18796.269	1860.164	0	3.141	0	0	613.2	854.533	270.63	263.497	414.592	232

4	year	indicator	BLL	COD-NS	HAD	PLE-EC	PLE-NS	POK	SOL-EC	SOL-NS	TUR	WHG-NS	WIT	NEP10	NEP32	NEP33	NEP34	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH-NS
sq_E	2024	landings	1433.544	16513.574	60022.671	439.680	25933.574	59664.506	1106.568	2882.973	1884.275	22118.610	1404.617	0	1.499	0	0	308.241	452.985	131.431	130.102	4.965	289.718
sq_E	2025	landings	1525.384	16741.843	55944.363	449.762	27430.016	62473.688	1092.039	2922.145	1941.008	20352.968	1419.590	0	1.161	0	0	235.91	353.253	99.488	99.362	3.741	167.045
sq_E	2023	discards	0	13078.149	23808.854	3710.403	58684.312	5798.654	452.546	800.549	97.183	14314.086	270.576	0.003	0.001	0.002	0.003	0.003	0.008	0.001	0.006	0.005	0.002
sq_E	2024	discards	0	31118.347	11820.432	3618.516	59971.462	6066.252	584.919	1754.254	147.797	11809.734	994.587	0.002	0.001	0.001	0.001	0.002	0.004	0.001	0.003	0.002	0.001
sq_E	2025	discards	0	30488.317	10804.171	3317.959	56087.751	6174.678	576.665	3173.352	227.220	10744.155	1298.110	0.001	0	0.001	0.001	0.001	0.003	0	0.002	0.001	0.001
cod-ns	2023	Fbar	0.141	0.323	0.120	0.234	0.100	0.341	0.235	0.141	0.296	0.111	0.272	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
cod-ns	2024	Fbar	0.185	0.144	0.054	0.118	0.053	0.142	0.127	0.080	0.146	0.055	0.121	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
cod-ns	2025	Fbar	0.163	0.108	0.040	0.096	0.043	0.103	0.108	0.068	0.118	0.042	0.093	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
cod-ns	2023	ssb	6591.547	95161.393	497596.703	29501.944	885883.978	157291.473	11314.504	21618.903	6940.891	348136.680	4540.042	1	217	1094	881	1642	2774.818	5946.144	2053.233	1489.116	1056
cod-ns	2024	ssb	7972.631	112296.101	511860.325	27857.291	895352.812	170312.686	11062.982	25448.691	6848.986	347288.817	5235.126	0.498	103.535	534.828	433.216	815.581	1463.39	2887.469	1011.577	718.573	523.046
cod-ns	2025	ssb	8717.209	151625.772	533673.903	28445.336	1036503.113	210980.164	12041.927	34755.516	7853.048	354084.672	6444.147	0.38	77.797	405.698	328.435	619.345	1035.939	2182.242	769.178	540.687	396.521
cod-ns	2023	catch	926.754	42168.464	70973.245	4372.182	81956.582	60506.652	1744.614	3752.824	1823.670	33110.355	2130.739	1	213.859	1094	881	1028.8	1920.285	5675.514	1789.735	1074.524	824
cod-ns	2024	catch	1478.886	22691.000	34164.129	2227.475	46337.851	30099.467	1004.328	2763.982	1117.648	17064.922	1187.124	0.498	102.037	534.828	433.216	507.591	1037.192	2756.044	881.645	713.608	234.871
cod-ns	2025	catch	1420.028	22691.000	25220.180	1826.108	38016.835	26910.642	937.626	3318.950	1110.815	12583.512	1221.837	0.38	76.671	405.698	328.435	384.845	734.065	2082.908	670.378	536.952	234.871
cod-ns	2023	landings	926.754	29090.315	47164.390	661.779	23272.270	54707.998	1292.068	2952.275	1726.488	18796.269	1860.164	0	3.141	0	0	613.2	854.533	270.63	263.497	414.592	232
cod-ns	2024	landings	1478.886	16513.574	28509.764	399.194	13722.329	27271.965	771.747	2168.303	1117.648	10583.295	1056.437	0	1.499	0	0	307.991	426.198	131.425	129.932	4.965	288.174
cod-ns	2025	landings	1420.028	17697.415	21312.749	348.483	12313.104	24575.156	718.878	2605.305	1110.815	7755.818	1109.550	0	1.126	0	0	234.5	301.874	99.334	98.8	3.736	161.65
cod-ns	2023	discards	0	13078.149	23808.854	3710.403	58684.312	5798.654	452.546	800.549	97.183	14314.086	270.576	1	213.859	1094	881	1028.8	1920.285	5675.514	1789.735	1074.524	824
cod-ns	2024	discards	0	6177.426	5654.365	1828.282	32615.522	2827.502	232.581	595.680	0.000	6481.627	130.687	0.498	102.037	534.828	433.216	507.591	1037.192	2756.044	881.645	713.608	234.871

4	year	indicator	BLL	COD-NS	HAD	PLE-EC	PLE-NS	POK	SOL-EC	SOL-NS	TUR	WHG-NS	WIT	NEP10	NEP32	NEP33	NEP34	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH-NS
cod-ns	2025	discards	0	4993.585	3907.431	1477.626	25703.731	2335.487	218.748	713.645	0.000	4827.694	112.286	0.38	76.671	405.698	328.435	384.845	734.065	2082.908	670.378	536.952	234.871
pgy	2023	Fbar	0.141	0.323	0.120	0.234	0.100	0.341	0.235	0.141	0.296	0.111	0.272	0	3.141	0	0	613.2	854.533	270.63	263.497	414.592	232
pgy	2024	Fbar	0.185	0.144	0.055	0.116	0.053	0.142	0.121	0.080	0.146	0.056	0.121	0	1.499	0	0	307.991	426.198	131.425	129.932	4.965	288.174
pgy	2025	Fbar	0.161	0.106	0.041	0.092	0.041	0.103	0.100	0.062	0.111	0.042	0.087	0	1.126	0	0	234.5	301.874	99.334	98.8	3.736	161.65
pgy	2023	ssb	6591.547	95161.393	497596.703	29501.944	885883.978	157291.473	11314.504	21618.903	6940.891	348136.680	4540.042	0.003	0.001	0.002	0.003	0.003	0.008	0.001	0.006	0.005	0.002
pgy	2024	ssb	7972.631	112296.101	511860.325	27857.291	895352.812	170312.686	11062.982	25448.691	6848.986	347288.817	5235.126	0.011	0.008	0.02	0.021	0.019	0.067	0.007	0.03	0.029	0.01
pgy	2025	ssb	8718.461	151636.217	533273.179	28492.430	1036521.913	210967.515	12098.409	34761.577	7853.776	353810.847	6444.339	0.017	0.016	0.032	0.035	0.027	0.087	0.014	0.051	0.049	0.015
pgy	2023	catch	926.754	42168.464	70973.245	4372.182	81956.582	60506.652	1744.614	3752.824	1823.670	33110.355	2130.739	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
pgy	2024	catch	1477.634	22681.563	34613.520	2180.823	46317.479	30113.548	951.312	2758.940	1116.830	17344.766	1186.812	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
pgy	2025	catch	1399.79	22377.430	25444.960	1768.713	36079.642	26805.382	874.672	3048.710	1044.759	12647.771	1144.478	10	2168.529	10940	8810	16360.193	18895.776	162837.402	18597.056	14897.638	10560
pgy	2023	landings	926.754	29090.315	47164.390	661.779	23272.270	54707.998	1292.068	2952.275	1726.488	18796.269	1860.164	1	217	1094	881	1642	2774.818	5946.144	2053.233	1489.116	1056
pgy	2024	landings	1477.634	16506.988	28846.127	398.062	13714.233	27285.054	725.154	2164.123	1116.830	10611.397	1056.157	3.494	717.342	4365.296	3133.212	6888.394	13260.078	20577.487	7660.587	5774.578	4328.345
pgy	2025	landings	1399.79	17476.246	21476.348	337.572	11702.921	24480.260	663.771	2446.365	1044.759	7752.081	1038.166	5.635	1188.828	6515.166	4987.262	10020.238	17006.198	33162.698	12096.466	9040.089	6391.778
pgy	2023	discards	0	13078.149	23808.854	3710.403	58684.312	5798.654	452.546	800.549	97.183	14314.086	270.576	1	213.859	1094	881	1028.8	1920.285	5675.514	1789.735	1074.524	824
pgy	2024	discards	0	6174.575	5767.392	1782.761	32603.247	2828.494	226.158	594.817	0.000	6733.369	130.654	3.494	299.6	918	652	786.95	1138.708	11742.092	2727.446	1757.771	234.871
pgy	2025	discards	0	4901.184	3968.613	1431.141	24376.721	2325.122	210.901	602.344	0.000	4895.689	106.312	5.635	299.6	918	652	786.95	1053.468	11742.092	2727.446	1757.771	234.871

Table 6.12. Mixed fisheries for the North Sea. Catch per mixed fisheries scenario 2024, in absolute values.

Stock	Single.stock.advice	max	min	sq_E	pgy	cod.ns
bll.27.3a47de	2456	1478	4817	1434	1478	1479
cod.27.47d20	22691	22682	100119	47632	22682	22691
had.27.46a20	149024	34156	245322	71843	34614	34164
ple.27.7d	2367	2181	17367	4058	2181	2227
ple.27.420	155015	46317	376411	85905	46317	46338
pok.27.3a46	73815	30099	177583	65731	30114	30099
sol.27.7d	1504	951	5506	1691	951	1004
sol.27.4	3675	2759	17466	4637	2759	2764
tur.27.4	2052	1117	5328	2032	1117	1118
whg.27.47d	128290	17021	128576	33928	17345	17065
wit.27.3a47d	1579	1187	6892	2399	1187	1187
nep.fu.5	1256	816	6888	1642	816	816
nep.fu.6	1607	1463	13260	2775	1463	1523
nep.fu.7	12302	2887	20577	5946	2887	2888
nep.fu.8	3129	1012	7661	2053	1012	1012
nep.fu.9	1770	719	5775	1489	719	719
nep.fu.10	37	0	3	1	0	0
nep.fu.32	304	104	717	217	104	104
nep.fu.33	918	535	4365	1094	535	535
nep.fu.34	652	433	3133	881	433	434
nep.27.4outFU	301	523	4328	1056	523	525

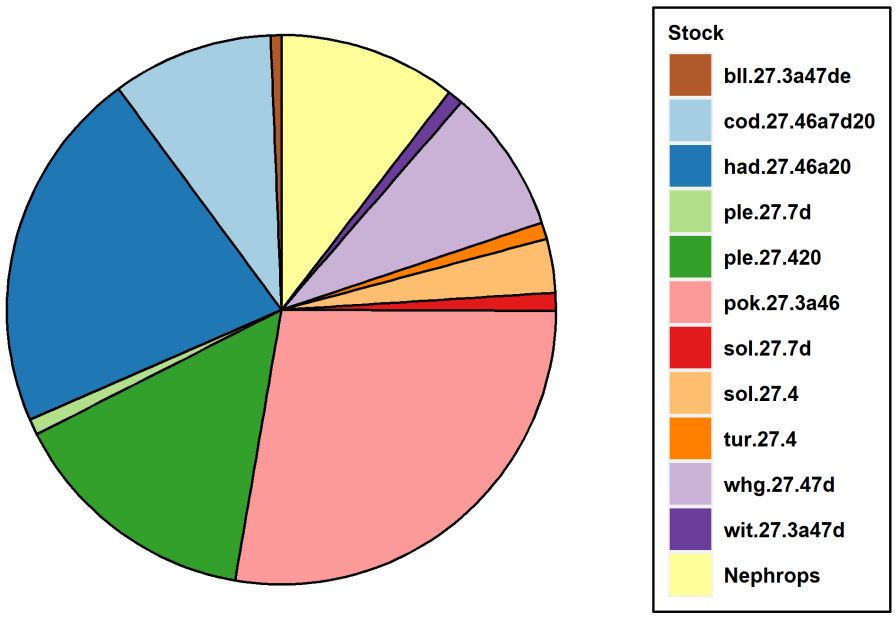

Figure 6.1. Distribution of 2022 landings of those stocks included in the mixed fisheries projections.

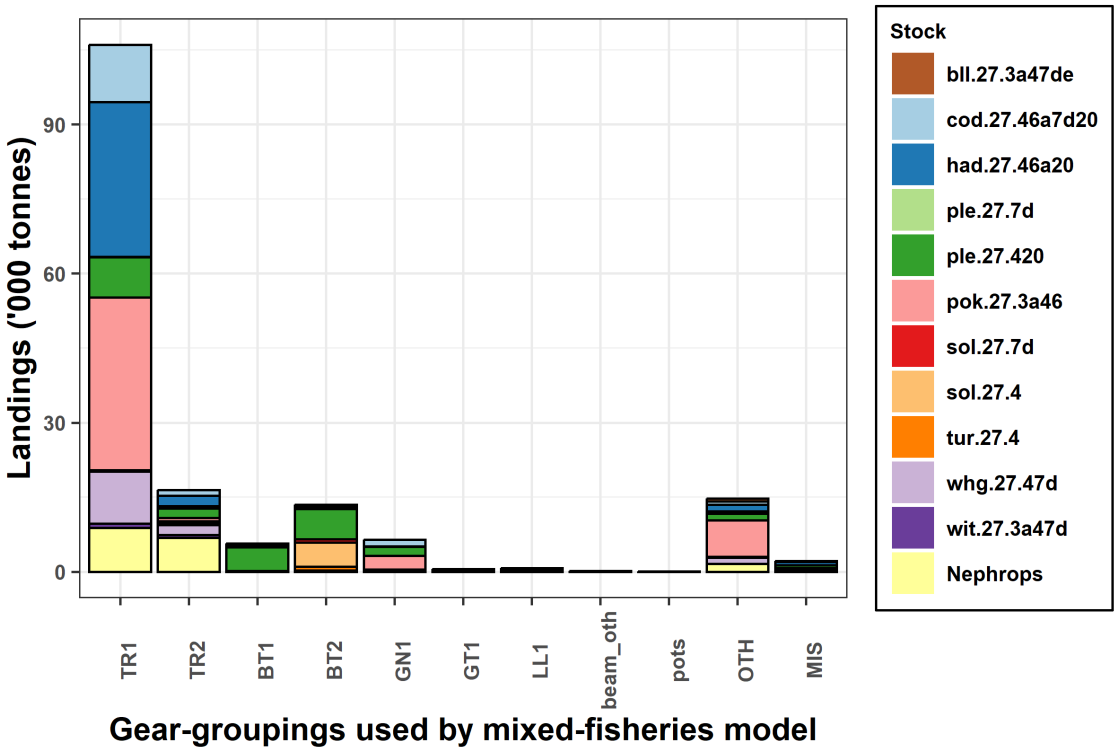

Figure 6.2. 2022 landings distribution of species by métier category. Note: "MIS" contains landings of "small" métiers that, within a fleet, fail to catch at least 5% of the fleet's total landings of at least one stock. The "OTH" displayed here is a mixed category consisting of (i) landings without corresponding effort contained in the BLL_OTH, NO_<15 and OTH_OTH fleets and (ii) landings of uncommon métiers.

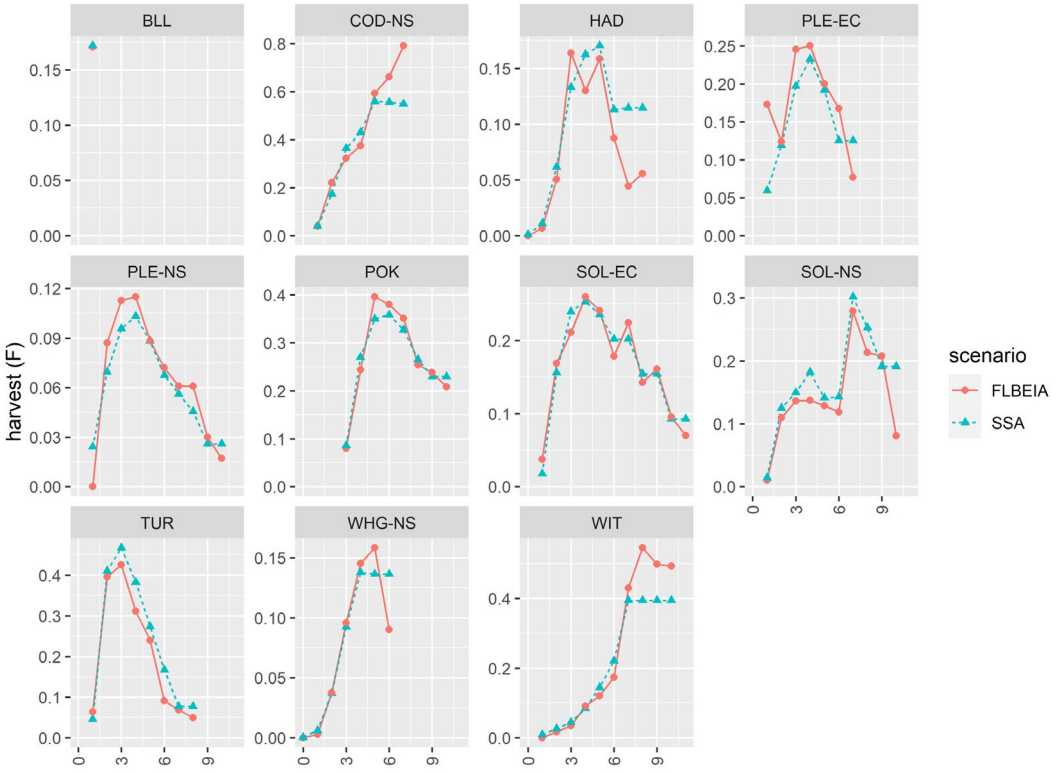

Figure 6.3. Fishing mortality-at-age in the last assessment year (2022).

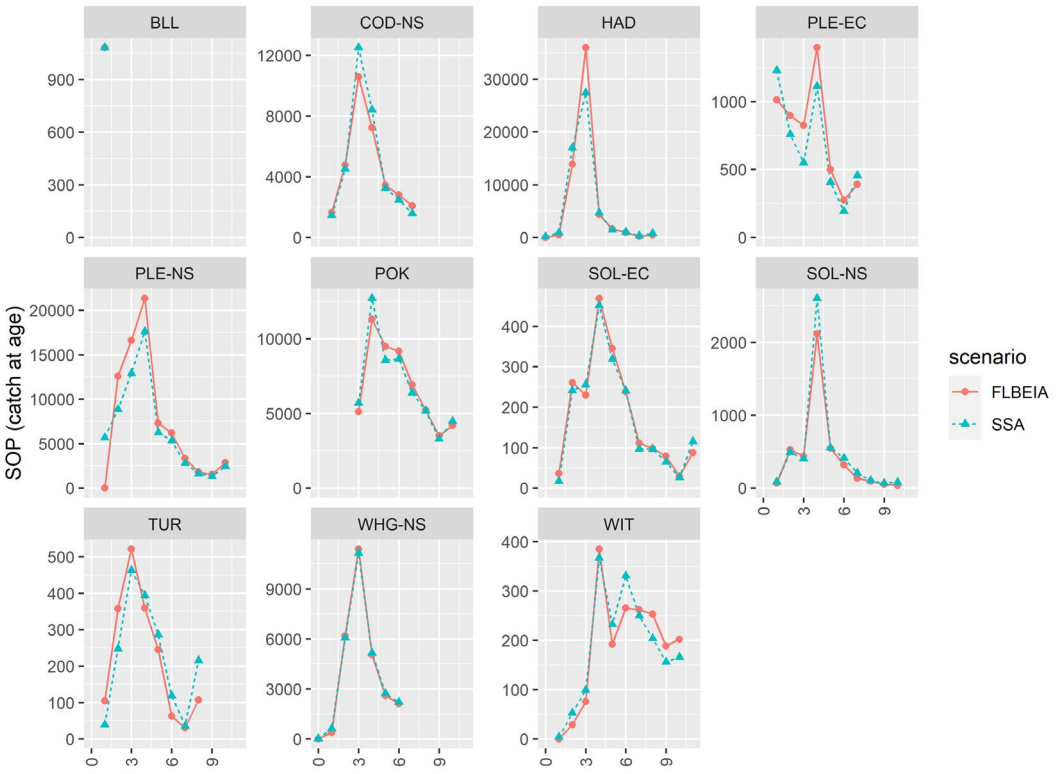

Figure 6.4. Sum of product (numbers*weight) catches in the last assessment year (2022).

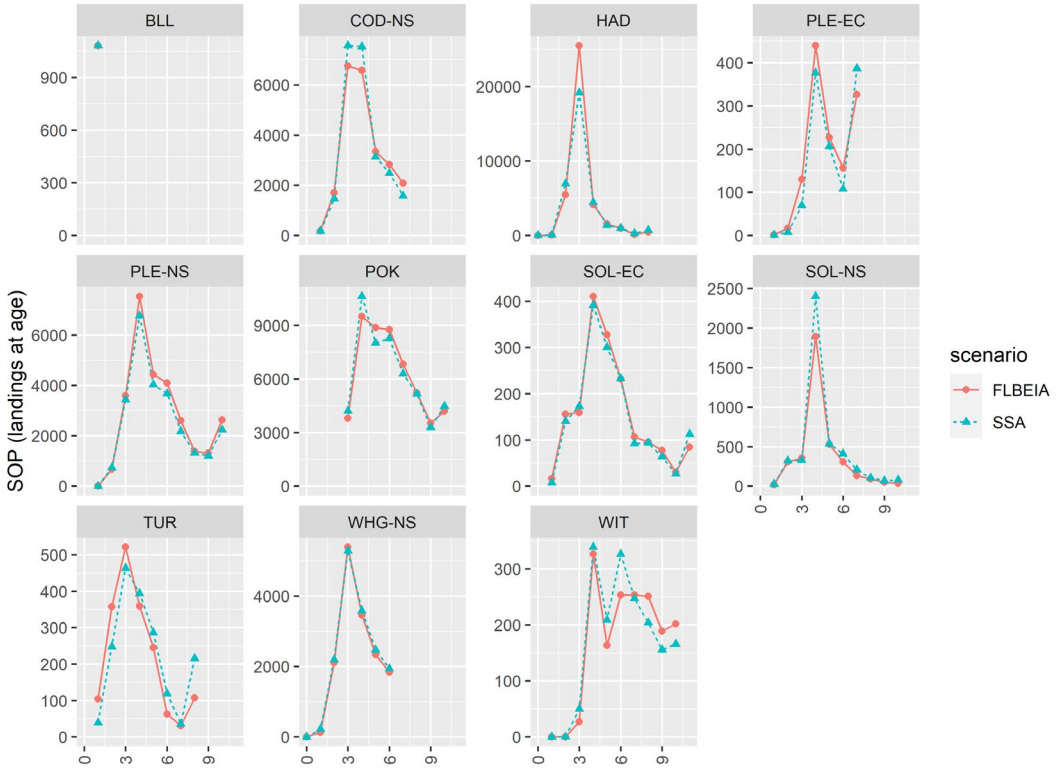

Figure 6.5. Sum of product (numbers*weight) landings in the last assessment year (2022).

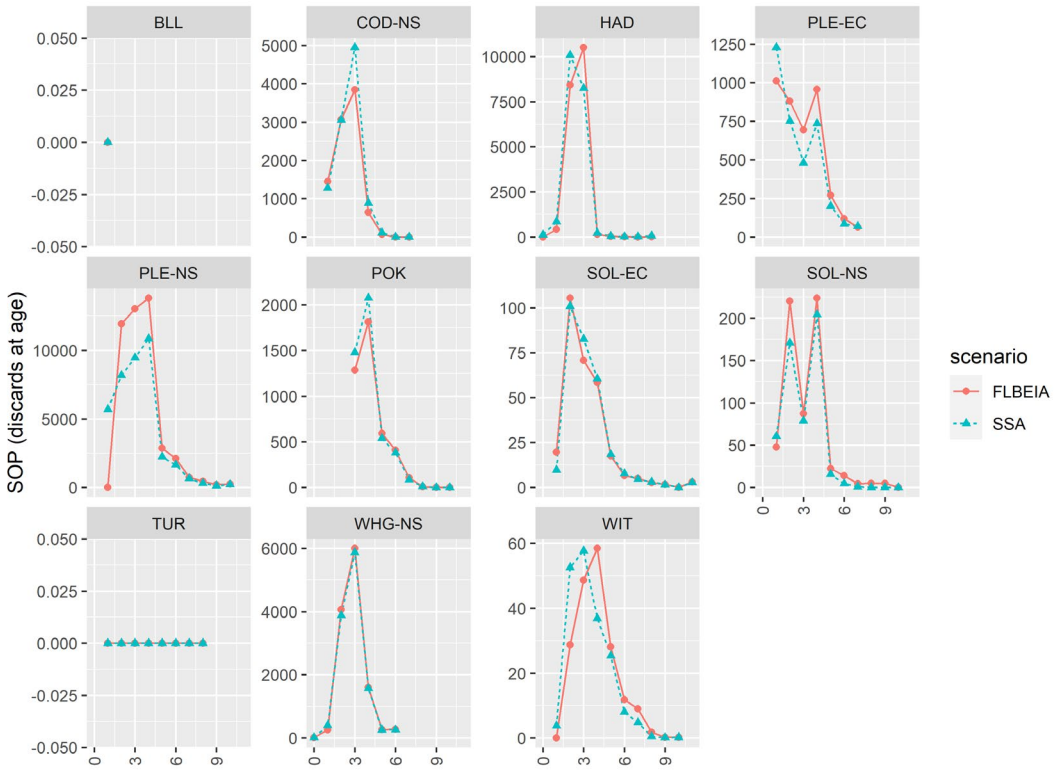

Figure 6.6. Sum of product (numbers*weight) discards in the last assessment year (2022).

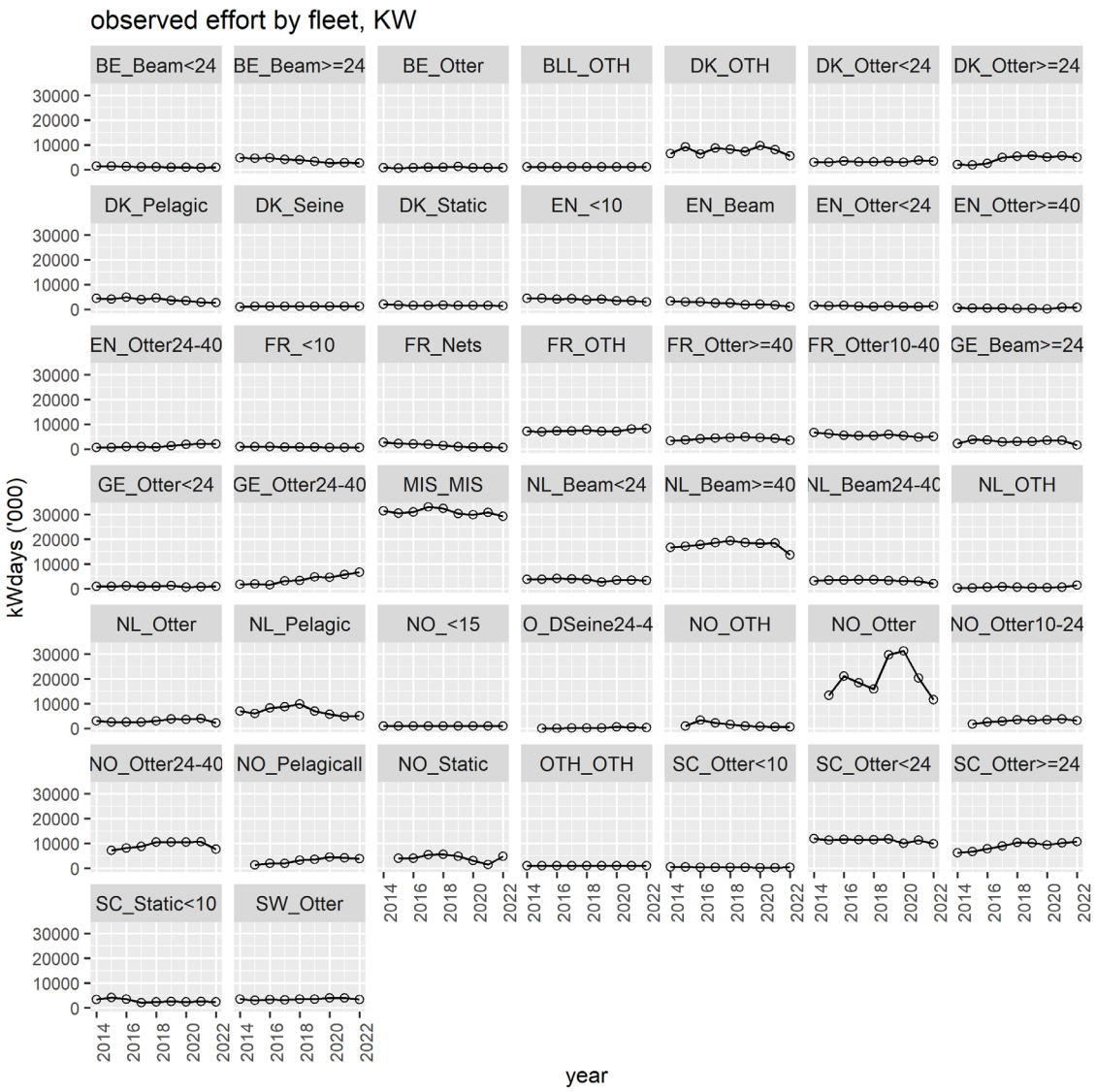

Figure 6.7. Effort by fleet and year for the North Sea demersal fleets, in '000 KWdays.

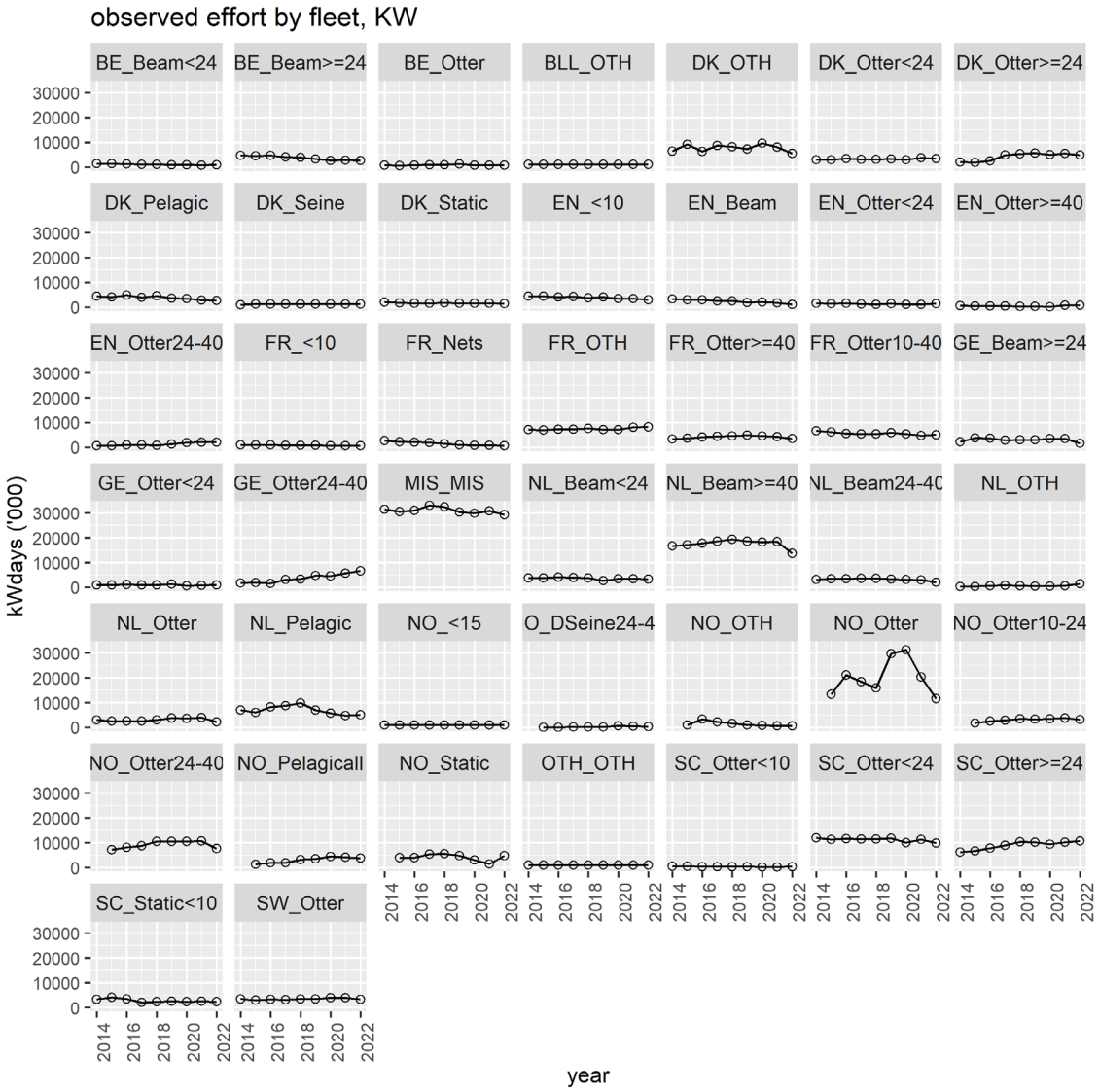

Figure 6.8. Relative trends (compared to the 2022 value) in effort (KW Days) by fleet and year for the North Sea demersal fleets.

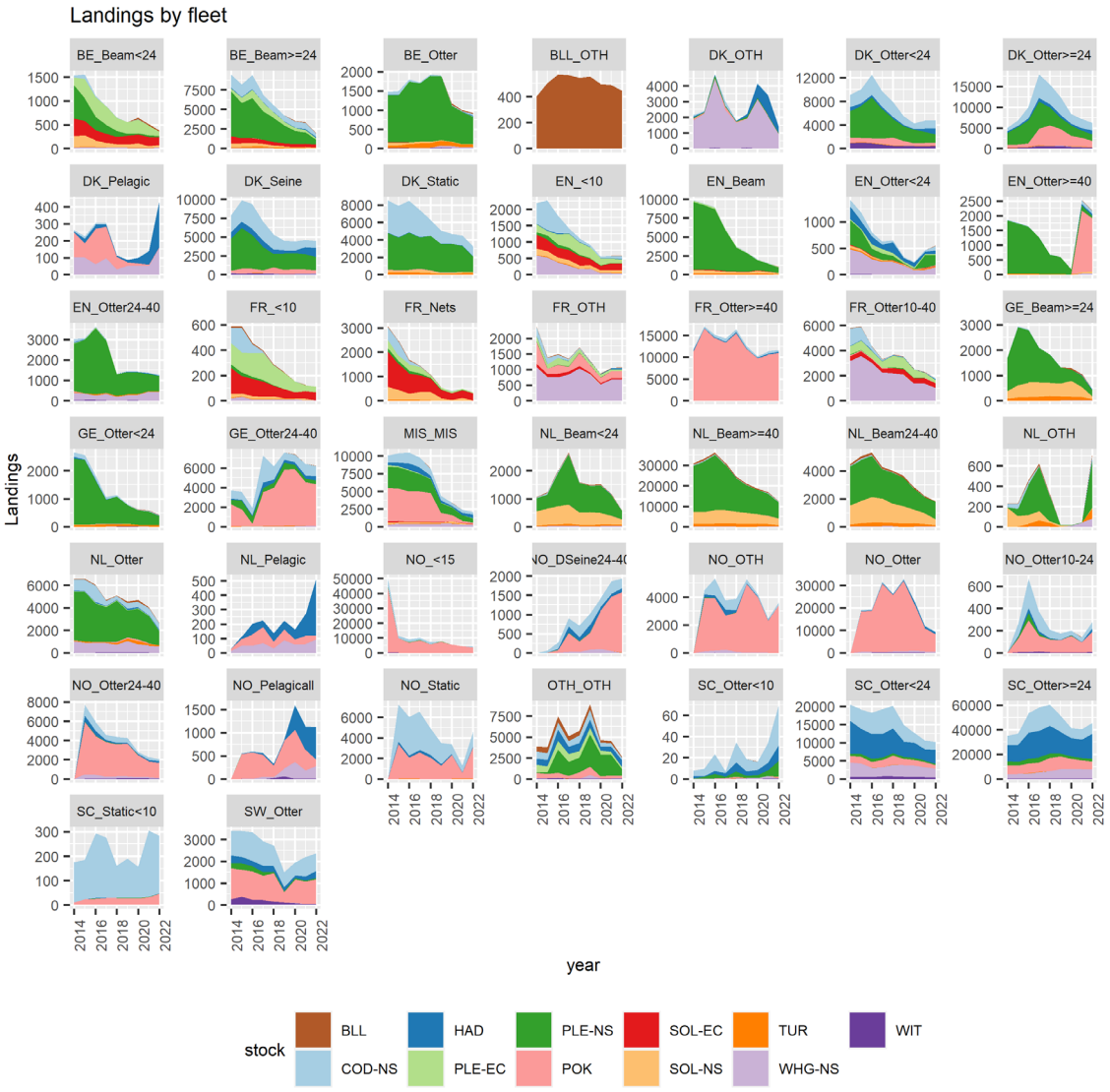

Figure 6.9. Landings by fleet, stock and year.

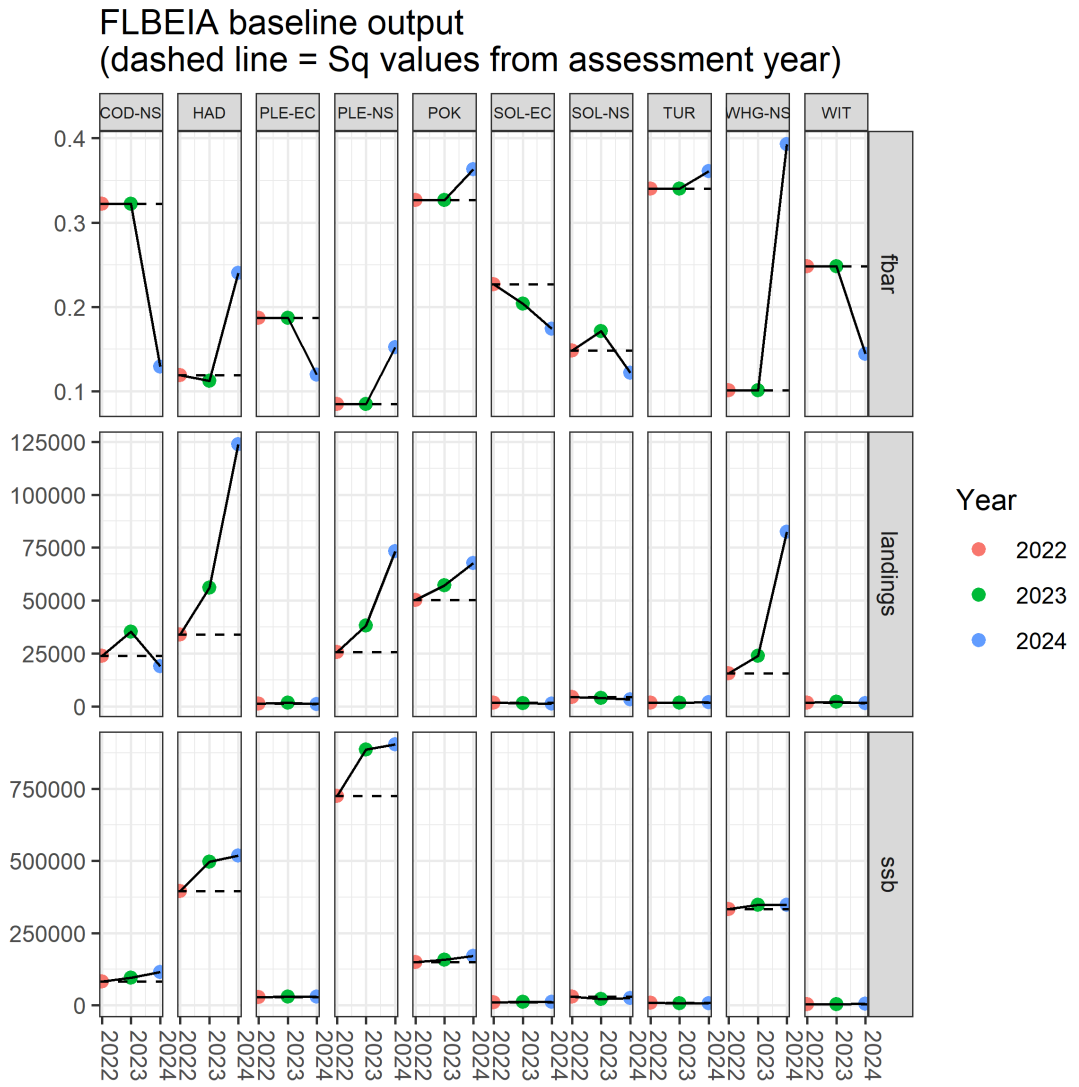

Figure 6.10. Summary of the relative changes in the single-stock advice for 2022 and 2023 compared to the situation in 2021.

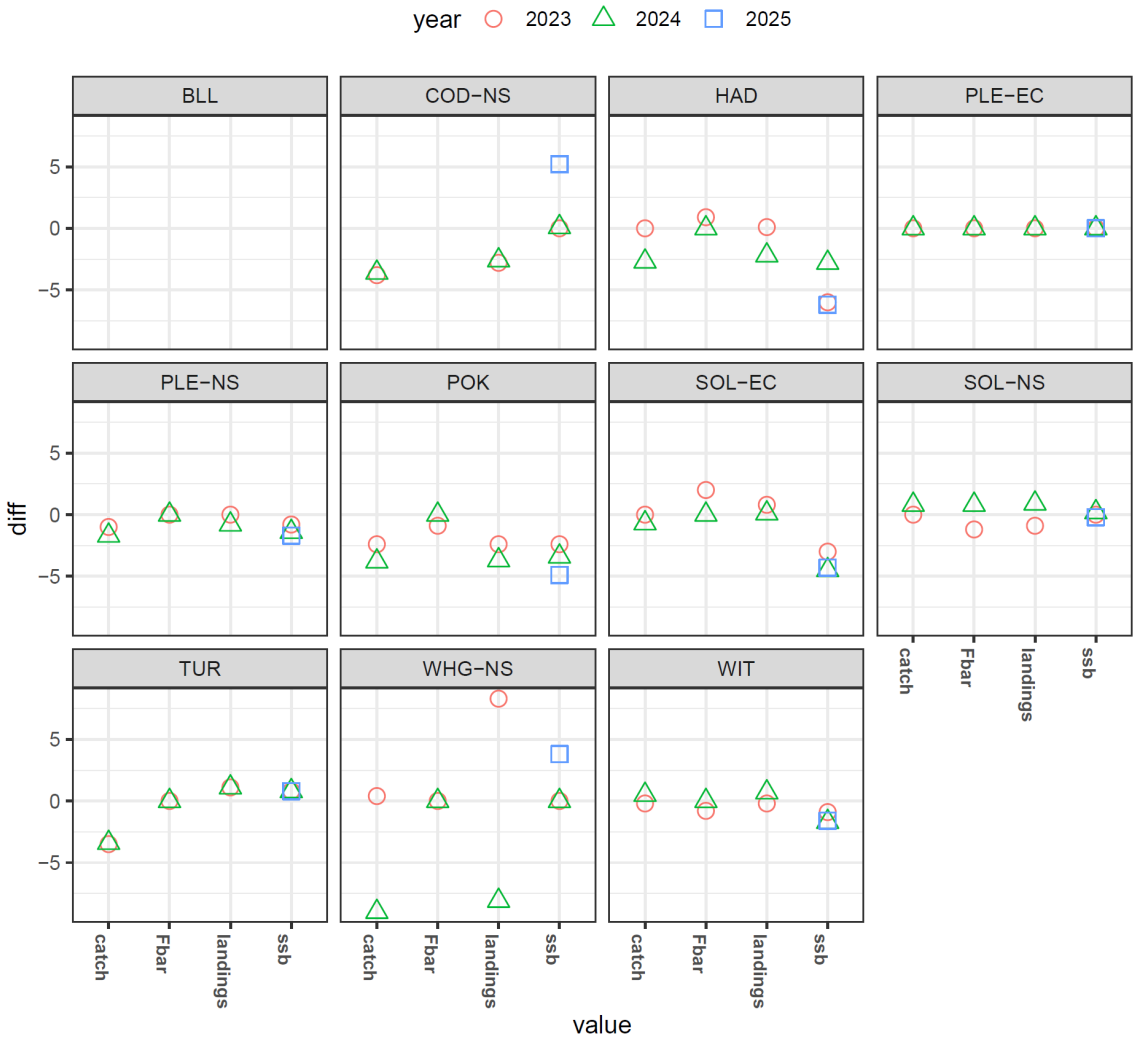

Figure 6.11. Difference (in percent) between WGMIXFISH-FLR baseline run and Single-stock advice for finfish stocks, showing Fbar, catch, landings (2022–2023), and SSB (2022–2024).

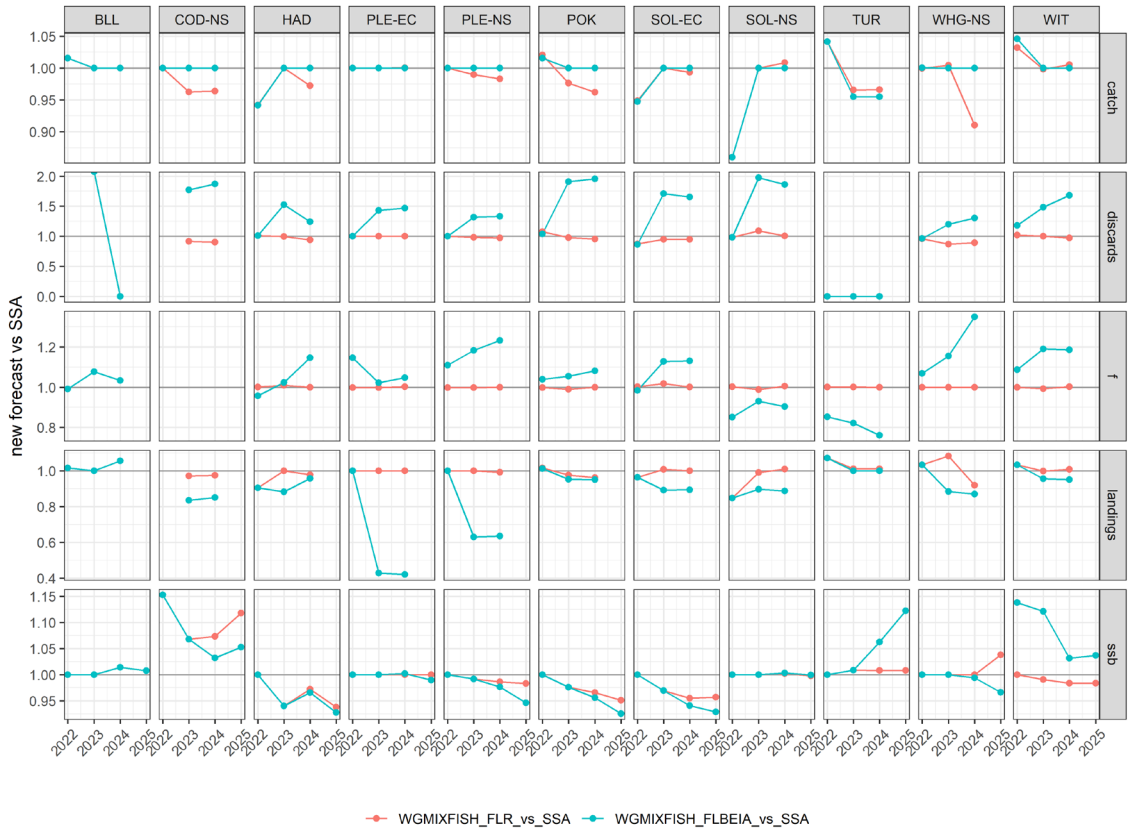

Figure 6.12. Comparison of the WGMIXFISH baseline runs and the WGNSSK single-stock advice. Displayed are the ratios of the WGMIXFISH baseline runs values (FLR in blue and FLBEIA in red) over those of the single-stock advice.

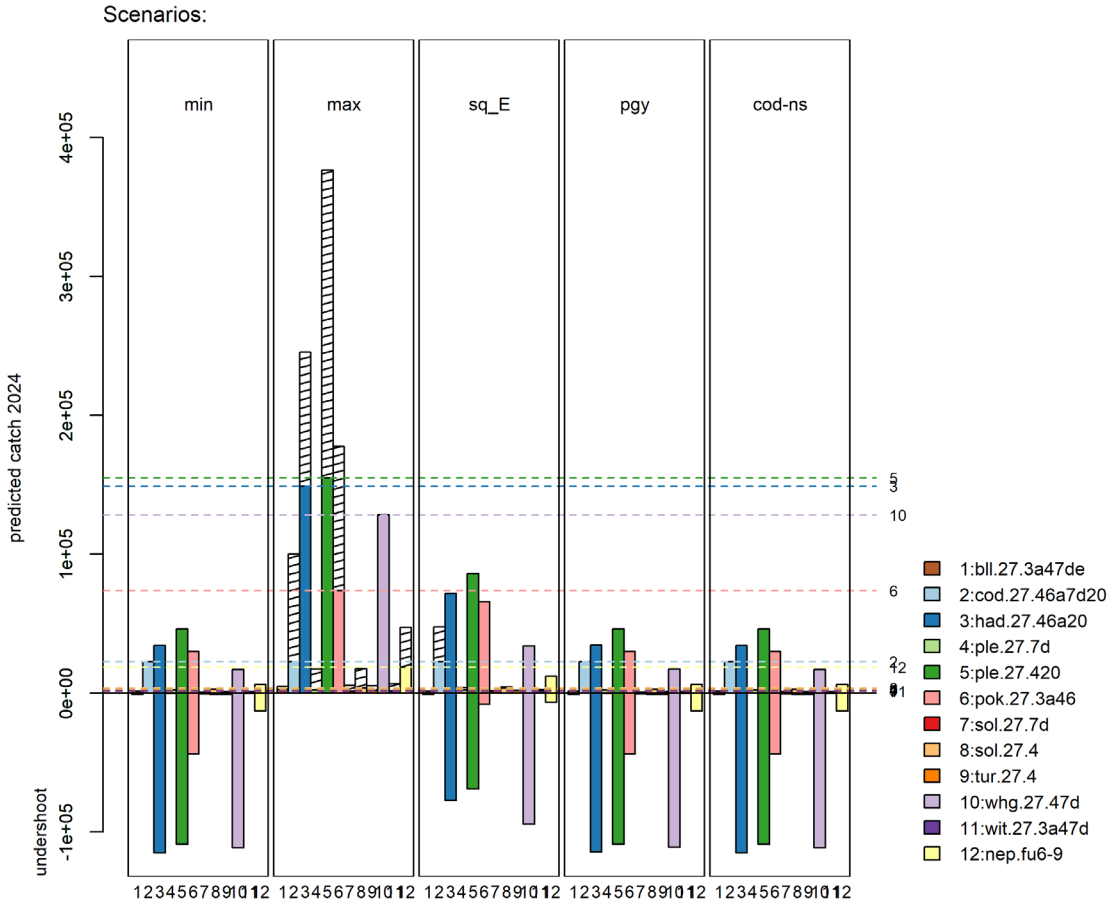

Figure 6.13. Mixed fisheries projections. Estimates of potential catches (in tonnes) by stock and by scenario. The horizontal lines correspond to the single-stock catch advice for 2024. Bars below the value of zero show undershoot (compared to single-stock advice) where catches are predicted to be lower when applying the scenario. Hatched bars represent catches that overshoot the single-stock advice. Norway lobster functional units 6–9 are the main surveyed and updated stocks although all ten FUs are included in the analysis.

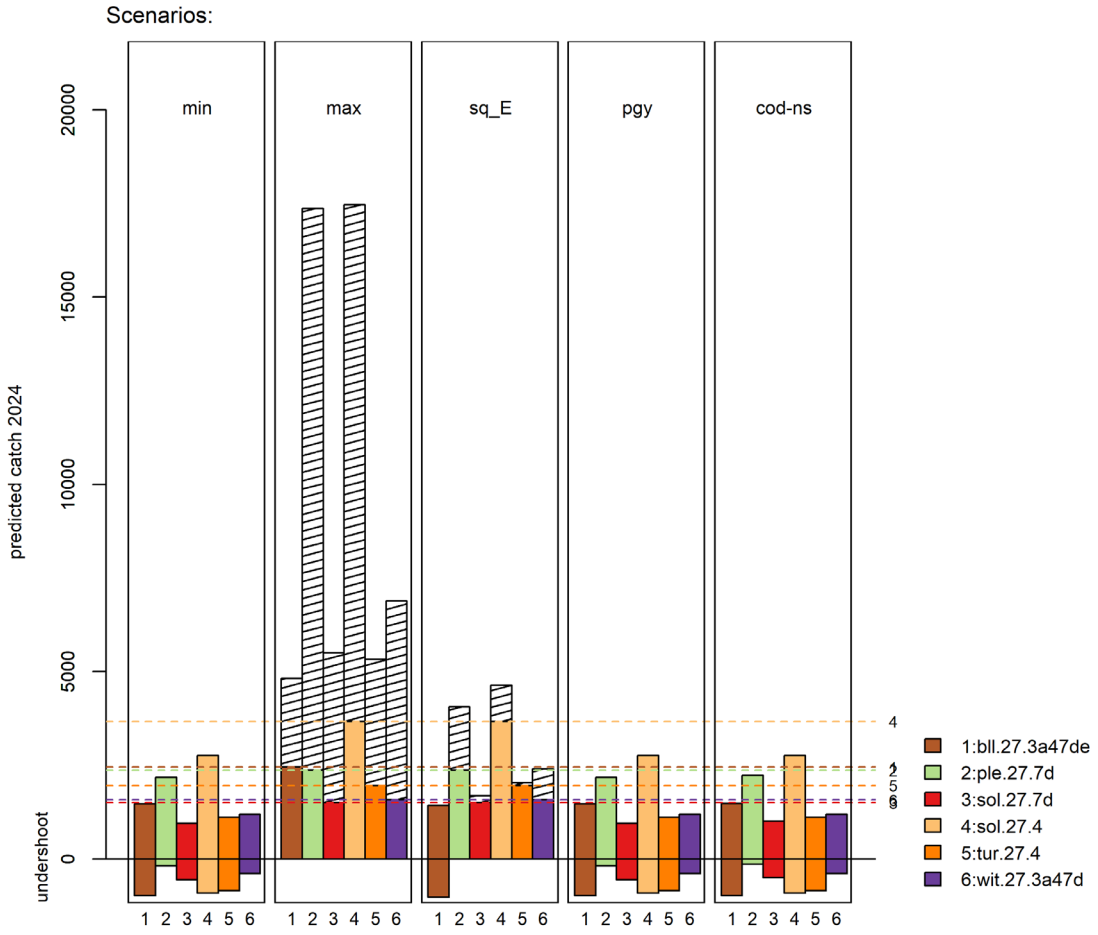

Figure 6.14. Mixed fisheries projections results for the stocks subject to lower landings (detail from Figure 6.). Estimates of potential catches (in tonnes) by stock and by scenario. Horizontal lines correspond to the single-stock catch advice for 2024. Bars below the value of zero show undershoot (compared to single-stock advice) where catches are predicted to be lower when applying the scenario. Hatched columns represent catches that overshoot the single-stock advice.

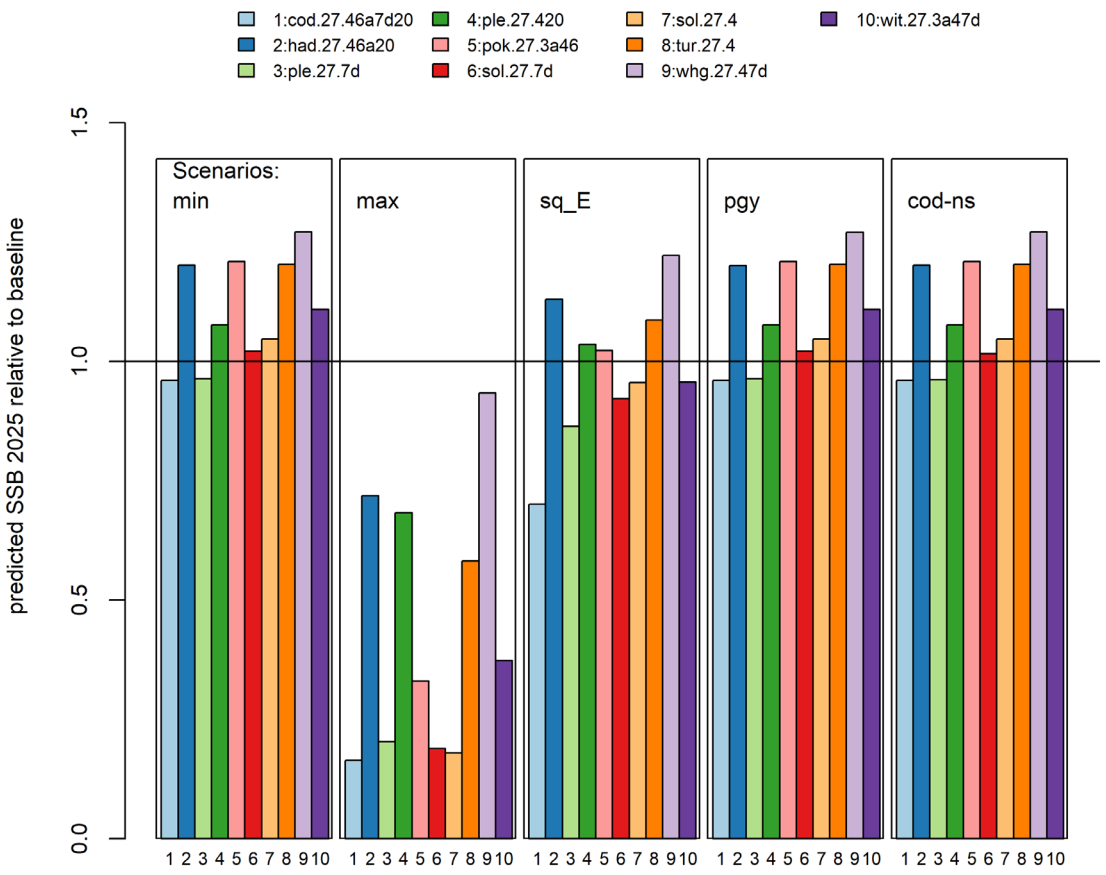

Figure 6.15. Mixed fisheries for the North Sea. Estimated SSB at the start of 2025 by stock after applying the mixed fisheries scenarios, expressed as a ratio to the single-stock advice forecast. The horizontal line corresponds to the SSB resulting from the single-stock advice. Norway lobster are not included as the abundance was not forecasted in the mixed fisheries model.

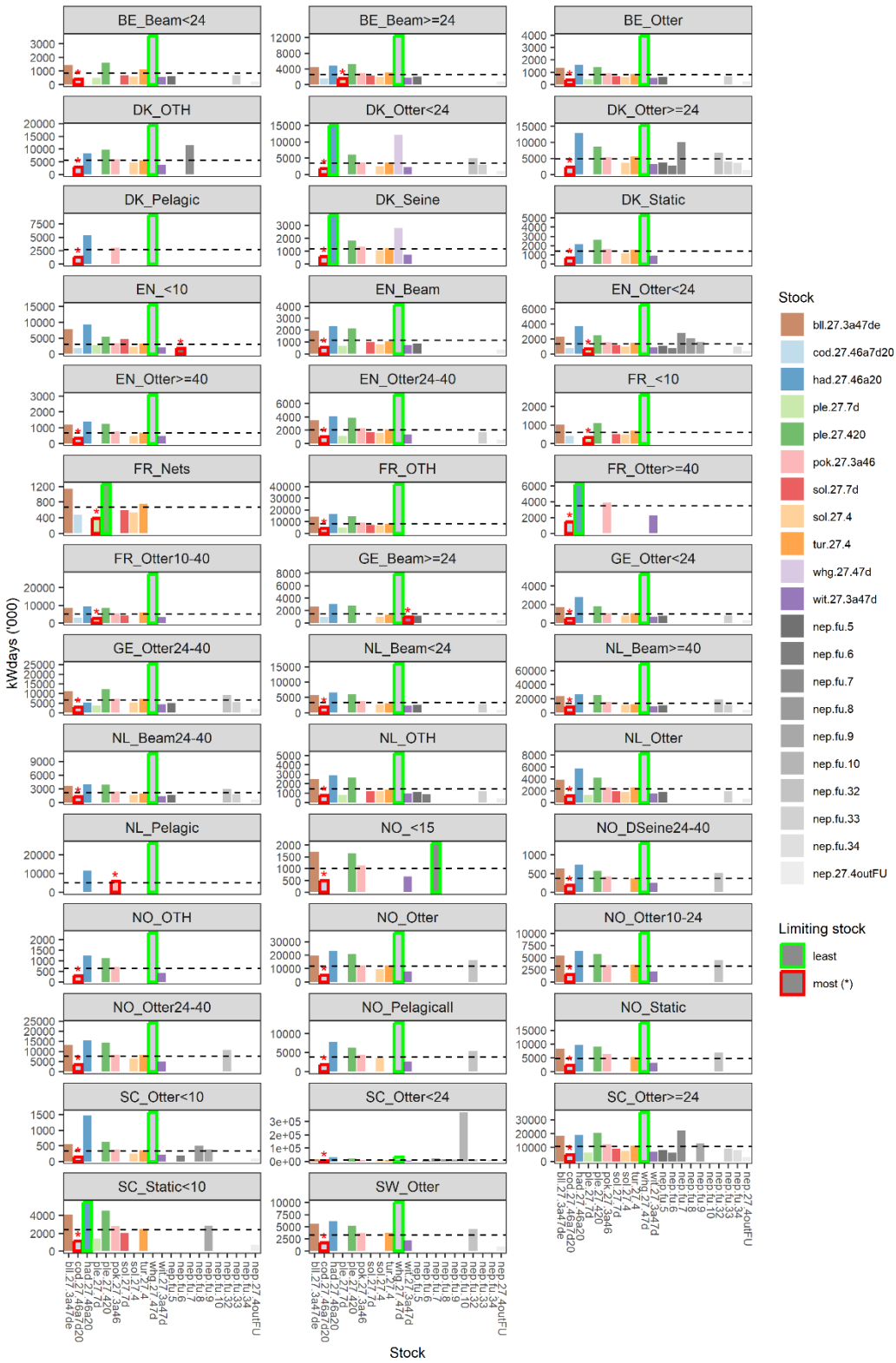

Figure 6.16. Mixed fisheries for the North Sea. Estimates of effort by fleet needed to reach each single-stock advice. Red triangles highlight the most limiting species for that fleet in 2024 ("choke species"), whereas the green triangles highlight the least limiting species. Fleet names are given by country (BE = Belgium, DK = Denmark, EN = England, FR = France, GE = Germany, IE = Ireland, NI = Northern Ireland, NL = the Netherlands, NO = Norway, SC = Scotland, SW = Sweden, OTH = Others) and by meaningful combinations of main gear and vessel size differing across countries and based on homogeneous average fishing patterns. FDF = Fully Documented Fisheries vessels. Vessels in the various fleet segments can engage in several fisheries (métiers) over the year.

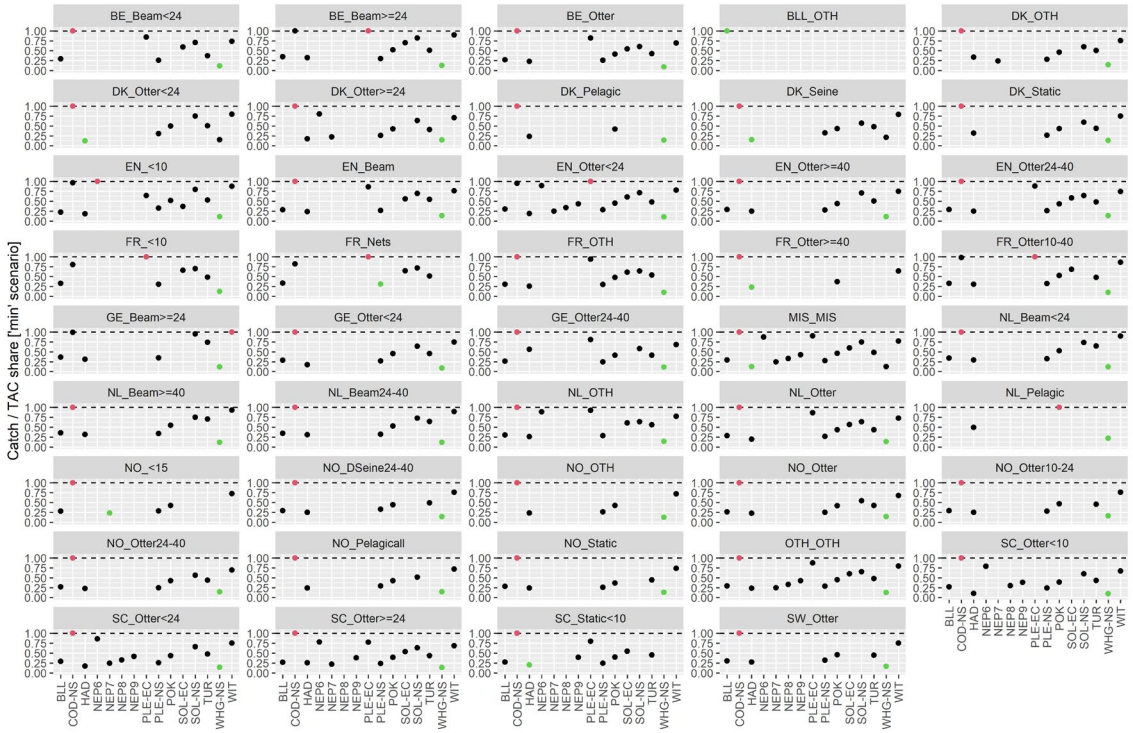

Figure 6.17. Quota uptake in 2024 in the min scenario. Red dots highlight the most limiting species for that fleet ("choke species"), whereas the green dots highlight the least limiting species.

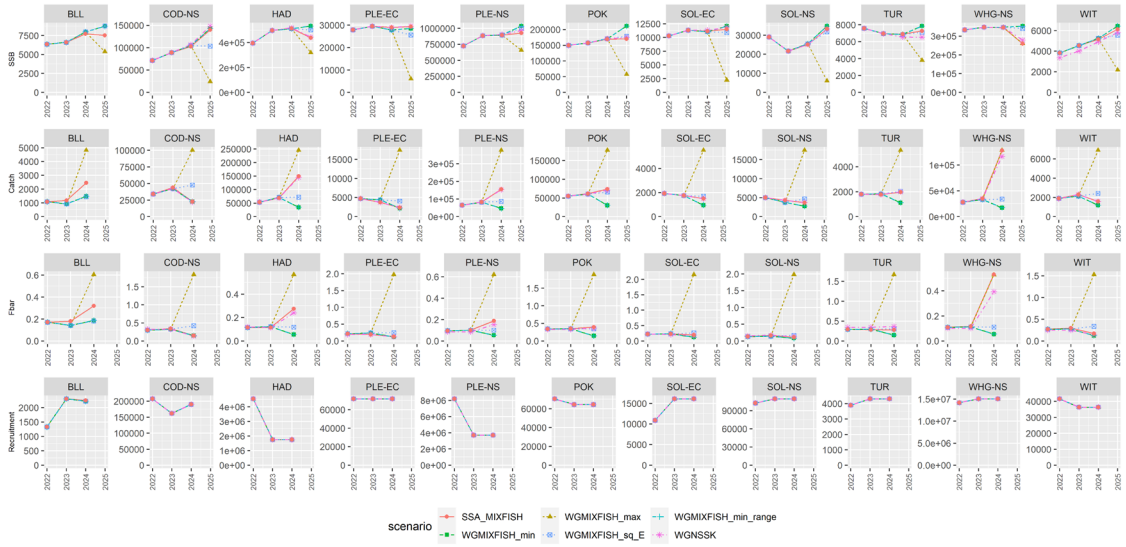

Figure 6.18. Comparison of the mixed fisheries projections in all the scenarios (WGMIXFISH) with the single-species advice projections (WGNSSK).

7 Baltic Sea

Mixed fisheries considerations

7.1 Background

A review of data held for the Baltic Sea was conducted last year at WGMIXFISH-METHODS (ICES, 2022) to assess the potential for developing mixed fisheries considerations for the ecoregion. The results of this found that most countries submitting data for the Baltic were reporting using relatively high-level métier codes (i.e. "active", "passive") rather than level 6 métier codes. Although these high-level métiers match the métier codes using in InterCatch for this ecoregion (as requested in the data call), the grouping of multiple métiers in this way may lead to false technical interactions being apparent in the data. This limits our ability to provide high quality mixed fisheries information for this region.

Requesting a refresh of the entire time-series would have invoked a large burden on national data submitters. Therefore, it was decided to explore alternative data sources, especially as the data call will be superseded by the RDBES in a few years. In this year's WGMIXFISH-METHODS (ICES, 2023) comparison between RDB effort and landings data with our accessions data were done. The comparison showed that the RDB data closely matches the accession data for total landings and follows similar trends for effort.

As the RDBES data call for 2022 year data were available for the meeting, it was opted to use the latest data available, as there has been significant changes in the fisheries behaviour in the last years. Year 2022 data were used to describe the current technical interactions and to provide landings composition plots for the Baltic Sea Fisheries Overview. Comparison between RDBES and accession landings data are in Figure 7.1 (note that some stocks are missing in this comparison due to differences how final data for stock assessment is compiled, i.e. outside InterCatch). There are some discrepancies for some countries and stocks. This can be partially related to how the stock boundaries in RDBES were defined. In RDBES landings data call, the landings are given by species and not by stock. Therefore, we allocated the landings to stock by using only subdivision (SD) border as criteria. This causes differences in landings for stocks which to some extent are also caught outside the stock area (e.g. central Baltic herring which is also caught in Gulf of Riga; SD 28.1). There are some larger discrepancies for Latvia's sprat landings, and for Poland in sprat and central Baltic herring landings. For Latvia, it seems that some portions of the landings were not reported in RDBES. There are also some discrepancies for Poland.

However, although there are some discrepancies in the RDBES data, it was agreed that the data are robust enough to provide initial descriptions of the technical interactions of species in the Baltic Sea.

7.2 Fleets and métiers

7.2.1 Data and methods

In RDBES there are no stock codes attached to the landings and effort data. Therefore, the first step was to connect the data to specific stocks. We defined 19 stocks for the Baltic Sea:

"cod-2532", "her-2529+32(-GOR)", "bzq-26+28", "tur-2232", "spr-2232", "cod-2224", "fle-2223", "bzq-2425", "ple-2432", "her-2024", "dab-2232", "ple-2123", "bll-2232", "sol-2024", "her-3031", "bwp-27+2932", "her-28", "ns-cod", "kat-cod".

All other species/stocks were grouped together as 'OTH'.

Allocating landings data to stocks was done based on subdivision borders. This however is not ideal, as for some stocks there is mixing between subdivisions which is accounted for in the stock assessment. However, for the simplicity of this analysis, this is currently ignored here. This affects the following stocks:

1. Mixing of her-2529+32(-GOR) and her-28 in subdivisions 28.1 and 28.2.
2. Mixing of cod-2532 and cod-2224 in subdivision 24.

We have included landings data from subdivisions 20–32 for the analysis. This has some shortcomings.

1. Significant part of her-2024 stock landings/catches are taken in North Sea (i.e. outside the area considered in this analysis) but not included in this analysis.
2. Stock defined as "ns-cod" is part of the larger cod stock cod.27.46a7d20, while here only landings from Subdivision 20 are shown.
3. "kat-cod" is caught mainly in the *Nephrops* fishery, however no *Nephrops* management units as stocks are included in this analysis (grouped under 'OTH').

Adjustments to vessel length categories were made compared to what was submitted to RDBES. All vessels below 12 m were grouped together and defined as "< 12 m", vessels from 12–18 meters were grouped together as "12–18 m"; other vessel length categories were kept the same ("18–24 m", "24–40 m", "> 40 m"). When considering the pelagic fishery in the Baltic we grouped together passive gears such as FYK, GNS, FPN, FPO, GTR and gave a one common name 'passive' for métier including these gear types. The pelagic fishery is mostly operated with trawlers, and passive gears are in some areas used during the spawning season.

7.2.2 Baltic Sea

We aimed to describe the technical interactions in the pelagic and demersal fishery. For the pelagic fishery description, we included all the métiers that had caught one of the five pelagic stocks, and for demersal fisheries we included all métiers that had caught at least one of the 14 demersal stocks. For each métier we adopted a *gear_id* which based on country + métier level 4 + vessel size class (i.e. EE_OTM_SPF_18–24m). We identified a total of 212 and 126 *gear_id*s for demersal and pelagic fishery, respectively (note that there are overlapping *gear_id*s between the two fisheries). To lessen the amount of *gear_id*s for a clearer picture we adopted following procedures:

1. By stock we calculated *gear_id* contribution to the total stock catches.
2. *Gear_id*s which contributed less than 1% to total stock catches were grouped together and named 'country_MIS_MIS'.
3. We excluded *gear_id*s which had over 80% landings of 'OTH' category.
4. For demersal fishery we also excluded *gear_id*s which had over 80% landings of pelagic species (i.e. the five pelagic stocks in Baltic Sea).

To describe métier contributions to stock landings we adopted following procedures:

1. For each métier we adopted *gear_id* which based in country + métier level 4.
2. By stock we calculated *gear_id* contribution to the total stock catches.

3. *Gear_id*s which contributed less than 5% to total stock catches were grouped together and named 'MIS_MIS'.

7.2.3 Central Baltic (subdivisions 25–29, and 32)

In addition to looking at the overall technical interactions in the pelagic and demersal fisheries, we also looked specifically at technical interactions in the central Baltic pelagic fishery, which involves the central Baltic herring (CBH) and sprat stock. This specific investigation is driven by the fact that the status of CBH stock is declining, while sprat stock status is good.

To describe the technical interaction in the pelagic fisheries which involves Central Baltic herring (CBH) and sprat, we used landings data only from subdivisions 25–28.2, 29 + 32 (excluding Gulf of Riga, SD 28.1, as there is a separate herring stock, and no sprat targeted fishery is present in that area). The pelagic fisheries were defined by métiers (métier level 6 + vessel length class) which contributed at least 0.5% to total landings of either CBH or sprat stock. The comparison of all métiers which have caught herring or sprat compared to métiers above the 0.5% threshold are shown in Figure 7.2 and 7.3. Further analyses were conducted using only data from métiers which exceeded to the 0.5% threshold (23 unique métiers, Table 7.1).

7.3 Results

The results are shown in Figure 7.4, 7.5, and 7.6. The Baltic Sea has diverse mixed demersal fisheries. Landing profiles by métier vary between countries but do have similar trends when fishing areas overlap. Germany and Denmark demersal fishery inhibits similar landing profiles of species/stocks caught. Main species caught with bottom trawls are flounder and plaice for Germany, and plaice and cod for Denmark. Poland bottom-trawler catch mainly flounder with small bycatches of cod. Sweden, Latvia, Lithuania, Estonia, Finland uses mainly passive gears in the demersal fisheries. Main gears used in the pelagic fishery are pelagic trawlers (PTM), midwater (OTM) and bottom trawlers (OTB). To a lesser extent, passive gears are also used. Mixture of herring and sprat are caught in the pelagic fisheries. Central Baltic (SD 25–29, 32) is the main area where sprat and herring mix in the pelagic fishery, and the level of mixing can be variable (Figure 7.6). The overall trend is that when trawlers use smaller mesh size (16–31) then sprat proportion in landings is higher, while usage of larger mesh size (32–89) usually indicates that herring is more targeted.

7.4 References

ICES 2022. Working Group on Mixed Fisheries Methodology (WGMIXFISH-METHODS). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.20401389.v3

ICES. 2023. Working Group on Mixed Fisheries Advice Methodology (WGMIXFISH-METHODS). ICES Scientific Reports. 5:105. https://doi.org/10.17895/ices.pub.24496048

Table 7.1. All métiers which have caught either Central Baltic herring (CBH) or Baltic sprat in subdivisions 25–28.2, 29+32. Métiers which have contributed at least 0.5% to total stock landings are marked with yellow (23 métiers). Based on RDBES 2022 landings data.

Métier	Contribution to CBH landings (%)	Contribution to Baltic sprat landings (%)
LLD_SPF__0_0_0_12-18m	0.00%	
LLS_SPF__0_0_0_< 12m	0.00%	
MIS_MIS__0_0_0_< 12m		0.00%
OTB_DEF__<16_0_0_< 12m	0.00%	
OTB_DEF__<16_0_0_12-18m	0.00%	0.00%
OTB_DEF__<16_0_0_18-24m		0.00%
OTB_DEF__>=120_3_120_12-18m	0.01%	0.02%
OTB_DEF__105-115_1_120_12-18m	0.00%	0.00%
OTB_FWS__>0_0_0_24-40m		0.00%
OTB_SPF__>0_0_0_> 40m	0.23%	2.12%
OTB_SPF__16-31_0_0_< 12m	0.52%	0.15%
OTB_SPF__16-31_0_0_12-18m	0.04%	0.14%
OTB_SPF__16-31_0_0_18-24m	1.19%	0.47%
OTB_SPF__32-89_0_0_< 12m	0.13%	0.10%
OTB_SPF__32-89_0_0_12-18m	0.06%	0.06%
OTB_SPF__32-89_0_0_18-24m	0.44%	0.05%
OTM_DEF__<16_0_0_12-18m	0.01%	0.00%
OTM_DEF__<16_0_0_18-24m	0.01%	0.02%
OTM_DEF__<16_0_0_24-40m	0.02%	0.04%
OTM_DEF__>0_0_0_12-18m	0.00%	
OTM_SPF__<16_0_0_> 40m	0.09%	0.03%
OTM_SPF__>0_0_0_> 40m	0.67%	0.41%
OTM_SPF__>0_0_0_12-18m	2.18%	0.03%
OTM_SPF__>0_0_0_18-24m	2.08%	0.27%
OTM_SPF__>0_0_0_24-40m	6.11%	2.53%
OTM_SPF__16-31_0_0_< 12m	0.69%	0.33%
OTM_SPF__16-31_0_0_> 40m	15.67%	31.46%
OTM_SPF__16-31_0_0_12-18m	0.69%	1.74%

Métier	Contribution to CBH landings (%)	Contribution to Baltic sprat landings (%)
OTM_SPF__16-31_0_0_18-24m	7.04%	10.92%
OTM_SPF__16-31_0_0_24-40m	21.75%	40.40%
OTM_SPF__32-89_0_0_< 12m	1.86%	0.03%
OTM_SPF__32-89_0_0_> 40m	0.16%	1.35%
OTM_SPF__32-89_0_0_12-18m	1.21%	0.02%
OTM_SPF__32-89_0_0_18-24m	4.98%	0.79%
OTM_SPF__32-89_0_0_24-40m	9.04%	0.45%
passive___< 12m	8.42%	0.00%
passive___12-18m	0.03%	0.00%
passive___18-24m	0.00%	0.00%
PS__SPF__16-31_0_0_12-18m	0.34%	
PS__SPF__32-89_0_0_< 12m	0.09%	
PTM_SPF__16-31_0_0_< 12m	0.00%	0.00%
PTM_SPF__16-31_0_0_> 40m	0.21%	1.13%
PTM_SPF__16-31_0_0_12-18m	3.72%	1.63%
PTM_SPF__16-31_0_0_18-24m	1.80%	1.46%
PTM_SPF__16-31_0_0_24-40m	2.79%	1.79%
PTM_SPF__32-89_0_0_24-40m	5.68%	0.06%
SSC_DEF__32-89_0_0_< 12m	0.00%	
SSC_FWS__>0_0_0_< 12m	0.01%	

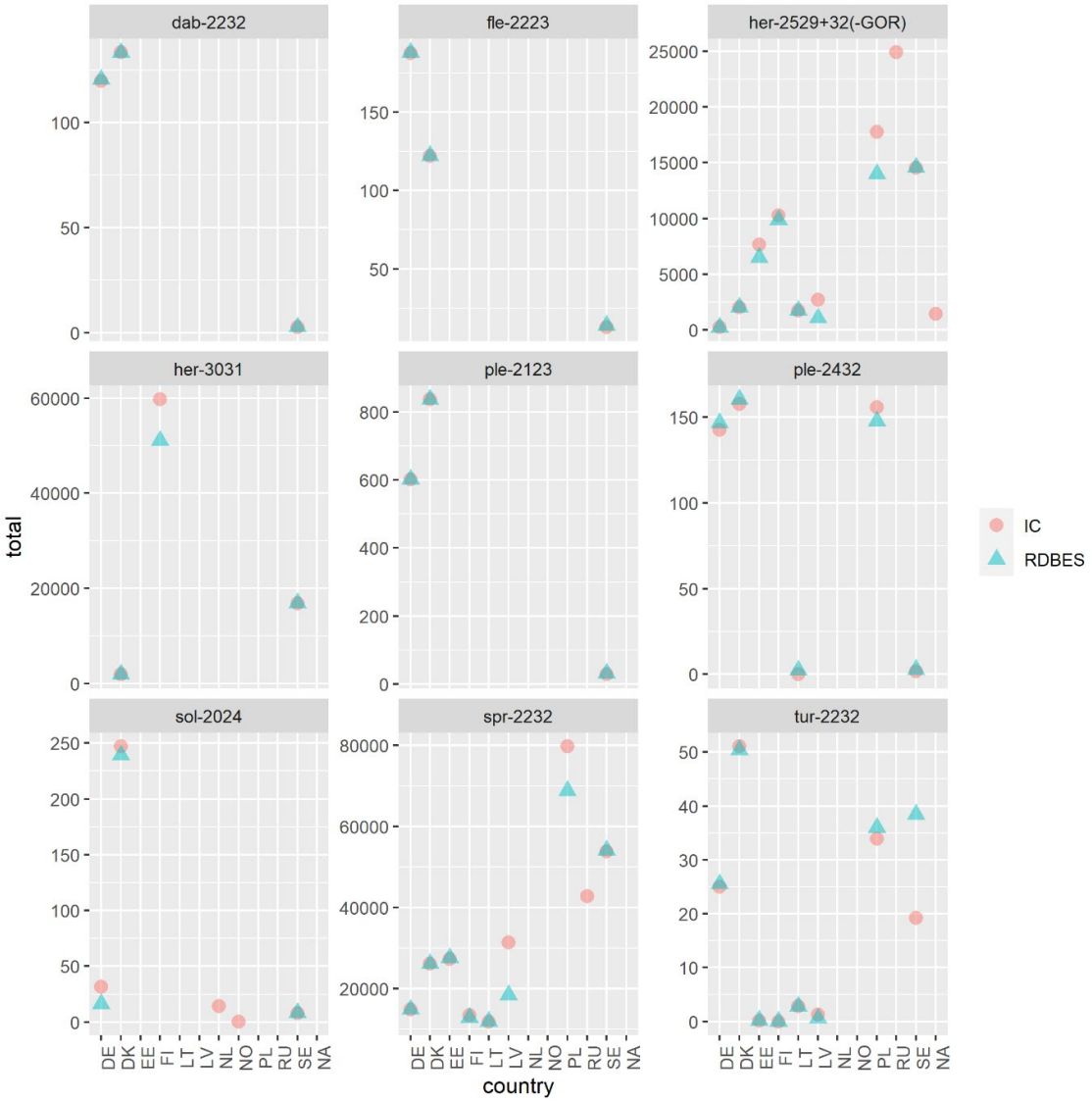

Figure 7.1. Total landings by stock comparison between InterCatch and RDBES data for Baltic Sea (subdivisions 20–32) in 2022. Note that some stocks are missing from the comparison due to differences in data compilation methods (i.e. done outside InterCatch).

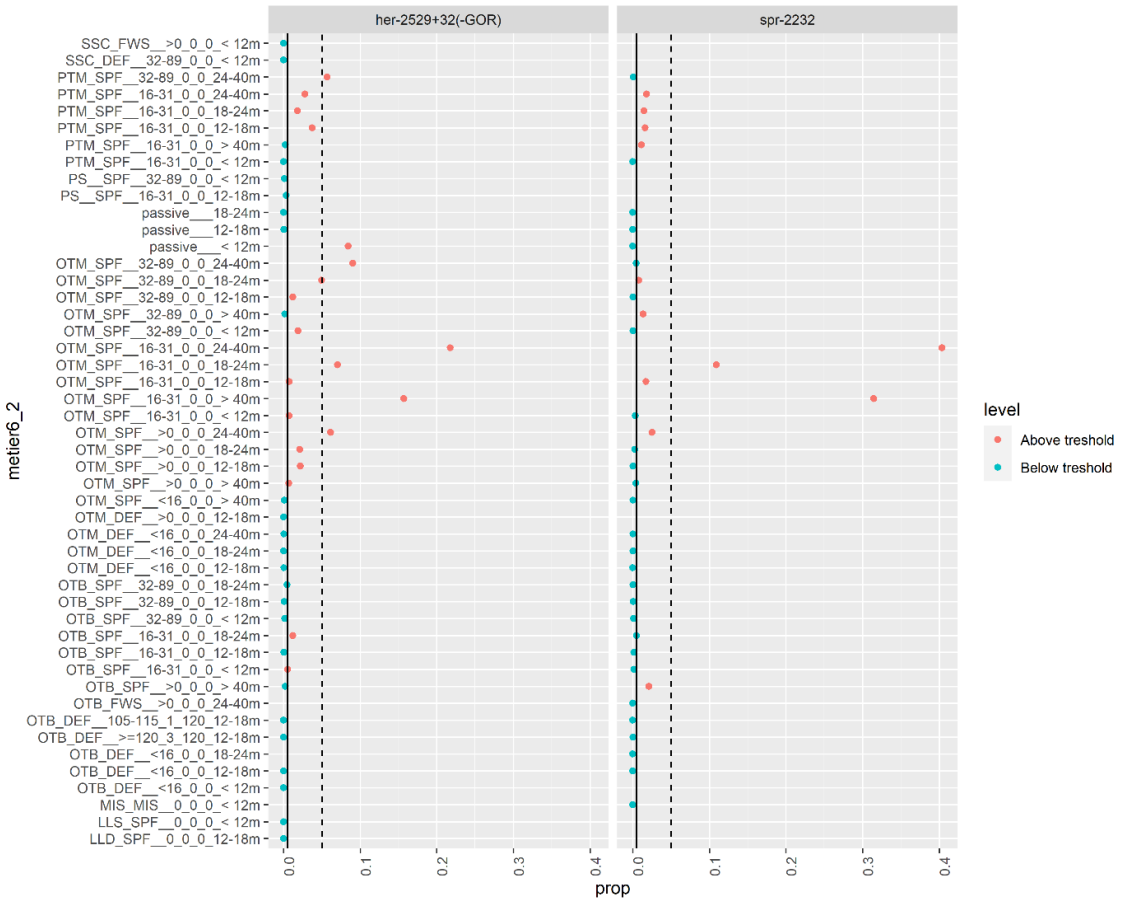

Figure 7.2. All métiers which have caught either herring or sprat in subdivisions 25–28.2,29+32. Above threshold (red) points shows métier which have contributed at least 0.5% of total stock catches. Below threshold (blue) points show métiers which have contributed <0.5% of total stock catches. Solid black vertical line indicates the 0.5% threshold and black dashed line indicates 5% threshold. Based on RDBES 2022 landings data.

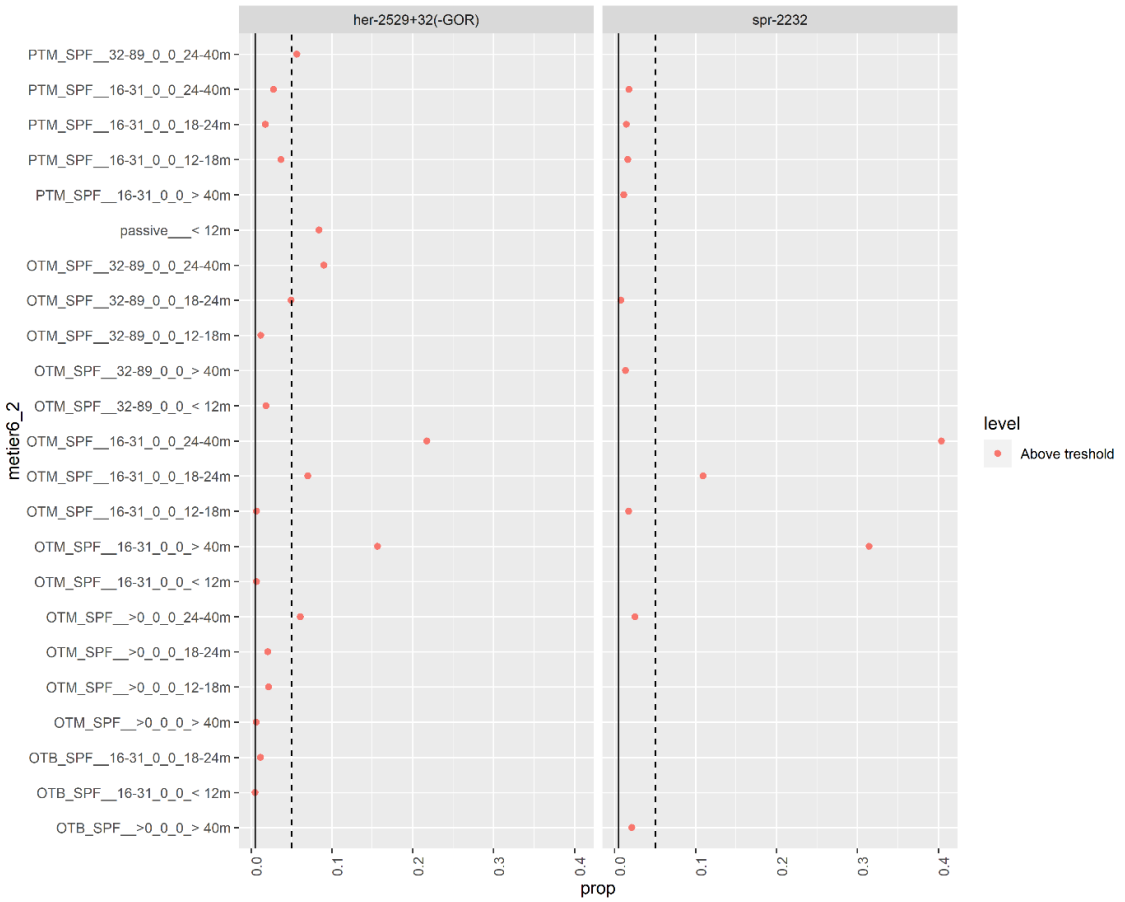

Figure 7.3. Excerpt from Figure 7.1. Showing on métiers which are considered above the 0.5% threshold. Solid black vertical line indicates the 0.5% threshold and black dashed line indicates 5% threshold. Based on RDBES 2022 landings data.

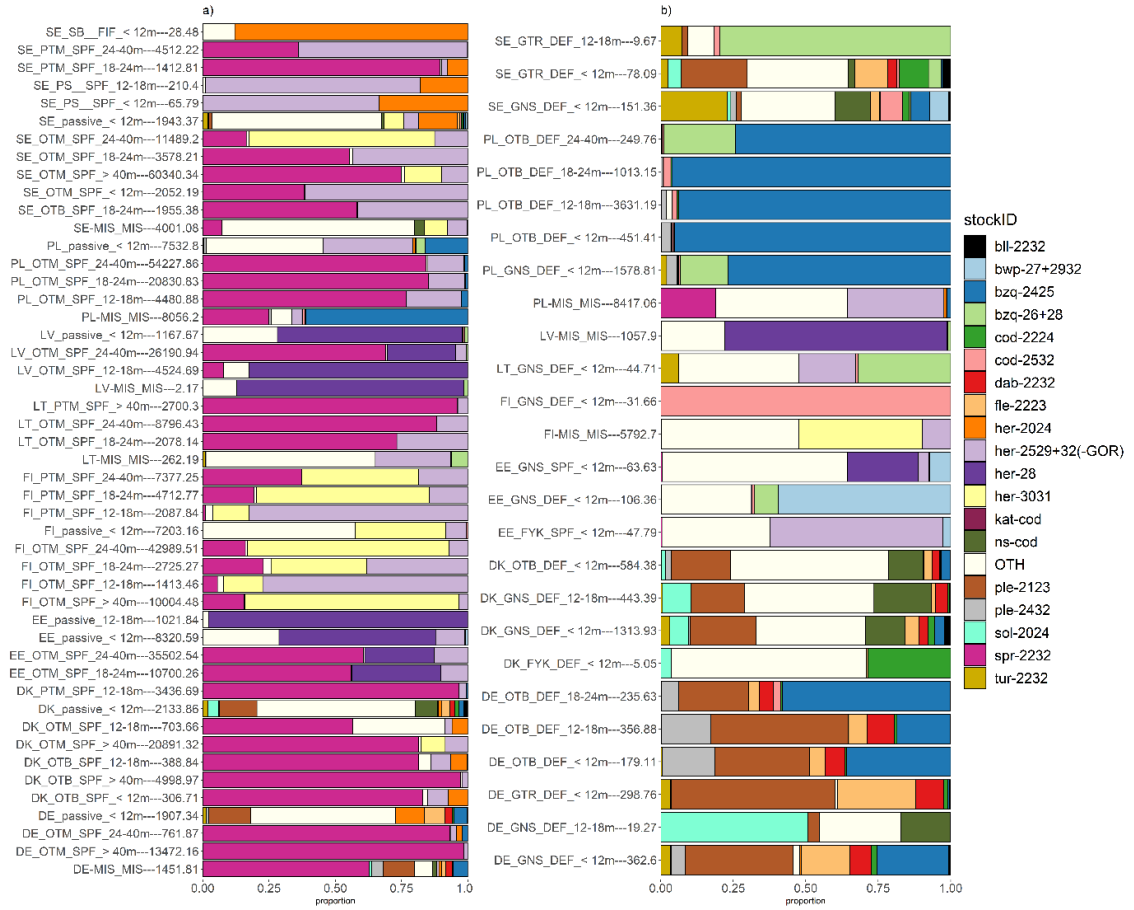

Figure 7.4. Description of technical interactions of demersal and pelagic species in the Baltic Sea as proportions of 2022 landings. The left panel (a) shows the pelagic fisheries and right panel (b) demersal fisheries. The y-axis label incorporates the country code, main gear, target species assemblage, vessel size class and 2022 landings (tonnes). Based on RDBES 2022 data.

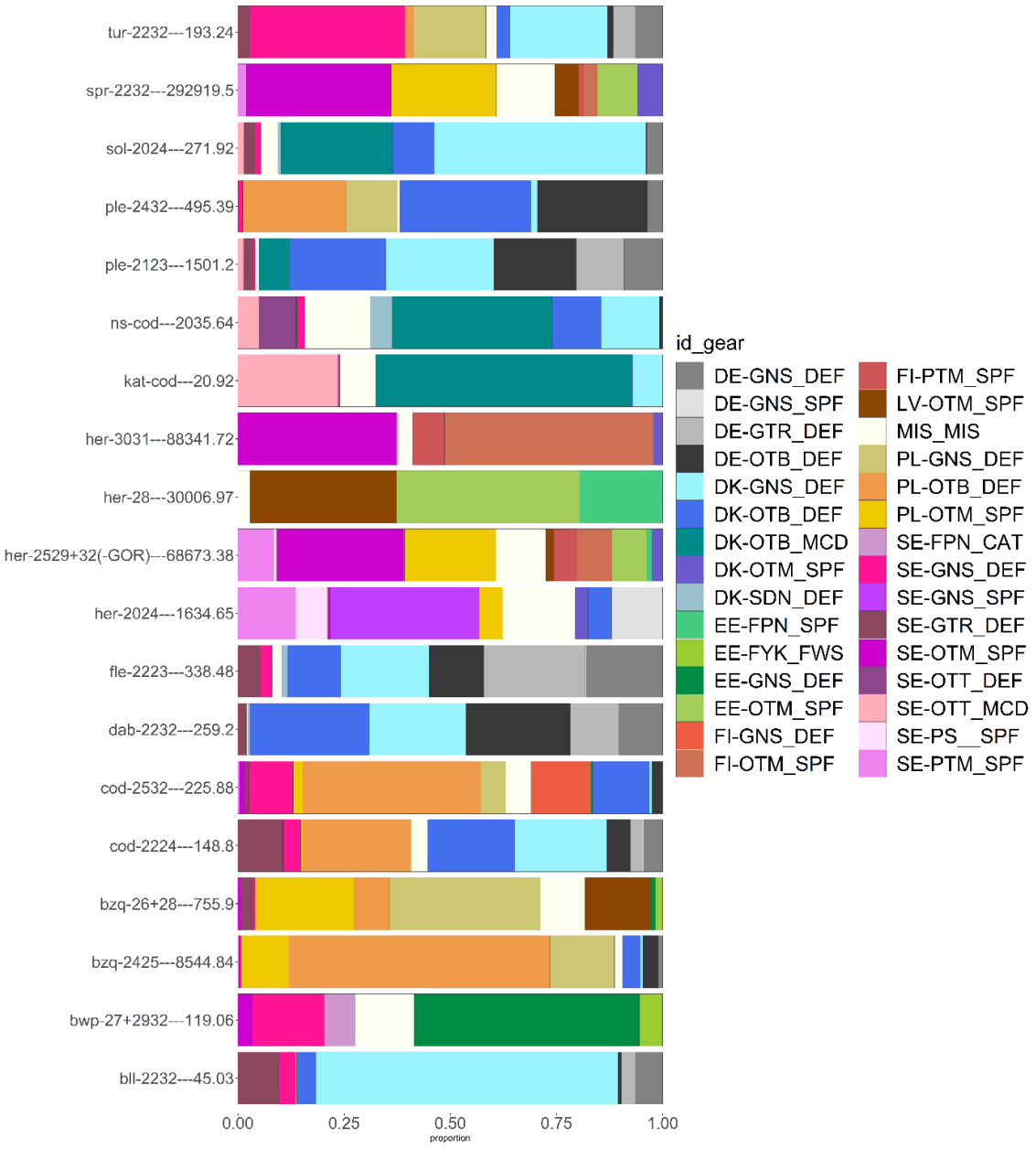

Figure 7.5. Description of technical interactions of species in the Baltic Sea in 2022. Proportion of landings of each stock accounted for by the different country métiers. The y-axis label incorporates stock code and 2022 landings (tonnes). Based on RDBES 2022 data.

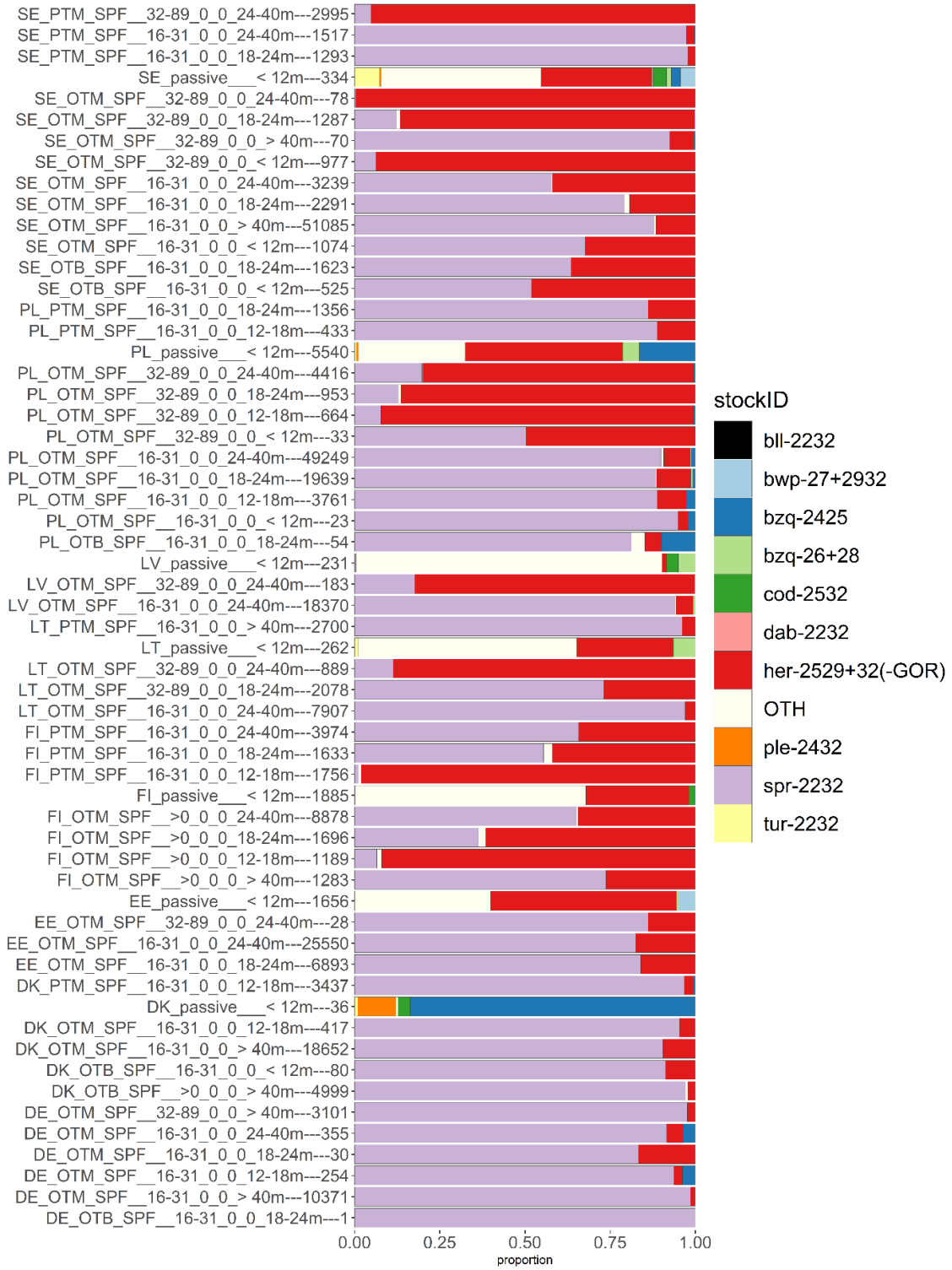

Figure 7.6. Landings composition by country + métier combination in subdivisions 25–28.2, 29+32. *Y*-axis label includes country code + métier + vessel length class + total landings (t). Based on 2022 RDBES data.

8 WGMIXFISH-METHODS 2024 planning

8.1 All regions

The following issues have been identified as being relevant to all ecoregions and therefore need to be addressed from an "all regions" perspective:

- Analyse stability of main model parameters, i.e. catchability, total effort, effort share and quota share. Based on the analysis consider the best way of conditioning the model at fleet/métierlevel, recent years average or last year value.
- Develop criteria for choosing relevant scenarios to run. In case of zero-catch advice, exzero may be considered as a standard scenario for estimating bycatch.
- Develop criteria for stock inclusion in the mixed fisheries models. Where possibly, advice summary tables should include all stocks for which the variable can be estimated (e.g. F for category 1 *Nephrops*).
- Define maximum fleet effort (e.g. multiple of *status quo*) as upper limit in scenarios.
- Assess possible use of grouped TAC constraints to better reflect management.

8.2 Baltic

- Continue work on the comparison of RDBES data to the InterCatch data to be certain that the data matches.
- RDBES landings data does not include information about stock. The landings data were allocated to stock based on subdivision border only, however some stocks are also caught outside the specified stock area. Work on correcting the allocation of landings to stock is needed.
- Current usage of RDBES landings data has the drawback that information on discards is not included in the analysis which would be important especially for the demersal fishery. Investigate how to get discard estimates from the RDBES data.
- Set up code in TAF for producing catch composition plots.
- Further analyses on mixed fisheries fleets to best reflect the technical interactions in the region.

8.3 Bay of Biscay

There are several issues in the modelling process to provide mixed fisheries advice for Bay of Biscay that need to be addressed in future meetings.

- 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.
- 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, white anglerfish and blue whiting.
- Improve fleet structure based on this year's fleet configuration, if considered necessary. Revise the assumptions for the pelagic fleets with very low or null bycatch of demersal stocks (currently all removed from the analysis, but should be reconsidered how to deal with fleets with minor bycatch, e.g. French purse-seiners). Revise the assumptions for out of area

catches for harmonization with other case studies. Documentation and justification of the procedure.
- 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.
- Analyse the option of including fleet-dependent age structure in the conditioning of the model for some stocks.
- Analyse the relevance of existing scenarios and identify new relevant ones. For example, include sensitivity runs to the impact of combined TACs for anglerfish (*Lophius* spp.) and rays (in case they are included next year).
- Consider defining maximum fleet effort as an upper limit in scenarios.

8.4 Celtic Seas

The following topics have been identified for future work in the Celtic Sea case study:

- Continue work on the implementation of an age-based model.
- 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),
- 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,
- Investigate raising procedure and "top-up" fleets: currently operating on landings and discards independently, but need to consider total catch,
- Consider whether to split the Static fleet into separate Longline and gillnet fleets to better represent differences,
- 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.
- Evaluate alternative effort scenarios based on changes implemented to allow fleet specific vectors of choking stocks,
- Develop methods for longer term projections based on rebuilding of depleted stocks,

8.5 Iberian waters

The following issues have been identified for future work in the Iberian waters case study:

- Improve mixed fisheries fleets to best reflect the technical interactions in the region.
- Improvement of code structure in TAF. Continued implementation of report results, tables and figures in in R markdown.
- Inclusion of other stocks: The wide distributed stocks *Scomber scombrus* (mac.27.nea) and Micromesistius poutassou(whb.27.1-91214) are to be tested in the mixed fisheries model. These species have their southernmost distribution in the area and only have some sea-

sonal, minor catches (when compared to the rest of the wide stock) but are relevant to some demersal métiers operating in the area.
- Consider other stocks in the area that are not included in the mixed fisheries methodology which are relevant to the effort allocation and technical interactions in mixed fisheries demersal métiers.
- Implement the "range" scenario following further development to be conducted for the North Sea and Celtic Sea.

8.6 Irish Sea

The following areas would be useful to address in order to improve the mixed fisheries assessment methods in the Irish Sea

- Investigate of further scenarios based on alternative advice options for zero-catch stocks (e.g. cod and whiting).
- Implement historic model validation techniques in annual workflow.
- Further streamlining code, repository and results tables and figures.
- Investigate the potential for implementation of an age-based model (e.g. FLBEIA/ age-based FCube model) and compare with current FCube approach.
- Investigate differences in catch compositions of fish-stocks between *Nephrops* FU's if data sources allow.

8.7 North Sea

The following topics have been identified for future work in the North Sea case study:

TAF; improvements of the scripts:

- Modify model_01 to read the BRPs (reference points) csv automatically.
- Better handle dataPrep scripts so they are run before running data.R.
- data.R and model_00 have similar code (e.g. stock names), make consistent and delete repetitions.
- Delete any reference to years in the script names so they do not need to be updated every year.
- Check if the projection is needed in output.R script or if the results from model_04 can be used instead.

Data

- The discards are not raised as they should if landings are 0. Data_02a and 02b scripts need to be modified to allow the raising.
- The function spfunction() in the file "bootstrap/initial/software/functions/FunctionDefineFleetCategories.R" needs to be checked for correct fleet naming convention. For instance, "SC_Otter10-24" and "SC_DSeine10-24" are aggregated under "SC_Otter<24" instead of "SC_Otter10-24". Other aggregation rules are sometimes taken for other countries. The best naming needs to be found.
- Consider adding *Nephrops* in FU 3 (and eventually in FU 4 if Kattegat also added) to the model.

Methodology

- Use the results of the STARMixFish report to update the methodology if relevant.

Report and Stock Annex

- Further maintenance if relevant.

- 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().

Annex 1: List of participants

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Annex 2: Resolutions

2022/2/FRSG15 The **Working Group on Mixed Fisheries Advice (**WGMIXFISH-ADVICE), chaired by Marc Taylor, Germany, and Harriet Cole, UK, will meet at ICES Headquarters in Copenhagen, Denmark, 2–6 October 2023 to:

a) Carry out mixed fisheries projections for the Bay of Biscay taking into account the single species advice and the management measures in place for 2023 for anglerfish, megrim, sea bass, hake, sole, Norway lobster, whiting and pollack that is produced by WGBIE in May 2023; for mackerel, horse mackerel, and blue whiting produced by WGWIDE in September 2023 and smooth hound produced by WGEF in October 2023.

b) Carry out mixed demersal fisheries projections for the Celtic Sea taking into account the single species advice and the management measures in place for 2023 for cod, haddock, whiting, hake, megrim, monkfish, sole and Norway lobster that is produced by WGCSE and WGBIE in 2023.

c) Carry out mixed fisheries projections for Iberian waters taking into account the single species advice and the management measures in place for 2023 for hake, four-spot megrim, megrim and anglerfish that is produced by WGBIE in May 2023.

d) Carry out mixed demersal fisheries projections for the Irish Sea (27.7.a) taking into account the single species advice for cod, haddock, whiting, plaice, sole, and Norway lobster that is produced by WGCSE in 2023.

e) Carry out mixed demersal fisheries projections for the North Sea taking into account the single species advice and the management measures in place for 2023 for cod, haddock, whiting, saithe, plaice, sole, turbot, Norway lobster, and witch that is produced by WGNSSK in May 2023.

f) Produce draft mixed fisheries sections for the ICES advisory report 2023 that includes a dissemination of the fleet and fisheries data and forecasts for the North Sea, Celtic Sea, Irish Sea, Bay of Biscay, and Iberian waters.

WGMIXFISH-ADVICE will report by 28 October 2023 for the attention of the 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 the provision of ICES 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 ap-proach 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 and science committees	ACOM and SCICOM.
Linkages to other groups	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.

Annex 3: Audit reports

Audit of the Mixed-fisheries advice for the Greater North Seas Ecoregion

Date: 23/10/2023

Auditor: Gianfranco Anastasi

Summary of the advice

1. **Assessment type:** FLBEIA mixed fisheries assessment
2. **Single stock Assessments used as basis** (stock/assessment model/EG forecast method)

Species	Assessment	Forecast
BRILL 4, 3.a and 7.de	SPiCT	SPiCT
COD 4, 3.a, 6.a and 7.d	Multistock SAM	Multistock SAM
HADDOCK 4, 3.a and 7.d	SAM	SAM
PLAICE 4	SAM	SAM
SAITHE 4, 3.a and 6	SAM	SAM
SOLE 4	AAP	FLR
WHITING 4 and 7.d	SAM	MFDP
PLAICE 7.d	AAP	FLR
SOLE 7.d	SAM	SAM
TURBOT 4	SAM	FLR
WITCH 4, 3.a and 7.d	SAM	SAM

For the *Nephrops* stocks, the assessment methods are simpler and conducted on excel spreadsheets.

3. **Framework used for mixed fisheries forecasts:**

The FLBEIA model using the FLR framework (www.flr-project.org). All analysis run in R.

4. **Data issues:**

None reported .

5. **Consistency:**

Cod in division 6.a has been added to the Cod stock in the model and Brill added as category 2 (SPiCT assessment).

The number of scenarios have been increased compared to last year, and include the "min", "max", "sq_E", "cod-ns" and a fifth scenario "min_range" same as min scenario to explores how the higher catch advice associated with the $F_{MSY\ upper}$ reference point may reduce choking behaviour in mixed fisheries and increase overall quota uptake.

Fleets landing less than 1% of each stock in 2022 have been aggregated to the "MIS_MIS" fleet and out of area catches for brill has been accounted for in a stock-specific fleet ("BLL_OTH"). The "OTH_OTH" fleet accounts for differences in total catch between the fleet data and observed catches from the single stock assessments for POK and WIT. Some mismatch between InterCatch and Accessions for Norwegian vessels < 15 m has been reported.

6. Mixed fisheries situation:

The most limiting stock for demersal fisheries in the Greater North Sea is cod, whose advised catch for 2024 is first reached for 35 of 43 defined fleets, whereas whiting is the least limiting stock (36 of 43 fleets).

7. Management Plan:

Demersal fisheries in the North Sea region are managed under a multi-annual plan for the North Seas region (Regulation (EU) 2018/973).

8. General comments

Advice sheet: The advice sheet is well written and presents mixed fisheries considerations based on simulations for the Greater North Seas ecoregion and adheres to the formatting guidelines agreed for all mixed fisheries advice sheets.

TAF: Well documented. Results were fully reproducible. Some issues to get the code running.

Report section: The report has not been fully updated at the time of the audit.

Stock annex: The stock annex is available on ICES SharePoint and was updated in October 2023. Comprehensive document that includes detailed information on the stocks and fisheries in the Ecoregion. In particular the latest version includes: information on the inclusion of Cod in division 6.a to the Cod stock in the model and an update on the data source and collection process (e.g. more automated, quality control process).

9. Technical comments

TAF: The TAF repository is well-structured with a clear and helpful 'README' that provides a brief outline and description of the key scripts in the analysis. To get the model to work properly a specific FLBEIA version is needed. Some information on sessionInfo() on the 'README ' file on the TAF repository would be useful. sourceAll() does not work correctly (some minor issues on creation of needed folders and producing the report that can be easily addressed). However, scripts work when manually run one by one.

Report section: The report has not been fully updated at the time of the audit.

10. Conclusions

The assessment is fully reproducible.

Audit of the Mixed-fisheries advice for the Iberian Waters

Date: [25/10/2023]

Auditor: Klaas Sys

Summary of the advice

1. **Assessment type:** FLBEIA mixed fisheries assessment
2. **Single stock Assessments used as basis** (stock/assessment model/EG forecast method)

Species	Assessment	Forecast
BLACK-BELLIED ANGLERFISH **ank.27.8c9a**	Surplus Production model (SpiCT)	NA
HAKE **hke.27.8c9a**	Length-based age-structured Stock Synthesis model (SS3)	SS3
FOUR-SPOT MEGRIM **ldb.27.8c9a**	Statistical catch-at-age model (a4a)	FLR STF
MEGRIM **meg.27.8c9a**	Statistical catch-at-age model (a4a)	FLR STF
WHITE ANGLERFISH **mon.27.8c9a**	Length-based age-structured Stock Synthesis model (SS3)	SS3 (ad hoc R code)

3. **Framework used for mixed fisheries forecasts:**

The FLBEIA model coded in R, using the FLR framework (www.flr-project.org).

4. **Data issues:**

Some discrepancies, related to methodological differences, between the single stock advice and the Baseline run to reproduce the advice were found, all discrepancies were <5%.

A lack of classification of different megrim species at fish auctions, and misidentification of anglerfish species may limits the quality of the fleet data.

5. **Consistency:**

The number of scenarios have been increased compared to last year, and include a "min_range" scenario that provides a catch option where TACs are set according the upper range of Fmsy where applicable.

The intermediate year assumption are similar to last year and based on the last 3 data years.

There have been some changes to the names of the defined fleets used in the mixed fisheries model with the "Other" fleet now called "FR_MIS" according to the WGMIXFISH guidelines.

6. **Mixed fisheries situation:**

Hake (hke.27.8c9a) is identified as the most limiting stock for all fleets. The least limiting stock is anglerfish (ank.27.8c9a) (11 of 11 fleets). When hake would be fished at the upper range of Fmsy, catch

opportunities would increase with 40 to 45% for all stocks. Each of the TACs for anglerfish and megrim covers two species (for anglerfish *Lophius piscatorius* and *L. budegassa*; for megrim *Lepidorhombus whiffiagonis* and *L. boscii*). The mixed-fisheries analysis is based on ICES catch advice for the individual stocks. As a consequence, the extent of effort limitation may differ if based on TAC unit rather than on individual stock.

7. Management Plan:

A multi-annual plan exists and covers all stocks included in the mixed fisheries model of the Iberian Waters.

8. General comments

Advice sheet: Well written and adheres to the generic format agreed for all mixed fisheries advice sheets. Data issues affecting the advice were explained within the text.

TAF: The taf repository does not follow the recommended TAF structure. However, all data and scripts with comments are available making the advice transparent and reproducible.

Report section: Wel written, includes detailed information on the stocks included in the WGMIXFISH projections, provides additional information on the scenarios and results. It would be helpful to have some additional table with the identified choking species by fleet for each scenario (min, max, min_range).

Stock annex: Comprehensive document that includes background information on the stocks and fisheries in the Ecoregion. No changes were made compared to last years. A description of the new min_range scenario could be added to the SA.

9. Technical comments

All technical comments for documents have been added to the documents as a tracked change or comment balloon.

Advice sheet: It is difficult to link the fleets/métiers reported in Figure 2 to the Figure 3 and Table 6. It would be helpful to have a table that allows to match the names, as well as state that the FR_MIS fleet and MIS fleet are removed from the figures.

TAF: The scripts on the repository are not structured to allow reproducing the results with the taf.bootstrap() procedure.

Report section: spotted and corrected some typos. It is difficult to link the fleets/métiers reported in Table 4.3 to the Figures 4.8 and 4.9. It would be helpful to have a table that allows to match the names, as well as state that the FR_MIS fleet and MIS fleet are removed from the figures.

Stock annex: /

10. Conclusions

The assessment has been carried out appropriately and is fully reproducible. The major change to last year is the inclusion of an alternative min_range scenario. Some restructuring to the TAF repository would be beneficial.

Audit of the Mixed-fisheries advice for the Bay of Biscay

Date: [18/10/2023]

Auditor: Santiago Cerviño

Summary of the advice

1. **Assessment type:** FLBEIA mixed fisheries assessment
2. **Single stock Assessments used as basis** (stock/assessment model/EG forecast method)

ICES Stock	Assessment	Forecast
mon.27.78abd	a4a	FLR-STF
hke.27.3a46-8abd	SS	SS - STF
sol.27.8ab	FLR-XSA	FLR STF
meg.27.7b-k8abd	A4a	FLR - STF
NORWAY LOBSTER 8.a-b	UWTV survey	Ad-hoc (excel sheet)
hom.27.2a4a5b6a7a-ce-k8	SS3	FLR-STF
mac.27.nea	SAM	FLR-STF
ank.27.78abd	SS	No
Pol.27.89a	Cat 3 (rfb))	No
SEABASS 8a,b	SS	SS3 (ad hoc R code)
SMOOTH-HOUND in the Northeast Atlantic and adjacent waters	Survey trend (Category 3)	Ad-hoc (excel sheet)
whb.27.1-91214	SAM	SAM
WHITING 8 and 9.a	None (Category 5)	No

3. **Framework used for mixed fisheries forecasts:**

The FLBEIA model coded in R, using the FLR framework (www.flr-project.org) and TAF available at https://github.com/ices-taf/2023_BoB_MixedFisheriesAdvice .

4. **Data issues:**

Some discrepancies between the single stock advice and the Baseline run to reproduce the advice were found, most of them lower than 5%, i.e. acceptable to make the projections.

The only exception is WHB SSB in 2024 (+7%). This was originally +12% and was improved by implementing the same approach for interim year than those applied to MAC. Discrepancies in estimated discards where very big for some stocks, specifically for hake, megrim and white anglerfish.

Many single stock assessment models follow a different dynamic than the mixed fishery model (FLBEIA) regarding fleets, length, recruitment period, sex, etc. So differences are expected. The Group accepted them to make projections.

5. Consistency:

The report follows the stock annex which have been reviewed this year to explain better all the process. All the new text are non-critical reviews. The updated stock annex text is clearer now.

The mixed fisheries projections include the same stocks than last year. No big differences in catch proportions by spp and fleet compared with last year. There are 28 metiers (21 resulting fleets) and 13 stocks.

Performance relative to advice sheet is good in general and some modifications were accepted to get a better one._The approach decided for WHB intermediate year is a modification in methodology compared with last year but was accepted given the better fit to single stock advice.

Scenarios developed include the "min", "max", "sq_E" and a specific horse mackerel scenario (min excluding HOM, where all fleets catch up their quota share for horse mackerel and pretty good yield (PGY). PGY is a new scenario this year.

***6.* Mixed fisheries situation:**

Horse mackerel (hom.27.2a4a5b6a7a-ce-k8) is most limiting stock due to the zero catch advice constraining 16 of the 22 modelled fleets. When excluding horse mackerel ("min-exhom" scenario), pollack becomes the most limiting stock constraining eight out of 22 fleet segments. The catch advice for this pollack stock has shown a 39% reduction in 2023-2024 relative to 2022

7. Management Plan:

A multi-annual plan exists and covers some stocks in Western Waters and adjacent waters however, for some of these stocks, this MAP is currently not recognised by Norway or the UK. In those cases, ICES advice is given on the ICES MSY approach.

8. General comments

BoB coordinator provided direct links to all needed documents helping quite a lot this audit.

Advice sheet: Well written and adheres to the generic format agreed for all mixed fisheries advice sheets. Data issues affecting the advice were explained within the text.

TAF: Generally, well documented and easy to follow. It includes many quality checks along the different scripts helping to identify causes of potential failures. Results were fully reproducible although not at the first run. I needed BoB coordinator support to get run the TAF in my computer.

Report section: Wel written, includes detailed information on the stocks included in the WGMIXFISH projections, provides additional information on the scenarios and results.

Stock annex: It was updated this year with not-critical changes resulting in a more comprehensive document that includes background information on the stocks and fisheries in the Ecoregion.

9. Technical comments

All technical comments for documents have been added to the documents as a tracked change or comment balloon.

Advice sheet: /

TAF: The repository includes all necessary files to run the taf.bootstrap() procedure. However, it fails in my computer when installing the FLBEIA version. It was corrected by removing the call to FLBEIA in SOFTWARE.bib allowing the script to use the FLBEIA version already installed in my computer.

Report section: spotted and suggested some minor changes

Stock annex: spotted and nothing to sugest

10. Conclusions

The assessment has been carried out appropriately and is fully reproducible. There are some minor deviations from previous years related to forecast assumptions of pelagic stocks and these changes were discussed and accepted by the WG and are justified in the report.

Audit of the Mixed-fisheries advice for the Celtic Sea

Date: [18/10/2023]

Auditor: Harriet Cole

Summary of the advice

1. **Assessment type: FCube mixed fisheries assessment**
2. **Single stock Assessments used as basis (stock/assessment model/EG forecast method)**

Species	Assessment	Forecast
BLACK-BELLIED ANGLERFISH 7, 8.a-b,d	SS3	FLR
WHITE ANGLERFISH 7, 8.a–b and 8.d	SS3	FLR
COD 7.e-k	SAM	SAM
HADDOCK 7.b-k	SAM	SAM
HAKE 3.a, 4, 6, 7 and 8.a,b,d	SS3	SS3
MEGRIM 7.b-k and 8.a-b,d	Bayesian statistical catch at age model (a4a)	FLR
WHITING 7.b-c,e-k	SAM	SAM
SOLE 7.e	XSA	FLR
SOLE 7.fg	SAM	SAM
nep.fu.16	Underwater TV survey	NA
nep.fu.17	Underwater TV survey	NA
nep.fu.19	Underwater TV survey	NA
nep.fu.2021	Underwater TV survey	NA
nep.fu.22	Underwater TV survey	NA
nep.out.7	Precautionary approach	NA

3. **Framework used for mixed fisheries forecasts:**

The FCube model coded in R, using the FLR framework (www.flr-project.org).

4. **Data issues:**

The production of WGMIXFISH advice additionally acts as a quality control check on the production of the single stock advice. A typo was found in the advice sheet for the SSB in 2023 for Celtic Sea haddock. This was corrected by the stock assessor and the advice sheet has been updated.

Otherwise, there were no major data issues.

5. Consistency:

The model remains unchanged from last year.

A new standard scenario was presented in all ecoregions for this year. The "min_range" scenario which uses the $F_{MSY\ upper}$ advice option for stocks with SSB >= MSY $B_{trigger}$ and the scaled F_{MSY} ($F = F_{MSY} * SSB/MSY\ B_{trigger}$) advice option for stocks with SSB below MSY $B_{trigger}$, even when the headline advice is for 0 catch. This is to provide some contrast with the "min" scenario when there are stocks with 0 catch advice. This new scenario also brings changes to the headline plot by adding reference lines for the $F_{MSY\ upper}$ and $F_{MSY\ lower}$ reference points.

An additional ecoregion-specific scenario was presented for this year in the Celtic Sea. This "min_exzero" scenario excludes the 0 catch advice stock (cod and whiting) from restricting fleet fishing effort to explore choking effects amongst the other stocks.

The spatial extent of 4 stocks (hake, white and black-bellied anglerfish and megrim) overlap both the Celtic Sea and Bay of Biscay ecoregions and are included in both models. Dummy "OTH" fleets are used to account for the catches taken out of the Celtic Sea region. However, these catches should only be considered representative in the context of the Celtic Sea and may not correspond to the predicted catches given by the Bay of Biscay model.

***6.* Mixed fisheries situation:**

Cod (cod.27.7e-k) is most limiting stock (30 out of 35 fleets) although whiting is almost as limiting (27 out of 35 fleets). This is due to the 0 catch advice for this stock and that nearly all fleets in the model catch cod and whiting. The most common least limiting stock is *Nephrops* FU 20-21 (18 fleets) and black-bellied anglerfish (ank.27.78bd, 16 fleets).

7. Management Plan:

A multi-annual plan exists for Western Waters and adjacent waters however, this MAP is currently not agreed with Norway or the UK. For affected stocks, ICES advice is given on the ICES MSY approach.

There are two species specific management plans in this region; a recovery plan for hake (Council Regulation (EC) No 811/2004) which implements a Total Allowable Catch (TAC) annually based on a defined Harvest Control Rule (HCR) and a management plan with both a HCR and effort management element for sole in the Western channel (7.e; Council Regulation (EC) No 509/2007). There are also a number of effort, technical and area closure measures in place.

Catches of all quota species within the Celtic Sea are subject to the landings obligation (with some de minimis and survivability exemptions).

8. General comments

Advice sheet: Clearly written and consistent with the advice sheets for other ecoregions.

TAF: Perhaps think about having a "development" repo as well as an "official" one for separating out test runs from the key run? Otherwise, the layout and labelling of code is clear and easy to follow.

Report section: The main results, plots and text had been updated by the time of the audit although some ancillary plots were still to be added. The main results and plots match the advice sheet. The report was generally well written and clearly laid out.

Stock annex: The stock annex has not been updated this year although the list of scenarios needs updating following the new additions. Otherwise, all other information looks correct.

9. Technical comments

All technical comments for documents have been added to the documents as a tracked change or comment balloon.

Advice sheet: Some checks are needed on some of the catch values in table 3 and the rounding in table 4.

TAF: Best practice is to have a "data.R" script in which all sub "data_...R" scripts are sourced. Similar for model.R etc. This means that TAF users can run source.all() which then runs all scripts in order.

Report section: Some small edits/comments/typos were found and were added to the document. Table 3.1 seems to be missing.

Stock annex: Some minor typos found.

10. Conclusions

The assessment has been carried out appropriately and is fully reproducible.

Audit of the Mixed-fisheries advice for the Irish sea

Date: [23/10/2023]

Auditor: Johnathan Ball

Summary of the advice

1. **Assessment type:** FLR mixed fisheries assessment
2. **Single stock Assessments used as basis** (stock/assessment model/EG forecast method)

Species	Assessment	Forecast
Cod.27.7.a	SS3	SS3 (ad hoc R code)
Had.27.7.a	ASAP	ad hoc R code
Sol.27.7.a	XSA	ad hoc R code
WHG.27.7.a	ASAP	ad hoc R code
Ple .27.7.a	SAM	FLR-STF
NEP 14 and 15	UTS	Ad-hoc (excel sheet)

3. **Framework used for mixed fisheries forecasts:**

The FLR model coded in R, using the FLR framework (www.flr-project.org).

4. **Data issues:**

Some discrepancies between the single stock advice and the Baseline run to reproduce the advice were found, all discrepancies were <4%.

5. **Consistency:**

A "min_range" scenario has been added this year, it replaces the range scenario in other case study's but is a new addition for the Irish Sea.

The other fleets and miscellaneous fleets have been renamed to OTH_OTH and MIS_MIS, this is a cross case study change to increase consistency and was agreed at the methods meeting.

A 6-stock model has been retained this year, there is some debate over including plaice and sole as the interaction between them and the species-specific scenarios was called in to question. A compromise has been put in place where fleets targeting sole stop at the zero-catch advice for sole in all the stock-specific scenarios. As catching more sole under for instance the nephrops scenario was deemed to be unrealistic for a bycatch only fleet.

6. **Mixed fisheries situation:**

The most limiting stock is whg.27.7a followed by cod and sole, all fleets are chocked by these stocks. The least limiting stock is plaice which chokes only 11 of the 12 fleets.

7. **Management Plan:**

A multi-annual plan exists and covers some stocks this MAP is currently not recognised by Norway or the UK. In those cases, ICES advice is given on the ICES MSY approach.

8. General comments

Advice sheet: Well written but currently still being drafted and subject to minor alterations and changes

TAF: A readme file could be added to the git to aid with running the scrips and correctly reproducing the assessment. Results were fully reproducible. There were no issues to get the code running after manual installing of some R packages.

Report section: Currently not available due to last minute changes

Stock annex: Currently not available due to last minute changes

9. Technical comments

All technical comments for documents have been added to the documents as a tracked change or comment balloon.

Advice sheet: /

TAF: The repository includes all necessary files to run the taf.bootstrap() procedure.

Report section: Currently not available due to last minute changes

Stock annex: Currently not available due to last minute changes

10. Conclusions

The code is well constructed and reproducible, the draft advice sheet available is well written but subject to change and still being drafted. The report was not available at this time.

Annex 4: Mixed Fisheries Annexes

The table below provides an overview of the WGMIXFISH Stock Annexes. Stock Annexes for other stocks are available on the ICES Library under Content Type: "Stock Annexes"

Stock code	Stock description	Last updated	DOI
mix.bob	Bay of Biscay Mixed Fisheries Annex	October 2023	https://doi.org/10.17895/ices.pub.24562840
mix.cs	Celtic Sea Mixed Fisheries Annex	October 2023	https://doi.org/10.17895/ices.pub.24562849
mix.iw	Iberian waters Mixed Fisheries Annex	October 2022	https://doi.org/10.17895/ices.pub.21518010
mix.is	Irish Sea Mixed Fisheries Annex	October 2022	https://doi.org/10.17895/ices.pub.21518034
mix.ns	North Sea Mixed Fisheries Annex	October 2023	https://doi.org/10.17895/ices.pub.24562855

Annex 5: Integration of benchmarked North Sea cod into mixed fisheries model

North Sea cod has been through a benchmark in 2023, resulting in the stock being split into 3 substocks (ICES, 2023). The integration of these stocks in the mixed fisheries model is hindered because spatially explicit data do not currently exist at the métier level and the substocks mix during the year, which prevents assigning a cod catch to a specific métier/substock interaction.

At WGMIXFISH-METHODS a detailed discussion was had on what would be the best way forward for the integration of cod in the model. Two possibilities were retained: either inclusion as a merged stock object, with some loss of consistency with the single-stock advice forecasts, or complete removal.

The concern with the inclusion of a merged stock object is the loss of substock advice considerations based on differing status, e.g. the two northern stocks are considered to be above their respective $B_{trigger}$ reference points while the southern substock is below. This disparity could lead to potentially different choke situations that would not be captured by a merged stock object in the mixed fisheries forecasts. This can potentially affect the credibility of our projections as it is inconsistent with the cod advice based on independent substocks.

Despite this drawback, the group felt it necessary to evaluate the technical feasibility of merging the 3 substocks into a single stock. In particular, the merging procedure was evaluated in terms of the possible consequences to short-term forecasts (STFs). Stocks were merged using existing functionality of the FLCore R library (Kell *et al*., 2007), whereby substocks were assigned to the *area* dimension of an FLStock object, and subsequently merged using the *simplify* function.

STFs were conducted for each substock individually, and for the merged stock object. As is normally done each year in WGMIXFISH-ADVICE, the STF is informed by the published advice in terms of assumed intermediate and advice year recruitment, F, and catch, as well as the resulting SSB. The STF settings for the merged stock object were to use the aggregated (i.e. summed) values for recruitment, catches, and SSB across the 3 substocks. Finally, the separate substock STFs were compared to the merged STF in terms of several stock parameters. In summary, the procedure was as follows:

1. Perform a short-term forecast for each substock and compare to values of the published advice.
2. Perform a short-term forecast for the merged stock object and compare to the aggregated values of the published advice.
3. Compare forecast year values of the merged stock object to aggregated values across the substocks (i.e. merged after the single-substock forecasts)

The merging procedure was found to work well for historical values, providing consistent results for aggregated numbers, mean weights and maturity. Merged fishing mortality (F) is provided via a cohort decay model by default but can be recalculated according to the Baranov catch equation if preferred.

A summary of the main stock indicators (catch, recruitment, SSB, and F) among substocks and the merged stock object are shown in Figure A5.1. While merged historical catch, recruitment, and SSB are simple sums of the values across substocks, F is recalculated according to the Baranov catch equation. This clearly shows that despite the higher F values in the Southern substock, the merged values are more similar to the Northwestern substock, which is associated with the highest SSB and catches.

Figure A5.2 compares indicators of the deterministic forecasts to the median stochastic forecast values reported in the advice. Generally, forecasts are within acceptable limits (< +/-10%), although some larger deviations are observed for the Southern stock in terms of SSB at the start of 2025 (-15%). As the Southern stock is one of the smaller substocks, this translates to a much smaller deviation in merged SSB (-4%). The reason for this discrepancy is likely due to the higher uncertainty associated with the assessment of the Southern substock, which translates to greater inconsistencies in the summary stock object based on median assessment values.

Figure A5.3 compares stock variables between the **post**-STF-aggregated substocks vs. the **pre**-STF-aggregated merged single stock for the forecasted years (2023–2024). The results show highly consistent total numbers-at-age for the stock (stock.n) and the catches (catch.n, landings.n, and discards.n) and weighted means for weight-at-age (stock.wt, catch.wt, landings.wt, and discards.wt) and maturity (mat). Slightly higher deviations are seen for the split of catches between landings and discards, likely due to inconsistencies in merging F values that are used to inform selectivity patterns in the forecast. As opposed to those of the default cohort decay model, Baranov-derived F values were used as the basis for the selectivity pattern in the merged stock forecast, which gave slightly more consistent results for the stock variables, but without significant improvements in the comparisons to aggregated substock SSB from the advice. As the mixed fisheries model for the North Sea restricts fleet fishing effort using catch-based advice, rather than landings-based, the slight discrepancy in discard ratio will not influence fleet behavior.

Finally, the forecast of the merged stock object was nearly identical with the post-STF-aggregated substocks (Figure A5.4). Thus, deviations in the forecast of the merged stock are mainly due to typical inconsistencies of translating stochastic assessments and forecasts into deterministic ones, and not from the merging process itself.

In conclusion, the merging process proved to be sufficient in reproducing the forecast dynamics of the individual substocks in aggregate. However, this test does not resolve the issue that a merged object would fail to detect differences in choking behaviour among the substocks. Nevertheless, given that cod is the stock that motivated the development of the mixed fisheries model in the North Sea, it was generally felt that its exclusion might diminish the relevance and utility of the mixed fisheries considerations. Until future data allows for the direct integration of substocks and differentiation among fleet catches, the current compromise is to proceed with the merged cod stock object and to add clarifying text explaining the deviation from the stock advice and the possible consequences for the mixed fisheries considerations. The group also discussed the possibility of treating the cod stock differently than the other stocks in the model (e.g. exclude it from the list of restrictive stocks), or running an extra more restrictive scenario using the smallest of the three substock catch advice. The inclusion of these possible extra scenarios will be further evaluated during the advice meeting.

References

ICES. 2023. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.22643143.v3

Kell, L. T., I. Mosqueira, P. Grosjean, J-M. Fromentin, D. Garcia, R. Hillary, E. Jardim, *et al.*, 2007. "FLR: An Open-Source Framework for the Evaluation and Development of Management Strategies." Journal Article. ICES Journal of Marine Science 64 (4): 640–46. http://icesjms.oxfordjournals.org/cgi/content/abstract/64/4/640

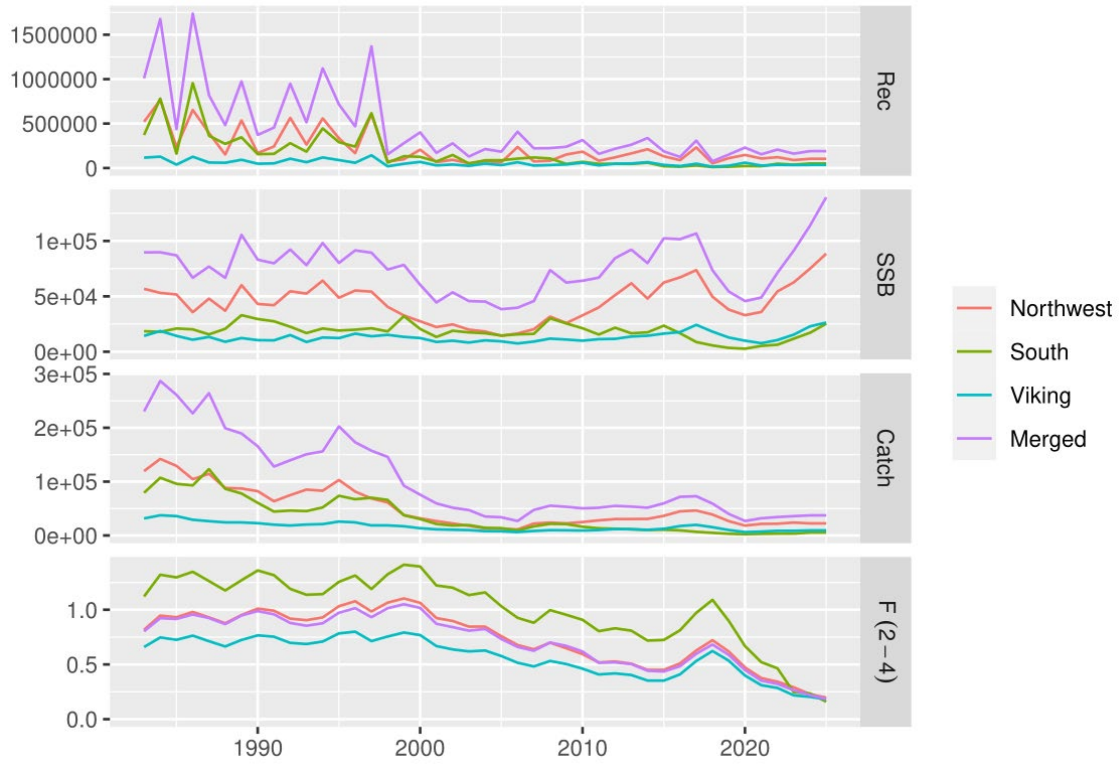

Figure A5.1. Summary of historical and forecast (2023–2025) trajectories of main variables from substocks and the merged stock. For the terminal year (2025), only SSB is of interest, representing the value at the start of the year following the implementation of advice in 2024.

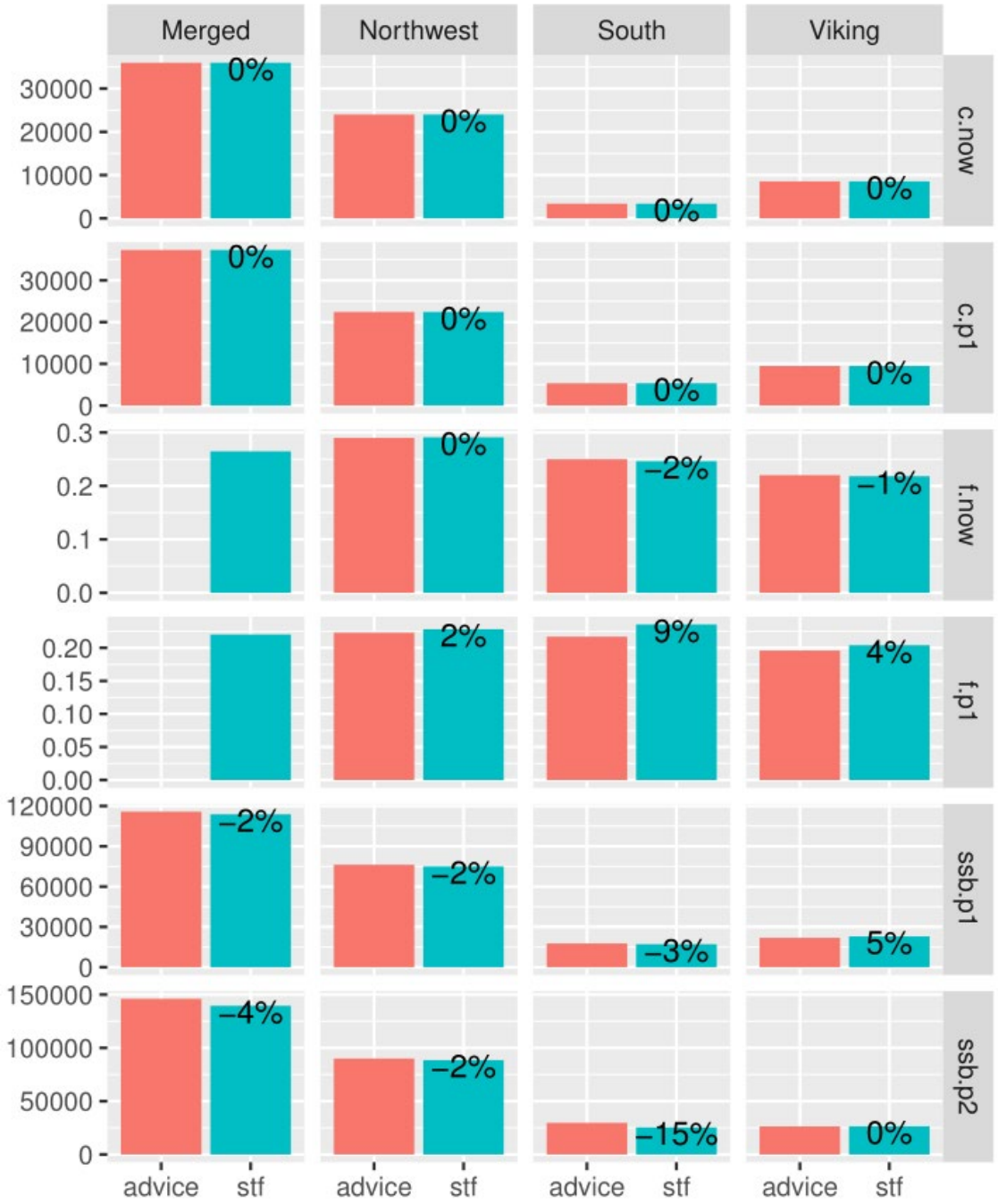

Figure A5.2. Comparison of the reproduced short-term forecast (stf) vs. the advice-reported values (advice) by substock and summary variable / projection year (c = catch, f = fishing mortality, ssb = spawning-stock biomass, now = intermediate year (2023), p1 = advice year (2024), and p2 = advice year + 1). Deviations to the advice-reported values, in percent, are shown as text for each forecasted value.

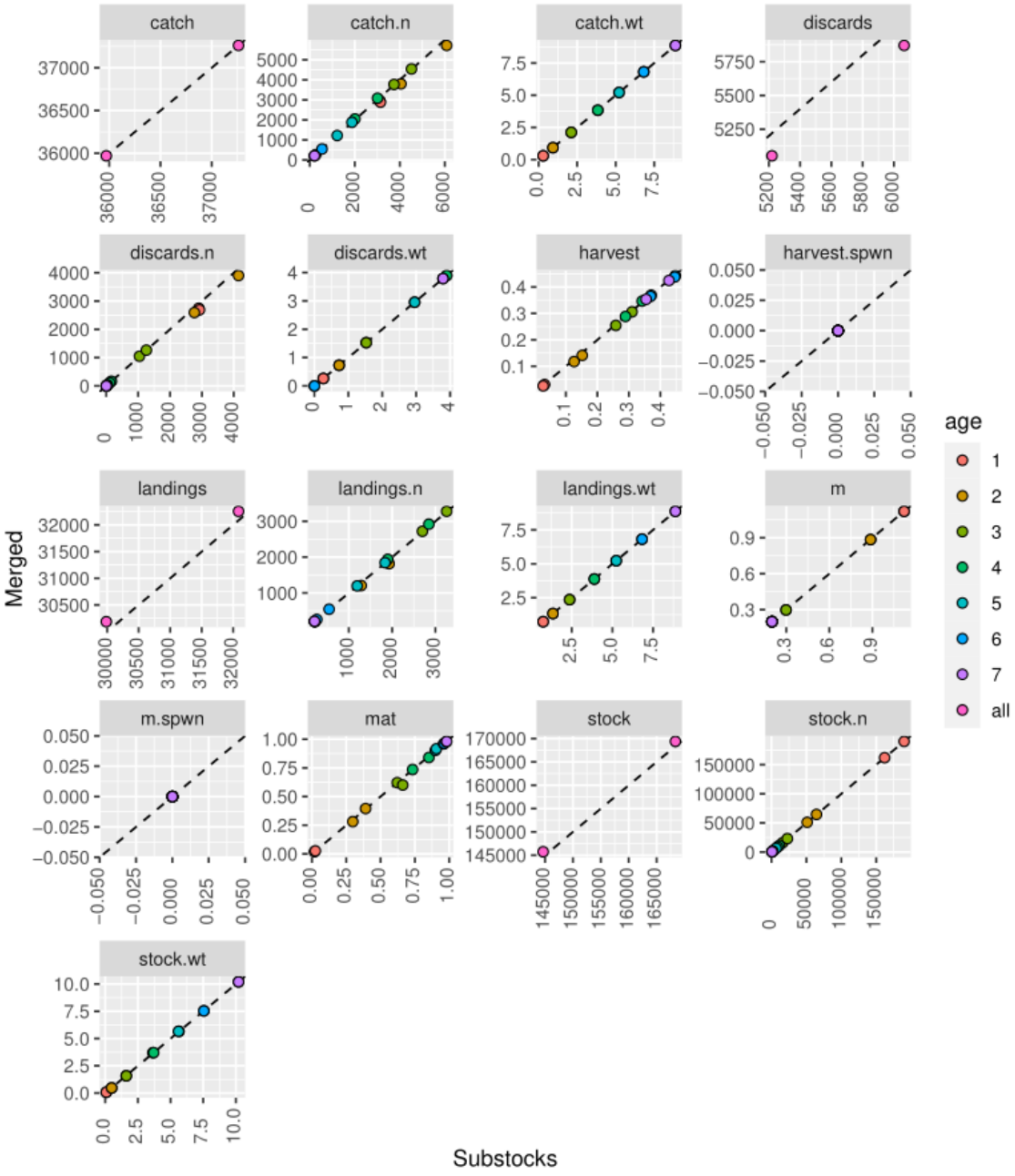

Figure A5.3. Comparison of stock variables between the post-STF-aggregated substocks ("Substocks") vs. the pre-STF-aggregated single stock ("Merged") for the forecasted years (2023–2024). Variables with age-specific information are coloured by age. A 1:1 slope line is shown for reference (dashed line).

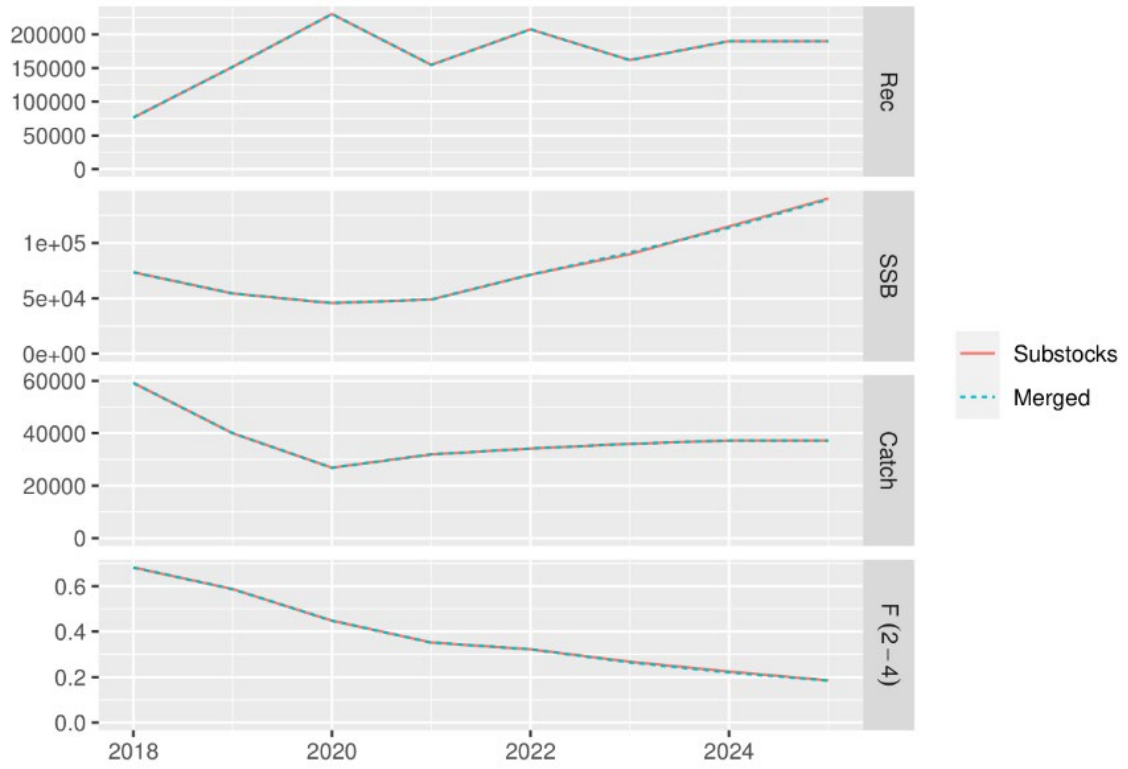

Figure A5.4. Comparison of recent historical and forecast (2023–2025) trajectories of main variables from post-STF-aggregated substocks ("Substocks") vs. the pre-STF-aggregated single stock ("Merged"). For the year (2025), only SSB is terminal of interest, representing the value at the start of the year following the implementation of advice in 2024.

Annex 6: WGMIXFISH data to fleet and métier category

Table A6.1. North Sea. List of métiers reported to WGMIXFISH through the annual data call for each fleet and métier category used in the mixed fisheries model

BE_Beam<24					
BT2.4	**BT2.7D**	**Beam.oth.4**			
TBB_DEF_70-99_0_0_all	TBB_DEF_70-99_0_0_all	TBB_CRU_16-31_0_0_all			
BE_Beam>=24					
BT1.4	**BT2.4**	**BT2.7D**			
TBB_DEF_>=120_0_0_all	TBB_DEF_70-99_0_0_all	TBB_DEF_70-99_0_0_all			
BE_Otter					
TR1.4	**TR2.4**	**TR2.7D**	**TR1.7D**	**OTB32-69.4**	**OTB32-69.7D**
OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all	OTB_CRU_70-99_0_0_all	OTB_DEF_100-119_0_0_all	OTB_DEF_32-69_0_0_all	OTB_DEF_32-69_0_0_all
OTB_DEF_100-119_0_0_all					
DK_OTH					
OTH.4	**OTH.3AN**				
MIS_MIS_0_0_0_HC	MIS_MIS_0_0_0_HC				
MIS_MIS_0_0_0_IBC	MIS_MIS_0_0_0_IBC				
DK_Otter<24					
TR1.4	**TR1.3AN**	**TR2.4**	**TR2.3AN**	**MIS**	
OTB_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all	OTB_CRU_90-119_0_0_all	OTB_CRU_32-69_0_0_all	
OTB_DEF_100-119_0_0_all				OTB_CRU_70-89_2_35_all	

DK_Otter>=24						
TR1.4	**TR1.3AN**	**TR2.4**	**TR2.3AN**	**OTB32-69.4**	**OTB32-69.3AN**	**MIS**
OTB_DEF_100-119_0_0_all OTB_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all	OTB_CRU_90-119_0_0_all	OTB_CRU_32-69_0_0_all	OTB_CRU_32-69_0_0_all	OTB_CRU_16-31_0_0_all
DK_Pelagic						
pelagic.4	**pelagic.6A**					
OTM_SPF_32-69_0_0_all	OTM_SPF_32-69_0_0_all					
DK_Seine						
TR1.4	**TR1.3AN**					
SSC_DEF_>=120_0_0_all SDN_DEF_>=120_0_0_all	SDN_DEF_>=120_0_0_all SSC_DEF_>=120_0_0_all					
DK_Static						
GN1.4	**GN1.3AN**	**LL1.4**	**LL1.3AN**			
GNS_DEF_120-219_0_0_all GNS_DEF_100-119_0_0_all GNS_DEF_90-99_0_0_all GNS_DEF_>=220_0_0_all	GNS_DEF_120-219_0_0_all GNS_DEF_>=220_0_0_all GNS_DEF_100-119_0_0_all	LLS_FIF_0_0_0_all	LLS_FIF_0_0_0_all			

EN_<10						
TR1.4	**TR2.4**	**TR2.7D**	**GN1.4**	**GN1.7D**	**GT1.4**	**GT1.7D**
OTB_CRU_100-119_0_0_all OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all OTB_DEF_70-99_0_0_all OTB_SPF_70-99_0_0_all	OTB_CRU_70-99_0_0_all OTB_DEF_70-99_0_0_all OTB_MOL_70-99_0_0_all	GNS_DEF_all_0_0_all	GNS_DEF_all_0_0_all	GTR_DEF_all_0_0_all	GTR_DEF_all_0_0_all
pots.4	**pots.7D**	**MIS**				
FPO_CRU_0_0_0_all	FPO_CRU_0_0_0_all	LLS_FIF_0_0_0_all MIS_MIS_0_0_0_HC OTB_CRU_32-69_0_0_all OTB_SPF_32-69_0_0_all TBB_DEF_70-99_0_0_all OTB_DEF_32-69_0_0_all				
EN_Beam						
BT1.4	**BT2.4**	**BT2.7D**	**beam_oth.4**	**beam_oth.7D**		
TBB_DEF_>=120_0_0_all	TBB_DEF_70-99_0_0_all	TBB_DEF_70-99_0_0_all	TBB_CRU_16-31_0_0_all	TBB_CRU_16-31_0_0_all		
EN_Otter<24						
TR1.4	**TR2.4**	**TR2.7D**	**Otter_oth.4**	**Otter_oth.7D**	**MIS**	
OTB_CRU_100-119_0_0_all OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all OTB_DEF_70-99_0_0_all	OTB_DEF_70-99_0_0_all	SSC_DEF_all_0_0_all	SSC_DEF_all_0_0_all	OTB_CRU_32-69_0_0_all	
EN_Otter>=40						
TR1.4	**TR1.6A**	**TR2.4**	**TR3.4**	**OTB32-69.4**		
OTB_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0_all	OTB_DEF_70-99_0_0_all	OTB_SPF_16-31_0_0_all	OTB_DEF_32-69_0_0_all		

EN_Otter24-40						
TR1.4	**TR1.6A**	**otter_oth.4**	**Otter_oth.7D**	**MIS**		
OTB_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0_all	SDN_all_0_0_all SSC_DEF_all_0_0_all	SDN_all_0_0_all SSC_DEF_all_0_0_all	OTB_DEF_32-69_0_0_all		
FR_<10						
TR2.4	**TR2.7D**	**GT1.4**	**GT1.7D**	**MIS**	**otter_oth.7D**	**OTH.4**
OTB_DEF_70-99_0_0 OTB_CRU_70-99_0_0_all	OTB_DEF_70-99_0_0	GTR_DEF_90-99_0_0_all	GTR_DEF_90-99_0_0_all GTR_DEF_100-119_0_0_all GTR_DEF_120-219_0_0_all GTR_DEF_>=220_0_0_all GTR_DEF_all_0_0_all	GNS_DEF_100-119_0_0_all GNS_DEF_120-219_0_0_all TBB_DEF_70-99_0_0_all GNS_DEF_all_0_0_all	OTB_DEF_<16_0_0_all	MIS_MIS_0_0_0
OTH.7D						
MIS_MIS_0_0_0 DRB_MOL_0_0_0_all DRB_all_0_0_all						
FR_Nets						
GT1.4	**GT1.7D**	**MIS**				
GTR_DEF_90-99_0_0_all GTR_DEF_>=220_0_0_all GTR_DEF_120-219_0_0_all GTR_DEF_all_0_0_all	GTR_DEF_100-119_0_0_all GTR_DEF_120-219_0_0_all GTR_DEF_all_0_0_all GTR_DEF_90-99_0_0_all GTR_DEF_>=220_0_0_all	GNS_DEF_120-219_0_0_all GNS_DEF_100-119_0_0_all GNS_DEF_>=220_0_0_all GNS_DEF_all_0_0_all				

FR_OTH						
TR2.4	**TR2.7D**	**otter_oth.7D**	**pelagic.4**	**pelagic.7D**	**OTH.4**	**OTH.7D**
SSC_DEF_70-99_0_0_all	SSC_DEF_70-99_0_0_all	SSC_DEF_all_0_0_all	OTM_SPF_32-69_0_0_all OTM_SPF_70-99_0_0_all	OTM_SPF_70-99_0_0_all OTM_DEF_70-99_0_0_all	MIS_MIS_0_0_0	DRB_all_0_0_all MIS_MIS_0_0_0 DRB_MOL_0_0_0_all
OTH.6A						
MIS_MIS_0_0_0						
FR_Otter>=40						
TR1.4	**TR1.6A**					
OTB_DEF_>=120_0_0 OTT_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0 OTB_DWS_>=120_0_0_all					
FR_Otter10-40						
TR1.6A	**TR1.7D**	**TR2.4**	**TR2.7D**	**OTB32-69.4**	**OTB32-69.7D**	**MIS**
OTB_DEF_>=120_0_0 OTT_DEF_>=120_0_0_all OTB_DWS_>=120_0_0_all	OTB_DEF_100-119_0_0 OTB_DEF_>=120_0_0	OTB_DEF_70-99_0_0 OTB_SPF_70-99_0_0_all	OTB_DEF_70-99_0_0 OTB_SPF_70-99_0_0_all OTT_DEF_70-99_0_0	OTB_DEF_32-69_0_0	OTB_DEF_32-69_0_0	OTB_DEF_<16_0_0_all
GE_Beam>=24						
BT1.4	**BT2.4**					
TBB_DEF_>=120_0_0_all	TBB_DEF_70-99_0_0_all					
GE_Otter<24						
TR1.4	**TR1.3AN**	**TR2.4**				
OTB_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all				
GE_Otter24-40						
TR1.4	**TR1.3AN**	**TR2.4**	**TR2.7D**			
OTB_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all	OTB_CRU_70-99_0_0_all			

MIS_MIS				
MIS				
FPO_CRU_0_0_0_all, GNS_DEF_all_0_0_all, LLS_FIF_0_0_0_all, MIS_MIS_0_0_0_HC, OTM_SPF_32-69_0_0_all, GTR_DEF_all_0_0_all, TBB_DEF_70-99_0_0_all, TBB_DEF_all_0_0_all, SSC_DEF_70-99_0_0_all, SSC_DEF_100-119_0_0_all, SSC_DEF_32-69_0_0_all, OTB_DEF_>=120_0_0_all, OTB_SPF_32-69_0_0_all, MIS_MIS_0_0_0_IBC, OTB_CRU_16-31_0_0_all, TBB_CRU_16-31_0_0_all, OTB_CRU_32-69_0_0_all, OTB_CRU_90-119_0_0_all, TBB_DEF_>=120_0_0_all, OTB_CRU_70-99_0_0_all, OTB_DEF_100-119_0_0_all, SDN_DEF_>=120_0_0_all, GNS_DEF_100-119_0_0, SSC_DEF_>=120_0_0, OTM_DEF_<16_0_0, PS_SPF_16-31_0_0, OTM_DEF_32-69_0_0, OTM_SPF_<16_0_0, OTM_DEF_16-31_0_0, OTM_SPF_32-69_0_0, PS_SPF_>0_0_0, SSC_DEF_32-69_0_0				
NL_Beam<24				
BT1.4	**BT2.4**	**beam_oth.4**		
TBB_DEF_>=120_0_0	TBB_DEF_70-99_0_0	TBB_CRU_16-31_0_0		
NL_Beam>=40				
BT1.4	**BT2.4**			
TBB_DEF_>=120_0_0	TBB_DEF_100-119_0_0 TBB_DEF_70-99_0_0			
NL_Beam24-40				
BT1.4	**BT2.4**	**beam_oth.4**		
TBB_DEF_>=120_0_0	TBB_DEF_70-99_0_0 TBB_DEF_100-119_0_0	TBB_CRU_16-31_0_0		
NL_OTH				
OTH.4	**OTH.7D**			
MIS_MIS_0_0_0_HC	MIS_MIS_0_0_0_HC			
NL_Otter				
TR1.4	**TR1.7D**	**otter_oth.4**	**otter_oth.7D**	**MIS**
OTB_DEF_100-119_0_0 SSC_DEF_>=120_0_0 SSC_DEF_100-119_0_0 OTB_DEF_>=120_0_0	SSC_DEF_100-119_0_0	OTB_MCD_>=55_0_0 SSC_DEF_all_0_0_all	SSC_DEF_all_0_0_all	SSC_DEF_70-99_0_0
NL_Pelagic				
pelagic.4	**pelagic.7D**	**pelagic.6A**		
OTM_SPF_32-69_0_0	OTM_SPF_32-69_0_0	OTM_SPF_32-69_0_0		

NO_DSeine24-40						
TR1.4	**TR1.3AN**	**otter_oth.4**	**MIS**			
SSC_DEF_>=120_0_0	SSC_DEF_>=120_0_0	SSC_DEF_<16_0_0 SSC_DEF_>0_0_0	SSC_DEF_16-31_0_0			
NO_OTH						
OTH.4	**OTH.3AN**					
MIS_MIS_0_0_0	MIS_MIS_0_0_0					
NO_Otter						
TR1.4	**TR1.3AN**	**TR3.4**	**OTB32-69.4**	**OTB32-69.3AN**	**otter_oth.4**	
OTB_DEF_>=120_0_0 SSC_DEF_>=120_0_0	OTB_DEF_>=120_0_0	OTB_DEF_16-31_0_0 OTB_SPF_16-31_0_0	OTB_DEF_32-69_0_0 OTB_CRU_32-69_0_0 OTB_SPF_32-69_0_0	OTB_CRU_32-69_0_0	OTB_DEF_<16_0_0 OTB_SPF_<16_0_0	
NO_Otter10-24						
TR1.4	**TR1.3AN**	**TR3.4**	**TR3.3AN**	**OTB32-69.4**	**OTB32-69.3AN**	**otter_oth.4**
OTB_DEF_>=120_0_0 OTB_CRU_>=120_0_0	OTB_DEF_>=120_0_0 OTB_CRU_>=120_0_0	OTB_CRU_16-31_0_0 OTB_DEF_16-31_0_0	OTB_CRU_16-31_0_0 OTB_DEF_16-31_0_0	OTB_DEF_32-69_0_0 OTB_CRU_32-69_0_0	OTB_CRU_32-69_0_0 OTB_DEF_32-69_0_0	OTB_CRU_<16_0_0
otter_oth.3AN						
OTB_CRU_90-99_0_0 OTB_CRU_<16_0_0 OTB_DEF_<16_0_0 OTB_DEF_90-99_0_0 OTB_DEF_70-89_0_0						
NO_Otter24-40						
TR1.4	**TR1.3AN**	**TR3.4**	**TR3.3AN**	**OTB32-69.4**	**OTB32-69.3AN**	**otter_oth.4**
OTB_DEF_>=120_0_0 OTB_CRU_>=120_0_0 OTB_CEP_>=120_0_0	OTB_DEF_>=120_0_0 OTB_CRU_>=120_0_0	OTB_CRU_16-31_0_0 OTB_DEF_16-31_0_0 OTB_SPF_16-31_0_0	OTB_CRU_16-31_0_0 OTB_DEF_16-31_0_0	OTB_CRU_32-69_0_0 OTB_DEF_32-69_0_0	OTB_CRU_32-69_0_0 OTB_DEF_32-69_0_0	OTB_CRU_<16_0_0 OTB_DEF_<16_0_0
otter_oth.3AN						
OTB_CRU_<16_0_0						

NO_Pelagicall						
pelagic.4		**pelagic.3AN**				
PS_SPF_16-31_0_0	PTM_DEF_32-69_0_0	OTM_DEF_100-119_0_0				
PS_SPF_32-69_0_0	OTM_SPF_16-31_0_0	OTM_DEF_>=120_0_0				
OTM_DEF_16-31_0_0	OTM_SPF_<16_0_0					
OTM_DEF_32-69_0_0	PS_SPF_>=120_0_0					
OTM_DEF_<16_0_0	PTM_DEF_16-31_0_0					
OTM_SPF_32-69_0_0	PTM_DEF_<16_0_0					
PS_SPF_>0_0_0	PTM_SPF_32-69_0_0					
NO_Static						
GN1.4	**GN1.3AN**	**LL1.4**	**LL1.6A**	**LL1.3AN**	**pots.4**	**pots.3AN**
GNS_DEF_120-219_0_0	GNS_DEF_120-219_0_0	LLS_DEF_0_0_0	LLS_DEF_0_0_0	LLS_DEF_0_0_0	FPO_CRU_>0_0_0	FPO_DEF_>0_0_0
GNS_DEF_71-89_0_0	GNS_DEF_>=220_0_0	LHM_DEF_0_0_0			FPO_DEF_>0_0_0	
GNS_DEF_90-99_0_0	GNS_DEF_50-70_0_0					
GNS_DEF_>=220_0_0	GNS_DEF_71-89_0_0					
GNS_DEF_50-70_0_0	GNS_DEF_90-99_0_0					
GNS_DEF_10-30_0_0						
SC_Otter<10						
TR1.4	**TR2.4**					
OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all					
SC_Otter<24						
TR1.4	**TR1.6A**	**TR2.4**	**TR2.6A**	**MIS**		
OTB_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all	OTB_CRU_70-99_0_0_all	OTB_CRU_16-31_0_0_all		
SC_Otter>=24						
TR1.4	**TR1.6A**	**TR2.4**	**TR2.7D**			
OTB_DEF_>=120_0_0_all	OTB_DEF_>=120_0_0_all	OTB_CRU_70-99_0_0_all	OTB_CRU_70-99_0_0_all			
SC_Static<10						
GN1.4	**GN1.7D**	**LL1.4**	**LL1.6A**	**pots.4**		
GNS_DEF_all_0_0_all	GNS_DEF_all_0_0_all	LLS_FIF_0_0_0_all	LLS_FIF_0_0_0_all	FPO_CRU_0_0_0_all		

SW_Otter				
TR1.4	**TR2.3AN**	**TR2_grid.3AN**	**OTB32-69.4**	**OTB32-69.3AN**
OTB_DEF_>=120_0_0_all	OTB_CRU_90-119_0_0_all	OTB_CRU_70-89_2_35_all	OTB_CRU_32-69_0_0_all	OTB_CRU_32-69_0_0_all OTB_CRU_32-69_2_22_all

Annex 7: EU request for a technical service on unavoidable bycatches in various Baltic fisheries

Unavoidable bycatches in various Baltic fisheries

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Introduction

ICES received a special request for advice from the European Commission, DGMARE, on unavoidable bycatches in various Baltic fisheries. This report addresses the first point of the request where:

1. *ICES is requested to assess if in the Baltic Sea sprat fisheries can be operated without any bycatches of herring (depending on the fishing area respectively bycatches of western herring, central herring and Bothnian herring), and if flatfish fisheries can be operated without any bycatches of cod.*

Data

To capture the diversity of fishing activity and describe technical interactions in the pelagic and demersal fisheries in the Baltic Sea and part of the Greater North Sea (subdivisions 20–32), we aimed to use data which units are consistent with DCF métier level 6 (2010/93/EU Appendix IV). Following ICES data calls, currently countries submitting data for Baltic Fisheries Assessment Working Group (WGBFAS) are reporting catch and effort using relatively high-level métier codes (i.e. "active," "passive") rather than level 6 métier codes. To accommodate the data needs, alternative data sources were explored. It has been previously discussed in the WGMIXFISH-METHODS (ICES, 2023a) meeting that RDBES could be a good alternative data source for exploring technical interactions, especially when the data call for WGBFAS will be superseded by the RDBES in a few years. In 2023 WGMIXFISH-ADVICE (ICES, 2023b) meeting the latest RDBES landings data were compared with official landings data reported by governmental statistical offices[2]. Some discrepancies were found; however, it was agreed based on this analysis that the data are robust enough to provide initial description of the technical interactions of the species/stocks relevant to this request in the Baltic Sea.

Therefore, technical interactions were analysed using the RDBES 2022 landings data which were submitted in 2023 September in response to the RDBES data call[3]. In the RDBES data call landings are not reported by stock but by species. The first step was to distribute landings to stocks, this was done based on the ICES Subdivision border only. Such an approach disregards mixing of stocks in some subdivisions, however, overlooking such details will not confound the detection of overall technical interactions. 19 stocks were defined for the Baltic Sea (subdivisions 20–32):

- *cod-2532* - cod in subdivisions 25–32.
- *her-2529+32(-GOR)* – herring in subdivisions 25–27, 28.2, 29, 32.
- *bzq-26+28* - flounder in subdivisions 26 and 28.

[2] https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx

[3] https://ices-library.figshare.com/articles/report/RDBES_Data_call_2023_Fisheries_data_for_the_RDBES_system/23623179

- *tur-2232* - turbot in subdivisions 22–32.
- *spr-2232* – Baltic sprat in subdivisions 22–32.
- *cod-2224* – cod in subdivisions 22–24.
- *fle-2223* – flounder in subdivisions 22–23.
- *bzq-2425* – flounder in subdivisions 24–25.
- *ple-2432* - plaice in subdivisions 24–32.
- *her-2024* – herring in subdivisions 20–24.
- *dab-2232* - dab in subdivisions 22–32.
- *ple-2123* – plaice in subdivisions 21–23.
- *bll-2232* – brill in subdivisions 22–32.
- *sol-2024* – sole in subdivisions 20–24.
- *her-3031* - herring in subdivisions 30–31.
- *bwp-27+2932* – flounder in subdivisions 27, 29–32.
- *her-28* – herring in Gulf of Riga (subdivision 28.1)
- *ns-cod* – cod in subdivision 20 (part of larger North Sea cod stock)
- *kat-cod* – cod in subdivision 21 (Kattegat cod)

All other species/stocks were grouped together as 'OTH'.

Adjustments to vessel length categories were made compared to what was submitted to RDBES. All vessels below 12 meters were grouped together and defined as "< 12 m", vessels from 12–18 meters were grouped together as "12–18 m"; other vessel length categories were kept the same ("18–24 m", 24–40 m",">40 m"). When considering the pelagic fishery in central Baltic (SDs 25–29 +32 (excluding Gulf of Riga, SD28.1)) we aimed to reduce the number of level 6 métiers of passive gears, as the pelagic fishery mainly operates with trawlers. Passive gears such as FYK, GNS, FPN, FPO, GTR were grouped together and defined as 'passive'. When investigating Gulf of Bothnia pelagic fishery and Baltic demersal fishery, such passive gear groupings were not made.

Mixed fisheries models developed in the WGMIXFISH group (ICES, 2023a, 2023b) have defined fleets by country, gear group and vessel length category, and métiers are defined by gear, target species, and areas. In this analysis we have not strictly followed the same criteria. Our current approach was to look landings composition by métier level 6 in combination with vessel length class and country. This approach allowed to have a rather detailed overview of landings composition and technical interactions.

Methods

To describe the technical interaction in the pelagic fisheries in central Baltic area, landings data from subdivisions 25–28.2, 29 + 32 were used. As herring and sprat are the main pelagic species caught in this area, and the main species of interest, we defined the pelagic fisheries by métiers (métier level 6 + vessel length class) which contributed at least 0.5% to total landings of either central Baltic herring (CBH) or sprat stock in this area. The comparison of all métiers which have caught herring or sprat compared to métiers above the 0.5% threshold are shown in Figure A7.1 and A7.2. Further analyses were conducted using only data from métiers which exceeded the 0.5% threshold (23 unique métiers, Table A7.1).

To describe the technical interactions in the pelagic fisheries in Gulf of Bothnia, landings data from SDs 30–31 were used. The pelagic fisheries were defined by métiers (métier level 6 + vessel length class) which had landed either herring or sprat (31 unique métiers). Métiers which had over 90% of 'OTH' landings were excluded.

To describe the technical interactions in the demersal fisheries catching western Baltic cod (WBC), landings data from SDs 22–24 were used. The mixing of WBC and eastern Baltic cod (EBC) in subdivision 24 is disregarded, and all cod landings in SD24 are allocated to WBC stock.

The demersal fishery was defined by métiers (métier level 6 + vessel length class) which had caught either of the following 9 stocks: "tur-2232","cod-2224", "fle-2223", "bzq-2425","ple-2432","dab-2232","ple-2123", "bll-2232", "sol-2024". This amounted to 84 métiers, of which 59 had caught cod. First, we aimed to describe specific métier contribution to cod landings, however, as there is in total 59 métiers which have caught cod, we grouped together métiers which had low contribution to total cod catches and named them 'MIS'. The threshold percentage was taken as 1%, as through visual inspection this led to optimal solution, considering that the total cod landings is very low.

For technical interaction exploration 1% threshold was not applied, however we excluded métier + country combinations which had over 80% of 'OTH' landings.

To describe the technical interactions in the demersal fisheries catching eastern Baltic cod, landings data from SDs 25–32 were used. The demersal fishery was defined by métiers (métier level 6 + vessel length class) which had caught either of the following 8 stocks: "tur-2232", "bzq-2425","bzq-26+28","ple-2432","dab-2232","bll-2232","cod-2532","bwp-27+2932". This amounted to 80 métiers, of which 54 had caught cod (Table A7.4). When specifically describing métier contributions to cod landings, métiers which had low contribution to total cod landings were grouped together and named 'MIS'. Here the threshold percentage was taken as 0.5%, as this led to optimal solution. For technical interaction exploration 0.5% threshold was not applied, however, we excluded métier + country combinations which had over 80% of 'OTH' or pelagic species (herring, sprat) landings.

Results

Central Baltic pelagic fisheries

Métier landings composition is shown in Figure A7.3. In overall, the pelagic fishery is rather selective catching mostly herring and sprat. Small catches of flounder are reported with pelagic trawls (i.e. by Poland, Germany). More mixing is happening when considering passive gears, however, when passive gears are deployed targeting herring during the spawning time then the landings can be considered rather clean.

Sweden – Pelagic pair trawl (PTM) fishery with small mesh size (16–31 mm) is directed towards catching sprat with minor herring bycatch, while PTM fishery with larger mesh size (32–89 mm) is directed towards catching herring with low sprat bycatches. Landings from the midwater otter trawl fishery (OTM) and small mesh size (16–31 mm) can be variable; sprat landings can constitute 60–90% of total landings of a métier, while with larger mesh size (32–89 mm) herring landings dominate, except for OTM vessels > 40 meters. Pelagic fishery with bottom otter trawl (OTB) is also a mixture of herring and sprat.

Poland – Fishery with pelagic pair trawl (PTM) with small mesh size (16–31 mm) corresponds to sprat directed fishery with around 20% of herring bycatch. Midwater otter trawl (OTM) fishery with large mesh size (32–89 mm) corresponds to herring directed fishery with up to 20% sprat bycatch, while using small mesh size (16–31 mm) leads to sprat directed fishery with around 20% herring bycatch rate.

Latvia – Fishery with midwater otter trawl (OTM) using small mesh size (16–31 mm) indicates sprat directed fishery with small amounts of herring bycatch (10%), and usage of larger mesh size (32–89 mm) leads to larger herring catches (80% herring, 20% sprat).

Lithuania – Fishery conducted with large vessels (24–40 meters) using midwater otter trawl (OTM) with large mesh size (32–89 mm) catches mostly herring (90%), while vessels in size category 18–24 meters target more sprat (75%) and less herring (25%). Usage of smaller mesh size (16–31 mm) indicates a sprat directed fishery.

Finland - Proportions of herring and sprat in fishery with pelagic pair trawl (PTM) with small mesh size (16–31 mm) are dependent on the vessels size, with decreasing vessel size class the herring proportions in the landings increase. Overall, there seems to be high mixing of herring and sprat. Similar trend in also seen in fishery using midwater otter trawl (OTM mm) gear.

Estonia – Fishery with midwater otter trawl (OTM) gear corresponds to around 80% sprat and 20% herring landings.

Denmark – In the pelagic pair trawl (PTM), midwater otter trawl (OTM) and bottom otter trawl (OTB) fisheries, sprat landings dominate and 10–15% landing consist of herring.

Germany – In the midwater otter trawl (OTM) and bottom otter trawl (OTB) fishery sprat landings dominate with 5% of landings being herring bycatch.

As was seen from this analysis, the level of mixing of herring and sprat in landings can be variable, although when using small mesh size (16–31 mm) cleaner sprat landings can be achieved. However, the picture of herring and sprat mixing is affected by the country's quota shares in herring and sprat stock. In Table A7.2 each country's 2022 final quota for Baltic sprat and Central Baltic herring stock are shown. These are the final quotas after the quota swaps between countries. Comparing country-specific quotas and fishing patterns, it can be seen that countries which rely mostly on sprat quota have clean sprat fishery with low levels on herring as bycatch. While countries which in proportion have larger CBH quotas show more mixing of herring and sprat catches by métier (e.g. Finland and Sweden). In addition, as CBH TAC has been decreasing while in comparison sprat TAC has been rather stable, implying that fishers need to be able to adapt to have clean(er) sprat fishery to accommodate this change. For example, Sweden used to have almost equal amount of CBH and sprat quotas (in tonnage) while in 2022 CBH quota was only 1/3 of the sprat quota.

However, caution is called upon, as species misreporting of herring and sprat has occurred in the past, and there is evidence that this is an ongoing problem (ICES, 2023c). The prevalence of species misreporting can distort the description of the fisheries behaviour and technical interaction shown in Figure A7.3.

Gulf of Bothnia pelagic fishery

Based on RDBES 2022 data sprat landings in SD30–31 were 2176 tonnes, sprat EU landings are 258 616 tonnes, meaning that sprat landings in SD30–31 make up to less than 1% of total EU sprat landings. Pelagic fisheries landing composition in SD30–31 are shown in Figure A7.4, conforming that sprat landings in Gulf of Bothnia are incidental bycatch. Sprat landings in Gulf of Bothnia are dependent on the migration of sprat into the gulf which varies in years. There is no sprat directed fisheries in Gulf of Bothnia.

Herring fishery in SDs 22–24

Western Baltic spring-spawning (WBSS) herring catches are disaggregated in different fleets based on assumptions which deviate from the definition of those flees for management purposes (based on TAC settings; ICES, 2023d; ICES, 2023e). Herring catches from SDs 22–24 are considered as 'Fleet F' in the WBSS herring stock assessment and assumed to be taken in a directed fishery for herring, with only a few as bycatch in a directed sprat fishery (ICES, 2023e).

Demersal fishery in SDs 22–24

Based on RDBES 2022 data cod landings in subdivisions 22–24 were 122 tonnes, which is less than the ICES estimated value of 136 tonnes (ICES, 2023f). This number includes landings of western Baltic cod stock as well as of the eastern Baltic cod stock in SD24. In SDs 22–24 cod was landed in total with 59 different métiers (Table A7.3). From there, 14 métiers contributed at least 1% to the total landings (Figure A7.5, Table A7.3), making up 95% of total cod landings. Main

cod landings come from using OTB and gillnets (GNS) targeting demersal species. In Figures 6 demersal fisheries landings composition by country and métier are shown. There are four countries fishing cod in SDs 22–24: Denmark, Germany, Poland, and Sweden. Largest landings are by Denmark (~50%), then Germany and Poland (~20% each of the two countries) and Sweden (~10%). Cod is caught in a mixture of other species. Bottom otter trawls (OTB) catch cod together with plaice, flounder, and dab. Gillnet fishery catches cod in addition to plaice, flounder, dab, brill and turbot, and in Denmark also sole is caught together with cod with gillnets.

Demersal fishery in SDs 25–32

Based on RDBES 2022 data cod landings by EU countries in subdivisions 25–32 were 200 tonnes, which closely matches to the ICES estimated value (ICES, 2023g). In SDs 25–32 cod was landed in total with 54 different métiers (Table A7.4). From there, 12 métiers contributed at least 0.5% to the total landings (Figure A7.7, Table A7.4) and constituted 97% of total cod landings in SDs 25–32. Similar to western Baltic area (SDs 22–24) cod is mainly caught with bottom otter trawls (OTB) and gillnets (GNS) targeting demersal species (Figure A7.7). In Figure A7.8 the landings composition of the demersal fishery in SDs 25–32 are shown. Half of the cod landings come from Poland, while Sweden, Germany and Finland combined make up the second half of the catches. Cod is caught together mainly with flounder and plaice; the exception seems to be the Finnish gillnet fishery with large mesh size which has pure cod catches.

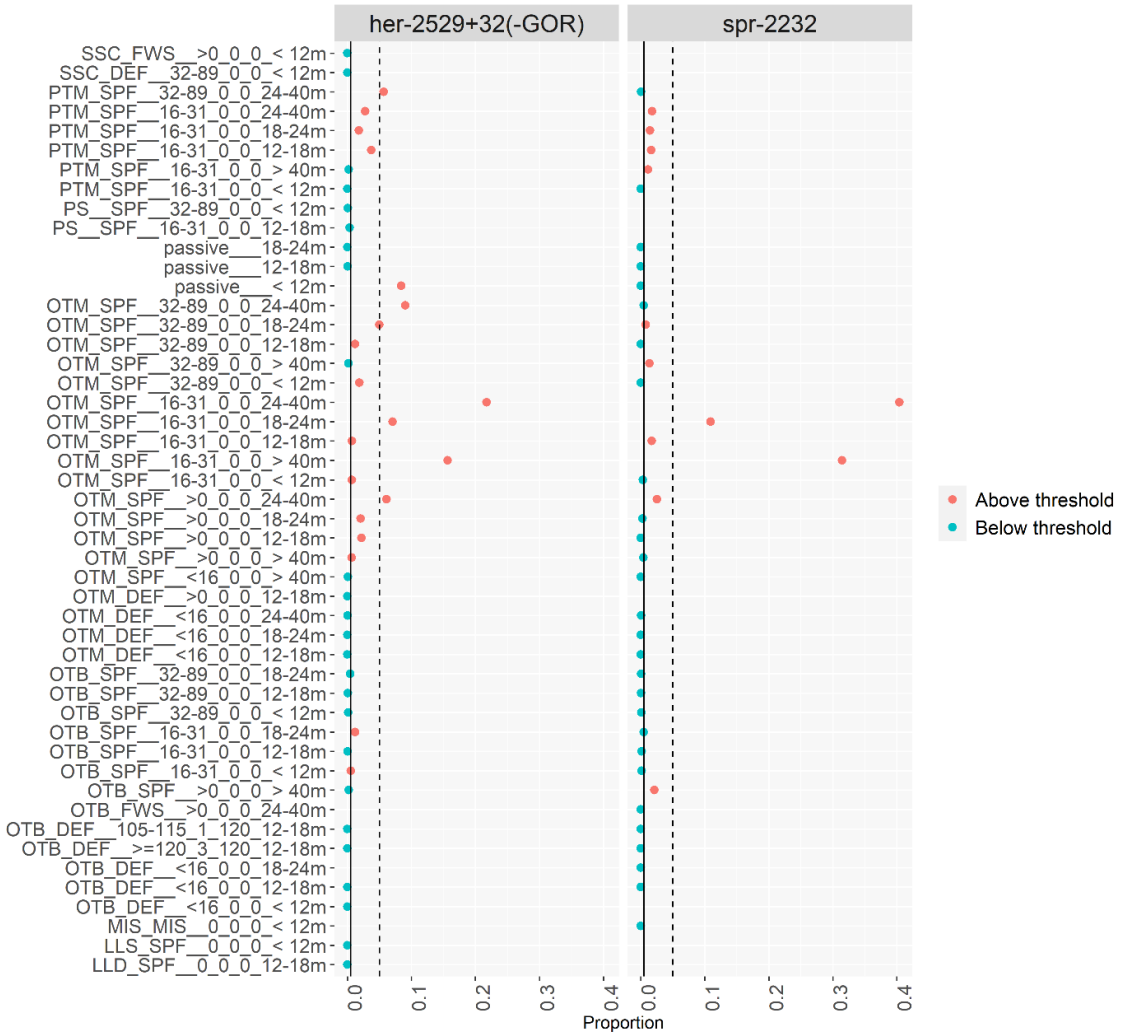

Figure A7.1. All métiers which have caught either herring or sprat in subdivisions 25–28.2,29+32. Above threshold (red) points shows métier which have contributed at least 0.5% of total stock landings. Below threshold (blue) points show

métiers which have contributed <0.5% of total stock landings. Solid black vertical line indicates the 0.5% threshold and black dashed line indicates 5% of landings in weight. Based on RDBES 2022 landings data.

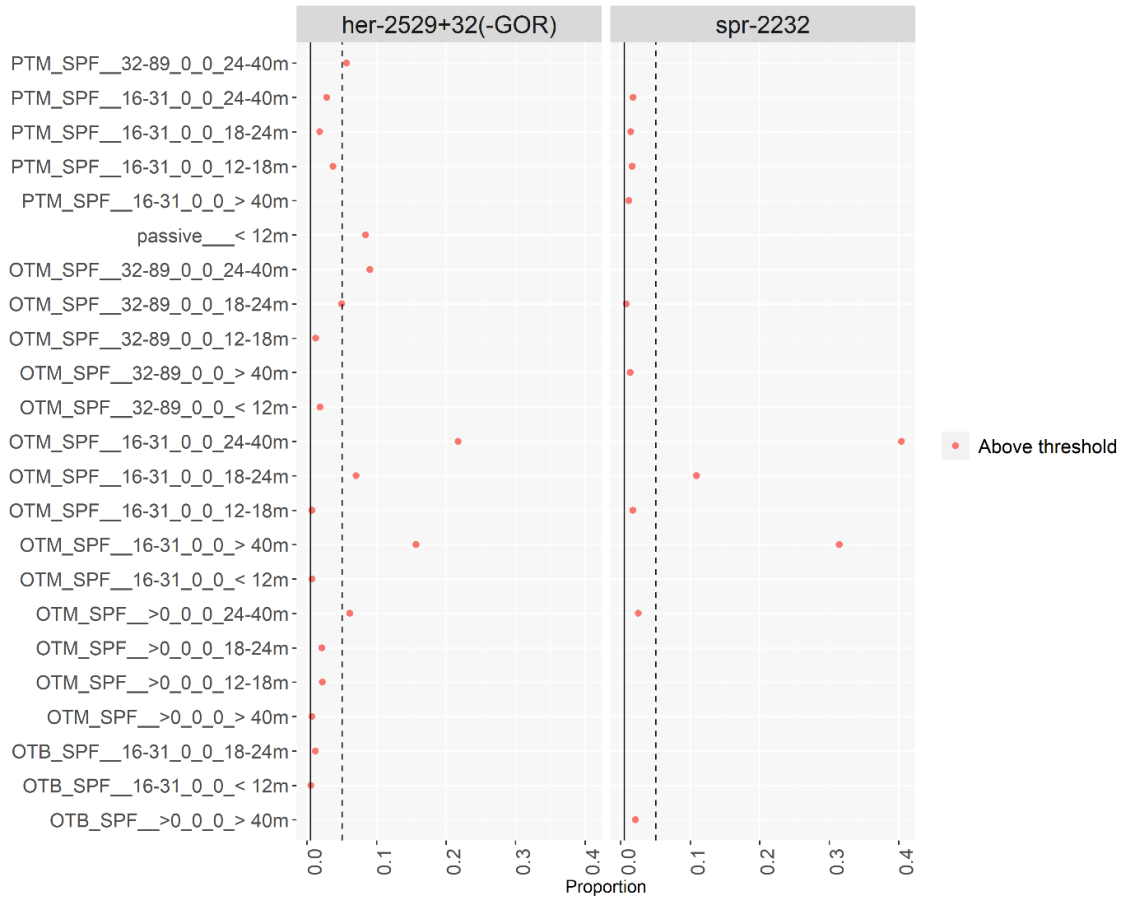

Figure A7.2. Excerpt from Figure 1. Showing on métiers which are considered above the 0.5% threshold. Solid black vertical line indicates the 0.5% threshold and black dashed line indicates 5% of the landings in weight. Based on RDBES 2022 landings data.

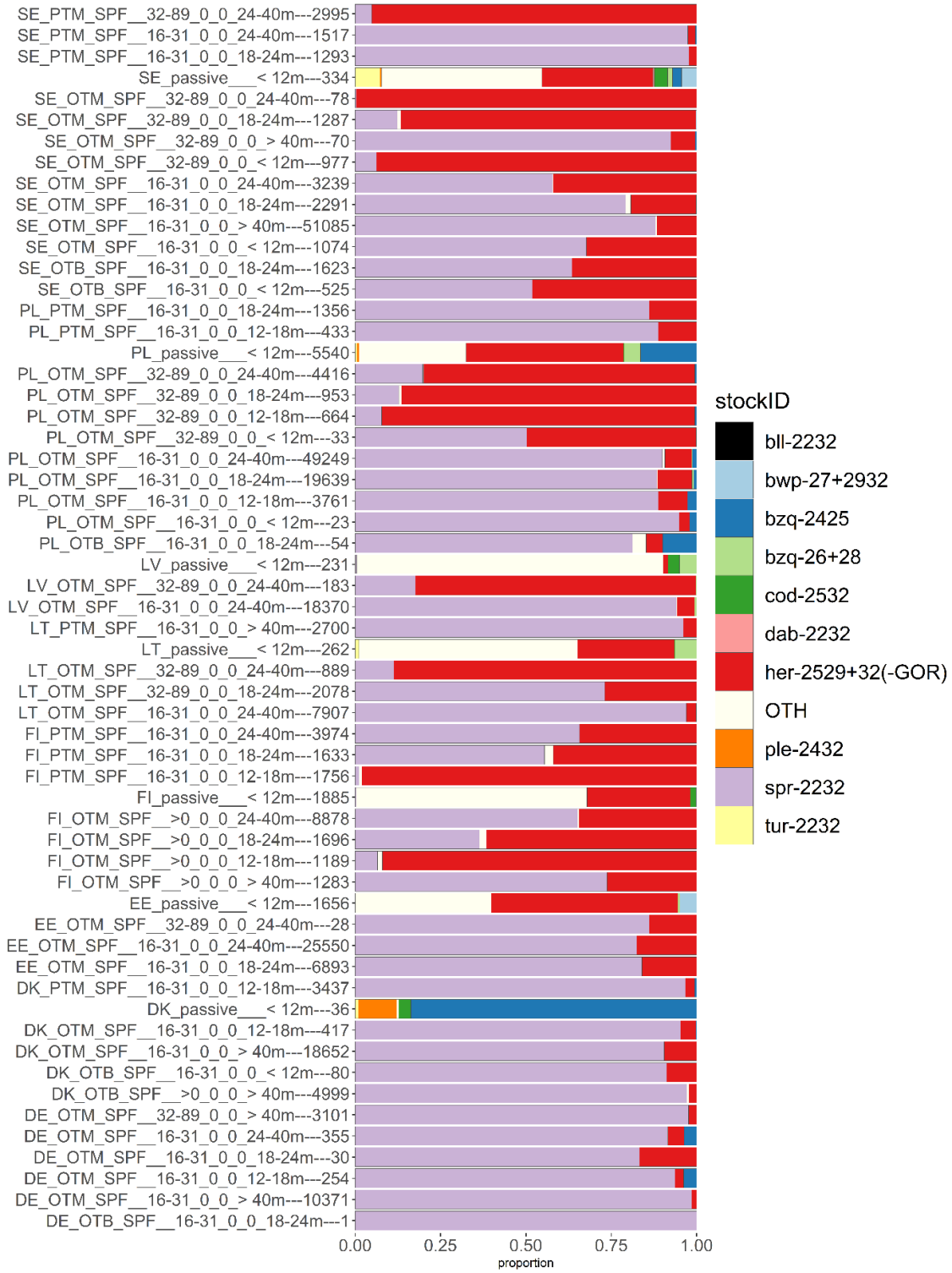

Figure A7.3. Landings composition of pelagic fishery in subdivisions 25–28.2,29+32. *Y*-axis label includes country code[4] + métier[5] + vessel length class + total landings (in tonnes). Based on 2022 RDBES data.

[4] https://vocab.ices.dk/?ref=337

[5] https://vocab.ices.dk/?ref=1498 and https://vocab.ices.dk/?ref=1499

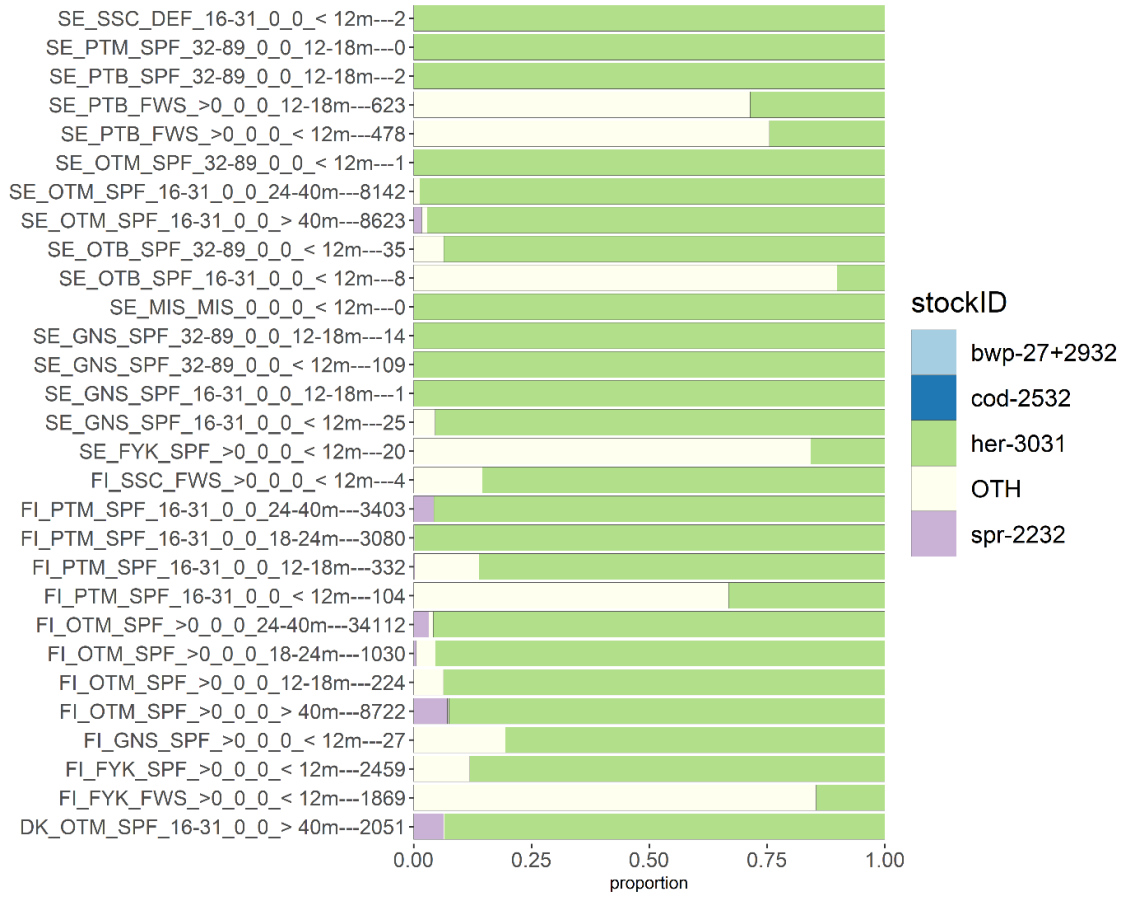

Figure 4. Landings composition of pelagic fishery in subdivisions 30–31. *Y*-axis label includes country code[6] + métier[7] + vessel length class + total landings (in tonnes; landings <0.5 tonnes appear as 0). Based on 2022 RDBES data.

[6] https://vocab.ices.dk/?ref=337

[7] https://vocab.ices.dk/?ref=1498 and https://vocab.ices.dk/?ref=1499

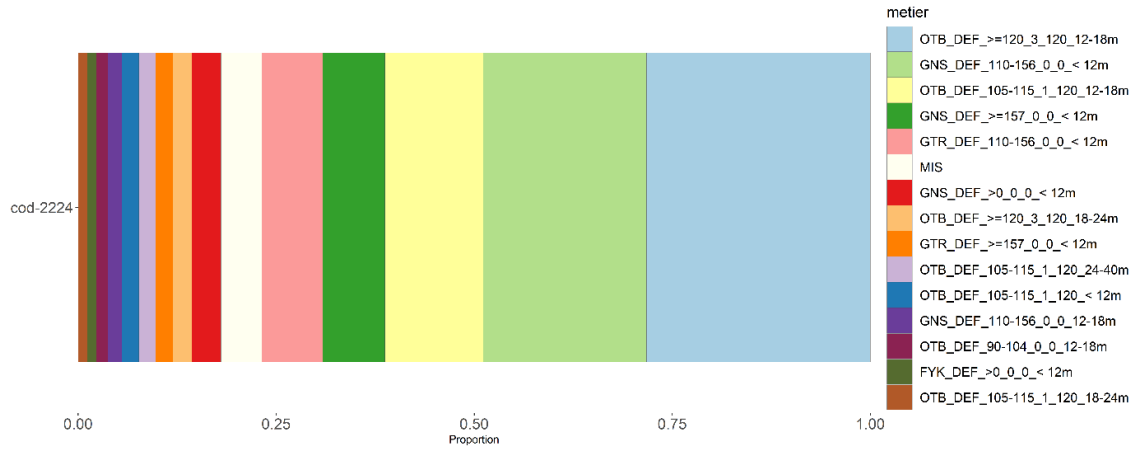

Figure A7.5. Cod landings in subdivision 22–24 in 2022 by métier. MIS=métiers which contributed <1% to total cod landings in weight. Based on RDBES 2022 data.

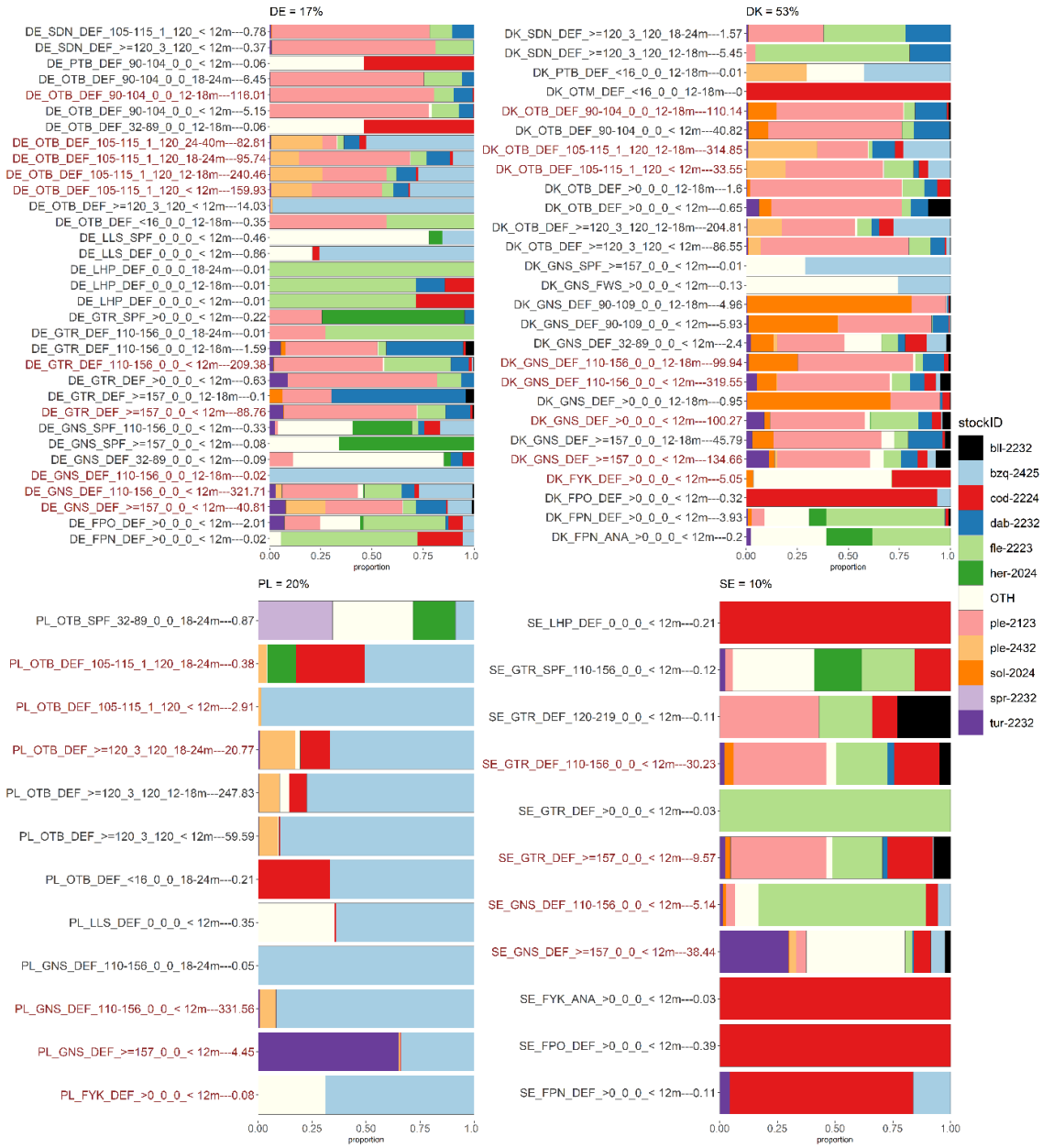

Figure A7.6. Landings composition of demersal fishery in subdivisions 22–24. *Y*-axis label includes country code[8] + métier[9] + vessel length class + total landings (in tonnes; landings < 0.01 tonnes appear as 0). *Y*-axis labels coloured red show métiers which have contributed >1% of total cod landings in tonnes (Table A7.3). Based on 2022 RDBES data. Pelagic species landings were excluded.

[8] https://vocab.ices.dk/?ref=337

[9] https://vocab.ices.dk/?ref=1498 and https://vocab.ices.dk/?ref=1499

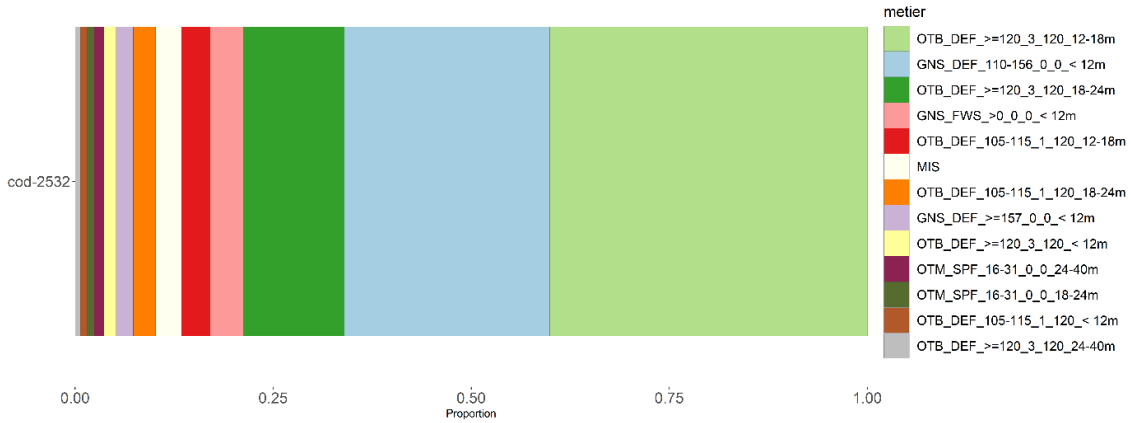

Figure A7.7. Cod landings in subdivision 25–32 in 2022 by métier. MIS=métiers which contributed <0.5% to total cod landings in tonnes. Based on RDBES 2022 data.

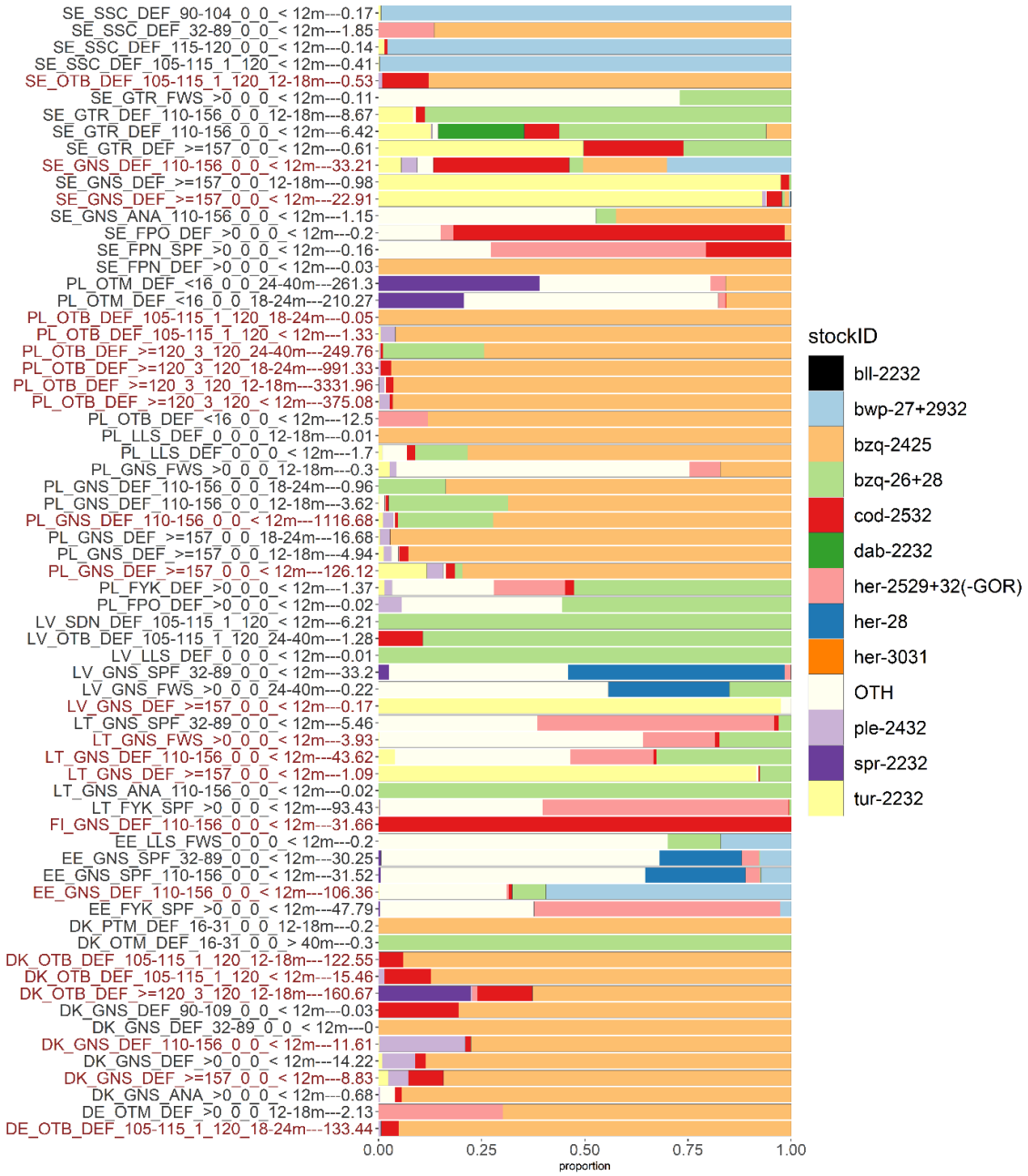

Figure A7.8. Landings composition of demersal fishery in subdivisions 25–32. *Y*-axis label includes country code[10] + métier[11] + vessel length class + total landings (in tonnes). *Y*-axis labels in red indicate métiers which have contributed at least 0.5% to total cod landings in tonnes (Table A7.4). Based on 2022 RDBES data. Pelagic species landings were excluded.

[10] https://vocab.ices.dk/?ref=337

[11] https://vocab.ices.dk/?ref=1498 and https://vocab.ices.dk/?ref=1499

Table A7.1. All métiers (48) which have caught either herring or sprat in subdivisions 25–28.2,29+32. Métiers which have contributed et least 0.5% to total stock landings in weight are marked in yellow (23 métiers). Based on RDBES 2022 landings data.

Métier	Contribution to herring landings (%)	Contribution to sprat landings (%)
LLD_SPF__0_0_0_12-18m	0.00%	
LLS_SPF__0_0_0_< 12m	0.00%	
MIS_MIS__0_0_0_< 12m		0.00%
OTB_DEF__<16_0_0_< 12m	0.00%	
OTB_DEF__<16_0_0_12-18m	0.00%	0.00%
OTB_DEF__<16_0_0_18-24m		0.00%
OTB_DEF__>=120_3_120_12-18m	0.01%	0.02%
OTB_DEF__105-115_1_120_12-18m	0.00%	0.00%
OTB_FWS__>0_0_0_24-40m		0.00%
OTB_SPF__>0_0_0_> 40m	0.23%	2.12%
OTB_SPF__16-31_0_0_< 12m	0.52%	0.15%
OTB_SPF__16-31_0_0_12-18m	0.04%	0.14%
OTB_SPF__16-31_0_0_18-24m	1.19%	0.47%
OTB_SPF__32-89_0_0_< 12m	0.13%	0.10%
OTB_SPF__32-89_0_0_12-18m	0.06%	0.06%
OTB_SPF__32-89_0_0_18-24m	0.44%	0.05%
OTM_DEF__<16_0_0_12-18m	0.01%	0.00%
OTM_DEF__<16_0_0_18-24m	0.01%	0.02%
OTM_DEF__<16_0_0_24-40m	0.02%	0.04%
OTM_DEF__>0_0_0_12-18m	0.00%	
OTM_SPF__<16_0_0_> 40m	0.09%	0.03%
OTM_SPF__>0_0_0_> 40m	0.67%	0.41%
OTM_SPF__>0_0_0_12-18m	2.18%	0.03%
OTM_SPF__>0_0_0_18-24m	2.08%	0.27%
OTM_SPF__>0_0_0_24-40m	6.11%	2.53%
OTM_SPF__16-31_0_0_< 12m	0.69%	0.33%
OTM_SPF__16-31_0_0_> 40m	15.67%	31.46%
OTM_SPF__16-31_0_0_12-18m	0.69%	1.74%
OTM_SPF__16-31_0_0_18-24m	7.04%	10.92%
OTM_SPF__16-31_0_0_24-40m	21.75%	40.40%
OTM_SPF__32-89_0_0_< 12m	1.86%	0.03%
OTM_SPF__32-89_0_0_> 40m	0.16%	1.35%
OTM_SPF__32-89_0_0_12-18m	1.21%	0.02%
OTM_SPF__32-89_0_0_18-24m	4.98%	0.79%
OTM_SPF__32-89_0_0_24-40m	9.04%	0.45%
passive___< 12m	8.42%	0.00%
passive___12-18m	0.03%	0.00%
passive___18-24m	0.00%	0.00%
PS__SPF__16-31_0_0_12-18m	0.34%	
PS__SPF__32-89_0_0_< 12m	0.09%	
PTM_SPF__16-31_0_0_< 12m	0.00%	0.00%
PTM_SPF__16-31_0_0_> 40m	0.21%	1.13%

Métier	Contribution to herring landings (%)	Contribution to sprat landings (%)
PTM_SPF__16-31_0_0_12-18m	3.72%	1.63%
PTM_SPF__16-31_0_0_18-24m	1.80%	1.46%
PTM_SPF__16-31_0_0_24-40m	2.79%	1.79%
PTM_SPF__32-89_0_0_24-40m	5.68%	0.06%
SSC_DEF__32-89_0_0_< 12m	0.00%	
SSC_FWS__>0_0_0_< 12m	0.01%	

Table A7.2. Final Baltic sprat and Central Baltic herring (CBH) quotas (in tonnes) for 2022 by country. Final quotas include quota swaps between countries. Information from FIDES system.

Year	Country	Baltic sprat	Central Baltic herring	Sprat % from total combined TAC (Baltic sprat + CBH)
2022	DE	15714	279	98%
2022	DK	28772	2371	92%
2022	EE	28737	7857	79%
2022	FI	13260	10719	55%
2022	LT	12212	1919	86%
2022	LV	31771	3640	90%
2022	PL	73188	17554	81%
2022	SE	53487	16198	77%

Table A7.3. All métiers (59) which have caught cod in subdivisions 22–24. Métiers which have contributed et least 1% to total cod landings in weight in SDs 22–24 are marked in yellow (14 métiers). Based on RDBES 2022 landings data.

FPN_CAT_>0_0_0_< 12m	GNS_DEF_32-89_0_0_< 12m	OTB_DEF_>=120_3_120_12-18m
FPN_DEF_>0_0_0_< 12m	GNS_DEF_90-109_0_0_< 12m	OTB_DEF_>=120_3_120_18-24m
FPN_SPF_>0_0_0_< 12m	GNS_DEF_90-109_0_0_12-18m	OTB_DEF_>0_0_0_12-18m
FPO_CAT_>0_0_0_< 12m	GNS_FWS_>0_0_0_< 12m	OTB_DEF_105-115_1_120_< 12m
FPO_CRU_>0_0_0_< 12m	GNS_SPF_>0_0_0_< 12m	OTB_DEF_105-115_1_120_12-18m
FPO_DEF_>0_0_0_< 12m	GNS_SPF_110-156_0_0_< 12m	OTB_DEF_105-115_1_120_18-24m
FYK_ANA_>0_0_0_< 12m	GNS_SPF_32-89_0_0_< 12m	OTB_DEF_105-115_1_120_24-40m
FYK_CAT_>0_0_0_< 12m	GTR_DEF_>=157_0_0_< 12m	OTB_DEF_32-89_0_0_12-18m
FYK_DEF_>0_0_0_< 12m	GTR_DEF_110-156_0_0_< 12m	OTB_DEF_90-104_0_0_< 12m
GNS_ANA_>=157_0_0_< 12m	GTR_DEF_110-156_0_0_12-18m	OTB_DEF_90-104_0_0_12-18m
GNS_ANA_>0_0_0_< 12m	GTR_DEF_120-219_0_0_< 12m	OTB_FWS_>0_0_0_< 12m
GNS_ANA_110-156_0_0_< 12m	GTR_SPF_110-156_0_0_< 12m	OTB_FWS_>0_0_0_18-24m
GNS_CAT_>0_0_0_< 12m	GTR_SPF_32-89_0_0_< 12m	OTM_DEF_<16_0_0_12-18m
GNS_CRU_>0_0_0_< 12m	LHP_DEF_0_0_0_< 12m	OTM_SPF_16-31_0_0_12-18m
GNS_DEF_>=157_0_0_< 12m	LHP_DEF_0_0_0_12-18m	OTM_SPF_16-31_0_0_18-24m
GNS_DEF_>=157_0_0_12-18m	LLS_CAT_0_0_0_< 12m	OTM_SPF_16-31_0_0_24-40m
GNS_DEF_>0_0_0_< 12m	LLS_DEF_0_0_0_< 12m	PTB_DEF_90-104_0_0_< 12m
GNS_DEF_>0_0_0_12-18m	LLS_FWS_0_0_0_< 12m	PTB_FWS_>0_0_0_< 12m
GNS_DEF_110-156_0_0_< 12m	OTB_DEF_<16_0_0_18-24m	PTB_FWS_>0_0_0_12-18m
GNS_DEF_110-156_0_0_12-18m	OTB_DEF_>=120_3_120_< 12m	

Table A7.4. All métiers (54) which have caught cod in subdivisions 25–32. Métiers which have contributed et least 0.5% to total cod landings in weight in SDs25–232 are marked in yellow (12 métiers). Based on RDBES 2022 landings data.

OTM_SPF_16-31_0_0_24-40m	FYK_DEF_>0_0_0_< 12m	OTB_DEF_105-115_1_120_< 12m
OTM_SPF_16-31_0_0_18-24m	OTB_DEF_>=120_3_120_< 12m	GNS_DEF_90-109_0_0_< 12m
OTM_SPF_32-89_0_0_24-40m	GNS_DEF_110-156_0_0_12-18m	OTM_SPF_16-31_0_0_> 40m
GNS_DEF_110-156_0_0_< 12m	OTM_SPF_16-31_0_0_12-18m	PTM_SPF_16-31_0_0_12-18m
GNS_FWS_>0_0_0_< 12m	GNS_ANA_>=157_0_0_< 12m	PTM_SPF_16-31_0_0_24-40m
FYK_FWS_>0_0_0_< 12m	LLS_DEF_0_0_0_< 12m	PTM_SPF_16-31_0_0_18-24m
GNS_ANA_110-156_0_0_< 12m	OTM_DEF_<16_0_0_18-24m	FPN_FWS_>0_0_0_< 12m
GNS_SPF_110-156_0_0_< 12m	OTM_SPF_32-89_0_0_12-18m	FPO_DEF_>0_0_0_< 12m
GNS_SPF_32-89_0_0_< 12m	OTM_DEF_<16_0_0_12-18m	OTM_SPF_16-31_0_0_< 12m
GNS_DEF_>=157_0_0_12-18m	OTB_SPF_32-89_0_0_12-18m	FPO_SPF_>0_0_0_< 12m
OTB_DEF_>=120_3_120_12-18m	GNS_DEF_>=157_0_0_18-24m	PTM_SPF_32-89_0_0_24-40m
OTB_DEF_>=120_3_120_18-24m	OTM_SPF_32-89_0_0_< 12m	SSC_DEF_115-120_0_0_< 12m
OTB_DEF_>=120_3_120_24-40m	FPN_SPF_>0_0_0_< 12m	GTR_DEF_110-156_0_0_12-18m
FYK_ANA_>0_0_0_< 12m	OTB_DEF_105-115_1_120_24-40m	FPN_CAT_>0_0_0_< 12m
GNS_ANA_>0_0_0_< 12m	FPO_FWS_>0_0_0_< 12m	GTR_DEF_110-156_0_0_< 12m
OTM_SPF_32-89_0_0_18-24m	GNS_DEF_>0_0_0_< 12m	GTR_DEF_>=157_0_0_< 12m
FYK_SPF_>0_0_0_< 12m	OTB_DEF_105-115_1_120_12-18m	OTB_SPF_32-89_0_0_18-24m
GNS_DEF_>=157_0_0_< 12m	OTB_SPF_16-31_0_0_12-18m	OTB_DEF_105-115_1_120_18-24m

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