WORKING GROUP FOR THE BAY OF BISCAY AND THE IBERIAN WATERS ECOREGION (WGBIE)

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i Executive summary

The ICES Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) hybrid meeting was held in Copenhagen and online from 3 to 11th of May 2023 and was chaired by Ching Villanueva (Fr) and Santiago Cerviño (Sp). The participants included 25 experts from 5 countries: France (FR), Ireland (IE), Portugal (PT), Spain (SP) and the United Kingdom (UK). WGBIE assesses the status of 23 stocks within ICES divisions 3.a to 9.a, mainly across subareas 7, 8, and 9. WGBIE is tasked with conducting assessments of stock status using analytical models, surplus production models or data-limited methods (DLS) to provide catch forecasts and a first draft of the ICES advice for 2024.

All the data requested by ICES had been uploaded to InterCatch ahead of the meeting and did not cause any delay in the assessment process of the WGBIE stocks. All forecasts and assessments are made following the ICES framework for category 1, 2, 3 and 5 stocks (ICES, 2023a).

Three category 5 stocks which include the plaice, pollack and whiting were benchmarked (WKBMSYSPiCT2; ICES, 2023g) during the end of 2022. During this benchmark, none of each stock's specific surplus-production in continuous time model (SPiCT; Pedersen and Berg, 2017) implemented was accepted. However, during this year's meeting, the WGBIE supported the implementation of the ICES framework for category 3 stocks on the pollack (pol.27.89a) and whiting (whg.27.89a) stocks (ICES, 2023a) where the new ICES harvest control rules (HCRs) for categories 2 and 3 stocks (ICES, 2022a) was also applied. Each stock used a stock-specific estimated biomass index and length-based indicators (LBIs) to provide an MSY-based advice which were then submitted for review before the 2023 WGBIE Advice Drafting Group (ADGBBI) meeting.

For the three remaining WGBIE category 5 stocks, the plaice (ple.27.89a) and the southern sea bass (bss.27.8c9a) stocks provided a precautionary approach landings advice for each of the years 2024 and 2025. The northern four-spot megrim (ldb.27.7b-k8abd), on the other hand, provided a precautionary approach catch advice (ICES, 2023a) last year which remains valid for this year (<867 t) and for each of the years 2024 and 2025 (ICES, 2022b).

For the *Nephrops* in Functional Units (FUs) 2324 and 30, the stock assessments will be done in October after the completion of the 2023 UWTV surveys and data integration. Catch advices for the *Nephrops* stocks in FUs 2627 and 25 were provided in 2022 for each of the years 2023 and 2024.

All the other stocks are scheduled for regular advice provision and release in June this year after updates to each of these stocks' information and assessment, except for the northern four-spot megrim and the *Nephorps* in FUs 2627 and 30. After the updates of stock information and the assessment for all the other WGBIE stocks, no advice revision was considered.

Analytical assessments using age-structured models were conducted for the northern and southern stocks of megrim (meg.27.7b–k 8abd and meg.27.8c9a) four-spot megrim in Iberian Waters (ldb.27.8c9a), and sole in the Bay of Biscay (sol.27.8ab). Northern and southern hake (hke.27.3a46–8abd and hke.27.8c9a), northern black-bellied anglerfish stocks (ank.27.78abd), and both white anglerfish stocks (mon.27.78abd and mon.27.8c9a) were assessed using models that allow the use of length-based age-structured data. A surplus-production model was used to assess the southern black-bellied anglerfish (ank.27.8c9a) and the *Nephrops* stocks in FUs 25, 26–27, and 31. An analytical age–length structured model is used for the Bay of Biscay sea bass. Length-based and survey trends-based methods were used to assess southern sole (sol.27.8c9a) and *Nephrops* in FUs 28–29. Length-based and commercial LPUE trends-based methods were used to assess the pollack (pol.27.89a) and whiting (whg.27.89a) during the WGBIE meeting this year for

potential upgrade considerations from category 5 to 3 stocks. Two *Nephrops* stocks (FUs 2324 and 30) are assessed using a bias-corrected UWTV survey abundance method (ICES, 2022b).

Plaice, pollack, whiting were benchmarked this year. Pollack and whiting are proposed to be upgraded to Category 3 stocks, while plaice remains as a Category 5 stock. The Bay of Biscay sea bass (bss.27.8ab), which is a category 1 stock, is undergoing subsequent benchmarks where the stock identification workshop (WKBSEABASSID; ICES, 2023c) was held early 2023 which will be followed up by the data compilation workshop later this year and finally an update assessment workshop which is expected to occur in 2024. The Bay of Biscay sole (sol.27.8ab) will be benchmarked in 2024. WGBIE also proposes a benchmark for the southern anglerfish stocks (ank.27.8c9a and mon.27.8c9a), preferably in 2025.

In 2020, the migration of assessment to TAF (Transparent Assessment Framework) was initiated by ICES on some specific stocks. WGBIE have started this migration with two initial stocks (hke.27.3a46–8abd and sol.27.8ab). There is no new or additional TAF-based assessment model presented this year. WGBIE recognises the value of TAF-based assessments and encourages other WG stock's experts to start and proceed with this migration, especially as a preparative and complementary step towards the imminent implementation of the RDBES-based stock assessments, replacing the InterCatch.

This year, all WGBIE categories 2 and 3 stocks applied the new ICES technical guidelines for harvest control rules (HCRs) and stock assessments (ICES, 2022a; 2023a; e). For category 3 stocks, the application, when possible, of the new '*rfb*' rule (Method 2.1 in ICES, 2022a) which replaced the 2-over-3 rule (ICES, 2012a; 2018a; 2019a) as the basis for the catch scenarios was applied with the exception of the *Nephrops* stock in FUs 2829, which used the previous procedures recommended by WKLIFE X for category 3 stocks on the basis that the advice should be provided with the most complete information (ICES, 2020a).

All the planned Terms of References (ToRs), both generic and specific to WGBIE, were covered.

ii Expert group information

Expert group name	Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE)
Expert group cycle	Annual
Year cycle started	2022
Reporting year in cycle	1/1
Chairs	Ching Villanueva, France
	Santiago Cerviño, Spain
Meeting venues and dates	03–11 May 2023, ICES Headquarters, Copenhagen, Denmark (27 participants)
	28 September 2023, online meeting scheduled for *Nephrops* stocks

1 Introduction

Working Group for the Bay of Biscay and the Iberian Waters Ecoregion

1.1 Stock-by-stock summary

1.1.1 Anglerfish (*Lophius piscatorius and L. budegassa*) in Subarea 7 and divisions 8.a, 8.b, and 8.d

Both species are caught on the same grounds and by the same fleets and are usually not separated by species in the landings. Anglerfish is an important component of mixed fisheries taking hake, megrim, sole, cod, plaice, and *Nephrops*. France contributes to most of the landings for the combined species in this area and has done so since 1990. Since 2011, the landings of both species combined have been above the average of the time-series. The TAC for both species combined was set at 57 967 t for 2023 (EU, 2023) which is very close to the combined catch/landings corresponding to advice for the two species of 61 081 t.

Age determination problems and an increase in the uncertainty in the discard levels have prevented the performance of an analytical assessment since 2007. Since then, the assessments were based on examining commercial LPUEs and survey data (biomass, abundance indices and length distributions from surveys). In 2018, both stocks were benchmarked (WKANGLER; ICES, 2018b) with *Lophius piscatorius* attaining an age-based analytical assessment with reference points and forecast and assessed following the category 1 framework (ICES, 2023a). *L. budegassa*, however, continued with assessing the status of the stock through examination of survey-based trends based on the framework for category 3 stocks until 2021 (ICES, 2021d). At the beginning of 2022, both stocks were benchmarked (WKANGHAKE; ICES, 2023b) and are now analytically assessed as length-based age-structured Stock Synthesis models (SS; Methot Jr. and Wetzel, 2013). *L. piscatorius* remains a category 1 stock while *L. budegassa* was upgraded from a category 3 (ICES, 2021d) to 1 (ICES, 2022d; 2023b).

Both stocks are under the EU multiannual management plan (EU MAP; EU, 2019a). However, there is no agreed shared Management Plan with the UK for this stock and ICES provides advice according to the ICES MSY approach. Catch scenario consistent with the MAP F_{MSY} ranges are provided.

For *L. piscatorius*, the available data indicate that the biomass has been increasing because of the good recruitment observed in 2001, 2004, 2009, 2014 and 2018. The F is calculated as the average annual F for ages 3–15 ($F_{ages\ 3–15}$). In 2022, ICES assessed that $F_{ages\ 3–15}$ of the stock is below F_{MSY}, which has been the case since 2010. The spawning stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}. There is evidence of good recruitment in the more recent years until 2020, which was followed by a considerable decline in 2021.

The assessment for *L. budegassa* excludes Division 7.a as they are only found in very small numbers at the very southern edge of this area. The discarding rate is 16% of the total catch weight, slightly lower than the value estimated in 2022 (ICES, 2022c), but still is a significant change and increase from the 2021 value (ICES, 2021d). The discard rate revision in 2022 is due to a data revision of discards submitted by Ireland in 2020 (ICES, 2022c). A new assessment method was implemented during the WKANGHAKE (ICES, 2023b) for this stock. New reference points were also estimated. Like *L. piscatorius*, this stock is now assessed using the SS framework (Methot Jr. and Wetzel, 2013) and as a result, it was upgraded to category 1 (ICES, 2023b; e; h). The SS assessment indicates that the biomass has increased and is now at its highest level of the time-series, like that observed using the previous assessment based on combined survey trends (ICES, 2021d). However, recruitment in 2020 increased significantly and is the highest value observed in the whole time-series which was followed by a considerable decline in 2021. The fishing mortality (F), calculated as the average annual F for ages 3–10, ($F_{ages\ 3–10}$) is below F_{MSY} and SSB is above MSY $B_{trigger}$, B_{pa} and B_{lim}.

Although the stocks are assessed separately, they are managed together.

For stock-specific reporting, see section 3.

1.1.2 Anglerfish (*L. piscatorius and L. budegassa*) in divisions 8.c and 9.a

Both species are caught in mixed bottom-trawl and artisanal fisheries using mainly fixed nets. The two species are usually landed together for most commercial categories and they are recorded together in port statistics. Total southern anglerfish landings increased in the early eighties reaching a maximum level in 1986 (9433 t) and 1988 (10 021 t) and decreased after that to a minimum of 1801 t in 2001. In the 2002–2005 period landings increased reaching 4757 t. This period was followed by a gradual decrease in landings which reached, in 2011, less than half of the 2005 amount (2105 t). From 2011 to 2014, landings slightly increased to 3030 t. Annual values then progressively decreased again to 1195 t in 2022, the lowest value recorded in the stocks' historical time-series.

Landings for *L. piscatorius* and *L. budegassa* in 2022 were 574 t and 621 t, respectively. The combined TAC was set at 3868 t for 2022 and 4335 t for 2023 (EU, 2023). The reported landings in 2022 were 31% of the established TAC. Both stocks are included in the EU MAP (EU, 2019a) in Western waters and adjacent waters. Although the stocks are assessed separately, they are managed together.

The two species were benchmarked in 2018 (WKANGLER; ICES 2018b) and are assessed separately using the Surplus Production in Continuous Time model (SPiCT; Pedersen and Berg, 2017), tuned with commercial LPUE series for *L. budegassa* following a category 2 approach (ICES, 2022a) and a length-based age-structured stock synthesis (SS; Methot Jr. and Wetzel, 2013) model following a category 1 approach (ICES, 2018b; 2023a; e; h) for *L. piscatorius*. *L. budegassa* was benchmarked again with SPiCT in WKMSYSPiCT in 2021 (ICES, 2021b) where a thorough evaluation of input data, model settings and diagnostics was performed. Although already assessed with SPiCT, this stock was upgraded from a category 3 to 2 stock (ICES, 2021b; 2022c), with relative reference points and the advice is based on projections performed with the model (ICES, 2022a; 2023e; h).

The biomass of *L. piscatorius* decreased during the 1980s and early 1990s but has progressively increased over the last two decades. The biomass has been estimated to be above the biomass reference point MSY $B_{trigger}$ since 2005. For 2023, spawning-stock biomass (SSB) is above MSY $B_{trigger}$, B_{pa}, and B_{lim}. The F is calculated as the average annual F for ages 3–15. $F_{ages\ 3–15}$ peaked during the late 1980s but has since declined and has been below F_{MSY} since 2010. Recruitment ate age-0 has been relatively low in recent years with a slight increase in 2019 and 2021.

Trends in relative biomass of *L. budegassa* indicate a steady decrease from the beginning of the series until 2002 and an increasing trend was observed since then. For 2023, biomass is above MSY $B_{trigger}$ and B_{lim}. The F is calculated as the average annual F for ages 3–10. $F_{ages\ 3–10}$ remained at high levels between the late 1980s and late 1990s then progressively declined from 2000 onwards. $F_{ages\ 3–10}$ is below F_{MSY} since 2007.

For stock-specific reporting, see section 4.

1.1.3 Megrim (*Lepidorhombus whiffiagonis and L. boscii*) in divisions 7.b–7.k, 8.a, 8.b, and 8.d

Lepidorhombus spp. in divisions 7.b–7.k, 8.a, 8.b, and 8.d is caught in a mixed demersal fishery with anglerfish, hake and *Nephrops.* Both are targeted species and are also considered as valuable bycatch. The two species are landed and recorded together in port statistics. Information from landings is available since 2017 for *L. boscii* which provided a rough proportion for splitting the two species. Before 2017, all landings were assigned as *L. whiffiagonis*.

The highest landings in the time-series were observed in the year 1989 (19 233 t). Since 2013 (16 025 t), landings declined with no constant trend. Landings in 2022 declined to 10 821 t, the lowest in the whole time-series. Discarding of smaller megrim is substantial and also includes individuals above the minimum landing size (MLS) of 20 cm. The discards were variable, between 1966 t (2019) and 6243 t (2004). Discards in 2022 were 2340 t, around historical mean.

The *L. whiffiagonis* was benchmarked early this year (WKMEGRIM, 2023d) and is now assessed using the "assessment for all" framework (a4a; Jardim *et al*., 2015; Millar and Jardim, 2019), replacing the previous Bayesian catch-at-age model (Plummer, 2003) which was used as a full analytical assessment since 2016 until 2021. During the WKMEGRIM benchmark (ICES, 2023d), a thorough evaluation of the input data, model settings and diagnostics was performed. Despite the re-estimation of new reference points and migration to a new assessment model, the overall perception of the stock remains the same (ICES, 2022c; 2023d). Catches, landings and discards data have varied without trend over the time-series, with a slight increase in 2017. Age-1 recruitment has fluctuated without trend over the time-series with 2017 to 2019 giving above-average values followed by a decline in the most recent years. In 2022, recruitment value is 140 647 t, the second lowest in the whole time-series. Biomass has steadily declined to its lowest level in 2006, keeping stable and increasing abruptly since 2017, with the most recent years SSB well above MSY $B_{trigger}$, B_{pa}, and B_{lim}. In 2023, SSB reached 95 559 t, which is the highest in the whole time-series. The average annual F for ages 3–6 ($F_{ages\ 3–6}$) decreased in recent years and is below F_{MSY} since 2019.

Before 2017, *L. boscii* in this area was unassessed. This stock was included in the ICES data call for the first time in 2018 and historical catch data were also requested. The *L. boscii* data on catches, landings, and discards for 2017–2020, were available to WGBIE and official landings are recorded under the combined species of *Lepidorhombus* spp. Data available from surveys did not provide adequate information to assess the status of the stock.

Sampling in 2020 was negatively affected by the COVID-19 pandemic and France could not estimate four-spot megrim catches for this year. LFDs for landings and discards were also not available from all countries due to the difficulty of accessing samples in 2020. For this reason, catches data from 2017 to 2019 are deemed to be the most reliable in the time-series and are used to determine recent average catches. The average discarding rate is around 17%.

Currently, *L. boscii* is classified as a category 5 (ICES, 2023a) data-limited stock (DLS) as only data on catch since 2017 is available with very limited information from surveys. The last advice for this stock under the precautionary approach was provided in 2022 where catches for each of the years 2023, 2024 and 2025 should be no more than 867 t.

ICES provides annual advice for *L. whiffiagonis* whereas the advice for *L. boscii* was provided for the first time in 2021. Catches in 2024 for *L. whiffiagonis* should be no more than 23 303 t when the MSY approach is applied (ICES, 2023a; e; h).

The combined TAC for *L. whiffiagonis* and *L. boscii* was set at 23 459 t for 2023 (EU, 2023).

Although the stocks are assessed separately, they are managed together.

For stock-specific reporting, see section 5.

1.1.4 Megrim (*L. whiffiagonis and L. boscii*) in divisions 8.c and 9.a

Southern megrims, *L. whiffiagonis* and *L. boscii*, are caught in mixed fisheries targeting demersal fishes including hake, anglerfish, and *Nephrops* and are not separated by species in landings. The majority of the catches are taken by Spanish trawlers. Landings of both species combined in 2022 were 954 t of which < 30% corresponds to *L. whiffiagonis*.

Both species were benchmarked in early 2022 during the WKMEGRIM (ICES, 2023d). Both were previously assessed separately, using the Extended Survivor Analysis model (XSA; Shepherd, 1999). Since 2022, the a4a framework (Millar and Jardim, 2019) is implemented as the analytical assessment for these stocks. During the WKMEGRIM benchmark (ICES, 2023d), a thorough evaluation of the input data, model settings and diagnostics was performed. The overall perception of the stocks remains quite similar despite the revision of the reference points for each of the two stocks (ICES, 2022c; 2023a; e; h).

For *L. whiffiagonis*, the assessment indicates that annual $F_{ages\ 2–4}$ (calculated as the average annual F for ages 2–4) has been erratic over time, ranging between 0.1 and 0.5, decreasing progressively since 2020 and is below F_{MSY} since 2020. The SSB values have fluctuated at a low level from 2000–2016 which was followed by a sharp increase since 2018 and is now estimated to be well above MSY $B_{trigger}$. Recruitment values for the stock have been high since 2015. In 2022, recruitment is the second highest for the whole time-series.

For *L. boscii,* the new assessment indicates that SSB decreased gradually from 1990 to 2001, the lowest value in the series, and has increased since then. The 2022 SSB was estimated to be the highest of the series, well above MSY $B_{trigger}$. Recruitment has fluctuated between 20 and 80 mill ions. Top values were observed during the years 2014–2016 then decreased afterwards to low values from 2020 to 2022. Estimates of $F_{ages\ 2–4}$ values show two different periods: an initial period with values around 0.5 from 1989 to 1995 followed by a second period with an oscillating but overall decreasing trend. $F_{ages\ 2–4}$ has declined more sharply since 2016 and has been below F_{MSY} since 2017, with the lowest values in the whole time-series estimated during the last three years.

The agreed combined TAC for megrim and four-spot megrim in ICES divisions 8.c and 9.a was set at 2445 and 3250 t (EU, 2023) in 2022 and 2023, respectively. Management of catches of the two megrim species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. Both stocks are included in the EU MAP for stocks in the Western waters and adjacent waters (EU, 2019a). A minimum conservation reference size (MCRS) set at 20 cm in this area was issued for this stock (EU, 2019b).

For stock-specific reporting, see section 6.

1.1.5 Sole in divisions 8.a and 8.b

The Bay of Biscay sole is caught in ICES divisions 8.a and 8.b. The fishery has two main components: one is a French gillnet fishery directed at sole (about two-thirds of total catch) and the other one is a trawl fishery (French otter or twin trawlers and Belgian beam trawlers). This is a category 1 stock (ICES, 2023a) assessed using an age-based Extended Survivor Analysis (XSA) model (Shepherd, 1999). The TAC was set at 2233 and 2685 t (EU, 2023) for 2022 and 2023, respectively. Landings show a declining trend since 1994 (7229 t) reaching 2306 t in 2022, the historical minimum value for this stock.

The 2022 ORHAGO survey was not used in this year's assessment because half of the hauls were missing due to bad weather conditions (ICES, 2023i). Details on this issue's impact to and proposed resolutions based on additional analyses to support WGBIE decisions on how to proceed with the assessment and advice of this stock are provided in subsection 1.3 of this chapter, section 7 and by Lecomte, 2023 (WD 1 in this report; ICES, 2023h). Discards are not included in the assessment as these are considered to be negligible for the ages included in the assessment, which starts at age 2.

The F is calculated as the average annual F for ages 3–6. Since 1986, $F_{ages\ 3–6}$ has gradually increased, peaking in 2002 (~0.8, highest value of the whole time-series) and decreasing substantially afterwards to 0.26 in 2022, the lowest value for the whole time-series. The SSB trend in earlier years increased from 1984 to a high value in 1993 (~16 000 t) showing afterwards a continuous decrease until 2003 (9559 t), the lowest value of the series. After this drop, SSB showed an increase and fluctuated around and above MSY $B_{trigger}$. At the beginning of 2022, SSB is estimated to be below MSY $B_{trigger}$ and B_{pa}. The recruitment series for age 2 ($R_{age\ 2}$) shows a decreasing trend since 1991 (~40 million individuals) declining towards a minimum value in 2021 (<10 million individuals).

In addition to the EU MAP (EU, 2019a), the industry implemented a mesh size restriction of > = 80 mm for the bottom trawls for the periods from 1 January to 31 May and from 1 October to 31 December. A seasonal closure was also applied during the spawning period, 1 January to 31 March, for the directed fishery for common sole. This closure consists of three periods of seven consecutive days for a total of 21 days of closure.

Since 2015, the French sole fishery in the Bay of Biscay (ICES divisions 8.a and 8.b) has been subjected to additional management measures aimed at reducing F and improving the recruitment level of the stock. Since 2016, these measures have concerned at least a 15-day fishing activity suspension during the first quarter for netters and a reinforcement of the trawl selectivity for at least 8 months of the year (including the first quarter). In 2022, additional management measures were again applied by the French sole fishery committee in the Bay of Biscay. A mechanism of temporary cessation of fishing activities have been set up for the benefit of the French fleet of gillnetters and bottom trawlers, which contributes to >90% of total landings of this stock, in order to compensate for the socio-economic consequences of the drastic reduction of the 2022 TAC as well as the French fishery consideration of preponderant impact and role of environmental factors (i.e. water quality, global change, etc.) affecting the changes in stock dynamics, particularly on recruitment decline. The details of the mechanism implemented are available in Annex 4 in the report.

For stock-specific reporting, see section 7.

1.1.6 Sole in divisions 8.c and 9.a

The Portuguese and Spanish fisheries are mainly targeting the southern *Solea solea*. This stock is mainly caught with gillnets and trammelnets. In Portugal, *S. solea* is caught together with other similar species, *S. senegalensis* and *Pegusa lascaris*. However, in recent years the reported official catches are separated by species. Historical landings of *S. solea* were corrected during the Workshop on Selected Stocks in the Western Waters (WKWEST) benchmark (ICES, 2021a). For the period 2011–2021, *S. solea* represented on average 56% of the total sole species catches, while *S. senegalensis* represented on average 24% then *Pegusa lascaris* is around 19% and finally, *Solea* spp only about 1%.

This stock was recently benchmarked during the WKWEST workshop (ICES, 2021a) and the stock was upgraded to category 3 (ICES, 2022c). Currently, an advice specific for *S. solea* is provided based on trends from the combined biomass index between commercial Portuguese LPUE and Spanish bottom trawl survey index and length-based indicators (LBIs; ICES, 2015; 2022c; 2023e).

Catches for each of the years 2024 and 2025 should be no more than 209 t if an MSY approach is applied. The catch advice is 35% lower than the previous advice due to the decline in the biomass index, the low biomass safeguard and the use of the precautionary multiplier.

Management of all southern sole species under a combined species TAC prevents the effective control of the single-species exploitation rates and could lead to the overexploitation of either species. The 2023 MSY TAC for *Solea* spp is set at 652 t (EU, 2023) similar to that for 2022 (EU, 2022a). *S. solea* accounts for 55% of the catches in the last three years. A minimum conservation reference size (MCRS) set at 24 cm in this area was issued for this stock (EU, 2019b).

Fishing pressure on the stock is below $F_{MSY\ proxy}$ and the stock size indicator is below the MSY $B_{trigger\ proxy}$ ($I_{trigger}$). Additional information suggest that the stock is in good status (LBSPR) and is exploited sustainably (MLZ) although these were not used to provide advice but only as ancillary information.

For stock-specific reporting, see section 8.

1.1.7 Hake in subareas 4, 6, and 7, and divisions 3.a, 8.a, 8.b, and 8.d

Northern hake is caught in nearly all fisheries in subareas 7 and 8, and in some fisheries in subareas 4 and 6. France accounts for the main part of the catches, followed by Spain and Scotland. Landings decreased steadily from 1989 to 1998. Up to 2003, landings fluctuated at around 40 000 t. Since then, landings have been increasing up to around 107 500 t in 2016 which is the highest value in the whole time-series. Since 2016, catches have been decreasing every year and are below both the TAC and the catch advice. TAC for 2023 is set at 31 422 t (EU, 2023). Catches in 2022 were 69 382 t. Discards are available since 2002. From 2003 until 2010, discards were provided as a total in all the divisions and subareas where the northern hake is caught. In 2014, discards were allocated to specific divisions where the highest discarding occurs in divisions 4 and 7. The discards had an increasing trend until 2013 and decreased steadily afterwards. In 2022, the total estimated discards were around 1951 t.

This stock was benchmarked in 2022 during the WKANGHAKE (ICES, 2023b). During this benchmark, the assessment model was updated under the same SS framework (Methot Jr. and Wetzel, 2013), using the most recent version of the software. The revised model includes an additional fleet (OTHER fleet disaggregated in trawlers and non-trawlers since 2013) and a new survey, the IE-IAMS (G3098). The population dynamics are now sex-separated with sex-dependent growth and natural mortality.

The assessment was carried out according to the Stock Annex, which was updated during the benchmark, and the group accepted the assessment as appropriate to providing advice. Catches in 2024 should be no more than 72 839 t if the MSY approach is applied. The advice for 2024 is 12% lower compared to 2023 due to the decreasing SSB trends. Compared to the 2022 assessment (ICES, 2022c), the retrospective pattern for 2023 showed significant and slight improvements for recruitment and $F_{1–7}$, respectively, while the female-only SSB is out of bounds.

The recruitment of age-0 ($R_{age\ 0}$) appears to fluctuate without a substantial trend over the years where the 2007 estimated value was the highest of the time-series (2177 million individuals) while the values since 2020 were slightly below the historical mean (~600 million individuals). From high levels at the start of the series (92 thousand t in 1980), the SSB decreased steadily to a low level at the end of the 1990s (~ 30 thousand t in 1998). Since then, SSB has increased to the highest value of the series in 2015 (~ 294 thousand t) then decreased progressively until 2023 (163 204 t). The F is calculated as the average annual F for ages 1–7. Values of $F_{ages\ 1–7}$ increased from values of around 0.30–0.37 in the late 1970s and early 1980s to values around 0.60 during the 1990s. Between 2006 and 2013, $F_{ages\ 1–7}$ declined sharply. Since 2009, $F_{ages\ 1–7}$ remains below F_{MSY} (0.21). The $F_{ages\ 1–7}$ estimate for 2022 is 0.191.

The stock is considered under the EU MAP in the Western waters and adjacent waters (EU, 2019a). This plan is not adopted by Norway and the UK. Thus, it was not used as the basis of the advice for this widely distributed and shared stock. ICES was requested to provide an advice based on the MSY approach and to include the MAP as a catch option.

For stock-specific reporting, see section 9.

1.1.8 Hake in divisions 8.c and 9.a

Hake in divisions 8.c and 9.a is caught in a mixed fishery by Spanish and Portuguese trawlers and artisanal fleets. Spain accounts for the main part of the landings (~2/3), followed by Portugal (~1/3) and small mounts from France (~1%). Total catches was over 20 000 t in 1983 then decreased to 7 824 t in 2004. This was followed by an increase to 22 175 t in 2009 which decreased again afterwards to 7 582 t in 2022 (historical minimum). Total discards are decreasing since 2014 (2602 t), declining to a value of 595 t in 2022 (historical minimum).

The EU MAP for stocks in the Western waters and adjacent waters has been agreed by the EU for this stock (EU, 2019a). Hake is managed by a TAC and technical measures. The agreed TAC for southern hake in 2022 and 2023 were 14 429 and 15 925 t (EU, 2023), respectively, almost twice of the TAC value in 2021. A minimum conservation reference size (MCRS) set at 27 cm in this area was issued for this stock (EU, 2019b).

The southern hake stock was benchmarked in 2014 (WKSOUTH; ICES 2014) with the GADGET model (Begley and Howell, 2004). In 2020, the assessment was updated and the model was rejected due to its strong and persistent retrospective pattern which was not possible to resolve (ICES, 2020b). Thus, the stock was downgraded to category 3 and the advice produced in 2020 for 2021 was based on trends, following the rules of a category 3 stock (ICES, 2012a; 2018a; 2019a). The stock was benchmarked again in early 2022 during the WKANGHAKE (ICES, 2023b). The main objective was to change the assessment model used for the stock to the SS framework (Methot Jr. and Wetzel, 2013). New reference points were estimated and implemented in the new length-age-based SS approach. The stock was upgraded again as a category 1 stock (ICES, 2022c; 2023b).

Recruitment at age 0 ($R_{age\ 0}$) is highly variable with a minimum of 111 million (2012) and a maximum of 565 million (2005), with a mean value of around 250 million individuals. Values in 2020–2022 are around the historical mean.

F is calculated as the average annual F for ages 1–7. $F_{ages\ 1–7}$ increased from 1982 ($F_{ages\ 1–7}$ = 0.26) and peaked in 1995–1997 to around 0.85–0.90, then decreased to 0.30 in 2006 and remained relatively stable until 2016. In recent years, $F_{ages\ 1–7}$ has been decreasing and reached a value of 0.164 in 2022, which is below F_{MSY} (0.221).

The SSB was very high in the early 1980s (40 000 t in 1982), then decreased to a minimum level of around 3000 t in 1998. After that, the biomass has been increasing with a peak value observed in 2011 (~20 000 t) then began to slightly decrease until 2017 (~13 000 t) after which the value started to increase again and attained a value of 21 905 t in 2023.

When the EU MAP (EU, 2019a) is applied, forecasted catches in 2024 that corresponds to the F ranges are between 9 119 and 17 445 t (ICES, 2023a). With F_{MSY} ($F_{ages\ 1–7}$ = 0.221) the projected catches in 2024 would be 12 919 t, with 11 783 t of landings and 1136 t of discards, whereas the SSB_{2025} would be 26 726 t.

In September 2022, DGMARE requested a revision of the catch advice given for 2022 using the new modelling approach after WKANGHAKE (ICES, 2023b). An updated advice for catches in 2022 was released on 12 October 2022[1] and Annex 10 (Cerviño *et al.*, 2022) was added to the WGBIE 2022 report to document this revision (ICES, 2022c).

For stock-specific reporting, see section 10.

1.1.9 Nephrops in divisions 8.a and 8.b (FUs 23–24)

There are two functional units (FUs) in ICES divisions 8.a and 8.b: FU 23 (Bay of Biscay North) and FU 24 (Bay of Biscay South), see Figure 1.2. *Nephrops* in these FUs are almost exclusively exploited by the French trawlers. Landings declined until 2000, from 5281 t in 1988 to 2848 t in 2000. After that year, they increased again to around 3421 t, remaining at levels > 3000 t until 2006. From 2007–2009, landings have been around 2800 t then increased to about 3200 t during the next 2 years. In 2012 and 2013, a reduction in the annual landings occurred (2290 t in 2012 and 2195 t in 2013) followed by an increase to 3425 t in 2015. In 2020, total nominal landings reached 2273 t, close to the historically lowest level of its time-series in 2018 (2125 t). In 2021, an increase of landings (3006 t) occurred which is an increase of 24% compared to 2020. This was followed by a 10% decrease in 2022 (2 694 t) compared to 2021.

The agreed TAC for 2022 was 3880 t and is fixed at 4 631 t for 2023 (EU, 2023).

A French regulation increased the minimum landing size in 2006 and several effort and gear selectivity regulations have also been put in place in recent years. The use of selective devices for trawlers targeting *Nephrops* became compulsory in 2008. All these measures are expected to be contributing in various ways to the change of landings and discard patterns recently observed. In general, discards values after 2000 have been higher than in earlier years, although sampling only occurred on a regular basis from 2003, so information about discards is considerably weaker for the earlier period. Since 2017, the use of a discarding quick-chute system onboard has become compulsory. This measure has a direct impact on the survival rate of discards. In 2019, a new survival rate of 50% was accepted for use in the assessment and advice of the stock during the WK*Nephrops* workshop (ICES, 2020c).

This stock was benchmarked in WKNEP in 2016 (ICES, 2017b) which reviewed the methods proposed using an underwater television survey (UWTV). The outcome of this evaluation process classified the stock as a category 1 stock and the methods developed were considered appropriate to assessing the stock and provision of advice (ICES, 2023a).

In 2022, the survey area was revised and reduced by 10%, removing part of the grounds with rough bottom which systematically presents zero burrows density. This work, presented in Annex 6 (Fifas *et al*., 2022) in the WGBIE 2022 report (ICES, 2022c) was validated by an appointed reviewer for the WGNEPS (Working Group on *Nephrops* Surveys) in November 2019 (ICES, 2020c).

No quantitative analytical assessment was carried out during the WG in spring since the survey used for the assessment had not been completed yet. An update of the assessment and the report will be carried out after the WG and the advice will be provided in October 2023.

For stock-specific reporting, see section 11.

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[1] ICES. 2022. EU request for an updated advice for hake (*Merluccius merluccius*) in divisions 8.c and 9.a, Southern stock (Cantabrian Sea and Atlantic Iberian waters) for catches in 2022. In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, sr.2022.14, https://doi.org/10.17895/ices.advice.21316344

1.1.10 *Nephrops* in Division 8.c (FUs 25 and 31)

There are two FUs in Division 8.c (Figure 1.2): FU 25 (North Galicia) and FU 31 (Cantabrian Sea).

Nephrops are caught in a mixed bottom-trawl fishery in the North and Northwest Iberian Atlantic. Landings from both FUs have declined dramatically in recent years reaching less than 15 t in each FU in 2015 which was below the agreed TAC in recent years despite being non-restrictive. The TACs were set at 0 t for all of Division 8.c for each of the years 2017, 2018, 2019 and 2020. However, a scientific quota was established for *Nephrops* in each of the FUs in order to undertake an observer programme from 2018 to 2020.

Until 2020, these stocks were assessed based on the analyses of the LPUE series trends according to the ICES DLS approach (ICES, 2015), both stocks were considered as category 3.1.4 (ICES, 2023a). In 2021, these two stocks were benchmarked during the WKMSYSPiCT (ICES, 2021b) and both were upgraded to category 2 stocks (ICES, 2022a; 2023a; e) based on the SPiCT model (Pedersen and Berg, 2017) assessment, that estimated the FU stock-specific relative reference points, and is now used as the basis for advice. For both stocks, catches and SpGFS-WIBTS-Q4 (G2784) bottom trawl survey abundance index time-series were used as input data. Since 2021, the ICES-specific advice for both FUs 25 and 31 were based on the SPiCT outputs (ICES, 2021b; 2022c; 2023h).

A recovery plan for southern hake and Iberian *Nephrops* stocks has been implemented in 2006 (EU, 2005) and was repealed in 2019 with the EU MAP for stocks in the Western waters and adjacent waters has been agreed by the EU for this stock (EU, 2019a).

In FU 25, F is below F_{MSY} since 2012 and the total biomass is below B_{lim} since 1997. ICES provided a zero-catch advice in 2022 for each of the years 2023, 2024 and 2025 (ICES, 2022a; 2023a; e) as the stock size has been below B_{lim} with no signal of recovery (ICES, 2022c; 2023h).

For FU 31, F is below F_{MSY} since 2009 and the total biomass is below B_{MSY} and MSY $B_{trigger}$ since 2000 and now it is above B_{lim}. Catch projections for 2024 should not be more than 12.4 t if the MSY approach is applied. This advice for 2024 is 29% lower this year than that provided in 2023 due to the downwards scaling of the stock size relative to the reference points. This year the new MSE of HCR is applied to the FU 31 assessment and advice (Method 1; ICES, 2022a).

A single TAC covers the entire ICES Division 8.c. In 2016, a zero TAC was set for *Nephrops* in ICES Division 8.c for each of the years 2017, 2018 and 2019. In 2019, this measure was advised again for each of the years 2020, 2021 and 2022. However, *Nephrops* agreed TAC for division 8.c was split by FU since 2022 based on the ICES advise that the management area should be consistent with the assessment area. Thus, a specific TAC was set for each FU since 2022 (ICES, 2022c). The agreed TAC in 2022 for 2023 based on the SPiCT assessment was 0 t for FU 25 and 17 t for FU 31 (EU, 2023).

For stock-specific reporting, see section 12.

1.1.11 *Nephrops* in Division 9.a (FUs 26–27, 28–29, and 30)

There are five FUs in Division 9.a (Figure 1.2): FU 26 (West Galicia), FU 27 (North Portugal), FU 28 (Alentejo, Southwest Portugal), FU 29 (Algarve, South Portugal) and FU 30 (Gulf of Cádiz). To ensure that the stocks in these FUs are exploited sustainably, ICES advises that management should be implemented at the FU level.

Landings from the five FUs combined were 207 t in 2021 and 148 t in 2022. The TAC set for the whole of subareas 9 and 10 and Union waters of CECAF 34.1.1 was 355 t for 2022 and 298 t (EU, 2023) for 2023, respectively.

A recovery plan for southern hake and Iberian *Nephrops* stocks had been in force since 2006. The recovery plan aims to rebuild the stocks within 10 years, with a reduction of 10% in F relative to the previous year and the TAC set accordingly (EU, 2005). In March 2019, the European Parliament and the Council have published the MAP for the Western Waters and adjacent waters (EU, 2019a) which repealed the previous recovery plan. This plan applies to demersal stocks including *Nephrops* in ICES Division 9.a.

1.1.11.1 FUs 26 and 27 (West Galicia and North Portugal)

The fishery shares the same characteristics as that in Division 8.c, described above.

The advice for these *Nephrops* stocks was triennial (ICES, 2023a). The last advice given in 2019 was valid for 2020, 2021 and 2022. However, as it is now considered a category 2 stock since 2022, a new advice according to this category was provided (ICES, 2022c). For *Nephrops* in FUs 26–27, ICES advised that when the precautionary approach is applied, there should be zero catch for each of the years 2022, 2023 and 2024.

Landings are reported by Spain and, in minor quantities, by Portugal. Since 2012, quantities have been similar and at very low levels (≤ 7 t). Spanish fleets fish in FU 26 and FU 27, whereas Portuguese artisanal fleet fish with traps in FU 27. Two periods can be distinguished in the landings time-series available from 1975–2020. During 1975–1989, the mean landing was 680 t, fluctuating approximately between 575 and 800 t. From 1990 onwards, there has been a marked downward trend in landings, being below 50 t from 2005 to 2011. In the last nine years, landings continued to decrease and are currently below 10 t. Discard rates are considered negligible.

This stock was considered as a category 3.1.4 according to the ICES data-limited approach since 2012 (ICES, 2012) and was assessed by the analysis of the LPUE series trend. *Nephrops* in FUs 26–27 were recently benchmarked during the WKMSYSPiCT (ICES, 2021b). In 2022, the stochastic production SPiCT model (Pedersen and Berg, 2017) was accepted for assessment and the stock was upgraded to a category 2 (ICES, 2021b; 2022c). Since 2022, this stock is being assessed using the SPiCT model (ICES, 2022c) and advice is provided accordingly (ICES, 2023a).

Nephrops landings in FU 2627 decreased to more than 95% along the time-series while the biomass survey indices indicate extremely low biomass. Biomass is below MSY $B_{trigger}$ since the end of the 1980s while F is below F_{MSY} since 2012.

For stock-specific reporting, see section 13.1.

1.1.11.2 FUs 28 and 29 (Southwest and South Portugal)

Nephrops are taken by a multispecies and mixed bottom-trawl fishery. The trawl fleet is comprised of two components: one targeting fishes that operates along the entire coast while the other targeting crustaceans but operates mainly in deep waters along the southwest and southern areas. There are two main target species in the crustacean fishery, Norway lobster and deep-water rose shrimp, with different but overlapping depth distributions. In years of high rose shrimp abundance, the fleet directs its effort to this species as a preference.

The advice for this stock is biennial and is valid for each of the years 2024 and 2025. Based on the ICES approach for DLS, catches in 2022 for FUs 28 and 29 should be no more than 213 t in each of the years 2024 and 2025 if the precautionary approach is applied (ICES, 2023a). The catch advice is 20% lower than the previous advice due to the decline in biomass index (ICES, 2023h). To ensure that the stock in FUs 28 and 29 is exploited sustainably, ICES advises that management should be implemented at the FU level.

For the period 1984–1992, the recorded landings from FUs 28 and 29 have fluctuated between 420 and 524 t, with a long-term average of about 480 t followed by a declining period in 1990–1996 down to 132 t. From 1997 to 2005, landings increased to levels observed during the early

1990s, decreasing again in recent years. The landings in 2009–2011 were stable at around 150 t, increasing to 299 t over the years 2014–2018. Landings in 2021 and 2022 were 207 and 148 t, respectively. There are no discards of *Nephrops* in the fishery (ICES, 2023h).

According to the ICES DLS approach, this stock is classified as category 3.2.0 (ICES, 2015) and the advice is based on standardized CPUE and effort trends (ICES, 2023a). Standardized effort shows a consistent declining trend until 2010, fluctuating at low levels since. The standardized CPUE model, used as an index of biomass, was reviewed during WKMSYSPiCT (ICES, 2021b) and presents a slightly increasing trend since 2014 with some fluctuations. Proxy reference points were estimated using the Mean-Length Z (MLZ) approach as defined in WKLIFE V (ICES, 2015) with the standardized effort. The results indicate that the stock is exploited at levels below the F_{MSY} reference point.

This stock was last benchmarked during the WKMSYSPiCT in early 2021 (ICES, 2021b) where the SPiCT method (Pedersen and Berg, 2017) was implemented for assessment and to produce the advice. However, given the available input data for the stock, the proposed stochastic production SPiCT model during the WKMSYSPiCT workshop was rejected. Thus, the stock remains in category 3 (ICES, 2022c; 2023a; e; h).

This year, the ICES framework for application of the '*rfb*' rule category 3 stocks (Method 2.1 in ICES, 2022a) was not applied as the fishing pressure indicator from the MLZ issued from WKMSYSPiCT (ICES, 2021b) provides a more complete information compared to the value estimated using the new '*rbf*' rule (Method 2.1 in ICES 2022a; 2023a; e; h). Further details and supporting arguments are provided in the specific report section for the stock.

For stock-specific reporting, see section 13.2.

1.1.11.3 FU 30 (Gulf of Cádiz)

Nephrops in the Gulf of Cádiz are caught in a mixed fishery by the trawl fleet. Landings are markedly seasonal with high values from April to September. Landings were reported by Spain and, in minor quantities, by Portugal. Landings in 1995 was 131 t which significantly decreased in 1996 (49 t). Higher levels were observed at the beginning of the 2000s and reached 307 t in 2002 which is the highest value for the whole time-series. Landings decreased again until 2008 fluctuating at around 100 t from 2008 to 2012. In 2013–2015, landings dropped to around 20 t, due to a sanction applied by the European Commission for Spain having exceeded the quota in 2012 so that the *Nephrops* fishery was closed with vessels only fishing for *Nephrops* for a few days during summer and winter periods. From 2016, effort and landings have resumed back to levels seen prior to this period, with the inclusion of the unreported landings. Estimates since 2016 are considered the best information available.

According to the ICES DLS approach, this stock is classified as category 3.2.0 (ICES, 2015) and the advice is based on the underwater TV survey (UWTV) series trends. Qualitative evaluation suggests declining B with F unknown. No quantitative analytical assessment was carried out during the WG in spring since the survey used for the assessment had not been completed yet. The UWTV survey was not conducted in 2020 due to the COVID-19 disruption which led to the absence of an abundance index estimate for 2020. The advice for 2021 was produced based on the survey trends assuming for 2020 the same abundance estimate as 2019. The results from the 2021 survey indicate that the biomass of the stock was reduced. Following the rules for advice of category 3, ICES advises that when the precautionary approach is applied, catches in 2024 should be no more than 32 t. The 2023 catch advice is 36% lower than 2022 due to the decrease in the abundance estimate and the application this year of the precautionary buffer (ICES, 2023a; e; h).

In 2022, a review of the survey area has been carried out, removing areas of no occurrence of Norway lobster based on the seabed morphological, sediment, and habitat updated information as well as on bottom trawl survey data and beam trawl hauls carried out during UWTV surveys in this FU (ICES, 2022c). The area was reduced by approximately 22% with minor effect on the abundance estimates. The UWTV survey index time-series has been updated, taking into account the new survey area. The 2022 survey results indicate that the biomass is at the lowest level of the series.

This report will be updated in autumn when the 2023 UWTV survey results are available and the advice for 2024 is proposed.

For stock-specific reporting, see section 13.3.

1.1.11.4 General comments

The five *Nephrops* FUs (assessed as 3 separate stocks) are managed jointly, with a single TAC set for the whole of subareas 9, 10 and CECAF 34.1.1. Since 2018, a maximum limit on landings from FU 30 is included in the TAC regulation. This may lead to unbalanced exploitation of individual stocks. The northernmost stocks (FUs 26–27) are at extremely low levels, whereas the southern ones (FUs 28–29 and FU 30) are in better condition.

The TAC set for the whole Division 9.a was 374 t for 2021, of which no more than 6% may be taken in FUs 26 and 27, and no more than 65 t may be taken in FU 30. For 2022, the TAC for Division 9.a was set as 355 t, with a maximum of 50 t for FU 30. The TAC set for the whole division 9.a for 2023 was set at 298 t, with a maximum of 32 t for FU 30 (EU, 2022c). No catches are allowed to be taken in FUs 26 and 27.

A single TAC covers the entirety of ICES subareas 9 and 10, and EU waters of CECAF 34.1.1. Since 2022, the regulation has different catch limits for each FU in this area.

1.1.12 Sea bass in divisions 8.a and 8.b

Sea bass in the Bay of Biscay is targeted by France (more than 97.9% of international landings in 2021) by line fisheries (handlines and longlines) which take place mainly from July to October. Other exploitations such as nets, pelagic trawlers, and mixed bottom-trawl fisheries occur from November to April, the period when pre-spawning and spawning grounds when sea bass aggregate. Since the late 1990s, total landings were stable with an average of around 2600 t over time. Landings of netters are highly dependent on weather conditions and have increased since 2011 due to a decrease of sole quotas from 2011 and a redistribution of effort towards this species combined with good weather conditions in 2014. In 2022, total landings decreased slightly compared to 2021. Recreational removals are an important part of the total fisheries but these are not accurately quantified. Discards are known to take place but are not fully quantified. The available data suggests that discards can be considered negligible (< 5%).

The sea bass stock in the Bay of Biscay was benchmarked in 2017 (WKBASS, ICES 2018c), and 2018. Currently, the assessment of the stock relies on a short data time-series: length composition time-series started in 2000; age-at-length time-series started only in 2008 (with a proper sampling after 2010); recreational data were surveyed for only one year in 2010. In addition, there is no scientific survey for adult sea bass to scale the model to an appropriate level of abundance. There is no survey for recruits either. All these elements introduce uncertainties in the assessment. The stock is being benchmarked in 2023 and 2024 addressing some of these problems. The stock identification workshop held early this year was already discussed (WKSEABSSID; ICES, 2023b) above which included both the recreational removals and commercial landings and is tuned by commercial landings per-unit-effort series.

The only available tuning index fluctuates without trend with the years 2012 to 2016 showing a decline and then an increase in 2017. The SSB fluctuated around 20 000 t. SSB is currently around MSY $B_{trigger}$ and B_{pa} and well above B_{lim}. The recruitment for age 0 ($R_{age\ 0}$) series was variable and is ~ 30 million individuals per year. Below average $R_{age\ 0}$ were observed for each of the years 2010, 2015 and 2016. F is estimated as the average of ages 4–15 ($F_{ages\ 4–15}$), has fluctuated without trend over the time-series. Currently, $F_{ages\ 4–15}$ is decreasing and is below F_{MSY}.

Sea bass in the Bay of Biscay is not subjected to the EU TACs and quotas but is ruled by an EU multiannual plan (MAP; EU, 2019a) for the Western waters and adjacent waters since 2019. When the EU MAP (EU, 2019a) is applied, catches (include both commercial catch and recreational removals) in 2023 that correspond to the F ranges in the MAP are between 2897 and 3398 t, and catches corresponding to F_{MSY} are 3464 t.

For stock-specific reporting, see section 14.

1.1.13 Sea bass in divisions 8.c and 9.a

Spanish and Portuguese vessels represent almost all the total annual landings in divisions 8.c and 9.a. Commercial landings represented 815 t in 2021 and 816 t in 2022, values lower than in 2020 (896 t). A peak in landings was observed in 1989–1990 and again in 2013, reaching a value of 1046 t while the lowest landings have been observed in 1980, 1981, and 1985 and in 2003. Landings in 2003 is the lowest in the entire time-series (466 t). Discards from observer programmes show that discarding is negligible for this stock. Recreational removals are not quantified but considered not negligible.

This stock was last benchmarked in 2012 (ICES, 2012c). No stock assessment is carried out as the stock is considered as a DSL category 5.2.0 (ICES, 2012a; 2023e). Advice is given every two years. Information on abundance and exploitation are not yet available and the update of the landings data does not change the perception of the stock.

This stock is included in the EU MAP for Western Waters and adjacent waters (EU, 2019a) but not subjected to EU TACs and quotas. Advice for this stock is based on the precautionary approach. Commercial catches in each of the years 2024 and 2025 should be no more than 382 t if ICES rule is applied since the precautionary buffer was already applied in 2021. Landings are well above the advised catch since 2014.

For stock-specific reporting, see section 15.

1.1.14 Plaice in Subarea 8 and Division 9.a

Plaice (*Pleuronectes platessa*) are caught as bycatch by various fleets and gear types covering small-scale artisanal and trawl fisheries. Portugal and France are the main participants in the fishery with Spain playing a minor role. Present fishery statistics are considered to be preliminary as there are concerns about the reliability of data. Landings may also contain misidentified flounder (*Platichthys flesus*) as they are often confounded at sales auctions in Portugal. The quantity of discarding is uncertain. For these reasons, the landings are unlikely to be a good indicator of total removals and ICES considers that it is not possible to quantify the catches.

This stock is ranked as a DLS in category 5.2.0 (ICES, 2012; 2022c; 2023a; e) as only landings data are available. In 2022, the stock catch data were updated and the perception of the stock has not changed. The development of a SPiCT model was explored during the WKBMSYSPiCT2 workshop in late 2022 but was rejected (ICES, 2023g). Thus, this remains as category 5 stock.

This stock is included in the EU MAP for Western Waters and adjacent waters (EU, 2019a) and is under the EU landing obligation since 2016. The advice for this stock is biennial (ICES, 2023a) and the last advice was released in 2021 (ICES, 2021d). This year, ICES advises that landings should be no more than 124 t for each of the years 2024 and 2025 if the precautionary approach is applied.

The TAC for this stock is set at 155 t (EU,2023). A minimum conservation reference size (MCRS) set at 30 cm in this area was issued for this stock (EU, 2019b).

For stock-specific reporting, see section 16.

1.1.15 Pollack in Subarea 8 and Division 9.a

Pollack is mainly caught by France (77%) and Spain (18%) by several types of gears such as nets, lines and trawls. Most of the landings are from gillnets (53%) followed by the line (37%) fisheries. Since the early 2000s, the landings have been relatively stable between around 1500 and 2200 t. The recreational removals are unquantified but considered non-negligible. Discards by Spanish netters indicate that the discards are considered negligible. Discards by French netters and liners are about 1.2% and 0.1% of their catches, respectively.

The advice for this stock is biennial (ICES, 2023a) and the last advice was released in 2021 (ICES, 2021d) and, thus remains valid for this year. ICES advises that catches should be no more than 905 t for each of the years 2022 and 2023.

The stock was classified as a DLS in category 5.2.0 (ICES, 2012; 2022c) as the only available information is on catches. This year, the stock was benchmarked during the WKBMSYSPiCT2 (ICES, 2023g) meeting at the end of 2022 to explore the feasibility of using a surplus production model for assessment and provision of advice. The developed SPiCT model (Pedersen and Berg, 2017) was explored but was rejected during the WKBMSYSPiCT2 workshop (ICES, 2023g). During the WGBIE meeting this year, the ICES framework for category 3 stocks and the '*rfb*' rule (Method 2.1 in ICES 2022a) were applied to provide an MSY advice on commercial catches (ICES, 2023h). Standardized LPUEs and a length-based spawning potential ratio (LBSPR) were used in the assessment and as an indicator of stock development to provide a category 3 advice (ICES, 2023a) using assessment of trends from biomass index from commercial FRANCE_GNS LPUEs, length compositions of commercial catches (2010–2022) and life-history parameters to produce assessment trends from biomass index from commercial FRANCE_GNS LPUEs and LBIs (ICES, 2023h). This proposition will be reviewed and the decision for upgrade from a category 5 to 3 will be taken during the WGBIE ADG in June 2023.

An advice based on a category 3 stock is proposed which indicates that commercial catches should be no more than 872 t in each of the years 2024 and 2025 if the MSY approach is applied under the '*rfb*' rule. This catch advice is 36% lower than the reference catch and is due to the decreasing trend of the biomass index, the application of the biomass safeguard and the precautionary multiplier (ICES, 2023a; e; h).

The TAC for this stock is only set at 1648 t (EU, 2023) in Subarea 8. For Division 9.a, ICES is not aware of any precautionary management plan in this area. A minimum conservation reference size (MCRS) set at 30 cm in this area was issued for this stock (EU, 2019b).

For stock-specific reporting, see section 17.

1.1.16 Whiting in Subarea 8 and Division 9.a

Whiting (*Merlangius merlangus*) are caught in mixed demersal fisheries primarily by France and Spain. Present fishery statistics are considered to be preliminary. Total landings have fluctuated around an average of 2000 t since 2010. The 2016 landings (2525 t) are reported to be one of the highest of the time-series and decreased afterwards. In 2022, both landings and discards increased and were estimated at 1197 and 370 t, respectively. Discards and bycatch were about 27% in the period 2016–2022. Whiting has never been recorded in Spanish discards and is negligible in Portuguese discards. However, there are indications that discarding occurs in the French fleet (ICES, 2022c).

This species is at the southern extent of its range in the Bay of Biscay and the Iberian Peninsula. It is not clear whether this is a separate stock from a biological point of view. A minimum conservation reference size (MCRS) set at 30 cm in this area was issued for this stock (EU, 2019b).

The stock was classified as a DLS in category 5.2.0 (ICES, 2012; 2022c) as the only available information is on catches. Last year, the updated time-series of landings and discards including the 2022 data did not change the perception of the stock (ICES, 2022c). In 2022, the LBI (ICES, 2017c; 2018a; b) analysis suggests that F is below the proxies of the MSY reference points (ICES, 2022c).

This year, the stock was benchmarked during the WKBMSYSPiCT2 (ICES, 2023g) meeting at the end of 2022 to explore the feasibility of using a surplus production model for assessment and provision of advice. However, the developed SPiCT model (Pedersen and Berg, 2017) was explored but rejected during the WKBMSYSPiCT2 workshop (ICES, 2023g). However, during the WGBIE meeting this year, the ICES framework for category 3 stocks and the '*rfb*' rule (Method 2.1 in ICES 2022a) were applied to provide an MSY advice on commercial catches (ICES, 2023h). The precautionary approach was applied in previous years when providing the advice for the stock (ICES, 2022c). Standardized LPUEs and a length-based spawning potential ratio (LBSPR) were used in the assessment of trends from biomass index of the commercial LPUEs and LBIs and as an indicator of stock development (ICES, 2023h). WGBIE accepted the new assessment method and agreed to provide a landings advice for a category 3 stock (ICES, 2022a; 2023a; e; h). As a category 3 stock, ICES advises that commercial landings should be no more than 1880 t in each of the years 2024 and 2025 if the MSY approach is applied.

The TAC for this stock is only set at 2276 t (EU, 2023) in Subarea 8. For Division 9.a, the TAC is delegated to the Member States.

For stock-specific reporting, see section 18.

1.2 Available data

Catch (totals and/or age–length structured) and effort data according to species, country, area and *métier* were requested in the ICES standard data call for WGBIE. A deadline of 5th April 2023 was set to prepare the datasets for the WG and progress on the use of InterCatch.

For most of the stocks assessed by WGBIE, InterCatch was used mainly to extract catch, landings, and discards data. The data delivered to accessions via worksheet format were, for some stocks, used as the primary data source and compared to the data submitted on InterCatch.

The main data problems previously detected by WGBIE was the delay in the data submission via InterCatch or accessions of catch and associated length and age samples and survey and commercial indices. However, all data were received before the WGBIE meeting without no time to perform the assessment before the WGBIE started for most stocks.

Several stocks assessed by the WG are managed employing TACs that apply to areas different from those corresponding to individual stocks, notably in Subarea 7, as well as for the *Nephrops* FUs in 8.c and 9.a, or to a combination of species in the cases of anglerfish and megrim.

1.3 Stock data problems relevant to data collection

WGBIE was made aware early this year of issues relevant to the incomplete 2022 survey for the Bay of Biscay due to bad weather conditions (see Annex 7.1 in ICES, 2023i) by the WGBEAM, affecting the estimation of the Bay of Biscay sole (sol.27.8ab) abundance. Analyses were performed to explore the impacts of considering or not the 2022 survey (Lecomte, 2023; see WD 1 in this report). Based on results from these analyses, WGBIE decided to exclude the 2022 survey for this year's assessment. WGBIE decided to reduce the period considered for computing the geometric mean (GM) of the recruitment, considering only the years 2019–2021. The new value obtained and used for the recruitment projection resulted to a more realistic scenario where recruitment has been low in recent years (see WD 1 for detailed information).

WGBIE also suggested to the Bay of Biscay stock coordinator to explore ways to "fill-in" the missing survey year index through a model-based approach such as the vector autoregressive spatio-temporal (VAST; Thorson 2019) model that can be implemented using the publicly available VAST (www.github.com/james-thorson/VAST) package which is an approach that has been primarily implemented in 2019 in the case of Black anglerfish in Subarea 7 and divisions 8.a–b and 8.d (ank.27.78abd) due to the absence of the 2018 EVHOE-WIBTS-Q4 (G9527) abundance survey index (Gerritsen and Minto, 2019; ICES, 2019c) and since then has been accepted by ICES as a reliable approach to resolve the absence of survey abundance series issue. However, due to time constraints the stock coordinator will explore this approach intersessionally after this year's meeting and present the results as a WD at the 2024 WGBIE meeting for review and validation.

1.4 Use of InterCatch in WGBIE 2023 stock assessments

This year, most of the WGBIE SCs is still using the ICES InterCatch web-based system where national data submitters upload national fish catches, official catch statistics and survey data which are then accessed by SCs to download necessary data for their respective stock assessments. Submitted and collected information on national inputs and ICES data processing are documented and stored on this online databank and after more than a decade, progress has been made by the group with regards to the use of InterCatch for their respective assessments. Several stocks are still only partly using InterCatch in this process but as a place to hold all the raw data with the files being processed and raised externally. Currently, ICES is developing a new web-based framework that will replace InterCatch. Further details about this new data portal is provided below (see 1.13 of this section).

1.5 TAF-based stock assessments

In 2020, two WGBIE stock assessments were implemented to a Transparent Assessment Framework (TAF): the northern hake and the Bay of Biscay sole and where the two stock coordinators and/or assessors were nominated as TAF ambassadors for WGBIE.

The facility of the implementation seems to be linked with the assessment model used for each stock. The Bay of Biscay sole assessed using an age-structured XSA (Shepherd, 1999) model demanded less time and effort for coding and integration into TAF while the northern hake SS (Methot Jr. and Wetzel, 2013) assessment model required some more work (i.e. coding and data tables reformatting) for its implementation.

WGBIE considers that TAF is quite a useful tool and supports the implementation of additional stocks. The general objective is to implement the TAF-based assessment to most, if not all, of the WGBIE stocks as this process will also be complementary with the migration from InterCatch to the new ICES web data portal discussed below. However, no other stock assessment has been implemented in TAF in 2023.

1.6 Assessment and forecast auditing process

WGBIE carried out the standard audits of individual assessments and forecasts where available for all stocks assessed. Following a template provided by the ICES secretariat, the choice of assessment model, the model configuration, and the data used in the assessments have been checked against the corresponding settings described in the Stock Annex. Not all audits could be completed by the end of the WGBIE meeting specifically for three *Nephrops* stocks (nep.fu.2324, nep.fu.2627 and nep.fu.30) as the 2023 UWTV survey data needed to complete their respective assessments and advice will only be collected during the summer. The audit of these remaining stocks will be done after the meeting before the ADGNEPH in autumn.

In general, for all stocks audited during the WGBIE meeting, only minor corrections were raised by the auditors and these were corrected accordingly.

1.7 Mohn's rho

As standard practice, for each of the stocks assessed using a full analytical assessment of a category 1 of stock assessment, the Mohn's rho (Mohn, 1999) values were calculated using a 5–year peel for ten category 1 and four category 2 stocks (Figure 1.3). WGBIE assesses ten stocks that fall into this category of assessment using a combination of age and/or length structured models, either SS (Methot Jr. and Wetzel, 2013) or a4a (Millar and Jardim, 2019), and four stocks that are assessed with the SPiCT model (Pedersen and Berg, 2017). As can be observed in Figure 1.3, only three category 1 stocks (northern hake, southern white anglerfish and the Bay of Biscay sole) and two category 2 stocks have F and SSB Mohn's rho values within the 20% threshold. For the northern hake, F and SSB values showed slight retrospectivity but still along acceptable limits. Recruitment Mohn's rho values for five (northern black and white anglerfish, Bay of Biscay sea bass, southern four-spot megrim and northern megrim) out of the ten WGBIE category 1 stocks shows high retrospective bias suggesting that recruitment is not easily estimated by each of these stocks' respective assessment models.

1.8 Application new harvest control rules (HCRs) and stock assessments for categories 2 and 3

Until 2021, the ICES technical guidelines for category 3 stocks (Annex III in WKLIFE VIII; ICES, 2020) applied the revised 2-over-3 rule (ICES, 2012a; 2018a; 2019a) as the basis for the catch scenarios for providing advice. This year, this was replaced by the new '*rbf*' rule (Method 2.1 in ICES, 2022a) which is specifically used for category 3 stocks as a part of the new ICES technical guidance for HCRs and stock assessment for categories 2 and 3 stocks (ICES, 2022a). WGBIE observed that the new '*rbf*' rule does not use the available information coming from DLS methods such as LBI, LBSPR, and MLZ and the indicators used named *r*, *b* and *f*, suggest a different stock and fishery status compared with DLS methods. WGBIE suggest the development of interseasonal work to explore ad-hoc methods that consider the most relevant information in each case.

During the WGBIE meeting this year, these new '*rfb*' rule were applied to three stocks, namely the pollack (pol.27.89a) and whiting (whg.27.89a) in subarea 8 and division 9a as well as the sole in divisions 8c and 9a (sol.27.8c9a).

However, with regards to the *Nephrops* stock in FU 2829 (nep.fu.2829), the '*rfb*' rule was not applied for the advice in 2023 and 2024. It should be noted that in 2021, the *Nephrops* in FU 2829 stock was classified as a DLS category 3.2.0 and provided advice based on:

- the trends of the standardized commercial CPUE series (since 1998), used as the index of stock development;
- the fishing pressure determined by sex, using the Mean Length-Z with effort (THoG), defined in WKLIFE V (ICES, 2015), accepted and approved during the WKProxy (ICES, 2015), and reviewed in WKNEPS (ICES, 2020c).

The input data for this method includes the length composition of the catches, the effort series derived from the standardized commercial CPUEs, and the life-history parameters. The basis for the assessments is documented in the stock annex of the *Nephrops* stock in FU 2829 (nep.fu.2829).

WKLIFE X (ICES, 2020a) recommends that the advice for category 3 stocks should be based on the most complete information available. Based on this rationale, an advice using the new ICES '*rfb*' rule (Method 2.1 in ICES, 2022a) was considered by WGBIE as a step back on the basis of the assessment for this stock as it only considers the LBI F_{MSY} proxy indicator, which in turn ignore the consideration of the effort series. Also, although both indicators suggest that the fishing pressure is below the F_{MSY}, the perception from the MLZ is that F is at a lower level than when using the LBI. For these reasons, WGBIE suggested to keep and apply the previously used advice methodology in 2021 for the years 2022 and 2023 (ICES, 2021d). Please refer to section 13.2 in this report for further details.

For the *Nephrops* in FU 30 (nep.fu.30), which is also a category 3 stock, will apply the new ICES guideline for HCRs and assessment (ICES, 2022a). The advice for this stock will be drafted, reviewed and released in autumn. It should be noted that nep.fu.30 is one of the five *Nephrops* FUs (assessed as 3 separate stocks with nep.fu.2627 and nep.fu.2829) stocks which are managed jointly with a single TAC set for the whole of subareas 9, 10 and CECAF 34.1.1. Since 2018, a maximum limit on *Nephrops* landings from FU 30 is included in the TAC regulation. Please refer to section 13.3 in this report for further details.

1.9 Stock annexes

WGBIE identified that some of the existing Stock Annexes available on the ICES sharepoint need to be updated with the revised versions which describes and defines all the current parameters and conditions used for assessment and advice. Although this seems to concern mainly those stocks that were recently benchmarked, all stock coordinators was requested to check and verify that the most recent version of the stock annex for each of their respective stocks are uploaded and available on the sharepoint.

1.10 DGMARE special request for zero catch advice

During the meeting, WGBIE was made aware of a DGMARE special request to explore alternatives to zero catch for stocks that are caught in mixed fisheries. Currently, two WGBIE stocks are concerned by this request: the *Nephrops* stocks in FUs 25 and 26–27. However, these stocks are not required to provide catch advice this year. The latest advice for each of these two stocks were released in 2022 and these catch advices remain valid for each of the years 2023, 2024 and 2025. Furthermore, the task would require mixed fishery analysis and these FUs are not implemented in the current mixed fishery model. WGBIE requested for more information and clarifications from ICES but DGMARE failed to provide sufficient details which led to an ICES decision that WGBIE is not obliged to address this request this year.

1.11 Updates on some WGBIE stocks genetic studies

In 2021, WGBIE wrote a recommendation with regards to the stock structure of white anglerfish and hake in the areas northern shelf (463a), the southern shelf north (78abd) and the southern shelf south (8c9a). Having the current ICES stock definitions in mind and reflecting upon any needs for revisions of those, WGBIE agreed that the science and the work on the assessments of these stocks have advanced sufficiently to such a stage that it was an opportune time to make a request to SIMWG and WGAGFA in 2021 to review the existing and recent literature (i.e. Aguirre-Sabaira *et al*., 2021 and a WD by Abad *et al*., 2021 in ICES, 2021d) with regards to the stock structure of the white anglerfish and hake in the northern shelf (463a), southern shelf north (78abd) and southern shelf south (8c9a) areas considering the current ICES stock definitions in mind and reflecting upon any needs for revisions of those, based on the new findings observed.

In 2022, WGAGFA responded positively to this request and presented some of their ongoing studies related and which may be of great interest to the WGBIE requests to the WG, specifically works that are being and/or may be conducted on the WGBIE stocks enumerated above.

This year, WGAGFA presented some preliminary results of three of their on-going genetic analyses on (1) hake genetic connectivity (Rodríguez-Ezpeleta, N. *et al*., 2023a; WD 4 in this report), (2) anglerfish stock ID and hybridization (Rodríguez-Ezpeleta, N. *et al*., 2023b; WD 5 in this report) (3) the exploration of using the close-kin mark-recapture (CKMR) methods to estimate accurate spawning-stock biomass for hake (Rodríguez-Ezpeleta, N. *et al*., 2023c; WD 6 in this report) during the WGBIE meeting. Future research needs and planned genetic studies relevant to WGBIE are detailed further in this section.

WGBIE will renew request to SIMWG for further review of the northern and southern anglerfish stock IDs and population structure.

1.12 WKREBUILD2 and WKNEWREF

Two ICES workshops on rebuilding plans (WKREBUILD2) and re estimation of reference points (WKNEWREF) which were recently approved by ACOM were presented to the WG during the WGBIE meeting. These workshops are scheduled in late 2023 and early 2024 and the presentations were made not only to provide information to ACOM expert groups (EGs) but also to request the EGs to nominate stock/s in their respective WGs to participate in one or both of the two future workshops. However, the candidate stock/s that will be nominated in each ACOM EG must fulfill some of the workshop-specific requirements for potential stock consideration/participation in each workshop.

The ICES WKREBUILD2 which is already scheduled on November 2023 aims at developing guidelines and methods for the evaluation of rebuilding plans. One of the most pertinent requirements is that the stock’s SSB should be below B_{lim}. WGBIE has some stocks that could be very good candidates for this workshop, mainly the *Nephrops* in FU 25 (nep.fu.25). However, due to time constraints and substantial workload of the SCs, a potential participation to this workshop will require considerable intersessional supplementary tasks especially for the nep.fu.25 SC who already has an annual WGNEP workshop scheduled in autumn. Thus, WGBIE will not be able to nominate a potential candidate stock for consideration in this workshop.

For the WKNEWREF which is scheduled in February 2024 and where the number of participants will be limited to about 25 stocks, stocks for consideration must include those that cover a wide range of geographical areas, life-history types, exploitation histories and assessment characteristics. As this workshop will occur early next year, there is a lesser risk of time constraint. Therefore, WGBIE agreed to propose four stocks to this workshop whose respective SCs are very interested to participate and raised no issues on allotting supplementary intersessional time to prepare and perform tasks necessary for workshop participation. The four selected stocks include the northern and southern hakes and the northern white-bellied and black-bellied anglerfish.

1.13 Future implementation of the Regional Database and Estimation System (RDBES) on WGBIE stock assessments

Currently, ICES is strongly pushing through the database migration towards the RDBES framework (ICES, 2022b) as a replacement to InterCatch. The RDBES has been developed to increase transparency, ensure harmonization and enhance data quality at a regional level to facilitate fisheries assessment (ICES, 2022b). This tool, which is still under development but already usable and operational, centralizes detailed commercial fisheries sampling data and aggregated effort and landings data. This data portal aims to assist in the regional approach to survey and data collection. Currently, most stock submitters and coordinators are still using InterCatch but ICES aims that future stock assessments be carried out using the RDBES for regional data call and submissions. This gradual and successful transition from InterCatch to RDBES is ensured by continuous and collective testing and exploration of the portal. The capabilities and efficiency of this tool on estimations and raising are still being compared with InterCatch, as the latter is gradually being phased out and is planned to be completely replaced by the RDBES once explorations and testing are fully validated in 2025.

1.14 Recent benchmarks of single-species assessments

In 2022, the benchmark issues lists were completed for five stocks (two category 1 and three category 5 stocks) in preparation for potential future benchmarks and to review future research needs. The WG reviewed the stocks to be benchmarked using the benchmark prioritization scoring sheet. There are five scoring categories (with different weights) each with a score of 0, 2 to 5 (5 being the highest priority). These scores are combined and the final selection of stocks to benchmark is determined via a system of ranking all stocks assessed by ICES.

In late 2022 and early 2023, four WGBIE stocks were benchmarked, distributed between two separate benchmark workshops: WKBSEABASSID (ICES, 2023b) and the WKBMSYSPiCT2 (ICES, 2023g), respectively.

Three separate workshop benchmarks were approved by ACOM for the Bay of Biscay sea bass (bss.27.8ab) for 2023 and 2024. This first benchmark on stock identification (WKBSEABASSID) was held in January 2023 (ICES, 2023b). The workshop's objective was to review information on sea bass stock identification for the Celtic Sea (bss.27.4bc7ad-h) and the Bay of Biscay (bss.27.8ab) stocks, and conduct a comparative review of Atlantic sea bass population structure, including critical evaluation of inferences from each source of information, to build up a picture of sea bass stock structure in Celtic Sea, Bay of Biscay and adjacent areas. Some of the general conclusions established during the WKBSEABASSID workshop were (i) a substantial evidence of the stock's identity were achieved compared to the previous process made, (ii) some gaps were identified which includes the ICES division 8.b should be affiliated with, can the area of mixing be narrowed down, were all the regionally-specific Single nucleotide polymorphisms (SNPs) identified for the areas of interest and how does Scottish and Irish stocks interact with other ICES units for advice. Some highlights will be provided in section 14 of this report. However, the complete details and information on this workshop can be found on the WKBSEABASSID report (ICES, 2023b).

The WKBMSYSPiCT2 (ICES, 2023g) benchmark was held last December 2022. There were three WGBIE category 5 stocks that were included in this workshop: plaice, pollack and whiting. The objective of the workshop was to test and evaluate the feasibility of each of these three stocks to be assessed using the SPiCT method (Pedersen and Berg, 2017). During the benchmark process, the application and development of a SPiCT model was explored integrating new and revised data, when available, and newly standardized LPUEs. The main conclusion from the recent WKBMSYSPiCT2 workshop was that all three SPiCT assessment models developed were not appropriate to the assessment of these stocks and, thus, all three stock-specific SPiCT model was rejected (ICES, 2023g). However, the pollack and whiting stocks applied and explored the used of trends from biomass index and commercial LPUEs and/or LBIs assessment methods (ICES, 2023a; e; h) with the implementation of the new '*rbf*' rule for providing category 3 advice (Method 2.1 in ICES, 2022a) during the WGBIE meeting this year. Consequently, the revisions of the previous assessment models for each of the pollack and whiting stocks which included (i) the integration of new standardized LPUEs, (2) the use of LBSPR and/or LBIs from (commercial) catches (ICES, 2023h) and (3) the implementation of the new '*rfb*' rule for category 3 stocks (Method 2.1 in ICES, 2022a) allowed to give MSY advice. Further details can be found in sections 17 and 18, respectively (ICES, 2023h). If the proposed methods for these two stocks are accepted, both the WGBIE pollack and whiting will be upgraded to category 3 stocks this year (ICES, 2023h) and the 2023 ICES advice for each of these two stocks for release will be drafted accordingly for the ADG review in June 2023.

Otherwise, the plaice remains as a category 5 stock using the same LBI method (ICES, 2015) for the evaluation of this stock (ICES, 2022c; 2023h).

1.14.1 Future benchmarks

The table below summarizes some information on the recently completed benchmarks with the respective conclusions reached for each workshop as well as the stocks for future benchmarks from the second semester of 2023 to 2025, specifying their respective objective/s and needs for a benchmark recommendation. Several stocks with their respective assessment models were benchmarked in 2022.

Three separate benchmark workshops scheduled for 2023 and 2024 were approved by the ACOM for the Bay of Biscay sea bass (bss.27.8ab). As mentioned above, WKBSEABASSID (ICES, 2023b) was held at the beginning of the year while the two other benchmarks will be held during the end of the year and another in 2024. The second phase in this multi-benchmark process will be the data collection workshop in 2023 followed by the third workshop on assessment model revision in 2024. Although there are still some outstanding issues with regards to the WKBSEABASSID meeting, a significant progress was achieved in terms of what is currently known on genetic connectivity and distributions. The upcoming benchmarks will be focused on the improvement of the current SS assessment model for the stock and the integration of recently collected or available data. These future benchmark workshops could also be an avenue to resolve other issues such as (a) the work on stock identification, (b) the estimation of new recruitment estimates from scientific surveys in three estuaries directly connected to the Bay of Biscay, (b) development of drift models to identify spawning and recruitment grounds, (c) evaluation of stock mixing and spatial dynamics, (d) integration of genetic and tagging results and (e) further analyses to identify bias and resolution schemes to increase the accuracy of age data. WGBIE considers that the revision of the existing analytical SS assessment model for the northern stock would be important in resolving the assessment quality issues and improving the advice for this stock.

The fourth benchmark approved by ACOM this year is for the WGBIE Bay of Biscay sole in divisions 8.a and 8.b which will be held in 2024. This stock has not been benchmarked since 2011

(ICES, 2011). The main reasons for organizing this benchmark are to test the implementation of a new assessment method for this stock which is currently using a deterministic model (XSA; Shepherd, 1999) for the assessment and to work on the nominal standardization of the LPUEs. For the upcoming benchmark for this stock, the objective is to migrate to a stochastic assessment model, potentially an a4a assessment model (Millar and Jardim, 2019), with standardized LPUEs to improve the current assessment. Furthermore, biological parameters such as the maturity ogive, have not been updated since 2000 and the integration of these data will also be tested during the next benchmark

Name	Assessment status	Latest Benchmark	Benchmark next year	Planning Year +2	Comments/Issues
Black-bellied anglerfish in divisions 8.c and 9.a	SPiCT trends (Pedersen and Berg, 2017)	WKANGLER (ICES, 2018c); WKMSYSPiCT (ICES, 2021b)	–	Yes	Exploration and development of the preliminary SS assessment model explored in WKTaDSA (ICES, 2021g).
Hake in subareas 4, 6, and 7 and divisions 3.a, 8.a,b,d	Update SS model (Methot Jr. and Wetzel, 2013)	WKSOUTH (ICES, 2014); IBPHAKE (ICES, 2019b); WKANGHAKE (ICES, 2023b)	Yes	–	IBP was recommended by WGBIE during the 2022 meeting to explore and solve issues with the 2022 retrospective patterns (ICES, 2022c). Issues to be resolved intersessionally by WGBIE, following the new benchmark guidelines (ICES,2023f)
Megrim in divisions 8.c and 9.a	a4a model (Millar and Jardim, 2019)	IBPMEGRIM (ICES, 2016); WKMEGRIM (ICES, 2023d)	Yes	–	IBP was recommended during WGBIE meeting in 2022 to organize a specific workshop with a4a assessment model expert/s to improve the configuration and fix the retro bias issue observed during the WKMEGRIM (ICES, 2023d) and WGBIE meeting in 2022 (ICES, 2022c). Issues to be resolved intersessionally by WGBIE, following the new benchmark guidelines (ICES,2023f)
Plaice in Subarea 8 and Division 9.a	Category 5. LBI as fishing pressure indicator (ICES, 2015).	WKBMSYSPiCT2 (ICES, 2023g)	–	–	SPiCT model was rejected during WKBMSYSPiCT2 (ICES, 2023g).
Pollack in Subarea 8 and Division 9.a	Category 5. LBI as fishing pressure indicator (ICES, 2017c; 2022c; 2023a; e) but may be upgraded to category 3 if LBI and HCR advice (ICES, 2022a; 2023a; e; h) are accepted by external reviewers.	WKBMSYSPiCT2 (ICES, 2023g)	–	–	SPiCT model developed during WKBMSYSPiCT2 was rejected (ICES, 2023g). Explored statistical models to standardize commercial LPUEs (ICES, 2023a; e; h). Collect or estimate missing data and consolidate existing data: time-series data of (a) catch, (b) length structure, (C) commercial CPUEs, and (d) consolidated discards. Review biological parameters. Explored statistical models to standardize FR-GNS>90mm-8a-2s abundance index and CPUEs. Evaluate stock distribution. Used DLS (LBI and HCR for Category 3) methods for stock assessment and advice for category 3 stocks (under review after WGBIE 2023 meeting; ICES, 2023a; e; h).

Name	Assessment status	Latest Benchmark	Benchmark next year	Planning Year +2	Comments/Issues
Sea bass in divisions 8.a and 8.b	Update SS (Methot Jr. and Wetzel, 2013)	WKBASS (ICES, 2018c); IBPBASS (ICES, 2018d); WKSEABASSID (ICES, 2023c)	Yes	–	Progress achieved during the stock structure identification workshop in early 2023 (WKSEABASSID; ICES, 2023c) but will need further studies. Explore the integration of new recruitment indices, improve ALK data accuracy, spatial dynamics and distribution and estimate new/robust abundance indices. The benchmark workshops are jointly organized with the other sea bass stocks in the Celtic Sea.
Sole in divisions 8.a and 8.b	XSA (Shepherd, 1999) deterministic.	WKFLAT (ICES, 2011)	Yes	–	Change of assessment model to a stochastic model (a4a or SAM). LPUEs standardization will improve model assessment. Biological parameters have not been updated since the last benchmark (maturity ogive has not been updated since 2000).
White-bellied anglerfish in divisions 8.c and 9.a	Update SS model (Methot Jr. and Wetzel, 2013)	WKANGLER (ICES, 2018c)	–	Yes	Remaining issues (tuning fleets, length composition). Absence of large-size individuals. Improvement of standardized LPUEs. SS model update.
Whiting in Subarea 8 and Division 9.a	Category 5. LBI as fishing pressure indicator (ICES, 2017c; 2022c; 2023a; e) but may be upgraded to category 3 if LBI and HCR advice (ICES, 2022a; 2023a; e; h) are accepted by external reviewers.	WKBMSYSPiCT2 (ICES, 2023g)	–	–	SPiCT model developed during WKBMSYSPiCT2 was rejected (ICES, 2023g). Explored statistical models to standardize commercial LPUEs (ICES, 2023a; e; h). Used DLS (LBI and HCR for Category 3) methods for stock assessment and advice for category 3 stocks (under review after WGBIE 2023 meeting; ICES, 2022a; 2023a; e; h). Collect or estimate missing data and consolidate existing data: time-series data of (a) catch, (b) length structures, (C) commercial CPUEs, and (d) consolidated discards. Review biological parameters. Evaluate stock distribution.

1.15 Fisheries overviews

Some progress on the development of a mixed-fishery analysis has been made in WGMIXFISH-ADVICE (ICES, 2021e) and WGMIXFISH-METHODS (ICES, 2021f) using some Iberian stocks and some Bay of Biscay stocks in a separate analysis. The group has contributed in 2022 to the review of the fisheries description and provided the inputs from the stocks assessment for the analyses carried out in these two groups. This year, the latest version of this document was reviewed by the group during the meeting, some comments, suggestions and corrections were raised which will be communicated to the WGMIXFISH. It was, however, suggested that the WGBIE chairs request to be updated and/or have a member of the group invited in the WGMIXFISH annual meeting leading to the update of this document for future relay to the rest of the WGBIE members. It was also suggested that the review process the document be reviewed by the chairs and/or expert members before the release of the final version covering the WGBIE ecoregion.

1.16 Ecosystem overviews

No progress has been made on this term of reference as the latest version of this document was not reviewed by the group due to time constraints. WGBIE decided that the review process for the document on the Bay of Biscay and Iberian waters ecoregion be done after the ADGBBI and publication of the 2023 WGBIE report. Comments and suggestions on the text will be communicated to the WGEAWESS.

1.17 WGBIE comments on potential creation of *Nephrops*-specific WG in 2024

This year, the WG discussed an ICES proposition of regrouping all the *Nephrops* stocks from different advisory working groups into one where experts of these stocks will collectively meet and work together on assessments and advice and will potentially be scheduled every April each year. Currently, *Nephrops* stocks in this WG includes 6 stocks separated into functional units (FUs). WGBIE sees both advantages and disadvantages with regards to this proposed reorganization.

WGBIE acknowledges the interests on the prospect of having a single annual WG for all the *Nephrops* stocks (like WGCRAB, WGEF, WGEEL, etc) such as (1) the facilitation of data compilation, standardization and knowledge exchange, (2) the rapid development, improvement, identification and explanation of gaps in current ICES *Nephrops* assessment methods and (3) the opportunity to identify specific challenges and/or develop species-specific tools for evaluation, particularly for DLSs.

However, being an integral part of WGBIE has also allowed these *Nephrops* stocks to gain wider perspectives on each of these stocks' respective assessment and evaluation considering that these stocks are caught in mixed-fisheries. Also, the interest of having these stocks assessed during the WGBIE corresponds to the ICES framework as their evaluation at the ecoregional level facilitates and supports the transfer and enrichment of knowledge provided to the fisheries (WGMIXFISH) and ecosystem (WGEAWESS) overviews expert groups as well as the current opportunities of their integration into the MSFD assessment (i.e. evaluation of SBL).

In terms of practicality, two of the WGBIE *Nephrops* stocks (nep.fu.2324 and nep.fu.30, potentially will include nep.fu.25 in future) using UWTV data surveys can only proceed to the complete assessment of these stocks once these survey data are available, usually during summer, such that the advice can only be drafted and reviewed during a designated ADG in autumn. It should also be noted that aside from this meeting, a specific annual WGNEPS is held in November for the international coordination group of the UWTV and trawl surveys. If the potential new WG regrouping all *Nephrops* stocks will be scheduled in April each year, this WG sees no real advantage for the evaluation of these *Nephrops* stocks especially those using UWTV surveys in their assessments and advice. WGBIE feels that the proposed period of annual meeting for this new specific WG seems to be less convenient and presents a high risk of failure of completely achieving the generic and future WG-specific ToRs as some *Nephrops* stocks will still not have access to all data needed for the assessment in April and the stock coordinators of this new WG may not be able to finish their assessments in time for the meeting due to severe time constraints.

It should be noted that the potential dates or period for assessment of the *Nephrops* stock that will migrate into this new WG must take into consideration the feasibility of this WG to continue their annual data provision to the WGMIXFISH on time.

1.18 Research needs of relevance for the expert group

1.18.1 Recruitment indices for adult populations

Many of the stocks have recruitment indices available with limited indices for the adult population (e.g. hake and anglerfish). Therefore, it would be advantageous to develop and use adult biomass indices to help reduce the uncertainty in the spawning-stock biomass (SSB) estimates. Further research and appropriate evaluation are recommended in the development of such indices for stocks where standard surveys are not appropriate due to catchability issues.

1.18.2 Absence of relevant biological parameters

For the stocks of hake, megrim, four-spot megrim, anglerfish, sea bass, and some of the *Nephrops* Functional Units, further studies are required to better understand the mixing between areas and the biology over time such as growth, maturity, length-weight, sex-ratio, and natural mortality. To fully make use of new research on these stocks it would be beneficial to focus on developing appropriate assessment methods and reviewing the performance of such models through comprehensive sensitivity analyses.

1.18.3 Improvement and validation of population structure identification from genetic analyses

1.18.3.1 Anglerfish stocks identification and hybridization (collaboration with WGAGFA)

The WGBIE recognizes the significance the implementation of a regular monitoring network for white and black anglerfish genetic material collection for standardized genetic analyses to minimize misidentification and hybridization between black and white anglerfish. A recent study has shown that white and black anglerfish hybridize and that the most used morphological diagnostic characteristic for species identification is equivocal (Aguirre-Sarabia *et al*., 2021; Rodríguez-Ezpeleta *et al*., 2023b; WD 5 in this report). Further analyses based on an increased dataset and improved methodology have confirmed this and revealed that:

i. hybrids constitute about 9% of white anglerfish samples overall and up to 12% in the Northern stock; and
ii. that misidentification is high in the southernmost locations.

Although those analyses were based on more than 1000 and 500 white and black anglerfish samples, the number of samples in some locations was small and thus more samples also covering more years are necessary to further understand the abundance and distribution of hybrids. Additionally, little is known about the hybrids and although so far, only first-generation hybrids and backcrosses (hybrids reproducing with hybrids) have been found, which indicates no or lower fitness of hybrids, this must be confirmed with more samples. Knowing the abundance and distribution of hybrids and their viability is important for improving the species assessment because if hybrids cannot reproduce, this should be reflected in the evaluation and if they can, analyses on their fate should be performed.

1.18.3.2 Sea bass stock ID

A joint WGBIE-WGCSE WKBSEABASSID benchmark (ICES 2023c) for the sea bass population structure identification was held early this year to review and discuss the most recent studies, data analyses and future research needs for the stock identification. The main conclusions and findings from this workshop were mentioned before and further detailed in the WKBSEABASSID workshop report (ICES, 2023c). However, like the anglerfish stocks, WGBIE recognizes the relevance of the implementation of regular monitoring and analyses to increase dataset for validation and improvement of current ICES stock definitions.

1.18.3.3 European hake connectivity

A genome-wide based population structure study was conducted on European hake to identify differentiation of Mediterranean and Northeast Atlantic regions. The study showed that hake in the Norwegian Sea has higher differences from the rest of the locations/regions considered in the study while hakes from the eastern Bay of Biscay and the northwestern Iberian Peninsula are genetically more similar (Leone *et al.*, 2019). A pilot study on the hake genetic analyses of samples collected from different ecoregions showed a clearly scattered stock population structure, with close similarity between close regions but a very distinct gradient across the geography (Rodríguez-Ezpeleta *et al.*, 2023a; WD 4 in this report). Further studies are needed to determine and evaluate how the hake genetic population structure coincide with the assessment units or ecoregions as these will improve future stock exploitation and management.

1.18.3.4 Estimation of hake and anglerfish spawning-stock biomass (SSB)

WGBIE recognizes the significance of having an accurate estimation of hake and anglerfish SSB to improve the quality of the assessment and advice for these stocks. Currently, preliminary collaboration work with WGAGFA shows that the Close-Kin Mark-Recapture (CKMR) is a candidate procedure to collect data for in support of the estimations of SSB (Rodríguez-Ezpeleta *et al.*, 2023c; WD 6 in this report). Future applications of this method that will be explored in collaboration with WGAGFA is the relevance of this method in hake and anglerfish stocks species characterization of hake and anglerfish and provide accurate age estimations.

1.18.4 Develop (generic) integration procedures of stock or population structure data for Category into the SS assessment models

WGBIE needs to develop standardized procedure/s for the integration of these newly derived information on stock IDs, CKMR analyses and population structure into the SS assessment model framework of some category 1 stocks with which data collected from genetic analyses are available and, potentially, routinely performed as the WG recognizes the pertinence of this development for the improvement of future assessment and advice.

1.19 Recommendations, proposals for future benchmark and workshop

1.19.1 Request RCG to assist in the implementation of routine collection of genetic materials for some WGBIE stocks through the DCF

WGBIE recommends that the RCG NANSEA supports the implementation of an annual data collection framework of genetic material of hake and monkfish to: (1) determine hake and white anglerfish metapopulation structure; (2) estimate hake and white anglerfish spawning-stock biomass through Close-Kin Mark-Recapture (CKMR); (3) monitor species misidentification and hybridization between black and white anglerfish.

Sample collection

It is proposed to collect sufficient samples on existing trawl surveys.

- Anglerfish (*Lophius* spp): up to 9,000 individuals per year
- Hake: up to 23,000 individuals per year

WGBIE is aware of 13 RCG NANSEA-coordinated annual sample collection surveys for measuring for the two anglerfish (about 50 000 yr^{-1}) and hake (about 110 000 yr^{-1}) species, and where 6 (FR-EVHOE, IE-IAMS, IE-IGFS, PT-IBTS, NS-IBTS and SP-NORTH) of these surveys are relevant to provide the needed genetic samples to provide or improve current knowledge of stock identification, estimation of population size and/or structure (Roldán *et al*., 1998; Leon *et al*., 2019; Abad *et al*., 2021), kinship probabilities and SSB for this WG.

The effort in collection of genetic samples is like that of collecting otoliths, but apart from this staff time there will be no cost to the participating institutes. The analysis of the samples will be done by AZTI and is funded under a PhD project for the next few years. Sampling kits will be prepared and sent to survey coordinators. The surveys identified above have already provided more than 2,000 genetic samples to AZTI on an ad-hoc basis for previous genetics projects.

Scientific background

Population structure and SSB: Preliminary simulations of CKMR modelling in hake and anglerfish suggest that this method could represent an alternative for accurate Spawning-stock biomass estimation in these species. Application of CKMR requires many samples in the order of thousands per year (Aguirre-Sarabia *et al*., 2021), which can only be achieved as part of a regular monitoring network collecting tissue samples for genetic analyses. CKMR cannot only be used for SSB but can also provide information about movements of individuals and thus the metapopulation structure, which is invaluable for complementing current population structure analyses suggesting panmixia in white anglerfish (Aguirre-Sarabia *et al*., 2021) and isolation by distance in hake (Rodríguez-Ezpeleta *et al*., 2023a;WD 4 in this report).

Misidentification and hybridization: Recently, Aguirre-Sarabia *et al*. (2021) showed that hybridization occurs between white and black anglerfish and that the most used morphological diagnostic characteristic for species identification is equivocal and that unequivocal species identification requires genetic analysis. Further analyses based on an increased dataset and improved methodology have confirmed these findings and revealed that i) hybrids constitute about 9% of white anglerfish samples overall and up to 12% in the Northern stock and ii) that misidentification is high in the most southern locations. However, it should be noted that these rates were from analyses based on about more than 1000 and 500 white and black anglerfish samples and in some locations the sample number collected was low. Thus, more samples, covering more years are necessary to further understand abundance and distribution of hybrids. Currently, little is known about the hybrids and although so far only first-generation hybrids and backcrosses (hybrids reproducing with pure individuals) have been found, suggesting no or lower fitness of hybrids, this must be confirmed with more samples. Estimating the abundance and distribution of hybrids and their viability is important for improving the species assessment because if hybrids cannot reproduce, this should be reflected in their evaluation and if possible, additional analyses on their fate should be performed.

1.19.2 Benchmark for the southern white and black anglerfish

WGBIE recommends that an ICES benchmark workshop with relevant experts be organized, as soon as possible, for the development of new and improved assessments with the SS framework (Methot Jr. and Wetzel, 2013) for the southern black (ank.27.8abd) and white (mon.27.8c9a) anglerfish stocks, respectively. The main reasons for supporting a new benchmark for the two southern anglerfish stocks relates with issues identified and conclusions made for both stocks during previous WGBIE meetings (ICES, 2020b; 2021d; 2022c; 2023h), the ICES Workshop on Tools and Development of Stock Assessment Models Using a4a and Stock Synthesis (WKTADSA; ICES, 2021a) and WKMSYSPiCT benchmark for the southern black anglerfish in 2021 (ICES, 2021b). In the case of the southern black anglerfish (ank.27.8c9a) last benchmarked in 2021 currently uses the SPiCT assessment model (Pedersen and Berg, 2017). However, following the suggestion of reviewers during WKMYSPiCT (ICES, 2021b), the potential of replacing this SPiCT model with a SS integrated model (Methot Jr. and Wetzel, 2013) should be tested and explored. If this new assessment model is validated and accepted, the stock will move from a category 2 to 1 and, will make use of the same assessment methodology as the three WGBIE anglerfish stocks. In the case of the southern white anglerfish (mon.27.8c9a) which was last benchmarked in 2018 (ICES, 2018c), the configuration of the current SS model needs to be improved to better track the large size population. The main reasons for supporting a benchmark aside from the change of assessment model in the case of the southern black anglerfish also includes the need to estimate new or improved standardized LPUEs for commercial fleets (and exploitable sizes), following the most adequate methods (e.g. see ICES, 2021b for conclusions for ank.27.8c9a and ICES, 2023g for standardization guidelines) and the experience gained in the recent WKANGHAKE (ICES, 2023b) where both the northern black (ank.27.78abd) and white (mon.27.78abd) anglerfish were also benchmarked with SS. Both the southern anglerfish stocks were part of the Workshop on Tools and Development of Stock Assessment Models Using a4a and SS, where different SS model configurations were tested (WKTaDSA; ICES, 2021g).

1.19.3 Resolve quality issues in assessment models.

WGBIE recommended last year for two separate IBP workshops for northern hake (hke.27.3a46-8abd) and the megrim stock in divisions 8.c and 9.a (meg.27.8c9a) to resolve some outstanding issues in the parametrization of these stocks respective assessment models which were identified during the 2022 meeting but were not resolved due to time constraints and need of external a4a experts, respectively (ICES, 2022c). These IBPs were planned to be organized in late 2022 or early 2023. The main reason was the consistent out-of-bounds retrospective patterns observed. This year, additional stocks have been identified as out-of-bounds (Figure 1.3) which WGBIE considers pertinent to explore, review and validate intersessionally.

No progress has been made for the resolutions of these issues in 2022 and plans for 2023 are unclear, especially since the benchmark process has recently changed in 2022 and where the IBP workshop is no longer considered (ICES, 2023f).

Following the new benchmark guidelines (ICES, 2023f), WGBIE plans to hold intersessional works among WGBIE relevant expert members to resolve these issues and improve the quality of the assessment by testing and validating scenarios within the WG. Once significative progress and resolutions are achieved by the WGBIE and if/when needed, a recommendation for specific benchmark workshops will be done to request for reviews and validation by external experts, following the new ICES benchmark guidelines (ICES, 2023f).

1.19.4 Workshop on CKMR standardized protocols and analyses for WGBIE demersal stocks

WGBIE plans to organize a CKMR workshop on demersal species in collaboration with WGAGFA with the potential participation of other renowned genetics research experts either this year or in 2024. Among the workshop's primary ToRs would include (i) the development of a standardized CKMR protocols for sample collection and analyses (ii) explore and review the methods application for accurate age and SSB estimations on European hake and anglerfish stocks (ii) development and exploration of potential and effective integration procedures of collected genetic data into the assessment models.

1.19.5 Development and improvement of standardized CPUE/LPUE series

WGBIE recommends the development and/or improvement of standardized CPUE/LPUE series for the following stocks:

- **Category 1 stocks**: northern sea bass (bss.27.8ab), Bay of Biscay sole (sol.27.8ab); southern white anglerfish (mon.27.8c9a);
- **Category 2 stocks**: southern black anglerfish (ank.27.8c9a);
- **Category 3 stock:** *Nephrops* in FUs 2829 (nep.fu.2829), Pollack in Subarea 8 and Division 9.a, (pol.27.89a), whiting in Subarea 8 and Division 9.a (whg.27.89a);
- **Category 5 stocks**: sea bass in divisions 8.c and 9.a (bss.27.8c9a); plaice in Subarea 8 and Division 9.a (ple.27.89a).

1.19.6 Issues for improvement of category 5 stocks evaluation

The southern sea bass (bss.27.8c9a) is considered a category 5 DLS stock as opposed to the northern stock which is considered a category 1 stock. Lack of relevant data are the main reason for this status, like the two other WGBIE category 5 stocks: plaice (ple.27.89a) and northern four-spot megrim (ldb.27.7b-k8abd).

Contrary to plaice and northern four-spot megrim, WGBIE is aware of ongoing projects on southern sea bass species in Portugal and Spain. WGBIE is trying to contact these researchers to collaborate on establishing an approach that can help to improve the knowledge for this stock through an exchange of available information or the development of feasible data collection approaches. Furthermore, the ongoing sea bass benchmarks may identify and provide new or additional information, especially in the productivity process (i.e. growth, maturity, M, etc.) and, if possible, on its stock identity. WGBIE considers that a future benchmark will be an advantage for the southern stock as soon as new information become available.

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1.21 Tables

Table 1.1.a. Biological sampling levels by stock and country. Number of individuals measured and aged from landings in 2022.

	Number	Anglerfish (*L. piscatorius*)		Anglerfish (*L. budegassa*)		Megrim (*L. whiffiagonis*)		Megrim (*L. boscii*)		Sole (*S. solea*)	
		7.b–k & 8.abd	8.c & 9.a	7.b–k & 8.abd	8.c & 9.a	7.b–k & 8.abd	8c & 9a	7.b–k & 8.abd	8.c & 9.a	8.a,b	8.c & 9.a
Belgium	Lengths	5086		5196		21550				11955	
	Ages					1132				208	
	Samples**	27		27		27					
E & W (UK)	Lengths	19866		5964		30320					
	Ages					1265					
	Samples*	366		154		627					
France	Lengths	6450		3585		7508				22097	
	Ages					NA				2650	
	Samples*	5140		235		NA					
Portugal	Lengths		307		1214		248		510		1701
	Ages***		0								
	Samples*		91		100		10		19		116
Republic of Ireland	Lengths	4977		2883		12428					
	Ages					NA					
	Samples**	133		93		NA					

	Number	Anglerfish (*L. piscatorius*)		Anglerfish (*L. budegassa*)		Megrim (*L. whiffiagonis*)		Megrim (*L. boscii*)		Sole (*S. solea*)	
		7.b–k & 8.abd	**8.c & 9.a**	**7.b–k & 8.abd**	**8.c & 9.a**	**7.b–k & 8.abd**	**8c & 9a**	**7.b–k & 8.abd**	**8.c & 9.a**	**8.a,b**	**8.c & 9.a**
Spain	Lengths	13249	3732	16947	4554	33606	17507		30443	1765	2634
	Ages		0		0	NA	848		751		
	Samples	92	284	88	269	NA	187		211		183
Denmark	Lengths										
	Ages										
	Samples										
Total	Lengths	49628		34575	5768	105412	17765		30953		
	Ages					2397					
Total nb. in international landings ('000)		**6760**	**155**	**7176**	**4472**	**45198**	**2140**		**5161**		
Nb. measured as % of annual nb. caught		**0.73**	**2.60**	**0.48**	**0.13**	**0.23**	**0.83**		**0.60**		

* **Vessels**

** **Categories**

*** **Ages, surveys**

**** **Boxes/hauls (for sampling on board)**

***** **Otoliths collected and prepared but not read**

Table 1.1a. (continued)

	Number	Hake		*Nephrops*			Sea bass		Pollack	Whiting	Plaice
		3.a, 4, 6, 7 & 8.ab	8.c & 9.a	8.ab FU 23–24	8.c FU 25–31	9.a FU 26–30	8.ab	8.c & 9.a	8 & 9.a	8 & 9.a	8 & 9.a
Scotland (UK)	Lengths	4164									
	Ages										
	Samples*	100									
E & W (UK)	Lengths	8568									
	Ages										
	Samples*	196									
France	Lengths	17740		13122			14822		5296		
	Ages*****						865		0		
	Samples****	771		304			1235		553		
Portugal	Lengths		7423					?			
	Ages***							?			
	Samples*		151					?			
Republic of Ireland	Lengths	5318									
	Ages*****										
	Samples*	112									
Spain	Lengths	62649	58013		6268			2498	1637		
	Ages				-		1	?	3 0	4	5

	Number	Hake		*Nephrops*			Sea bass		Pollack	Whiting	Plaice
		3.a, 4, 6, 7 & 8.ab	**8.c & 9.a**	**8.ab FU 23–24**	**8.c FU 25–31**	**9.a FU 26–30**	**8.ab**	**8.c & 9.a**	**8 & 9.a**	**8 & 9.a**	**8 & 9.a**
	Samples*	291	731		29[a]		6	106	8 137	9	10
Denmark	Lengths	20733									
	Ages										
	Samples*	321									
Belgium	Lengths	818									
	Ages										
	Samples*	26									
Germany	Lengths	434									
	Ages										
	Samples*	60									
Sweden	Lengths	49									
	Ages										
	Samples*	5									
Total	Lengths	120473	65436				14822	2498	6933		
	Ages						1235				
Total No. in international landings ('000)			**14755**	**116190**	**94**		**?**	**?**	**694**		
Nb. meas. as % of annual nb. caught			**0.4400**	**0.0113**	**6.6000**				**1.0000**		

* **Vessels**

** **Categories**

*** **Ages, surveys**

**** **Boxes/hauls (for sampling on board), (a) hauls**

***** **Otoliths collected and prepared but not read**

Table 1.1.b. Biological sampling levels by stock and country. Number of individuals measured and aged from discards in 2022.

	Number	Anglerfish (*L. piscatorius*)		Anglerfish (*L. budegassa*)		Megrim (*L. whiffiagonis*)		Megrim (*L. boscii*)		Sole (*S. solea*)	
		7.b–k & 8.abd	8.c & 9.a	7.b–k & 8.abd	8.c & 9.a	7.b–k & 8.abd	8.c & 9.a	7.b–k & 8.abd	8.c & 9.a	8.a,b	8.c & 9.a
Belgium	Lengths	4957		7210		11274				1240	
	Ages					1196					
	Samples	27		27		27					
E & W (UK)	Lengths	6322		1620		7259					
	Ages					7					
	Samples	376		74		36					
France	Lengths	688		257		558				417	
	Ages										
	Samples	261		83							
Portugal	Lengths										
	Ages										
	Samples[1]										
Republic of	Lengths	1952		749		2367	799				

	Number	Anglerfish (*L. piscatorius*)		Anglerfish (*L. budegassa*)		Megrim (*L. whiffiagonis*)		Megrim (*L. boscii*)		Sole (*S. solea*)	
		7.b–k & 8.abd	**8.c & 9.a**	**7.b–k & 8.abd**	**8.c & 9.a**	**7.b–k & 8.abd**	**8.c & 9.a**	**7.b–k & 8.abd**	**8.c & 9.a**	**8.a,b**	**8.c & 9.a**
Ireland	Ages										
	Samples	152		35			238				
Spain	Lengths	6	34	226	268	5005			2221	1	
	Ages										
	Samples	150	291	322	300				297		
Denmark	Lengths										
	Ages										
	Samples										
Total	Lengths	13925		10062		26463			2221	542	
	Ages					1232					
Total no. in international discards ('000)		**3508**	**NA**	**8365**	**4**	**18351**					
Nb. meas. as % of annual nb. discarded		**0.027**	**NA**	**0.120**	**6.500**	**0.144**					

Table 1.b (continued).

	Number	Hake		*Nephrops*			Sea bass		Pollack	Whiting	Plaice
		3.a, 4, 6, 7 & 8.a,b	**8.c & 9.a**	**8.ab FU 23–24**	**8.c FU 25 & 31**	**9.a FU 26–30**	**8.ab**	**8.c & 9.a**	**8 & 9.a**	**8 & 9.a**	**8 & 9.a**
Scotland (UK)	Lengths	1012									

	Number	Hake		*Nephrops*			Sea bass		Pollack	Whiting	Plaice
		3.a, 4, 6, 7 & 8.a,b	8.c & 9.a	8.ab FU 23–24	8.c FU 25 & 31	9.a FU 26–30	8.ab	8.c & 9.a	8 & 9.a	8 & 9.a	8 & 9.a
	Ages										
	Samples	88									
E & W (UK)	Lengths	551									
	Ages										
	Samples	83									
France	Lengths	3607		1885			568		65		
	Ages								0		
	Samples	419		54			398		210		
Portugal	Lengths										
	Ages										
	Samples[1]										
Republic of Ireland	Lengths	1908									
	Ages										
	Samples	188									
Spain	Lengths	3031	3637		97						
	Ages										
	Samples	498	516		71[2]						

	Number	Hake		*Nephrops*			Sea bass		Pollack	Whiting	Plaice
		3.a, 4, 6, 7 & 8.a,b	8.c & 9.a	8.ab FU 23–24	8.c FU 25 & 31	9.a FU 26–30	8.ab	8.c & 9.a	8 & 9.a	8 & 9.a	8 & 9.a
Denmark	Lengths	330									
	Ages										
	Samples	74									
Belgium	Lengths	4496									
	Ages										
	Samples	26									
Sweden	Lengths	261									
	Ages										
	Samples	15									
Total	Lengths	15196	3637	1885	97		568		65		
	Ages										
Total no. in international discards ('000)			**10349**	**85841**	**66**				**NA**		
Nb. meas. as % of annual nb. discarded			**0.0350**	**0.0022**	**0.1470**				**NA**		

Trips

1.22 Figures

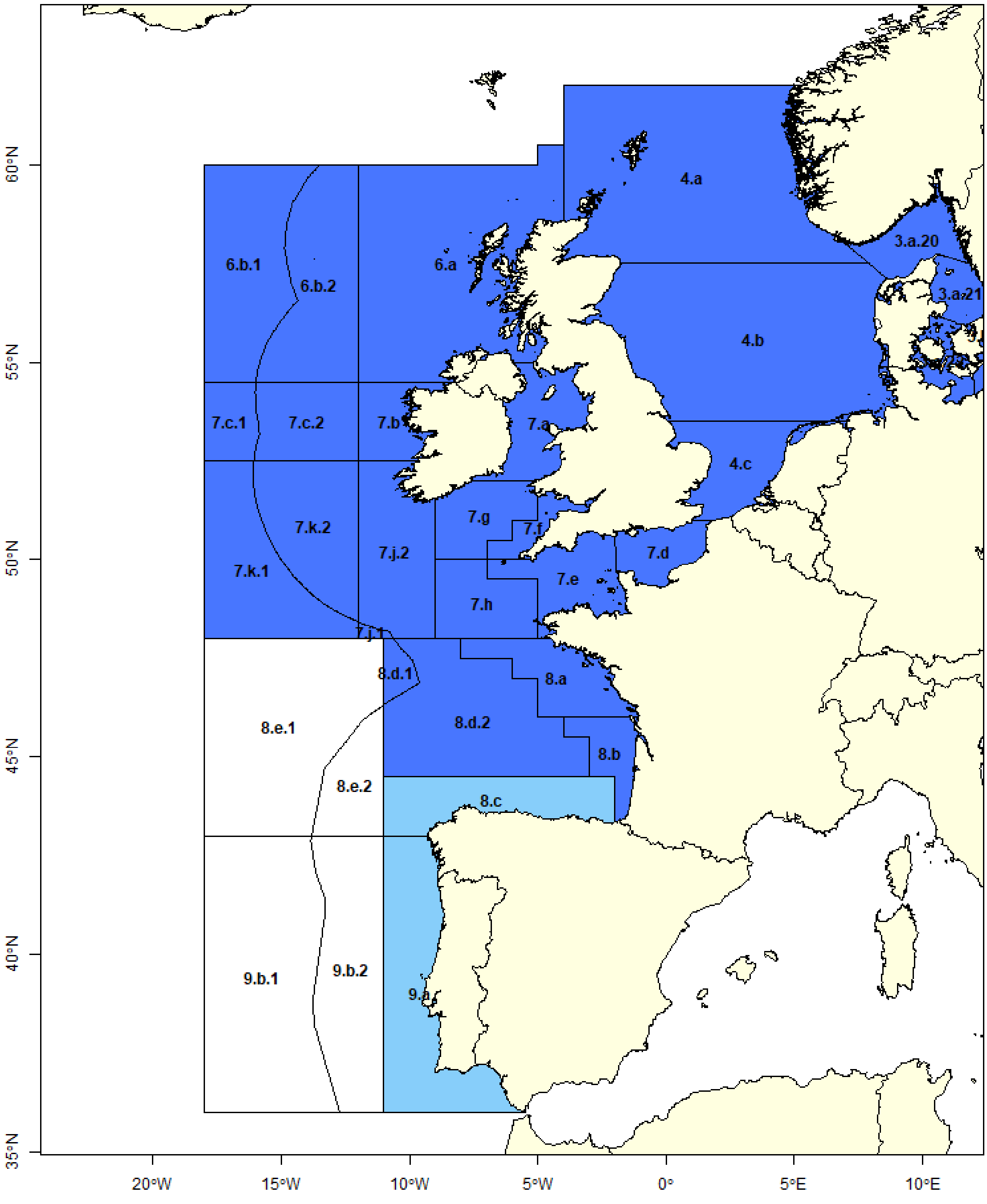

Figure 1.1. Map of ICES divisions. Northern (3.a, 4, 6, 7. and 8.a, 8.b, 8.d) and southern (8.c and 9.a) divisions are shown with different blue shading.

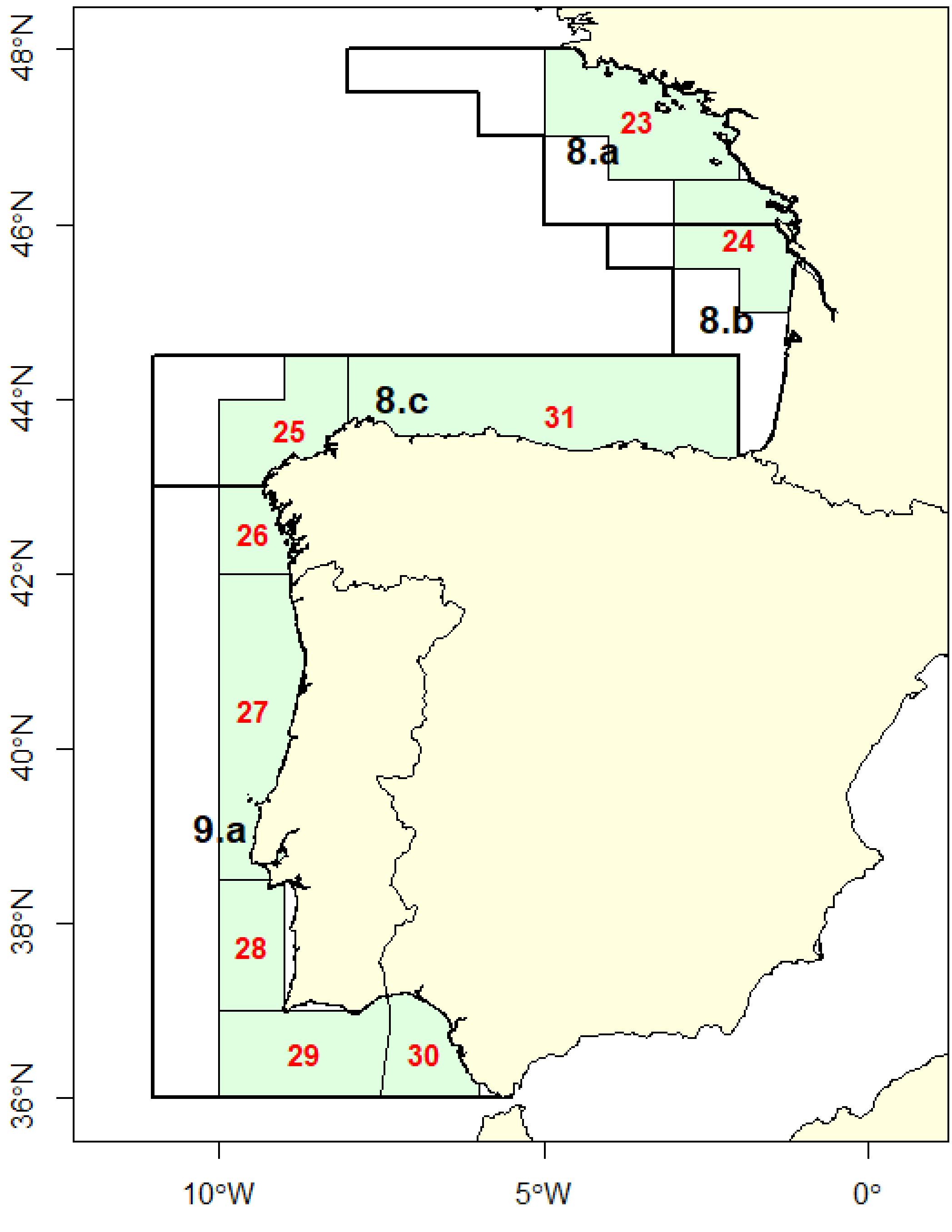

Figure 1.2. ICES divisions 8 and 9.a with *Nephrops* functional units (FUs). Divisions 8.a and 8.b: FUs 2324. Division 8.c: FUs 25 and 31. Division 9.a: FUs 26–30.

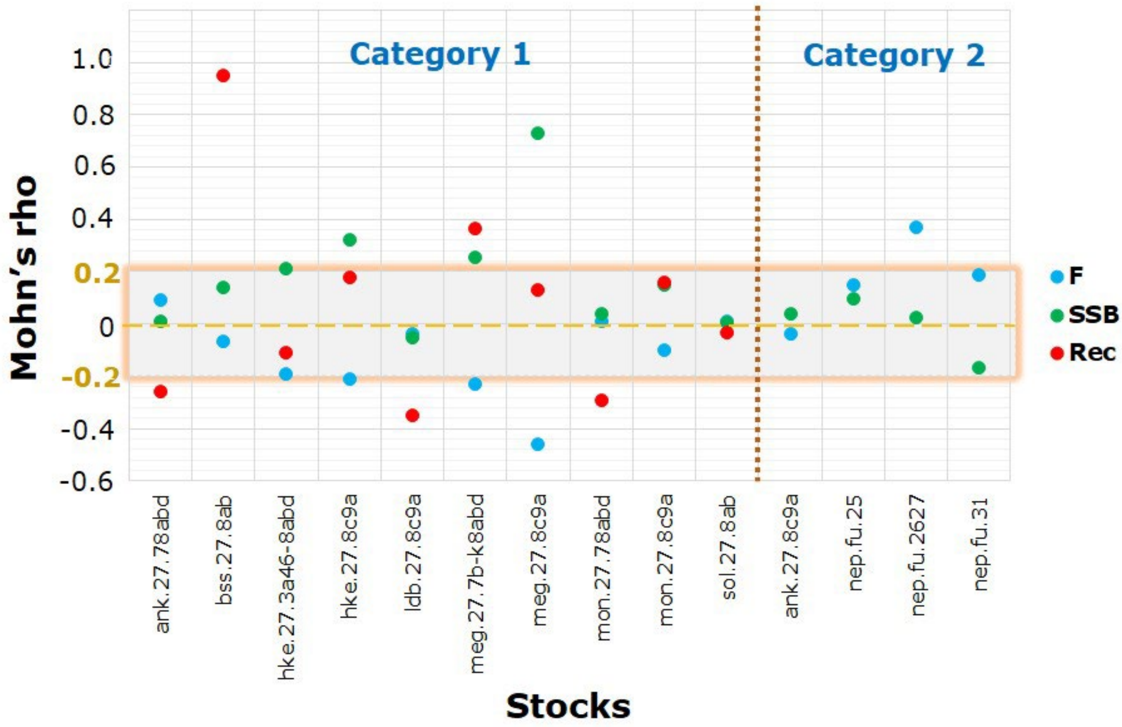

Figure 1.3. Mohn's rho 2023 values for ten WGBIE category 1 stocks with full analytical assessment (stock synthesis [Merthot Jr. and Wetzel, 2013] or a4a [Millar and Jardim, 2019]) models and for four category 2 stocks assessed using the SPiCT (Pedersen and Berg, 2017) approach.

2 Description of commercial fisheries and research surveys

2.1 Fisheries description

This section describes the fishery units relevant to the stocks assessed by WGBIE. Additionally, to facilitate the use of InterCatch (IC), it presents the fleets that the working group proposes to use for data submission in InterCatch.

2.1.1 Celtic-Biscay Shelf (Subarea 7 and divisions 8.a, 8.b, and 8.d)

The fleets operating in the ICES Subarea 7 and divisions 8.a, 8.b, and 8.d are used by WGBIE following the Fishery Units (FUs) defined by the ICES Working Group on Fisheries Units in subareas 7 and 8 (Table 2.1) (ICES, 1991).

Table 2.1. ICES Fishery Units definition in Subarea 7 and Division 8.

Fishery Unit	Description	Subarea
FU1	Longline in medium to deep water	7
FU2	Longline in shallow water	7
FU3	Gillnets	7
FU4	Non-*Nephrops* trawling in medium to deep water	7
FU5	Non-*Nephrops* trawling in shallow water	7
FU6	Beam trawling in shallow water	7
FU8	*Nephrops* trawling in medium to deep water	7
FU9	*Nephrops* trawling in shallow to medium water	8
FU10	Trawling in shallow to medium water	8
FU12	Longline in medium to deep water	8
FU13	Gillnets in shallow to medium water	8
FU14	Trawling in medium to deep water	8
FU15	Miscellaneous	7 and 8
FU16	Outsiders	3.a, 4, 5, and 6
FU00		French unknown

Under the implementation of the mixed-fisheries approach to ICES Working Group reporting, updating some of the national fleet segmentations were presented in WGHMM reports from general overviews (ICES, 2004; ICES, 2005) to detailed national descriptions: French fleets (ICES, 2006), Irish fleets (ICES, 2007), and Spanish fleets (ICES, 2008). This information in relation to the *métiers* definition has not changed the FUs used in the single-stock assessments. However, the hierarchical disaggregation of FUs into *métiers* is essential not only for carrying out mixed-fisheries assessments but also for a deeper understanding of fisheries behaviour.

The EU Data Collection Framework (DCF; Council Regulation (EC) 199/2008; EC Regulation 665/2008; Decision 2008/949/EC) establishes a framework for the collection of economic, biological and transversal data by the Member States. One of the most relevant changes of this more recent period with respect to the previous Data Collection Regulation (DCR; Reg. (EC) No 1639/2001) has been the inclusion of the ecosystem approach by means of moving from stock-based to *métier*-based sampling. The DCF defines the *métier* as "a group of fishing operations targeting the same species or a similar assemblage of species, using similar gear, during the same period of the year and/or within the same area, and which are characterized by a similar exploitation pattern". Due to the sampling design, established in 2009, which can affect the fishery data supplied to this working group, it had been agreed to detail the *métiers* related to the stocks assessed by this working group trying to find the correspondence with the FUs.

Data for stock assessment are provided to InterCatch according to the DCF *métiers*. In the case of discards and/or biological data, although sampling may be done at the DCF *métier* Level 6, estimates are often re-aggregated to Level 5 due to low sampling levels reached by countries. Thus, this working group agreed to use DCF Level 5 (without mesh size) as the fleet level to introduce data in InterCatch. Table 2.2 shows the fleets to be used for InterCatch and their correspondence with the old FUs and the DCF *métiers* at Level 6.

Table 2.2. InterCatch fleets' correspondence with the old Fishery Units and DCF *métiers* (Level 6).

FU	Fleet for InterCatch	DCF *métier* (Level 6)	Description	FR	IR	SP	UK
FU1	LLS_DEF	LLS_DEF_0_0_0	Set longline directed to demersal fish			X	X
FU2							
FU3	GNS_DEF	GNS_DEF_100-219_0_0	Set gillnet directed to demersal fish (100–219 mm)	X	X	X	
FU4	OTB_DEF	OTB_DEF_70-99_0_0	Bottom otter trawl directed to demersal fish (70–99 mm)		X	X	X
	OTB_DEF	OTB_DEF_100-119_0_0	Bottom otter trawl directed to demersal fish (100–119 mm)		X	X	X
FU5	OTB_DEF		Otter trawl directed to demersal fish in shallow water				X
FU6	TBB_DEF		Beam trawl		X		X
FU8	OTB_CRU						
FU9	OTB_CRU	OTB_CRU_70-99_0_0	Bottom otter trawl directed to crustaceans (70–99 mm)	X	X		X
FU10	OTB_DEF						
FU12	LLS_DEF	LLS_DEF_0_0_0	Set longline directed to demersal fish	X		X	
FU13	GNS_DEF	GNS_DEF_45-59_0_0	Set gillnet directed to demersal fish (45–59 mm)	X			
	GNS_DEF	GNS_DEF_>=100_0_0	Set gillnet directed to demersal fish (at least 100 mm)	X	X	X	
FU14	OTB_DEF	OTB_DEF_>=70_0_0	Bottom otter trawl directed to demersal fish (at least 70 mm)	X	X	X	
	OTB_MCF	OTB_MCF _>=70_0_0	Bottom otter trawl directed to mixed cephalopods and demersal fish (at least 70 mm)			X	
	OTT_DEF	OTT_DEF _>=70_0_0	Multi-rig otter trawl directed to demersal fish (at least 70 mm)	X	X		
	OTB_CRU	OTB_CRU _>=70_0_0	Bottom otter trawl directed to crustaceans (at least 70 mm)	X	X		

FU	Fleet for InterCatch	DCF *métier* (Level 6)	Description	FR	IR	SP	UK
	OTT_CRU	OTT_CRU _>=70_0_0	Multi-rig otter trawl directed to crustaceans (at least 70 mm)	X	X		
	OTB_MPD	OTB_MPD _>=70_0_0	Bottom otter trawl directed to mixed pelagic and demersal fish (at least 70 mm)			X	
	PTB_DEF	PTB_DEF _>=70_0_0	Bottom pair trawl directed to demersal fish (at least 70 mm)			X	
FU15	SSC_DEF		Fly shooting seine directed to demersal fish		X		
	OTB_DEF	OTB_DEF _100-119_0_0	Bottom otter trawl directed to demersal fish (100–119 mm)	X	X	X	X
FU16	LLS_DEF	LLS_DEF _0_0_0	Set longline directed to demersal fish			X	
	SSC_DEF		Fly shooting seine directed to demersal fish		X		
FU00	PTM_DEF		Midwater pair trawl directed to demersal fish				

2.1.2 Atlantic Iberian Peninsula Shelf (divisions 8.c and 9.a)

The FUs operating in the Atlantic Iberian Peninsula waters were described originally in the re-port of the “southern hake task force” meeting (STECF, 1994), and have been used in this working group as summarized in the following table.

Country	Fishery Unit	Description
Spain	Small gillnet	Gillnet fleet using “beta” gear (60 mm mesh size) for targeting hake in divisions 8.c and 9.a North
	Gillnet	Gillnet fleet using “volanta” gear (90 mm mesh size) for targeting hake in Division 8.c
		Gillnet fleet using “rasco” gear (280 mm mesh size) for targeting anglerfish in Division 8.c
	Longline	Longline fleet targeting a variety of species (hake, great fork beard, conger) in Division 8.c
	Northern artisanal	Miscellaneous fleet exploiting a variety of species in divisions 8.c and 9.a North

Country	Fishery Unit	Description
	Southern artisanal	Miscellaneous fleet exploiting a variety of species in Division 9.a South (Gulf of Cádiz)
	Northern Trawl	Miscellaneous fleet operating in divisions 8.c and 9.a North composed of bottom pairtrawlers targeting blue whiting and hake (55 mm mesh size, and 25 m of vertical opening); and two types of bottom otter trawlers (70 mm mesh size): trawlers using the “baca” gear (1.5 of vertical opening) targeting hake, anglerfish, megrim and *Nephrops*, and trawlers using “jurelera” (often referred to as "HVO", high vertical opening, in the present report) gear (>5 m of vertical opening) targeting mackerel and horse mackerel.
	Southern Trawl	Bottom otter trawlers operating in Division 9.a South (Gulf of Cádiz) exploiting a variety of species (sparids, cephalopods, sole, hake, horse mackerel, blue whiting, shrimp, Norway lobster).
Portugal	Artisanal	Miscellaneous fleet with two components (inshore and offshore) operating in Portuguese waters of Division 9.a involving gillnet (80 mm mesh size), trammel (>100 mm mesh size), longline and other gears. Species caught: hake, octopus, pout, horse mackerel and others
	Trawl	Trawl fleet operating in Portuguese waters of Division 9.a compounded by bottom otter trawlers targeting crustaceans (55 mesh size), and bottom otter trawlers targeting different species of fish (65 mm mesh size).

The Spanish and Portuguese fleets operating in the Atlantic Iberian Peninsula Shelf were segmented into *métiers* under the EU project IBERMIX (DG FISH/2004/03-33), and the results were described in section 2 of the 2007 WGHMM report (ICES, 2007). The correspondence between FUs and DCF *métiers* has also been compiled for the southern stock fleets and is presented in the following table.

Country	**FU (STECF, 1994)**	***Métiers* (Level 5)**	***Métiers* (Level 6)**	**Description (mesh size in brackets)**	**SP**	**PT**
Spain	Gillnet	GNS_DEF	GNS_DEF_80-99_0_0	Set gillnet directed to demersal species (80–99 mm)	X	
		GNS_DEF	GNS_DEF_280_0_0	Set gillnet directed to demersal species (at least 280 mm)	X	
	Small gillnet	GNS_DEF	GNS_DEF_60-79_0_0	Set gillnet directed to demersal fish (60–79 mm)	X	
	Longline	LLS_DEF	LLS_DEF_0_0_0	Set longline directed to demersal fish	X	
	Southern artisanal	LLS_DWS	LLS_DWS_0_0_0	Set longline directed to deep-water species	X	
	Northern trawl	PTB_MPD	PTB_MPD_>=55_0_0	Pair bottom trawl directed to mixed pelagic and demersal fish (at least 55 mm)	X	
		OTB_DEF	OTB_DEF_>=55_0_0	Otter bottom trawl directed to demersal fish (at least 55 mm)	X	
		OTB_MPD	OTB_MPD_>=55_0_0	Otter bottom trawl directed to mixed pelagic and demersal fish (at least 55 mm)	X	
	Southern trawl	OTB_MCD	OTB_MCD_>=55_0_0	Otter bottom trawl directed to mixed crustacean and demersal fish (at least 55 mm)	X	
Portugal	Artisanal	GTR_DEF	GTR_DEF_>=100_0_0	Trammel nets directed to demersal fish (at least 100 mm)		X
		GNS_DEF	GNS_DEF_80-99_0_0	Set gillnet directed to demersal fish (80–99 mm)		X
		LLS_DEF	LLS_DEF_0_0_0	Set longline directed to demersal fish		X
		LLS_DWS	LLS_DWS_0_0_0	Set longline directed to deep-water species		X
	Trawl	OTB_CRU	OTB_CRU_>=55_0_0	Otter bottom trawl directed to crustaceans (at least 55 mm)		X
		OTB_DEF	OTB_DEF_60-69_0_0	Otter bottom trawl directed to demersal fish (60–69 mm)		X

2.2 Description of surveys

This section gives a brief description of the surveys referred to in this working group report. The surveys are summarized in the following table, including the acronym used by WGBIE currently and those used previously by WGHMM before 2010 (ICES, 2010). The DCF acronym and newer ICES survey acronyms are used throughout this report and in the stock annexes. The newer survey acronyms used are provided by ICES in order to foster consistency across ICES expert groups. When an ICES survey is not included in the list for which acronyms have been provided, the WGHMM (ICES, 2010) acronym will remain in use.

Survey	WGHMM 2010 acronym	DCF acronym	ICES survey acronym (as of 2011)
Spanish groundfish survey – quarter 4	G2784 = SP-NSGFS	IBTS-EA-4Q	SpGFS-WIBTS-Q4
Spanish Porcupine groundfish survey	SP-PGFS	IBTS-EA	SpPGFS-WIBTS-Q4
Spanish Cádiz groundfish survey – Autumn	SP-GFS-caut		SPGFS-caut-WIBTS-Q4
Spanish Cádiz groundfish survey – Spring	SP-GFS-cspr		SPGFS-cspr-WIBTS-Q1
Spanish Cádiz ISUNEPCA *Nephrops* UWTV survey		UWTV/FU30	
Spanish experimental *Nephrops* FU 26 bottom trawl survey			GALNEP26
Portuguese groundfish survey – October	P-GFS-oct	IBTS-EA-4Q	PtGFS-WIBTS-Q4
Portuguese groundfish survey – July (ended in 2001)	P-GFS-jul		----
Portuguese crustacean trawl survey/*Nephrops* Survey Offshore Portugal NepS	P-CTS	NepS (FU 2829)	PT-CTS (UWTV (FU 2829))
Portuguese winter groundfish survey/Western IBTS 1st quarter (2005–2008)	PESCADA-BD		PtGFS-WIBTS-Q1
French EVHOE groundfish survey	EVHOE	IBTS-EA-4Q	EVHOE-WIBTS-Q4
French RESSGASC groundfish survey (ended in 2002)	RESSGASC		----
French Bay of Biscay sole beam trawl survey	ORHAGO		ORHAGO
French *Nephrops* survey in Bay of Biscay	LANGOLF		LANGOLF
French *Nephrops* UWTV survey in Bay of Biscay		UWTV 2324	
UK west coast groundfish survey (ended in 2004)	UK-WCGFS		-----
UK Western English Channel beam trawl survey			UK-WECBTS
UK bottom trawl survey			EN-Cefas-A, B

Survey	WGHMM 2010 acronym	DCF acronym	ICES survey acronym (as of 2011)
English fisheries science partnership survey	EW-FSP		FSP-Eng-Monk
Irish groundfish survey	IGFS	IBTS-EA-4Q	IGFS-WIBTS-Q4
Combined IGFS/EVHOE WIBTS survey	-	-	FR_IE_IBTS
Irish monkfish survey		SIAMISS/IAMS	IE_Monksurvey; IE_IAMS

A brief description of each survey follows. General maps identifying survey areas can be found in the ICES IBTS WG report (ICES, 2018a) and WGNEPS report (ICES, 2019).

2.2.1 Spanish groundfish survey (SpGFS-WIBTS-Q4, G2784)

The SpGFS-WIBTS-Q4 covers the northern Spanish shelf comprised in ICES Division 8.c and the northern part of 9.a, including the Cantabrian Sea and off Galicia waters. It is a bottom trawl survey that aims to collect data on the distribution, relative abundance and biology of commercial fish species such as hake, monkfish and white anglerfish, megrim, four-spot megrim, blue whiting and horse mackerel. Abundance indices are estimated by length and in some cases by age, with indices also estimated for *Nephrops*, and data collected for other demersal fish and invertebrates. The survey is ca. 120 hauls and is from 30–800 m depths, usually starting at the end of the 3rd quarter (September) and finishing in the 4th quarter.

2.2.2 Spanish porcupine groundfish survey (SpPGFS-WIBTS-Q4, G5768)

The SpPGFS-WIBTS-Q4 occurs at the end of the 3rd quarter (September) and the start of the 4th quarter (October). It is a bottom trawl survey that aims to collect data on the distribution, relative abundance and biology of commercial fish in ICES divisions 7.b–k , which corresponds to the Porcupine Bank and the adjacent area in western Irish waters between 180–800 m. The survey area covers 45 880 km^2 and approximately 80 hauls per year are carried out.

2.2.3 Cádiz groundfish surveys-spring (SPGFS-cspr-WIBTS-Q1, G7511) and autumn (SPGFS-caut-WIBTS-Q4, G4309)

The bottom trawl surveys SPGFS-cspr-WIBTS-Q1 and SPGFS-caut-WIBTS-Q4 occur in the southern part of ICES Division 9.a, the Gulf of Cádiz. It collects data on the distribution, relative abundance, and biology of commercial fish species. The area covered is 7224 km^2 and extends from 15–800 m. The primary species of interest are hake, horse mackerel, wedge sole, sea breams, mackerel and Spanish mackerel. Data and abundance indices are also collected and estimated for other demersal fish species and invertebrates such as rose and red shrimps, *Nephrops* and cephalopod molluscs.

2.2.4 Spanish FU30 UWTV surveys in the Gulf of Cádiz (ISUNEPCA, U9111)

The ISUNEPCA UnderWater TeleVision (UWTV) survey was launched in 2015 although an exploratory UWTV survey was conducted previously in 2014. ISUNEPCA is a multidisciplinary survey in nature but the main objective is to estimate the *Nephrops* burrows density using underwater videos and to confirm the boundaries of the *Nephrops* area distribution in FU 30. As result, geostatistical *Nephrops* abundance is estimated. Other ecosystem data are also collected (temperature, salinity, sediment samples, trawl marks and seabed morphological and backscatter data). The survey design follows a randomly isometric grid with stations at 4 nm spacing. The survey area covers 3000 km^2 between 90 and 700 m of depth and about 65–70 stations are planned every year.

2.2.5 Spanish Experimental *Neprhops* FU26 bottom trawl survey (GALNEP26)

The fishing industry promoted the GALNEP26 survey onboard a commercial vessel in order to estimate a *Nephrop*s biomass index in FU 26 with an observer onboard and under the supervision of IEO since 2019. The survey design follows a systematic sampling scheme over a 5 x 5 nm grid. A total of 43 hauls are planned yearly covering the historical *Nephrops* distribution area in FU 26 (West Galicia). The survey area was established on the base of the VMS analysis linked to the bottom trawl logbooks in the 2009–2017 period. The main objectives of the GALNEP26 survey are to estimate a *Nephrops* abundance index, the discard rate and the size composition for both sexes in this FU.

2.2.6 Portuguese groundfish survey October (PtGFS-WIBTS-Q4, G8899)

PtGFS-WIBTS-Q4 extends from latitude 41°20' N to 36°30' N (ICES Division 9.a) and from 20–500 m depth. The survey takes place in autumn. The main objective of the survey is to estimate the abundance and study the distribution of the most important commercial species in the Portuguese trawl fishery (hake, horse mackerel, blue whiting, sea bream and *Nephrops*), and most importantly to monitor the abundance and distribution of hake and horse mackerel recruitment. The surveys aim to carry out ca. 90 stations per year.

2.2.7 Portuguese crustacean trawl survey/Nephrops survey offshore Portugal NepS (PT-CTS (UWTV (FU 28–29, G2913)))

The *Nephrops* Survey Offshore Portugal, NepS (FU 28–29), is carried out in May-July and covers the southwest coast (Alentejo or FU 28) and the south coast (Algarve or FU 29). The main objectives are to estimate the abundance, to study the distribution and the biological characteristics of the main crustacean species, namely *Nephrops norvegicus* (Norway lobster), *Parapenaeus longirostris* (rose shrimp) and *Aristeus antennatus* (red shrimp). The average number of trawl stations in the period 1997–2004 was 60. Sediment samples have been collected since 2005 with the aim to study the characteristics of the *Nephrops* fishing grounds. In 2008 and 2009, the crustacean trawl survey conducted in FUs 28 and 29 were combined with an experimental video sampling.

2.2.8 Portuguese winter groundfish survey/Western IBTS 1st quarter (PTGFS-WIBTS-Q1)

The PtGFS-WIBTS-Q1 survey has been carried out along the Portuguese continental waters from latitude 41°20' N to 36°30' N (ICES Division 9.a) and from 20–500 m depth. The winter groundfish survey plan comprised 75 fishing stations, 66 at fixed positions and 9 at random. The main aim of the survey was to estimate the spawning biomass of hake. This survey ended in 2008.

2.2.9 French EVHOE groundfish survey (EVHOE-WIBTS-Q4, G9527)

The EVHOE-WIBTS-Q4 survey covers the Celtic Sea with ICES divisions 6.a, 7.b, 7.c, 7.g, and 7.j, and the French part of the Bay of Biscay in divisions 8.a and 8.b. This annual survey is conducted from 15 to 600 m depths, usually in the fourth quarter, starting at the end of October. The primary species of interest are hake, monkfish, anglerfish, megrim, cod, haddock and whiting, with data also collected for all other demersal and pelagic fish. The sampling strategy is stratified random allocation, the number of sets per stratum based on the 4 most important commercial species (hake, monkfish and megrim) leaving at least two stations per stratum and 140 valid tows are planned every year although this number depends on available sea time.

2.2.10 French RESSGASC groundfish survey (FR-RESSGASC, G2537)

The RESSGASC survey was conducted in the Bay of Biscay from 1978–2002. Over the years 1978–1997, the survey was conducted with quarterly periodicity. It was conducted twice a year, in spring and autumn, after that. Survey data prior to 1987 are normally excluded from the time-series since there was a change of vessel at that time.

2.2.11 French Bay of Biscay sole beam trawl survey (ORHAGO, B1706)

The ORHAGO survey was launched in 2007, with the aim of producing an abundance index and biological parameters such as length distribution for the Bay of Biscay sole (Léauté *et al*., 2018a; b). It is usually carried out in November, with approximately 23 days of duration and sampling 70–80 stations. It uses beam trawl gear and is coordinated by the ICES WGBEAM (ICES, 2018b).

2.2.12 French Nephrops survey in the Bay of Biscay (LANGOLF)

This survey commenced in 2006 specifically for providing abundance indices of *Nephrops* in the Bay of Biscay. It is carried out on the area of the Central Mud Bank of the Bay of Biscay (ca.11 680 km^2), in the second quarter (May apart from the 1st year when the survey occurred in April), using twin trawl, with hours of trawling around dawn and dusk. The whole mud bank is divided into five sedimentary strata and the sampling allocation combines the surface by stratum and the fishing effort concentration. 70–80 experimental hauls are carried out annually. Since the IBP *Nephrops* 2012 (ICES, 2012), this survey is included as tuning series in the stock assessment.

2.2.13 French *Nephrops* UWTV survey in Bay of Biscay

A new experimental UWTV survey for burrow counting has been undertaken since 2014 covering the five sedimentary muddy strata of the former trawl survey on the FU23–24 *Nephrops* stock. The survey is carried out by the Irish scientific vessel "Celtic Voyager" with a French scientific team on the basis of a systematic onboard sampling plan. A longer survey in the period 2016–2019 allowed covering the area contained in the outline of the Central Mud Bank not belonging to any sedimentary stratum. This area, known as not trawled due to the rough seabed, is crossed by muddy channels and concentrates a moderate fishing effort targeting *Nephrops*. Investigations on the basis of stratified statistical estimators as well as geostatistics were carried out and examined by WKNEP 2016 (ICES, 2017), which validated the UWTV approach.

2.2.14 UK west coast groundfish survey (UK-WCGFS)

This survey, which ended in 2004, was conducted every March in the Celtic sea with ca. 62 hauls. It does not include the 0-age group, therefore, primarily aims at the investigation of age groups 1 and 2. Numbers-at-age for this abundance index is estimated from length compositions using a mixed distribution by statistical method.

2.2.15 English fisheries science partnership survey (FSP-Eng-Monk)

The FSP-Eng-Monk survey, part of the English fisheries science partnership programme, has been carried out on an annual basis since 2003, reaching a total of 208 valid hauls in 2010, but was discontinued in 2012. The aims of the survey were to investigate abundance and size composition of anglerfish on the main UK anglerfish fishing grounds off the southwest coast of England within ICES subdivisions 7.e–h.

2.2.16 English Western English Channel beam trawl survey

Since 1989, the survey has remained relatively unchanged, apart from small adjustments to the position of individual hauls to provide an improved spacing. In 1995, two inshore tows in shallow water (8–15 m) were introduced. The survey now consists of 58 tows of 30 minutes duration, with a towing speed of 4 knots in an area within 35 miles radius of Start Point. The objective is to provide indices of abundance, which are independent of commercial fisheries, of all age groups of sole and plaice on the western Channel grounds, and an index of recruitment of juvenile (1–3-year-old) soles before full recruitment to the fishery.

2.2.17 English bottom trawl survey

This bottom trawl survey covered the Irish, Celtic Sea and Western English Channel but was discontinued in 2004.

2.2.18 Irish groundfish survey (IGFS-WIBTS-Q4, G7212)

The IGFS-WIBTS-Q4 is carried out during the fourth quarter in divisions 6.a, 7.b, 7.c, 7.g, and 7.j, in depths of 30–600 m. The annual target is 170 valid tows of 30-minute duration which are carried out in daylight hours at a fishing speed of 4 knots. Data are collected on the distribution, relative abundance and biological parameters of a large range of commercial fish such as haddock, whiting, plaice and sole with survey data provided also for cod, white and black anglerfish, megrim, lemon sole, hake, saithe, ling, blue whiting and several elasmobranchs as well as several pelagics (herring, horse mackerel and mackerel).

2.2.19 Combined EVHOE IGFS survey (FR_IE_IBTS)

The Irish IBTS Q4 groundfish survey (IGFS-WIBTS-Q4, G7212) covers areas 27.7bgjk. The French EVHOE-WIBTS-Q4 (G9527) survey covers areas 27.7j8ab. Both surveys are coordinated and largely standardized under WGIBTS and both use a GOV trawl. Together the two surveys cover the majority of the ank.27.78abd and mon.27.78abd stock areas up to depths of 200–300 m. This is where most of the young fish occur. Older fish migrate to deeper waters and are not fully available for these surveys.

Data for Irish and French IBTS Q4 groundfish surveys (IGFS and EVHOE) were obtained from DATRAS, quality checked and cleaned. The two surveys were combined into a single index (with the survey code FR_IE_IBTS) by weighting their average catches by the area covered by each survey series (IGFS gets a weight of approximately 45% and EVHOE 55%).

Indices of catch weight per hour and catch numbers-at-length per hour fished are calculated for the years 2003 onwards for black and white anglerfish and megrim.

2.2.20 Irish monkfish survey (IE_Monksurvey; IE-IAMS, G3098)

Irish anglerfish survey data in Area 27.7 are available for the years 2007 and 2008 under the acronym SIAMISS then IAMS from 2016 onwards. These surveys were designed to estimate the biomass of anglerfish and they cover a significant part of the stock in all depths up to 1000 m.

The survey index consists of biomass and catch numbers-at-length per swept-area.

The midpoint of the survey period is in January or February. However, because the survey data are available for the current year at the time of the WG assessment, it is beneficial to include the current year's survey in the assessment. The only way to do that in the current assessment framework is to offset the survey by a small amount so the survey is nominally taking place on the 31 December of the previous year.

2.3 References

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3 Black-bellied and white anglerfish in Celtic Seas and Bay of Biscay

ank.27.78abd and mon.27.78abd – *Lophius budegassa* and *Lophius piscatorius* in Subarea 7 and divisions 8.a, 8.b, and 8.d

3.1 General

3.1.1 Stock description and management units

The stock assessment area (27.78.abd) is the same for both species of anglerfish (*L. budegassa* and *L. piscatorius*). The two stocks are managed through TACs for the two species combined. There is a separate TAC for Subarea 27.7 and divisions 27.8.abde. Catches in 27.8.e are negligible.

3.1.2 ICES advice applicable to 2023

For *L. budegassa*, ICES advises that when the precautionary approach is applied, catches in 2023 should be no more than 23 436 t.

For *L. piscatorius*, ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 34 540 t.

ADGBBI 2022: Before 1986 the landings by species *L. piscatorius* and *L. budegassa* are estimated from the official landings of both *Lophius* species, assuming that the proportion of species of the first data years by country were similar to the past. The use of the full time series was discussed and analyzed during the WKANGHAKE benchmark (ICES, 2023b). If landings data before 1986 are removed, the model has to estimate an *F* at the beginning of the times series without knowledge of the earlier development of the fisheries, leading to increased uncertainty about the absolute scale of F and SSB. So, during the benchmark it was decided to use the full time series of landings in the model and to account for higher uncertainty about the historic landings (particularly the species-split), the standard error in the historic part of the landings was set at a higher value (0.2) than in the more recent period (0.1). There is no reason for WGBIE to change this decision.

3.1.3 Management applicable to 2023

The combined TAC for 27.7 and 27.8abde was 57 976 t, which corresponds to the combined advice for the two species. There are no *de minimis* or high-survivability exceptions included in the multiannual plan for the North Western Waters and adjacent waters (EU, 2019) for anglerfish.

Species *Lophiidae*	Subarea 7 (ANF/07)[1 2] (tonnes)	Divisions 8.a, 8.b, 8.d, and 8.e (ANF/8ABDE)[3] (tonnes)
Belgium	4003	-
Germany	446	-
Spain	1591	1866
France	25687	10386
Ireland	3283	-
The Netherlands	518	-
European Union	35528	12252
UK	10196	-
TAC	45724	12252

3.1.4 The fishery

Both species of anglerfish (*L. piscatorius* and *L. budegassa*) are taken in a mixed fishery mainly with hake, megrim, and *Nephrops*.

The fishery for anglerfish developed in the late 1960s and landings quickly reached around 25 000 t (for both *Lophius* species combined). Since then, landings have fluctuated between 20 and 40 thousand t per year (Figure 3.1.1).

France takes the vast majority of the landings, followed by Spain, the UK, and Ireland. Minor landings have been recorded for Belgium, Germany and Portugal (Figure 3.1.1).

Around 2/3 of the catches are taken by otter trawlers targeting demersal fish; gillnets take between 10–20% and the remainder is taken by beam trawlers and otter trawlers targeting *Nephrops*.

Around 80% of the catch is taken in Subarea 27.7.

3.1.5 Information from stakeholders

WGBIE did not receive information from stakeholders regarding these stocks.

3.1.6 Data

3.1.6.1 Landings and discards

Figure 3.1.1 shows the time-series of the official landings of the combined species.

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[1] Stock area code from the Commission of the European communities on the description of the ICES sub-areas and divisions used for the purposes of fishing statistics and regulations in the North East Atlantic

[2] Special condition: of which up to 10% may be fished in 8.a, 8.b, 8.d, and 8.e.

The combined-species landings are split into species-specific landings at the national level using the species composition in the sampling data from the onshore and offshore sampling programmes. Figure 3.1.2 shows the proportions of the two species over time. The overall proportion of *L. piscatorius* in the combined *Lophius* landings varied between 62% and 82% with a mean of 73%. The proportion of *L. piscatorius* in area 8abd is generally lower than in area 7 and more variable. The proportion of *L. piscatorius* in the discards is also lower than in the landings and the last year decreases until 38%.

3.1.7 References

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3.1.8 Figures and tables

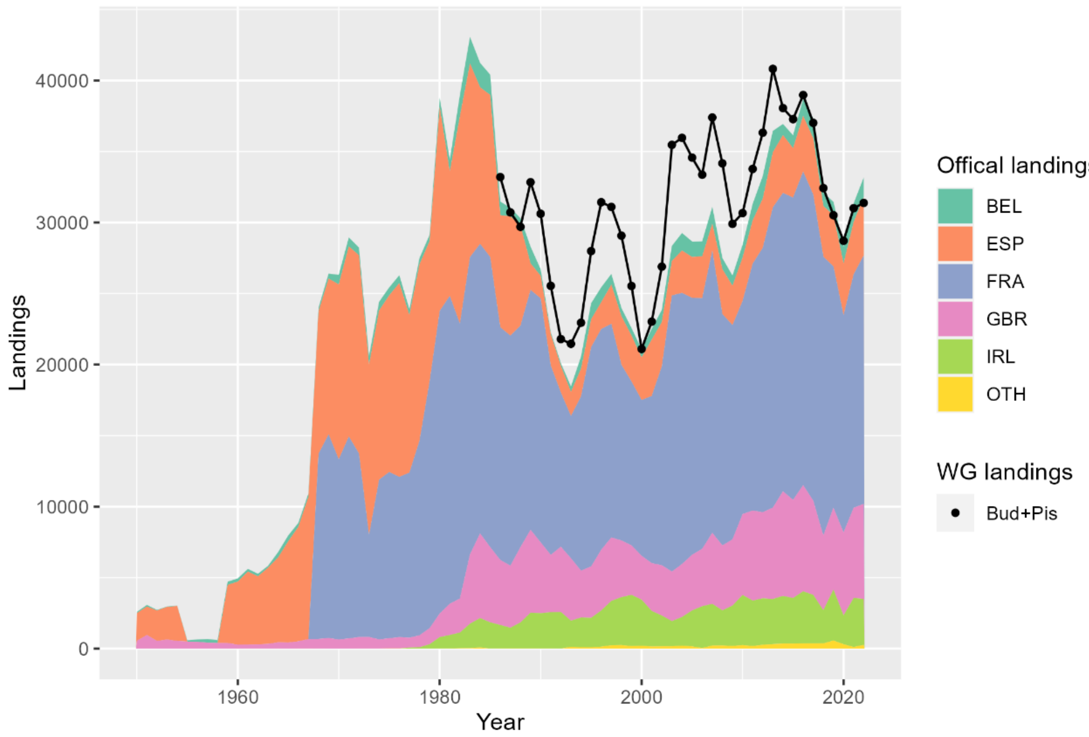

Figure 3.1.1. *Lophius* spp. in 27.78abd. Time-series of the official landings (tonnes) by country: Belgium (BEL), Spain (ESP), France (FRA), Great Britain (GBR), Ireland (IRL), other countries (OTH).

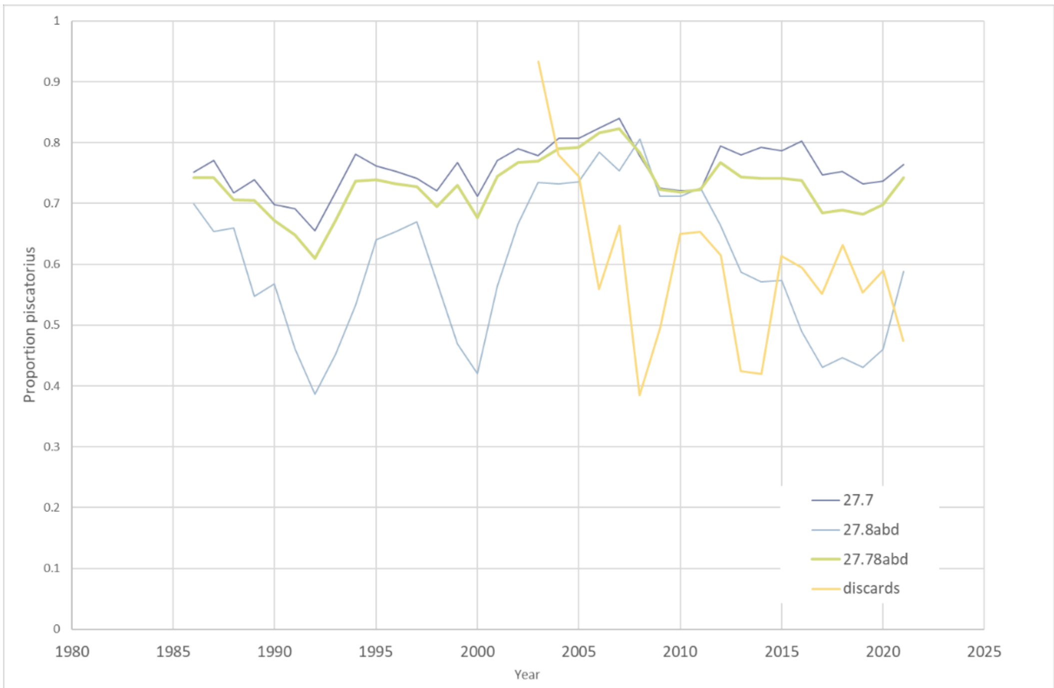

Figure 3.1.2. *Lophius* spp. in 27.78abd. Species composition in the landings (by area) and discards.

3.2 White anglerfish (*Lophius piscatorius*) in Subarea 7 and divisions 8.a, 8.b, and 8.d

3.2.1 Data

3.2.1.1 Landings and discards

Landings and discards data were extracted from InterCatch and processed according to the methods outlined in the Stock Annex. Normally, discard rates (proportion of the catch weight that was discarded) are used to estimate the discard volume for strata with missing discard data. This year, the discard rates of the French OTB_DEF fleets appeared to be unrealistically high (Figure 3.2.1) while the proportion of the Irish discards from OTB_CRU and OTB_DEF was too low compared to previous years. These values were not replaced but they were not considered to fill in unsampled discards. The true discard proportions were assumed to be similar to those observed in previous years. Thus, the average discard rates of those fleets from 2017–2019 were used to fill in unsampled discards.

Overall, discard rates are relatively low and when adding the extrapolated values to fill in missing discards data, has resulted in around 16 % of the estimated discard volume. Discards amount to around 7% of the total catch weight (average of most recent 5 years) (Figure 3.2.2).

Table 3.2.1. provides the ICES landings and discards estimates by country and area. Table 3.2.2. provides the landings and discards by fleet considered in the assessment model and year.

3.2.1.2 Catch numbers at length

The methods for filling in strata with unsampled landings and discards are described in the Stock Annex. Figure 3.2.2. shows that about 50% of the landings had length-associated data. This was an improvement from the year 2020 with less than 50% of landings with length associated data. This may presumably be related to the difficulties in collecting samples during the COVID-19 pandemic starting in 2020.

Figure 3.2.3a. shows the aggregated catch with LFD data both before and after filling in the values for unsampled catches. While discards consist of a relatively small proportion of the catch weight, they contributed to about 36% of the catch numbers over the last 3 years. Increases in mesh size in the trawl fisheries do not appear to have reduced the catches of anglerfish below 30 cm, likely due to their shape, which makes it difficult for even the smallest individuals to escape through the meshes. Figure 3.2.3b. shows the aggregated LFD of the landings and discards data by fleet considered in the assessment. Figures 3.2.3c., 3.2.3d., 3.2.3e., and 3.2.3f. show the LFD of the landings and discards data of gillnets, French trawlers, other trawlers and Spanish trawlers, respectively, which are the fleets considered in the assessment.

3.2.1.3 Surveys

The surveys are described in detail in the Stock Annex. Three surveys indices are used:

- IE-IGFS (G7212) and EVHOE (G9527) surveys; this combined French and Irish survey index is referred to by the ICES acronym FR_IE_IBTS;
- The Irish Anglerfish and Megrim survey IAMS (G3098);
- The SpGFS-WIBTS-Q4 survey (G5768, the previous acronym was SP-PGFS).

The survey indices are provided in Table 3.2.3.

FR_IE_IBTS

Figure 3.2.4a shows the spatial distribution of the catches of recruits on the combined FR_IE_IBTS surveys. Recruitment generally occurs in the western Celtic Sea while only for some years in the

Bay of Biscay. Recruitment in 2022 appears to be higher than in 2021 in the south (EVHOE-WIBTS-Q4) but not in the north (IGFS-WIBTS-Q4).

Figure 3.2.4b shows the comparison between the spatial distribution of the catch weights for the two IBTS surveys. During some years, the catches are highest in the area covered by the IGFS-WIBTS-Q4 (G7212) survey while in other years the EVHOE-WIBTS-Q4 (G9527) survey showed higher catches. It is unclear whether this is due to the movement of the stock or whether it is due to factors affecting the catchability on the surveys (e.g. weather, gear performance, etc.).

Figure 3.2.5 shows the biomass indices of the two IBTS surveys as well as the combined IBTS index. The combined survey biomass index is more stable than the single survey indices. The trends of both surveys in some periods are similar but with some differences in some periods. For example, in 2022 the EVHOE-WIBTS-Q4 (G9527) survey showed a moderate declining trend, while the IGFS-WIBTS-Q4 (G7212) survey index significantly increased (ICES, 2022).

In 2017, the French survey vessel Thalassa suffered major mechanical issues and the majority of the EVHOE-WIBTS-Q4 (G9527) bottom trawl survey could not be completed (ICES, 2018). Therefore, the 2017 data of this index was not included in the model.

IAMS (G3098)

Figure 3.2.6. shows the spatial distribution of the catches on the IAMS (G3098) survey.

Figure 3.2.7. shows the abundance index of the IAMS survey. This survey takes place at the start of the year, but to facilitate the inclusion of an in-year index, the data are provided to the model as if the survey occurred on the last day of the previous year. Such that the 2022 index is used for the assessment performed in WKANGHAKE 2022 (ICES, 2023b), but provided to the model as if it occurred on 31 December 2021.

SpPGFS-WIBTS-Q4 (G5768)

Figure 3.2.8. shows the spatial distribution of the catches on the SpPGFS-WIBTS-Q4 (G5768) survey, the previous acronym SP-PGFS.

Figure 3.2.9. shows the abundance index of the SpPGFS-WIBTS-Q4 (G5768) survey. The index was at the historical maximum in 2014 and 2017 but since 2018 the index is decreasing until 2021 which starts again to increase.

3.2.1.4 Biology and model settings

Maturity, natural mortality, length-weight and female growth parameters are all fixed (not estimated by the model) and described in the Stock Annex, while in the case of males, the maximum length (L_{inf}) is assumed fixed but growth is estimated by the model following a von Bertalanffy growth pattern. For both males and females, the length-at-age 1 is estimated by the model. Figure 3.2.10. shows the growth curves for males and females.

Recruitment bias adjustment settings are updated annually (following the Stock Annex).

3.2.1.5 Deviations from the Stock Annex

There were no deviations from the Stock Annex.

3.2.2 Model diagnostics

The model diagnostics broadly follow the approach described by Carvalho *et al*. (2021).

3.2.2.1 Convergence

- The model was run with the latest SS version available 3.30.21 (Released in February of 2023) while SS version used 3.30.18 was until in 2022 assessment (ICES, 2022b). The outputs with both models gave similar results.
- No parameters are estimated at/or near the bounds nor with unusual large variance.
- Final gradient on the likelihood is 0.00200643, which is larger than the recommended SS value of 0.0001. However, this is not considered a major concern as all the other indicators of convergence are good.
- The Hessian is positive definite.
- The model shows with a jitter analysis that depending on the starting values of the parameters to be estimated within the model, the model can converge to a local minimum. However, the assessment model converged in the global minimum and therefore, WGBIE did not identify any problems with regards to the model convergence (Figure 3.2.11).

3.2.2.2 Goodness-of-fit

Catch

Figure 3.2.12 shows the observed and fitted landings and discards. The fit to the discards does not follow the observations very closely, reflecting the uncertainty in the discard data. For most fleets, the fit is not consistently lower or higher than the observed values. However, the fit for Spanish trawlers is much lower than the observed discards. The fit to the landings is quite close to the observed values during the early 1980s when the model expects higher landings for French trawlers than observed. This occurs just before the sampling data are introduced into the model in 1986. This may reflect the inability of the model to accommodate recruitment variability before 1986. In 2000, the estimated landings of the French trawler are lower than the observed values.

Indices

Figure 3.2.13 shows the fit of the indices. For some years, the indices show some discrepancies for example around 2015 when the FR_IE_IBTS and the other two indices SpPGFS-WIBTS-Q4 (G5768) and IAMS (G3098) surveys show diverging values. During the last year, the three indices show an increase in the population. The combined FR_IE_IBTS and IAMS (G3098) surveys passed the test runs while the SPGFS-WIBTS-Q4 (G5768) survey runs failed. This, however, is not considered a major concern and is to be expected when conflicts between indices occur.

Length compositions

The fit to the length data is quite good, although there are some residual patterns mainly on the SpPGFS-WIBTS-Q4 (G5768) survey (Figure 3.2.13) and male and female LFDs from the combined FR_IE_IBTS and IAMS (G3098) surveys. Figure 3.2.14 shows the fit to the aggregated length distributions and Figure 3.2.15 provides the fit to the mean length size in catches. The residual plots and the runs tests are shown in Figures 3.2.16 and 3.2.17 which indicate that the residuals of the fit for fleet length composition passed the runs test but not for SP_TR, where in this case the residuals are not distributed with a random pattern.

Retention

Retention (the proportion of catches that are landed in each size class) is modelled with a logistic curve and for the French trawler (TR_FR) and other trawlers fleet (TR_OT) is allowed to vary during the period 2003–2022 with a random walk. For Gillnets (GNS) and Spanish trawler (SP_TR), this parameter has no time-varying flexibility. Figure 3.2.18 shows that the length at 50% retention is fitted quite closely to the observed data. The differences observed occurred due to the fitting variations of the landings and discard volumes as well as lengths.

Sex-ratio

Figure 3.2.19 shows the fit to the sex ratio-at-length. This fit is not part of the likelihood optimization but it is a useful diagnostic index for the model fit. The sexual dimorphism that is apparent from the survey data cannot be fully accommodated with the current model settings at the smallest size, but there may also be differences in natural mortality that are currently not accounted for.

Conclusion

WGBIE did not identify significant concerns with the fit of the model.

3.2.2.3 Model consistency

Retrospective analysis

Figure 3.2.20 shows the summary plot of the retrospective analysis. Mohn's rho (Mohn, 1999) values obtained for SSB and F were well inside the WKFORBIAS guidelines (ICES, 2020). All the peels for SSB and F are inside the uncertainty bounds. Therefore, no SSB or F significant retrospective bias is observed. Nevertheless, the estimated F values for the peel-1 is above of the other runs but this is due to local minimum convergency where the estimate of length at age 1 of females (*L_at_Amin_Fem*) is larger, and for males lower (*L_at_Amin_Mal*), and this also affects the growth of males (*VonBert_K_Mal_GP_1*) that is estimated within the model (Figure 3.2.21). The retros were run again fixing this value at 18.98 cm, the estimated value in the assessment run, so that the output of the assessment model is not changed. Thus, this pattern disappears and more similar values are estimated for all peels (Figure 3.2.22). Most peels for recruitment, on the other hand, are outside the uncertainty bounds. WGBIE considers that the model has a poor ability to estimate recruitment in the final year (ICES, 2023c).

Hindcasting

Figure 3.2.23 shows the hindcasting analysis results for the indices. The three surveys show a MASE score of < 1, indicating good prediction skill. The MASE scores for the mean length in the two commercial fleets French trawler (TR_FR) and other trawlers (TR_OT) are < 1 indicating good prediction skill (figure not shown).

Conclusion

WGBIE did not identify significant concerns with the model consistency.

3.2.3 Historical stock development

3.2.3.1 Update assessment

The stock summary is shown in Figure 3.2.24 and Table 3.2.4. Recruitment is highly variable and last year recruitment is replaced following the Stock Annex. F shows a declining trend in the last years . F is estimated to have been below F_{MSY} since 2009. SSB is well above the biomass reference points and has been increasing since 2003.

3.2.3.2 Comparison with previous assessments, alternative runs

No alternative runs were performed.

The current assessment cannot be directly compared to assessments previous to 2022 because the assessment method as well as the reference points have been updated at the WKANGHAKE benchmark (ICES, 2023b). Figure 3.2.25 shows a comparison on a relative scale. The general perception of the stock is unchanged: SSB is above the reference points and shows a generally increasing trend since 2012; F shows an overall decreasing trend and has been below F_{MSY} since

2009 and recruitment is variable, similar to the previous a4a assessment model (Millar and Jardim, 1999) used in WGBIE 2021 (ICES, 2021b). It should be noted that the previous assessment model only indicated that F was below since around 2017 (ICES, 2021b).

Figure 3.2.26 compares the last year assessment results with this year assessment. The estimated outputs are very similar until the forecast year where in WGBIE2022 is assumed as the advice estimated with F_{MSY} and in WGBIE 2023 where the catches and, therefore, F is much lower. The small differences are due to the revised estimate of recruitment as well as in catches at age, SSB at age and F at age (Figure 3.2.27).

3.2.4 Biological reference points

In 2022, the WKANGHAKE benchmark (ICES, 2023b) established new reference points for this stock. However, these values were revised in the WD 01 presented by Urtizberea (2022) during the WGBIE 2022 (ICES, 2022b). Note that although the SS model is sex-disaggregated, the biomass reference points were calculated relative to the combined-sex SSB following the standard ICES approach (ICES, 2023a). All figures and tables refer to the biomass related to the combined-sex biomass for this stock.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	28275	B_{pa}; in tonnes	ICES (2022b)
	F_{MSY}	0.192	Stochastic simulations (EqSim) with Beverton–Holt stock–recruitment relationship estimated by the assessment model.	ICES (2022b)
Precautionary approach	B_{lim}	23868	SSB_{2004}; lowest observed SSB with high recruitment; in tonnes	ICES (2022b)
	B_{pa}	28275	B_{lim} × exp(1.645 × 0.103); in tonnes	ICES (2022b)
	F_{lim}	Undefined	Inconsistent with F_{pa}	ICES (2022b)
	F_{pa}	0.212	$F_{p.05}$; the F that leads to SSB ≥ B_{lim} with 95% probability	ICES (2022b)
Management plan	MAP MSY $B_{trigger}$	28275	MSY $B_{trigger}$; in tonnes.	ICES (2022b)
	MAP B_{lim}	23868	B_{lim}; in tonnes.	ICES (2022b)
	MAP F_{MSY}	0.192	F_{MSY}	ICES (2022b)
	MAP range F_{lower}	0.131	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with F_{MSY}.	ICES (2022b)
	MAP range F_{upper}	0.212	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with F_{MSY}.	ICES (2022b)

3.2.5 Short-term projections

The approach used for the short-term projections is outlined in the Stock Annex.

WGBIE decided to replace the recruitment in the most recent year (2022) of data with the predicted recruitment from the stock–recruit relationship estimated in the model following the Stock Annex. The original estimate of 93 341 thousand was replaced with 110 863 thousand, since the retrospective analysis indicates that the model estimate in the final year is unreliable. The recruitment values assumed in 2023 and 2024 in the short term forecast are estimated with the stock recruitment relationship, 111245 and 111482 respectively.

$F_{status\ quo}$ was defined as the average F over the last 3 years 0.125 and was used as the intermediate-year assumption with catches of 24026 t, landings of 21198 t and discards of 2828 t. Landings and discards values of the intermediate year assume the ratio at age as the average of the last 3 years.

Figure 3.2.28 shows the contribution of each cohort to the landings in 2024 and SSB in 2025 under the MSY catch option. The landings are expected to be dominated by the cohorts from 2020 (19%) while the SSB of 2025 is dominated by the cohorts from 2018 to 2020.

3.2.6 Quality of the assessment

The assessment model was developed during the WKANGHAKE benchmark (ICES, 2023b) with the revisions presented in the WD 01 (Urtizberea, 2022) during the WGBIE in 2022 (ICES, 2022).

The comment from the reviewers was:

Overall, the SS assessment model (Methot and Wetzel, 2013) was configured properly and showed good diagnostics. The model exhibited some minor instability (jitters) and an inability to match the observed discards for the TR_SP fleet. These issues should be further evaluated before the next benchmark assessment. In particular, improvements in the sex-specific life history parameters and a better understanding of the stock delimitation may help resolve some of the model instability and data conflicts observed during the WKANGHAKE (ICES, 2023b). An externally derived selectivity pattern for the SPGFS-WIBTS-Q4 (G5768) survey or improved standardization of this survey's composition data can be performed as complementary input data prior to the next SS update assessment model runs and may also improve the model diagnostics.

3.2.6.1 Other indicators

There are no other reliable indicators than the 3 surveys currently considered in the model.

3.2.7 Management considerations

Management of the two anglerfish species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. However, since the stock sizes of both species are currently increasing, neither of the *Lophius* species appears to be at risk of overexploitation.

3.2.8 Recommendations for the next benchmark

The SS model (Methot and Wetzel, 2013) was developed during the WKANGHAKE benchmark (ICES, 2023b). The model is very good in terms of the performance in diagnostics compared to the previous a4a assessment model (Millar and Jardim, 2019) used for the stock. However, for the next benchmark, some recommendations are proposed below:

- The SS assessment model shows very good diagnostics in terms of test runs or hindcasting. However, due to the different spatial distribution of the surveys and the different trends during some periods in the time-series, the inclusion of a spatial model could improve the survey's fit.

- The life history parameters are different for males and females. However, little is known about growth and natural mortality by sex. Future research and additional information on this aspect could improve the model stability (jitter).

3.2.9 References

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3.2.10 Figures and tables

Figure 3.2.1. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. The proportion of discards by gear and country. Discards data are only available from 2003.

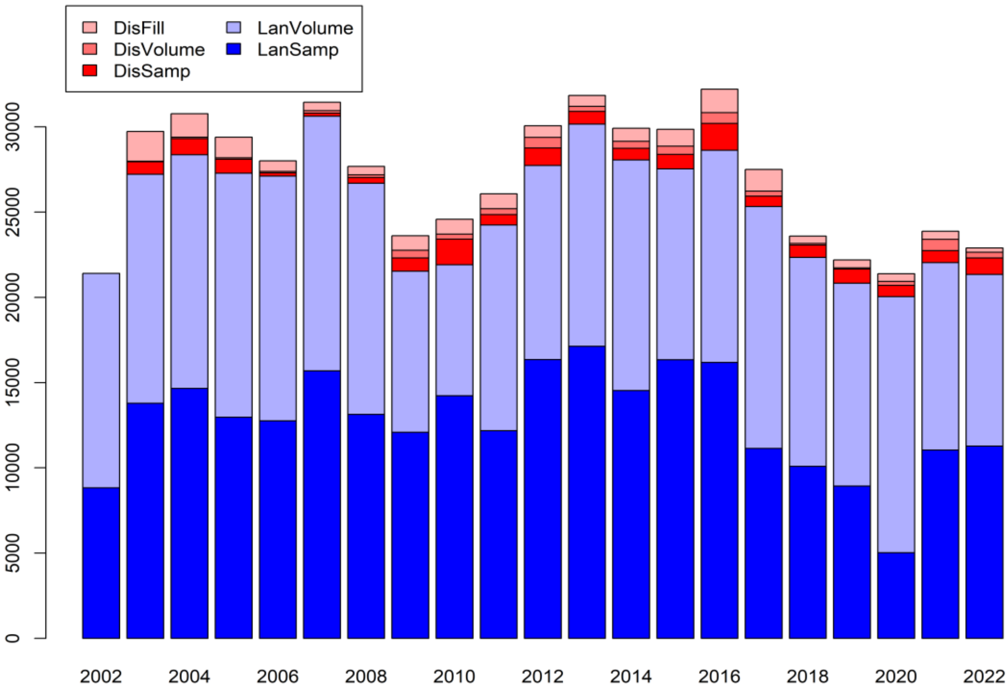

Figure 3.2.2. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Allocations of unsampled landings and discards by year. Dark blue represents the sampled landings while light blue represents landings for which only the total weight (in tonnes) without length data were available and red represents the complete sampled discards (weight and length data). Medium pink represents discards for which an estimate of the weight (in tonnes) was available but no length data (length data 'borrowed' from other strata) while light pink represents the strata for which no discard weight or length data were available and where discard rate and length data were 'borrowed' from other strata.

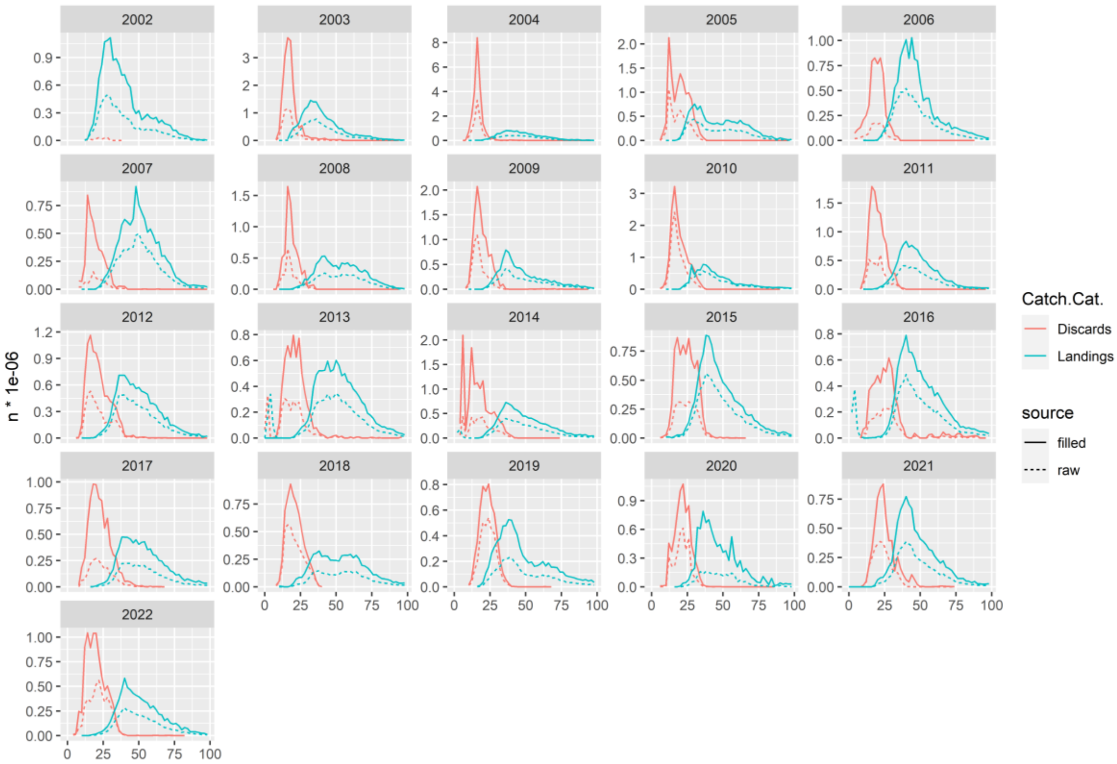

Figure 3.2.3a. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Annual length–frequency distributions of the landings (blue) and discards (red). The dotted lines show the sampled strata submitted to InterCatch; the solid lines are the estimates after allocations of unsampled catches. No discard data were available before 2003.

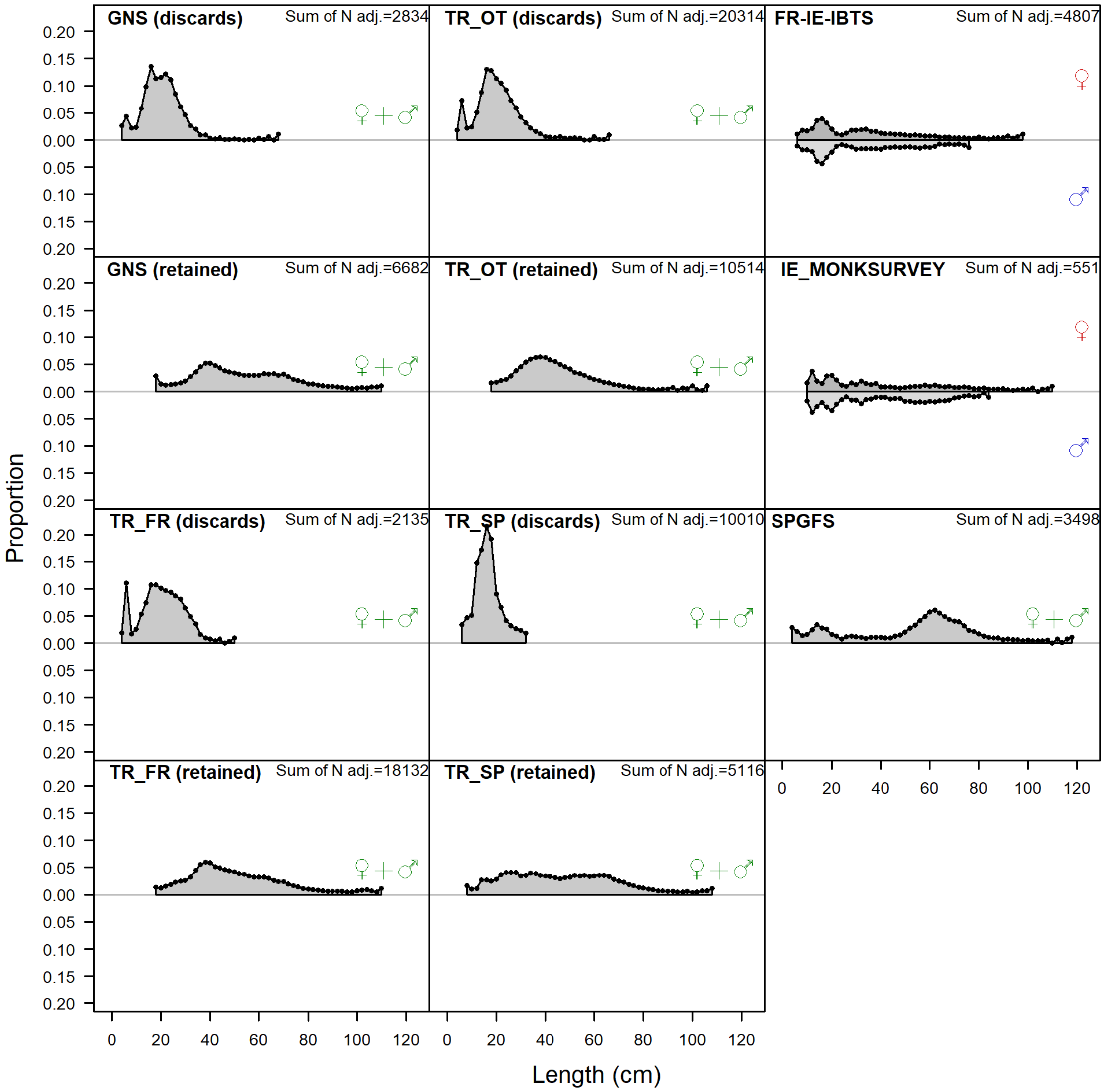

Figure 3.2.3b. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Aggregated length composition by fleet of landings and discards.

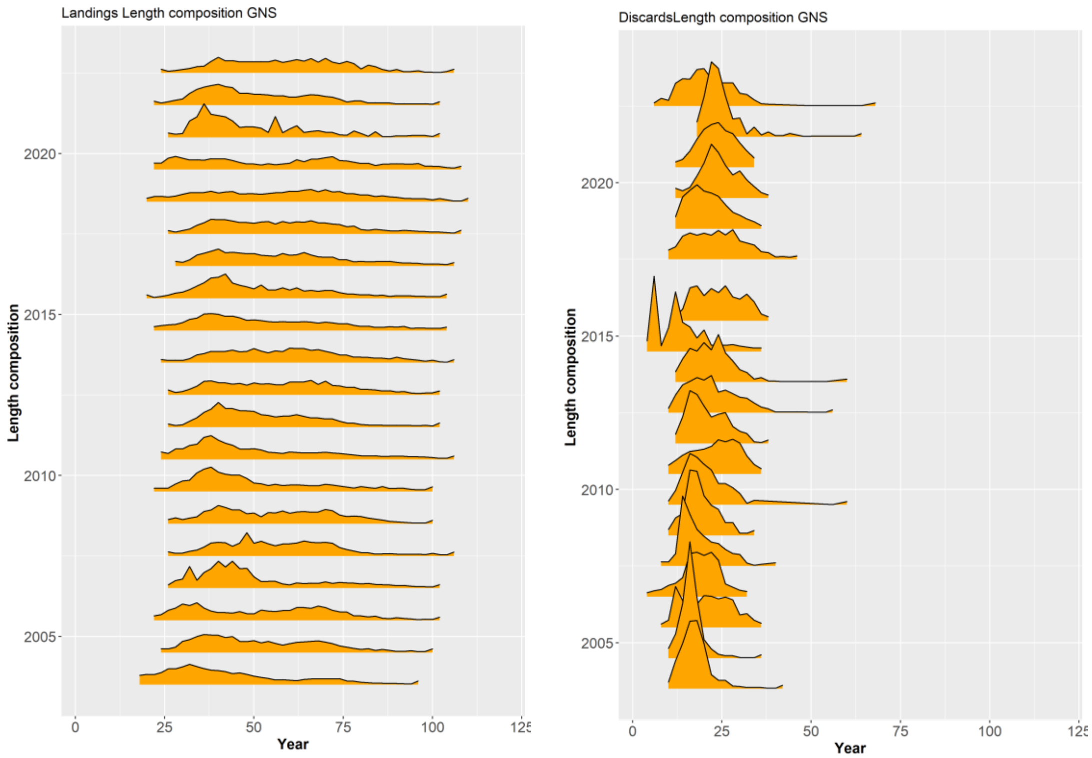

Figure 3.2.3c. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Gillnets (GNS) landings and discards length composition by year (discards length composition available from 2003).

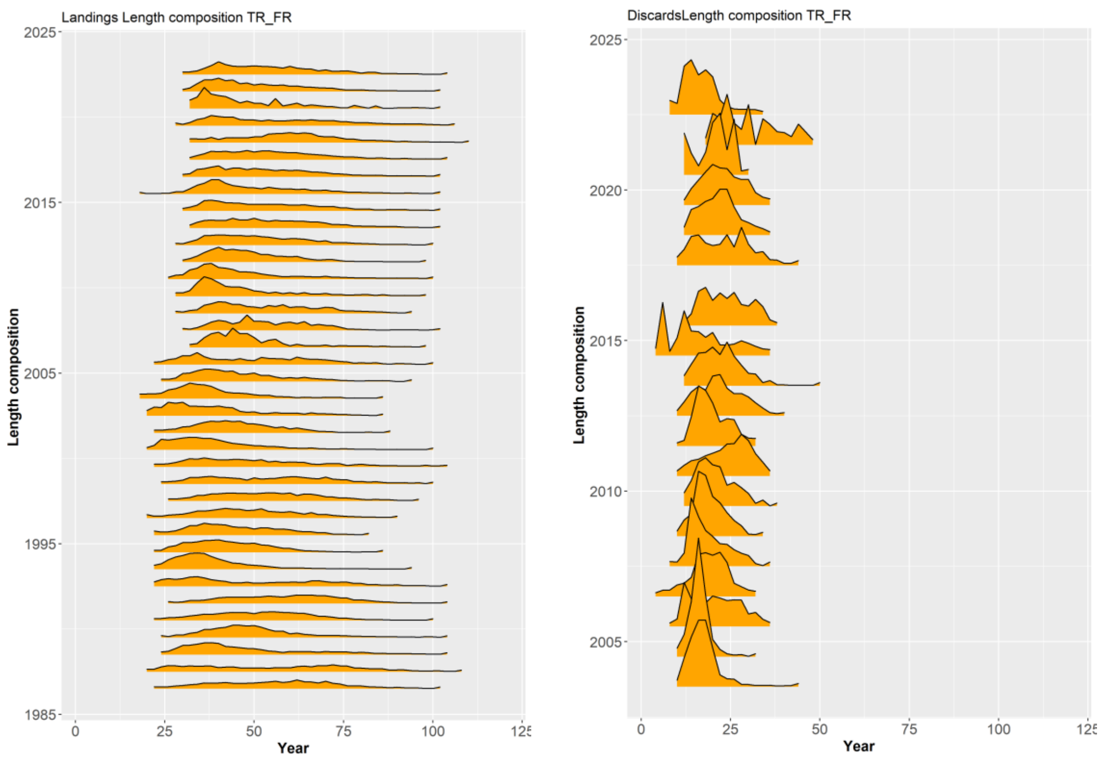

Figure 3.2.3d. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. French trawlers (TR_FR) landings length composition by year (discards length composition available from 2003).

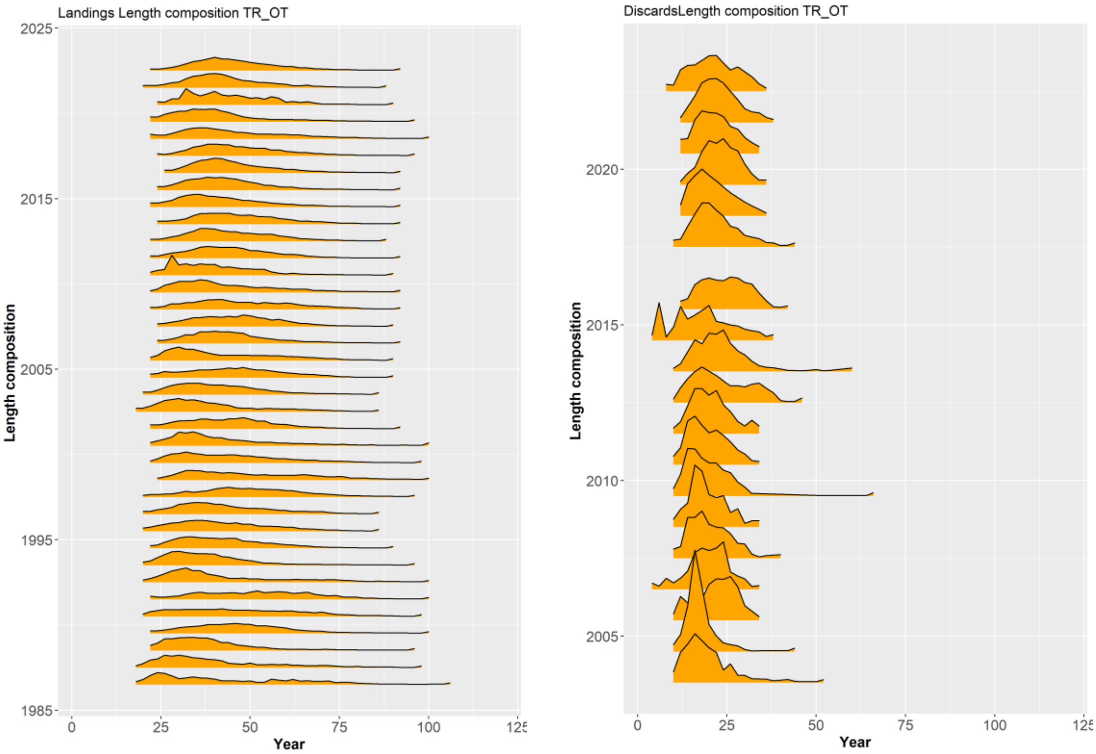

Figure 3.2.3e. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Other trawlers (TR_OT) landings length composition by year (discards length composition available from 2003).

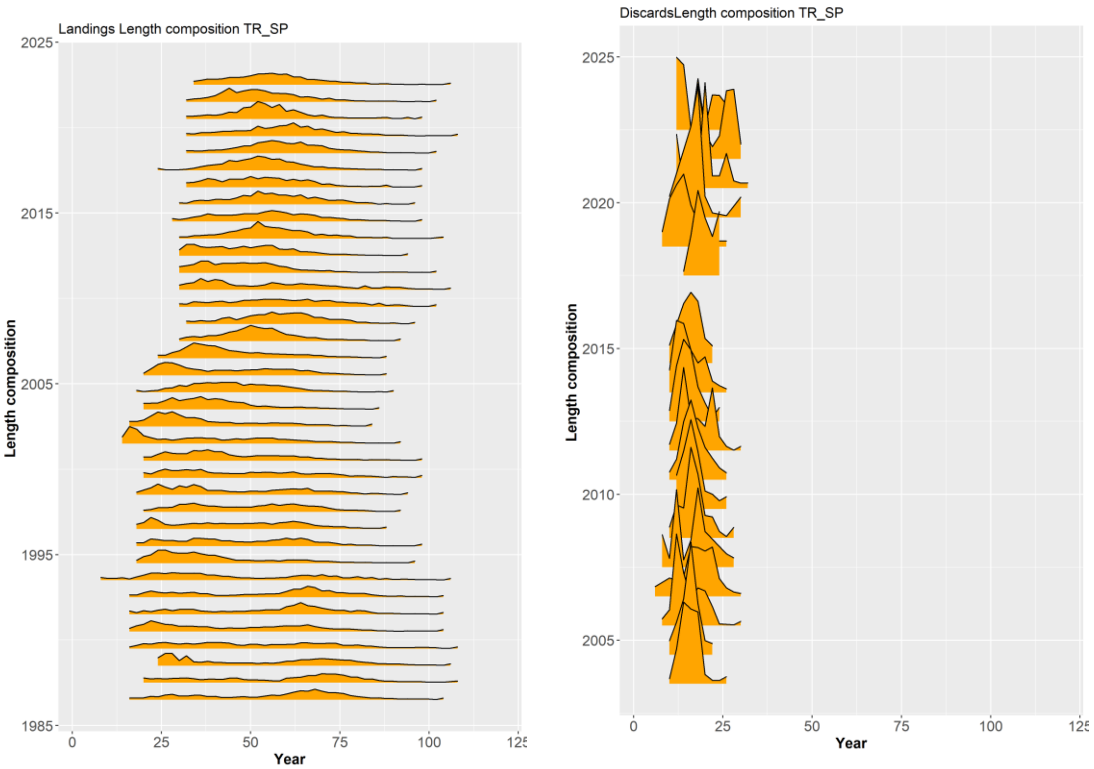

Figure 3.2.3f. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Spanish trawlers (TR_SP) discards length composition by year (discards length composition available from 2003).

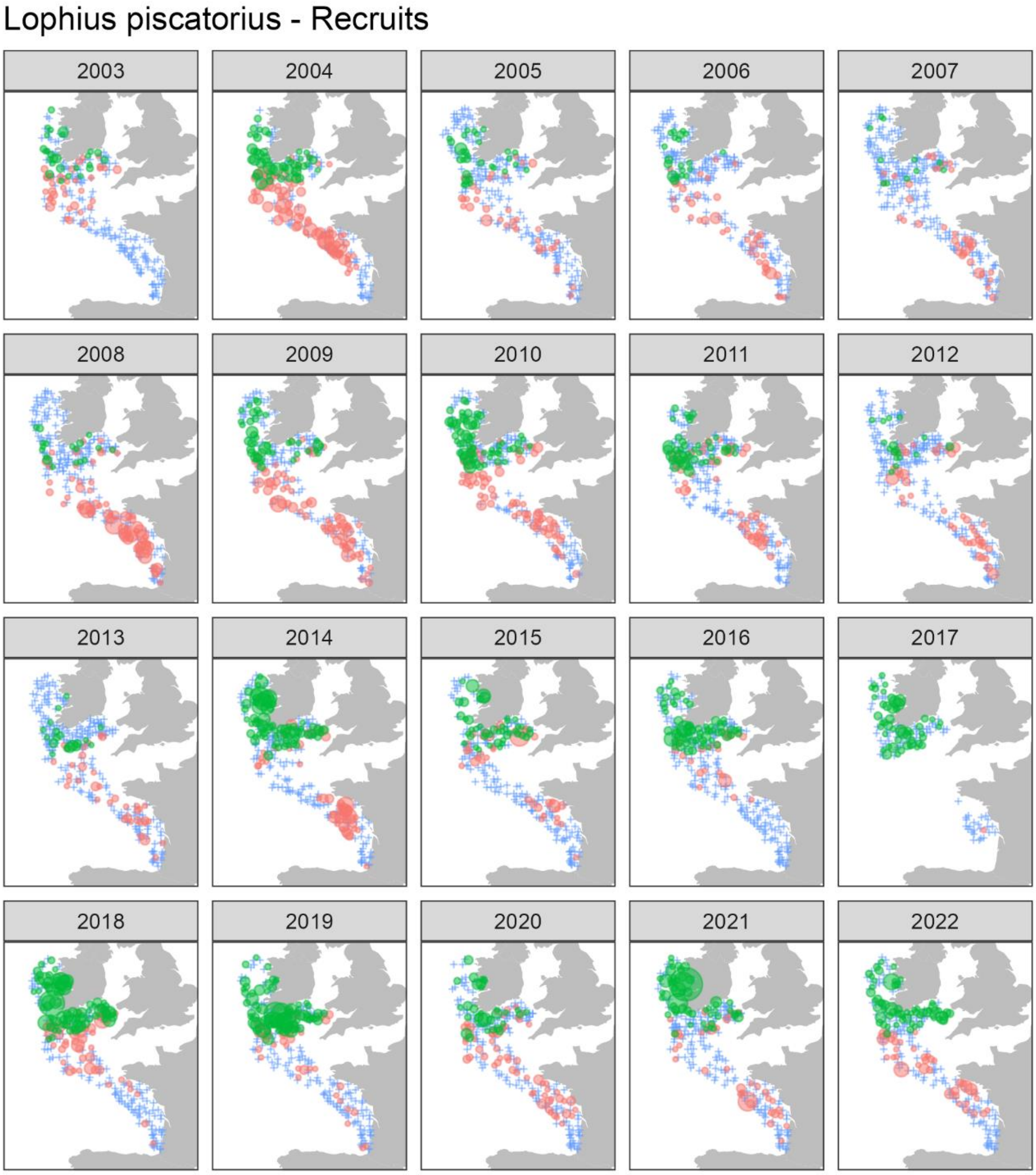

Figure 3.2.4a. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Abundance of recruits (< 24cm) in the IGFS-WIBTS-Q4 (G7212; in green) and EVHOE-WIBTS-Q4 (G9527; in red) surveys.

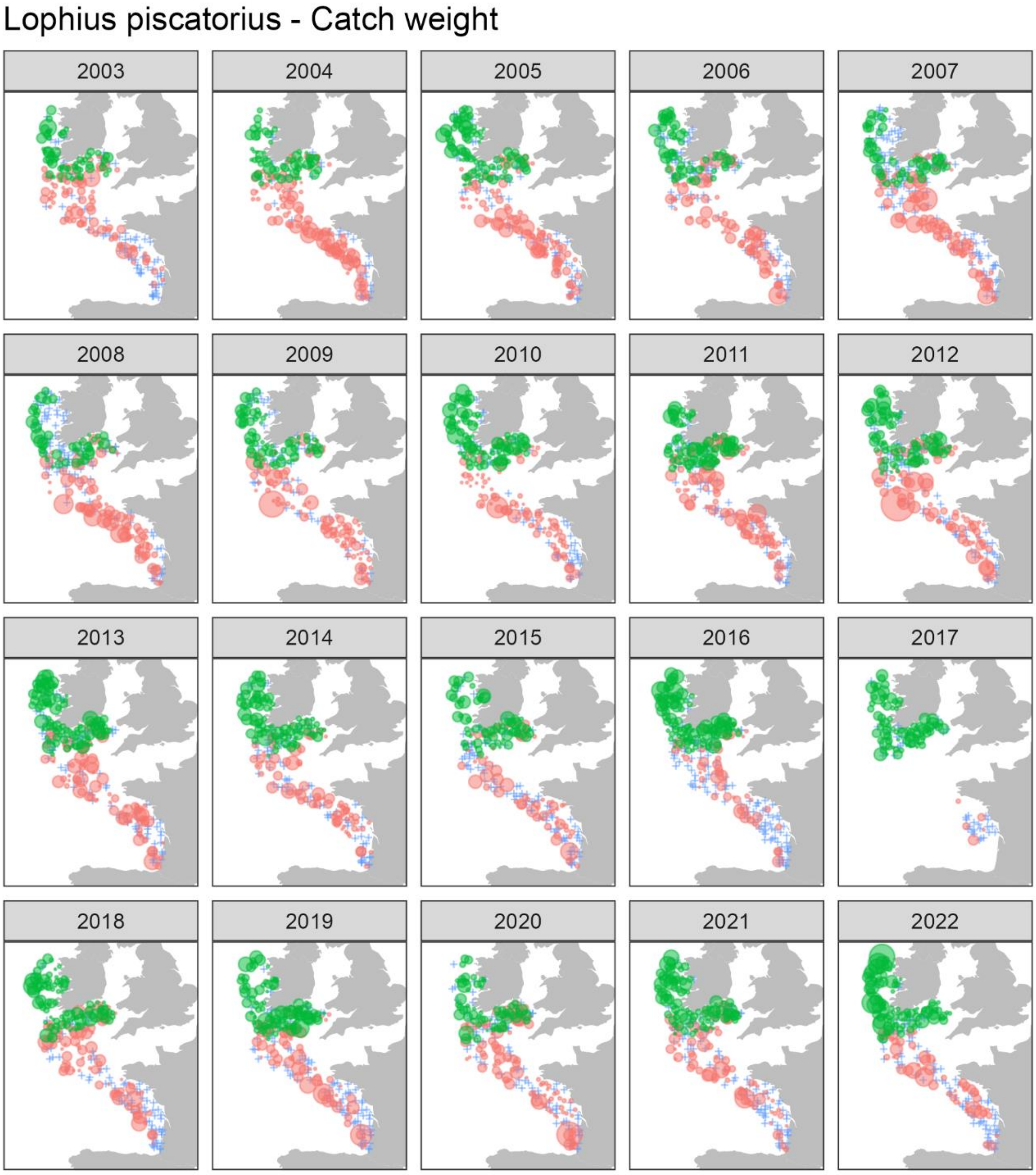

Figure 3.2.4b. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Catch weights in the IGFS-WIBTS-Q4 (G7212; in green) and EVHOE-WIBTS-Q4 (G9527; in red) surveys.

Figure 3.2.5. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Survey index of the EVHOE-WIBTS-Q4 (G9527) index is shown in green, IGFS-WIBTS-Q4 (G7212) in blue and the combined FR_IE_IBTS survey index in red, all with 95% confidence intervals.

Figure 3.2.6. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Catch rates on the IAMS (G3098) survey.

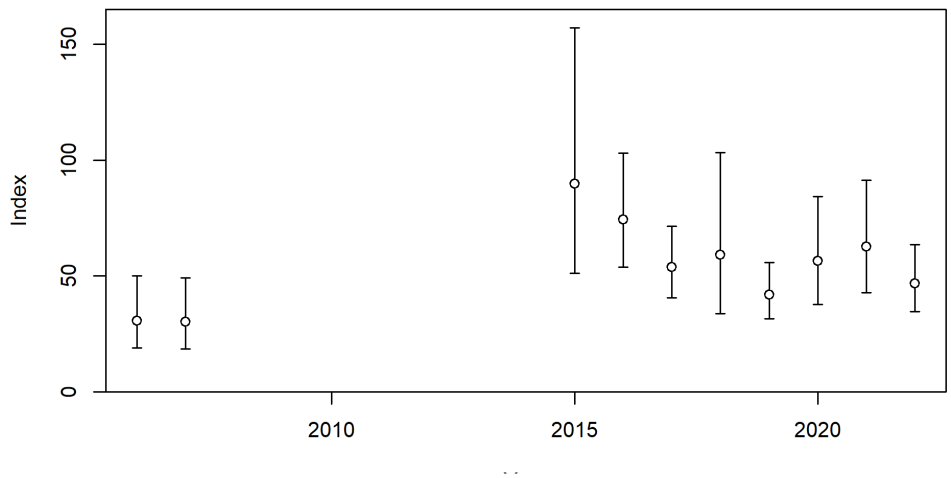

Figure 3.2.7. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Abundance index of the IAMS (G3098) survey.

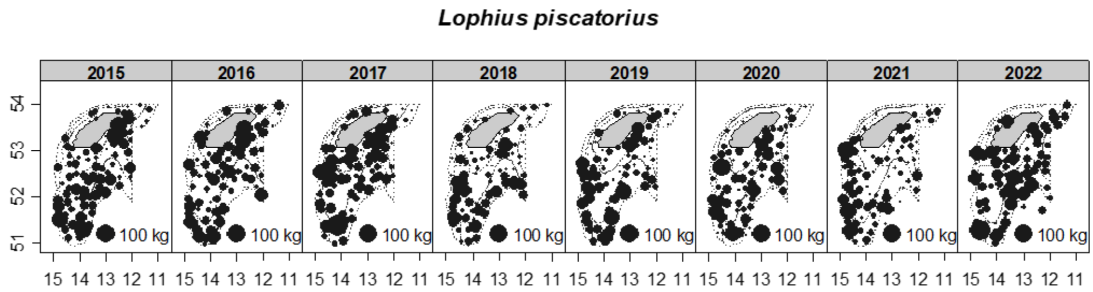

Figure 3.2.8. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Catch rates of the SpPGFS-WIBTS-Q4 (G5768; previous acronym was SP-PGFS) survey.

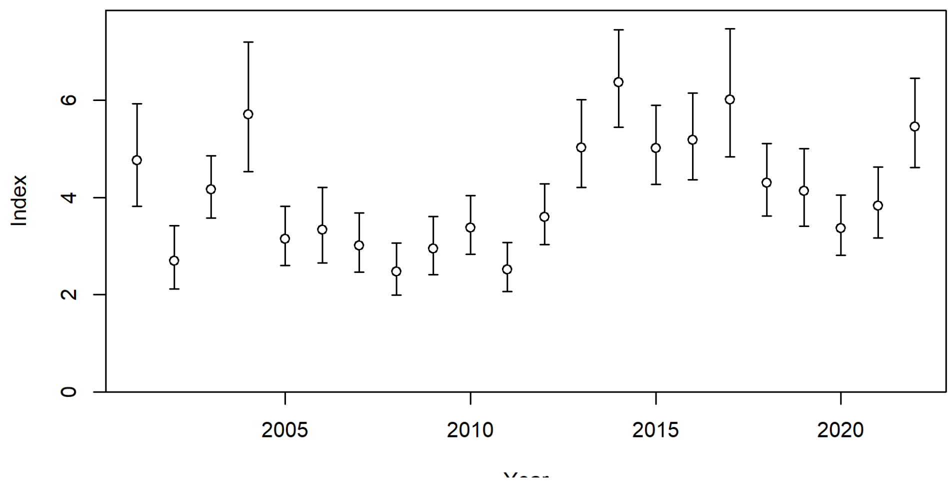

Figure 3.2.9. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Abundance index of the SpPGFS-WIBTS-Q4 (G5768; previous acronym was SP-PGFS) survey.

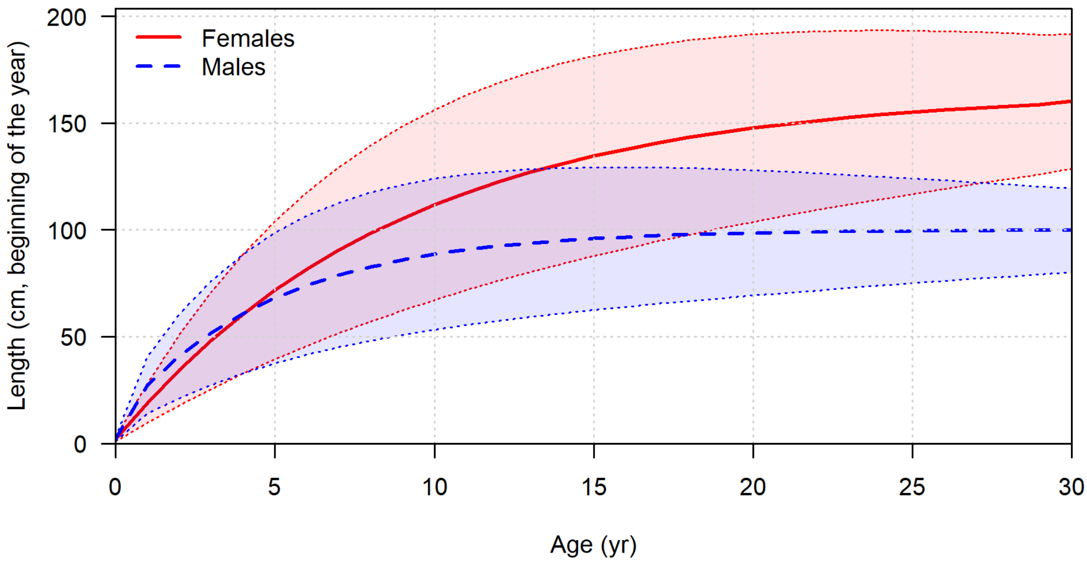

Figure 3.2.10. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Assumed growth curves for females and estimated growth for males assuming a fix maximum length. The length-at-age 1 for both males and females is estimated by the model.

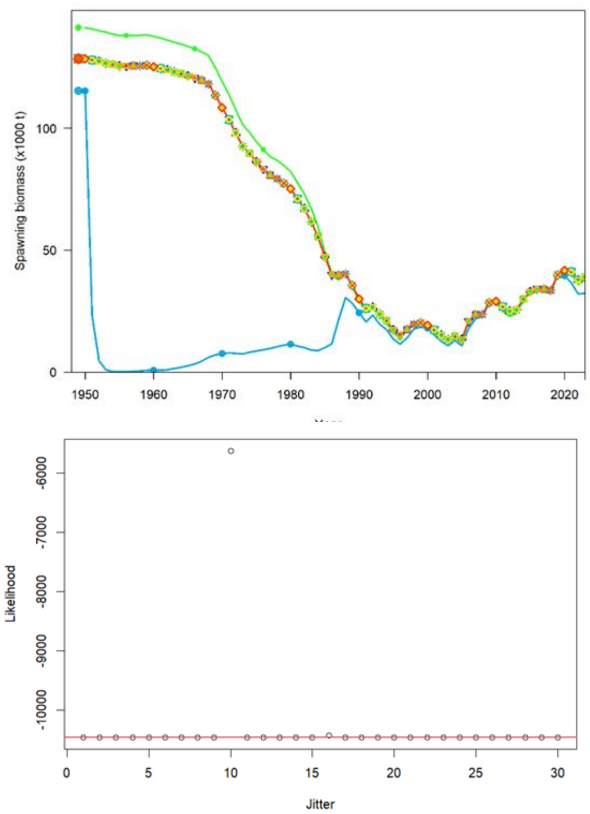

Figure 3.2.11. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Estimated SSB value of 30 runs with a jitter analysis.

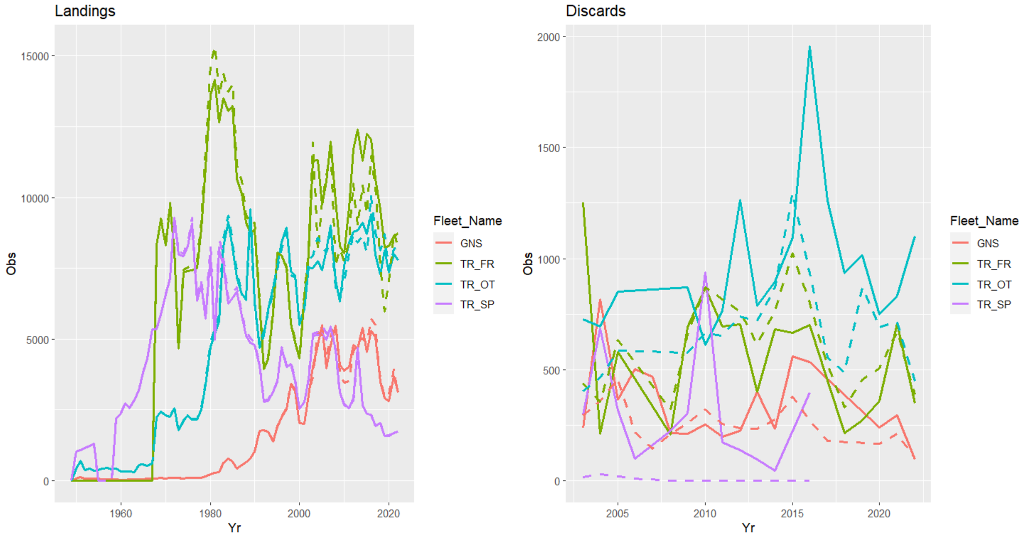

Figure 3.2.12. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Observed (continuous lines) and fitted (discontinuous lines) discards and landings by fleet.

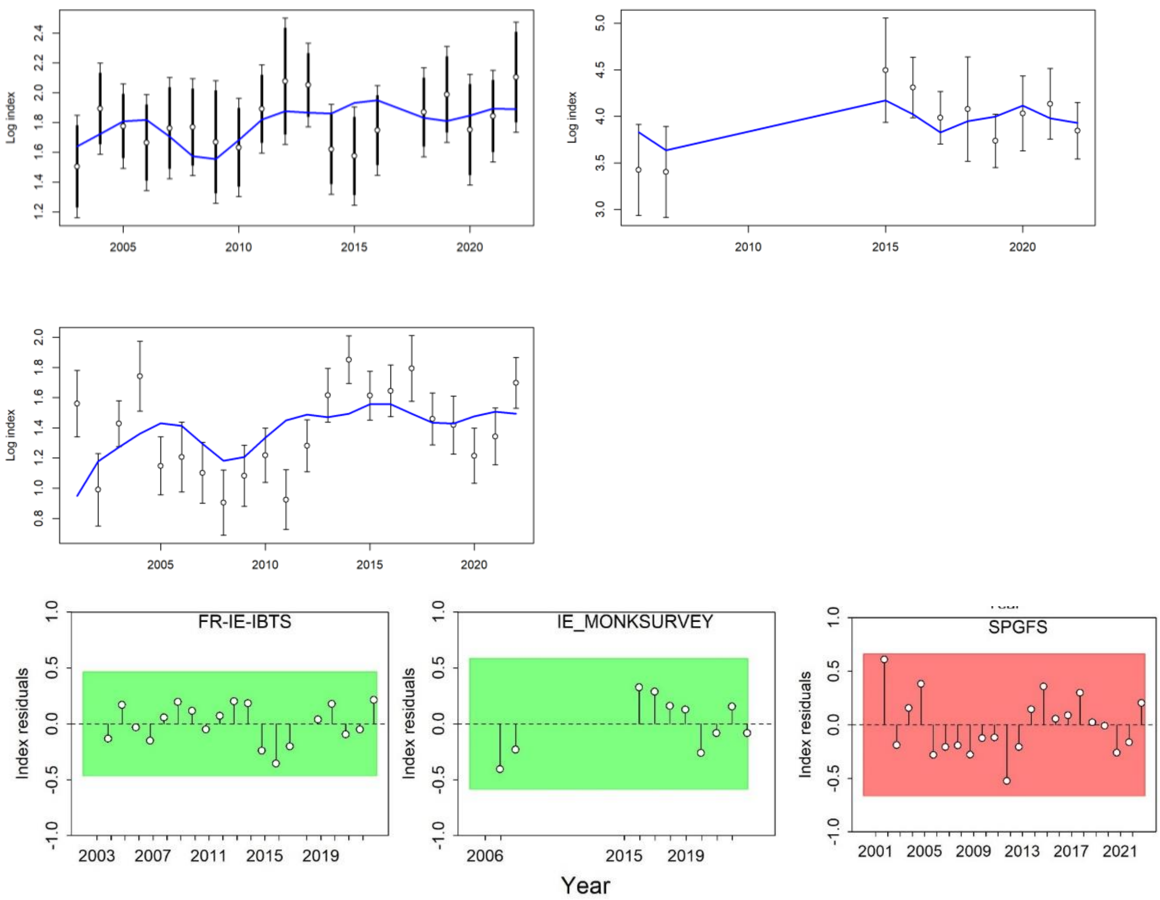

Figure 3.2.13. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Index fit (top) and residuals (bottom). SpPGFS-WIBTS-Q4 (G5768; previous acronym was SP-PGFS) index failed the test runs (red shading) due to the non-randomness in the sign of the residuals. The red and green shadings indicate three standard deviations and observations outside this area and can be considered outliers.

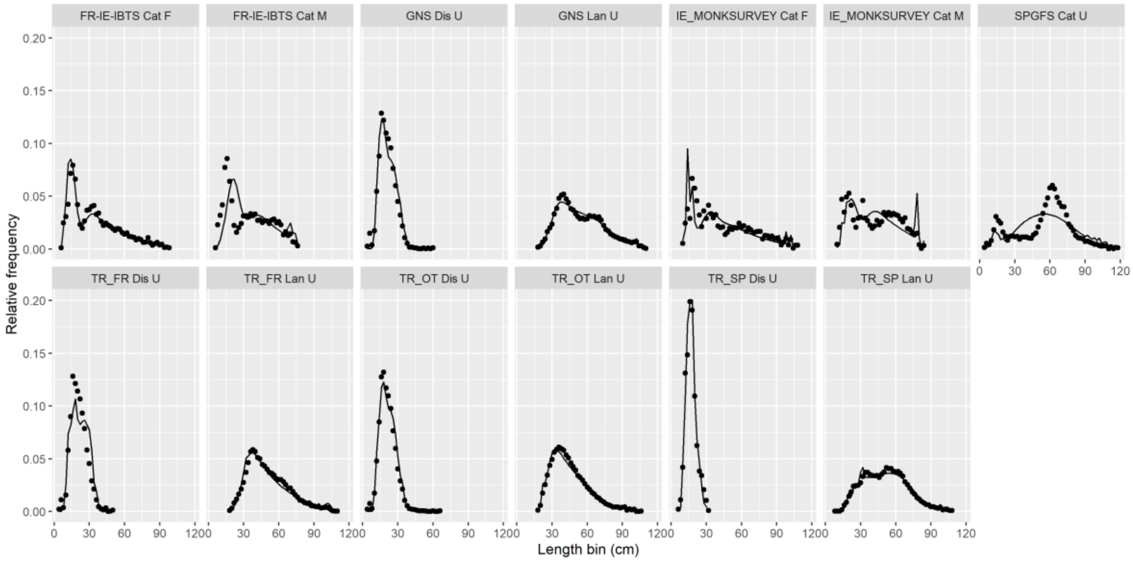

Figure 3.2.14. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Observed (points) and fitted (lines) length compositions of landings, discards and surveys, aggregated overall years. Length compositions for males (Cat M) and females (Cat F) from the EVHOE-WIBTS-Q4 (G9527) and IAMS (G3098) surveys.

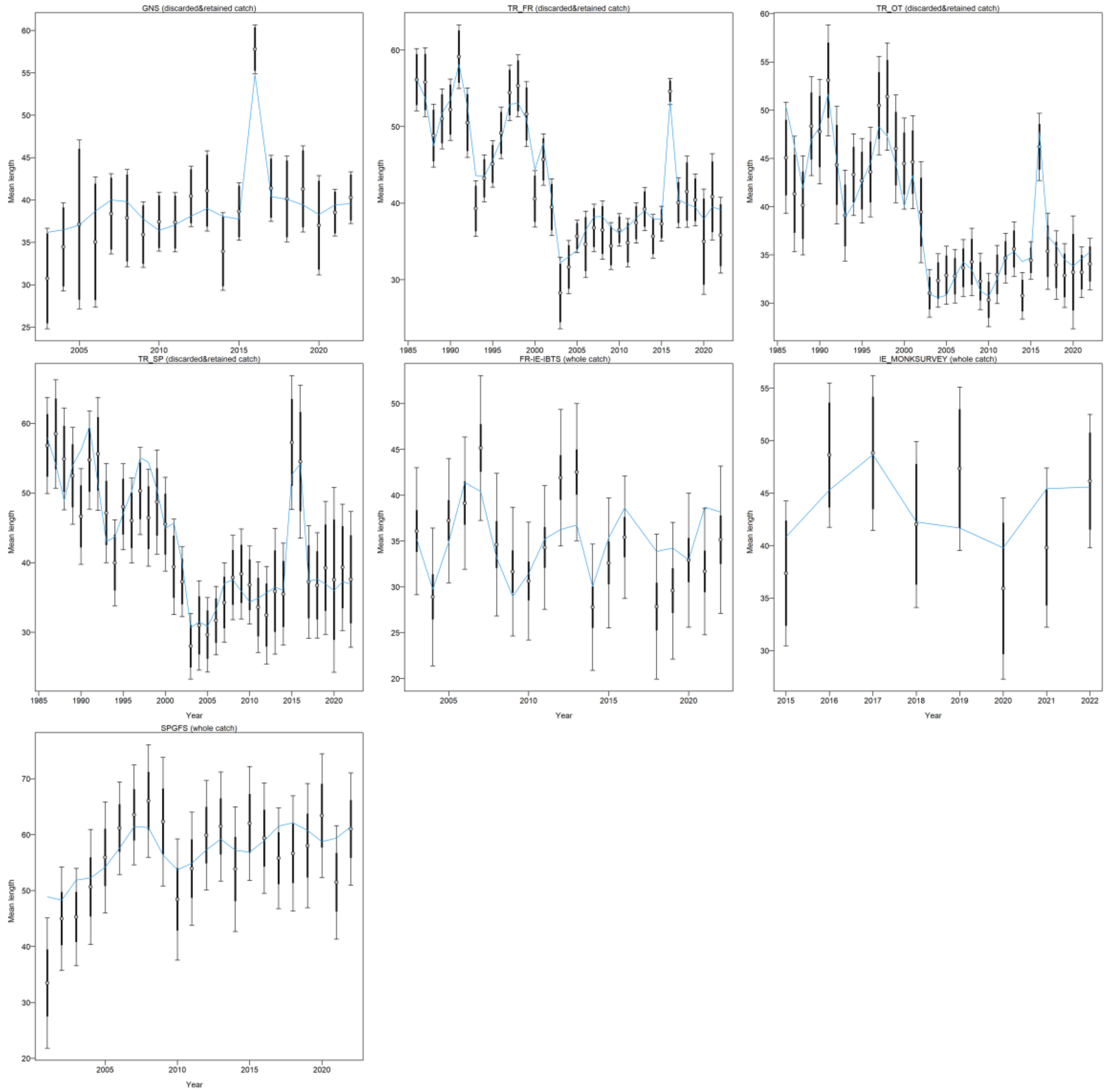

Figure 3.2.15. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Observed (points), the vertical lines the SE and fitted (blue lines) average length compositions by year.

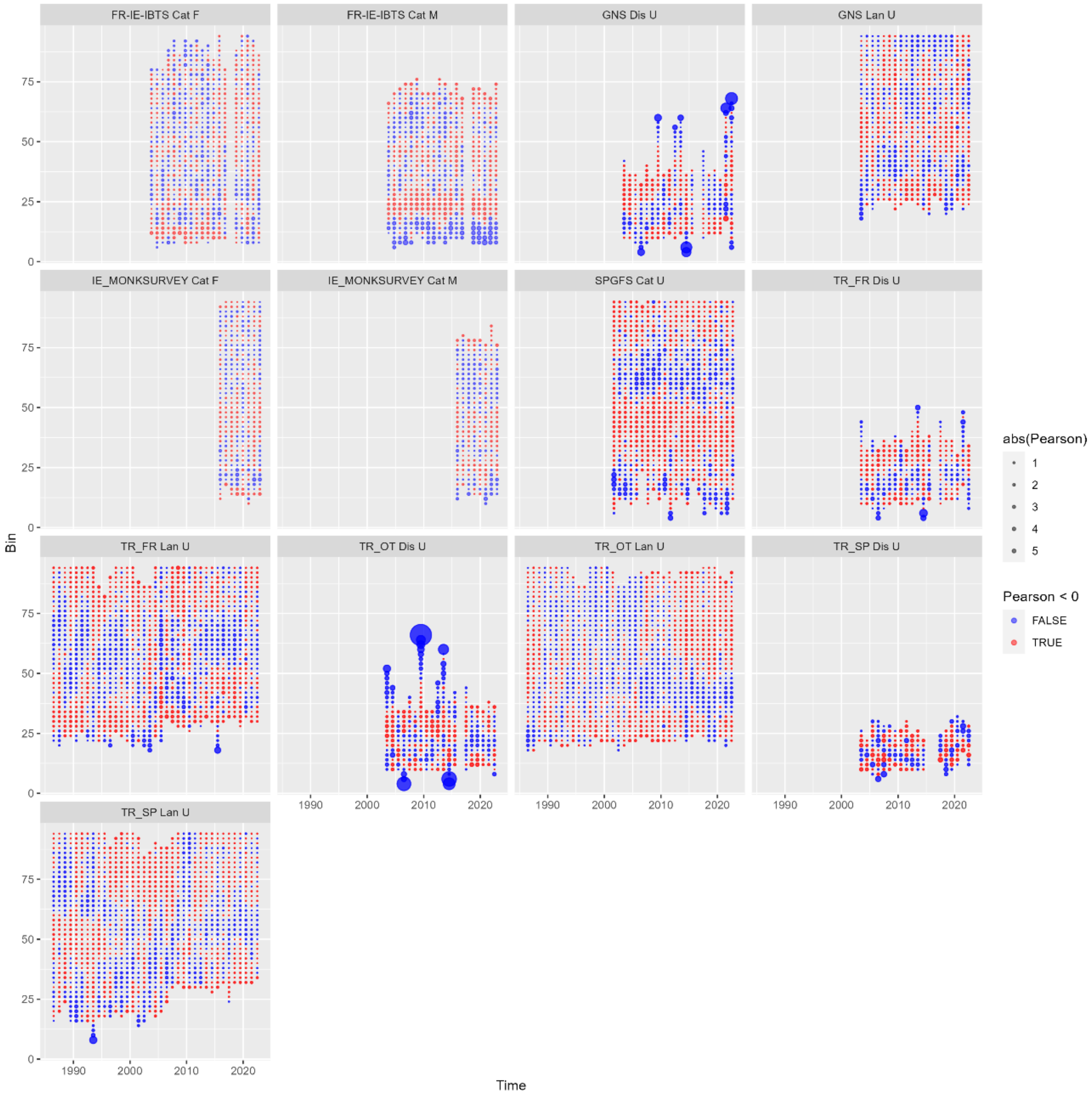

Figure 3.2.16. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Bubble plots of the residuals to the length composition fit.

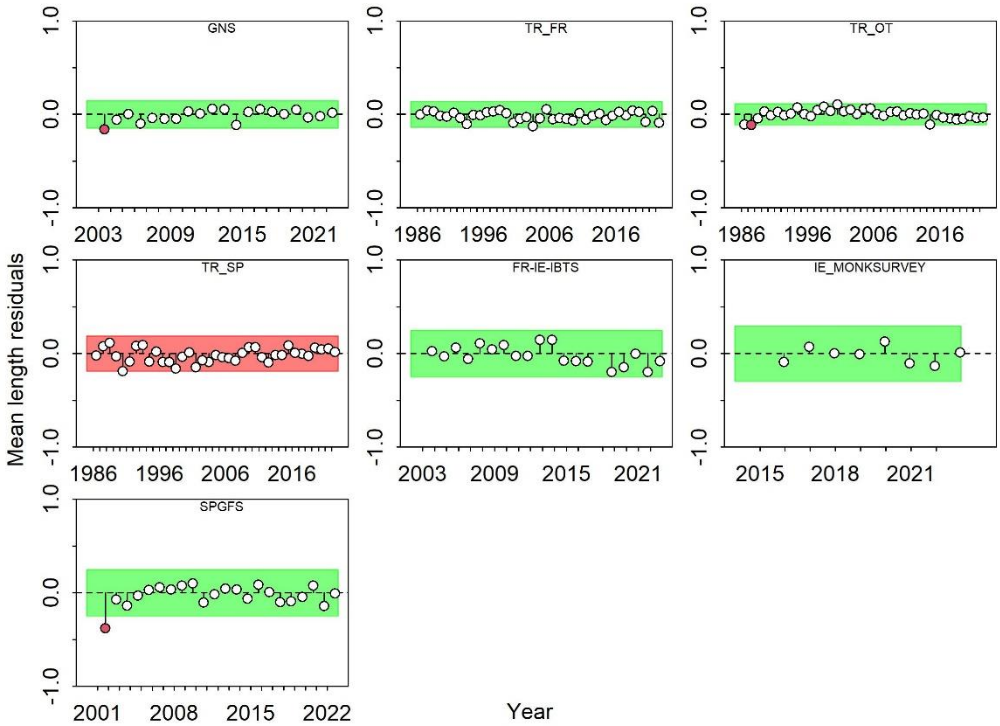

Figure 3.2.17. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Test runs on the mean-length residuals. All the residuals of the commercial fleets and surveys passed the test runs (green shading). This indicates that all the residuals follow a random pattern.

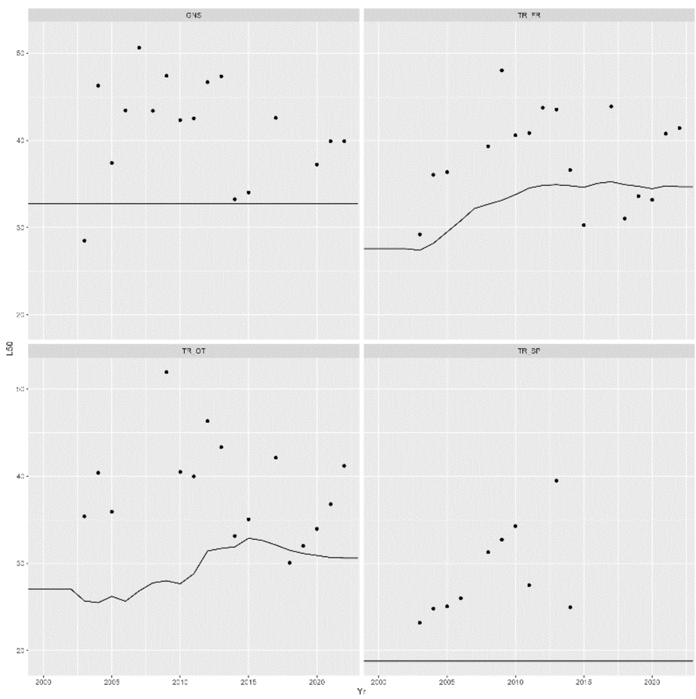

Figure 3.2.18. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Observed (points) and fitted (lines) length at 50% retention. Retention (the proportion of catches that are landed in each size class) is modelled with a logistic curve and the inflection point of the French trawler (TR_FR) and Other trawler (TR_OT) fleets is allowed to vary during the period 2003–2021 with a random walk. For Gillnets (GNS) and Spanish trawler (TR_SP) this parameter has no time-varying flexibility.

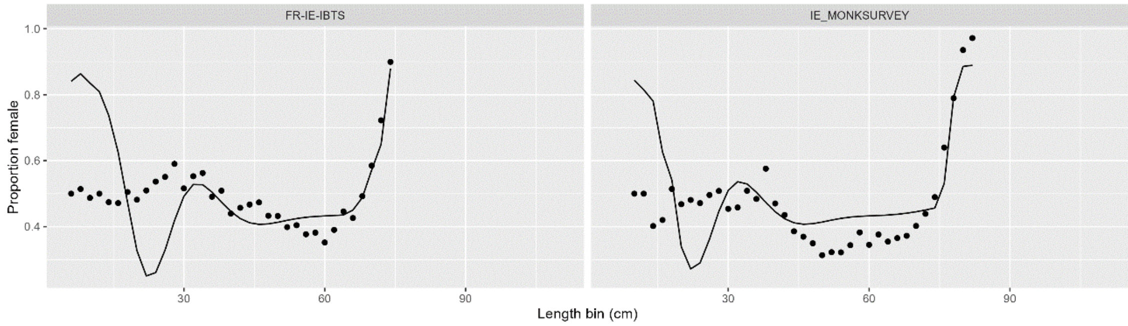

Figure 3.2.19. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Observed (points) and fitted (lines) sex ratio (proportion female) at length. The sexual dimorphism that is apparent from the survey data cannot be fully accommodated with the current settings at the smallest size.

Figure 3.2.20. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Retrospective analysis. The purple line corresponds to the current model run (last data year 2022, for SSB last year 2023). The other colours represent −1 to −5-year peels. The 95% confidence intervals of the final model are indicated by the grey shading.

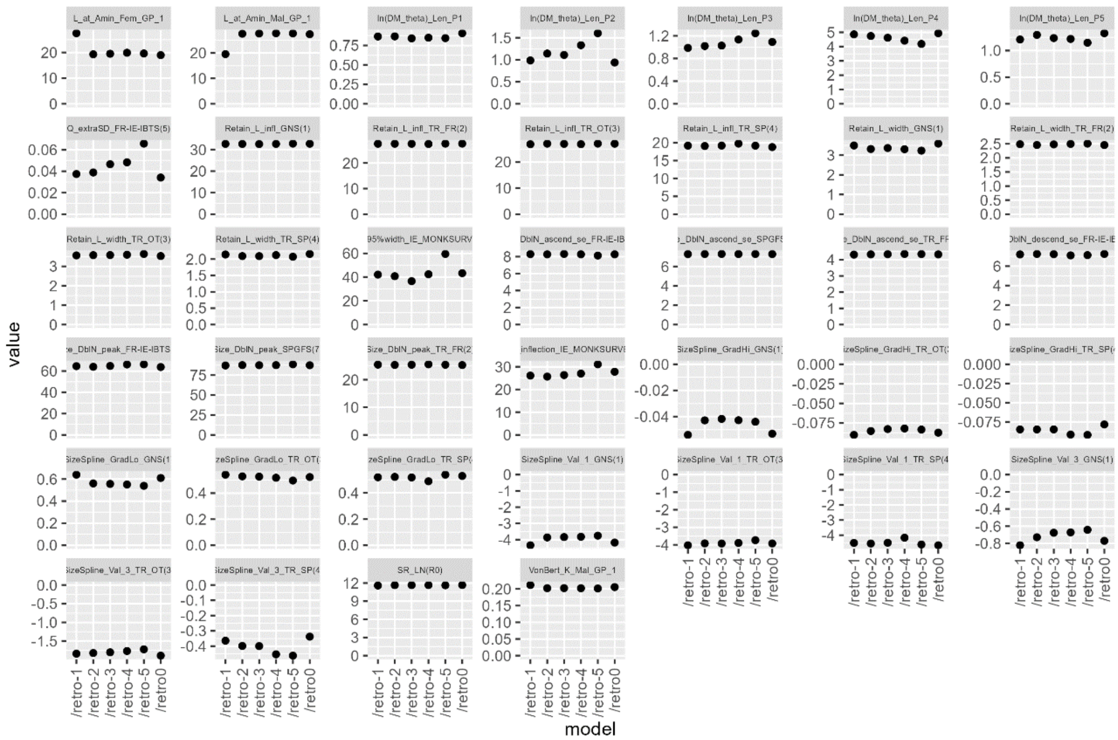

Figure 3.2.21. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. The parameters estimated at each peel from the retrospective analysis.

Figure 3.2.22. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Retrospective analysis assuming a fixed value for length at age 1 for females (*L_at_Amin_Fem* =18.98). The purple line corresponds to the current model run (last data year 2022 and for SSB 2023). The other colours represent −1 to −5-year peels. The 95% confidence intervals of the final model are indicated by the grey shading.

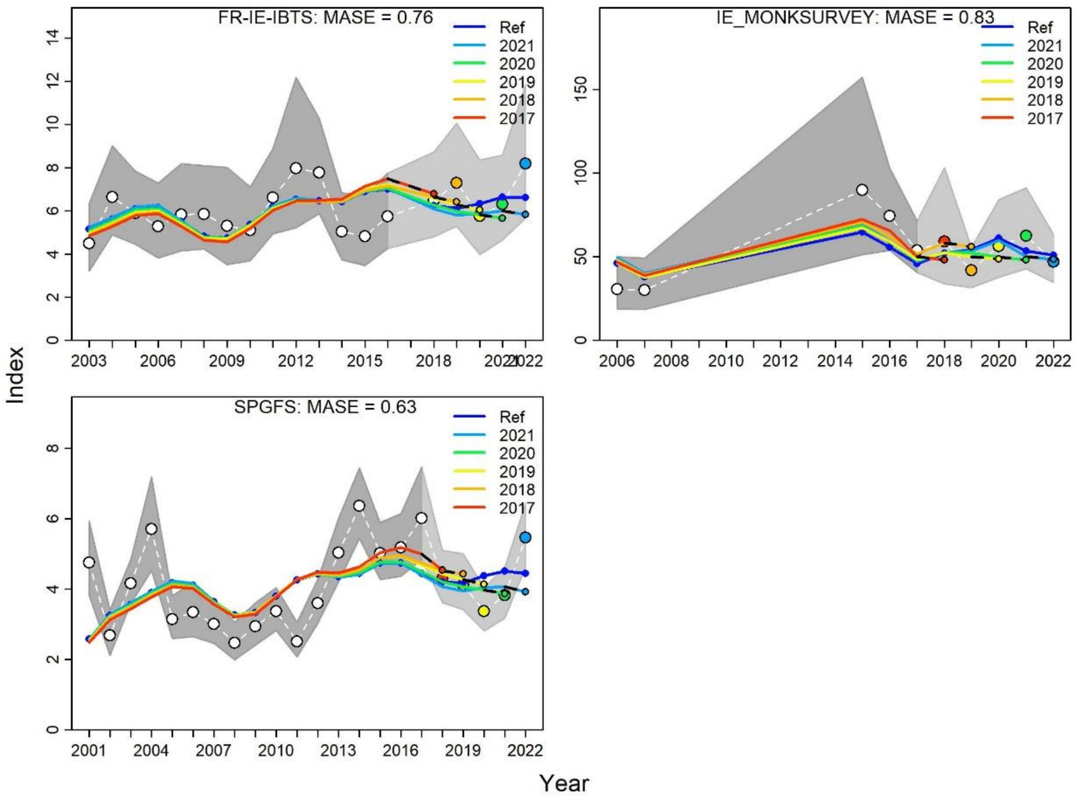

Figure 3.2.23. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Hindcasting results for the survey indices. The three surveys have a very good MASE score of below 1, indicating that the model can predict the indices.

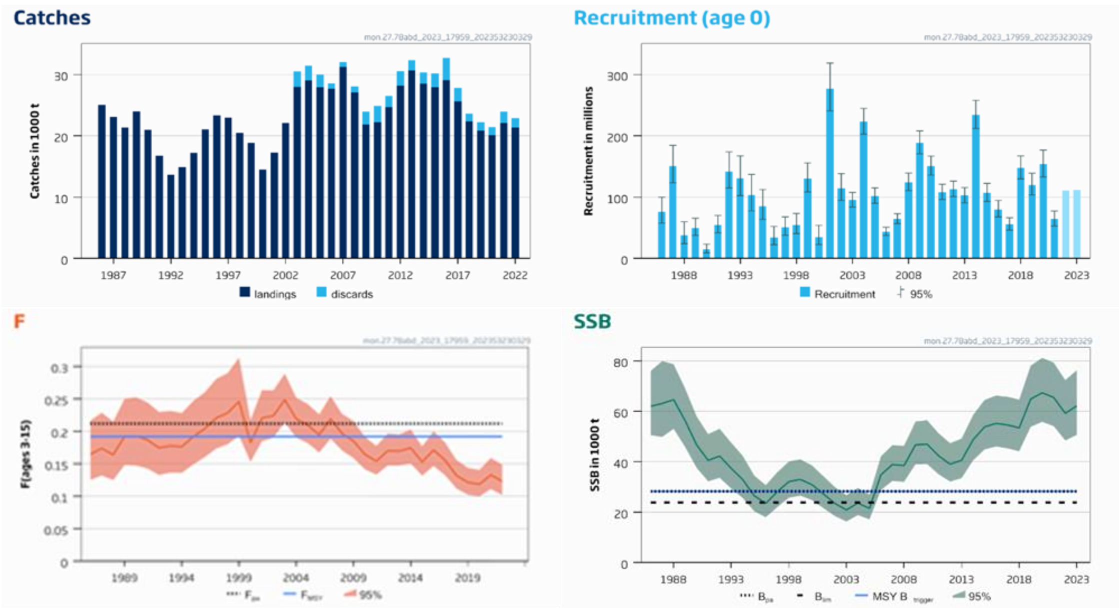

Figure 3.2.24. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Summary plot. Discard observations are available since 2003. Annual landings are available to the model from 1950 but the plots only show the more data-rich period since 1986. SSB displayed here is for both sexes combined. Confidence intervals were scaled up from only the female SSB because the model does not provide CIs for the combined-sex SSB. The assumed recruitment values for 2022 and 2023 are shaded in a lighter colour.

Figure 3.2.25. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Comparison of the current SS assessment (thick, orange line) with the previous assessments (green lines) with SS in 2022 and the previous one with a4a assessment models showing the different reference points. The broad perception of the stock remains unchanged.

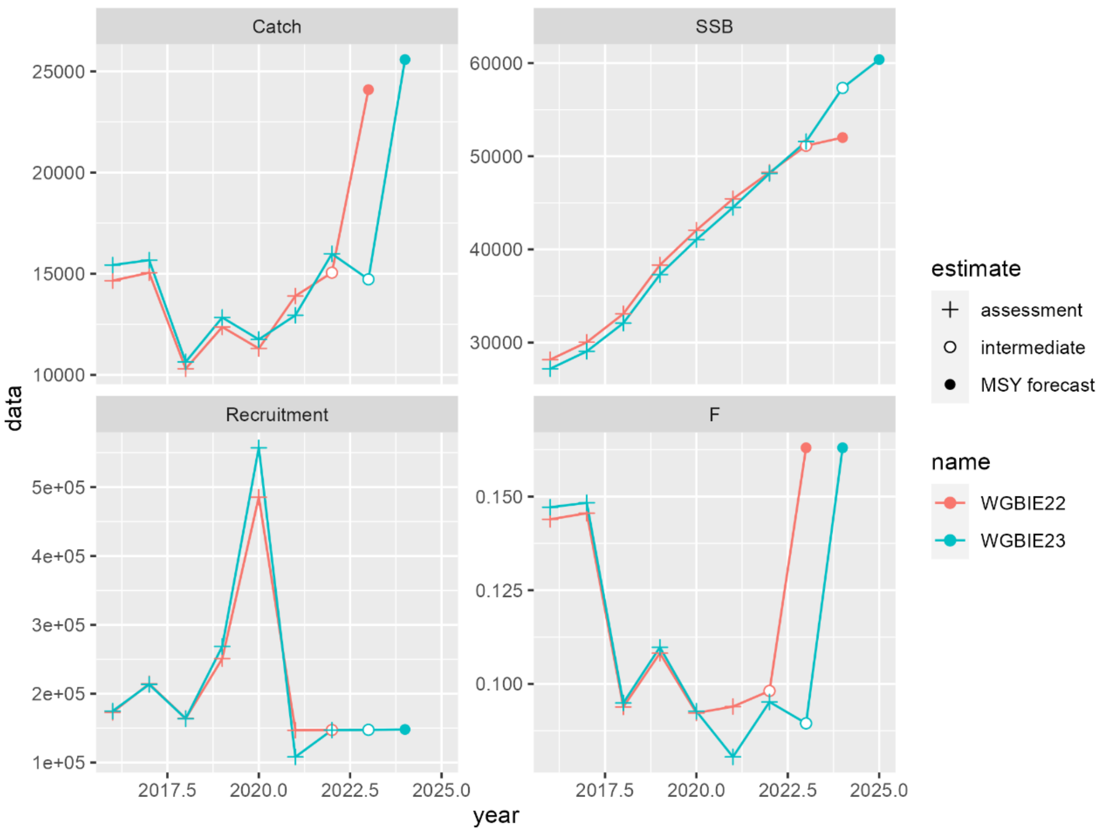

Figure 3.2.26. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Comparison of the current SS assessment (green line) with the previous assessment in 2022 (green line).

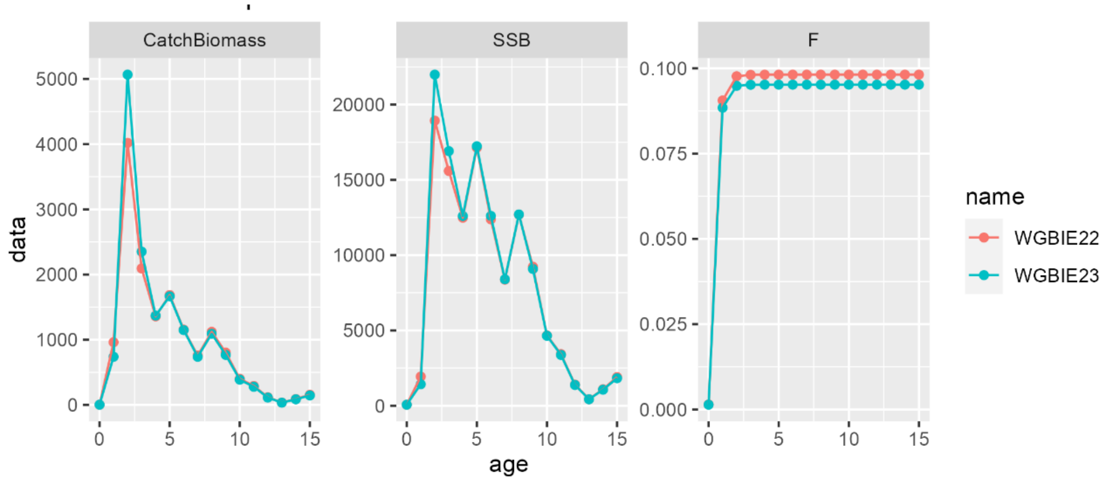

Figure 3.2.27. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Contribution of each age to catches, SSB and the harvest rate at age in 2022.

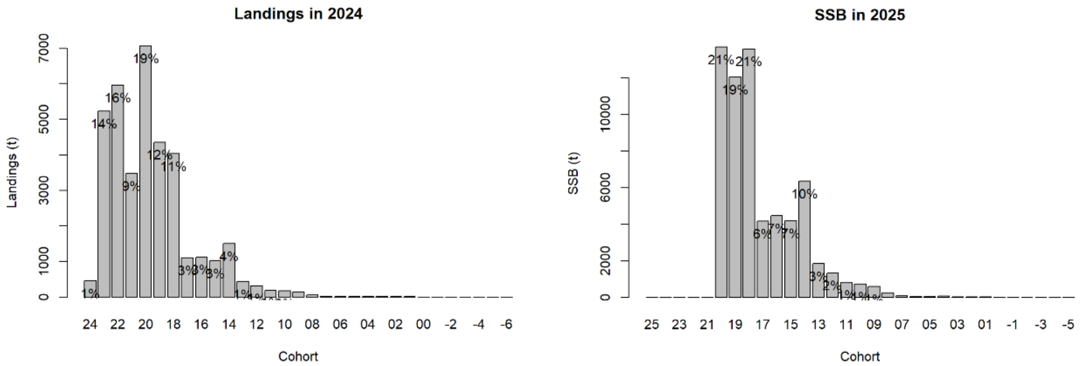

Figure 3.2.28. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Contribution of each cohort to the forecasted landings in 2024 and SSB in 2025.

Table 3.2.1 White-bellied anglerfish (*L. piscatorius*) in 27.78abd. ICES estimates of the catch and landings by area and by country. All weights are in tonnes.

ICES estimated landings from Subarea 7								
Year	FRA	IRL	ESP	GBR	OTH	Unallocated	Total_7	Disc_7
1986	9180	950	5831	3145	1753	0	20859	-
1987	7998	868	5059	3164	1272	0	18361	-
1988	7677	608	4291	3415	1375	0	17366	-
1989	8233	1482	4253	3746	3411	0	21126	-
1990	8161	1371	3985	2647	1440	0	17603	-
1991	6930	1012	3554	2454	655	0	14604	-
1992	5206	1050	2484	2570	946	0	12255	-
1993	5611	1147	2543	2346	1660	0	13308	-

ICES estimated landings from Subarea 7								
Year	FRA	IRL	ESP	GBR	OTH	Unallocated	Total_7	Disc_7
1994	6834	1891	2652	2117	1663	0	15156	-
1995	8867	1541	3004	2374	2134	0	17921	-
1996	9237	1289	3849	2999	1971	0	19345	-
1997	8895	1855	3302	3143	1871	0	19066	-
1998	8052	1896	3403	3049	1287	0	17688	-
1999	7623	3076	2954	2812	853	0	17318	-
2000	6167	1660	2187	2574	831	0	13420	-
2001	7780	1535	2395	2903	1057	0	15669	-
2002	9195	1884	3084	2985	1397	0	18546	-
2003	12081	1456	4662	2850	1569	0	22619	2077
2004	12281	1646	4507	2906	1743	0	23083	1968
2005	11137	2071	4663	3032	1469	0	22371	1779
2006	10607	2656	4589	3137	1375	0	22366	674
2007	12253	2902	5065	4036	1596	0	25852	620
2008	10871	2419	4107	2928	1062	0	21387	743
2009	8691	2048	2754	3013	857	0	17363	1509
2010	8188	2523	2353	3675	993	0	17732	2038
2011	9546	2304	920	4287	1174	1313	19544	1443
2012	12225	2648	1398	4028	1835	1167	23302	1833
2013	12775	2557	3316	4629	1625	1148	26051	1405
2014	11410	2707	1892	6129	1055	337	23529	1443
2015	11721	2582	1693	5644	1284	414	23338	1796
2016	12667	2761	1754	6052	1578	351	25164	3056
2017	11473	2543	1744	5222	1498	0	22479	1912
2018	10360	2148	1810	4156	770	85	19327	1192
2019	9379	2285	1473	4553	858	0	18651	1314
2020	9372	2388	1477	4171	994	0	18185	804
2021	9673	2696	1567	4778	1173	0	19887	1132

ICES estimated landings from Subarea 7								
Year	FRA	IRL	ESP	GBR	OTH	Unallocated	Total_7	Disc_7
2022^	9970	2219	1596	4275	1149	0	19210	985

ICES estimated landings from divisions 8.a–b and 8.d							ICES estimate for Subarea 7 and divisions 8.a–b and 8.d		
Year	FRA	SP	OTH	Unallo-cated	Total_8	Disc_8	Landings	Disc.	Catch
1986	3265	858	0	0	4122	-	24981		0
1987	3955	774	0	0	4729	-	23090		0
1988	3129	819	0	0	3948	-	21314		0
1989	2264	625	0	0	2889	-	24015		0
1990	2580	800	0	0	3379	-	20983		0
1991	1657	502	0	0	2158	-	16763		0
1992	1066	296	0	0	1362	-	13617		0
1993	1314	274	0	0	1587	-	14895		0
1994	1564	481	0	0	2045	-	17201		0
1995	2402	482	0	228	3113	-	21033		0
1996	2216	834	0	938	3988	-	23333		0
1997	2143	707	0	1068	3917	-	22983		0
1998	1534	711	0	542	2787	-	20474		0
1999	924	549	0	0	1473	-	18792		0
2000	690	341	0	0	1032	-	14451		0
2001	1240	384	0	0	1624	-	17293		0
2002	3023	514	0	0	3537	-	22083		0
2003	4806	508	0	0	5315	434	27933	2511	30444
2004	5227	718	0	0	5945	443	29028	2411	31439
2005	4927	571	0	0	5498	332	27869	2110	29980
2006	4819	420	48	0	5287	219	27652	892	28545
2007	4935	401	25	0	5361	197	31213	816	32029
2008	5132	527	7	0	5666	250	27053	993	28046
2009	4065	374	33	0	4472	569	21835	2078	23913

ICES estimated landings from divisions 8.a–b and 8.d							ICES estimate for Subarea 7 and divisions 8.a–b and 8.d		
Year	FRA	SP	OTH	Unallo-cated	Total_8	Disc_8	Landings	Disc.	Catch
2010	4043	367	73	0	4483	634	22215	2672	24886
2011	4569	422	93	30	5114	388	24657	1832	26489
2012	4221	430	194	41	4887	497	28188	2330	30519
2013	4105	318	137	0	4560	279	30611	1684	32295
2014	4279	408	174	84	4945	416	28474	1859	30333
2015	4153	293	65	10	4521	528	27859	2324	30183
2016	3561	283	69	5	3919	529	29083	3585	32668
2017	2886	203	66	0	3154	263	25634	2175	27808
2018	2844	156	15	3	3018	58	22345	1250	23595
2019	1987	130	64	0	2181	50	20832	1364	22196
2020	1666	129	57	0	1852	545	20037	1350	21387
2021	1973	151	29	0	2153	706	22040	1839	23878
2022	1850	219	64	0	2134	567	21343	1552	22895

Table 3.2.2. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Stock assessment model annual landings and discards (in tonnes) input data by fleet: gillnets (GNS), French trawlers (TR_FR), Other trawlers (OT_TR), Spanish trawlers (SP_TR).

Landings

Year	GNS	TR_FR	TR_OT	TR_SP	Year	GNS	TR_FR	TR_OT	TR_SP
1949	0	0	0.00	0	1986	429	10678	7185.00	6689
1950	71.7987	0	416.27	1039.95	1987	560	10132	6565.00	5833
1951	124.25	0.314717	696.75	1070.65	1988	643	9106	6456.00	5109
1952	70.12	0	377.45	1145.29	1989	781	8771	9586.00	4878
1953	82.9043	0	432.85	1229.23	1990	1021	8850	6327.00	4784
1954	70.12	0	362.20	1314.24	1991	1752	6250	4704.00	4056
1955	64.9546	0	383.79	0	1992	1773	3931	5133.00	2780
1956	62.1136	0	425.61	0	1993	1742	4295	6041.00	2817
1957	54.753	0	455.92	0	1994	1377	5901	6790.00	3133
1958	51.8521	0.94415	398.21	0.643461	1995	1915	8026	7605.00	3486
1959	51.5246	0	418.13	2188.45	1996	2244	7960	8446.00	4683

1960	36.0746	0.629434	339.50	2374.41	1997	2538	7494	8941.00	4009
1961	37.0016	0.94415	320.22	2746.76	1998	3398	5559	7404.00	4114
1962	39.7134	0.94415	327.13	2556.95	1999	3162	4885	7242.00	3503
1963	43.3891	0	309.53	2869.1	2000	2034	4322	5567.00	2528
1964	57.6631	0.94415	556.27	3197.5	2001	2002	6463	6048.00	2779
1965	55.786	0	573.59	3811.74	2002	3007	7990	7528.00	3558
1966	66.5734	0.94415	528.56	4309.63	2003	4015	11301	7506.00	5112
1967	86.3309	0.94415	603.29	5358.68	2004	4798	11332	7758.00	5140
1968	88.5032	8297	2223.10	5352.58	2005	5501	9732	7434.00	5203
1969	96.3342	9205.5	2436.38	5865.98	2006	3965	10563	8151.10	4974
1970	83.8082	8313.14	2314.42	6581.38	2007	4775	11980	9012.40	5445
1971	93.235	9708.49	2271.19	7157.23	2008	5467	9900	7067.01	4620
1972	105.291	8127.82	2550.55	9298.86	2009	4101	8287	6337.60	3109
1973	105.936	4669.46	1788.17	7977.11	2010	3902	8023	7583.90	2707
1974	84.1126	7357.35	2117.28	7933.26	2011	4023	9642	8418.76	2573
1975	92.8199	7417.04	2313.70	8289.17	2012	4796	11691	8794.83	2906
1976	102.376	7418.66	2155.80	9092.72	2013	4675	12404	8842.27	4689
1977	90.6984	7508.33	2152.85	6362.12	2014	5393	11294	9114.77	2672
1978	108.883	8877.72	2510.87	6919.76	2015	4544	12250	8710.43	2354
1979	146.074	11058.8	3397.60	5711.61	2016	5287	12052	9408.92	2335
1980	214.829	13638	4709.04	7956.41	2017	5067	10672	7971.52	1922
1981	284.363	14152.6	5184.02	4978.79	2018	3496	9553	7270.00	2025
1982	310.107	12653	5630.97	8132.96	2019	2911	8221	8122.00	1578
1983	630.914	13498.8	8265.45	7619.91	2020	2814	8280	7354.00	1589
1984	772.911	13049.5	9130.690	6260.77	2021	3699	8645	8007	1690
1985	685.339	13225.1	8205.86	6444.24	2022	3106	8724	7780	1733

Discards

Year	GNS	TR_FR	TR_OT	TR_SP	disc.noLikelihood*
2003	237	1250	727.00	297	
2004	817	213	695.00	685	
2005	364	578	853.00	316	
2006	503			100	290.00
2007	468				348.00
2008	215	209		226	343.00
2009	211	691	871.00	304	
2010	254	869	612.00	937	
2011	199	695	764.00	173	
2012	224	705	1265.00	137	
2013	402	399	787.00	96	
2014	235	682	897.00	44	
2015	560	667	1095.00		2.00
2016	535	700	1954.00	396	
2017	457	453	1260.00		6.00
2018	NA	215	936.00		98.00
2019	NA	274	1016.00		74.00
2020	241	358	748.00		3.00
2021	294	707	832		6.00
2022	98	349	1102	4	4

*The discards not considered in the likelihood.

Table 3.2.3. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Survey indices used in the model. IE_Monksurvey (G3098, n/km^2) and SpPGFS-WIBTS-Q4 (G5768, previous acronym was SP-PGFS, n/30 mins) survey indices are specified in numbers and the combined FR_IE_IBTS survey in biomass (kg/h). log se is the standard error on the log scale which is similar to the CV of the index.

Year	Month	Fleet	Index	log se	Year	Month	Fleet	Index	log se
2003	10.5	FR_IE_IBTS	1.030	0.18	2001	9.5	SPGFS	4.76	0.11
2004	10.5	FR_IE_IBTS	1.228	0.17	2002	9.5	SPGFS	2.69	0.12
2005	10.5	FR_IE_IBTS	1.128	0.17	2003	9.5	SPGFS	4.17	0.08
2006	10.5	FR_IE_IBTS	1.514	0.14	2004	9.5	SPGFS	5.71	0.12
2007	10.5	FR_IE_IBTS	1.722	0.15	2005	9.5	SPGFS	3.15	0.10

2008	10.5	FR_IE_IBTS	2.921	0.12	2006	9.5	SPGFS	3.34	0.12
2009	10.5	FR_IE_IBTS	2.187	0.13	2007	9.5	SPGFS	3.01	0.10
2010	10.5	FR_IE_IBTS	2.004	0.15	2008	9.5	SPGFS	2.47	0.11
2011	10.5	FR_IE_IBTS	1.926	0.14	2009	9.5	SPGFS	2.95	0.10
2012	10.5	FR_IE_IBTS	2.010	0.16	2010	9.5	SPGFS	3.38	0.09
2013	10.5	FR_IE_IBTS	2.345	0.13	2011	9.5	SPGFS	2.52	0.10
2014	10.5	FR_IE_IBTS	2.001	0.13	2012	9.5	SPGFS	3.60	0.09
2015	10.5	FR_IE_IBTS	1.957	0.22	2013	9.5	SPGFS	5.03	0.09
2016	10.5	FR_IE_IBTS	2.419	0.13	2014	9.5	SPGFS	6.37	0.08
2017	10.5	FR_IE_IBTS	2.877	0.20	2015	9.5	SPGFS	5.02	0.08
2018	10.5	FR_IE_IBTS	4.437	0.12	2016	9.5	SPGFS	5.18	0.09
2019	10.5	FR_IE_IBTS	4.434	0.11	2017	9.5	SPGFS	6.01	0.11
2020	10.5	FR_IE_IBTS	4.416	0.12	2018	9.5	SPGFS	4.30	0.09
2021	10.5	FR_IE_IBTS	4.865	0.11	2019	9.5	SPGFS	4.13	0.10
2022	10.5	FR_IE_IBTS	8.190	0.15	2020	9.5	SPGFS	3.37	0.09
2006	12	IAMS (G3098)	21.890	0.25	2021	9.5	SPGFS	3.83	0.10
2007	12	IAMS (G3098)	29.650	0.25	2022	9.5	SPGFS	5.46	0.09
2015	12	IAMS (G3098)	69.040	0.18					
2016	12	IAMS (G3098)	73.400	0.17					
2017	12	IAMS (G3098)	47.908	0.23					
2018	12	IAMS (G3098)	49.640	0.18					
2019	12	IAMS (G3098)	40.970	0.18					
2020	12	IAMS (G3098)	47.170	0.20					
2021	12	IAMS (G3098)	96.410	0.22					
2022	12	IAMS (G3098)	46.810	0.15					

Table 3.2.4. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Assessment summary results with 95% confidence intervals. Weights are in tonnes and recruitment is in thousands. Discard observations are available since 2003. Annual landings are available to the model from 1950 but the plots only show the more data-rich period since 1986.

Year	Recruitment Age 0			SSB (male + female)			Landings**	Discards**			
	Recruits	2.5%	97.5%	SSB	2.5%	97.5%			F	2.5%	97.5%
1986	57519	75763	99793	50528	61972	76008	24981		0.125	0.165	0.22

Year	Recruitment Age 0			SSB (male + female)			Land-ings**	Dis-cards**			
	Recruits	2.5%	97.5%	SSB	2.5%	97.5%			F	2.5%	97.5%
1987	123260	150769	184417	49806	63082	79896	23090		0.132	0.174	0.23
1988	24145	38013	59847	53031	64603	78701	21314		0.125	0.164	0.22
1989	37525	49634	65651	45832	56278	69104	24015		0.148	0.192	0.25
1990	9107	14629	23501	37545	46659	57984	20983		0.147	0.193	0.25
1991	41931	54312	70348	32240	40536	50965	16763		0.143	0.187	0.24
1992	115044	141371	173722	33628	42248	53079	13617		0.133	0.175	0.23
1993	102491	130972	167367	29372	37378	47566	14895		0.136	0.178	0.23
1994	77813	103308	137157	25603	32938	42374	17201		0.136	0.176	0.23
1995	63614	84591	112486	20354	26515	34541	21033		0.149	0.192	0.25
1996	22327	34133	52181	17977	23510	30745	23333		0.160	0.20	0.26
1997	37939	50797	68013	22007	28085	35843	22983		0.173	0.22	0.28
1998	40661	54569	73233	25713	32115	40112	20474		0.180	0.23	0.29
1999	108278	129937	155928	26558	32988	40975	18792		0.193	0.25	0.31
2000	22699	35071	54186	24818	30945	38585	14451		0.153	0.183	0.22
2001	240639	276937	318711	21624	27237	34307	17293		0.185	0.22	0.26
2002	94592	114360	138260	18459	23518	29963	22083		0.191	0.22	0.26
2003	83850	95044	107732	16301	20883	26754	27933	2511	0.21	0.25	0.29
2004	202603	222581	244529	18855	23639	29637	29028	2411	0.190	0.22	0.25
2005	89974	101811	115206	17143	21484	26925	27869	2110	0.182	0.21	0.24
2006	37444	43708	51020	28770	34833	42173	27652	892	0.167	0.195	0.23
2007	56799	64438	73105	32440	38889	46619	31213	816	0.189	0.22	0.25
2008	110599	124021	139072	31980	38477	46294	27053	993	0.171	0.197	0.23
2009	170622	188403	208037	38969	46693	55949	21835	2078	0.159	0.185	0.22
2010	135881	150672	167074	39092	46986	56473	22215	2672	0.141	0.165	0.191
2011	96149	107917	121126	35024	42392	51311	24657	1832	0.133	0.154	0.178
2012	100727	112756	126222	32134	39019	47379	28188	2330	0.147	0.170	0.197
2013	90614	102286	115462	33482	40577	49175	30611	1684	0.147	0.170	0.195
2014	212047	233878	257957	40541	48713	58532	28474	1859	0.150	0.175	0.20

Year	Recruitment Age 0			SSB (male + female)			Land-ings**	Dis-cards**			
	Recruits	2.5%	97.5%	SSB	2.5%	97.5%			F	2.5%	97.5%
2015	92957	106713	122504	44883	53819	64532	27859	2324	0.132	0.153	0.177
2016	67732	80039	94583	46034	55225	66250	29083	3585	0.147	0.171	0.20
2017	46198	55427	66499	45290	54569	65749	25634	2175	0.132	0.156	0.183
2018	129912	147424	167297	44129	53414	64652	22345	1250	0.112	0.132	0.156
2019	103312	119791	138898	53865	64869	78120	20832	1364	0.102	0.121	0.144
2020	132864	153211	176674	55814	67311	81177	20037	1350	0.100	0.119	0.141
2021	53059	64079	77387	54082	65487	79296	22040	1839	0.111	0.133	0.159
2022	110863*			48419	59187	72349	21343	1552	0.102	0.123	0.149
2023	111245*			50625	62159	76321					

*** Assumed recruitment based on stock–recruit relationship (model estimate was 93 341 t)**

**** Observed landings and discards (tonnes); not all discard observations were provided to the model.**

Table 3.2.5. White-bellied anglerfish (*L. piscatorius*) in 27.78abd. Catch options based on different F values (F mult): Catch, landings and discards in 2023.All weights are in tonnes. F of the catch, landings and discards in 2023. SSB in 2024 (in kilotonnes). dSSB, dadv are the change in SSBand advice with the previous year (%).

F_{mult}	Catch23	Land23	Dis23	FCatch23	FLand23	FDis23	SSB24	dSSB	dadv23
0	0	0	0	0	0	0	79055	23.13	-100%
0.01	2028	1777	251	0.01	0.0099	0.000089	78232	21.84	-94%
0.02	4036	3536	500	0.02	0.0198	0.000177	77417	20.57	-88%
0.03	6022	5276	746	0.03	0.03	0.00027	76611	19.32	-83%
0.04	7989	6999	990	0.04	0.04	0.00035	75814	18.08	-77%
0.05	9934	8703	1231	0.05	0.05	0.00044	75024	16.85	-71%
0.06	11860	10390	1470	0.06	0.059	0.00053	74243	15.63	-66%
0.07	13766	12060	1706	0.07	0.069	0.00062	73470	14.43	-60%
0.08	15653	13712	1941	0.08	0.079	0.00071	72706	13.24	-55%
0.09	17520	15347	2173	0.09	0.089	0.0008	71949	12.06	-49%
0.10	19367	16965	2402	0.10	0.099	0.00089	71200	10.89	-44%
0.11	21196	18567	2629	0.11	0.109	0.00097	70459	9.74	-39%
0.12	23006	20152	2855	0.12	0.119	0.00106	69726	8.60	-33%
0.13	24798	21720	3077	0.13	0.129	0.00115	69001	7.47	-28%
0.14	26571	23273	3298	0.14	0.139	0.00124	68283	6.35	-23%

0.15	28326	24809	3517	0.15	0.149	0.00133	67572	5.24	-18.00%
0.16	30062	26329	3733	0.16	0.159	0.00142	66869	4.15	-13.00%
0.17	31781	27834	3947	0.17	0.168	0.00151	66174	3.06	-8.00%
0.18	33483	29324	4159	0.18	0.178	0.00159	65486	1.99	-3.10%
0.19	35167	30798	4369	0.19	0.188	0.00168	64804	0.93	1.82%
0.20	36834	32256	4577	0.20	0.198	0.00177	64131	-0.12	6.60%
0.21	38484	33700	4783	0.21	0.21	0.00186	63464	-1.16	11.40%
0.22	40117	35129	4987	0.22	0.22	0.00195	62804	-2.19	16.10%
0.23	41733	36543	5189	0.23	0.23	0.002	62151	-3.20	21%
0.24	43333	37943	5390	0.24	0.24	0.0021	61504	-4.21	25%
0.25	44916	39328	5588	0.25	0.25	0.0022	60865	-5.21	30%
0.26	46483	40699	5784	0.26	0.26	0.0023	60232	-6.19	35%
0.27	48035	42056	5978	0.27	0.27	0.0024	59606	-7.17	39%
0.28	49570	43400	6171	0.28	0.28	0.0025	58987	-8.13	44%
0.29	51090	44729	6361	0.29	0.29	0.0026	58373	-9.09	48%
0.30	52595	46045	6550	0.30	0.30	0.0027	57767	-10.03	52%
0.31	54084	47347	6737	0.31	0.31	0.0027	57166	-10.97	57%
0.32	55558	48636	6922	0.32	0.32	0.0028	56572	-11.89	61%
0.33	57017	49912	7105	0.33	0.33	0.0029	55984	-12.81	65%
0.34	58461	51174	7287	0.34	0.34	0.003	55403	-13.71	69%
0.35	59891	52424	7467	0.35	0.35	0.0031	54827	-14.61	73%
0.36	61306	53661	7645	0.36	0.36	0.0032	54258	-15.50	77%
0.37	62707	54885	7821	0.37	0.37	0.0033	53694	-16.37	82%
0.38	64094	56097	7996	0.38	0.38	0.0034	53136	-17.24	86%
0.39	65466	57297	8169	0.39	0.39	0.0035	52584	-18.10	90%
0.40	66825	58484	8341	0.40	0.40	0.0035	52038	-18.95	93%
0.41	68170	59659	8511	0.41	0.41	0.0036	51498	-19.79	97%
0.42	69501	60823	8679	0.42	0.42	0.0037	50963	-20.63	101%
0.43	70819	61974	8845	0.43	0.43	0.0038	50434	-21.45	105%
0.44	72124	63114	9010	0.44	0.44	0.0039	49910	-22.27	109%

0.45	73416	64242	9174	0.45	0.45	0.004	49392	-23.07	113%
0.46	74694	65358	9336	0.46	0.46	0.0041	48879	-23.87	116%
0.47	75960	66464	9496	0.47	0.47	0.0042	48372	-24.66	120%
0.48	77213	67558	9655	0.48	0.48	0.0043	47869	-25.45	124%
0.49	78453	68641	9813	0.49	0.49	0.0043	47372	-26.22	127%
0.50	79681	69713	9969	0.50	0.50	0.0044	46881	-26.98	131%
0.51	80897	70774	10123	0.51	0.51	0.0045	46394	-27.74	134%
0.52	82100	71824	10276	0.52	0.52	0.0046	45913	-28.49	138%
0.53	83292	72864	10428	0.53	0.53	0.0047	45436	-29.24	141%
0.54	84471	73893	10578	0.54	0.54	0.0048	44965	-29.97	145%
0.55	85639	74912	10727	0.55	0.55	0.0049	44498	-30.70	148%
0.56	86795	75920	10875	0.56	0.56	0.005	44037	-31.41	151%
0.57	87939	76918	11021	0.57	0.56	0.005	43580	-32.13	155%
0.58	89072	77907	11166	0.58	0.57	0.0051	43128	-32.83	158%
0.59	90194	78885	11309	0.59	0.58	0.0052	42680	-33.53	161%
0.60	91304	79853	11451	0.60	0.59	0.0053	42238	-34.22	164%
0.61	92404	80812	11592	0.61	0.60	0.0054	41799	-34.90	168%
0.62	93492	81761	11731	0.62	0.61	0.0055	41366	-35.57	171%
0.63	94570	82700	11870	0.63	0.62	0.0056	40937	-36.24	174%
0.64	95637	83630	12007	0.64	0.63	0.0057	40512	-36.90	177%
0.65	96693	84551	12142	0.65	0.64	0.0058	40092	-37.56	180%
0.66	97739	85462	12277	0.66	0.65	0.0058	39677	-38.20	183%
0.67	98774	86364	12410	0.67	0.66	0.0059	39265	-38.85	186%
0.68	99799	87257	12542	0.68	0.67	0.006	38858	-39.48	189%
0.69	100814	88141	12673	0.69	0.68	0.0061	38455	-40.11	192%
0.70	101819	89016	12803	0.70	0.69	0.0062	38057	-40.73	195%
0.71	102814	89883	12931	0.71	0.7	0.0063	37662	-41.34	198%
0.72	103799	90741	13059	0.72	0.71	0.0064	37272	-41.95	200%
0.73	104775	91590	13185	0.73	0.72	0.0065	36886	-42.55	200%
0.74	105741	92431	13310	0.74	0.73	0.0066	36504	-43.15	210%

0.75	106697	93263	13434	0.75	0.74	0.0066	36125	-43.74	210%
0.76	107644	94087	13557	0.76	0.75	0.0067	35751	-44.32	210%
0.77	108581	94903	13679	0.77	0.76	0.0068	35381	-44.9	210%
0.78	109510	95710	13799	0.78	0.77	0.0069	35014	-45.47	220%
0.79	110429	96510	13919	0.79	0.78	0.007	34651	-46.03	220%
0.80	111339	97302	14037	0.80	0.79	0.0071	34292	-46.59	220%
0.81	112240	98085	14155	0.81	0.8	0.0072	33937	-47.14	220%
0.82	113132	98861	14271	0.82	0.81	0.0073	33586	-47.69	230%
0.83	114016	99629	14387	0.83	0.82	0.0073	33238	-48.23	230%
0.84	114891	100390	14501	0.84	0.83	0.0074	32894	-48.77	230%
0.85	115757	101143	14614	0.85	0.84	0.0075	32553	-49.30	240%
0.86	116615	101888	14727	0.86	0.85	0.0076	32216	-49.82	240%
0.87	117465	102626	14838	0.87	0.86	0.0077	31882	-50.34	240%
0.88	118306	103357	14949	0.88	0.87	0.0078	31552	-50.86	240%
0.89	119139	104081	15058	0.89	0.88	0.0079	31226	-51.37	240%
0.90	119964	104797	15167	0.90	0.89	0.0080	30902	-51.87	250%
0.91	120781	105506	15274	0.91	0.90	0.0081	30582	-52.37	250%
0.92	121589	106209	15381	0.92	0.91	0.0081	30266	-52.86	250%
0.93	122390	106904	15487	0.93	0.92	0.0082	29953	-53.35	250%
0.94	123184	107592	15591	0.94	0.93	0.0083	29643	-53.83	260%
0.95	123969	108274	15695	0.95	0.94	0.0084	29336	-54.31	260%
0.96	124747	108949	15798	0.96	0.95	0.0085	29032	-54.78	260%
0.97	125518	109617	15900	0.97	0.96	0.0086	28732	-55.25	260%
0.98	126280	110279	16002	0.98	0.97	0.0087	28435	-55.71	270%
0.99	127036	110934	16102	0.99	0.98	0.0088	28140	-56.17	270%
1.00	127784	111583	16201	1.00	0.99	0.0089	27849	-56.63	270%

3.3 Black-bellied anglerfish (Lophius budegassa) in Subarea 7 and divisions 8.a, 8.b, and 8.d

3.3.1 Data

3.3.1.1 Data revisions

UK submitted revised landings data in October 2022. This resulted in an increase of 1 319 t of landings for 2021.

3.3.1.2 Landings and discards

Landings and discard data were extracted from InterCatch and processed according to methods outlined in the Stock Annex[3]. Normally, discard rates (proportion of the catch weight that was discarded) are used to estimate the discard volume for strata with missing discard data. This year, the discard rates of the French OTB_CRU and OTB_DEF fleets appeared to be unrealistically high (Figure 3.3.1) and were replaced with the average discard rates of other OTB_CRU and OTB_DEF fleets from 2017-2022. (Note that this was to fill in un-sampled discards only).

Overall, discard rates are relatively low (between 5 and 20% of the catch over the full time series; the average of last 3 years was 17%). Typically, between 20 and 55% of the estimated discards result from fill-ins; the average of this figure over the last 3 years was 43% (Figure 3.3.2).

Table 3.3.1 provides the ICES estimates of landings and discards by country and area.

3.3.1.3 Catch numbers-at-length

The Stock Annex describes the methods for filling in un-sampled landings and discards. Figure 3.3.2 shows that >50% of the landings had length data associated with them. This was an improvement from the previous year when this figure was less than 40%. Figure 3.3.3 shows the annual LFDs of the catch data both before and after filling in un-sampled catches.

While discards consist of a relatively small proportion of the catch weight, they contributed 61% of the catch numbers over the last 3 years. Increases in mesh size in the trawl fisheries do not appear to have reduced catches of anglerfish below 30 cm, this is likely due to their shape, which makes it difficult for even the smallest individuals to escape through the meshes.

3.3.1.4 Surveys

The surveys are described in detail in the Stock Annex. Three surveys are used:

- IE-IGFS (G7212) and EVHOE (G9527); this combined French and Irish survey index is referred to by the ICES acronym FR_IE_IBTS.
- The Irish Anglerfish and Megrim survey IAMS (G3098);

The survey indices are provided in Table 3.3.2.

FR_IE_IBTS

Figure 3.3.4a shows the spatial distribution of the catches of recruits on the FR_IE_IBTS surveys. Recruitment generally occurs in the western Celtic Sea and some years in Biscay. In 2020, there

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[3] ICES. 2022. ICES Stock Annex: Black-bellied anglerfish (*Lophius budegassa*) in Subarea 7 and divisions 8.a–b and 8.d (Celtic Seas, Bay of Biscay). Produced by the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) and updated in August 2022 by the Benchmark workshop on anglerfish and hake (WKANGHAKE; ICES, 2023b). https://doi.org/10.17895/ices.pub.18622010.

were large numbers of recruits, particularly in the Biscay area. Recruitment in 2022 appears to be quite good in both the Celtic Sea and Biscay but not as high as the year before.

Figure 3.3.4b shows the spatial distribution of the catch weights on the two IBTS surveys. During some years, the catches are highest in the area covered by the IGFS-WIBTS-Q4 (G7212) survey, in other years the EVHOE-WIBTS-Q4 (G9527) survey has higher catches. It is unclear whether this is due to the movement of the stock or whether it is due to factors affecting the catchability on the surveys (e.g. weather, gear performance).

Figure 3.3.5 shows the biomass indices of the two IBTS surveys as well as the combined FR_IE_IBTS index. The combined FR_IE_IBTS survey biomass index is more stable than the single IBTS survey indices. Both the French and Irish IBTS surveys recorded high biomass in the last year. The (Irish) IGFS-WIBTS-Q4 (G7212) survey had shown a moderate declining trend between 2018 and 2020 but had recovered since then. The (French) EVHOE-WIBTS-Q4 (G9527) survey index has been increasing since 2016. The combined FR_IE_IBTS index was stable between 2018 and 2020 and has been increasing moderately in the last 2 years.

In 2017, the French survey vessel Thalassa suffered major mechanical issues and the majority of the EVHOE bottom trawl survey could not be completed. The VAST (Vector Autoregressive Spatio-Temporal; Thorson 2019) model (www.github.com/james-thorson/VAST) was used to estimate the missing 2017 data (Gerritsen and Minto, 2019). VAST is a spatially explicit model that predicts population density for all locations within a spatial domain, and then predicts derived quantities (e.g. biomass, abundance) by aggregating population density across the spatial domain while weighting density estimates by the area associated with each estimate. VAST imputes biomass or abundance in unsampled areas using spatially correlated random effects. Details were provided in Working Document (WD) 01 (Gerritsen and Minto, 2019) to WGBIE in 2019 (ICES, 2019).

IAMS

Figure 3.3.6 shows the spatial distribution of the catches on the IAMS (G3098) survey. The catch rates in 2022 in the south-western Celtic Sea were very high, following exceptional recruitment in 2021.

Figure 3.3.7 shows the index of the IAMS (G3098) survey. The survey takes place at the start of the year, but in order to facilitate the inclusion of an in-year index, the data are provided to the model as if the survey occurred on the last day of the previous year such that, for example, the 2023 index is used for the assessment performed in 2023, but provided to the model as if it occurred on 31 December 2022. An industry-science partnership survey was carried out in 2006 and 2007 on-board a commercial vessel using the same fishing gear and methodology as the IAMS (G3098) survey and these data points were included in order to extend the time series.

3.3.1.5 Biology and model settings

Maturity, natural mortality, growth, and length-weight parameters are all fixed (not estimated by the model) and are described in the Stock Annex. Figure 3.3.8 shows the assumed growth curves for males and females.

Recruitment bias adjustment settings were updated following the Stock Annex.

3.3.1.6 Deviations from the Stock Annex

There were no deviations from the Stock Annex.

3.3.2 Model diagnostics

The model diagnostics broadly follow the approach described by Carvalho *et al*. (2021).

3.3.2.1 Convergence

- No parameters are estimated at or near bounds or with unusually large variance.
- The final gradient is < 1e-7.
- The Hessian is positive definite.
- 50 jitter runs were performed using default settings for magnitude and 37 of these runs converged. Out of the converged runs, 33 converged on the same likelihood as the base run (-15649.5) and 4 runs resulted in a slightly higher negative log-likelihood (-15644.9).
- There was a strong correlation in the parameters controlling the ascending part of the double-normal selectivity curve for the combined FR_IE_IBTS survey (97%). However, because nearly all (33/37) the converged jitter runs found the same solution this correlation was not considered to be problematic.

WGBIE did not identify problems with model convergence.

3.3.2.2 Goodness-of-fit

Catch

Figure 3.3.9 shows the observed and fitted landings and discards. The fit to the discards does not follow the observations very closely, reflecting the uncertainty in the discard data. However, the fit is not consistently lower or higher than the observed discards. The fit to the landings is quite close to the observed values, except in the early 1980s when the model expected higher landings than observed. This occurs just before the sampling data are introduced to the model in 1986 which may reflect the inability of the model to accommodate the variability of recruitment before 1986.

Indices

Figure 3.3.10 shows the fit of the indices. There is some conflict between the two indices, but they agree on an overall increasing trend. The FR_IE_IBTS survey failed the runs test, presumably because the residuals are all positive in the last 5 years while they were mainly negative in the preceding years. This is not a major concern and is to be expected when there is a conflict between indices. The joint residuals are generally negative at the start of the time-series, indicating that there is also some conflict between the surveys and other data sources (probably the catch). However, the Root Mean Square Error RMSE is relatively small (21.9%) indicating a reasonably precise fit to the indices while Carvalho et. al. (2021) suggests a rule-of-thumb value of < 30%.

Length compositions

The fit to the length data is generally quite good, although there are some residual patterns. Figure 3.3.11 shows, by fleet, the fit to the aggregated length distributions and Figure 3.3.12 provides annual length distributions of landings and discards by fleet and for males and females in case of surveys. The residual plots (Figure 3.3.13) indicate that the medium-sized fish (30-60cm) in the landings of fleet 1 (Trawls) tend to be positive, while the large-sized fish (>75cm) have negative residuals. This suggests that the logistic selection curve may be too restrictive. The model has also predominantly positive residuals for females (>25cm) in the combined FR_IE_IBTS survey and negative residuals for large-sized males (>50cm) in the same survey. This indicates that sexual dimorphism cannot be fully accommodated with the current settings. Figure 3.3.14 shows the results from the run test on the mean length. The residuals of the commercial fleets are very small but both failed the runs test, indicating non-randomness in the sign (positive/negative) of the residuals. The two surveys passed the run test, despite some apparent patterns in the residuals. The RMSE of the joint residuals is very small (7.3%) suggesting a precise fit.

Retention

Retention (the proportion of catches that are landed in each size class) is modelled with a logistic curve and the inflection point of the FL1 fleet (Trawls) is allowed to vary during the period 2003–2022 with a random walk. For FL2 (Gillnets), this parameter has no time-varying flexibility. Figure 3.3.15 shows that the length at 50% retention is fitted quite closely to the observed data (the differences occur due to the fitting of the landings and discard volumes as well as lengths).

Sex-ratio

Figure 3.3.16 shows the fit to the sex ratio-at-length. This fit is not part of the likelihood optimization but it is a useful diagnostic for the model fit. The sexual dimorphism that is apparent from the survey data cannot be fully accommodated with the current model settings. The difference in growth rates between males and females might be larger than assumed but there may also be differences in natural mortality that are currently not accounted for.

Conclusion

WGBIE did not identify significant concerns with the fit of the model.

3.3.2.3 Model consistency

Profiling

An R0 profile was performed for the WKANGHAKE benchmark (ICES, 2023b) but no R0 or other profiling was done for the update assessment during WGBIE 2023 (ICES, 2023c).

Retrospective analysis

Figure 3.3.17 shows the summary plot of the retrospective analysis. Mohn's rho (Mohn, 1999) values for SSB and F were well inside the WKFORBIAS guidelines (ICES, 2020). All the peels for SSB are inside the uncertainty bounds and only one of the peels for F is outside the bounds. Therefore, there is no concern of significant retrospective bias in SSB or F. Mohn's rho for recruitment, on the other hand, is large and most peels are outside the uncertainty bounds although the exceptionally strong recruitment that was estimated at the benchmark has not been revised significantly with the addition of an extra year of data. WGBIE considers that the model has a poor ability to estimate recruitment in the final year.

Hindcasting

Figures 3.3.18 and 3.3.19 show the results of the hindcasting analysis for the indices and mean length. The combined FR_IE_IBTS index has a MASE score of >1, indicating poor prediction skill. This may be related to the fact that this index is considerably influenced by recruitment in the survey year, which is unpredictable. The IAMS (G3098) survey index has a MASE score of <1 (0.79) indicating good prediction skill. The MASE scores for the mean length in the two commercial fleets and the combined FR_IE_IBTS survey are <1 indicating good prediction skill, although the reduction in mean length in 2020 due to strong recruitment was not (and could not be) predicted. The MASE score for mean length in the IAMS (G3098) survey has improved since last year and is now just <1 (0.97).

Conclusion

WGBIE did not identify significant concerns with the model consistency.

3.3.3 Historical stock development

3.3.3.1 Update assessment

The stock summary is given in Figure 3.3.20 and Table 3.3.3. Recruitment is highly variable and the 2020 recruitment is the highest in the time-series. F shows a declining trend and is estimated to have been below F_{MSY} since 2015. SSB is well above the biomass reference points and has been increasing since 2003.

3.3.3.2 Comparison with previous assessments, alternative runs

No alternative runs were performed.

The general perception of the stock is unchanged: SSB is increasing, F is decreasing and below F_{MSY} in recent years and recruitment is variable although the current model suggests less variability than the recruitment index from the combined FR_IE_IBTS survey previously suggested (ICES, 2022).

3.3.4 Biological reference points

The WKANGHAKE benchmark (ICES, 2023b) established new reference points for this stock. Note that although the SS model is sex-disaggregated, the biomass reference points were calculated relative to the combined-sex SSB following the standard ICES approach (ICES, 2023a). All figures and tables referring to biomass relate to combined-sex biomass for this stock.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	16776	B_{pa}; in tonnes	ICES (2023b)
	F_{MSY}	0.163	Stochastic simulations (EqSim) with Beverton–Holt stock–recruitment relationship estimated by the assessment model.	ICES (2023b)
Precautionary approach	B_{lim}	12073	SSB_{2004}; lowest observed SSB with high recruitment; in tonnes	ICES (2023b)
	B_{pa}	16776	$B_{lim} \times \exp(1.645 \times 0.2)$; in tonnes	ICES (2023b)
	F_{lim}	Undefined	Inconsistent with F_{pa}	ICES (2023b)
	F_{pa}	0.257	$F_{p.05;}$ the F that leads to SSB ≥ B_{lim} with 95% probability	ICES (2023b)
Management plan	MAP MSY $B_{trigger}$	16776	MSY $B_{trigger}$; in tonnes.	ICES (2023b)
	MAP B_{lim}	12073	B_{lim}; in tonnes.	ICES (2023b)
	MAP F_{MSY}	0.163	F_{MSY}	ICES (2023b)
	MAP range F_{lower}	0.112	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with F_{MSY}.	ICES (2023b)

	MAP range F_{upper}	0.245	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with F_{MSY}.	ICES (2023b)

3.3.5 Short-term projections

The approach to short-term projections is outlined in the Stock Annex.

WGBIE decided to replace the recruitment in the most recent data year (2022) with the predicted recruitment from the stock–recruit relationship estimated in the model. The original estimate was very close to the value it was replaced with (147 359 thousand) but the retrospective analysis indicates that the model estimate in the final year is unreliable.

$F_{status\ quo}$ was defined as the average F over the last three years and was used as the intermediate-year assumption.

Figure 3.3.22 shows the contribution of each cohort to the landings in 2023 and SSB in 2024 under the MSY catch option. The landings are expected to be dominated by the (very strong) 2020 cohort (31%) but also include a large number of older age classes. The assumed 2022 and 2023 recruitments are expected to contribute a modest 9% and 7% of the landings, respectively.

3.3.6 Quality of the assessment

The stock was benchmarked at WKANGHAKE in 2022 (ICES, 2023b). The basis for the advice has changed from a trends-based analysis (category 3; ICES, 2021b) to an analytical assessment (category 1). The broad perception of the stock is unchanged ($F < F_{MSY}$ and increasing stock size).

WKANGHAKE (ICES, 2023b) considers the current model to be suitable for providing advice, however, there is room for further development (see section 3.3.8 Recommendations for the next benchmark).

The final year's recruitment is not always estimated accurately (there is a significant retrospective bias), therefore it is replaced by the expected recruitment estimated from the stock–recruit relationship.

3.3.6.1 Other indicators

No other indicators are included in the assessment model.

3.3.7 Management considerations

Management of the two anglerfish species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species. However, currently, the stock size of both species is increasing and neither species appears to be at risk of overexploitation.

3.3.8 Recommendations for the next benchmark

- Some of the conflicts in the model may result from regional changes in the stock over time and may be resolved by fitting a model with more than one area.
- The selectivity of the commercial fleets is quite rigid; more flexible options resulted in unrealistic scaling of F and SSB (generally creating large cryptic biomass). Logistic

selection was considered the "least bad" option, however, it does appear to cause some lack of fit.

- The length composition data dominates the likelihood components. Downscaling did not affect the perception of the stock but may be more appropriate.
- Only two commercial fleets were retained in the final model and one of these was responsible for the vast majority of the catch. One of the issues with having more fleets was the poor quality of the discard data. It may be possible to explore an option with a single discard fleet but multiple landings fleets.
- Growth of females for the first 6 years of life or so could be tracked quite well in the length data by following strong cohorts. However, it is not clear whether growth of females continues at the same rate after maturation (around age 6) because so few mature females are caught. Linked to this, natural mortality of spawning females may be considerable but there is currently no information to inform how high this may be. Spent/recovered females have been caught so the species is not entirely semelparous but the investment in reproduction is considerable and this is likely to have consequences for M at older ages.
- Growth of males could only reliably be tracked up to around age 3 (which is also the age at maturation of males). For the first 3 years, the growth of the two sexes is almost identical but the sex ratio-at-length suggests that male growth slows down after this age and/or male natural mortality is higher after this age. More analysis of the sex-ratio information may help improve estimates of male growth and M.

3.3.8.1 Benchmark scoring

1. Assessment has no substantial or only minor issues (score: 2);
2. Minor improvement in data or methods will be available (score: 2);
3. Management importance: all attributes below apply (score: 5);
    a) Catch advice is requested by EC;
    b) The stock is the object of the multi-annual plan for Western Waters (WWMAP; EU, 2019) (although not all parties have agreed);
    c) The stock is object of a dedicated fishery;
    d) Most catches of anglerfish originate in directed fisheries;
4. The stock is not included in the mixed fisheries analysis for the Celtic Sea;
5. The biomass is perceived to be near the highest on record (score: 1);
6. The stock was last benchmarked in 2022 in WKANGHAKE (ICES, 2023b) (score: 1).

Overall score: 2.1, no requirement for a benchmark in the near future.

3.3.9 References

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3.3.10 Figures and tables

Figure 3.3.1. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Un-sampled discards (i.e. métiers with landings without discard data) were filled in using available discard rates following the procedure described in the Stock Annex. However, the French OTB_CRU and OTB_DEF proportions were very different from recently observed values and were average discard rates of other OTB_CRU and OTB_DEF fleets from 2017-2022.

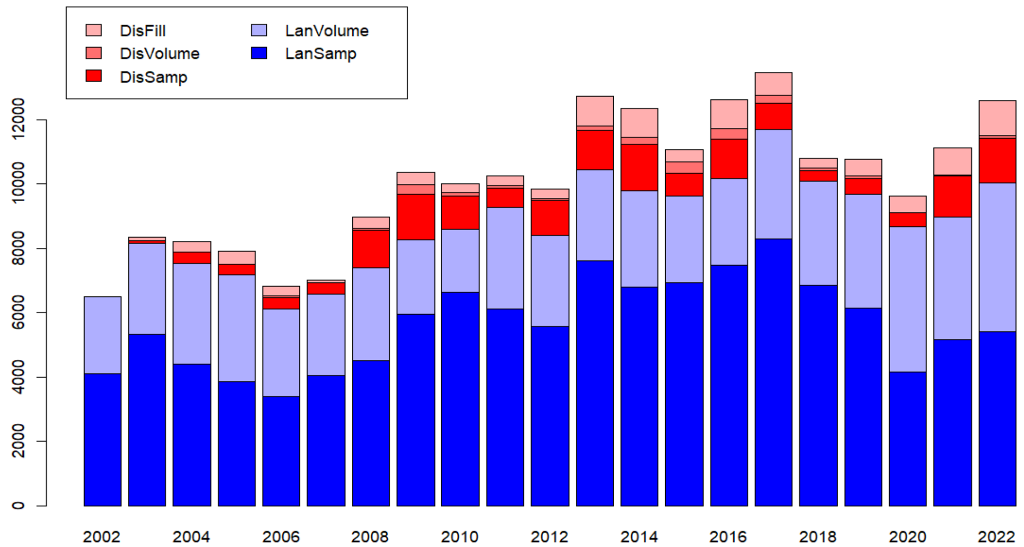

Figure 3.3.2. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Allocations of un-sampled landings and discards by year. Dark blue represents the sampled landings; light blue represents landings for which only the tonnage was available but no length data; Red represents the fully sampled discards (tonnage and length data); medium pink represents discards for which an estimate of the tonnage was available but no length data (length data 'borrowed' from other strata) and light pink represents strata for which no discard tonnage or length data were available (discard rate and length data 'borrowed' from other strata).

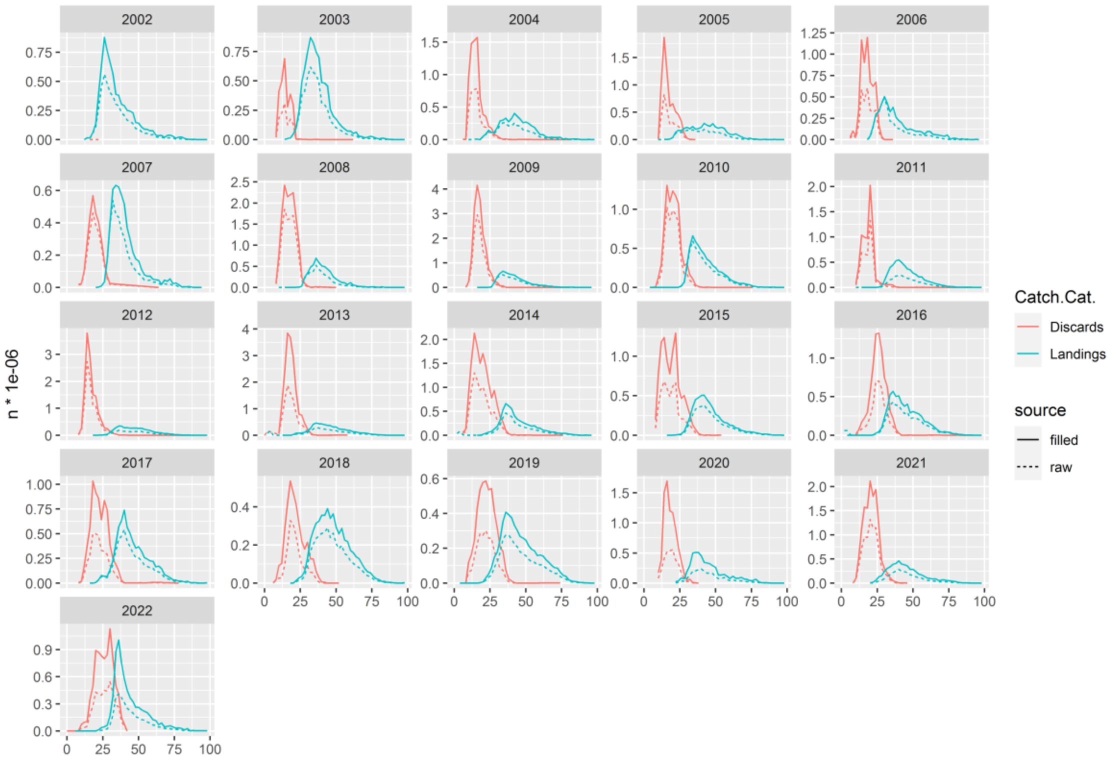

Figure 3.3.3. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Annual length–frequency distributions of the landings (blue) and discards (red). The dotted lines show the sampled strata submitted to InterCatch; the solid lines are the estimates after allocations of unsampled catches. No discard data were available prior to 2003.

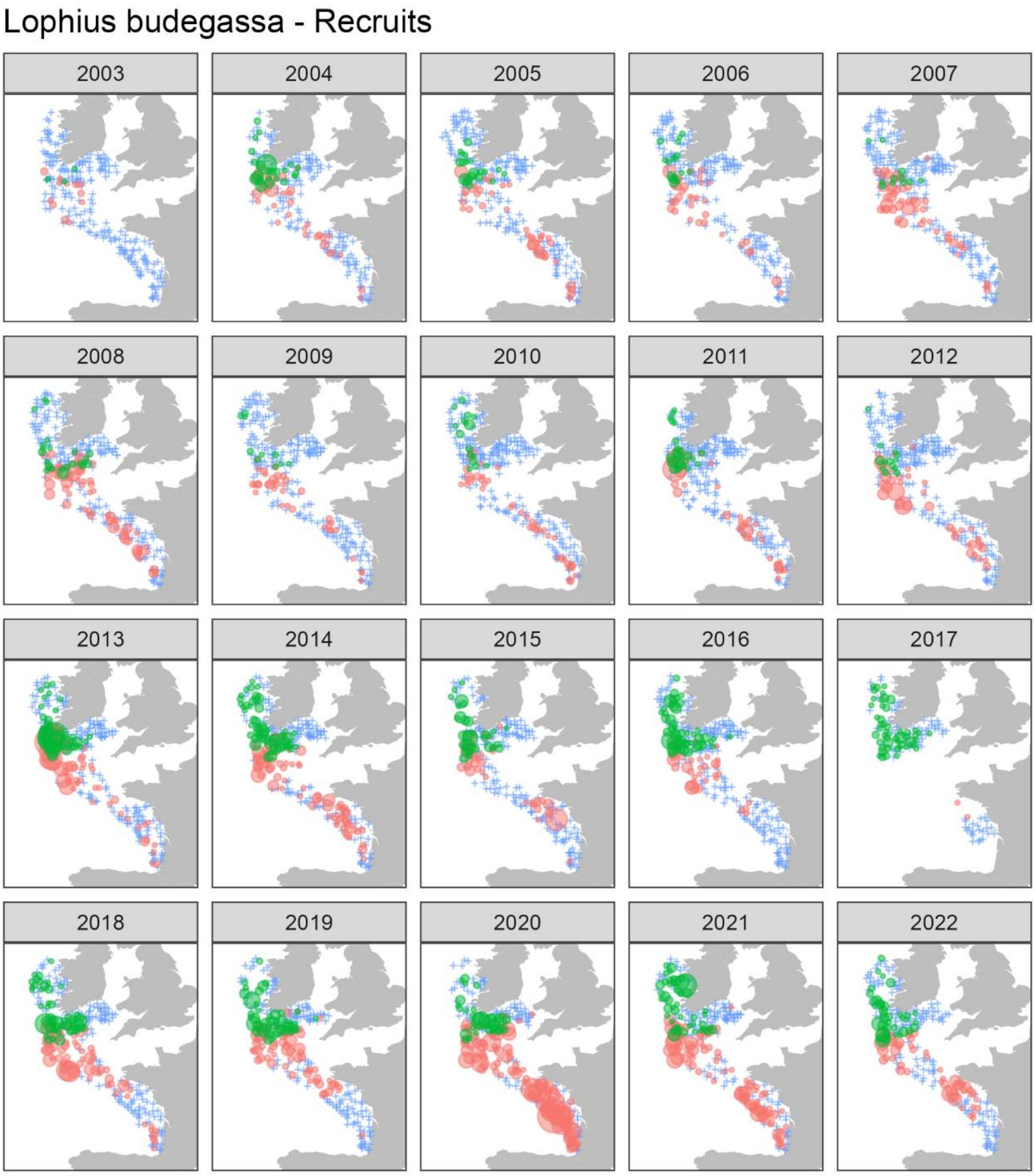

Figure 3.3.4a. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Abundance of recruits (< 24 cm) on the IGFS-WIBTS-Q4 (G7212 in green) and EVHOE-WIBTS-Q4 (G9527 in red) surveys (blue crosses represent hauls with zero catches).

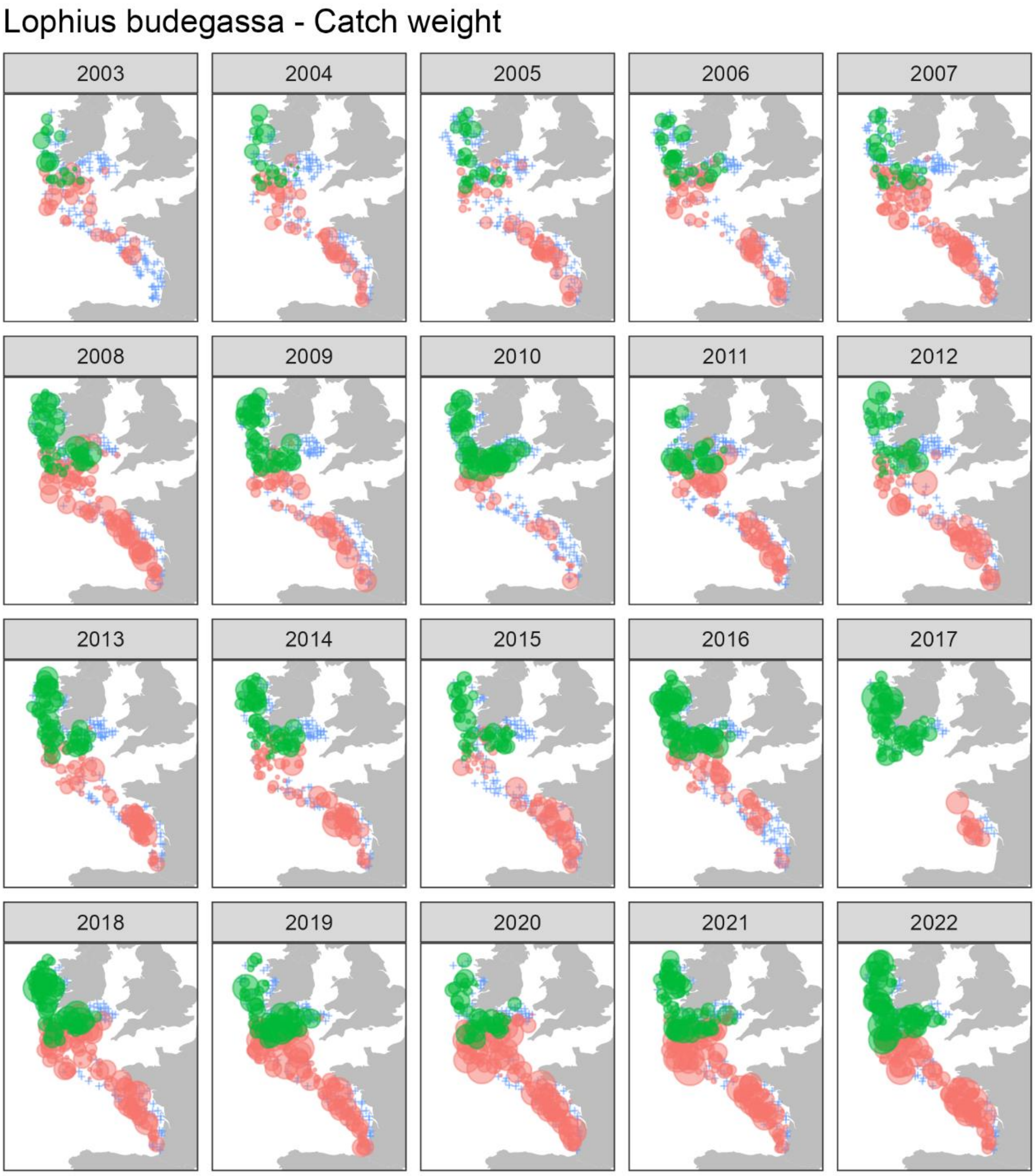

Figure 3.3.4b. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Catch weights on the IGFS-WIBTS-Q4 (G7212 in green) and EVHOE-WIBTS-Q4 (G9527 in red) surveys (blue crosses represent hauls with zero catches).

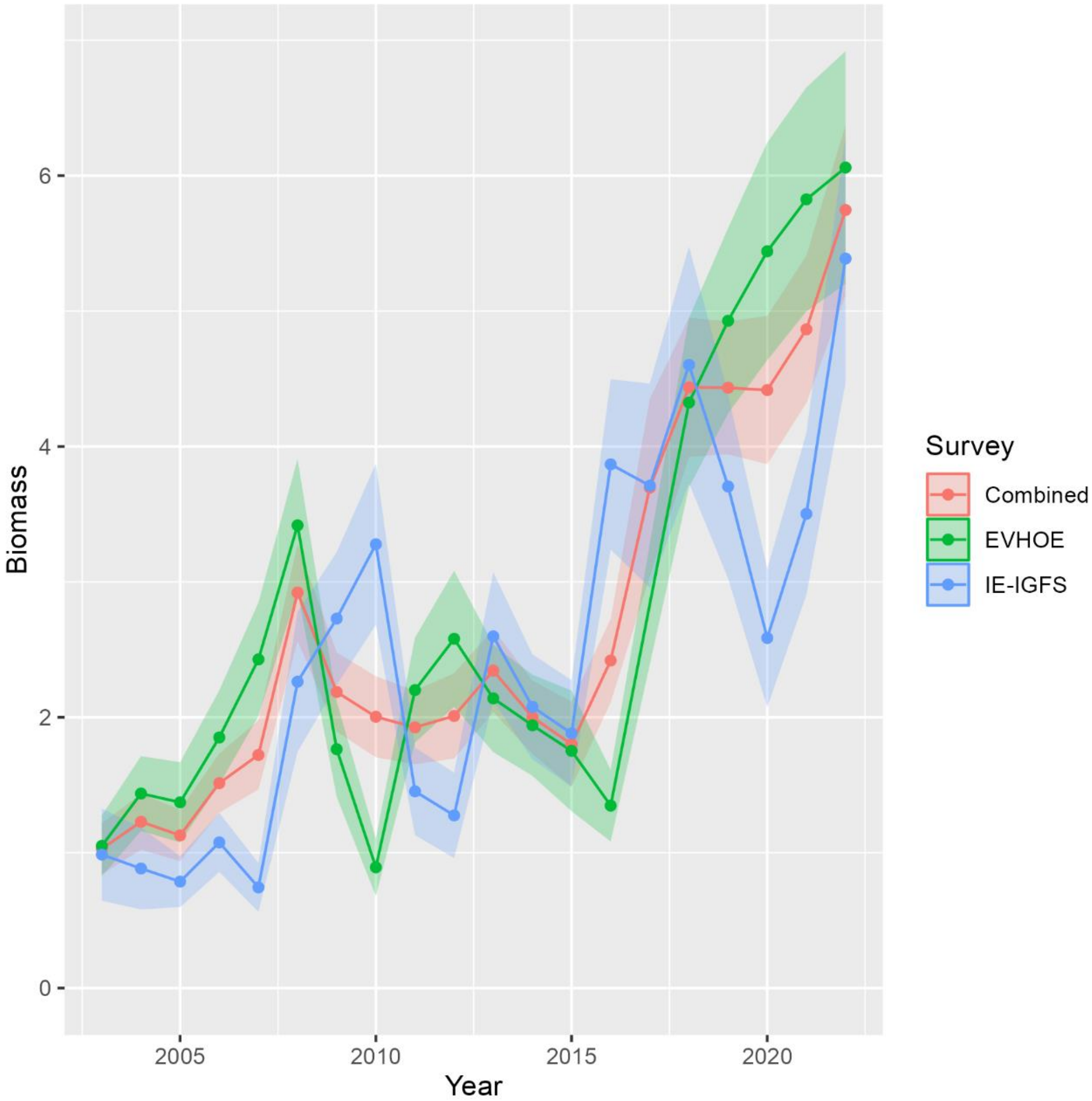

Figure 3.3.5. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Survey index of the EVHOE-WIBTS-Q4 (G9527) index is shown in green, IGFS-WIBTS-Q4 (G7212) in blue and the combined FR_IE_IBTS survey index in red, all with 95% confidence intervals.

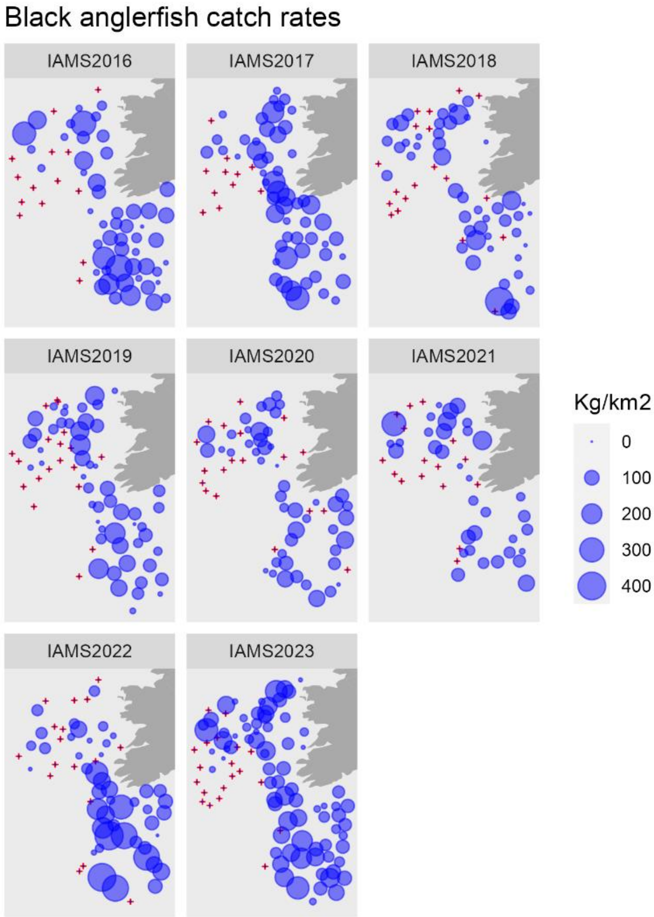

Figure 3.3.6. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Catch rates on the IAMS (G3098) survey (Note: survey indices are included in the assessment as December of the previous year).

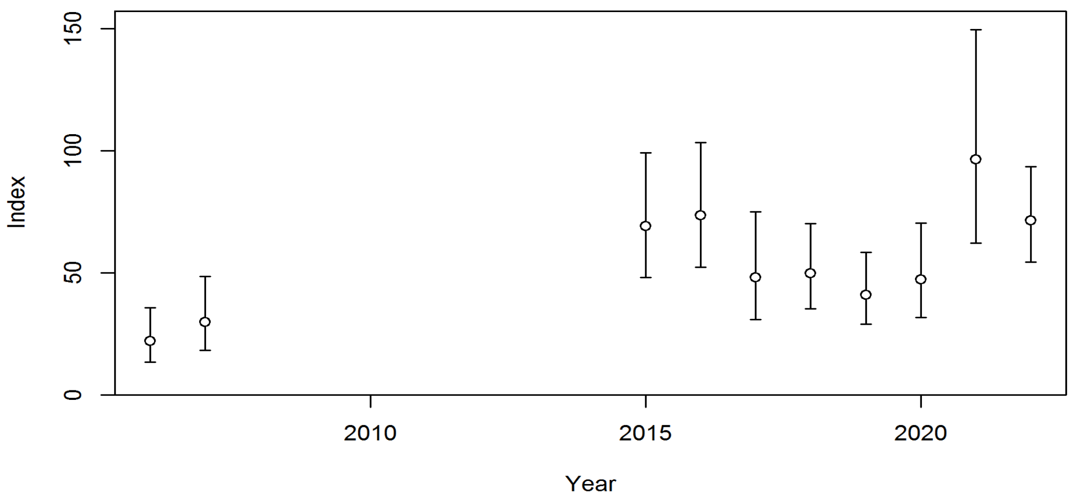

Figure 3.3.7. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Biomass index of the IAMS (G3098) survey (Note: Data points for 2006 and 2007 were from an earlier survey which used the same methodology and procedures as the IAMS (G3098) survey).

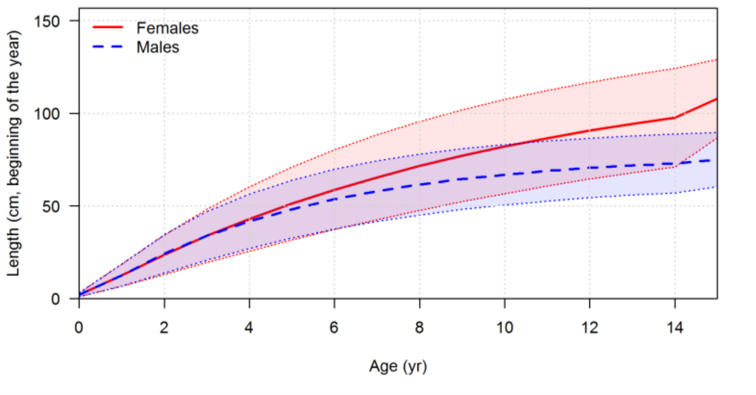

Figure 3.3.8. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Assumed growth curves for males and females.

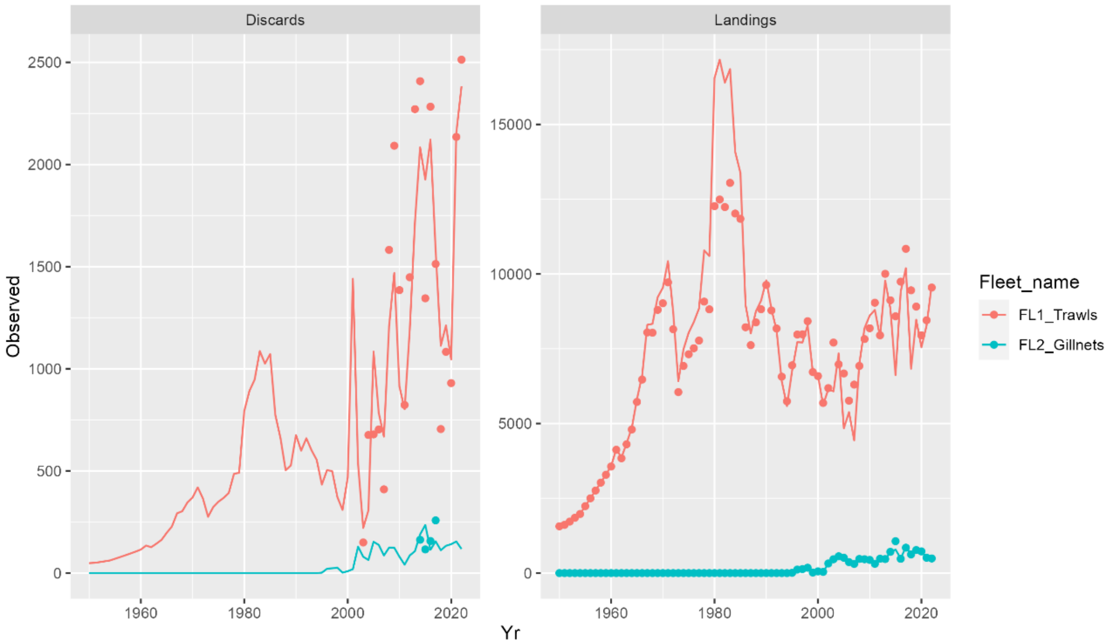

Figure 3.3.9. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Observed (points) and fitted (lines) of discards and landings (in tonnes).

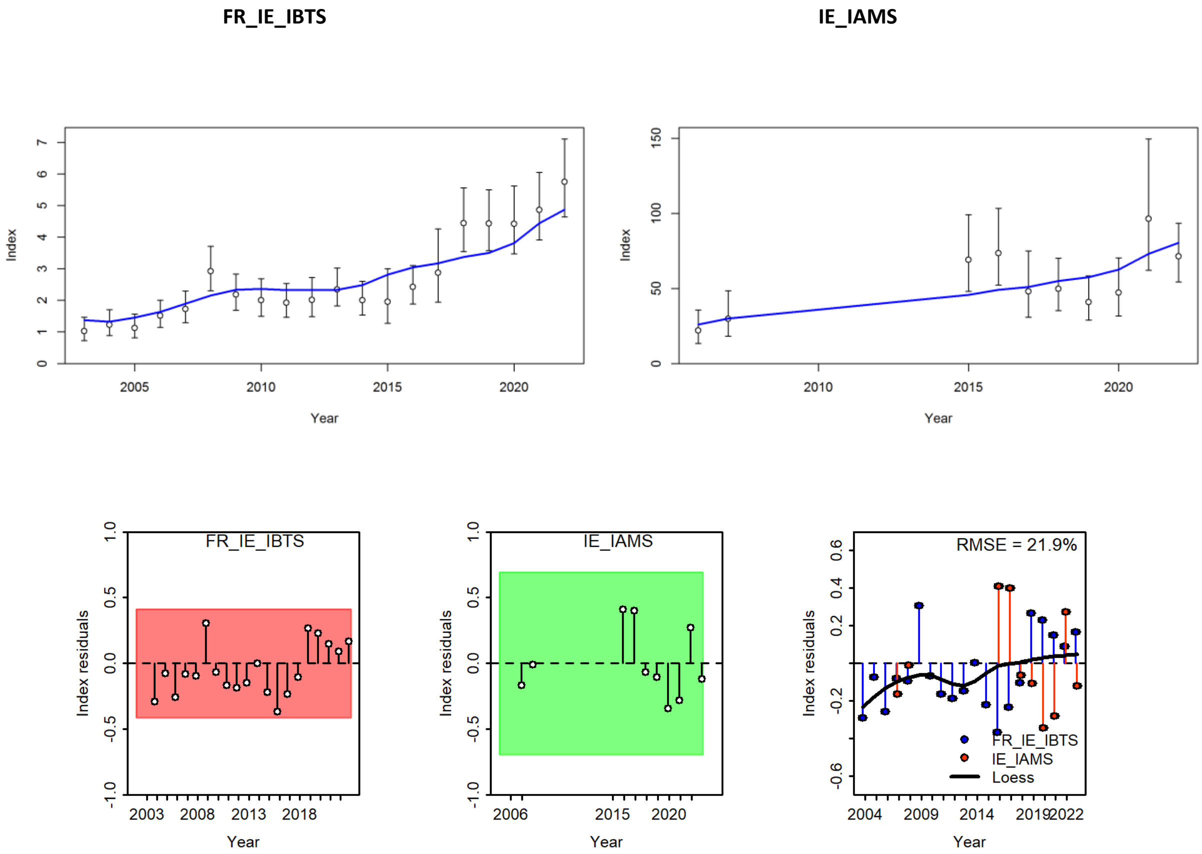

Figure 3.3.10. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Index fit (top) and residuals (bottom). The combined FR_IE_ITBS index failed the runs test (red shading) due to non-randomness in the sign of the residuals. The red and green shading indicates three standard deviations and observations outside this area can be considered outliers. The joint residual RMSE is relatively small (< 30%) indicating a reasonably precise model fit to the indices.

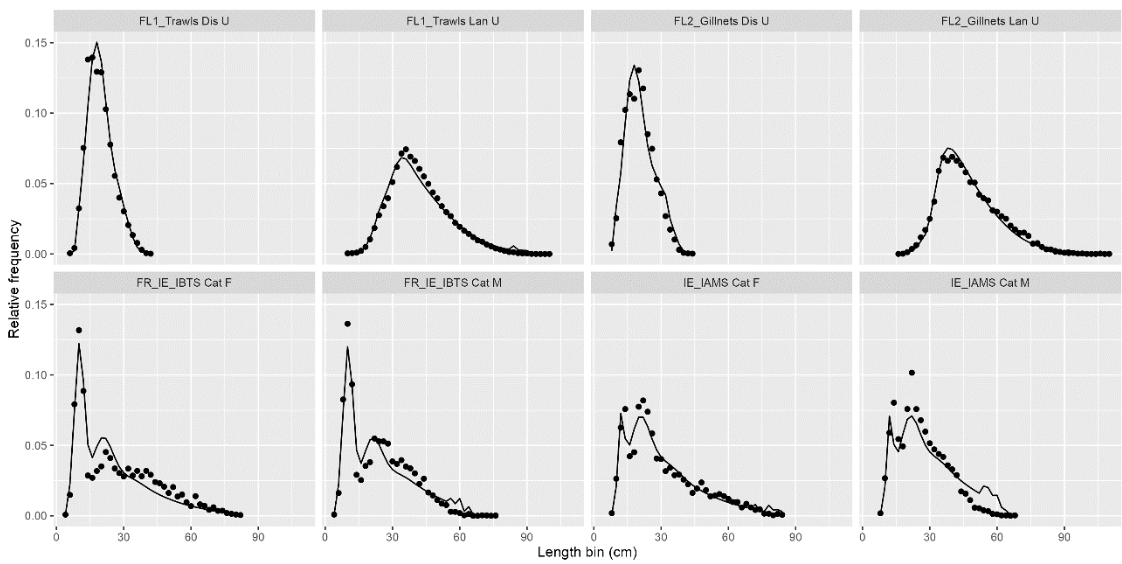

Figure 3.3.11. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Observed (points) and fitted (lines) length compositions, aggregated overall years by fleet.

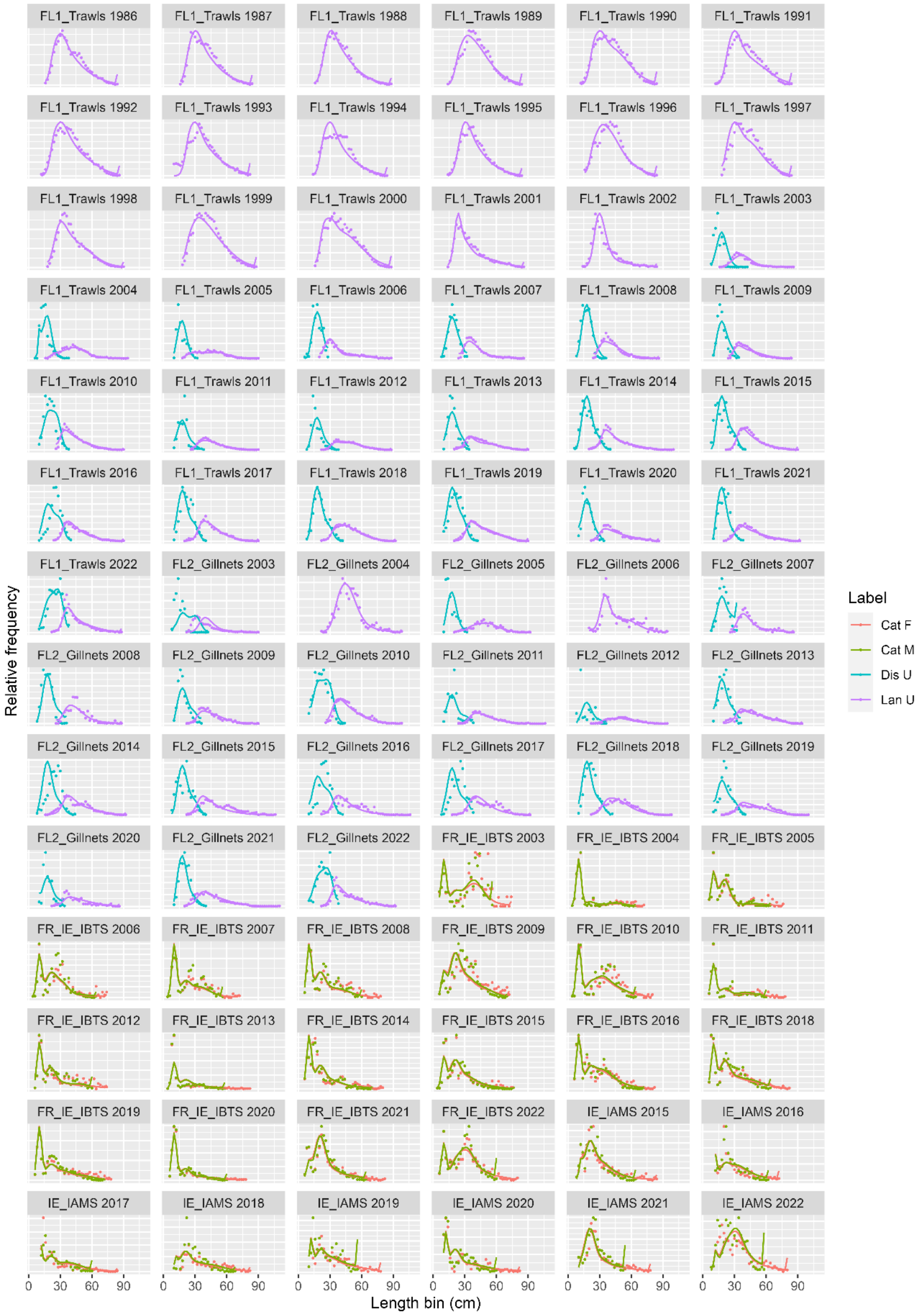

Figure 3.3.12. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Observed (points) and fitted (lines) length

compositions, by year. Note that all length compositions are standardized to a relative scale so landings and discards or males and females cannot be directly compared.

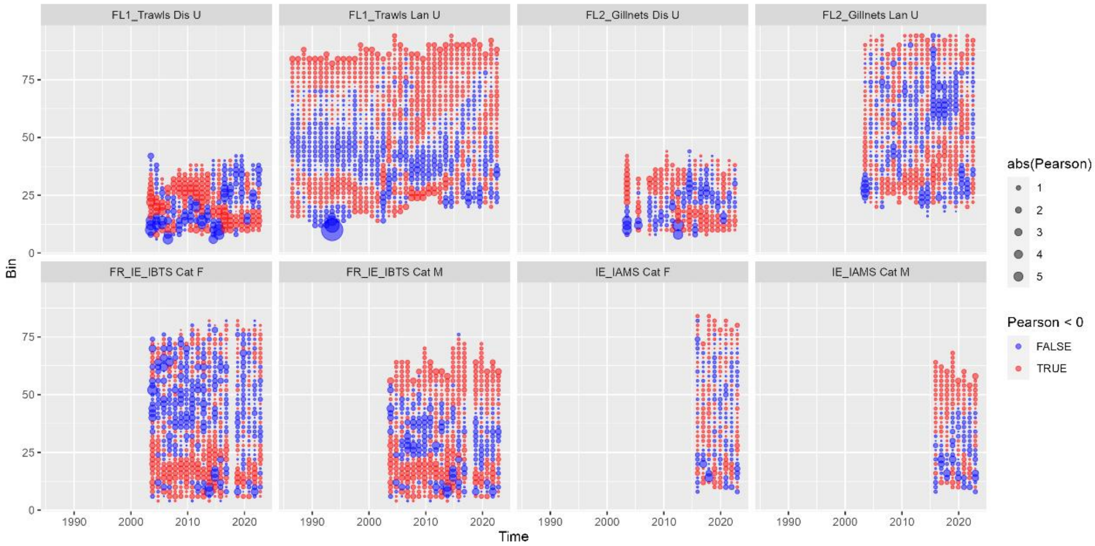

Figure 3.3.13. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Bubble plots of the residuals to the length composition fit.

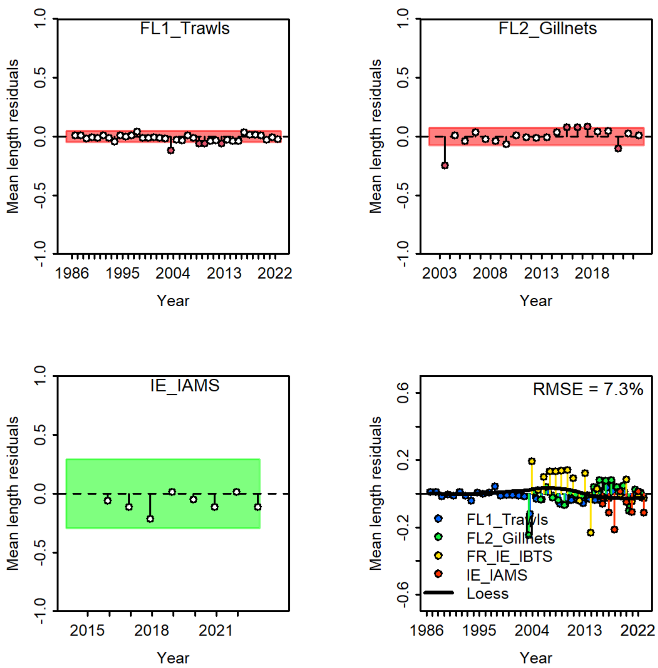

Figure 3.3.14. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Runs tests on the mean-length residuals. The residuals of the two commercial fleets do not vary much from year-to-year but they still fail the runs test (red shading); this indicates some non-randomness in the residuals. The combined FR_IE_IBTS survey passes the runs test (green shading), despite having mainly positive residuals in the first half of the time-series. The IAMS (G3098) survey also passes despite having mostly negative residuals.

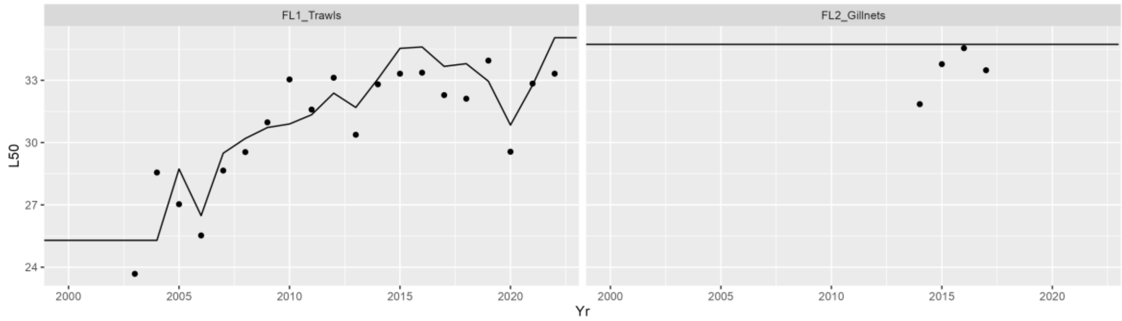

Figure 3.3.15. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Observed (points) and fitted (lines) length at 50% retention. Retention (the proportion of catches that are landed in each size class) is modelled with a logistic curve and the inflection point of the FL1 fleet (Trawls) is allowed to vary during the period 2003–2021 with a random walk. For FL2 (Gillnets), this parameter has no time-varying flexibility.

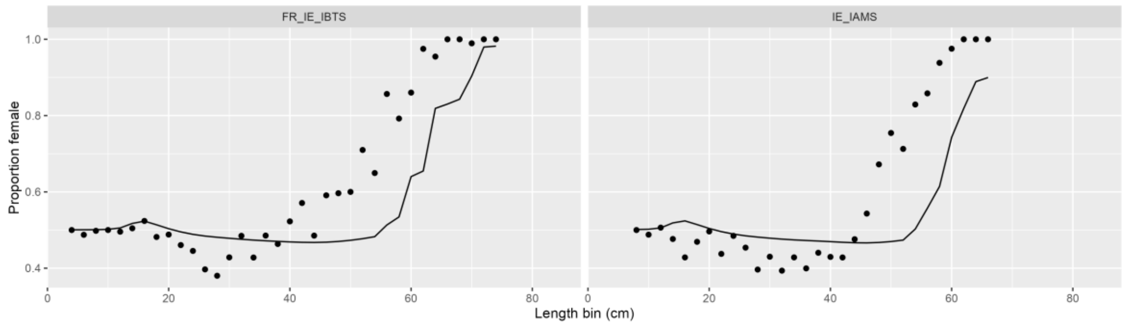

Figure 3.3.16. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Observed (points) and fitted (lines) sex ratio (proportion female) at length. The sexual dimorphism that is apparent from the survey data cannot be fully accommodated with the current settings.

Figure 3.3.17. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Retrospective analysis. The purple line corresponds to the current model run (last data year 2021). The other colours represent −1 to −5-year peels. The 95% confidence intervals of the final model are indicated by grey shading. SSB refers to combined-sex SSB (mature biomass).

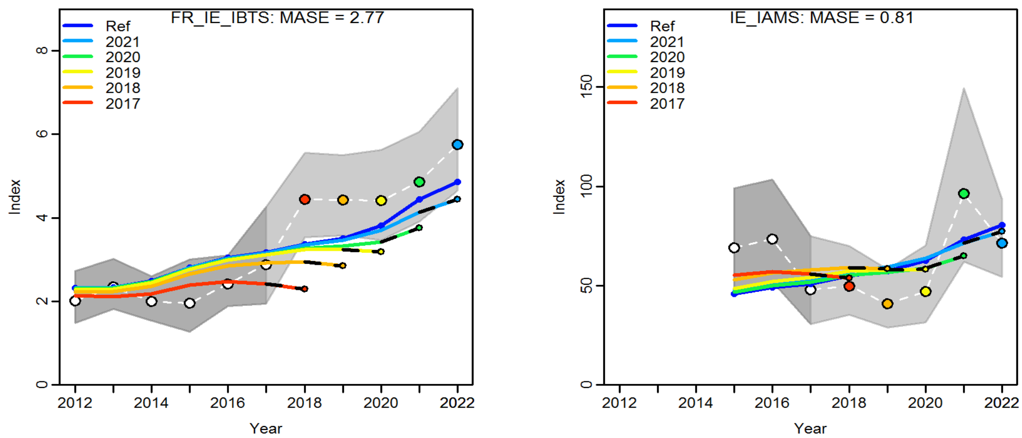

Figure 3.3.18. Black-bellied anglerfish (L. budegassa) in 27.78abd. Hindcasting results for the survey indices. The combined FR_IE_IBTS index has a poor MASE score, indicating that the model has poor capacity to predict this index. This

may not be surprising as the index is influenced considerably by recruitment. The MASE score for the combined FR_IE_IBTS survey is below 1 but the time-series is too short to draw strong conclusions.

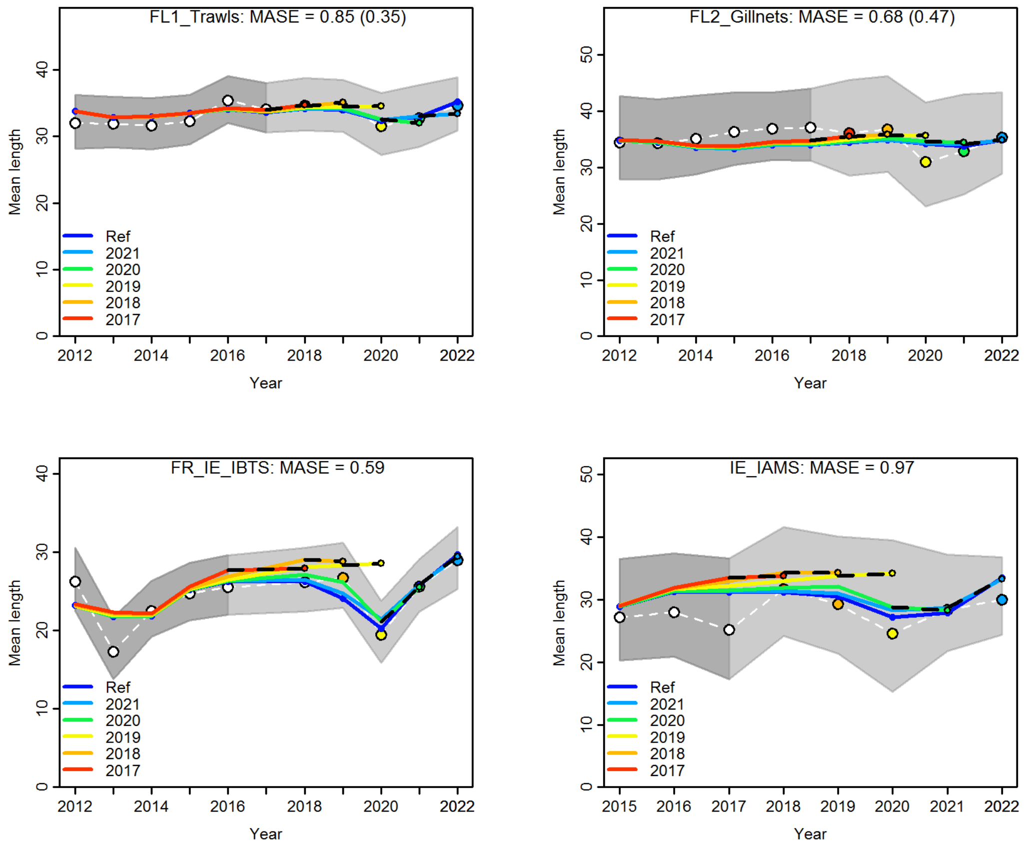

Figure 3.3.19. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Hindcasting results for the mean length in the commercial and survey fleets. The IAMS (G3098) survey has a score >1 but the other fleets have MASE scores <1 indicating good prediction skill.

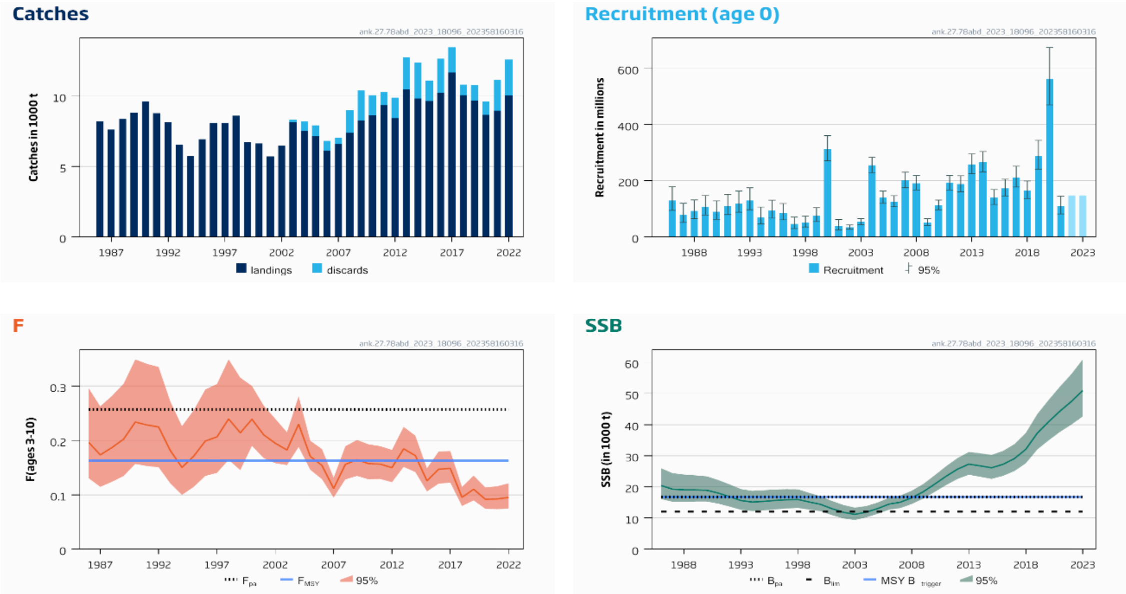

Figure 3.3.20. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Summary plot. Discard observations are available since 2003. Annual landings are available to the model from 1950 but the plots only show the more data-rich period since 1986. The assumed recruitment values for 2022 and 2023 are shaded in a lighter colour.

Figure 3.3.21. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Comparison of the current assessment (thick, orange line) with previous category 3 assessments. The broad perception of the stock is unchanged.

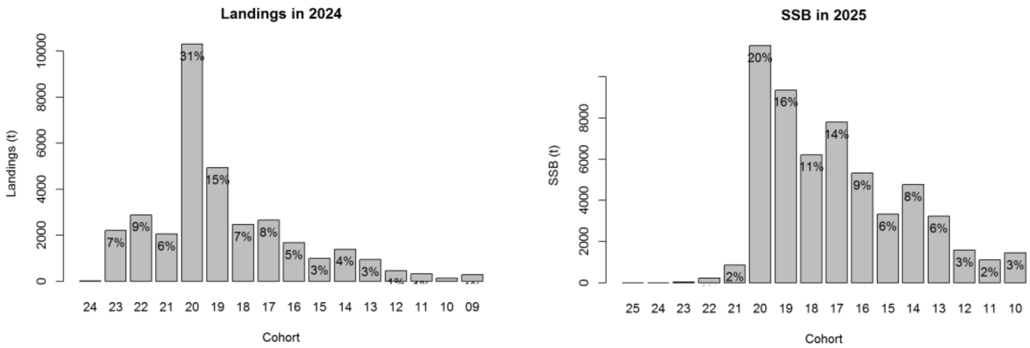

Figure 3.3.22. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Contribution of each cohort to the forecasted landings and SSB.

Table 3.3.1. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. ICES estimates of the catch and landings by area and by country. All weights are in tonnes.

Year	ICES estimated landings from Subarea 7						ICES estimated landings from divisions 8.a, 8.b, 8.d				ICES estimated; Subarea 7 and divisions 8.a, 8.b, 8.d		
	ESP	FRA	GBR	IRL	OTH	Total 7	ESP	FRA	OTH	Total 8.a, 8.b, 8.d	Landings	Discards	Catch
1986	2816	2251	949	262	165	6443	485	1289	0	1775	8217		
1987	2174	1868	805	241	28	5116	953	1551	0	2504	7620		
1988	2316	2572	1160	234	65	6347	695	1341	0	2035	8382		
1989	2445	2932	472	310	275	6434	602	1785	0	2387	8820		
1990	2393	2914	1030	614	109	7061	571	2000	0	2571	9632		
1991	2180	2390	809	858	17	6254	799	1727	0	2526	8780		
1992	1763	2440	1002	774	28	6008	536	1632	0	2168	8176		
1993	1304	1941	727	607	68	4646	589	1331	0	1919	6566		
1994	1374	1820	378	290	86	3948	624	1172	0	1796	5744		
1995	1668	2448	389	630	69	5204	463	1287	0	1750	6954		
1996	1909	2763	576	641	90	5979	525	1589	0	2114	8093		
1997	2143	2804	644	557	38	6185	366	1563	0	1929	8114		
1998	2042	2419	763	1234	53	6510	441	1648	0	2089	8599		
1999	2434	1771	193	529	141	5068	458	1212	0	1670	6739		
2000	2051	1961	167	873	169	5220	445	980	0	1424	6645		

Year	ICES estimated landings from Subarea 7						ICES estimated landings from divisions 8.a, 8.b, 8.d				ICES estimated; Subarea 7 and divisions 8.a, 8.b, 8.d		
	ESP	FRA	GBR	IRL	OTH	Total 7	ESP	FRA	OTH	Total 8.a, 8.b, 8.d	Landings	Discards	Catch
2001	2083	1516	131	580	168	4478	333	918	0	1251	5728		
2002	2451	1710	146	309	119	4734	463	1309	0	1771	6505		
2003	3600	2175	181	180	119	6256	396	1520	0	1916	8171	179	8351
2004	2875	1845	256	224	157	5358	471	1708	0	2178	7537	676	8213
2005	2902	1530	248	365	167	5214	415	1559	0	1974	7187	727	7914
2006	2737	1536	131	200	71	4675	282	1171	2	1456	6131	704	6835
2007	2451	1747	150	348	162	4857	316	1434	1	1751	6608	413	7021
2008	3017	2030	279	508	205	6039	265	1095	1	1360	7399	1585	8985
2009	3498	1635	304	797	244	6478	293	1515	2	1809	8287	2113	10400
2010	2866	2179	469	981	316	6812	317	1490	8	1815	8626	1436	10062
2011	3812	1863	418	941	382	7416	503	1423	8	1933	9348	971	10319
2012	2888	2032	365	621	53	5959	692	1612	167	2471	8429	1459	9888
2013	3896	2211	484	615	68	7274	790	2032	379	3200	10475	2285	12760
2014	1629	2829	862	720	74	6114	945	2526	246	3718	9832	2570	12402
2015	1384	2945	1046	839	69	6284	749	2480	136	3365	9649	1460	11109
2016	1118	2881	1063	970	94	6127	918	2968	206	4093	10220	2441	12660
2017	1287	4255	1183	793	0	7518	941	3000	231	4172	11690	1770	13460
2018	890	3443	898	1110	0	6341	766	2807	161	3734	10076	727	10803
2019	1366	3500	993	940	0	6800	645	2156	79	2880	9680	1084	10764
2020	1538	2575	757	1445	187	6502	611	1547	16	2174	8676	926	9601
2021	1548	3790	1309	721	78	7445	422	1085	13	1520	8965	2141	11107
2022	1758	4345	873	995	213	8185	527	1321	3	1851	10035	2564	12600

Table 3.3.2. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Survey indices used in the model. Both indices are specified in biomass; log se is the standard error on the log scale which is similar to the CV of the index.

Year	Month	Fleet	Index	log se
2003	10.5	FR_IE_IBTS	1.030	0.18

Year	Month	Fleet	Index	log se
2004	10.5	FR_IE_IBTS	1.228	0.17
2005	10.5	FR_IE_IBTS	1.128	0.17
2006	10.5	FR_IE_IBTS	1.514	0.14
2007	10.5	FR_IE_IBTS	1.722	0.15
2008	10.5	FR_IE_IBTS	2.921	0.12
2009	10.5	FR_IE_IBTS	2.187	0.13
2010	10.5	FR_IE_IBTS	2.004	0.15
2011	10.5	FR_IE_IBTS	1.926	0.14
2012	10.5	FR_IE_IBTS	2.010	0.16
2013	10.5	FR_IE_IBTS	2.345	0.13
2014	10.5	FR_IE_IBTS	2.001	0.13
2015	10.5	FR_IE_IBTS	1.801	0.17
2016	10.5	FR_IE_IBTS	2.419	0.13
2017	10.5	FR_IE_IBTS	3.696	0.18
2018	10.5	FR_IE_IBTS	4.437	0.12
2019	10.5	FR_IE_IBTS	4.434	0.11
2020	10.5	FR_IE_IBTS	4.416	0.12
2021	10.5	FR_IE_IBTS	4.865	0.11
2022	10.5	FR_IE_IBTS	5.747	0.11
2015	12	IAMS (G3098)	69.171	0.19
2016	12	IAMS (G3098)	73.559	0.18
2017	12	IAMS (G3098)	48.083	0.23
2018	12	IAMS (G3098)	49.729	0.18
2019	12	IAMS (G3098)	41.051	0.18
2020	12	IAMS (G3098)	47.265	0.21
2021	12	IAMS (G3098)	96.625	0.23
2022	12	IAMS (G3098)	71.295	0.14

Table 3.3.3. Black-bellied anglerfish (*L. budegassa*) in 27.78abd. Assessment summary results with 95% confidence intervals. Weights are in tonnes and recruitment is in thousands. Discard observations are available since 2003. Annual landings are available to the model from 1950 but the plots only show the more data-rich period since 1986.

Year	Recruitment (age 0)			Stock size			Landings (tonnes) **	Discards (tonnes) **	F ages 3–10		
	Low	R	High	Low	SSB	High			Low	F	High
1986	94904	130283	178850	16088	20449	25991	8217		0.131	0.197	0.3
1987	51997	78962	119912	15228	19285	24421	7620		0.115	0.174	0.26
1988	65400	92922	132028	15185	19082	23980	8382		0.124	0.187	0.28
1989	77990	107520	148231	15295	19050	23727	8820		0.135	0.2	0.3
1990	63328	90312	128792	15306	18931	23414	9632		0.157	0.23	0.35
1991	80052	110039	151260	14639	18044	22242	8780		0.153	0.23	0.34
1992	88261	120105	163438	13690	16889	20835	8176		0.151	0.22	0.34
1993	97377	130608	175180	12647	15633	19324	6566		0.121	0.182	0.27
1994	46740	70640	106760	12243	15142	18727	5744		0.1	0.151	0.23
1995	67165	93827	131074	12457	15359	18937	6954		0.114	0.171	0.26
1996	61208	85436	119254	12780	15655	19176	8093		0.135	0.199	0.29
1997	30059	46100	70700	13069	15876	19285	8114		0.14	0.21	0.3
1998	35560	51493	74565	13251	15967	19239	8599		0.164	0.24	0.35
1999	55071	75901	104610	12705	15164	18098	6739		0.145	0.21	0.32
2000	270751	312608	360936	12191	14393	16992	6645		0.19	0.24	0.3
2001	25290	39535	61806	10912	13002	15493	5728		0.168	0.21	0.26
2002	27922	34716	43164	9871	11840	14202	6505		0.158	0.195	0.24
2003	43709	53180	64703	9380	11194	13358	8171	179	0.155	0.183	0.22
2004	228876	254965	284028	10209	11897	13865	7537	676	0.188	0.23	0.28
2005	119640	139906	163605	11370	13057	14993	7187	727	0.146	0.171	0.2
2006	107814	126088	147459	12675	14472	16523	6131	704	0.129	0.154	0.184
2007	175821	201434	230778	13213	15101	17259	6608	413	0.095	0.112	0.132
2008	167679	191704	219171	14518	16519	18795	7399	1585	0.128	0.156	0.189
2009	40753	51389	64801	16244	18444	20941	8287	2113	0.135	0.165	0.2
2010	97144	113129	131744	18380	20885	23731	8626	1436	0.129	0.158	0.193

Year	Recruitment (age 0)			Stock size			Landings (tonnes) **	Discards (tonnes) **	F ages 3–10		
	Low	R	High	Low	SSB	High			Low	F	High
2011	167841	192109	219886	20567	23406	26638	9348	971	0.129	0.157	0.19
2012	161384	187668	218233	22545	25680	29251	8429	1459	0.123	0.15	0.183
2013	225516	258417	296119	23907	27316	31212	10475	2285	0.151	0.185	0.23
2014	231651	265598	304520	23248	26754	30789	9832	2570	0.142	0.172	0.21
2015	115898	139878	168819	22568	26143	30285	9649	1460	0.106	0.126	0.149
2016	146184	173556	206053	23541	27255	31556	10220	2441	0.121	0.147	0.18
2017	178060	211866	252090	25082	29090	33738	11690	1770	0.122	0.149	0.181
2018	136898	165228	199421	27561	32073	37325	10076	730	0.079	0.095	0.115
2019	241241	288185	344264	31960	37220	43347	9680	1099	0.09	0.11	0.136
2020	470211	563375	674998	34921	40906	47917	8676	939	0.074	0.092	0.114
2021	81776	109023	145348	37655	44346	52227	8965	2166	0.074	0.092	0.116
2022		147359*		40004	47436	56249	10035	2564	0.075	0.095	0.121
2023		147781*		42615	50975	60974					

*** Assumed recruitment based on stock–recruit relationship.**

**** Observed landings and discards; not all discard observations were provided to the model.**

4 Black-bellied and white anglerfish in Cantabrian Sea and Atlantic Iberian waters

ank.27.8c9a and mon.27.8c9a – *Lophius budegassa* and *L. piscatorius* in divisions 8.c and 9.a

4.1 General

Update assessment for *Lophius piscatorius* and *L. budegassa* in 2022. Software used: Stock Synthesis (SS; Merthot Jr. and Wetzel, 2013) for *L. piscatorius* and SPiCT (Pedersen and Berg, 2017) for *L. budegassa*. No data revisions this year.

4.1.1 Introduction

Two species of anglerfish, *L. piscatorius* and *L. budegassa* are found in ICES divisions 8.c and 9.a. Both species are caught in mixed bottom-trawl fisheries and artisanal fisheries using mainly fixed nets.

The two species have been landed together for the majority of the commercial categories and being recorded together in the ports' statistics. Therefore, estimates of each species in Spanish landings from divisions 8.c and 9.a and Portuguese landings of Division 9.a have been derived from their relative proportions in market samples. However, sampling data from Portugal suggests that species identification greatly improved in recent years with potential significant misidentification issues at a smaller number of landing ports. Consequently, since 2021 that Portuguese landings correspond to the official landings of each species with corrections for a reduced number of ports.

The total anglerfish landings are given in Table 4.1.1 by ICES Division, country and fishing gear. Landings increased in the early eighties reaching a maximum level in 1986 (9 433 t) and 1988 (10 021 t), and decreased after that to a minimum of 1801 t in 2001. In 2002–2005 period landings increased reaching 4 757 t. This period was followed by another one where landings gradually declined and in 2011 landings were less than half of the 2005 amount (2105 t). From 2011 to 2014, landings slightly increased to 3030 t. Annual values then progressively decreased again in the next eight years to 1 195 t in 2022, the lowest value recorded in the stocks' historical time-series.

The species proportion in the landings has changed since 1986. At the beginning of the time-series (1980–1986), *L. piscatorius* represented more than 70% of the total anglerfish landings. After 1986, the proportion of *L. piscatorius* decreased in the annual landings but in 1999–2002 both species showed approximately the same weight. In 2003, the proportion of *L. piscatorius* started to increase again, with a mean proportion of 66% in total landings from 2003 to 2019. Since 2021 the proportion of *L. budegassa* represents between 52 to 54% of total anglerfish landings.

ICES performs assessments for each species separately. The latest benchmark assessment for *L. piscatorius* in divisions 8.c and 9.a was carried out in 2018 (ICES, 2018) when new settings and data were incorporated into the existing Stock Synthesis (SS) model (Methot Jr. and Wetzel, 2013). A benchmark assessment using SPiCT (Pedersen and Berg, 2017) for *L. budegassa* was conducted during WKMSYSPiCT (ICES, 2021). The time-series of available CPUE data were revised and several tests were conducted.

The ageing estimation problems detected during the previous benchmark (see WKFLAT report; ICES, 2012) continued unsolved for *L. piscatorius* (ICES, 2018) and no new studies were carried out for *L. budegassa*. The growth pattern inferred from mark-recapture and length composition data analyses (Landa *et al*., 2008) was used in the assessment of *L. piscatorius*.

4.1.2 Summary of ICES advice for 2023 and management for 2022 and 2023

4.1.2.1 ICES advice for 2023

ICES gave separate advice for each of these species in 2022. ICES advises for *L. piscatorius* that when the EU multiannual plan (MAP) for Western waters and adjacent waters (EU, 2019) is applied, catches in 2022 that correspond to the F ranges are between 1 613 and 2 986 t. Catches higher than those corresponding to F_{MSY} (2 271 t) can only be taken under conditions specified in the MAP. For *L. budegassa,* ICES advises that when the precautionary approach is applied, catches in 2023 should be no more than 2 064 t.

4.1.2.2 Management applicable for 2022 and 2023

The two species are managed under a common TAC that was set at 3 868 t for 2022 and 4 335 t (EU, 2023) for 2023. The reported landings in 2022 were 31% of the established TAC.

There is no minimum landing size for anglerfish. However, the Council Regulation (EC) No. 2406/96, layed down common marketing standards for certain fishery products, fixes a minimum weight of 500 g for anglerfish (EU, 1996). In Spain, this minimum weight was implemented in 2000.

4.1.2.3 Management considerations

L. piscatorius and *L. budegassa* are subject to a common TAC. Both species of anglerfish are reported together because of their similarity but they are assessed and their advice is provided separately.

It should be noted that both anglerfish are essentially caught in mixed fisheries. Hence, management measures applied to these species may have implications for other stocks and vice versa. Although these stocks are assessed separately, they are managed together. Due to the differences in the current status of the individual stocks the advice is given separately.

4.1.3 References

EU. 1996. Council Regulation (EC) No 2406/96 of 26 November 1996 laying down common marketing standards for certain fishery products.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj

EU. 2023. Council Regulation (EU) 2023/194 of 30 January 2023 fixing for 2023 the fishing opportunities for certain fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, as well as fixing for 2023 and 2024 such fishing opportunities for certain deep-sea fish stocks.

ICES. 2012. Report of the Benchmark Workshop on Flatfish Species and Anglerfish (WKFLAT), 1–8 March 2012, Bilbao, Spain. ICES CM 2012/ACOM:46. 283 pp.

ICES. 2018. Report of the Benchmark Workshop on Anglerfish stocks in the ICES area (WKANGLER), 12–16 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM: 31. 172 pp.

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Pedersen, M.W., Berg, C.W. 2017. A stochastic surplus production model in continuous time. Fish and Fisheries, 18: 226–243.

Table 4.1.1. White-bellied and black-bellied anglerfish (*L. piscatorius* and *L. budegassa*) in divisions 8.c and 9.a. Landings (in tonnes) by the main fishing fleets from 1978–2022 as estimated by the WGBIE.

	Div. 8c						Div. 9a						Div. 8c+9a			Div. 8c+9a
	SPAIN			FRANCE			SPAIN			PORTUGAL						
Year	Trawl	Gillnet	Others	Trawl	Gillnet	TOTAL	Trawl	Gillnet	Others	Trawl	Artisanal	TOTAL	SUBTOTAL	Unallocated/ Non-reported		TOTAL
1978	n/a	n/a				n/a	506			n/a	222	728	728			
1979	n/a	n/a				n/a	625			n/a	435	1 060	1 060			
1980	4 008	1 477				5 485	786			n/a	654	1 440	6 926			6926
1981	3 909	2 240				6 149	1 040			n/a	679	1 719	7 867			7867
1982	2 742	3 095				5 837	1 716			n/a	598	2 314	8 151			8151
1983	4 269	1 911				6 180	1 426			n/a	888	2 314	8 494			8494
1984	3 600	1 866				5 466	1 136			409	950	2 495	7 961			7961
1985	2 679	2 495				5 174	977			466	1 355	2 798	7 972			7972
1986	3 052	3 209				6 261	1 049			367	1 757	3 172	9 433			9433
1987	3 174	2 571				5 745	1 133			426	1 668	3 227	8 973			8973
1988	3 583	3 263				6 846	1 254			344	1 577	3 175	10 021			10021
1989	2 291	2 498				4 789	1 111			531	1 142	2 785	7 574			7574
1990	1 930	1 127				3 057	1 124			713	1 231	3 068	6 124			6124
1991	1 993	854				2 847	878			533	1 545	2 956	5 802			5802
1992	1 668	1 068				2 736	786			363	1 610	2 758	5 493			5493
1993	1 360	959				2 319	699			306	1 231	2 237	4 556			4556
1994	1 232	1 028				2 260	629			149	549	1 327	3 587			3587
1995	1 755	677				2 432	814			134	297	1 245	3 677			3677
1996	2 146	850				2 995	749			265	574	1 589	4 584			4584
1997	2 249	1 389				3 638	838			191	860	1 889	5 527			5527
1998	1 660	1 507				3 167	865			209	829	1 903	5 070			5070
1999	1 110	1 140				2 250	750			119	692	1 561	3 811			3811
2000	710	612				1 322	485			146	675	1 306	2 628			2628
2001	614	364				978	247			117	459	823	1 801			1801
2002	587	415		61	8	1 072	344			104	380	828	1 901			1901
2003	1 190	771		55	0	2 016	617			96	529	1 242	3 258			3258
2004	1 513	1 389		87	32	3 021	549			77	602	1 229	4 250			4250
2005	1 651	1 719		160	55	3 586	653			60	458	1 171	4 757			4757
2006	1 490	1 371		72	6	2 938	801			68	351	1 220	4 158			4158
2007	1 327	1 076		26	7	2 437	866			78	303	1 247	3 683			3683
2008	1 280	1 238		31	9	2 558	473			50	246	770	3 328			3328
2009	1 151	1 207		20	10	2 389	386			43	262	691	3 080			3080
2010	689	1 036		14	3	1 742	355			72	203	630	2 372			2372
2011	458	598	105	18	2	1 180	216	88	146	122	199	770	1 951	154		2105
2012	432	610	89	14	2	1 148	163	60	132	161	533	1 049	2 197	339		2536
2013	495	853	52	23	7	1 430	142	85	140	114	412	893	2 323	288		2612
2014	545	1 073	35	30	11	1 694	211	93	8	143	408	863	2 557	474		3030
2015	557	943	5	13	14	1 532	190	114	3	161	422	890	2 422	395		2818
2016	579	964	9	12	10	1 573	179	146	3	127	377	832	2 405	419		2824
2017	410	879	1	4	11	1 305	215	128	2	98	440	883	2 188	119		2307
2018	414	770	34	12	15	1 245	244	72	2	58	280	656	1 901	16		1916
2019	299	553	0	2	2	856	183	81	1	65	239	570	1 426	152		1577
2020	302	320	2	12	5	641	222	45	5	157	445	874	1 515	0		1515
2021	300	257	1	5	0	563	204	30	4	113	411	763	1 326	0		1326
2022	332	220	1	0	0	553	207	14	2	96	323	641	1 195	0		1195

n/a: not available

4.2 White anglerfish (*Lophius piscatorius*) in divisions 8.c and 9.a

4.2.1 General

4.2.1.1 Ecosystem aspects

The ecosystem aspects of the stock are common with *L. budegassa and* are described in the Stock Annex.

4.2.1.2 Fishery description

L. piscatorius is mainly caught by Spanish and Portuguese bottom trawlers and gillnet fisheries. For some gillnet fishery, it is an important target species, while it is also bycatch of trawl fishery targeting hake or crustaceans (see Stock Annex). Since 2010, Spanish landings were on average 79% of total landings of the stock.

The length distribution of the landings is considerably different between both fisheries, with the gillnet landings showing higher mean lengths compared to those landed by trawls. From 2010 to 2022, the Spanish landings were on average 37% from the trawl fleet (in 2022, mean lengths of 54 cm and 56 cm in divisions 8.c and 9.a, respectively were observed) and 51% from the gillnet fishery (mean length of 64 cm in Division 8.c was observed in 2022). For the same period, Portuguese landings were on average 15% from bottom trawlers (mean length of 54 cm in 2022) and 85% from the artisanal fleet (mean length of 72 cm in 2022).

4.2.2 Data

4.2.2.1 Commercial catches and discards

Total landings by country and gear for the period 1978–2022, as estimated by the WG, are given in Table 4.3.1. Unallocated and non-reported landings for this stock are available from 2011 to 2019. The unallocated and non-reported values are considered realistic and are taken into account for the assessment. Unallocated or non-reported landings were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort of each *métier* and quarter. Landings have been decreasing from 2005 (3 824 t) until 2022 (574 t), the historical minimum.

Spanish discards estimates and landings below minimum size of *L. piscatorius* in weight are shown in Table 4.3.2. No discards were reported in logbooks by any country. For the available time-series, anglerfish discards represent less than 16% of trawl catches. The maximum value observed from the time-series occurred in 2006 (99 t). Discards from the Spanish gillnet fleet are only available from 2013 to 2021 with quantities between 0 t and 144 t. The occasional high and zero values of discards reported for the gillnet fleet could be related to a very low sampling level. *L. piscatorius* discards in the Portuguese trawl fisheries are considered negligible (Fernandes and Prista, 2012; Prista *et al*., 2014). Based on the Spanish and Portuguese discards information, the WG concluded that discards could be considered negligible.

4.2.2.2 Biological sampling

The procedure for sampling this species is the same as for *L. budegassa* (see Stock Annex).

The sampling levels for Portugal in 2022 are shown in Table 1.4. Following the requirement of the EU Data Collection Framework (DCF), the *métier* sampling adopted in Spain and Portugal in 2009 can affect the provided data. Spanish sampling levels are similar to previous years but a significant reduction in Portuguese samplings was observed in 2009–2011. Despite Portugal having increased their sampling effort, the number of samples and length measured are still low.

Since 2009, the length composition of trawl and artisanal Portuguese fisheries is not used in the assessment.

Length composition

The annual length compositions for all combined fleets for the period 1986–2022 are presented in Figure 4.3.1. Landings in number, the mean length and mean weight in the landings between 1986 and 2022 are shown in Table 4.3.4. The lowest total number of landings (year 2001) is 4% of the maximum value (year 1988). After 2001, values increased up to 2006 followed by a decreasing annual trend in 2007 to 2012. Since 2016, there is a strong downward trend in total landings number reaching 135 thousand in 2021 (value almost similar to the smallest number, 127 thousand in 2001, observed for the whole time-series). Mean lengths and mean weights in the landings increased sharply between 1995 and 2000. In 2002, low values of mean lengths and mean weights were observed, around the minimum of the time-series, due to the increase in smaller individuals. After that, increases in mean length were observed reaching 71 cm in 2010. Since 2018, the mean length and mean weight in landings have decreased from 77 cm to 55 cm and from 7 163 g to 3 711 g, respectively.

Biological information

The growth pattern used in the assessment follows a von Bertalanffy model with fixed K = 0.11 and L_{inf} is estimated by the model. Length-weight relationship, updated during the benchmark (ICES, 2018), maturity ogive and natural mortality (M) used in the assessment are described in the Stock Annex.

4.2.2.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period of 1983 to 2022 are summarized in Table 4.3.5.

The abundance index from the Spanish SpGFS-WIBTS-Q4 (G2784) survey is shown in Figure 4.3.2. Since 2000, the highest abundance values were detected in 2001 and 2006, following this year a downward trend was observed. In 2016, 2017, 2018 and 2019, the abundance indices were the lowest of the series (Figure 4.3.2) and almost no individuals < 20 cm were recorded (Figure 4.3.3). In 2021, slight increases in abundance were observed.

Since 2013, the Spanish SpGFS-WIBTS-Q4 (G2784) survey is conducted using a different vessel. The results of two inter-calibration experiments carried out between the two oceanographic vessels in 2012 and 2014 indicated that catches of white anglerfish have not been affected by the change of the vessel. Although in 2021, the Spanish SpGFS-WIBTS-Q4 (G2784) survey was partially carried out with a different vessel, it is considered that this change had no effect on abundance estimates.

4.2.2.4 Commercial catch-effort data

Landings, effort and LPUE data are given in Table 4.3.6 and Figure 4.3.4. Values for Spanish trawlers (Division 8.c) from the ports of Santander and Avilés have been collected since 1986, for A Coruña since 1982, and for the Portuguese trawlers (Division 9.a) since 1989. A Coruña fleet series (landings, effort and LPUE) were updated to incorporate years at the beginning of the series (1982–1985). Three series are presented for A Coruña fleet: (1) A Coruña port for trips that are exclusively landed in the port; (2) A Coruña trucks for trips that are landed in other ports; and (3) A Coruña fleet that takes into account all the trips of the fleet. For 2020, no information for A Coruña port was provided. Although the abundance series from A Coruña port can be potentially used in the assessment, a previous analysis of the whole time-series must be done before taking this into account. The A Coruña fleet index, used in the assessment as an abundance index from 1982–2012, is not available since 2013.

Until 2011, most logbooks of Portuguese fleets were filled in paper but have been progressively replaced thereafter by electronic logbooks. In 2013, more than 90% of the logbooks were completed in the electronic version. The LPUEs series were revised from 2012 onwards. To revise the series backwards, further refinement of the algorithm is required.

For each fleet, the proportion of the landings in the stock is also given in Table 4.3.6. In 2007, a data series from the artisanal fleet from the port of Cedeira in Division 8.c was provided. This LPUE series is annually standardized to incorporate a new year of data and the latest available standardized series, from 1999–2011, is presented. Due to the reduction in the number of vessels of Cedeira fleet, this tuning series could not be considered a representative abundance index of the stock and it is no longer recorded. Standardized effort provided for Portuguese trawl fleets (1989–2008) and their corresponding LPUEs are also given in Table 4.3.6, but not represented in Figure 4.3.4.

All fleets show a general decrease in landings during the eighties and early nineties. From 2000 to 2005, Spanish fleets of A Coruña, Avilés and Cedeira showed an increase in landings while those landed by the Portuguese fleets remained at low levels. Since 2005–2009, landings from A Coruña and Cedeira fleets showed an overall decreasing trend. Proportion in total landings per fleet is higher for the Cedeira and A Coruña. Landings for both Portuguese fleets increased in 2014 and 2015 then decreased afterwards.

Effort trends show a general decline since the mid-nineties in all trawl fleets. In the last five years, low effort values were observed despite some slight fluctuations. Despite these variations along the time-series, the Cedeira artisanal fleet shows an overall increasing trend until 2008. After this year, the effort sharply declined to the minimum value of the series in 2011. From 2007–2011, the effort from A Coruña fleet was reduced by 47%, showing the lowest values of the series in 2011. The Portuguese Crustacean fleet shows high effort values in 2001 and 2002 that might be related to a change in the target species due to the very high abundance of rose shrimps during that period.

LPUEs (Table 4.3.6 and Figure 4.3.4) from all available fleets show a general decline during the eighties and early nineties followed by some increases. From 2002 to 2005, LPUEs increased for all fleets. This general LPUE trend is consistent between fleets including the artisanal fleet. In 2010 and 2011, an important increase in the Cedeira LPUE was observed. After 2012, only subdivision 9a was tracked. The LPUE was quite noisy these years although it shows a decreasing trend in recent years (since 2019). Portuguese fleets showed a one-off increase in 2011. Then in 2017 and 2019, Portuguese trawl fleet targeting crustaceans showed the highest LPUE value of the time-series with 2 kg/hour.

4.2.3 Assessment

This is an update assessment in relation to the model assessment adopted in the 2018 WKANGLER benchmark (ICES, 2018). Last year's assessment (ICES, 2022) was updated with the inclusion of the 2022 data.

4.2.3.1 Input data

Input data used in the assessment are presented in the Stock Annex.

Due to the problems described in the previous section (see section 4.3.2.4 on commercial catch-effort data), the A Coruña-fleet and Cedeira-fleet abundance indices from 2013 to 2022 were not included in the assessment. Length composition of landings for the Spanish artisanal fleet in ICES Division 8.c (SPART8C) for the 1st and 4th quarters are the only length composition used as input data for the year 2020. In 2021 and 2022, the length composition of landings for both

Spanish commercial fleets and the length composition from the Spanish SpGFS-WIBTS-Q4 (G2784) survey were the only length composition used in the assessment.

4.2.3.2 Model

The Stock Synthesis (SS; Merthot Jr. et al., 2018) software was selected to be used in the assessment of this stock and has been implemented since 2012 (ICES, 2012). The description of the model including the structure, settings, and parameter assumptions are presented below:

- **Model used:** Stock Synthesis (SS) (Methot Jr, 2000; Methot Jr. and Wetzel, 2013).
- **Software used:** Stock Synthesis v3.30.10 (Methot Jr. *et al*., 2018).

Stock Synthesis is an integrated assessment model. SS has been used for stock assessment all around the world. The area of highest use is on the US Pacific Coast. SS is coded in C++ using an Auto-Differentiation Model Builder[1] and available at the NOAA Virtual Laboratory[2]. SS has three main characteristics that differentiate it from classical assessment models:

1. SS model structure allows for the building of simple to complex models depending upon the data available. Models can be built using age, length and/or both and spatial structure;
2. It is capable of integrating different sources of information;
3. All parameters have a set of controls to allow prior constraints, time-varying flexibility, and linkages to environmental data.

The overall SS model is subdivided into three submodels. The first submodel simulates the population dynamics, where the basic abundance, mortality and growth functions create a synthetic representation of the true population. The second submodel is the observation submodel. It contains the processes and filters designed to derive expected values for the various types of data. The last submodel is the statistical model that quantifies the magnitude of the difference between observed and expected data and employs an algorithm to find the set of parameters that maximizes the goodness-of-fit.

The SS model developed for the southern white anglerfish during the WKANGLER (ICES, 2018) has been designed for a particular set of data and specifications. This stock is harvested by four fleets, and two commercial LPUE series and one fishery-independent survey provide information about its relative abundance. No discards information is considered. Length composition data are available from both the fisheries and surveys. No age information is available for this stock.

Input data

Years: 1980–2022.

Model structure

- Temporal unit: quarterly-based data (landings, LPUE and length–frequency data; LFD) were used in SS calculations.
- Spatial structure: one area.
- Sex: both sexes combined.

Fleet definition

Four fleets were defined based on the gear type and country:

- Spanish trawlers in ICES divisions 8.c–9.a (SPTR8C9A);
- Spanish artisanal in ICES Division 8.c (SPART8C);

[1] http://www.admb-project.org
[2] https://vlab.ncep.noaa.gov/

- Portuguese trawlers in ICES Division 9.a (PTTR9A);
- Portuguese artisanal in ICES Division 9.a (PTART9A).

Landed catches

Quarterly landings are used as biomass (in weight) input in the model for the four fleets. Landings data for January 1980 to December 2022 were used to conduct the stock assessment.

From 1980 to 1988, quarterly landings were estimated using the average proportion for the years 1989–1993 by fleet. In the case of SPART8C, quarterly landings were estimated from 1980 to 1993 using the average proportion of the consecutive five years (1994–1998).

Abundance indices

- A Coruña trawlers (SPCORTR8C): Quarterly LPUEs in weight from 1982 to 2012. It is considered in the model as four separate indices, one index per quarter.
- Cedeira gillnetters (SPCEDGN8C): Quarterly LPUE in weight from 1999 to 2011. It is considered in the model as four separate indices, one index per quarter.
- Spanish Groundfish Survey (SPGFS): Abundance index in numbers from 1983 to 2022, except for 1987.

Length composition of data

The length bin was set by 2 cm, from 4 to 100 cm, by 10 cm from 100 to 160 cm and by 40 cm from 160 to 200 cm. Length composition for the four fishing fleets and the three abundance indices were used. The available length data and their disaggregated level differ among fleets:

Length composition of fleets

- SPTR8C9A: 1986–2022, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Super-Period approach available in SS.
- SPART8C: 1986–2022, quarterly basis. From 1986 to 1994 quarterly length proportions were estimated from an annual proportion using the Data Super-Period approach available in SS.
- PTTR9A: 1986–2009, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Super-Period approach presented in SS.
- PTART9A: 1986–2009, quarterly basis. From 1986 to 1988 quarterly length proportions were estimated from an annual proportion using the Data Super-Period approach present in SS.

Length composition of abundance indices

- SPCORTR8C: 1982–2012, quarterly basis, with gaps in each of the years 1982, 1984, 1985 and 1986.
- SPCEDGN8C: 1999–2011, quarterly basis.
- SPGFS: length composition for the 4^{th} quarter, from 1983–2022. The 1987 length composition is missing.

Model assumptions and parameters

Natural mortality: M = 0.2 for all ages and years.

Growth: von Bertalanffy function: K = 0.11 fixed, L_{max} and mean length-at-age of 0.75 are estimated.

Maturity ogive: length-based logistic, L_{50} = 61.84 and slope = −0.1001, constant over time.

Weight-at-length: a = 2.5×10−5; b = 2.853, not estimated.

Recruitment allocation in Quarter 3.

Stock–recruitment relationship: Beverton–Holt model: steepness h = 0.999, sigmaR = 0.4, R0 estimated.

Selectivity: For all fleets selectivity was only length-based and was modelled as a double normal function. Selectivity for fishery PTART9A was set to be flattop (asymptotic). Selectivity varies among fleets but is assumed to be time-invariant.

Sample size of length composition: The sample size of length composition of landings for the two Spanish fleets is set at 125, as only information with a good sampling level was included in the model. However, in 2022 the length composition of landings for the SPART8C Fleet seems to indicate a change in the selectivity to smaller sizes (Figure 4.3.5). Two different metiers, GNS_DEF_≥ 100_0_0 and GTR_DEF_60-79_0_0, with different selectivity are included in this fleet. In recent years, both gears are used in the same trip. Due to this, the *métier* is not well identified in the length sampling. Therefore, the fleet length composition aggregated was not properly representing the overall fleet catches and caused changes in the fishery selectivity estimates (Figure 4.3.6). For these reasons, it was decided to set the sample size in the year 2022 at 25 for the SPART8C Fleet.

4.2.3.3 Assessment results

The model diagnosis is carried out employing the residual analysis of the abundance indices. Residual plots of the fits to the abundance indices are shown in Figure 4.3.7. Although some minor trends have been detected, as was observed for A Coruña indices from 1996 to 2002, it can be considered that the model follows the abundance indices trends used in the model (A Coruña and Cedeira). For the SpGFS-WIBTS-Q4 survey (G2784), the model is overestimating the index from 2014 to 2022. Pearson residual plots are presented for the model fits to the length-composition data of the abundance indices (Figure 4.3.8). No specific pattern was detected in any of the abundance indices. However, some high positive residuals are evident for the SpGFS-WIBTS-Q4 survey (G2784) index. Nevertheless, the model fits reasonably well.

The model estimates size-based selectivity functions for commercial fleets (Figure 4.3.9) and abundance indices (Figure 4.3.10). All the selection patterns was assumed constant over time. The selection pattern for the Spanish trawl fleet is efficient for a wide range of lengths, from smaller to very large individuals. The Spanish artisanal fleet is most efficient at a narrow length range of large-sized fish, mainly from 75 to 90 cm. The Portuguese trawl fleet selection pattern indicates that this fishery is most efficient for individuals with size ranging between 30 and 60 cm. This selection pattern shows a strange selection pattern over larger fish, possibly due to insufficient length sampling. The Portuguese artisanal fleet has an asymptotic selection pattern, which is modelled to be asymptotic, that retains all fish measuring above 60 cm.

The selection patterns are equal for all quarters in A Coruña and Cedeira indices. For the A Coruña index, the selection pattern has a wide length range while Cedeira index shows more selectivity directed to larger individuals. The SpGFS-WIBTS-Q4 survey (G2784) index shows a well-defined selectivity for smaller individuals.

A variance-covariance matrix (Hessian calculation) was calculated to represent uncertainty in the spawning biomass and recruitment. The annual F summary reported in the standard SS output files (with both point estimate and standard deviation) does not correspond to the F summary used here (the average of lengths over 30 to 130 cm). The uncertainty of F could not be calculated from the variance-covariance matrix.

4.2.3.4 Historic trends in biomass, fishing mortality and recruitment

Table 4.3.7 and Figure 4.3.11 provide the summary of results from the assessment model and observed landings. Maximum values of recruitment are recorded at the beginning of the time-series (1982, 1986, 1987 and 1989) with values over 3 million individuals. Along the time-series, other high recruitment values were detected such as in 1994 and 2001. Since 2014, the recruitment has been below 1 million individuals except for the years 2019 and 2021. The abundance estimates of age-0 from 2015 to 2017 were very low, and are considered as the minimum values of the whole time-series. Landings steadily decreased from 3.8 kt in 2005 to 1.1 kt in 2011, coinciding with the decrease in F, from 0.380 in 2005 to 0.135 in 2011. Compared to 2021, landings and F decreased in 2022 by 6% and 17%, respectively. Since 2005, SSB was above 6 kt and it steadily increased to 11.3 kt, value estimated at the beginning of 2023.

The very low recruitment values estimated by the model for the years 2015 to 2018 have not been reflected in the SSB. In fact, the SSB has been stable or increasing slightly from 2015 to 2019. Taking into account that white anglerfish reaches its maturity at 62 cm, which corresponds approximately to 4 years, the potential impact of low recruitments on SSB will only be detected after 4 or 5 years. In 2023, the SSB values increased slightly relative to the previous year's estimates. However, the progressive decline in landings detected from 2017 to 2022 may reflect the low exploitation abundance of ages 2, 3 and 4 in the fishery. The moderate recruitment level observed in 2019 and 2021 could be related to the increase of smaller individuals detected in the length composition of landings in 2021 and 2022, and the decrease of the mean length of landings from 77 cm in 2018 to 58 cm in 2022.

4.2.3.5 Retrospective pattern for SSB, fishing mortality, yield and recruitment

In order to assess the consistency of the assessment from year to year, a retrospective analysis was carried out. It was conducted by removing one year (2022), two years (2022 and 2021), three years (2022–2020), four years (2022–2019) and five years (2022–2018) of data while using the same model configuration (Figure 4.3.12). All the retrospective analysis runs was similar to the recruitment estimates. Although there are some uncertainties in recent recruitment estimates, no consistent bias was observed. Retrospective analysis showed an overestimation of the SSB in the final years and an underestimation of F. Nevertheless, there was no strong retrospective pattern observed and the assessment was accepted for projections. The Mohn's rho index (Mohn, 1999) for the last five years was estimated for recruitment (0.19), F (–0.10) and SSB (0.15).

4.2.4 Catch options and prognosis

4.2.4.1 Short-term projections

This year's projections were performed on the basis of the present assessment.

For fishing mortality, the F *status quo* (F_{sq}) is equal to 0.081, estimated as the average of $F_{2020\text{-},2022}$ over lengths 30–130 cm, was used for the intermediate year (2023). Although there is a decreasing trend in F, it was decided not to scale the F_{sq} to the final year because of the uncertainty of SSB estimates. Unscaled F_{sq} was considered more precautionary as a higher value of F is closer to F_{MSY}.

The recruitment used for projections in this WG is the geometric mean (GM) calculated from 2003 to the final assessment year (2022), following the option indicated in the Stock Annex when a trend in the time-series was detected. Recruitment short-term projection assumption value is given in Table 4.3.8. Projected landings for 2024 and SSB at the beginning of 2025 for different management options in 2024 are presented in Table 4.3.8. Under F_{sq} scenario in 2024, a 13% increase in landings with respect to 2023 as well as an 8% of increase in SSB in 2025 with respect to 2024 are expected.

4.2.4.2 Yield and biomass per recruit analyses

The summary table of Yield- and SSB-per-recruit analyses is given in the table below:

	SPR level	Fmult	F(30-130cm)	YPR(land)	SSB/R
Fmax	0.14	3.13	0.255	1.92	6.80
F0.1	0.26	2.02	0.165	1.82	12.45
F40%	0.40	1.33	0.108	1.58	19.00
F35%	0.35	1.54	0.125	1.67	16.64
F30%	0.30	1.79	0.146	1.76	14.27

The F that maximizes the yield-per-recruit, F_{max}, is estimated at 0.255 which is well above F_{sq} (0.068) and which corresponds to a SPR level of 14%. The $F_{0.1}$, rate of F at which the slope of the YPR curve falls to 10% of its value of origin is equal to 0.165 and it corresponds to a SPR level of 26%. Fishing mortalities at $F_{30\%}$, $_{35\%}$ and $_{40\%}$ were estimated at 0.146, 0.125 and 0.108, respectively. The F_{sq} is below F_{max}, $F_{0.1}$, $F_{30\%}$, $F_{35\%}$ and $F_{40\%}$.

4.2.5 Biological reference points of stock biomass and yield

Biological reference points for the southern white anglerfish stock were calculated in WKANGLER (ICES, 2018). In 2021, WGBIE followed the ACOM guidelines (ICES, 2020) where the value of F_{pa} was revised according to the new definition "$F_{p0.5}$, the F that leads to SSB ≥ B_{lim} with 95% probability" (calculated with $B_{trigger}$). Since the new F_{pa} value was higher than the F_{lim}, the F_{lim} value was discarded and has not been defined yet (ICES, 2021b). The reference points in use for the stock are presented in the following table:

Framework	Reference points	Value	Rational
Precautionary approach	B_{lim}	1993 t	B_{loss}
	B_{pa}	2769 t	B_{lim}*exp (1.645*0.2).
	F_{lim}	not defined	
	F_{pa}	0.87	$F_{p0.5}$; the F that leads to SSB ≥ B_{lim} with 95% probability, calculated using $B_{trigger}$.
MSY approach	F_{MSY}	0.24	Stochastic simulation, F maximizes median equilibrium yield.
	$F_{MSY-lower}$	0.164	Stochastic simulations, 5% reduction in long-term yield compared with MSY.
	$F_{MSY-upper}$	0.33	
	MSY $B_{trigger}$	6283 t	5th percentile of SSB when fishing at F_{MSY}.

4.2.6 Comments on the assessment

The spawning-stock biomass (SSB) values increased from 2007 to 2019, decreased in 2020 and 2021, then increased again in 2022 and 2023. SSB in 2023 is estimated at 11.3 kt which is well above B_{pa} (2 769 t) and MSY $B_{trigger}$ (6 283 t). SSB have been corrected downwards every year as showed by the retrospective plot (Figure 4.3.12). F in 2022 has decreased by 17% relative to 2021. F in 2022 is estimated to be at a value of 0.068, below F_{pa} (0.87) and F_{MSY} (0.24). An increase in landings occurred from 1.1 kt in 2011 to 2.0 kt in 2014 but declined to 0.6 kt in 2022. For the period 2015–2018, recruitments were extremely low, being the main concern about the status of the stock. In 2019 and 2021, the estimated recruitment values indicate a moderate increase in the abundance of age-0 individuals.

Since 2017, the catches for the two *Lophius* species in 8c and 9a are considerably lower than the agreed combined TAC for *Lophius* spp. for the same area. Although the combined TAC has been increasing in line with the ICES advice, landings of the two species have been decreasing. The reasons for this mismatch are not totally understood. The partial fishing effort information available until 2020 indicates that effort has decreased for some fleets (Figure 4.3.4). In the case of white anglerfish, the information from the Northern Spanish Shelf Groundfish Survey (SpGFS-WIBTS-Q4, G2784) is representative of small individuals (< 40 cm) revealing a very low levels of recruitment for the period 2015-2018 (Figure 4.3.2). On the other hand, the series of abundance indices for commercial sizes ended in 2012 and no other fishery-dependent information is available. Although the assessment model results are indicating high levels of SSB since 2015 (Table 4.3.7), the low catches represent an opposite perception of the stock size. The dynamics of the Spanish fleets targeting anglerfishes (trawlers and gillnetters) could have changed to catching other species in recent years. Thus, reducing the fishing effort towards the anglerfish species and, consequently, reducing their catches.

4.2.7 Quality considerations

The available unallocated and non-reported landing information for the period 2011–2019 are included in the stock assessment since the estimates were considered as realistic information. Uncertainty of the assessment model may have increased due to the absence of commercial abundance indices since 2012. For the last 11 years, the model lacks an abundance indicator for larger individuals which might have an effect on the F and SSB calculations for larger individuals.

4.2.8 Management considerations

Management considerations for both southern anglerfish stocks are included in section 4.2.

4.2.9 Recommendations for next benchmark

Given the uncertain results, WGBIE recommends for this stock to go to a benchmark as soon as possible. Intersessional works should be made and results presented on next WGBIE to evaluate progress to support the benchmark recommendation and, at the same time, improve the quality of the current assessment model for next year's advice. During the WKTADSA (ICES, 2021c), a number of issues to improve the current assessment model of the stock (mon.27.8.c9.a) was identified. The following tasks are proposed for the next benchmark:

- Simplify the current model by changing the structure from a quarter to an annual time-step.
- Reduce the number of fishing fleets included in the model. The four fleets defined in the current model could be reduced to 2 fleets: Gillnet Fleet and Trawler Fleet.
- Explore the selectivity pattern of the fleets. Although Stock Synthesis experts indicated that there are reasons against and for selecting a specific selectivity pattern, but disagreements occur with regards to the rule that should be considered such as "at least one fleet-selectivity must be asymptotic". A specific residual analysis should be carried out to identify the potential impact of the different selectivity patterns on F and SSB estimates.
- Use an age-variant natural mortality (M). The differential sex growth (females reach larger sizes than males) should also be taken into account to define an M for older ages.

- Inclusion of a standardized abundance index for larger individuals by considering the potential of using a standardized commercial abundance index from the Spanish gillnet fleet targeting anglerfish.
- The model-based estimates of effective sample size should be updated every year using the Dirichlet-Multinomial method.
- Create a protocol for model diagnostics to ease model development and selection using the functions included in the R library *ss3diags* (Winker *et al*., 2021).

4.2.10 References

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4.3 Tables and figures

Table 4.3.1. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Landings (in tonnes) by the main fishing fleets from 1978–2022 as estimated by the WGBIE.

	Div. 8c						Div. 9a						Div. 8c+9a		Div. 8c+9a
	SPAIN			FRANCE			SPAIN			PORTUGAL					
Year	Trawl	Gillnet	Others	Trawl	Gillnet	TOTAL	Trawl	Gillnet	Others	Trawl	Artisanal	TOTAL	SUBTOTAL	Unallocated / Non-reported	TOTAL
1978	n/a	n/a				n/a	258				115	373			
1979	n/a	n/a				n/a	319				225	544			
1980	2 806	1 270				4 076	401				339	740	4 816	0	4 816
1981	2 750	1 931				4 681	535				352	887	5 568	0	5 568
1982	1 915	2 682				4 597	875				310	1 185	5 782	0	5 782
1983	3 205	1 723				4 928	726				460	1 186	6 114	0	6 114
1984	3 086	1 690				4 776	578			186	492	1 256	6 032	0	6 032
1985	2 313	2 372				4 685	540			212	702	1 454	6 139	0	6 139
1986	2 499	2 624				5 123	670			167	910	1 747	6 870	0	6 870
1987	2 080	1 683				3 763	320			194	864	1 378	5 141	0	5 141
1988	2 525	2 253				4 778	570			157	817	1 543	6 321	0	6 321
1989	1 643	2 147				3 790	347			259	600	1 206	4 996	0	4 996
1990	1 439	985				2 424	435			326	606	1 366	3 790	0	3 790
1991	1 490	778				2 268	319			224	829	1 372	3 640	0	3 640
1992	1 217	1 011				2 228	301			76	778	1 154	3 382	0	3 382
1993	844	666				1 510	72			111	636	819	2 329	0	2 329
1994	690	827				1 517	154			70	266	490	2 007	0	2 007
1995	830	572				1 403	199			66	166	431	1 834	0	1 834
1996	1 306	745				2 050	407			133	365	905	2 955	0	2 955
1997	1 449	1 191				2 640	315			110	650	1 075	3 714	0	3 714
1998	912	1 359				2 271	184			28	497	710	2 981	0	2 981
1999	545	1 013				1 558	79			9	285	374	1 932	0	1 932
2000	269	538				808	107			4	340	451	1 259	0	1 259
2001	231	294				525	57			16	190	263	788	0	788
2002	385	341		51	7	784	110			29	168	307	1 090	0	1 090
2003	911	722		46	0	1 679	312			29	305	645	2 324	0	2 324
2004	1 262	1 269		73	27	2 631	264			27	335	626	3 257	0	3 257
2005	1 378	1 622		134	46	3 180	371			29	244	643	3 824	0	3 824
2006	1 166	1 247		60	5	2 478	260			29	230	519	2 997	0	2 997
2007	955	1 009		22	6	1 992	181			13	192	386	2 378	0	2 378
2008	894	1 168		26	8	2 096	138			11	127	275	2 371	0	2 371
2009	850	1 058		17	9	1 935	213			10	148	371	2 306	0	2 306
2010	370	955		12	2	1 339	158			2	119	279	1 618	0	1 618
2011	243	483	73	15	2	816	59	28	48	46	80	260	1 077	80	1 157
2012	271	527	67	12	2	880	54	20	42	6	163	285	1 165	230	1 395
2013	274	718	38	19	6	1 054	47	30	50	15	154	296	1 350	190	1 541
2014	358	947	28	25	9	1 368	91	47	4	27	122	291	1 659	374	2 032
2015	324	802		11	12	1 149	86	53	2	34	200	375	1 524	244	1 767
2016	376	846	3	10	8	1 243	76	67	1	8	120	273	1 516	294	1 809
2017	248	726	1	3	8	986	106	66	1	30	138	341	1 327	119	1 446
2018	227	614	34	5	6	886	117	35	1	6	94	253	1 139	4	1 144
2019	161	435	0	0	0	597	74	33	1	22	104	233	830	78	909
2020	175	256	1	8	3	443	84	40	2	28	125	279	722	0	722
2021	178	233	1	3	0	415	88	7	2	16	80	193	608	0	608
2022	221	197	1	0	0	419	67	7	1	19	61	154	574	0	574

n/a: not available

Table 4.3.2. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Weights and proportions of unwanted catches for Spanish fleets.

Discards Recorded in Logbooks		Gillnet
Year	Weight (t)	Weight (t)
2019	0	0
2020	0	0
2021	0	0
2022	0	0

Landings BelowMinimumSize		Gillnet
Year	Weight (t)	Weight (t)
2018	0.027	0.111
2019	0	0
2020*	0.001	0
2021	0	0
2022	0	0

Discards Estimates: Trawl

Year	Weight (t)	CV	% Trawl Catches	% Total Catches
1994	20.9	34.05	2.2	1.0
1995	n/a	n/a	n/a	n/a
1996	n/a	"	n/a	n/a
1997	5.4	68.13	0.3	0.1
1998	n/a	n/a	n/a	n/a
1999	0.7	"	0.1	0.0
2000	6.2	"	1.6	0.5
2001	n/a	"	n/a	n/a
2002	n/a	"	n/a	n/a
2003	26.2	"	2.0	1.1
2004	64.9	"	3.8	2.0
2005	56.2	"	2.9	1.4
2006	99.3	"	6.2	3.2
2007	17.2	"	1.4	0.7
2008	5.1	"	0.5	0.2
2009	24.5	"	2.2	1.1
2010	12.5	"	2.3	0.8
2011	30.1	"	7.7	2.5
2012	66.7	"	16.3	4.6
2013	65.8	"	15.7	3.8
2014	24.4	"	4.6	1.2
2015	20.8	"	4.4	1.2
2016	0.03	"	0.0	0.0
2017	13.3	"	3.3	0.9
2018	4.1	"	1.2	0.4
2019	1.9	"	0.7	0.2
2020*	2.2	"	0.7	0.3
2021	13.1	"	4.4	2.1
2022	5.9	"	1.9	1.0

Discards Estimates: Gillnet

Year	Weight (t)	% Gillnet Catches	% Total Catches
2013	143.8	13.7	8.2
2014	0.0	0.0	0.0
2015	7.6	0.7	0.4
2016	24.2	2.3	1.3
2017	17.0	1.8	1.2
2018	1.8	0.2	0.2
2019	16.7	2.8	1.8
2020*	3.8	0.9	0.5
2021	0.0	0.0	0.0
2022	n/a	n/a	n/a

n/a: not available

CV: coefficient of variation

* only for 3rd and 4th quarter

Table 4.3.3. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Length composition by fleet and adjusted length composition for total landings (in thousands) in 2022. Adjusted total: adjusted landings including fleets without length composition.

	Div. 8c			Div. 9a				Div. 8c+9a	
	SPAIN			SPAIN	PORTUGAL				
Length (cm)	Trawl	Gillnet	TOTAL	Trawl	Trawl	Artisanal	TOTAL	TOTAL	Ajusted TOTAL
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.05	0.00	0.00	0.06	0.06	0.06
23	0.00	0.00	0.00	0.07	0.00	0.00	0.07	0.07	0.07
24	0.00	0.00	0.00	0.05	0.00	0.00	0.06	0.06	0.06
25	0.00	0.00	0.00	0.05	0.00	0.00	0.06	0.06	0.06
26	0.00	0.00	0.00	0.12	0.02	0.00	0.14	0.14	0.14
27	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.04
28	0.00	0.00	0.00	0.11	0.02	0.00	0.13	0.13	0.13
29	0.18	0.00	0.18	0.20	0.01	0.00	0.21	0.39	0.40
30	0.79	0.00	0.79	0.26	0.02	0.00	0.28	1.06	1.07
31	1.05	0.00	1.05	0.29	0.02	0.00	0.31	1.36	1.37
32	1.51	0.00	1.51	0.53	0.06	0.00	0.59	2.10	2.11
33	2.31	0.00	2.31	0.40	0.07	0.00	0.47	2.78	2.80
34	2.67	0.00	2.67	0.57	0.08	0.01	0.67	3.34	3.37
35	2.90	0.13	3.03	0.45	0.04	0.01	0.50	3.53	3.56
36	2.69	0.05	2.74	0.49	0.08	0.12	0.68	3.43	3.45
37	1.95	0.10	2.05	0.29	0.17	0.09	0.56	2.61	2.63
38	3.39	0.31	3.70	0.80	0.35	0.08	1.22	4.92	4.95
39	2.20	0.12	2.32	0.35	0.11	0.14	0.60	2.92	2.93
40	2.18	1.05	3.23	0.67	0.77	0.16	1.60	4.84	4.90
41	2.18	0.17	2.35	0.19	0.16	0.10	0.45	2.80	2.81
42	1.99	0.98	2.97	0.40	0.14	0.23	0.77	3.74	3.80
43	1.41	0.42	1.84	0.26	0.08	0.19	0.52	2.36	2.39
44	1.73	0.88	2.61	0.72	0.16	0.28	1.16	3.77	3.82
45	1.79	1.27	3.06	0.30	0.37	0.32	1.00	4.06	4.14
46	1.43	0.65	2.08	0.33	0.04	0.19	0.56	2.64	2.67
47	0.96	1.29	2.24	0.52	0.20	0.29	1.00	3.25	3.31
48	1.35	1.60	2.96	0.15	0.12	0.09	0.35	3.31	3.39
49	1.13	0.90	2.03	0.19	0.15	0.22	0.57	2.60	2.64
50	1.21	0.98	2.19	0.65	0.30	0.20	1.16	3.34	3.39
51	1.30	1.66	2.96	0.15	0.12	0.18	0.45	3.41	3.50
52	1.23	2.01	3.25	0.55	0.10	0.08	0.73	3.98	4.08
53	1.21	2.15	3.36	0.35	0.07	0.10	0.52	3.88	3.99
54	1.73	1.78	3.51	0.33	0.11	0.12	0.56	4.06	4.16
55	1.28	2.37	3.65	0.37	0.15	0.08	0.59	4.24	4.36
56	1.29	1.01	2.30	0.16	0.17	0.17	0.51	2.80	2.85
57	1.65	0.58	2.23	0.72	0.20	0.11	1.03	3.26	3.30
58	0.90	1.53	2.43	0.45	0.07	0.08	0.60	3.03	3.10
59	1.38	0.42	1.80	0.25	0.02	0.07	0.35	2.15	2.18
60	0.97	0.87	1.84	0.12	0.03	0.11	0.27	2.11	2.15
61	1.12	0.74	1.86	0.15	0.04	0.16	0.35	2.20	2.24
62	1.20	0.73	1.93	0.30	0.02	0.21	0.54	2.46	2.51
63	0.94	0.27	1.20	0.07	0.01	0.00	0.08	1.28	1.30
64	0.92	0.60	1.52	0.27	0.05	0.00	0.32	1.85	1.88
65	0.57	0.61	1.18	0.22	0.01	0.11	0.33	1.51	1.54
66	1.03	0.83	1.86	0.12	0.02	0.00	0.13	2.00	2.04
67	0.98	0.64	1.61	0.21	0.02	0.00	0.24	1.85	1.88
68	0.91	0.91	1.82	0.16	0.00	0.00	0.16	1.98	2.02
69	1.02	0.59	1.61	0.20	0.02	0.00	0.22	1.83	1.86
70	0.95	0.55	1.49	0.00	0.00	0.08	0.08	1.58	1.59
71	0.83	0.37	1.20	0.08	0.12	0.06	0.26	1.46	1.48
72	0.83	0.76	1.59	0.54	0.09	0.00	0.63	2.22	2.26
73	0.55	0.61	1.16	0.22	0.02	0.10	0.34	1.50	1.53
74	0.78	0.69	1.47	0.05	0.00	0.00	0.05	1.52	1.54
75	0.43	1.12	1.55	0.15	0.00	0.16	0.31	1.87	1.90
76	0.64	0.22	0.86	0.06	0.01	0.00	0.07	0.93	0.94
77	0.62	0.42	1.05	0.09	0.00	0.00	0.09	1.14	1.16
78	0.63	0.65	1.28	0.05	0.00	0.02	0.07	1.35	1.38
79	0.38	0.61	0.99	0.20	0.05	0.00	0.25	1.24	1.26
80	0.30	0.56	0.86	0.05	0.00	0.10	0.15	1.01	1.03
81	0.70	0.36	1.05	0.07	0.01	0.06	0.14	1.20	1.21
82	0.28	0.58	0.86	0.14	0.02	0.00	0.16	1.02	1.05
83	0.17	0.35	0.52	0.18	0.00	0.02	0.19	0.72	0.73
84	0.73	0.15	0.89	0.11	0.00	0.00	0.11	1.00	1.01
85	0.47	0.52	0.99	0.07	0.02	0.00	0.08	1.07	1.09
86	0.06	0.46	0.52	0.13	0.00	0.06	0.20	0.72	0.73
87	0.33	0.64	0.97	0.04	0.00	0.07	0.11	1.08	1.10
88	0.34	0.07	0.41	0.00	0.04	0.01	0.05	0.46	0.46
89	0.54	0.27	0.81	0.16	0.13	0.00	0.29	1.10	1.11
90	0.07	0.21	0.29	0.15	0.01	0.00	0.16	0.45	0.45
91	0.21	0.26	0.47	0.28	0.03	0.10	0.40	0.87	0.89
92	0.41	0.30	0.71	0.00	0.00	0.06	0.06	0.77	0.78
93	0.25	0.17	0.42	0.05	0.00	0.02	0.06	0.49	0.50
94	0.24	0.27	0.51	0.00	0.00	0.01	0.01	0.52	0.53
95	0.04	0.04	0.09	0.10	0.04	0.00	0.14	0.22	0.23
96	0.32	0.09	0.40	0.00	0.00	0.08	0.08	0.49	0.49
97	0.17	0.23	0.39	0.03	0.01	0.06	0.10	0.50	0.51
98	0.35	0.22	0.57	0.05	0.00	0.02	0.08	0.64	0.65
99	0.17	0.28	0.46	0.41	0.19	0.00	0.60	1.06	1.08
100+	1.51	2.35	3.87	0.80	0.22	1.56	2.58	6.45	6.54
TOTAL	75.0	45.6	120.6	18.9	5.8	7.0	31.7	152.2	154.6
Tonnes	220.9	197.3	418.1	67.3	18.7	60.7	146.7	564.9	573.7
Mean Weight (g)	2945	4329	3468	3566	3239	8681	4636	3711	3711
Mean length (cm)	54.0	63.9	57.8	56.1	54.2	72.4	59.4	58.1	58.1

Table 4.3.4. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Numbers, mean weights and lengths of landings between 1986 and 2022.

Year	Total (thousands)	Mean Weight (g)	Mean Length (cm)
1986	1 872	3 670	61
1987	2 806	1 832	44
1988	2 853	2 216	50
1989	1 821	2 744	54
1990	1 677	2 261	49
1991	1 657	2 197	50
1992	1 256	2 692	54
1993	857	2 719	54
1994	704	2 850	54
1995	876	2 093	48
1996	1 153	2 564	52
1997	1 043	3 560	60
1998	583	5 113	68
1999	290	6 674	71
2000	190	6 885	72
2001	127	6 189	64
2002	381	2 766	50
2003	784	2 907	54
2004	809	3 456	61
2005	856	4 259	63
2006	923	3 211	58
2007	553	4 251	62
2008	540	4 327	63
2009	492	4 630	64
2010	288	5 569	71
2011	249	4 252	62
2012	244	4 711	65
2013	269	4 929	66
2014	289	5 630	70
2015	307	4 902	66
2016	327	5 485	69
2017	233	6 205	73
2018	161	7 163	77
2019	139	6 519	73
2020	na	na	na
2021	135	4 500	64
2022	155	3 711	58

na: not available

Table 4.3.5 White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Abundance indices from Spanish and Portuguese surveys.

	SP-NORTH-Q4 (G2784) September-October (total area Miño-Bidasoa)					PT-IBTS-Q4 (G8899) October				
Year	Hauls	kg/30 min		nº/30 min		Hauls	kg/60 min		nº/60 min	
		Yst	se	Yst	se		Yst	se	Yst	se
1983	145	2.03	0.29	3.50	0.46	117	n/a		n/a	
1984	111	2.60	0.47	2.90	0.55	na	n/a		n/a	
1985	97	1.33	0.36	1.90	0.26	150	n/a		n/a	
1986	92	4.28	0.80	10.70	1.40	117	n/a		n/a	
1987	ns	ns	ns	ns	ns	81	n/a		n/a	
1988	101	3.33	0.70	1.50	0.25	98	n/a		n/a	
1989	91	0.44	0.08	2.40	0.30	138	0.09		0.07	
1990	120	1.19	0.22	1.20	0.22	123	0.46		0.05	
1991	107	0.71	0.22	0.50	0.09	99	+		+	
1992	116	0.76	0.15	1.18	0.16	59	0.09		0.01	
1993	109	0.88	0.16	1.20	0.14	65	0.08		0.01	
1994	118	1.66	0.62	3.70	0.49	94	+		0.02	
1995	116	2.19	0.32	5.70	0.69	88	0.05		0.03	
1996*	114	1.54	0.26	1.40	0.16	71	0.27		0.18	
1997	116	1.69	0.39	0.67	0.11	58	0.49		0.03	
1998	114	1.40	0.37	0.39	0.08	96	+		+	
1999*	116	0.75	0.23	0.36	0.06	79	+		+	
2000	113	0.57	0.19	0.88	0.18	78	+		+	
2001	113	1.09	0.24	2.88	0.28	58	+		+	
2002	110	1.34	0.21	2.76	0.29	67	0.06		0.04	
2003*	112	1.67	0.40	1.41	0.16	80	0.29		0.15	
2004*	114	2.09	0.32	2.71	0.32	79	0.16		0.12	
2005	116	3.05	0.54	2.04	0.19	87	0.12		0.04	
2006	115	1.88	0.40	2.86	0.30	88	+		+	
2007	117	1.65	0.25	2.56	0.25	96	+		+	
2008	115	1.85	0.37	1.96	0.35	87	+		+	
2009	117	1.07	0.17	1.91	0.17	93	+		+	
2010	114	1.29	0.25	1.95	0.28	87	+		+	
2011	114	0.77	0.16	1.09	0.18	86	+		+	
2012	115	1.11	0.27	1.06	0.14	ns	ns		ns	
2013**	114	2.09	0.64	2.30	0.30	93	0.34		0.02	
2014**	116	1.56	0.36	1.24	0.17	81	0.00		0.00	
2015**	114	1.14	0.25	0.58	0.10	90	0.00		0.00	
2016**	114	0.76	0.28	0.30	0.06	85	0.00		0.00	
2017**	112	0.53	0.30	0.18	0.07	89	0.00		0.00	
2018**	113	0.64	0.25	0.13	0.03	53	0.00		0.00	
2019**	113	0.53	0.21	0.31	0.07	n/a	n/a		n/a	
2020**	109	0.73	0.22	0.37	0.07	n/a	n/a		n/a	
2021***	113	0.90	0.23	0.78	0.11	93	0.002		0.0215	
2022****	114	1.53	0.33	0.88	0.10	61	0.00		0.00	

Yst = stratified mean
se = standard error
ns = no survey
n/a = not available
+ = less than 0.01
* For Portuguese Surveys - R/V Capricornio, other years R/V Noruega
** For Spanish Surveys - R/V Miguel Oliver, other years R/V Coornide de Saavedra
*** For Spanish Surveys - R/V Miguel Oliver and R/V Vizconde de Eza
**** For Spanish Survey - R/V Miguel Oliver and Portugal R/V Mário Ruivo

Table 4.3.6. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Landings (in thousands), fishing effort and LPUEs for trawl and gillnet fleets. For the landings, the proportion relative to the total annual stock landings is given.

	SP-AVITR8C				SP-SANTR8C				STAND-SP-CEDGNS8C			
Year	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (soaking days)	LPUE (kg/soaking day)
1986	500	7	10 845	46.1	516	8	18 153	28.4				
1987	500	10	8 309	60.2	529	10	14 995	35.3				
1988	401	6	9 047	44.3	387	6	16 660	23.3				
1989	214	4	8 063	26.5	305	6	17 607	17.3				
1990	260	7	8 497	30.6	278	7	20 469	13.6				
1991	245	7	7 681	31.9	281	8	22 391	12.6				
1992	198	6	--	--	222	7	22 833	9.7				
1993	76	3	7 635	9.9	186	8	21 370	8.7				
1994	116	6	9 620	12.0	188	9	22 772	8.2				
1995	192	10	6 146	31.2	186	10	14 046	13.2				
1996	322	11	4 525	71.1	270	9	12 071	22.4				
1997	345	9	5 061	68.1	381	10	11 776	32.3				
1998	286	10	5 929	48.3	316	11	10 646	29.7				
1999	108	6	6 829	15.8	182	9	10 349	17.6	342	18	4 582	74.5
2000	28	2	4 453	6.3	75	6	8 779	8.6	140	11	2 981	46.8
2001	23	3	1 838	12.5	54	7	3 053	17.6	87	11	1 932	44.8
2002	75	7	2 748	27.5	57	6	3 975	14.3	130	13	2 398	54.3
2003	111	5	2 526	44.0	85	4	3 837	22.1	159	7	2 703	59.0
2004	216	7	--	--	106	3	3 776	28.1	382	12	4 677	81.6
2005	278	8	--	--	59	2	1 404	41.9	434	12	3 325	130.4
2006	148	5	--	--	89	3	2 718	32.7	415	14	3 911	106.2
2007	101	4	--	--	103	4	4 334	23.8	233	10	3 976	58.6
2008	99	4	--	--	--	--	--	--	228	10	5 133	44.3
2009	69	3	--	--	35	2	1 125	31.3	183	8	2 300	79.5
2010	--	--	--	--	44	3	1 628	27.1	231	15	1 880	122.7
2011	--	--	--	--	44	4	--	--	60	6	522	115.9
2012	--	--	--	--	22	2	--	--	63	5	--	--

	SP-CORTR8C-PORT				SP-CORTR8C-TRUCKS				SP-CORTR8C-FLEET			
Year	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)
1982	1618	28	63 313	26					1618	28	63 313	25.6
1983	1490	24	51 008	29					1490	24	51 008	29.2
1984	1560	26	48 665	32					1560	26	48 665	32.1
1985	1134	18	45 157	25					1134	18	45 157	25.1
1986	825	12	40 420	20					825	12	40 420	20.4
1987	618	12	34 651	18					618	12	34 651	17.8
1988	656	10	41 481	16					656	10	41 481	15.8
1989	508	10	44 410	11					508	10	44 410	11.4
1990	550	15	44 403	12					550	15	44 403	12.4
1991	491	13	40 429	12					491	13	40 429	12.1
1992	432	13	38 899	11					432	13	38 899	11.1
1993	385	17	44 478	9					385	17	44 478	8.7
1994	245	12	39 602	6	63	3	12 795	5	309	15	52 397	5.9
1995	260	14	41 476	6	57	3	10 232	6	316	17	51 708	6.1
1996	413	14	35 709	12	83	3	8 791	9	496	17	44 501	11.2
1997	411	11	35 494	12	59	2	9 108	6	470	13	44 602	10.5
1998	138	5	29 508	5	30	1	--	--	168	6	--	--
1999	168	9	30 131	6	--	--	--	--	--	--	--	--
2000	85	7	30 079	3	2	0	--	--	88	7	--	--
2001	84	11	29 935	3	--	--	--	--	--	--	--	--
2002	130	12	21 948	6	61	6	6 747	9	191	18	28 695	6.7
2003	228	10	18 519	12	115	5	7 608	15	342	15	26 127	13.1
2004	277	9	19 198	14	162	5	10 342	16	439	13	29 540	14.9
2005	391	10	20 663	19	248	6	10 302	24	639	17	30 965	20.6
2006	242	8	19 264	13	273	9	12 866	21	515	17	32 130	16.0
2007	222	9	21 651	10	233	10	13 187	18	455	19	34 838	13.1
2008	274	12	20 212	14	153	6	9 812	16	428	18	30 024	14.2
2009	165	7	16 152	10	152	7	12 930	12	317	14	29 092	10.9
2010	129	8	16 680	8	70	4	9 003	8	165	10	22 746	7.3
2011	92	8	12 835	7	--	--	--	--	146	13	18 617	7.9
2012	132	9	14 446	9	--	--	--	--	142	10	21 110	6.7
2013	122	8	14 736	8	--	--	--	--	--	--	--	--
2014	114	6	18 060	6	--	--	--	--	--	--	--	--
2015	88	5	13 309	7	--	--	--	--	--	--	--	--
2016	138	8	13 718	10	--	--	--	--	--	--	--	--
2017	76	5	12 449	6	--	--	--	--	--	--	--	--
2018	95	8	13 247	7	--	--	--	--	--	--	--	--
2019	42	5	12 824	3	--	--	--	--	--	--	--	--
2020	--	--	--	--	--	--	--	--	--	--	--	--
2021	56	9	13 498	4	--	--	--	--	--	--	--	--
2022	49	8	13 478	4	--	--	--	--	--	--	--	--

	PT-CRUST						PT-FISH					
Year	LANDINGS	%	EFFORT (1000 hours)	EFFORT (1000 hauls)	LPUE (kg/hour)	LPUE (kg/haul)	LANDINGS	%	EFFORT (1000 hours)	EFFORT (1000 hauls)	LPUE (kg/hour)	LPUE (kg/haul)
1989	85	2	76	23	1.1	3.7	175	3	52	18	3.3	9.9
1990	106	3	90	20	1.2	5.2	219	6	61	17	3.6	12.8
1991	73	2	83	17	0.9	4.4	151	4	57	15	2.6	9.8
1992	25	1	71	15	0.3	1.6	51	2	49	14	1.0	3.7
1993	36	2	75	13	0.5	2.7	75	3	56	13	1.3	5.7
1994	23	1	41	8	0.6	3.0	47	2	36	10	1.3	4.9
1995	22	1	38	8	0.6	2.8	45	2	41	9	1.1	4.9
1996	45	2	64	14	0.7	3.1	88	3	54	12	1.6	7.1
1997	51	1	43	11	1.2	4.5	59	2	27	9	2.2	6.7
1998	11	<1	48	11	0.2	1.0	17	1	35	10	0.5	1.8
1999	3	<1	24	8	0.1	0.4	6	<1	18	6	0.3	1.0
2000	2	<1	42	10	0.0	0.2	2	<1	19	6	0.1	0.4
2001	9	1	85	18	0.1	0.5	7	1	19	5	0.4	1.4
2002	18	2	62	10	0.3	1.9	11	1	14	4	0.8	2.4
2003	13	1	42	10	0.3	1.3	16	1	17	6	0.9	2.8
2004	12	<1	21	7	0.6	1.9	14	<1	14	4	1.0	3.3
2005	12	<1	20	5	0.6	2.2	17	<1	13	4	1.3	4.7
2006	13	<1	22	5	0.6	2.4	16	1	12	4	1.3	4.2
2007	7	<1	22	6	0.3	1.1	6	<1	8	3	0.8	2.1
2008	6	<1	14	4	0.4	1.5	5	<1	5	2	1.0	2.9
2009	5	<1	15	--	0.3	--	5	<1	6	--	0.8	--
2010	1	<1	21	--	0.0	--	1	<1	14	--	0.1	--
2011	24	2	18	--	1.3	--	22	2	9	--	2.4	--
2012	3	<1	36	--	0.1	--	3	<1	16	--	0.2	--
2013	8	<1	27	--	0.3	--	7	<1	12	--	0.6	--
2014	16	1	32	--	0.5	--	13	1	16	--	0.8	--
2015	18	1	17	--	1.1	--	16	1	14	--	1.2	--
2016	4	<1	12	--	0.3	--	4	<1	11	--	0.3	--
2017	16	1	8	--	2.0	--	15	1	11	--	1.3	--
2018	3	<1	5	--	0.6	--	3	<1	6	--	0.4	--
2019	12	1	6	--	1.9	--	11	1	5	--	2.0	--
2020	15	2	13	--	0.6	--	14	2	7	--	0.9	--
2021	8	1	11	--	0.4	--	7	1	8	--	0.4	--
2022	12	2	11	--	0.7	--	7	1	11	--	0.2	--

Table 4.3.7. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Summary of the assessment results.

	Recruit Age0 (thousands)	Total Biomass (t)	Total SSB (t)	Landings (t)	Yield/SSB	F (30-130 cm)
1980	671	15 440	9 760	4 817	0.49	0.30
1981	1 918	16 488	11 341	5 566	0.49	0.33
1982	7 353	15 556	11 893	5 782	0.49	0.38
1983	1 968	14 348	10 639	6 113	0.58	0.49
1984	767	14 050	8 821	6 031	0.68	0.51
1985	1 811	13 061	8 449	6 139	0.73	0.53
1986	6 488	10 828	7 821	6 870	0.88	0.80
1987	3 695	7 463	4 859	5 139	1.06	0.92
1988	1 080	7 353	3 201	6 321	1.98	1.37
1989	3 313	5 992	2 524	4 995	1.98	1.08
1990	2 237	4 958	2 437	3 790	1.56	0.81
1991	1 066	4 818	2 231	3 640	1.63	0.83
1992	1 329	4 526	2 131	3 382	1.59	0.86
1993	1 686	3 810	1 991	2 329	1.17	0.62
1994	3 098	3 861	2 090	2 007	0.96	0.50
1995	1 831	4 675	2 370	1 835	0.77	0.33
1996	336	6 625	3 342	2 956	0.89	0.38
1997	283	7 586	4 413	3 715	0.84	0.45
1998	223	6 871	4 802	2 981	0.62	0.38
1999	741	5 847	4 645	1 933	0.42	0.29
2000	642	5 160	4 311	1 256	0.29	0.24
2001	3 687	5 007	4 056	788	0.194	0.16
2002	1 629	5 890	4 262	1 093	0.26	0.188
2003	346	8 027	4 887	2 326	0.48	0.29
2004	2 144	9 440	5 960	3 258	0.55	0.33
2005	1 365	9 652	6 896	3 827	0.56	0.38
2006	1 269	9 077	6 605	2 998	0.45	0.34
2007	703	8 866	6 380	2 377	0.37	0.28
2008	759	9 125	6 723	2 372	0.35	0.26
2009	851	9 150	7 076	2 307	0.33	0.26
2010	1 444	8 907	7 141	1 620	0.23	0.185
2011	1 119	9 265	7 426	1 156	0.156	0.135
2012	501	10 370	8 136	1 396	0.172	0.143
2013	760	11 404	8 989	1 540	0.171	0.142
2014	1 416	12 143	9 942	2 033	0.204	0.179
2015	225	12 236	10 253	1 771	0.173	0.158
2016	191	12 536	10 456	1 809	0.173	0.170
2017	184	12 334	10 551	1 447	0.137	0.139
2018	401	12 063	10 762	1 144	0.106	0.119
2019	1 409	11 689	10 744	908	0.085	0.106
2020	399	11 456	10 454	720	0.069	0.094
2021	1 390	11 742	10 260	608	0.059	0.082
2022	756	12 350	10 539	574	0.05	0.07
2023*	706	13 488	11 324			

*geometric.mean(2003-2022)

Table 4.3.8. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Catch option table.

SSB(2023)	Rec proj	F(30-130cm)	Land(2023)	SSB(2024)
11 324	706	0.081	827	12 239

Fmult	Fland (30-130cm)	Landings (2024)	SSB (2025)
0	0	0	14 220
0.1	0.0081	98	14 121
0.2	0.0163	194	14 022
0.3	0.024	290	13 923
0.4	0.033	385	13 826
0.5	0.041	479	13 730
0.6	0.049	572	13 634
0.7	0.057	665	13 539
0.8	0.065	757	13 445
0.9	0.073	847	13 352
1	0.082	937	13 259
1.1	0.090	1027	13 168
1.2	0.098	1115	13 077
1.3	0.106	1203	12 986
1.4	0.114	1290	12 897
1.5	0.122	1376	12 808
1.6	0.130	1461	12 720
1.7	0.139	1546	12 633
1.8	0.147	1630	12 547
1.9	0.155	1713	12 461
2	0.163	1795	12 376
2.1	0.171	1877	12 292
2.2	0.179	1958	12 208
2.3	0.187	2038	12 125
2.4	0.196	2117	12 043
2.5	0.204	2196	11 962
2.6	0.212	2274	11 881
2.7	0.220	2352	11 801
2.8	0.228	2429	11 721
2.9	0.236	2505	11 642
3	0.244	2580	11 564

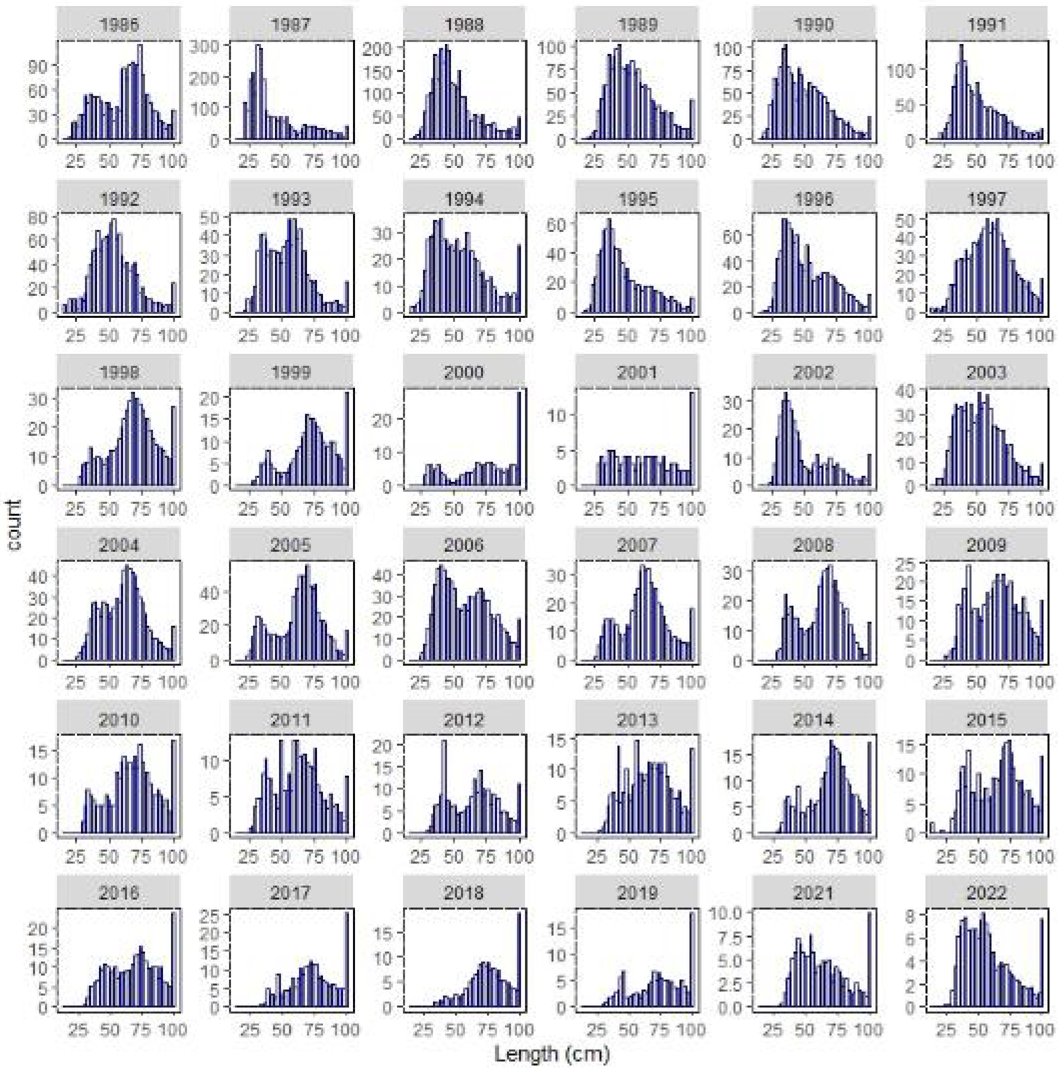


Figure 4.3.1. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Length distributions of landings (in thousands) from 1986 to 2022.

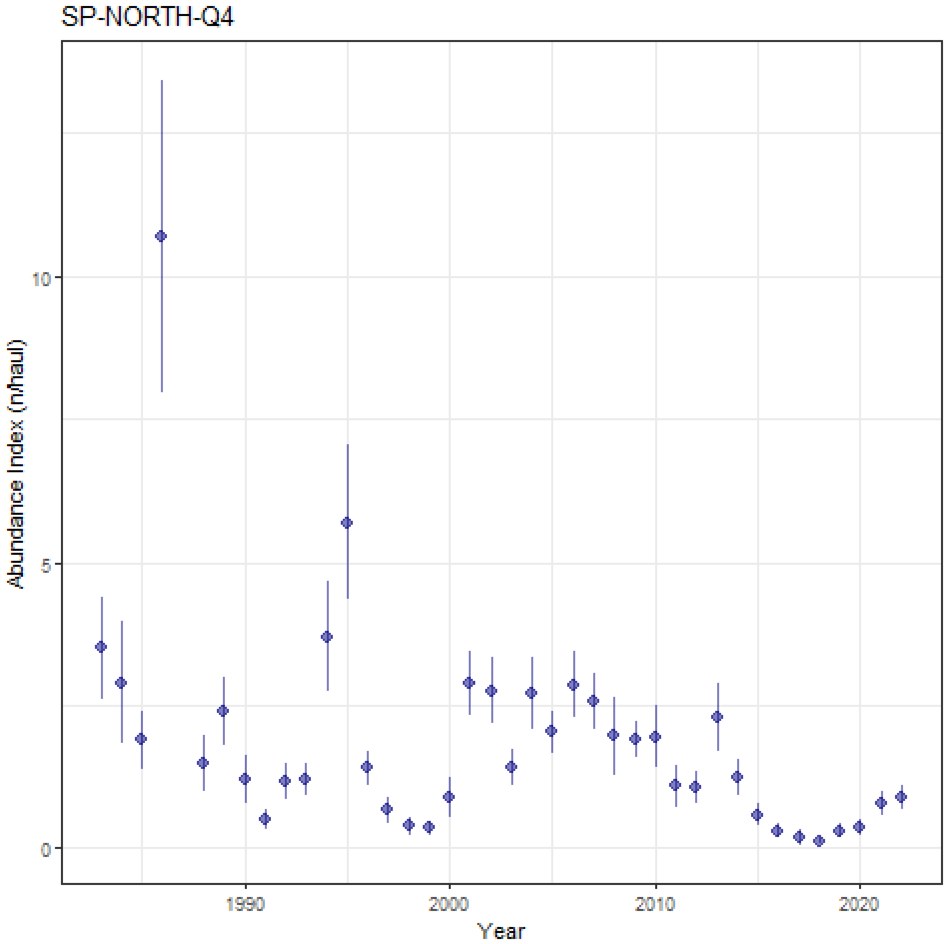


Figure 4.3.2. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Abundance index (in numbers/haul) from the SpGFS-WIBTS-Q4 (G2784) survey. Bars represent 95% confidence intervals.

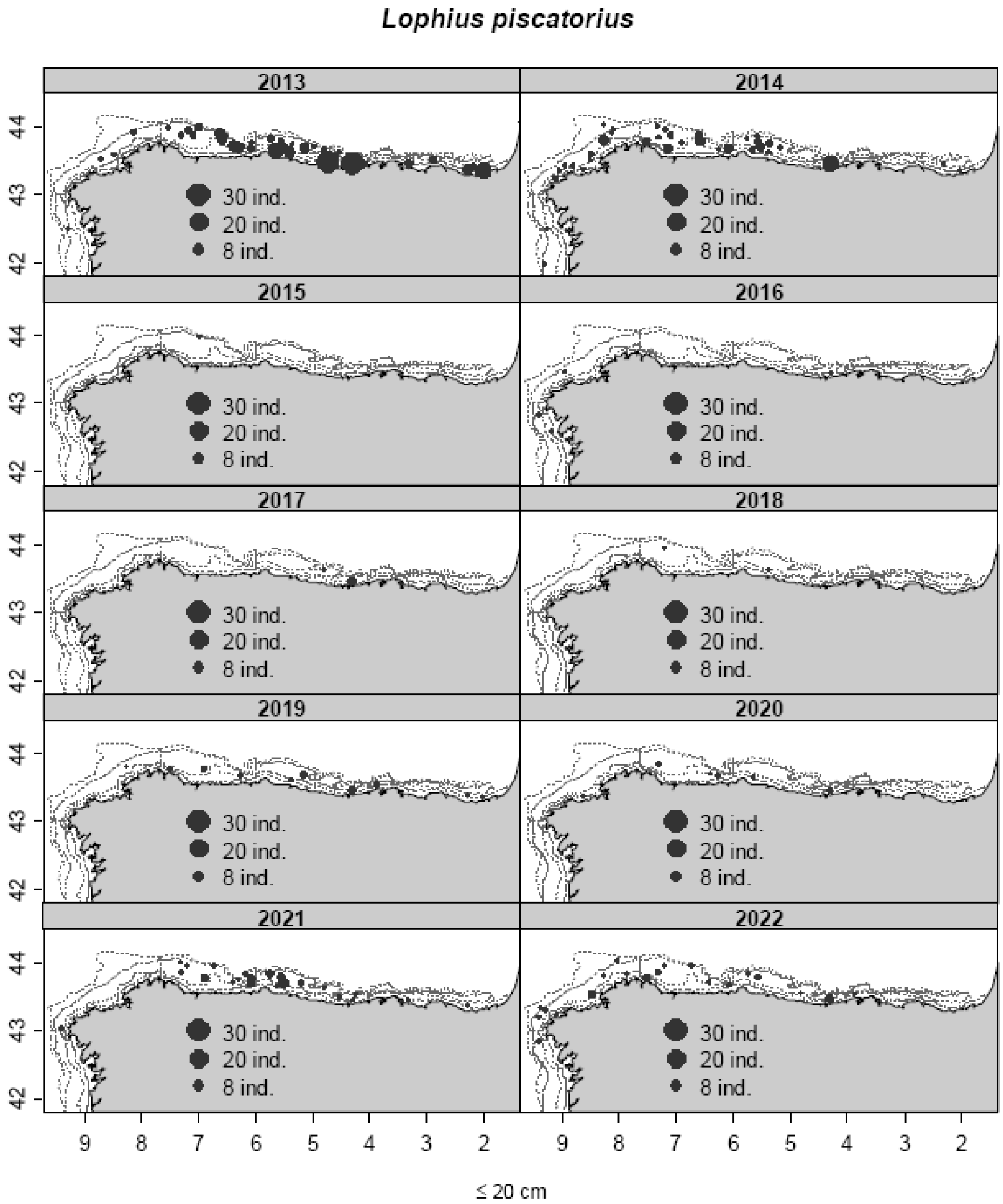


Figure 4.3.3. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Spatial distribution of juveniles (length 0–20 cm) in North Spanish Coast demersal survey (G2784) between 2012 and 2022.

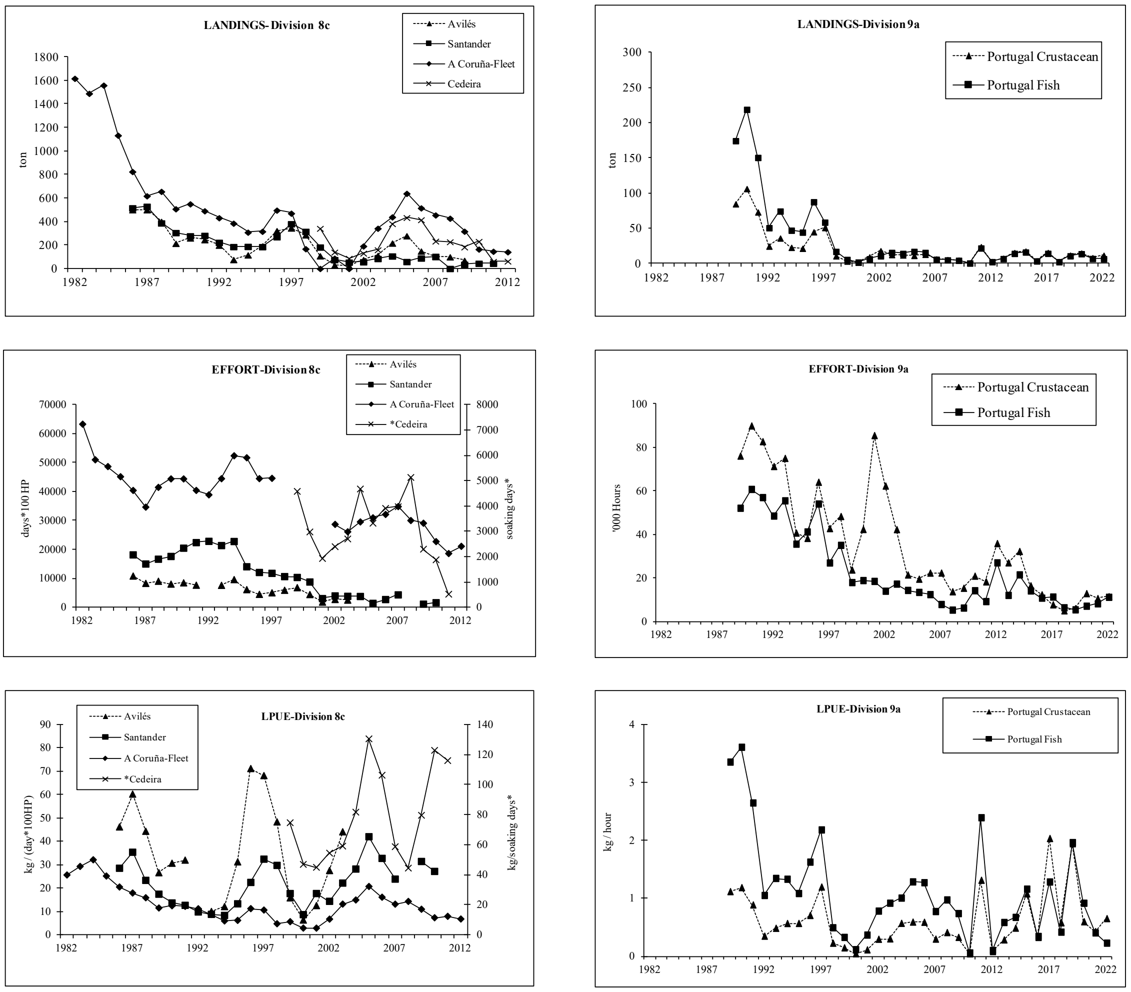


Figure 4.3.4. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Trawl (left) and gillnet (right) landings (in tonnes), effort (in day*100 HP in division 8c and '000 hours in division 9a) and LPUE (in kg/(day*100 HP in division 8c and Kg/hr in division 9c) data between 1982–2022.

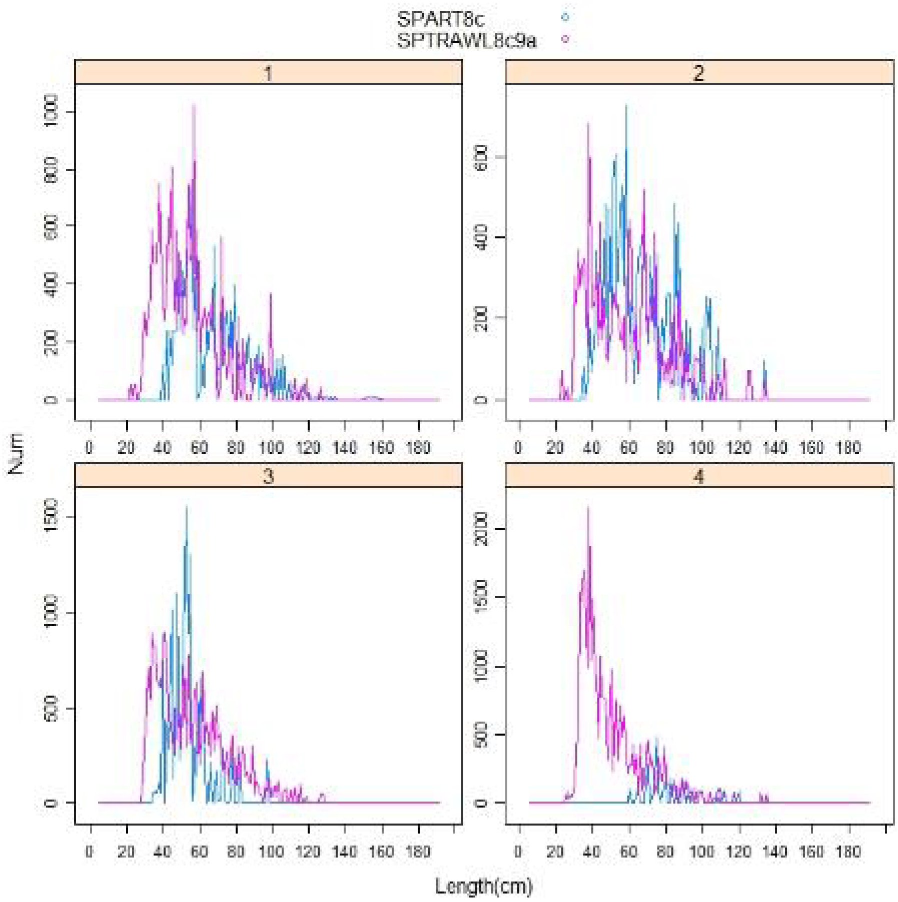


Figure 4.3.5. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Length composition by quarter in 2022 for the two Spanish fleets included in the SS model.

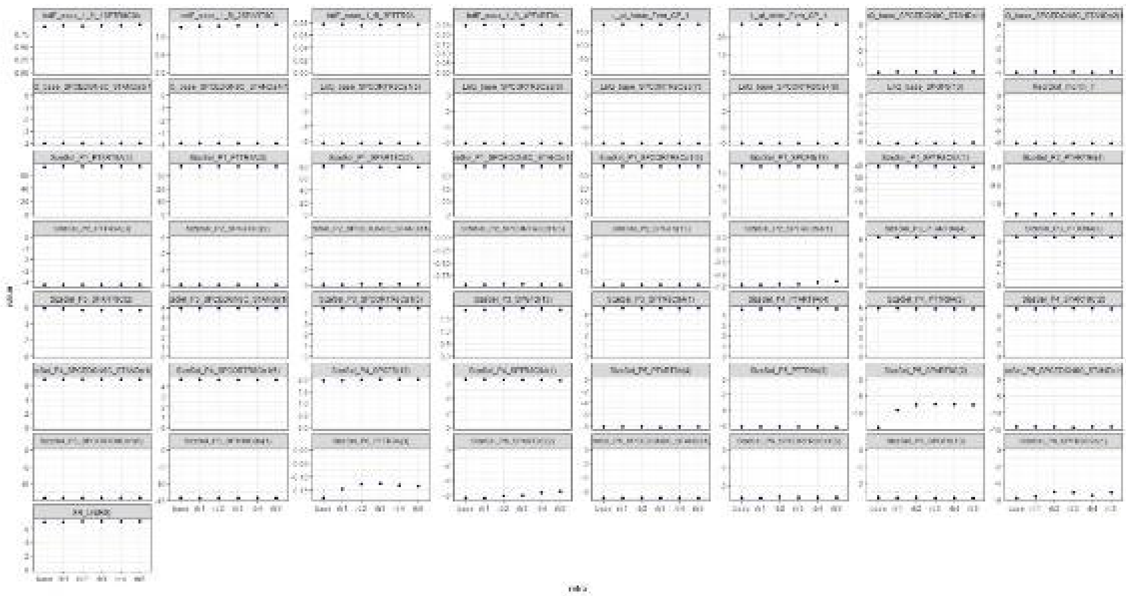


Figure 4.3.6. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Values of the estimated model parameters for a preliminary base model, that includes the 2022 length composition from a number of sample size of 125, and for 5 retrospective models.

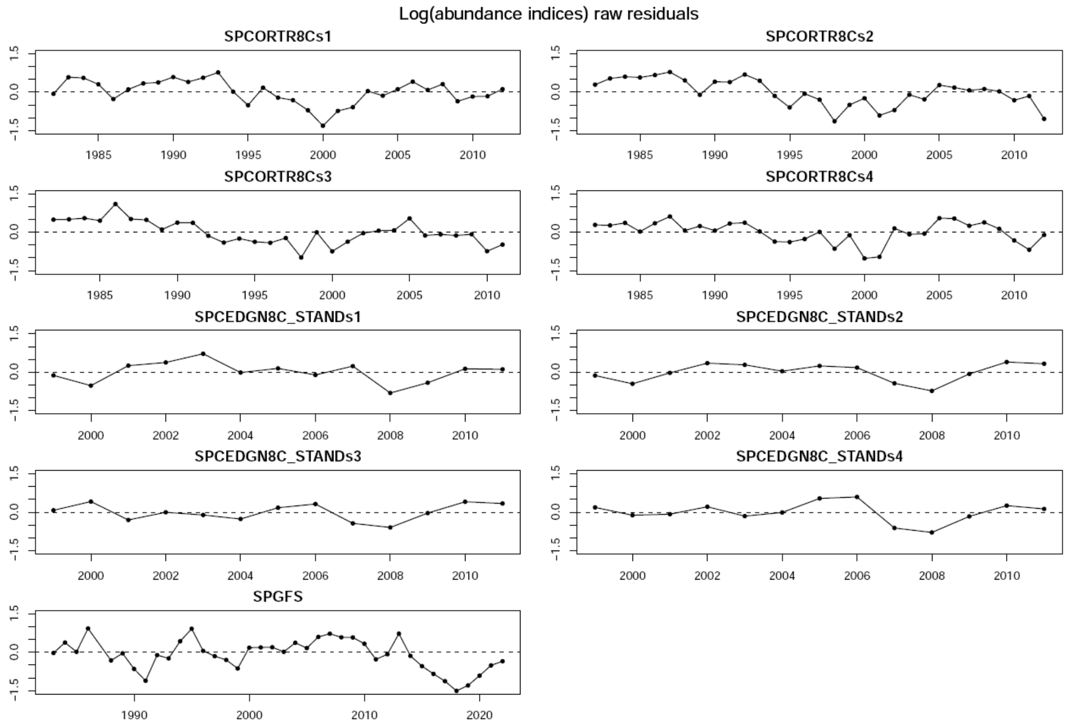
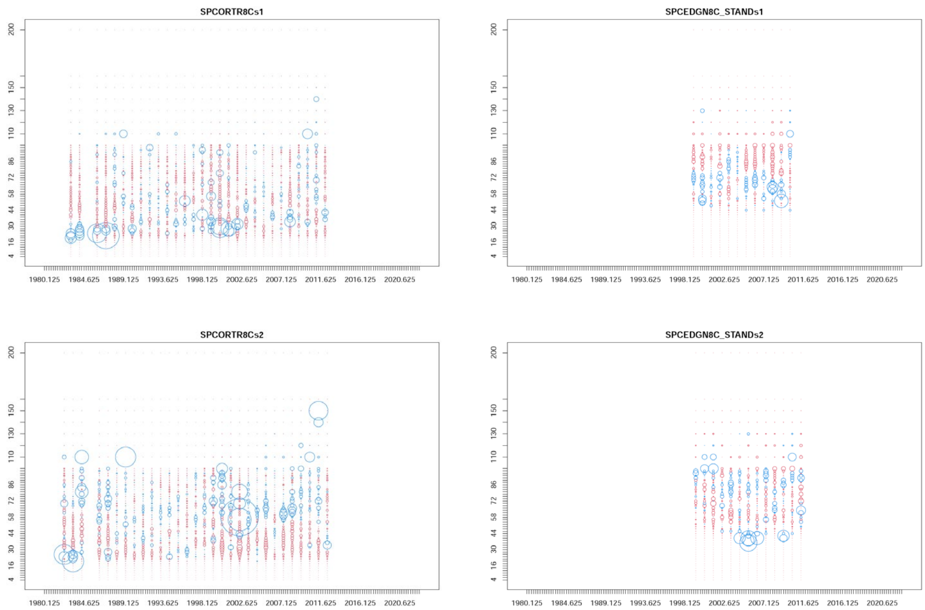


Figure 4.3.7. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Residuals of the fits to the surveys in log (abundance indices). A Coruña and Cedeira values are by quarters.



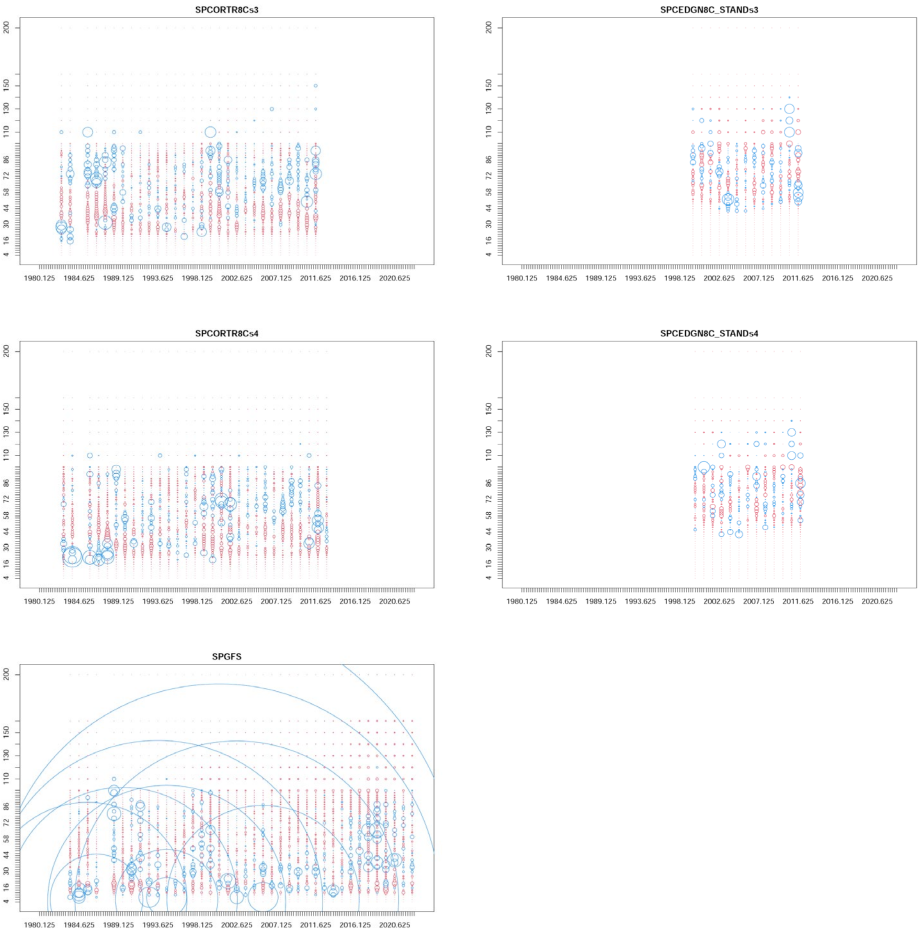


Figure 4.3.8. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Pearson residuals of the fit to the length distributions of the abundance indices. Blue=positive residuals and red=negative residuals.

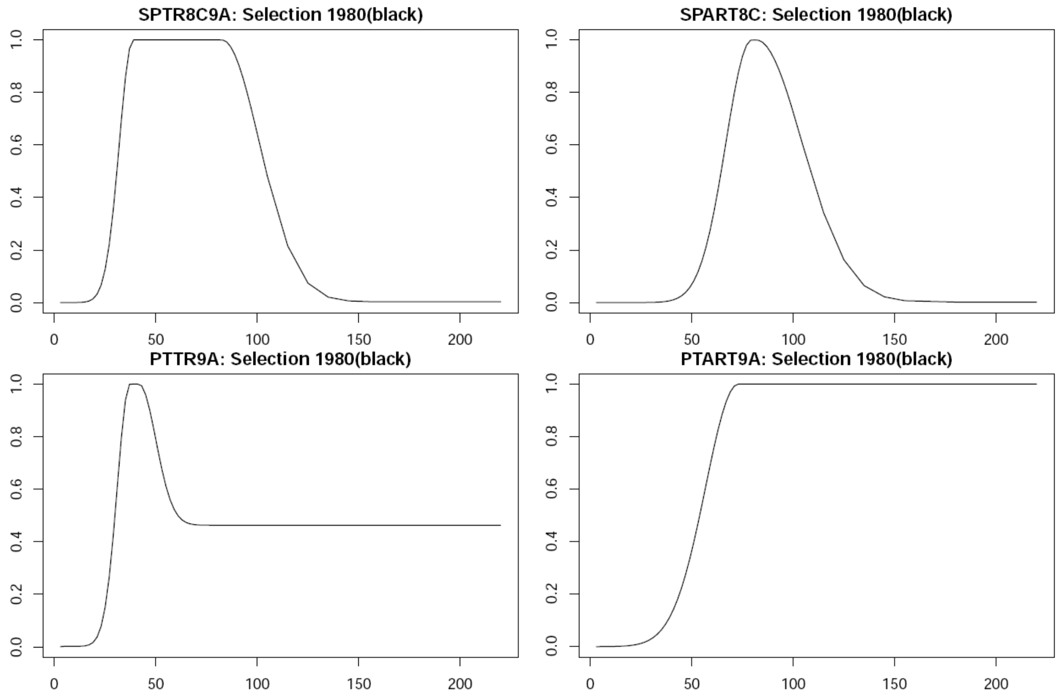


Figure 4.3.9. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Relative selection patterns at length by fishery estimated by the SS model.

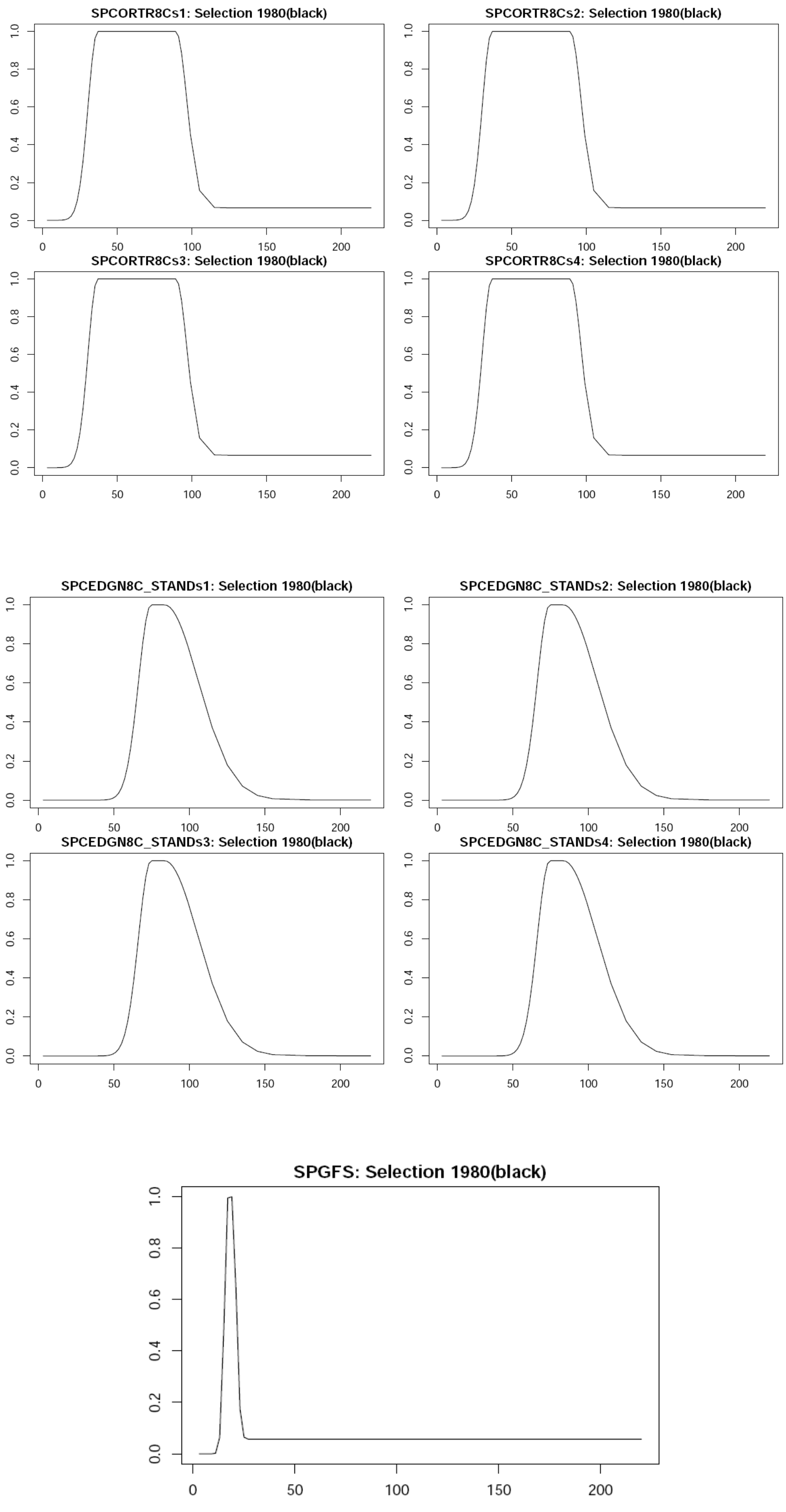


Figure 4.3.10. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Relative selection patterns at length by abundance index estimated by the SS model. A Coruña and Cedeira indices are by quarter.

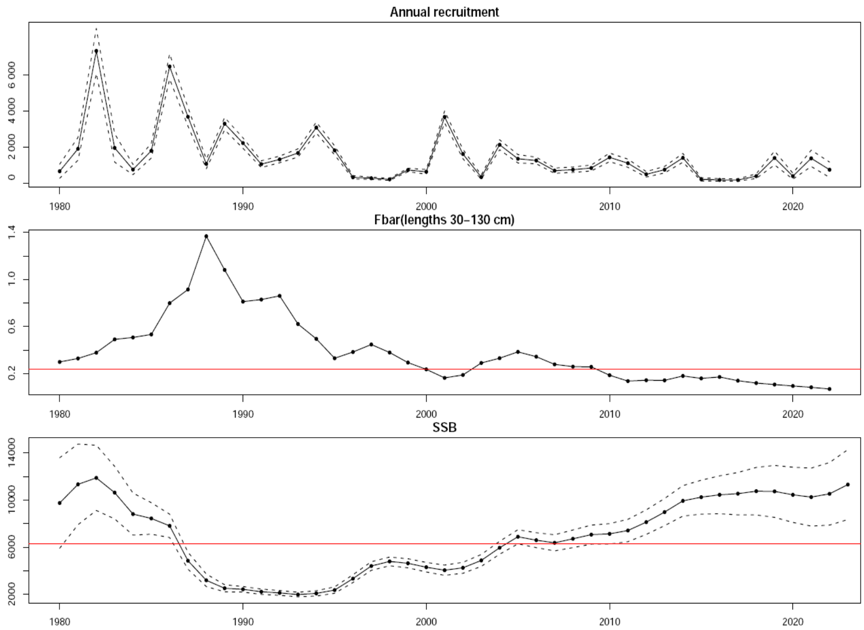


Figure 4.3.11. White-bellied anglerfish *(L. piscatorius*) in divisions 8.c and 9.a. Summary plots of stock trends with 95% intervals only for recruitment and SSB.

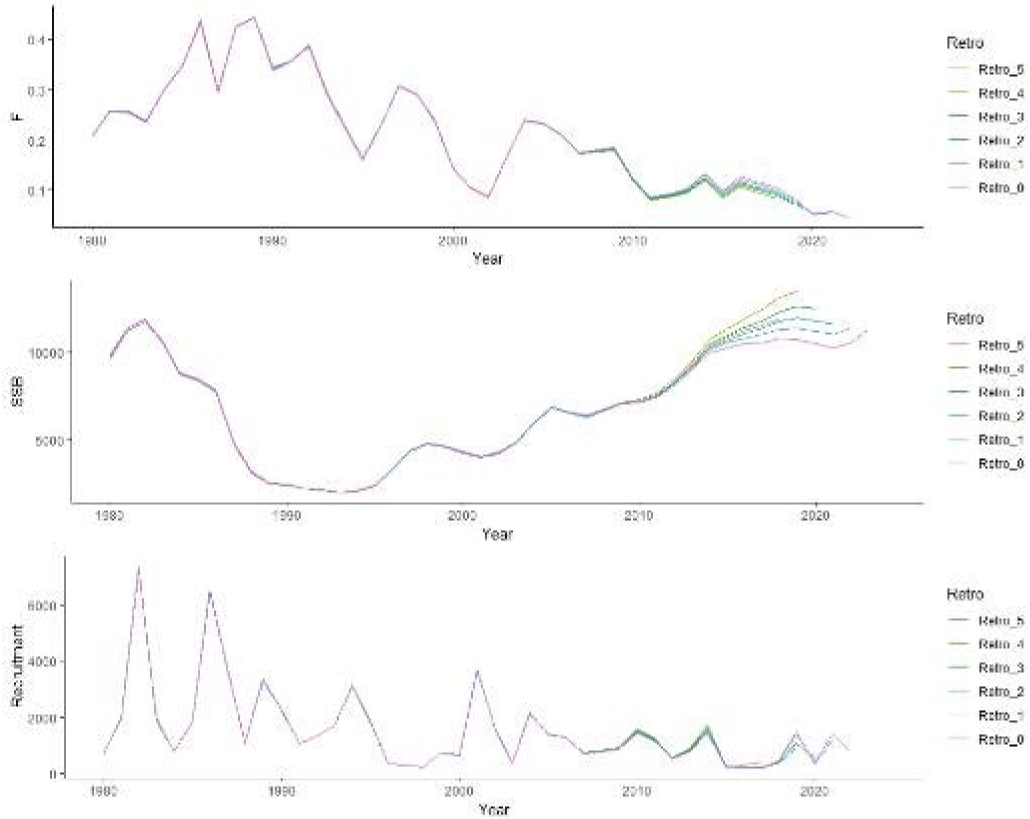


Figure 4.3.12. White-bellied anglerfish (*L. piscatorius*) in divisions 8.c and 9.a. Retrospective plots from the SS model.

4.4 Black-bellied anglerfish (*Lophius budegassa*) in divisions 8.c and 9.a

4.4.1 General

4.4.1.1 Ecosystem aspects

Biological/ecosystem aspects are common with *L. piscatorius* and are described in the Stock Annex.

4.4.1.2 Fishery description

L. budegassa is mainly caught by Spanish and Portuguese bottom trawlers and net fisheries (gillnet and trammelnets). As with *L. piscatorius*, *L. budegassa* is an important target species for the artisanal fleets and is a bycatch for the trawl fleets targeting other fishes or crustaceans (see Stock Annex). French trawl, gillnet and trammelnet fisheries also catch *L. budegassa*, but reported values represent <1% (on average) of the total stock landings.

The length distribution of the landings varies among fisheries, with gillnet and artisanal landings showing higher mean lengths compared to the trawl landings, except in 2017, when the mean lengths of the trawl and artisanal fisheries were similar. Since 2008, the Spanish landings were mostly allocated to the trawl fleet (89% in 2022; mean lengths in 2022 of 32.3 cm in division 9.a), followed by the gillnet fishery (11% in 2022; mean length in 2022 of 63 cm in Division 8.c) and other fleets (<1%). Portuguese landings, for the same period, were mainly from the artisanal fleet (77% in 2022; mean length of 53.3 cm in 2022), followed by the trawl fleet (23% in 2022; mean length of 49 cm in 2022). French landings since 2008 correspond, on average, to 67% from the trawl fleet, 32% from the gillnet fleet and 1% from other fleets.

4.4.2 Data

4.4.2.1 Commercial catches and discards

Total landings of *L. budegassa* by country and gear for the period 1978–2022, as estimated by WGBIE, are given in Table 4.4.1. Portuguese and Spanish landings and discards data were revised during the WKANGLER benchmark (ICES, 2018a). French landings data are available to WGBIE since 2002. Analysis of historical landings is presented in the Stock Annex. Unallocated/non-reported landings for this stock were available from 2011 to 2016 and again in 2018–2019. Estimates of unallocated or non-reported landings were based on the sampled vessels (Spanish concurrent sampling) and raised to the total effort for each *métier* and quarter. The unallocated/non-reported values were considered realistic and are, thus, included in the assessment.

From 2002 to 2007, landings increased to 1 306 t, decreasing afterwards to levels between 754–774 t in 2009–2010. From 2011 to 2016, landings fluctuated between 948 and 1 141 t and between 669 to 861 t for the period of 2017-2021. In 2022, landings were estimated at 621 t.

Spanish trawl and gillnet discard estimates of *L. budegassa* in weight and associated coefficient of variation (CV) are shown in Table 4.4.2. The estimated Spanish trawl discards observed from 1994–2022 shows two peaks: first in 2006 (114 t) and second in 2010 (64 t), followed by relatively lower levels since then. The estimated Spanish gillnet discards are available since 2011 and varied between 0 and 14.3 t. In total, Spanish discards represented ~ 4.6% of total catches of the stock in 2022.

Sampling effort and frequency of occurrence of *L. budegassa* discards in the Portuguese trawl fisheries were presented for the 2004–2013 period (Prista *et al*. 2014, WD03 in ICES, 2014). The maximum frequency of occurrence in discards in the trawl fleet targeting fishes is 2% (sampling effort varies between 50 and 194 hauls per year). The maximum occurrence of discards in the trawl fleet targeting crustaceans is 8% (sampling effort varies between 28 and 111 hauls per year). Due to the low frequency of occurrence of anglerfish in the discards, it is not possible to apply the algorithm used for the hake (presented in Prista *et al*. 2014; WD03 in ICES, 2014). For this reason, discards estimates have not been calculated. In 2021 and 2022, at-sea sampling in Portuguese waters was implemented with limitations in sampling effort due to issues related with subcontracting services.

Partial information on the Spanish and Portuguese discards was available and the WG concluded that discards could be considered negligible.

4.4.2.2 Biological sampling

The procedure for sampling this species is the same as for *L. piscatorius* (see both *L. piscatorius* and *L. budegassa* Stock Annexes).

The *métier* sampling adopted in Spain and Portugal in 2009, following the requirement of the EU Data Collection Framework (DCF), can affect the data provided. Excluding 2020, Spanish sampling levels are similar to previous years. Portuguese sampling levels declined significantly in 2009–2011, but increased since then. In 2021 and 2022, the Portuguese sampling effort was intentionaly increased in comparison to previous years to improve information on species identification in landing ports and collect more length data.

Length composition

Table 4.4.3 gives the annual length compositions by ICES Division, country and gear and the adjusted length composition for the 2022 total stock landings. However, these new data should be interpreted with caution given the low sampling levels for some fleets. Length composition is not used in the assessment of *L. budegassa* but provides ancillary information.

The annual length compositions for the years between 2002 and 2022 are presented in Figure 4.4.1. The total annual landings in numbers (in thousands), the annual mean length (in cm) and the mean weight (in g) are presented in Table 4.4.4. In 2022, landings (in numbers) were dominated by individuals < 30 cm and the mean length was estimated as 37 cm, smaller than the previous year.

The estimated total number of landed individuals shows a remarkable decrease in the year 2000 when compared to previous years. Since 2001, and excluding 2006 and 2007, estimated number of landed individuals oscilated between 230 and 531 thousands. The estimated mean weight is relatively high since 2012 (> 2 kg) with exception of the year 2022 where it reached a lower value.

4.4.2.3 Abundance indices from surveys

Spanish and Portuguese survey results for the period 1983–2022 are summarized in Table 4.4.5. The Portuguese survey was not performed in 2012, 2019, and 2020. Considering the very small number of black anglerfish caught in the SpGFS-WIBTS-Q4 (G2784) and PtGFS-WIBTS-Q4 (G8899) surveys, these indices were considered unsuitable to evaluate the change in abundance of this species. However, they can provide some incilliary information about recruitment. On the contrary, data from SpGFS-caut-WIBTS-Q4 (Gulf of Cádiz, G4309) are regular and its usefulness has been considered promising (ICES, 2018a, 2021a) but more studies on species distribution are needed to better interpret results from this survey. The biomass index from this survey increased since the beginning of the time-series, reaching a maximum value in 2022. No survey was conducted in 2021.

The small number of specimens < 20 cm in the Spanish bottom trawl surveys on the Northern Spanish Shelf suggests a lack of recruitment data for the surveyed area during the period 2017–

2019 (Figure 4.4.2; Blanco *et al.* 2023). The peak of individuals < 20 cm observed in 2020 is the first signal of recruitment since 2016. In 2021 and 2022, individuals < 20 cm were also recorded although at smaller levels than in 2020.

4.4.2.4 Commercial catch-effort data

Landings, effort and LPUE data are given in Table 4.4.6 and Figure 4.4.3 for Spanish trawlers from ports of Santander, Avilés and A Coruña (all in Division 8.c) since 1986, and for Portuguese trawlers (Division 9.a) since 1989. Data are also available for the standardized Cedeira gillnet fleet from 1999 to 2012. For each fleet, the proportion in relation to the total landings is given. Landed values for each of the Portuguese trawl fleets were updated from 2012 onwards.

Since 2013, Spain has only provided information for A Coruña port series. Effort data for this tuning fleet in 2013 were calculated using the information from electronic logbooks and following different criteria than those established for previous years. In order to check the consistency of the Spanish data time-series, a backward revision of the time-series is needed to compare the different estimation methods and information sources used. The standardization of the series should be also conducted.

Three LPUE series were presented in the past for the A Coruña trawler fleet: (a) "A Coruña port" for trips that are exclusively landed in the port; (b) "A Coruña trucks" for trips that are landed in other ports; (c) and "A Coruña fleet" that considers all the trips of the A Coruña trawler fleet. The LPUE series previously used in the assessment (A Coruña fleet) was not updated since 2012.

Until 2011, for the Portuguese trawl fleets targeting fishes and crustaceans, most logbooks were filled in paper but have thereafter been progressively replaced by electronic logbooks. Since 2013, > 90% of the logbooks were reported in the electronic version. Generalized linear mixed models (GLMMs) were used to standardize both LPUE data, considering Year, Quarter and Area as independent variables and Vessel as a random variable. Details can be found in the Benchmark Workshop on the development of MSY advice for category 3 stocks using the Surplus Production Model in Continuous Time report (WKMSYSPiCT; ICES, 2021a).

Logbook data from the Portuguese artisanal fleet, particularly from vessels targeting *Lophius* spp. are also available since 2008 (electronic and paper). An LPUE series for the fleet targeting anglerfish with trammelnets was presented to WKMSYSPiCT (ICES, 2021a). However, more work is needed particularly to accommodate targeting effects using more adequate methodologies (e.g. clustering methods) as well as higher spatial resolution (ICES, 2021a).

Excluding the Avilés and Santander fleets, the overall trend in landings for all fleets was decreasing from the late eighties to mid-1990s (Figure 4.4.4). A slight increase was observed from 1995 to 1998. The A Coruña fleet showed the most important drop in landings and relative proportion of total landings in 2002. LPUEs of Spanish Avilés and Santander fleets show high values during the second half of the 1990s. Despite the variability observed, a decreasing trend was observed for all fleets from 2000 to 2005 which was then followed by a slightly increasing trend. The LPUE time-series from the Portuguese trawl fleet targeting crustaceans shows an increasing trend reaching a maximum value in 2018. The value in 2022 is still among the highest in the time-series. The LPUE time-series from the Portuguese trawl fleet targeting fish is variable but also shows an increasing trend from 2001 to 2012. Similarly, to the crustacean fleet, the value in 2022 is among the highest of the time-series.

Effort trend analysis was presented in section 4.3.4.4.

4.4.3 Assessment

4.4.3.1 History of the assessment

In WKANGLER 2018 (ICES, 2018a), a new model, SPiCT (Pedersen and Berg, 2017), was proposed for the assessment of *L. budegassa*, a stochastic production model in continuous time. This model was considered more reliable than the previous model used, ASPIC (Prager, 1992; 1994). The benchmarked approach gave comparable trends, but the estimates of stock biomass were notably higher, and fishing mortality was lower compared with the previous assessment method. A stepwise approach was proposed by WGBIE 2018 but was rejected by ACOM. Given the uncertainties regarding the absolute levels of biomass and fishing pressure, the assessment was considered indicative of trends only and it was decided to present the advice as a category 3.2 stock with proxy reference points, based on SPiCT results (ICES, 2018b).

A new benchmark was proposed for this stock in 2021 using SPiCT. CPUE data available for the stock were revised and several tests were conducted. Results and discussion of the results are available in the WKMSYSPiCT report (ICES, 2021a). The stock was upgraded to category 2.

4.4.3.2 Exploratory assessment with Stock Synthesis

Tests with the Stock Synthesis model (SS; Methot Jr. and Wetzel, 2013) were conducted during the Workshop on Tools and Development of Stock Assessment Models Using a4a and Stock Synthesis (WKTADSA, ICES, 2021b). A length-based model was developed assuming one area, one season, catch data from nets fleets (gillnets and trammelnets) and from trawl fleets (data from Portugal and Spain combined), two commercial LPUE indices and one biomass series from SpGFS-WIBTS-Q4 (G2784) to inform about recruitment. Several model configurations were tested but more work is required to reach a base model. The workshop was conducted before WKMSYSPiCT and conclusions from this benchmark should be considered in future. However, results from the SS model were promising and are available in the WKTADSA report (ICES, 2021b). Some comments are also available in the WKMSYSPiCT report (see reviewers' comments in ICES, 2021a).

4.4.3.3 SPiCT Model

The SPiCT model was revised during the WKMSYSPiCT (ICES, 2021a). The new model assumes the Schaefer population growth model (fixed parameter) and the default biomass and catches observed/process error ratios (alpha and beta, respectively).

The SPiCT input data:

- Total landings from 1980–2022 (discards are considered negligible).
- Portuguese trawl fleet targeting fish (1989–2022; Index 1).

The input data are presented in Tables 4.4.1 (Landings) and 4.4.6. (CPUE index for the Portuguese trawl fleet targeting fish) and Figure 4.4.4.

SPiCT settings:

- Euler time-step (years): 1/16 (default).
- CPUE at the middle of the year.
- Production curve shape: assume Schaefer (n = 2).
- B/K prior: assume initial depletion rate of 0.5 (logbkratio = c(log(0.5),0.5,1)).
- Other parameters: default (estimated by the model).

From the LPUE tuning indices previously used, only the PT-TRF9a, now standardized, was maintained. The other two indices were not considered due to uncertainty around the trends in the last years of the series in the case of PT-TRC9 and autocorrelation issues with the SP-CORTR8c (fleet series; not updated since 2012). PT-TRC9 was driving the stock to a very optimistic status which is not in agreement with the historical landings trajectory and the low landings obtained in 2019. In this model, a prior for B/K of 0.5 was assumed, as exploitation was likely to occur before the beginning of the available time-series. Despite target fisheries development in the late 1970s, previously, the species was likely to be caught and discarded in other fisheries.

4.4.3.4 Assessment diagnostics

No significant bias or autocorrelation was found and both QQ-plot and the Shapiro test show normality in the residuals (Figure 4.4.5.). Confidence intervals for F/F_{MSY} and B/B_{MSY} do not extend more than 1 order of magnitude, as proposed by Mildenberger *et al*. (2021).

No strong retrospective pattern was observed (Figure 4.4.6.). Mohn's rho statistics (Mohn, 1999) were estimated as −0.036 and 0.039 for B/B_{MSY} and F/F_{MSY}, respectively.

When checking the model robustness to different initial parameter values, results point to the existence of two local optima in the likelihood function. However, most of the runs agree in the final value, which corresponds to the best fit (the objective functions of both models were compared). The model will be consistent in the results as SPiCT always uses the same initial parameters.

4.4.3.5 Assessment results

SPiCT results are presented in Tables 4.4.7. and 4.4.8 and in Figure 4.4.7. The stock biomass (B) has been increasing since 2002. B/B_{MSY} is estimated to be above MSY $B_{trigger}$ proxy over the whole time-series. Fishing mortality (F) has decreased since 1998 and is estimated to have been below F_{MSY} proxy since 2002 (with exception of 2006).

4.4.4 Short-term projections

Short-term projections consider the F in the intermediate year as the estimated F at the time-step of the last observation and the estimated seasonal F process. Results for each scenario discussed in WKMSYSPiCT (ICES, 2021a) are presented in Table 4.4.9. All the scenarios considered for F are expected to keep the stock above B_{MSY} in 2024. Although the stock is included in the EU MAP for stocks fished in the Western Waters and adjacent waters (EU, 2019), F_{MSY} ranges were not defined.

4.4.5 Biological reference points

WKMSYSPiCT (ICES, 2021a) reiterated the basis for MSY reference points previously assumed by ICES. Those reference points are considered proxies. See section 4.4.4. for further details.

Framework	Reference point	Relative value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	0.5*	Relative value (B/B_{MSY}) from the SPiCT assessment model. BMSY is estimated directly from the SPiCT model and changes when the assessment is updated.	ICES (2021a)
	F_{MSY}	1*	Relative value (F/F_{MSY}) from the SPiCT assessment model. FMSY is estimated directly from the SPiCT model and changes when the assessment is updated.	ICES (2021a)
Precautionary approach	$B_{lim\ proxy}$	0.3 × B_{MSY} *	Relative value (equilibrium yield at this biomass is 50% of the MSY proxy).	ICES (2021a)

Framework	Reference point	Relative value	Technical basis	Source
	B_{pa}	Not defined		
	$F_{lim\ proxy}$	1.7 × F_{MSY} *	Relative value (the F that drives the stock to the proxy of B_{lim}).	ICES (2021a)
	F_{pa}	Not defined		
Management plan	SSB_{mgt}	Not applicable		
	F_{mgt}	Not applicable		

***No reference points are defined for this stock in terms of absolute values. The SPiCT-estimated values of the ratios F/F_{MSY} and B/B_{MSY} are used to estimate stock status relative to the MSY reference points.**

4.4.6 Comments on the assessment

This stock was last benchmarked in 2021 during the WKMSYSPiCT (ICES, 2021a) and advice is now given under the MSY approach for a category 2 stock (ICES, 2023).

The stock is included in the EU MAP for stocks fished in the Western Waters and adjacent waters (EU, 2019) but reference points for F_{MSY} ranges are still not defined for this stock under the new assessment model.

Since 2017 that advised catches combined for the two *Lophius* species in 8c and 9a are considerably lower than the agreed TAC for *Lophius* spp. for the same area. Although TAC has been increasing in line with the ICES advice, landings of the two species have been decreasing. Spanish industry in the North of Spain notes they are not able to find and catch their corresponding quota for anglerfish (both black and white anglerfish)". The reasons for this mismatch are not totally understood. Data currently available until 2020 indicates that fishing effort has decreased for some fleets (Figure 4.4.3). However, it is acknowledged that this information needs to be revised. In addition, and particularly in the case of ank.27.8c9a, stock size indicators (Portuguese CPUE from commercial trawl fleets and Spanish Gulf of Cadiz Bottom Trawl Survey - G4309) suggest that biomass is at high values (Tables 4.4.5, 4.4.6 and Figure 4.4.3). Information from the Northern Spanish Shelf Groundfish Survey (SpGFS-WIBTS-Q4, G2784) reveals no trend in the biomass index (Table 4.4.5). The length distribution from this survey suggests relatively good levels of small fish in the last three years (Figure 4.4.2). Total length frequency data (LFD) from landings show that in 2022 landings were dominated by small-sized individuals, which may also indicate good recruitment in previous years. Data available for this stock thus support the model output. It should also be noted that the three mentioned stock size indicators of the southern black anglerfish reflect the biomass in the Portuguese southwest coast and in the Gulf of Cádiz and that reliable information for the northern waters of the stock is missing.

Current model is considered good to provide a category 2 advice for this stock. WGBIE recommends for this stock to go to benchmark together with the southern white anglerfish to explore the possibility of implementing the Stock Synthesis (SS; Methot Jr. and Wetzel, 2013) framework for potential upgrade to a category 1 stock. Intersessional work should be addressed this year for possible presentation on the next WGBIE meeting to determine the feasibility of proceeding to a benchmark.

Artisanal vessels can operate with different gears to target different species and their efforts regularly shifts toward other important commercial species both of which are commonly observed to occur particularly in Portuguese waters. Changes in the fishing pattern of the Spanish northern trawl fisheries were also known to take place, which can affect the catches of *Lophius* spp. This points out the need to revise the CPUE commercial indices during the future benchmark in order to take into account the targeting effects, as noted during the WKMSYSPiCT (ICES, 2021a).

4.4.7 Quality considerations

Until 2011, most logbooks were filled in paper for the Portuguese fleets but have thereafter been progressively replaced by e-logbooks. Since 2013, more than 90% of the logbooks are being completed in the electronic version. The Portuguese LPUE series from the trawl fleets were standardized using the data previously used in the assessment. However, data revision and improvement in the standardization methods should be considered to accommodate targeting effects using more adequate methodologies (e.g. clustering methods) as well as higher spatial resolution. Standardized LPUEs are also required from fleets operating in other areas where the stock distributes. In addition, more accurate information on stock biology, ecology and distribution as well as on the fisheries behaviour are desirable to understand and validate some biomass indicators available for the stock (ICES, 2021a).

4.4.8 Management considerations

Management considerations are in section 4.2.

4.4.9 References

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4.5 Tables and figures

Table 4.4.1. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Tonnes landed by the main fishing fleets for 1978–2022 as determined by WGBIE (n/a: not available).

	Div. 8c							Div. 9a						Div. 8c+9a		
	SPAIN			FRANCE				SPAIN			PORTUGAL				Unallocated/	
Year	Trawl	Gillnet	Others	Trawl	Gillnet	Others	TOTAL	Trawl	Gillnet	Others	Trawl	Artisanal	TOTAL	SUBTOTAL	Non reported	TOTAL
1978	n/a	n/a					n/a	248			n/a	107	355	355		355
1979	n/a	n/a					n/a	306			n/a	210	516	516		516
1980	1203	207					1409	385			n/a	315	700	2110		2110
1981	1159	309					1468	505			n/a	327	832	2300		2300
1982	827	413					1240	841			n/a	288	1129	2369		2369
1983	1064	188					1252	699			n/a	428	1127	2379		2379
1984	514	176					690	558			223	458	1239	1929		1929
1985	366	123					489	437			254	653	1344	1833		1833
1986	553	585					1138	379			200	847	1425	2563		2563
1987	1094	888					1982	813			232	804	1849	3832		3832
1988	1058	1010					2068	684			188	760	1632	3700		3700
1989	648	351					999	764			272	542	1579	2578		2578
1990	491	142					633	689			387	625	1701	2334		2334
1991	503	76					579	559			309	716	1584	2162		2162
1992	451	57					508	485			287	832	1603	2111		2111
1993	516	292					809	627			196	596	1418	2227		2227
1994	542	201					743	475			79	283	837	1580		1580
1995	924	104					1029	615			68	131	814	1843		1843
1996	840	105					945	342			133	210	684	1629		1629
1997	800	198					998	524			81	210	815	1813		1813
1998	748	148					896	681			181	332	1194	2089		2089
1999	565	127					692	671			110	406	1187	1879		1879
2000	441	73					514	377			142	336	855	1369		1369

Table 4.4.1. continued.

	Div. 8c							Div. 9a							Div. 8c+9a	
	SPAIN			FRANCE				SPAIN			PORTUGAL					
Year	Trawl	Gillnet	Others	Trawl	Gillnet	Others	TOTAL	Trawl	Gillnet	Others	Trawl	Artisanal	TOTAL	SUBTOTAL	Unallocated/ Non reported	TOTAL
2001	383	69					452	190			101	269	560	1013		1013
2002	202	74		10	1	0	288	234	0	0	75	213	522	810		810
2003	279	49		9	0	0	338	305	0	0	68	224	597	934		934
2004	251	120		14	5	0	391	285	0	0	50	267	603	993		993
2005	273	97		26	9	0	405	283	0	0	31	214	527	933		933
2006	323	124		12	1	0	460	541	0	0	39	121	701	1161		1161
2007	372	68		4	1	0	444	684	0	0	66	111	861	1306		1306
2008	386	70		5	1	0	462	336	0	0	40	119	495	957		957
2009	301	148		3	1	0	454	172	0	0	34	114	320	774		774
2010	319	81		2	1	0	403	197	0	0	70	84	351	754		754
2011	214	115	32	3	0	0	364	157	60	98	75	119	510	874	74	948
2012	161	83	22	2	0	0	268	109	40	90	156	370	765	1033	109	1141
2013	221	135	14	4	1	0	375	95	55	90	100	258	598	973	98	1071
2014	187	126	7	5	2	0	326	120	47	4	116	286	572	898	100	998
2015	233	141	1	2	2	0	380	103	62	2	126	222	515	895	152	1047
2016	203	118	5	2	2	0	330	103	79	2	120	257	560	889	125	1014
2017	163	153	0	1	3	0	319	109	62	1	68	302	542	861		861
2018	186	156	1	7	9	0	359	126	37	1	52	185	402	761	11	773
2019	137	117	0	1	2	0	259	109	49	1	43	135	337	595	73	669
2020	126	65	0	4	2	0	198	138	5	3	128	321	596	793		793
2021	122	24	0	2	0	0	148	116	23	2	97	331	570	718		718
2022	111	23	0	0	0	0	135	139	7	1	78	262	487	621		621

n/a: not available

Table 4.4.2. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Weight and percentage of discards for Spanish trawl and gillnet fleets.

Year	Weight (t)	CV	% Trawl Catches	% Total Catches
TRAWL				
1994	6.1	24.4	0.6	0.4
1995	n/a	n/a	n/a	n/a
1996	n/a	n/a	n/a	n/a
1997	21.3	35.2	1.6	1.2
1998	n/a	n/a	n/a	n/a
1999	19.7	43.7	1.6	1.0
2000	8.7	35.1	1.1	0.6
2001	n/a	n/a	n/a	n/a
2002	n/a	n/a	n/a	n/a
2003	1.4	n/a	0.2	0.1
2004	10.9	n/a	2.0	1.1
2005	9.3	n/a	1.7	1.0
2006	114.0	n/a	11.7	9.8
2007	4.2	n/a	0.4	0.3
2008	4.9	n/a	0.7	0.5
2009	23.3	n/a	4.7	3.0
2010	63.5	n/a	11.0	8.4

Year	Weight (t)	CV	% Trawl Catches	% Total Catches
2011	19.7	n/a	5.0	2.1
2012	5.9	n/a	2.1	0.5
2013	22.3	n/a	6.6	2.1
2014	27.8	n/a	8.3	2.8
2015	0.5	n/a	0.2	0.0
2016	0.4	n/a	0.1	0.0
2017	3.7	n/a	1.3	0.4
2018	1.1	n/a	0.3	0.1
2019	2.2	n/a	0.9	0.3
2020	2.2	n/a	0.8	0.3
2021	10.1	n/a	4.1	1.4
2022	28.7	n/a	10.3	4.6
GILLNETS				
2011	10.6	n/a		
2012	14.3	n/a		
2013	0	n/a		
2014	0.1	n/a	0.03	0.01
2015	0.4	n/a	0.18	0.04

Year	Weight (t)	CV	% Trawl Catches	% Total Catches
2016	5.0	n/a	2.47	0.49
2017	10.9	n/a	4.82	1.26
2018	2.6	n/a	1.33	0.34
2019	13.3	n/a	7.40	1.98
2020	0.9	n/a	1.33	0.12
2021	0.8	n/a	1.60	0.11
2022	0	n/a	0	0

n/a: not available.

CV: coefficient of variation.

Table 4.4.3. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Length composition by fleet for landings (thousands) in 2022. Unreported catches excluded. Adjusted Total: adjusted to landings from fleets without length composition. n/a: not available.

	Div.8c			Div.9a				Div. 8c+9a	
	SPAIN			SPAIN	PORTUGAL				Adjusted
Length (cm)	Trawl	Gillnet	TOTAL	Trawl	Trawl	Artisanal	TOTAL	TOTAL	TOTAL
15				0,522			0,522	0,522	0,906
16									0,000
17				1,414			1,414	1,414	2,454
18				0,799			0,799	0,799	1,387
19				2,644			2,644	2,644	4,589
20				3,247			3,247	3,247	5,635
21				4,744			4,744	4,744	8,233
22				4,117			4,117	4,117	7,145
23				6,423			6,423	6,423	11,147
24				9,176		0,104	9,280	9,280	16,029
25				12,307		0,209	12,516	12,516	21,567
26				16,365	0,042		16,407	16,407	28,443
27				16,961		0,209	17,170	17,170	29,644
28				15,081			15,081	15,081	26,172
29				14,211		0,197	14,408	14,408	24,859
30				14,079	0,037	0,209	14,325	14,325	24,679
31				13,198	0,178	0,104	13,481	13,481	23,187
32				9,252	0,245	0,037	9,534	9,534	16,338
33				7,088	0,443	0,936	8,467	8,467	13,680
34		0,006	0,006	7,278	1,065	4,250	12,593	12,599	17,956
35		0,018	0,018	4,026	0,676	2,415	7,117	7,135	10,109
36		0,029	0,029	6,058	0,340	1,941	8,339	8,368	12,844
37		0,030	0,030	3,853	1,879	1,230	6,962	6,992	9,848
38		0,059	0,059	2,926	1,683	0,657	5,265	5,324	7,520
39		0,029	0,029	2,952	2,342	0,357	5,651	5,680	7,872
40		0,084	0,084	3,227	1,600	1,403	6,230	6,314	8,749
41		0,090	0,090	1,262	1,837	2,921	6,020	6,111	7,105
42		0,043	0,043	2,701	1,664	6,805	11,169	11,212	13,230
43		0,052	0,052	2,512	1,245	0,582	4,339	4,391	6,277
44		0,086	0,086	4,388	1,195	1,802	7,385	7,471	10,762

Table 4.4.3. continued

	Div.8c			Div.9a				Div. 8c+9a	
	SPAIN			SPAIN	PORTUGAL				Adjusted
Length (cm)	Trawl	Gillnet	TOTAL	Trawl	Trawl	Artisanal	TOTAL	TOTAL	TOTAL
45		0,077	0,077	1,354	1,929	10,802	14,085	14,162	15,214
46		0,045	0,045	2,502	1,089	3,479	7,071	7,116	8,989
47		0,036	0,036	1,632	0,893	2,013	4,538	4,574	5,801
48		0,049	0,049	1,358	0,786	1,953	4,096	4,146	5,180
49		0,016	0,016	0,620	0,782	1,844	3,246	3,261	3,729
50		0,040	0,040	0,891	0,686	1,467	3,043	3,083	3,767
51		0,016	0,016	0,697	0,442	2,215	3,354	3,370	3,894
52		0,015	0,015	0,985	1,181	0,860	3,026	3,041	3,776
53		0,062	0,062	0,545	0,172	1,893	2,610	2,672	3,118
54		0,056	0,056	0,907	0,299	0,215	1,421	1,477	2,185
55		0,048	0,048	0,658	0,859	1,693	3,210	3,258	3,777
56		0,044	0,044	0,997	0,390	0,682	2,070	2,114	2,879
57		0,065	0,065	0,197	0,221	0,680	1,098	1,164	1,356
58		0,025	0,025	0,683	0,180	0,742	1,605	1,630	2,150
59		0,049	0,049	0,375	0,238	0,769	1,382	1,432	1,744
60		0,017	0,017	0,190	0,116	0,315	0,622	0,638	0,790
61		0,107	0,107	0,112	0,315	1,844	2,271	2,378	2,540
62		0,078	0,078	0,574	0,494	1,114	2,183	2,260	2,740
63		0,077	0,077	0,486	0,307	0,951	1,743	1,820	2,234
64		0,091	0,091	0,191	0,345	1,712	2,247	2,338	2,545
65		0,108	0,108	0,238	0,552	1,827	2,618	2,725	2,980
66		0,112	0,112	0,730	0,315	1,346	2,391	2,502	3,121
67		0,064	0,064	0,188	0,323	2,187	2,698	2,762	2,948
68		0,064	0,064	0,225	0,342	2,319	2,886	2,950	3,163
69		0,120	0,120	0,170	0,258	1,017	1,445	1,565	1,778
70		0,128	0,128	0,263	0,060	0,830	1,153	1,280	1,568
71		0,056	0,056	0,170	0,167	1,033	1,370	1,425	1,591
72		0,073	0,073	0,094	0,139	0,907	1,140	1,213	1,336
73		0,180	0,180	0,080	0,176	1,654	1,910	2,090	2,281
74		0,190	0,190	0,118	0,137	1,108	1,363	1,553	1,779

	Div.8c			Div.9a				Div. 8c+9a	
	SPAIN			SPAIN	PORTUGAL				Adjusted
Length (cm)	Trawl	Gillnet	TOTAL	Trawl	Trawl	Artisanal	TOTAL	TOTAL	TOTAL
75		0,108	0,108	0,138	0,163	0,930	1,231	1,339	1,520
76		0,134	0,134	0,186	0,565	0,900	1,651	1,785	2,021
77		0,025	0,025	0,132	0,055	0,500	0,687	0,712	0,827
78		0,073	0,073	0,252	0,085	0,562	0,899	0,972	1,211
79		0,102	0,102	0,191	0,000	0,559	0,750	0,852	1,068
80		0,092	0,092	0,367	0,115	0,687	1,169	1,260	1,597
81		0,040	0,040	0,108		0,378	0,486	0,525	0,634
82		0,051	0,051	0,340	0,011	0,074	0,425	0,476	0,764
83		0,044	0,044	0,247	0,022	0,918	1,187	1,231	1,445
84		0,022	0,022	0,170	0,399	0,307	0,876	0,898	1,039
85				0,117		0,188	0,305	0,305	0,391
86		0,022	0,022	0,134	0,030	0,591	0,755	0,777	0,891
87		0,017	0,017	0,088	0,450	0,631	1,169	1,186	1,263
88				0,242		0,069	0,311	0,311	0,489
89				0,102	0,011	0,134	0,247	0,247	0,322
90				0,060		0,097	0,157	0,157	0,201
91				0,034		0,149	0,183	0,183	0,208
92				0,054	0,011	0,155	0,221	0,221	0,260
93				0,101			0,101	0,101	0,175
94				0,036	0,011	0,030	0,077	0,077	0,104
95				0,000	0,000	0,159	0,159	0,159	0,159
96				0,034	0,566	0,030	0,630	0,630	0,655
97				0,015		0,060	0,075	0,075	0,086
98						0,129	0,129	0,129	0,129
99						0,726	0,726	0,726	0,726
100+				0,033		0,189	0,222	0,222	0,246
TOTAL		1	1	3	2	9	15	16	18
Landings (t)		23	23	139	78	262	479	502	621
Mean Weight (g)		31749	31749	43765	31092	28622	32287	32261	33715
Mean Length (cm)		78,9	78,9	81,9	84,4	81,5	82,1	81,9	81,8
Measured weight (t)		n/a	n/a	n/a	1171,3	738,8	1910,1	n/a	n/a

n/a: not available

Table 4.4.4. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Number, mean weight and mean length of landings between 1986 and 2022.

Year	Total (thousands)	Mean Weight (g)	Mean Length (cm)
1986	1704	1504	43
1987	4673	820	34
1988	2653	1395	43
1989	1815	1420	44
1990	1590	1468	44
1991	1672	1294	42
1992	1497	1410	45
1993	1238	1799	48
1994	1063	1486	44
1995	1583	1157	40
1996	1146	1422	44
1997	1452	1248	41
1998	1554	1380	42
1999	1268	1487	42
2000	680	2010	47
2001	435	2329	49
2002	514	1497	41
2003	507	1826	46
2004	468	1974	47
2005	408	2198	49
2006	1030	1115	37
2007	1036	1255	39
2008	503	1889	48
2009	298	2585	51
2010	387	1940	45
2011	531	1641	43
2012	435	2366	49
2013	361	2678	50

Year	Total (thousands)	Mean Weight (g)	Mean Length (cm)
2014	442	2011	43
2015	406	2195	49
2016	340	2602	52
2017	324	2662	50
2018	295	2015	51
2019	230	2591	50
2020	334	2377	42
2021	309	2325	47
2022	498	1248	37

	SpGFS-WIBTS-Q4					PtGFS-WIBTS-Q4					SPGFS-caut-WIBTS-Q4				
	September-October (total area Miño-Bidasoa)					October					Gulf of Cádiz				
Year	Hauls	kg/30 min	se	n/30 min	se	Hauls	kg/h	se	n/h	se	Hauls	g/h	se	n/h	se
1983	145	0,68	0,17	0,50	0,09	117	n/a		n/a						
1984	111	0,60	0,17	0,60	0,11	na	n/a		n/a						
1985	97	0,46	0,11	0,50	0,07	150	n/a		n/a						
1986	92	1,42	0,32	2,50	0,33	117	n/a		n/a						
1987	ns	ns	ns	ns	ns	81	n/a		n/a						
1988	101	2,27	0,38	1,50	0,21	98	n/a		n/a						
1989	91	0,45	0,10	0,90	0,21	138	0,19		0,23						
1990	120	1,52	0,47	1,50	0,22	123	0,17		0,11						
1991	107	0,83	0,14	0,60	0,10	99	0,02		+						
1992	116	1,16	0,19	0,80	0,11	59	+		+						
1993	109	0,90	0,20	0,90	0,13	65	0,04		0,02		29	215	20,95	0,22	0,02
1994	118	0,75	0,17	1,00	0,12	94	0,09		0,06		ns	ns	ns	ns	ns
1995	116	0,72	0,12	1,00	0,11	88	0,08		0,02		ns	ns	ns	ns	ns
1996*	114	0,95	0,17	1,30	0,18	71	0,50		0,27		ns	ns	ns	ns	ns
1997	116	1,16	0,20	0,97	0,11	58	0,01		0,03		27	267	28,94	0,24	0,02
1998	114	0,88	0,18	0,57	0,09	96	0,13	1,28	0,02	0,01	34	139	10,18	0,17	0,01
1999*	116	0,43	0,12	0,26	0,06	79	0,08	0,14	0,10	0,05	38	89	8,21	0,27	0,02
2000	113	0,66	0,18	0,40	0,08	78	0,34	5,93	0,28	0,12	30	514	29,84	0,92	0,04
2001	113	0,19	0,06	0,52	0,10	58	0,02	0,02	0,02	0,02	39	298	24,36	0,41	0,04
2002	110	0,26	0,09	0,33	0,07	67	0	0	0	0	39	224	22,58	0,33	0,02
2003*	112	0,36	0,11	0,35	0,10	80	0,39	2,57	0,35	0,15	41	370	30,20	0,30	0,02
2004*	114	0,76	0,23	0,44	0,12	79	0,21	0,83	0,15	0,07	40	509	37,94	0,26	0,02
2005	116	0,64	0,20	1,62	0,30	87	0,01	0,01	0,07	0,07	42	990	43,43	2,60	0,08
2006	115	1,08	0,22	1,16	0,19	88	0,00	0,00	0,00	0,00	41	465	37,91	0,22	0,01
2007	117	0,59	0,12	0,48	0,08	96	0,03	0,06	0,02	0,02	37	703	54,25	0,40	0,03
2008	115	0,35	0,09	0,29	0,05	87	0,36	4,67	0,07	0,04	41	449	25,49	0,24	0,01
2009	117	0,30	0,08	0,35	0,08	93	0,00	0,00	0,02	0,02	43	561	35,11	0,43	0,02
2010	127	0,35	0,09	0,53	0,09	87	0,18	1,75	0,09	0,05	44	726	60,01	0,73	0,04
2011	111	0,63	0,15	0,52	0,08	86	0,06	0,28	0,02	0,02	40	806	43,58	0,57	0,03
2012	115	0,61	0,10	0,74	0,11	ns	ns	ns	ns	ns	37	723	53,73	0,77	0,03
2013^	114	1,27	0,36	1,40	0,35	93	0,03	0,10	0,02	0,02	43	1572	69,91	1,29	0,07
2014^	116	1,11	0,27	0,87	0,15	81	0,00	0,00	0,00	0,00	45	531	28,31	0,38	0,02
2015^	114	0,55	0,13	0,36	0,08	90	0,00	0,00	0,00	0,00	43	2058	96,93	1,45	0,05
2016^	114	0,51	0,10	0,40	0,06	85	0,30	7,51	0,02	0,02	45	1196	51,70	1,16	0,05
2017^	112	0,55	0,15	0,35	0,08	89	0,05	0,16	0,09	0,05	44	1085	49,24	0,76	0,03
2018^	113	0,76	0,23	0,29	0,07	53	0,10	0,50	0,08	0,08	45	1645	82,01	1,85	0,05
2019^	113	0,41	0,15	0,17	0,04	ns	ns		ns	ns	43	1252	50,62	0,68	0,02
2020^	109	0,29	0,12	0,27	0,07	ns	ns		ns	ns	44	1296	65,29	1,23	0,03
2021**,^^	113	0,47	0,15	0,47	0,13	93	0,33	3,20	0,53	0,17	ns	ns	ns	ns	ns
2022^	114	0,46	0,09	0,71	0,12	61	0,37	0,94	0,59	0,18	45	2578	71,53	8,53	0,40

Table 4.4.6. Black-bellied anglerfish (L. budegassa) in divisions 8.c and 9.a. Landings (in tonnes), fishing effort, standardized fishing effort, LPUE and standardized LPUE for trawl (all except the STAND-SP-CEDGNS8C) and gillnet fleets (STAND-SP-CEDGNS8C). For the landings, the percentage relative to the total annual stock landings is given.

	Avilés, SP-AVITR8C				Santander, SP-SANTR8C				Standardized Cedeira, STAND-SP-CEDGNS8C			
Year	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (soaking days)	LPUE (kg/soaking day)
1986	64	3	10845	5,9	21	1	18153	1,1	--	--	--	--
1987	85	2	8309	10,3	16	0	14995	1,1	--	--	--	--
1988	125	3	9047	13,9	30	1	16660	1,8	--	--	--	--
1989	119	5	8063	14,7	32	1	17607	1,8	--	--	--	--
1990	58	2	8497	6,8	40	2	20469	1,9	--	--	--	--
1991	52	2	7681	6,7	62	3	22391	2,8	--	--	--	--
1992	33	2	--	--	107	5	22833,0	4,7	--	--	--	--
1993	53	2	7635	7,0	143	6	21370	6,7	--	--	--	--
1994	65	4	9620	6,7	196	12	22772	8,6	--	--	--	--
1995	141	8	6146	23,0	126	7	14046	9,0	--	--	--	--
1996	162	10	4525	35,8	89	5	12071	7,4	--	--	--	--
1997	143	8	5061	28,3	122	7	11776	10,4	--	--	--	--
1998	91	4	5929	15,3	114	5	10646	10,7	--	--	--	--
1999	41	2	6829	5,9	67	4	10349	6,5	14	1	4 582	3,0
2000	23	2	4453	5,1	44	3	8779	5,0	4	<1	2 981	1,3
2001	12	1	1838	6,7	28	3	3053	9,3	6	1	1 932	3,0
2002	11	1	2748	4,1	16	2	3975	4,1	7	1	2 398	3,0
2003	9	1	2526	3,6	15	2	3837	4,0	3	<1	2 703	0,9
2004	32	3	--	--	23	2	3776,0	6,0	5	1	4 677	1,1
2005	54	6	--	--	7	1	1404,0	4,9	2	<1	3 325	0,7
2006	16	1	--	--	18	2	2717,5	6,8	4	<1	3 911	1,0
2007	11	1	--	--	19	1	4333,7	4,5	2	<1	3 976	0,6
2008	10	1	--	--	--	--	--	--	0	<1	5 133	0,1
2009	5	1	--	--	8	1	1124,8	6,8	4	1	2 300	1,7
2010	--	--	--	--	19,4	3	1627,8	11,9	4	1	1 880	2,1
2011	--	--	--	--	36,4	4	--	--	1	<1	522	1,3
2012	--	--	--	--	21,8	2	--	--	4	<1	--	--

Table 4.4.6. continued

	A Coruña-Port, SP-CORTR8C-PORT				A Coruña-Trucks, SP-CORTR8C-TRUCKS				A Coruña-Fleet, SP-CORTR8C-FLEET			
Year	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)	LANDINGS	%	EFFORT (days*100hp)	LPUE (kg/day*100hp)
1982	655	28	63 313	10,3	--	--	--	--	655	28	63 313	10,3
1983	765	32	51 008	15,0	--	--	--	--	765	32	51 008	15,0
1984	574	30	48 665	11,8	--	--	--	--	574	30	48 665	11,8
1985	253	14	45 157	5,6	--	--	--	--	253	14	45 157	5,6
1986	352	14	40 420	8,7	--	--	--	--	352	14	40 420	8,7
1987	673	18	34 651	19,4	--	--	--	--	673	18	34 651	19,4
1988	570	15	41 481	13,7	--	--	--	--	570	15	41 481	13,7
1989	344	13	44 410	7,7	--	--	--	--	344	13	44 410	7,7
1990	288	12	44 403	6,5	--	--	--	--	288	12	44 403	6,5
1991	225	10	40 429	5,6	--	--	--	--	225	10	40 429	5,6
1992	211	10	38 899	5,4	--	--	--	--	211	10	38 899	5,4
1993	199	9	44 478	4,5	--	--	--	--	199	9	44 478	4,5
1994	166	11	39 602	4,2	37	2	12 795	2,9	204	13	52 397	3,9
1995	353	19	41 476	8,5	75	4	10 232	7,3	428	23	51 708	8,3
1996	334	21	35 709	9,4	68	4	8 791	7,8	403	25	44 501	9,0
1997	298	16	35 494	8,4	43	2	9 108	4,8	341	19	44 602	7,7
1998	323	15	29 508	10,9	72	3	--	--	394	19	--	--
1999	374	20	30 131	12,4	--	--	--	--	--	--	--	--
2000	287	21	30 079	9,6	6	0	--	--	293	21	--	--
2001	281	28	29 935	9,4	--	--	--	--	--	--	--	--
2002	76	9	21 948	3,5	31	4	6 747	4,6	107	13	28 695	3,7
2003	85	9	18 519	4,6	43	5	7 608	5,6	128	14	26 127	4,9
2004	68	7	19 198	3,5	40	4	10 342	3,8	107	11	29 540	3,6
2005	54	6	20 663	2,6	32	3	10 302	3,1	86	9	30 965	2,8
2006	70	6	19 264	3,6	81	7	12 866	6,3	151	13	32 130	4,7
2007	109	8	21 651	5,1	113	9	13 187	8,6	223	17	34 838	6,4
2008	163	17	20 212	8,1	98	10	9 812	10,0	261	27	30 024	8,7
2009	80	10	16 152	5,0	67	9	12 930	5,2	147	19	29 092	5,1
2010	74	10	16 680	4,4	87	12	9 003	9,7	199	26	22 746	8,7
2011	64	7	12 835	5,0	--	--	--	--	144	15	18 617	7,7
2012	102	9	14 446	7,0	--	--	--	--	172	15	21 110	8,2
2013	88	8	14 736	6,0	--	--	--	--	--	--	--	--
2014	79	8	18 060	4,4	--	--	--	--	--	--	--	--
2015	67	6	13 309	5,0	--	--	--	--	--	--	--	--
2016	89	9	13 718	6,5	--	--	--	--	--	--	--	--
2017	64	7	12 449	5,2	--	--	--	--	--	--	--	--
2018	79	10	13 247	6,0	--	--	--	--	--	--	--	--
2019	75	11	12 824	5,9	--	--	--	--	--	--	--	--
2020	--	--	--	--	--	--	--	--	--	--	--	--
2021	56,8	8	13498	4,2								
2022	55,3	8,9	13478	4,1								

	Portugal Crustacean, PT-TRC9A						Portugal Fish, PT-TRF9A					
Year	LANDINGS	%	EFFORT (1000 hours)	EFFORT (1000 hauls)	LPUE (kg/hour)	LPUE (kg/haul)	LANDINGS	%	EFFORT (1000 hours)	EFFORT (1000 hauls)	LPUE (kg/hour)	LPUE (kg/haul)
1989	89	3	76	23	--	3,92	183	7	52	18	3,1	10,4
1990	127	5	90	20	0,8	6,2	261	11	61	17	4,9	15,2
1991	101	5	83	17	--	6,1	208	10	57	15	3,5	13,5
1992	94	4	71	15	1,1	6,2	193	9	49	14	2,3	14,1
1993	64	3	75	13	0,9	4,8	132	6	56	13	2,2	10,1
1994	26	2	41	8	0,6	3,4	53	3	36	10	1,2	5,5
1995	22	1	38	8	0,7	2,8	46	2	41	9	1,4	5,0
1996	45	3	64	14	0,8	3,1	88	5	54	12	2,1	7,1
1997	38	2	43	11	1,0	3,3	43	2	27	9	1,3	4,9
1998	70	3	48	11	1,3	6,3	111	5	35	10	1,1	11,5
1999	41	2	24	8	0,9	5,0	69	4	18	6	1,5	12,2
2000	66	5	42	10	2,7	6,5	76	6	19	6	2,0	12,6
2001	59	6	85	18	0,8	3,2	42	4	19	5	1,0	8,5
2002	47	6	62	10	--	4,8	28	3	14	4	2,7	6,2
2003	30	3	42	10	0,7	3,1	38	4	17	6	2,2	6,7
2004	23	2	21	7	0,9	3,5	27	3	14	4	1,8	6,2
2005	12	1	20	5	0,7	2,4	19	2	13	4	1,1	5,0
2006	18	2	22	5	0,9	3,3	22	2	12	4	1,3	5,6
2007	34	3	22	6	1,3	5,6	31	2	8	3	2,4	10,5
2008	21	2	14	4	1,3	5,4	19	2	5	2	1,9	10,6
2009	18	2	15	--	1,0	--	16	2	6	--	1,7	--
2010	37	5	21	--	1,6	--	34	4	14	--	2,7	--
2011	39	4	18	--	2,4	--	36	4	9	--	2,6	--
2012	66	6	36	--	2,8	--	90	8	16	--	4,8	--
2013	37	3	27	--	2,6	--	62	6	12	--	3,6	--
2014	50	5	17	--	2,9	--	66	7	16	--	2,9	--
2015	48	5	17	--	3,4	--	78	7	14	--	2,6	--
2016	52	5	12	--	4,6	--	67	7	11	--	3,4	--
2017	42	5	9	--	4,0	--	26	3	11	--	2,4	--
2018	36	5	5	--	5,1	--	16	2	6	--	2,8	--
2019	27	4	6	--	3,7	--	16	2	5	--	2,6	--
2020	52	7	--	--	4,4	--	76	10	--	--	4,1	--
2021	52	7	--	--	4,1	--	45	6	--	--	4,0	--
2022	49	7	--	--	3,9	--	29	4	--	--	4,1	--

Table 4.4.7. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. SPiCT summary results.

Model parameter estimates w 95% CI				
	estimate	**cilow**	**ciupp**	**log.est**
alpha	3.183	0.442	22.918	1.158
beta	0.134	0.024	0.768	-2.006
r	0.245	0.115	0.521	-1.408
rc	0.245	0.115	0.521	-1.408
rold	0.245	0.115	0.521	-1.408
m	1735	1276	2358	7.460
K	28378	13977	57617	10.250
q	0.000	0.000	0.000	-8.510
sdb	0.091	0.016	0.529	-2.401
sdf	0.201	0.137	0.293	-1.606
sdi	0.289	0.207	0.403	-1.243
sdc	0.027	0.005	0.145	-3.613

Deterministic reference points (Drp)				
	estimate	**cilow**	**ciupp**	**log.est**
B_{MSYd}	14189	6988	28808	9.560
F_{MSYd}	0.122	0.057	0.260	-2.102
MSYd	1735	1276	2358	7.460

Stochastic reference points (Srp)					
	estimate	**cilow**	**ciupp**	**log.est**	**rel.diff.Drp**
B_{MSYs}	13918	6790	28531	9.540	-0.019
F_{MSYs}	0.120	0.057	0.252	-2.118	-0.017
MSYs	1673	1290	2169	7.420	-0.037
*					

Model parameter estimates w 95% CI				
	estimate	cilow	ciupp	log.est

States w 95% CI				
	estimate	cilow	ciupp	log.est
B_2022.94	19045	9990	36309	9.850
F_2022.94	0.032	0.016	0.064	-3.436
B_2022.94/B_{MSY}	1.368	0.853	2.195	0.314
F_2022.94/F_{MSY}	0.268	0.152	0.472	-1.317

Predictions w 95% CI				
	prediction	cilow	ciupp	log.est
B_2024.00	19885	10528	37559	9.900
F_2024.00	0.032	0.015	0.071	-3.436
B_2024.00/B_{MSY}	1.429	0.905	2.254	0.357
F_2024.00/F_{MSY}	0.268	0.134	0.537	-1.317
Catch_2023.00	627	445	884	6.44
E(B_inf)	23607	NA	NA	10.07

Table 4.4.8. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. SPiCT estimates for B/B_{MSY} and F/F_{MSY}. The 95% confidence intervals (CIs) are also provided.

Year	B/B_{MSY}			F/F_{MSY}		
	Estimate	CI high	CI Low	Estimate	CI high	CI Low
1980	1.42	2.90	0.69	0.93	1.69	0.52
1981	1.40	2.66	0.74	1.02	1.75	0.59
1982	1.38	2.49	0.76	1.07	1.81	0.64
1983	1.35	2.35	0.77	1.01	1.67	0.61
1984	1.29	2.19	0.76	0.86	1.40	0.53
1985	1.24	2.07	0.74	0.96	1.53	0.60
1986	1.27	2.05	0.79	1.42	2.55	0.79
1987	1.33	2.36	0.75	1.92	4.14	0.89
1988	1.26	2.63	0.60	1.68	3.57	0.79
1989	1.09	2.21	0.54	1.41	2.89	0.69
1990	1.01	1.97	0.51	1.43	2.93	0.69
1991	0.94	1.85	0.48	1.45	2.76	0.76
1992	0.86	1.56	0.47	1.69	3.10	0.93
1993	0.79	1.41	0.44	1.62	2.72	0.97
1994	0.68	1.12	0.42	1.52	2.46	0.94
1995	0.65	1.05	0.40	1.69	2.76	1.03
1996	0.63	1.02	0.39	1.62	2.63	1.00
1997	0.61	0.98	0.37	1.97	3.28	1.18
1998	0.60	1.00	0.36	2.15	3.87	1.19
1999	0.57	1.02	0.32	1.81	3.40	0.96
2000	0.54	0.98	0.29	1.36	2.51	0.74
2001	0.52	0.93	0.29	1.00	1.81	0.55
2002	0.52	0.93	0.29	0.89	1.64	0.48
2003	0.57	1.02	0.31	0.99	1.85	0.52
2004	0.60	1.10	0.33	0.94	1.69	0.52
2005	0.61	1.07	0.34	0.94	1.69	0.53
2006	0.64	1.13	0.36	1.11	2.14	0.57

Year	B/B_{MSY}			F/F_{MSY}		
	Estimate	CI high	CI Low	Estimate	CI high	CI Low
2007	0.70	1.32	0.37	0.97	1.91	0.49
2008	0.72	1.36	0.38	0.69	1.29	0.37
2009	0.73	1.33	0.40	0.56	1.04	0.30
2010	0.79	1.42	0.44	0.56	1.07	0.29
2011	0.89	1.65	0.47	0.64	1.38	0.30
2012	1.00	2.06	0.48	0.64	1.45	0.29
2013	1.05	2.23	0.50	0.58	1.20	0.28
2014	1.06	2.07	0.54	0.57	1.12	0.29
2015	1.07	2.03	0.57	0.57	1.13	0.29
2016	1.10	2.05	0.59	0.51	0.96	0.27
2017	1.10	1.96	0.61	0.44	0.80	0.25
2018	1.11	1.92	0.64	0.37	0.66	0.21
2019	1.13	1.92	0.67	0.35	0.62	0.20
2020	1.22	2.06	0.72	0.36	0.66	0.20
2021	1.31	2.23	0.76	0.30	0.52	0.17
2022	1.33	2.19	0.81	0.27	0.47	0.15
2023	1.37	2.20	0.86			

Table 4.4.9. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Estimates of catch. B/B_{msy} and F/F_{msy} for the scenarios proposed.

Scenario	Catch (t)	B/B_{MSY}	F/F_{MSY}
$F = 0$	0	1.52	0.00
$F = F_{sq}$	651	1.48	0.27
$F = F_{MSY}$	2337	1.36	1.00
$F = F_{MSY\_c\_fractile}$	2111	1.38	0.90

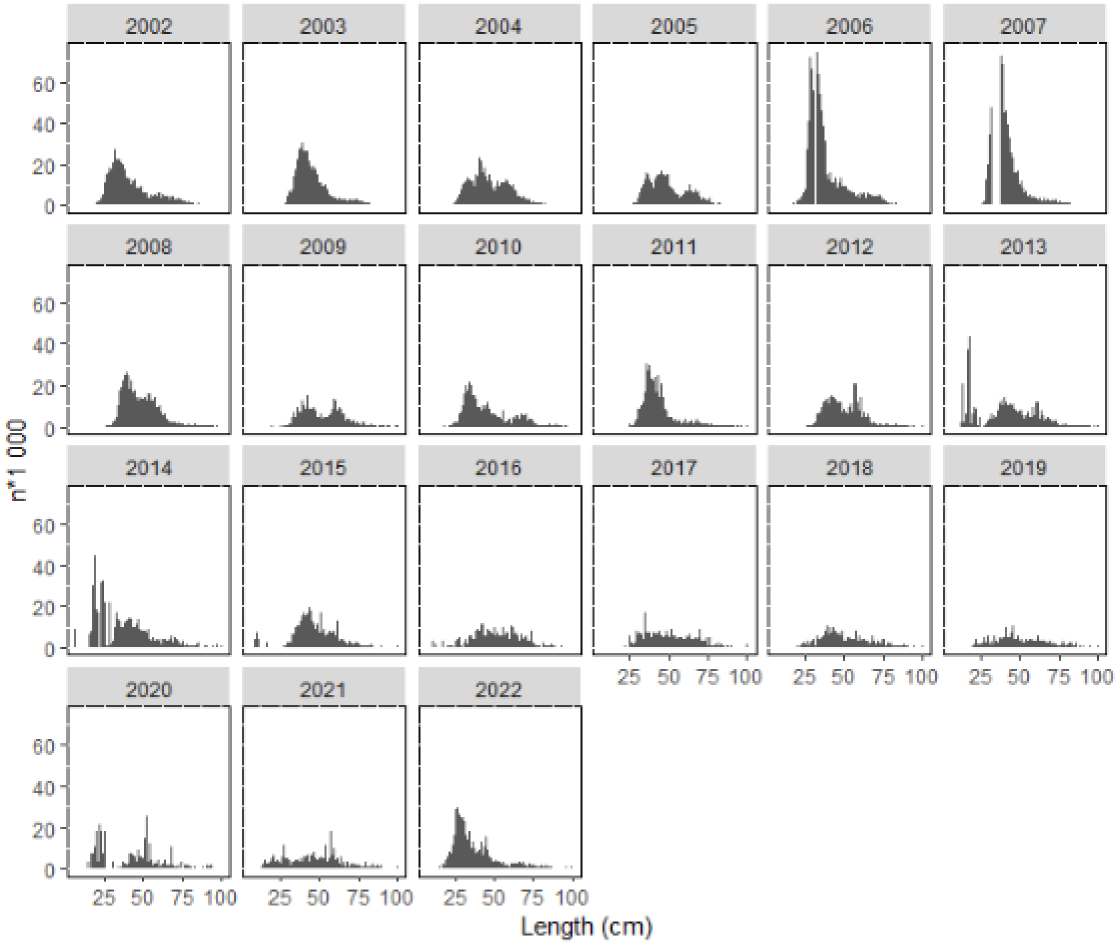

Figure 4.4.1. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Length distributions of commercial landings (in thousands) for the period 2002–2022.

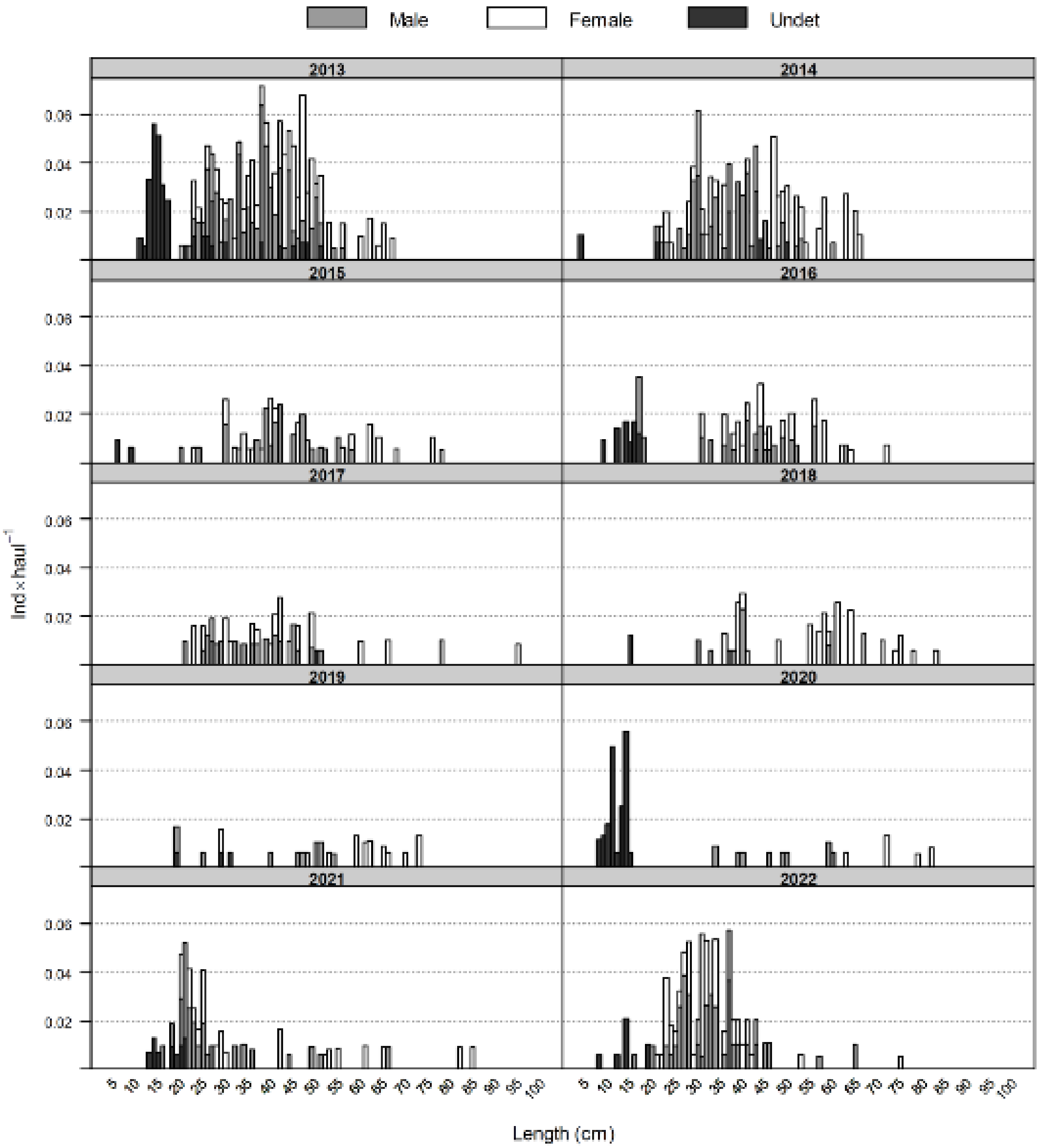

Figure 4.4.2. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Mean stratified length distributions in the Northern Spanish Shelf Groundfish Survey (SpGFS-WIBTS-Q4, G2784) for the period 2011–2022 (from Blanco *et al.*, 2023).

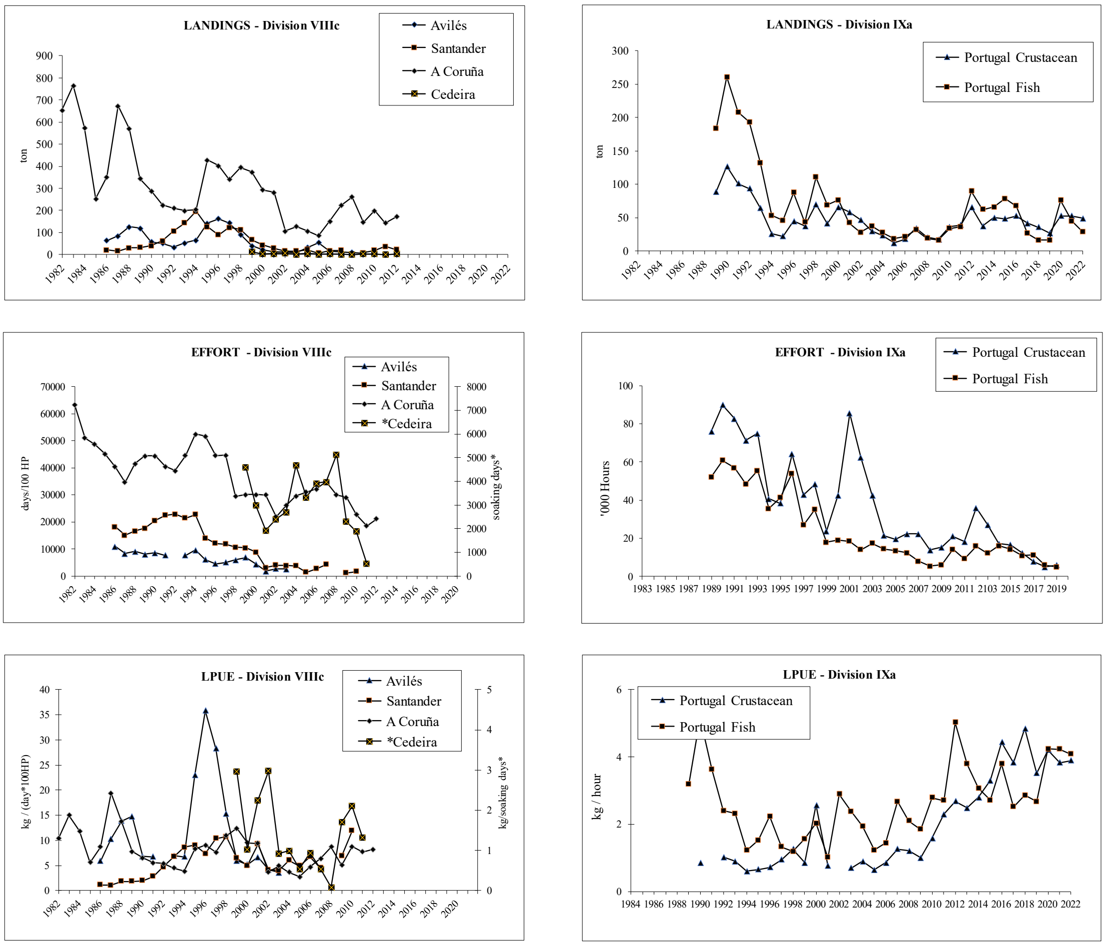

Figure 4.4.3. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Trawl (left) and gillnet (right) landings (in tonnes), effort (in days/100 HP in division 8c and '000 hours in division 9a) and LPUE (in kd/(day*100 HP) in division 8c and kg/hr in division 9a) data between 1986 and 2022.

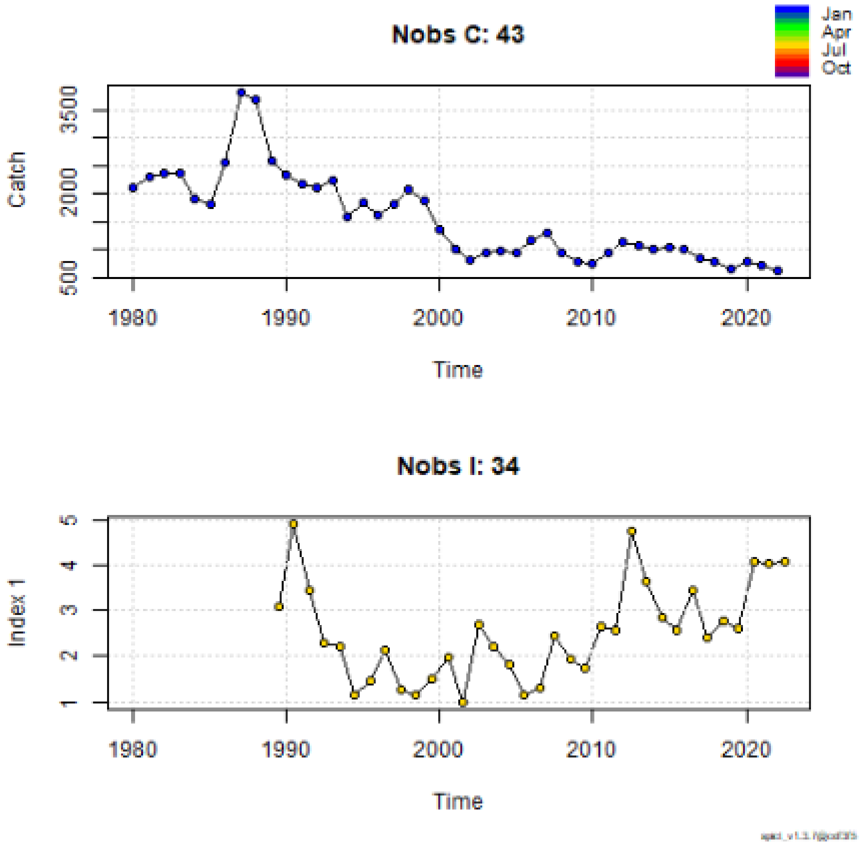

Figure 4.4.4. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. SPiCT input data. Catch data (upper panel) and Portuguese trawl fleet (PT-TRF9a) targeting fish LPUE index for the period of 1989 to 2022 (lower panel).

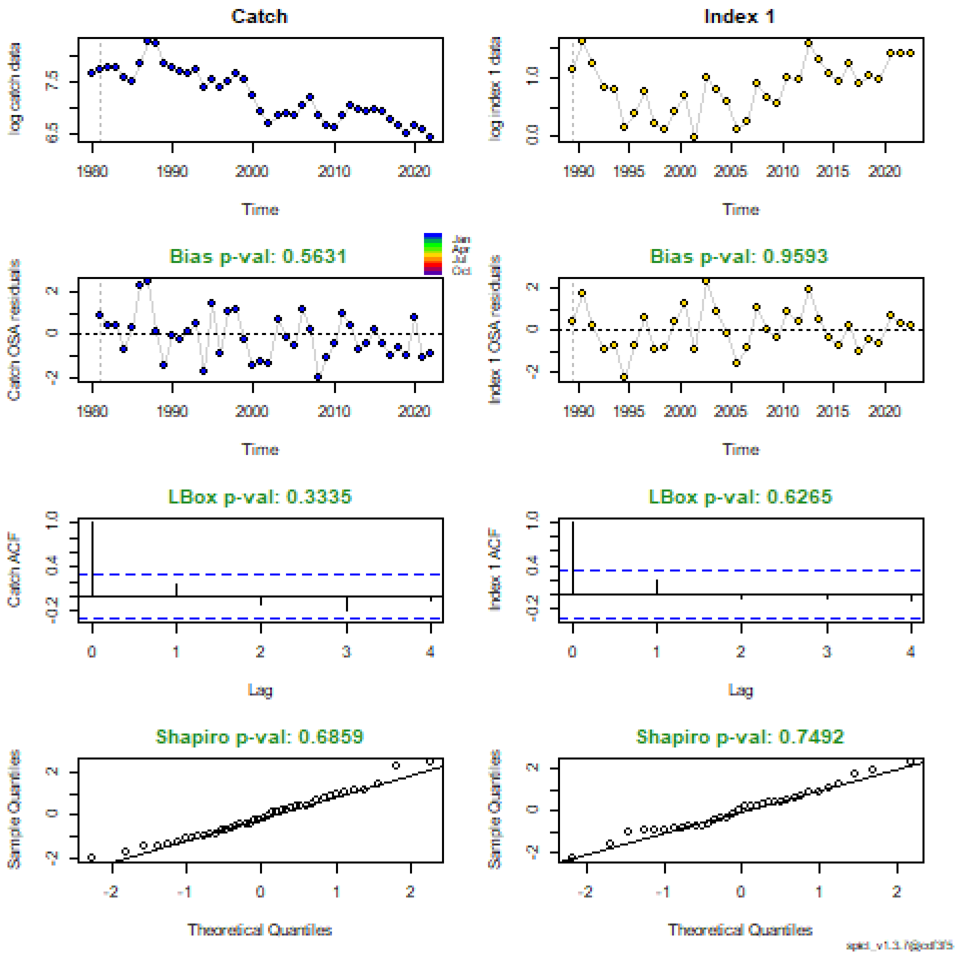

Figure 4.4.5. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. SPiCT diagnostics. Row1: Log of the input dataseries. Row 2: OSA residuals with the p-value of a test for bias. Row 3: Empirical autocorrelation of the residuals with tests for significant autocorrelation. Row 4: Tests for normality of the residuals, QQ-plot and Shapiro test.

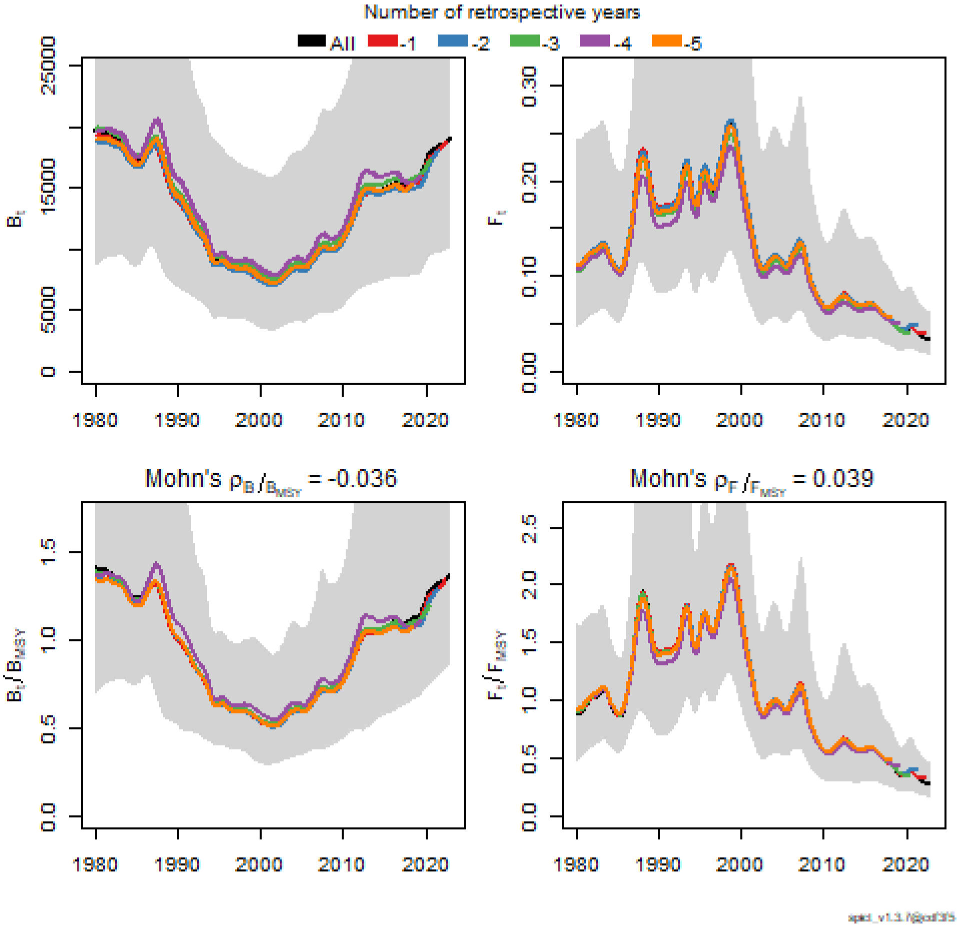

Figure 4.4.6. Anglerfish (*L. budegassa*) in divisions 8.c and 9.a. Five years retrospective analysis. Upper panel: absolute biomass and fishing mortality. Lower panel: relative biomass and fishing mortality. Grey regions represent the 95% CIs.

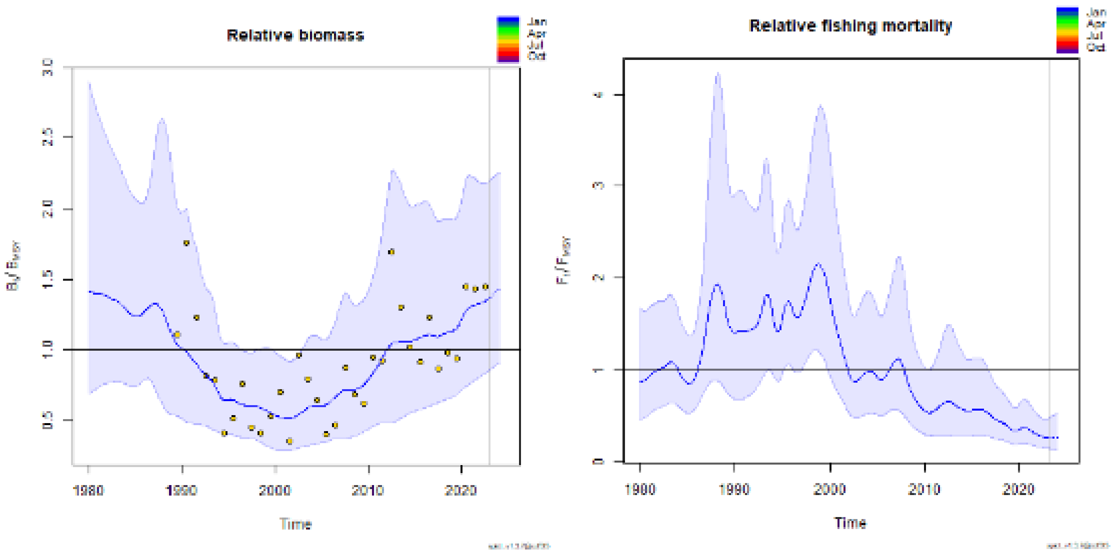

Figure 4.4.7. Black-bellied anglerfish (*L. budegassa*) in divisions 8.c and 9.a. SPiCT results: Left panel is the relative biomass and the right panel is the relative fishing mortality. Solid blue lines are estimated values; vertical grey lines indicate the time of the last observation beyond which dotted lines indicate forecasts; shaded blue regions are the 95% CIs for relative estimates; solid circles correspond to the Portuguese fish fleet (PT-TRF9a) index.

5 Megrim and four-spot megrim west and southwest of Ireland and in the Bay of Biscay

meg.27.7b-k8abd and ldb.27.7b-k8abd – *Lepidorhombus whiffiagonis* and *Lepidorhombus boscii* in divisions 7.b-k, 8.a-b, and 8.d

5.1 General

Megrim in divisions 7.b–k, 8.a–b, and 8.d (meg.27.7b-k8abd) is a category 1 stock (ICES, 2023a). This stock was last benchmarked at WKMEGRIM in 2022 (ICES, 2023b) using the a4a (Millar and Jardim, 2019) statistical catch-at-age model. Data revisions were also done at the benchmark (ICES, 2023b), including additional revision of discard data from Ireland for the year 2020.

Four-spot megrim in divisions 7.b–k, 8.a–b, and 8.d (ldb.27.7b-k8abd) is a category 5 stock (ICES, 2023a) with no quantitative assessment, for which either only data on landings or a short time-series of catch are available. Data revisions: first year of stock assessment (survey indices included) was done in 2022 (ICES, 2022).

5.1.1 Ecosystem aspects

See the Stock Annex (note: SA for meg.27.7b-k8abd was updated in the 2022 following the WKMEGRIM benchmark; ICES, 2023b)[1] for more details on the ecosystem aspects related to the megrim assessment.

5.1.2 Fishery description

Megrim (*L. whiffiagonis* and *L. boscii*) in the Celtic Sea, west of Ireland, and in the Bay of Biscay are caught in a mixed fishery predominantly by French vessels; followed by Spanish, UK, and Irish demersal vessels. In 2022, the four countries together have reported around 92% of the total landings (Table 5.2.1). Estimates of total landings (including unreported or misreported landings) and catches (landings and discards) as used by WGBIE up to 2022 are shown in Table 5.2.2.

5.1.3 Summary of ICES advice for 2023 and management for 2021 and 2022

5.1.3.1 ICES advice for 2023 (as extracted from ICES Advice 2022)

ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 23 596 t.

ICES notes the existence of a precautionary management plan (ICES, 2023a), developed and adopted by one of the relevant management authorities for this stock.

[1] ICES. 2022. ICES Stock Annex: Megrim (*Lepidorhombus whiffiagonis*) in divisions 7.b–k, 8.a–b, and 8.d (west and southwest of Ireland, Bay of Biscay). Produced by the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) and updated in August 2022 by the WKMEGRIM Benchmark workshop for selected megrim stocks (ICES, 2023b).

Management of catches of the two megrim species, *L. whiffiagonis* and *L. boscii*, under a combined species TAC prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species.

5.1.3.2 Management applicable for 2022 and 2023

The agreed TAC for the combined species was set at 23 459 t for 2022 and 2023.

The minimum landing size (MLS) for megrim was reduced from 25 to 20 cm in 2000.

5.2 Megrim (*L. whiffiagonis*) in divisions 7.b–k, 8.a, 8.b, and 8.d

5.2.1 General

See general section for both species.

5.2.2 Data

5.2.2.1 Commercial catches and discards

Megrim (*L. whiffiagonis*) stock catches for the period 1984–2022, as estimated by WGBIE, are given in Table 5.2.1. This is the sixth year that all landings and discards data have been uploaded to InterCatch. In addition to these imported data, both the discard raising and data allocation were implemented using the InterCatch tool.

Landings in 2022 (10 821 t) are slightly lower than in 2021 (12 418 t; < 13%).

Since 2011, estimates of unallocated or non-reported landings have been included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each métier.

Spanish data showed a decreasing trend from 2009 onwards until 2018. During the IBPMegrim workshop held in 2016 (ICES, 2016), the French landing data series were updated from 2003–2014. Landings data from France showed initially an increasing trend from 2015 onwards and remained stable in the last three years. In 2021, landings from Ireland, UK and Belgium increased.

French discards data from 2004–2014 were provided for the IBPMegrim in 2016 (ICES, 2016) and were updated in 2017. Apart from France, an increase in discards was observed for all other countries fishing for this stock in 2021.

Discard data available by country and the procedure to derive them are summarized in Table 5.2.3. The discards decrease observed in year 2000 can be partly explained by the reduction in the MLS from 25 cm to 20 cm. Since 2000, fluctuating trends were observed with a peak in 2004 while the minimum observed level in the whole series was observed in 2019. When a country uploads a blank field for discards, then it means that the discards are unknown (i.e. not monitored). During the WKMEGRIM benchmark (ICES, 2023b) in 2022, a discard raising procedure was implemented to take into account these unaccounted values.

Table 5.2.4 presents the discard ratio in percentage (%) from catches in weight of the most recent years.

5.2.2.2 Biological sampling

Age and length frequency distribution (AFD and LFD, respectively) data provided by countries are summarized in the Stock Annex (Annex E).

Age

France, Ireland, UK and Belgium initially provided numbers-at-age to InterCatch then eventually submitted a complete series with numbers- and weights-at-age up to 2022. Age distribution for landings and discards from 2011–2022 is presented in Figure 5.2.1.

Lengths

Table 5.2.5 shows the available original length composition of landings by Fishing Unit (FU) in 2022.

Natural Mortality

A value of 0.2 for the natural mortality (M) has been used as input data for all ages and years in the final assessment model.

5.2.2.3 Survey data

Western IBTS Q4 Porcupine Survey (Spain) – SP_PORC

The Spanish Groundfish Survey in the Porcupine bank (SpPGFS -WIBTS-Q3, G5768) covers ICES divisions 27.7c,k and a small portion of 27.7b corresponding to the Porcupine Bank and the adjacent area in western Irish waters from longitude 12°W to 15°W and from latitude 51°N to 54°N, covering depths between 180 and 800 m. The survey takes place at the end of the third quarter (September), and the beginning of 4th quarter.

The available survey index consists of catch numbers-at-age per 30 minutes fished for the years 2001 onwards. The age composition by year is presented in Figure 5.2.3.

Western IBTS Q4 EVHOE and IGFS surveys (France/Ireland) – FR_IE_IBTS

The Irish IBTS Q4 groundfish survey (IGFS-WIBTS-Q4, G7212) covers areas 27.7bgjk. The French EVHOE-WIBTS-Q4 (G9527) survey covers areas 27.7j8ab. Both surveys use a GOV trawl and are coordinated and largely standardized by the WGIBTS (ICES, 2009). Together the two surveys cover the majority of the stock area up to depths of 200–300 m. This is where most of the young fish occur. Older fishes migrate to deeper waters and, thus, are not well sampled by these surveys.

Data for Irish and French IBTS Q4 groundfish surveys (IGFS-WIBTS-Q4, G7212 and EVHOE-WIBTS-Q4, G9527) were obtained from DATRAS and then quality checked and cleaned. The two surveys were combined by weighting the average catches by the area covered by each survey series. This combined French and Irish survey index is referred to by the ICES acronym FR_IE_IBTS. Thus, IGFS-WIBTS-Q4 (G7212) represents a catch weight of approximately 45% and 55% for the EVHOE WIBTS-Q4 (G9527). The combined survey index appears to give a more coherent recruitment signal when used in the assessment than when each survey is used separately.

The age composition by year is presented in Figure 5.2.4.

Irish Anglerfish and Megrim Survey (Ireland) – IE_Monksurvey

Ireland has carried out the Irish Anglerfish and Megrim (IAMS, G3098) survey every year in Q1 since 2016.

The survey covers ICES areas 7bcjk and the western part of 7gh; the depth range is from around 50 to 1000 m. The survey covers the main distribution area of megrims in Area 7 and although areas 8.a, 8.b, and 8.d is not covered, this area only contributes around 10% of the landings. Therefore, the survey can be considered to cover the vast majority of the stock distribution.

The survey uses a relatively large mesh gear and the catchability of small megrims is relatively low. Because female megrims grow to a larger size than males, the catchability is expected to be different by sex. Therefore, both sex-specific and sex-combined indices are provided.

Available fisheries independent surveys used as tuning fleets.

Type	Name	Year range	Age range	Used in the assessment
Spanish Porcupine groundfish survey	SpPGFS-WIBST-Q3 (G5768)	2001-present	0–10+	Yes
Combined French and Irish survey	FR_IE_IBTS	2003-present	0–10+	Yes
French EVHOE groundfish survey	EVHOE-WIBTS-Q4 (G9527)	1997-present	1–9	No
Irish groundfish survey	IGFS-WIBTS-Q4 (G7212)	2003-present	0–10+	No
Irish Anglerfish and Megrim survey	IAMS-Q1 (G3098)	2016-present	0–10+	No

Abundance Indices for SpPGFS-WIBTS-Q4 (G5768) and for the combined FR_IE_IBTS surveys are presented in numbers-at-age in Table 5.2.6. The biomass abundance index is given in Table 5.2.7 while the scaled biomass indices trends are shown in Figure 5.2.2.

5.2.2.4 Commercial catch and effort data

The use of commercial CPUE data was rejected during the WKMEGRIM benchmark (ICES, 2023b) due to concerns about the changes in efficiency, targeting behaviour, quota restrictions, technical measures, discarding and compliance. However, information on trends in effort, landings and LPUE or CPUE may be used by WGBIE as supplementary information.

5.2.3 Assessment

A statistical catch-at-age stock assessment model developed as part of the Assessment For All (a4a; Millar and Jardim, 2019) initiative of the European Commission Joint Research Centre is used. The stock assessment model framework is a non-linear catch-at-age model implemented in R (R Core Team, 2022) and FLR (Kell *et al*., 2007), and uses an ADMB (Fournier *et al*., 2012) that can be applied rapidly to a wide range of situations with low parameterization requirements. The model structure is defined by sub-models, which are different parts, that require structural assumptions. There are five sub-models in operation: a model for F-at-age, a model for the initial age structure, a model for recruitment, a (list) of model(s) for abundance indices catchability-at-age, and a list of models for the observed variance of catch-at-age and abundance indices. The sub-models form use linear models.

- See https://github.com/flr/FLa4a/blob/master/docs/articles/sca.pdf/ for details on the a4a framework.

5.2.3.1 Data exploratory analysis

In summary, the stock's catch-at-age matrix shows three periods: 1984–1989; 1990–1998 and 1999–2022.

The data analysed consist of landed, discarded and catch numbers-at-age and abundance indices-at-age. Three of the available surveys were considered appropriate to include in the assessment model as tuning fleets: SpPGFS_WIBTS-Q4 (G5768) and the combined FR_IE_IBTS surveys based on their representativeness of the megrim stock abundance. Several exploratory data analyses were performed to examine their ability to track cohorts through time.

The time-series of catch-at-age (Figure 5.2.6) showed very low catches of ages 1–5 from 1984 to 1989. From 2004 to 2010, the catch of older ages (> 6) was remarkably low, whereas catches of ages 1 and 2 increased considerably from 2003. This could be a result of an underestimation of catches of these younger ages (especially age 1) during the previous years coupled by the sparseness of discard data during the same period. For ages 6 and older, large discrepancies in the number of individuals caught before and after 1990 are apparent, with large catches of these ages before 1990 and a decrease of all ages at the end of the data series.

The analysis of landings since 1990 is presented in Figure 5.2.7. Landings of ages 1 and 2 have increased from the beginning of the time-series. In fact, the proportion of older ages in the landings decreased significantly from 2004 to 2009, as already discussed in relation to the catch. Ages 1 increased significantly since 2017 mainly due to the French landings and there was an increase of age 4 in the last year 2022.

The signal coming from the discard data showed that the discards of age 1 were low at the beginning of the data series (Figure 5.2.8). Discards of this age increased particularly from 2003 onwards. From 2010 to 2013, ages 1 to 3 appeared to be highly discarded. An overall increase in older ages discards is observed during the last years (2016–2022).

The analysis of the standardized log abundance indices for the updated data revealed a strong year class in 2007 for the SpPGFS-WIBTS-Q4 (G5768) survey (Figure 5.2.9) but in general, shows little or no cohort tracking in the other surveys. Presumably, this is a consequence of the lack in recruitment variability which led to an absence of contrast between cohorts. In Figure 5.2.10, the combined FR_IE_IBTS survey shows a reduction of older ages in the years 2018–2020 then a slight increase in 2022.

5.2.3.2 Model

Model Specification

The model structure is defined by sub-models, which are the different parts that require structural assumptions. There are five sub-models in operation:

1. model for F-at-age,
2. model for the initial age structure,
3. model for recruitment,
4. (list) of model(s) for abundance indices catchability-at-age,
5. list of models for the observation variance of catch-at-age and abundance indices.

These sub-models were defined as:

fmodel:	~factor(replace(age, age > 7, 7)) + factor(year)
srmodel:	~factor(year)
n1model:	~s(age, k = 3)
qmodel:	
SP_PORC:	~I(1/(1 + exp(-age)))
CPUE.IRLFRsurvey:	~I(1/(1 + exp(-age)))
vmodel:	
catch:	~s(age, k = 3)
SP_PORC:	~1
CPUE.IRLFRsurvey:	~1

The F model is a separable model. The shape of the F-at-age pattern is independently estimated for each age except for ages 7 and older, which are assumed to have the same F. This F pattern is then independently scaled up and down for each year.

Stock–recruit model: Freely estimated for each year.

Catchability models:

For both the SpPGFS-WIBTS-Q4 (G5768) and the combined FR_IE_IBTS surveys, catchability is assumed to increase asymptotically.

N1 model (population in the first year of the time-series): default value a4aSCA function (independently estimated for each age).

Vmodel (the shape of the observation variances): default value a4aSCA function: smooth function for the catch numbers-at-age and 'flat' for the indices

Model Settings

- F_{bar} is set to ages 3–6.

After some exploratory analysis, the following changes were done to the initial input data

Age 1 in 2011 was removed from the combined FR_IE_IBTS survey as the value was not considered credible.

The catch-at-age matrix was explored due to doubts arising for the age 1 total catches data at the beginning of the historical series. The increase in age 1 from year 2000 onwards was considered not reasonable which may be due to the bad quality of discard data at the beginning of the time-series. Therefore, the catch.n of 1-year-olds is set to NA for the early years (1984: 2000).

The model is described in the Stock Annex.

5.2.3.3 Results

This model was selected based on a thorough investigation and selection of the input data (as described above) and optional model settings selected (by visual inspection) to reduce model residuals and improve both the model parsimony (AIC) and predictive capability (visual inspection of both Mohn's rho [Mohn, 1999] and retrospective analyses).

Results of the estimated spawning-stock biomass (SSB), reference fishing mortality (F_{bar}), recruits and catches are shown in Figure 5.2.11. The SSB shows an overall decreasing trend from the start of the series in 1984–2005 followed by a marked increasing trend in recent years until 2022. The uncertainty in the SSB was low for the whole time-series. The median recruitment fluctuated between 200 000 and 300 000 thousand in the whole series, with a decreasing trend in the last period. The F showed three marked data periods: 1984–1989, 1990–1998 and 1999–2022, with a decreasing trend, reaching the lowest value in 2022 of the series but with low uncertainty. This decreasing F trend explains the increase of SSB since catches and recruitment remain relatively constant in recent years. Overall, the catches showed a slightly decreasing trend.

A new assessment model is implemented and the reference points were revised during the WKMEGRIM benchmark (ICES, 2023b). New relative values in relation to these reference points for SSB, F and R were obtained during the WGBIE last year (ICES, 2022). Figure 5.2.13 shows the historical assessment results (final-year recruitment assumptions included for each line) relative to each year's reference points for comparison. The 2023 assessment is represented in orange while the previous year's assessment results are in blue.

5.2.3.4 Retrospective pattern

Retrospective analysis was conducted for 5 years. The retrospective time-series of the most relevant indicators are shown in Figure 5.2.12.

In terms of SSB, estimates were very similar throughout the entire time-series and there was a downward revision of the SSB with a Mohn's rho (Mohn, 1999) value of 0.254. F was revised upwards year after year with a Mohn's rho value of −0.229. Recruitment estimates towards the end of the time-series showed significant revisions in the retrospective analysis with a Mohn's rho value of 0.364. The latter is a common pattern as recruitment in the most recent year(s) is usually not correctly estimated by the assessment model. These Mohn's rho values are slightly out of the defined bounds in WKFORBIAS (ICES, 2020). However, a revision of the diagram was done by the EG and as the F < F_{MSY}, B >> MSY $B_{trigger}$, it was decided to give advice for this stock.

5.2.3.5 Short-term forecasts

Assumptions for the Interim Year

- Initial stock size: Taken from the a4a model survivors.
- Weight-at-age in the stock: average of the last five years.
- Weight-at-age in the catch: average of the last five years.
- Proportion discards-at-age in the catch: average of the last three years.
- Geometric mean (GM) recruitment: full time-series excluding the last two years.
- Recruitment assumptions: Recruitment in last year of assessment is not replaced with GM unless the estimate is highly uncertain or there appears to be a retrospective bias.
- Exploitation pattern: If there is a decreasing F trend the assessment time-series results, $F_{status\ quo}$ should be scaled to F_{bar} of the final assessment year. If not, $F_{status\ quo}$ should be replaced by the average F of the last three years.
- Stock–recruitment model used: None.
- No medium-term projections are proposed for this stock.

Assumptions for Forecast

- Same as for the interim year.

Methods

- Model used: `stf()` and `fwd()` functions in *R* packages *FLasher* and *FLCore*.
- Software used*:* *R* packages *FLasher* (version 0.6.7) and *FLCore* (version 2.6.18) in R (version 4.1.2).

Forecast Results

There is no clear decreasing trend in the F estimates during the last years, therefore, the mean of F during the last three years was used for the projections. For the 2023 recruitment, the GM of the recruitment posteriors during all the assessment years was used except for the final 2 years.

Landings in 2024 and SSB in 2025 predicted for various levels of F in 2024 are given in Table 5.2.8.

5.2.4 Biological reference points

Biological reference points were calculated during the WKMEGRIM benchmark (ICES, 2023b) and are shown in the Stock Annex.

5.2.5 Conclusions

During the WKMEGRIM benchmark (ICES, 2023b), a4a (Millar and Jardim, 2019) method was implemented as a new assessment model to replace the previous Bayesian SCA (Plummer, 2003) model. This previous model needed 10 hours to run so it was difficult to explore alternative settings and input thoroughly while the new a4a (Millar and Jardim, 2019) model is less time-consuming, thus, allowing for better and diverse settings explorations. The residual plots are not perfectly random and some retro bias remain (overestimation of SSB and underestimation of F), with Mohn's rho values slightly out of bounds, despite these, it was still decided to provide advice.

New maturity ogives based on the best practice histological methods (Dominguez-Petit, 2021) were adopted and the use of the female-only ogives was selected.

Several surveys were considered. Both the SpPGFS-WIBTS-Q4 (G5768) and the combined FR_IE_IBTS survey indices were included. No commercial CPUEs were explored due to their unreliability.

New biomass reference points obtained from the new assessment are fairly similar to the old ones, F_{MSY} is slightly higher. Thus, the status of the stock remains unchanged relative to these results ($F < F_{MSY}$, $B >> MSY\ B_{trigger}$).

5.2.6 References

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5.2.1 Tables and figures

Table 5.2.1. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Nominal landings and catches (in tonnes) by country provided by WGBIE.

	Landings									Discards										
	France	Spain	U.K. (England & Wales)	U.K. (Scotland)	Ireland	Northern Ireland	Belgium	Unallocated	Total landings	France	Spain	U.K.	Ireland	Northern Ireland	Belgium	Others	Total discards	WK Raised Discard	Total catches	TAC
1984									**16659**							2169	**2169**		**18828**	
1985									**17865**							1732	**1732**		**19597**	
1986	4896	10242	2048		1563		178		**18927**							2321	**2321**		**21248**	
1987	5056	8772	1600		1561		125		**17114**							1705	**1705**		**18819**	16460
1988	5206	9247	1956		995		173		**17577**							1725	**1725**		**19302**	18100
1989	5452	9482	1451		2548		300		**19233**							2582	**2582**		**21815**	18100
1990	4336	7127	1380		1381		147		**14370**							3284	**3284**		**17654**	18100
1991	3709	7780	1617		1956		32		**15094**							3282	**3282**		**18376**	18100
1992	4104	7349	1982		2113		52		**15600**							2988	**2988**		**18588**	18100
1993	3640	6526	2131		2592		40		**14929**							3108	**3108**		**18037**	21460
1994	3214	5624	2309		2420		117		**13684**							2700	**3284**		**16968**	20330
1995	3945	6129	2658		2927		203		**15862**				422			2230	**2652**		**18514**	22590
1996	4146	5572	2493		2699		199		**15109**				410			2616	**3026**		**18135**	21200
1997	4333	5472	2875		1420		130		**14230**		414		568			2083	**3066**		**17296**	25000
1998	4232	4870	2492		2621		129		**14345**		381		681			4309	**5371**		**19716**	25000
1999	3751	4615	2193		2597		149		**13305**		3135		162				**3297**		**16601**	20000
2000	4173	6047	2185		2512		115		**15031**		1033	208	630				**1870**		**16901**	20000
2001	3645	7575	1710		2767		80		**15778**		1275	250	736				**2262**		**18040**	16800
2002	2929	8797	1787		2413		62		**15987**		1466	435	912				**2813**		**18800**	14900
2003	3227	8340	1732		2249		163		**15711**		3147	279	582				**4008**		**19719**	16000
2004	2817	7526	1622		2288		106		**14358**	1003	4511	257	472				**6243**		**20602**	20200
2005	2972	5841	1764		2155		156		**12888**	697	1831	289	458				**3275**		**16163**	21500
2006	2763	5916	1509		1751		99		**12037**	382	2568	271	529				**3751**		**15788**	20400
2007	2745	6895	1462		1763		195		**13060**	330	2114	272	317				**3033**		**16092**	20400
2008	2578	5402	1387		1514		167		**11048**	329	1479	289	764				**2860**		**13908**	20400
2009	3032	8062	1840		1918	2	209		**15064**	674	1761	389	454				**3278**		**18342**	20400
2010	3651	7095	1805		2283	5	261		**15101**	937	3489	463	453				**5343**		**20444**	20106
2011	3235	3500	1845		2227		330	2089	**13226**	847	2097	898	344				**4187**		**17413**	20106
2012	4012	4055	1744		3047		609	966	**14433**	796	2668	88	152				**3704**		**18137**	19101
2013	4549	4982	2918		3038		538		**16025**	748	3792	53	286		5		**4885**		**20910**	19101
2014	4311	3318	2753	176	2391		179	150	**13277**	795	1337	72	360		5		**2569**		**15846**	19101
2015	3073	2863	2804	147	2436		246	1	**11569**	634	513	47	308		4		**1507**	**887**	**13962**	19101
2016	3141	2672	2694	145	2593		302	1	**11548**	1276	649	74	404		42		**2445**	**870**	**14863**	20056
2017	5101	3178	2512	176	2458		360		**13784**	783	706	265	378		40		**2173**	**1345**	**17303**	15043
2018	4680	2276	2337	112	2128	6	347	261	**12147**	610	483	85	495		66		**1738**	**1677**	**15562**	13528
2019	4332	2617	2150	129	2454	1	481		**12164**	424	130	63	252		120		**989**	**977**	**14130**	19836
2020	4387	2420	1883	5	1797	1	649		**11141**	398	253	53	510		117		**1331**	**1154**	**13626**	20526
2021	4380	2896	2199	144	2075	5	718	0	**12418**	238	437	90	877		166		**1807**	**796**	**15020**	20181
2022	3842	2813	1772	8	1506	1	879		**10821**	297	319	13	739		201		**1568**	**772**	**13161**	23459

Table 5.2.2. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Nominal landings and catches (in tonnes) provided by WGBIE.

	Total landings	Total discards	Total catches	Agreed TAC (1)
1984	16659	2169	18828	
1985	17865	1732	19597	
1986	18927	2321	21248	
1987	17114	1705	18819	16460
1988	17577	1725	19302	18100
1989	19233	2582	21815	18100
1990	14370	3284	17654	18100
1991	15094	3282	18376	18100
1992	15600	2988	18588	18100
1993	14929	3108	18037	21460
1994	13684	3284	16968	20330
1995	15862	2652	18514	22590
1996	15109	3026	18135	21200
1997	14230	3066	17296	25000
1998	14345	5371	19716	25000
1999	13305	3297	16601	20000
2000	15031	1870	16901	20000
2001	15778	2262	18040	16800
2002	15987	2813	18800	14900
2003	15711	4008	19719	16000
2004	14358	6243	20602	20200
2005	12888	3275	16163	21500
2006	12037	3751	15788	20425
2007	13060	3033	16092	20425
2008	11048	2860	13908	20425
2009	15064	3278	18342	20425
2010	15101	5343	20444	20106
2011	13226	4187	17413	20106
2012	14433	3704	18137	19101
2013	16025	4885	20910	19101
2014	13277	2569	15846	19101
2015	11569	2393	13962	19101
2016	11548	3315	14863	20056
2017	13784	3518	17303	15043
2018	12147	3415	15562	13528
2019	12164	1966	14130	19836
2020	11141	2485	13626	20526
2021	12418	2603	15020	20181
2022	10821	2340	13161	23459

(1) for both megrim species and VIIa included.

Table 5.2.3. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Discards information and derivation.

	FR	SP	IR	UK
1984	**FR84-85**	-	-	-
1985	**FR84-85**	-	-	-
1986	(FR84-85)	(SP87)	-	-
1987	(FR84-85)	**SP87**	-	-
1988	(FR84-85)	**SP88**	-	-
1989	(FR84-85)	(SP88)	-	-
1990	(FR84-85)	(SP88)	-	-
1991	**FR91**	(SP94)	-	-
1992	(FR91)	(SP94)	-	-
1993	(FR91)	(SP94)	-	-
1994	(FR91)	**SP94**	-	-
1995	(FR91)	(SP94)	**IR**	-
1996	(FR91)	(SP94)	**IR**	-
1997	(FR91)	(SP94)	**IR**	-
1998	(FR91)	(SP94)	**IR**	-
1999	-	**SP99**	**IR**	-
2000	-	**SP00**	**IR**	**UK**
2001	-	**SP01**	**IR**	**UK**
2002	-	(SP01)	**IR**	**UK**
2003	-	**SP03**	**IR**	**UK**
2004	**FR04**	**SP04**	**IR**	**UK**
2005	**FR05**	**SP05**	**IR**	**UK**
2006	**FR06**	**SP06**	**IR**	**UK**
2007	**FR07**	**SP07**	**IR**	**UK**
2008	**FR08**	**SP08**	**IR**	**UK**
2009	**FR09**	**SP09**	**IR**	**UK**
2010	**FR10**	**SP10**	**IR**	**UK**
2011	**FR11**	**SP11 (*)**	**IR**	**UK**
2012	**FR12**	**SP12 (*)**	**IR**	**UK**
2013	**FR13**	**SP13 (*)**	**IR**	**UK**
2014	**FR14**	**SP14 (*)**	**IR**	**UK**
2015	**FR15**	**SP15 (*)**	**IR**	**UK**
2016	**FR16**	**SP16 (*)**	**IR**	**UK**
2017	**FR17**	**SP17 (*)**	**IR**	**UK**
2018	**FR18**	**SP18 (*)**	**IR**	**UK**
2019	**FR19**	**SP19 (*)**	**IR**	**UK**
2020	**FR20**	**SP20 (*)**	**IR**	**UK**
2021	**FR21**	**SP21 (*)**	**IR**	**UK**
2022	**FR22**	**SP22 (*)**	**IR**	**UK**

- In bold: years where discards sampling programs provided information

- In (): years for which the length distribution of discards has been derived

(*) Scientific estimates were provided

Table 5.2.4. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Discard ratio in percentage (%) from catches-in-weight for the years 2008–2022.

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
% Discard	21%	18%	26%	24%	20%	23%	16%	17%	22%	20%	22%	14%	18%	17%	18%

Table 5.2.5. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Length composition by fleet (thousands) in 2022.

Length	FRANCE	SPAIN
class (cm)	OTT_DEF_>=70_0_0 (ICES 8a)	OTB_DEF_70-99_0_0 (ICES 7b-k)
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		3
21	2	10
22	2	70
23	0	151
24	8	455
25	38	974
26	60	1383
27	73	1277
28	48	1320
29	58	1209
30	61	980
31	49	770
32	61	586
33	90	449
34	62	305
35	83	218
36	80	156
37	64	124
38	69	96
39	51	65
40	49	65
41	53	59
42	31	47
43	21	30
44	19	28
45	15	19
46	11	18
47	13	13
48	9	11
49	4	8
50	1	5
51	0	2
52	0	1
53		2
54		
55		
56		
57		
58		
59		
60		
61		
62		
TOTAL	1185	10908

Table 5.2.6. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Abundance Indices for the SpPGFS-WIBTS-Q3 (G5768) and the combined FR_IE_IBTS surveys. Megrim numbers-at-age index (numbers per 10 hours fished) from the combined FR_IE_IBTS survey.

Year	1	2	3	4	5	6	7	8	9	10
2003	41.8	62.0	57.7	60.1	23.1	11.2	6.5	2.8	1.7	0.6
2004	34.6	80.9	72.7	51.4	26.5	12.2	6.3	3.3	1.3	1.1
2005	45.5	88.1	69.9	43.3	30.0	18.4	5.7	3.0	3.1	1.8
2006	65.9	96.2	75.6	47.5	26.1	13.5	6.2	4.9	1.3	0.8
2007	53.7	74.4	35.9	33.5	33.1	11.0	6.6	4.2	2.2	1.4
2008	29.4	129.7	76.4	37.6	17.3	9.2	4.0	2.3	0.7	0.6
2009	16.8	70.0	128.4	65.3	40.4	20.3	8.1	5.4	2.4	2.3
2010	29.1	44.2	73.9	70.3	38.1	20.5	7.7	3.8	2.2	0.6
2011	0.3	78.3	93.3	70.8	37.4	19.9	8.0	3.2	2.6	2.4
2012	19.8	71.9	101.5	35.0	23.4	12.0	8.2	2.2	2.3	1.2
2013	17.1	63.8	60.1	54.3	12.8	8.2	5.0	1.7	2.1	1.5
2014	14.8	83.4	39.5	56.0	21.2	9.0	4.3	3.6	1.6	0.8
2015	42.9	48.0	77.6	38.7	25.5	13.1	4.9	1.6	2.0	1.1
2016	42.2	95.0	56.8	43.5	33.8	21.2	7.8	7.1	2.7	1.5
2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018	75.4	126.9	93.2	62.1	27.3	17.0	5.6	3.0	1.5	1.2
2019	58.7	171.0	131.1	67.1	25.8	10.5	6.6	2.6	1.7	0.8
2020	53.8	164.0	128.5	71.1	44.0	20.7	6.3	4.5	2.3	1.0
2021	48.7	122.4	114.9	75.7	60.4	27.8	15.7	5.4	3.0	0.9
2022	48.7	146.8	118.6	70.2	34.6	20.7	8.2	4.8	3.6	1.6

Table 5.2.6 (cont) Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Northern megrim. Age composition Porcupine Bank groundfish survey. Stratified abundance indices per age group. Mean catches per 30' haul.

Year/Age	1	2	3	4	5	6	7	8
2001	18	22	28	34	19	14	5	3
2002	11	25	32	40	22	11	3	2
2003	11	29	41	53	28	13	4	2
2004	7	35	55	56	31	11	5	3
2005	6	6	23	82	50	26	5	2
2006	18	14	33	47	33	9	2	2
2007	49	70	36	36	18	9	2	2
2008	3	22	54	40	18	12	3	1
2009	5	7	53	70	16	9	4	2
2010	3	22	26	67	23	5	2	2
2011	4	12	25	39	51	15	3	3
2012	2	7	38	29	32	29	12	7
2013	15	12	12	16	37	27	17	8
2014	2	32	10	23	44	34	12	10
2015	22	22	41	21	18	21	11	7
2016	11	61	33	41	22	22	9	8
2017	19	52	36	26	31	16	5	5
2018	8	53	77	28	18	9	6	4
2019	9	44	55	33	33	19	6	6
2020	2	30	51	42	28	21	4	3
2021	3	13	43	68	65	26	12	4
2022	1	11	24	48	42	29	13	6

Table 5.2.7. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Northern megrim. Abundance Indices by kilograms and numbers per 30 minutes haul duration SpPGFS-WIBTS-Q4 (G5768) and combined FR_IE_IBTS surveys.

SpPGFS-WIBTS-Q4 (G5768): Megrim whiff: Stratified abundance index per 30 mins haul

New stratification

Kg / lance	TOTAL	
AÑO	Yst	SE
2001	6.80	0.88
2002	6.66	0.82
2003	8.16	0.98
2004	9.01	1.05
2005	9.81	1.26
2006	7.64	1.22
2007	9.15	0.94
2008	8.46	1.13
2009	11.79	1.03
2010	11.47	1.28
2011	11.89	1.40
2012	13.03	1.77
2013	12.82	1.71
2014	15.78	2.16
2015	13.07	1.44
2016*	14.77	2.00
2017*	14.11	2.02
2018*	11.15	1.24
2019*	13.64	1.41
2020*	12.63	1.64
2021*	18.16	2.86
2022*	13.50	1.30

New stratification

Nº / lance	TOTAL		
AÑO	Yst	SE	
2001	143.34	19.71	
2002	146.00	21.40	
2003	180.81	21.50	
2004	202.72	23.27	
2005	201.19	30.69	
2006	158.14	30.69	
2007	221.18	30.67	
2008	153.61	23.26	
2009	165.49	19.37	
2010	150.76	23.08	
2011	152.72	23.50	
2012	155.08	27.79	
2013	143.96	27.69	
2014	166.68	31.60	
2015	163.42	25.37	
2016*	207.93	31.84	*20' haul real trawling time, Index weighted to 30'
2017*	190.65	25.73	*20' haul real trawling time, Index weighted to 30'
2018*	202.65	28.26	*20' haul real trawling time, Index weighted to 30'
2019*	205.12	20.16	*20' haul real trawling time, Index weighted to 30'
2020*	181.00	27.36	*20' haul real trawling time, Index weighted to 30'
2021*	233.81	34.83	*20' haul real trawling time, Index weighted to 30'
2022*	173.76	16.49	*20' haul real trawling time, Index weighted to 30'

Table 5.2.7 (cont). Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Abundance Indices by kilograms and numbers per 30 minutes haul duration of the SpPGFS-WIBTS-Q4 (G5768) and combined FR_IE_IBTS surveys. Biomass index from the combined FR_IE_IBTS survey.

Year	Kg/h	ci_lower	ci_upper	Survey
2003	3.20	2.48	3.93	Combined
2004	3.27	2.54	4.01	Combined
2005	3.58	2.86	4.29	Combined
2006	3.63	2.93	4.33	Combined
2007	3.33	2.68	3.97	Combined
2008	4.26	3.56	4.96	Combined
2009	5.61	4.62	6.60	Combined
2010	4.73	3.93	5.52	Combined
2011	5.92	4.81	7.04	Combined
2012	4.81	3.93	5.69	Combined
2013	4.25	3.44	5.05	Combined
2014	3.78	3.14	4.42	Combined
2015	4.55	3.68	5.41	Combined
2016	5.06	4.21	5.91	Combined
2017	NA	NA	NA	Combined
2018	4.99	4.18	5.80	Combined
2019	6.09	5.04	7.14	Combined
2020	5.76	4.78	6.74	Combined
2021	5.88	4.89	6.87	Combined
2022	5.59	4.66	6.52	Combined

Table 5.2.8. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Catch forecast: management option table.

Basis	Total catch (2024)	Projected landings* (2024)	Projected discards**(2024)	$F_{ages\ 3–6}$ Total (2024)	SSB (2025)	% SSB change***	% advice change^
ICES advice basis							
MSY approach: F_{MSY}	23303	19670	3633	0.23	89889	-6.1	-1.24
Other scenarios							
EU MAP^^ = F_{MSY}	23303	19670	3633	0.23	89889	-6.1	-1.24
F = MAP^^ $F_{MSY\ lower}$	14912	12606	2306	0.14	98649	3.1	-
F = MAP^^ $F_{MSY\ upper}$	37722	31750	5972	0.41	74956	-22	-
F = 0	0	0	0	0.00	114313	19.5	-100
F_{pa}	39152	32943	6209	0.43	73485	-23	66
F_{lim}	49586	41616	7970	0.59	62817	-34	110
SSB (2025) = B_{lim}	72018	59997	12021	1.07	40444	-58	210
SSB (2025) = B_{pa}	77246	64204	13042	1.23	35398	-63	230
SSB (2025) = MSY B_{trig-}	72018	59997	12021	1.07	40444	-58	210
SSB (2025) = SSB	20166	17032	3134	0.195	93158	-3.5	-14.5
F = F_{2023}	17739	14988	2751	0.169	95693	2.7	-25

* Marketable landings, assuming recent discard rate.
** Including BMS landings (EU stocks), assuming recent discard rate.
*** SSB 2025 relative to SSB 2024.
^ Advice value for 2024 relative to advice value for 2023 (23 596 tonnes).
^^ EU multiannual plan (MAP) for the Western Waters (EU, 2019).
^^^ Advice value for 2024 relative to the advice value for 2023 for the $F_{MSY\ lower}$ (15 101 tonnes) and $F_{MSY\ upper}$ (38 191 tonnes).

The advice is 1.24% lower than last year due to a downward revision of SSB in the advised year.

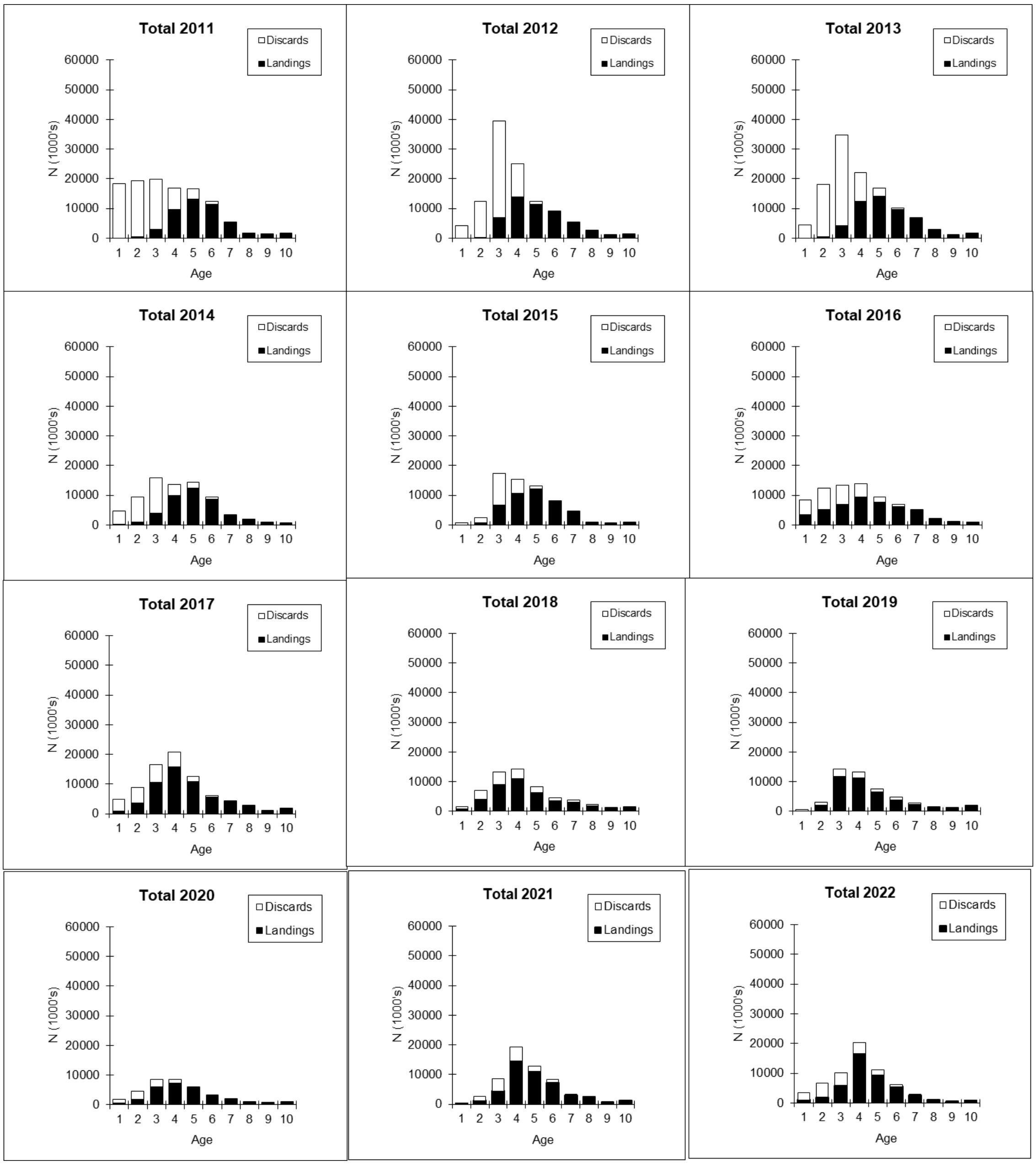


Figure 5.2.1. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8. Age composition of catches for the years 2008–2021.

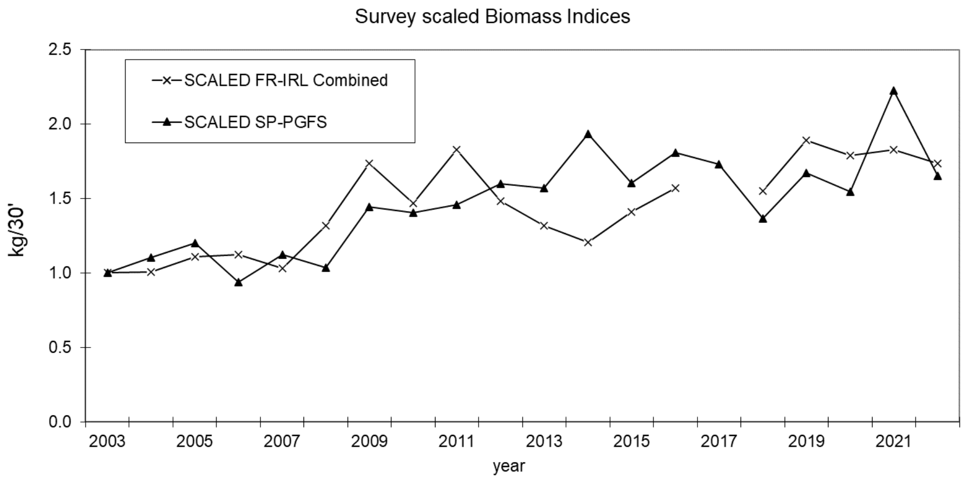


Figure 5.2.2. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Scaled Biomass Indices for both the SpPGFS-WIBTS-Q3 (G5768) and the combined FR_IE_IBTS surveys.

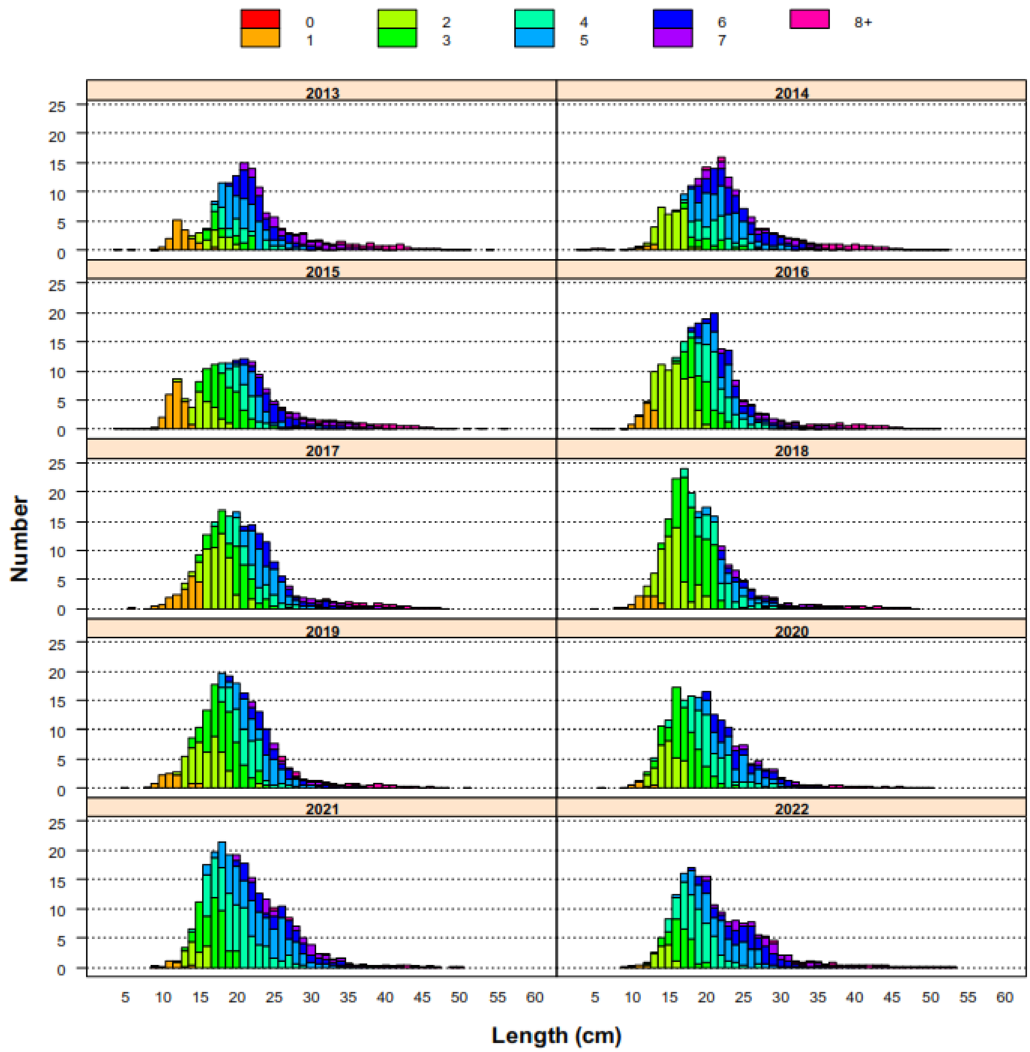


Figure 5.2.3. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Age composition of SpPGFS-WIBTS-Q4 (G5768) survey in abundance (numbers).

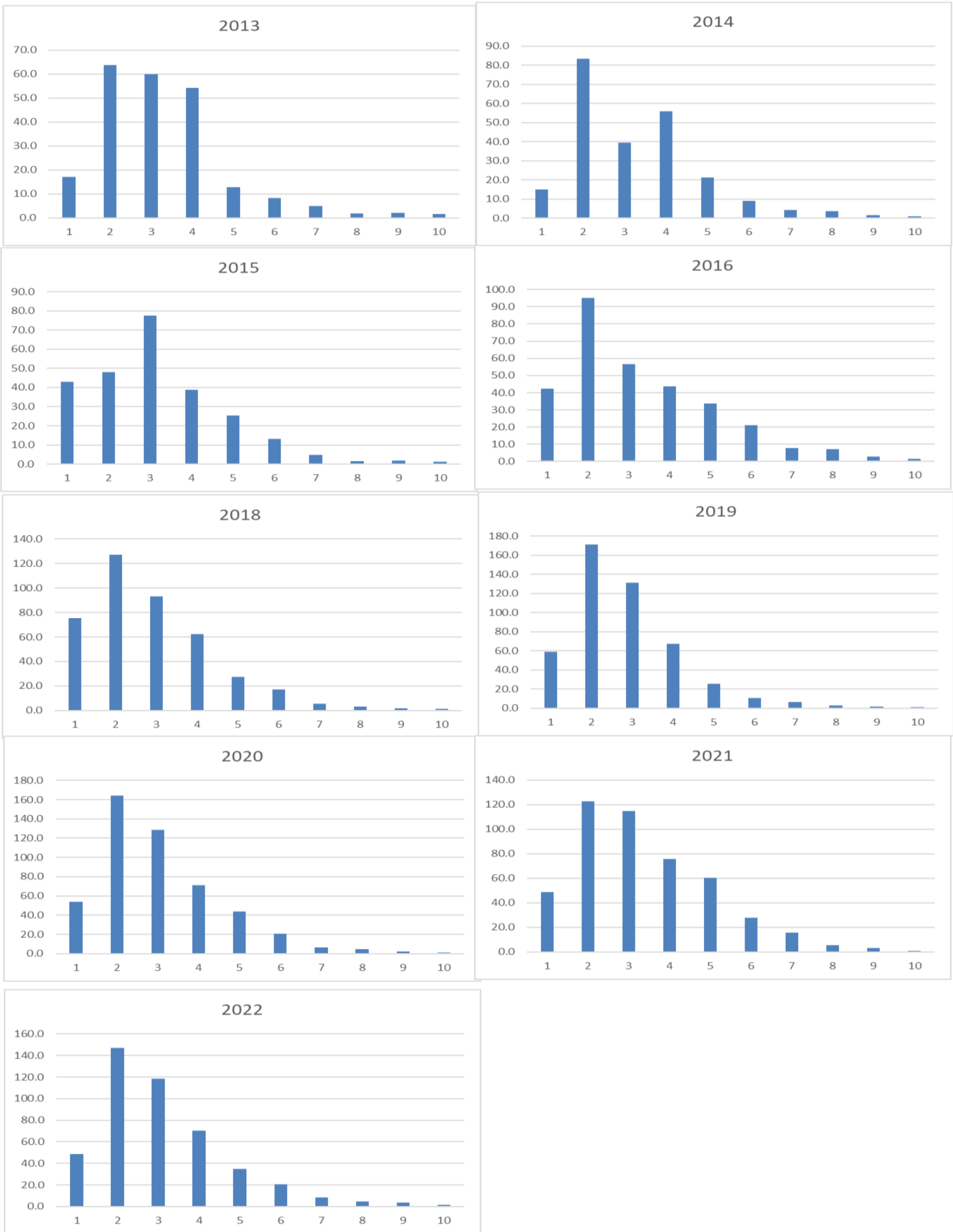


Figure 5.2.4. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Age composition of the combined FR_IE_IBTS survey in abundance (numbers/30min haul).

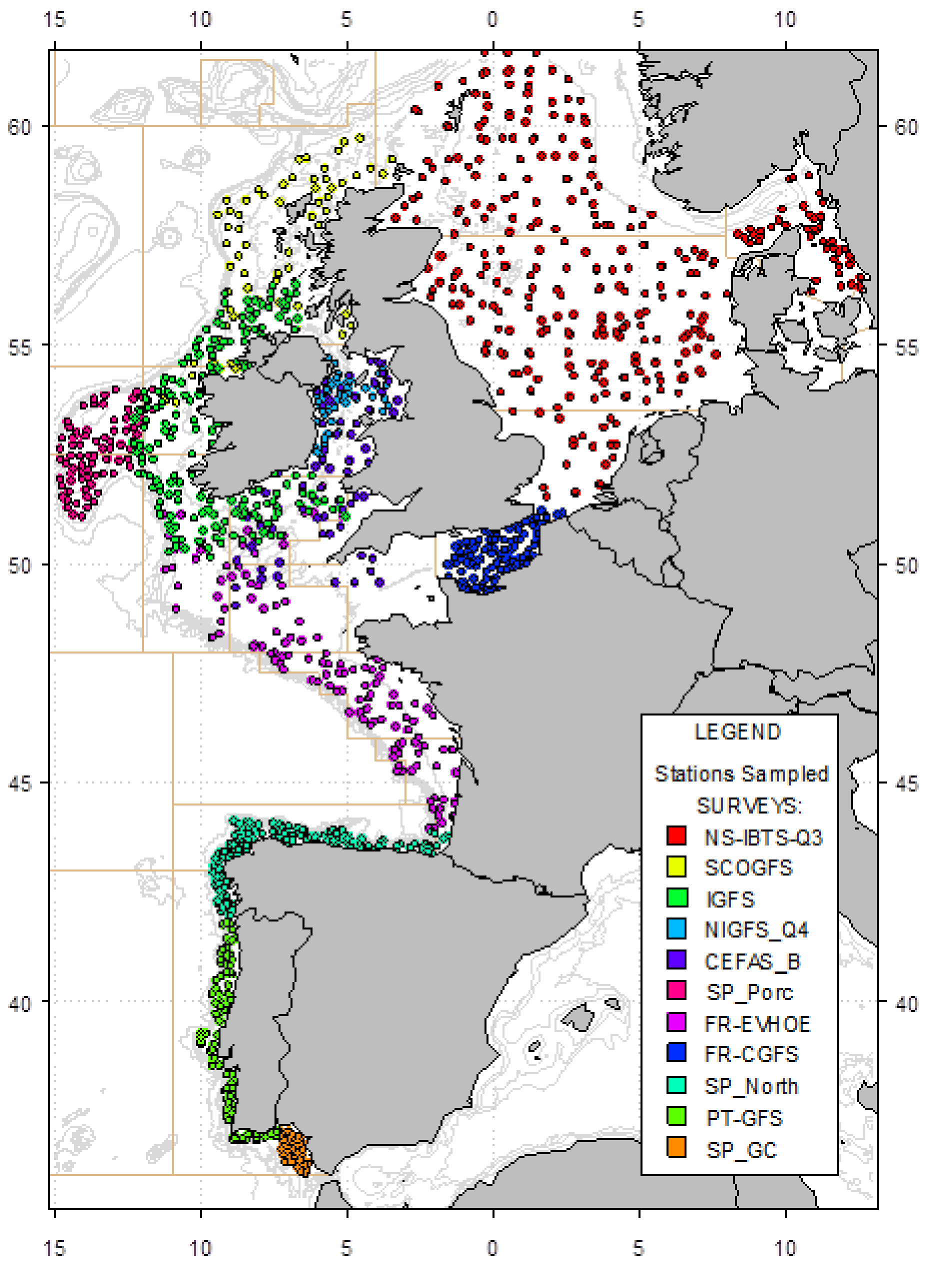


Figure 5.2.5. Station positions for the different IBTS surveys carried out in the Western Atlantic and North Sea area in autumn/winter of 2008 (ICES, 2009). Only used as general survey locations.

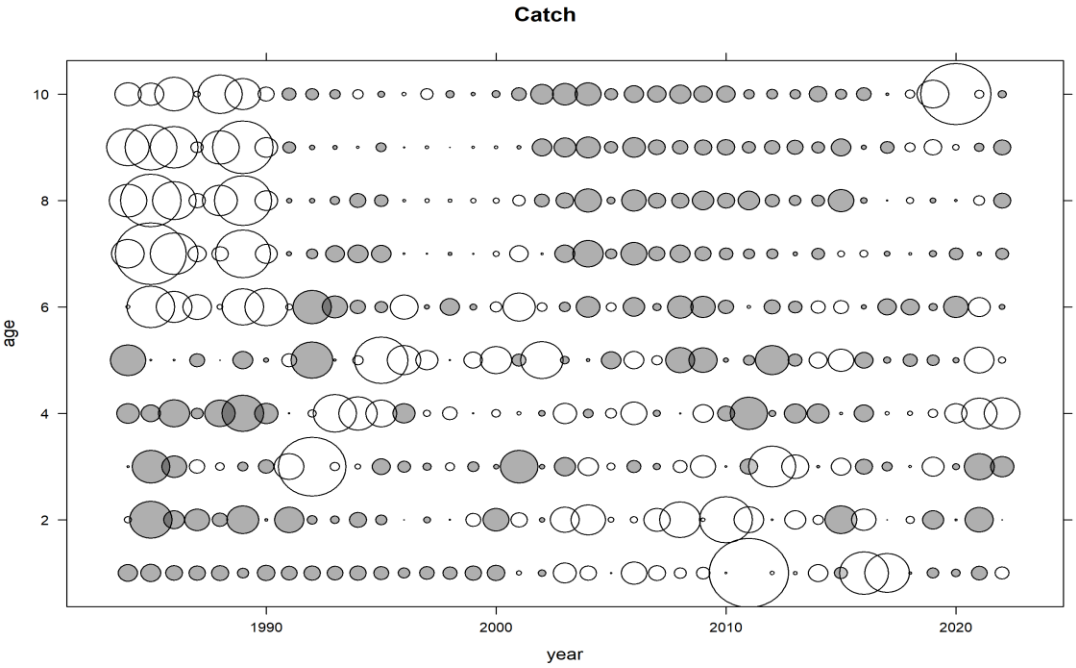


Figure 5.2.6. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Bubble plots for catch numbers-at-age (white – positive values, black – negative values).

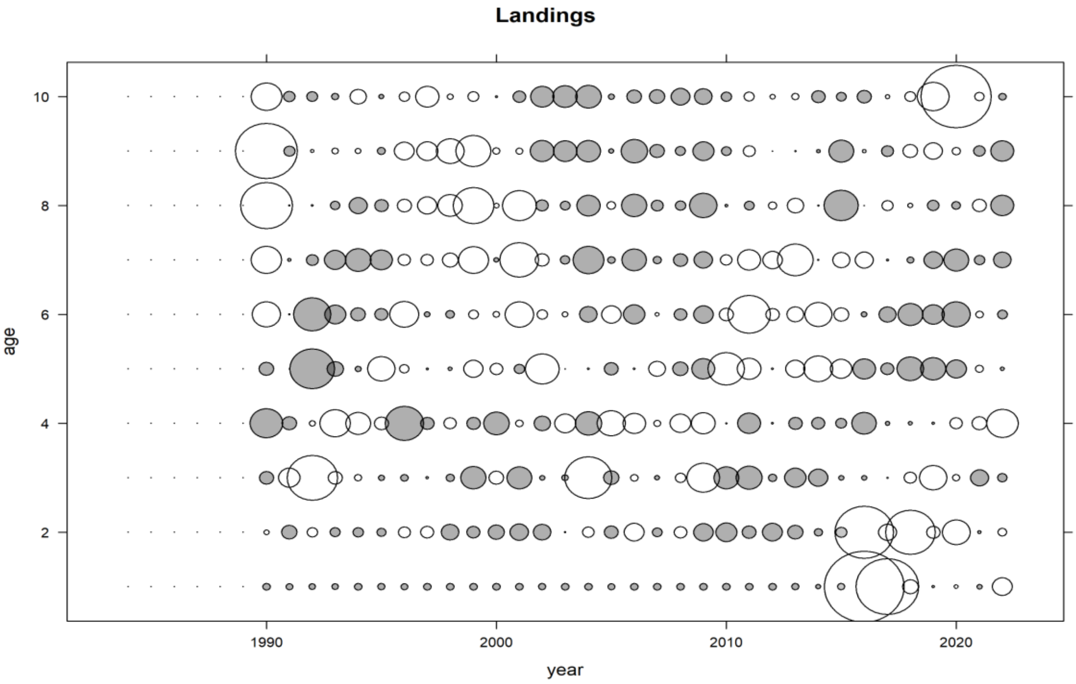


Figure 5.2.7. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Bubble plots for landing numbers-at-age (white – positive values, black – negative values).

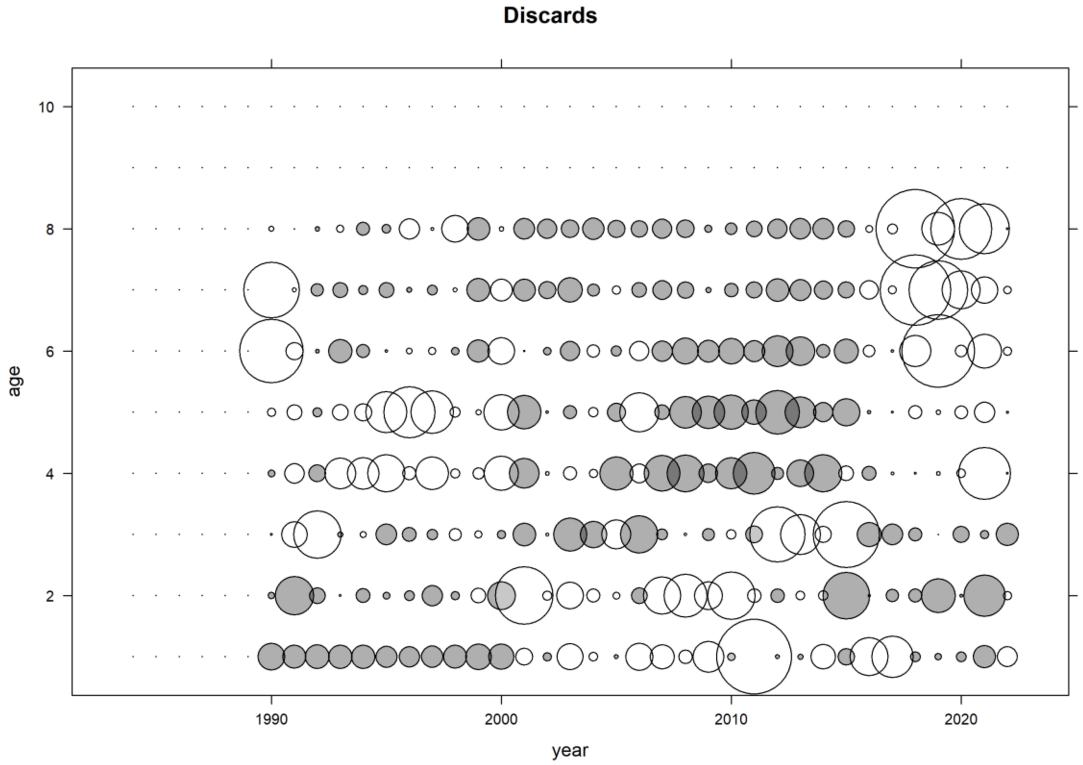


Figure 5.2.8. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Bubble plots for discarded numbers-at-age (white – positive values, black – negative values).

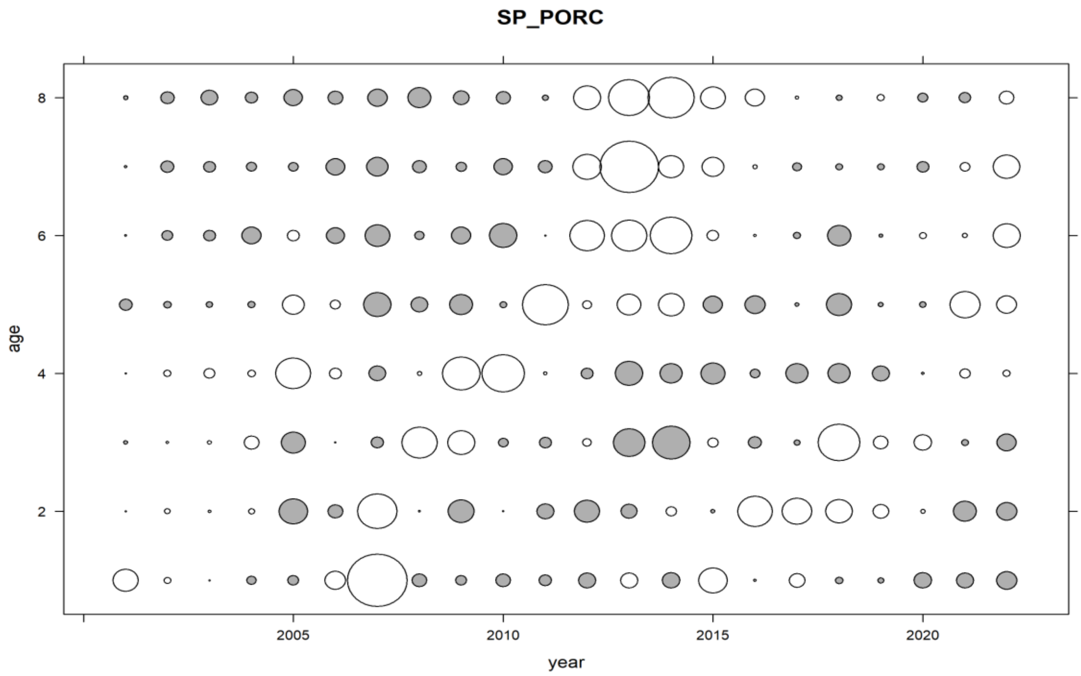


Figure 5.2.9. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Bubble plots for Porcupine SpPGFS-WIBTS-Q4 (G5768) survey numbers-at-age (white – positive values, black – negative values).

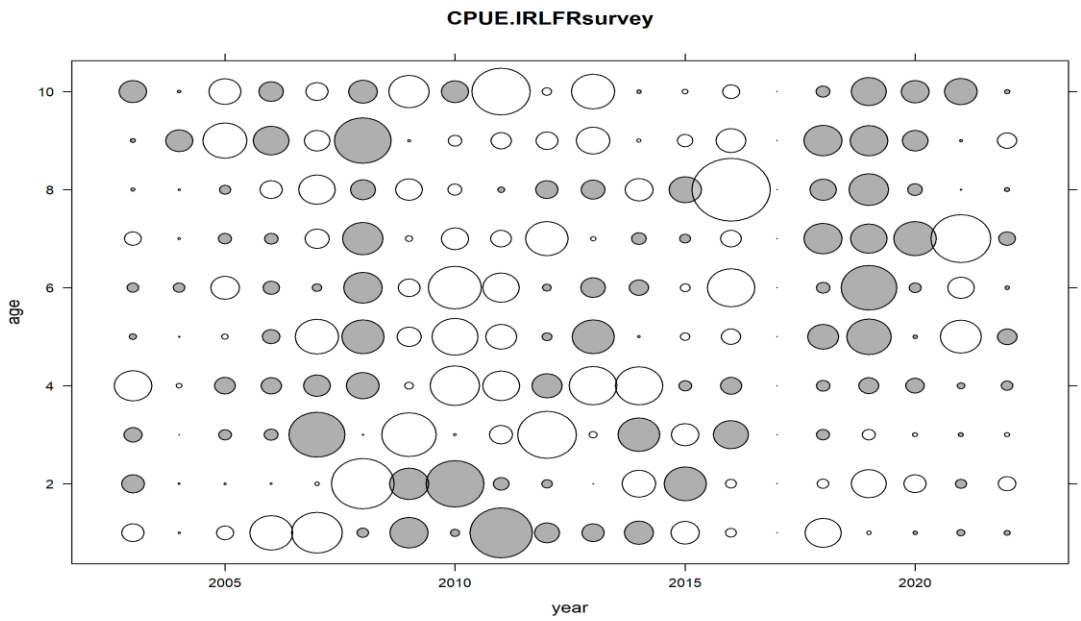


Figure 5.2.10. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Bubble plots for combined CPUE of the.FR_IE_IBTS survey numbers-at-age (white – positive values, black – negative values).

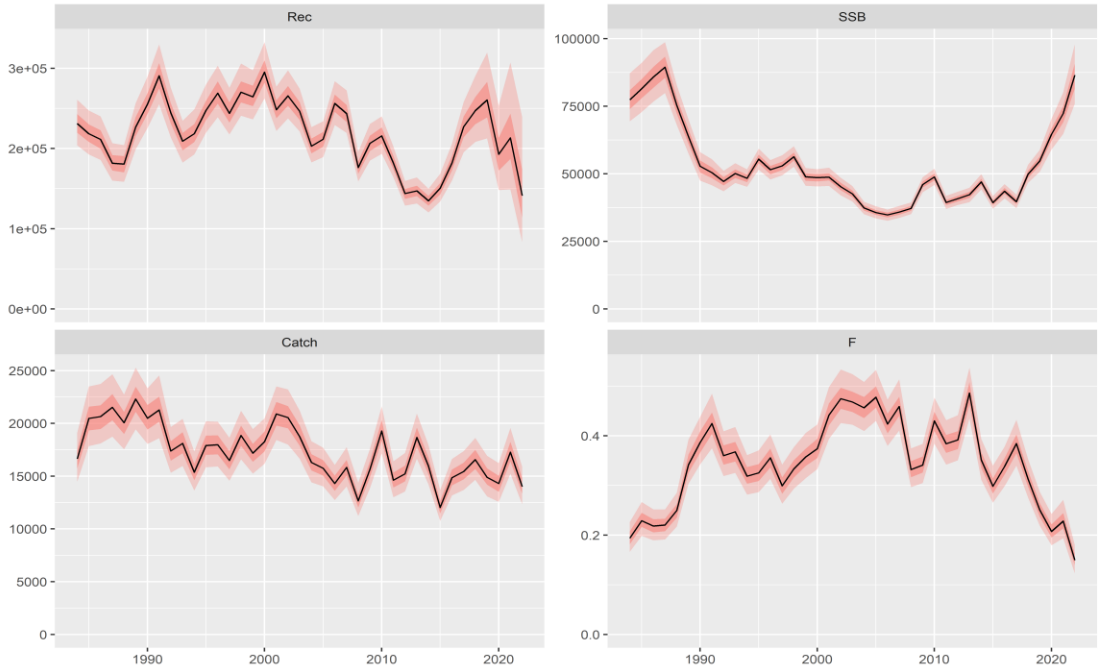
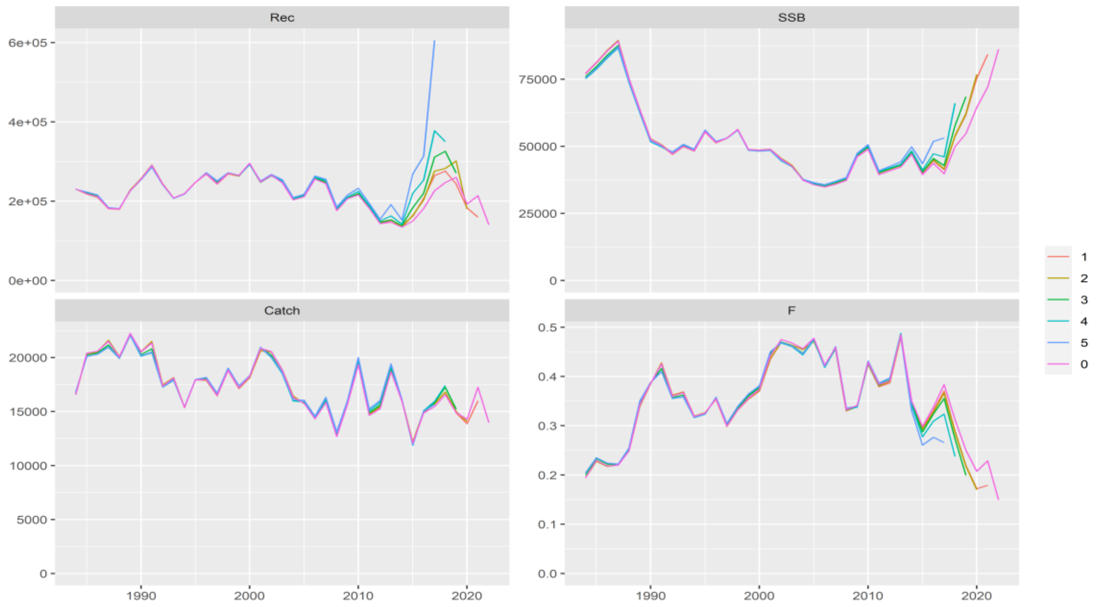


Figure 5.2.11. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Time-series results of spawning-stock biomass (SSB), recruits, F_{bar}, and catches from 1984 to 2022. The solid lines correspond to the median of the distribution and the dashed lines to the 5% and 95% quantiles.



Mohn´s rho F	Mohn´s rho SSB	Mohn´s rho R
-0.229	0.254	0.364

Figure 5.2.12. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Time-series of the median SSB, recruitment and F_{bar} in retrospective analysis.

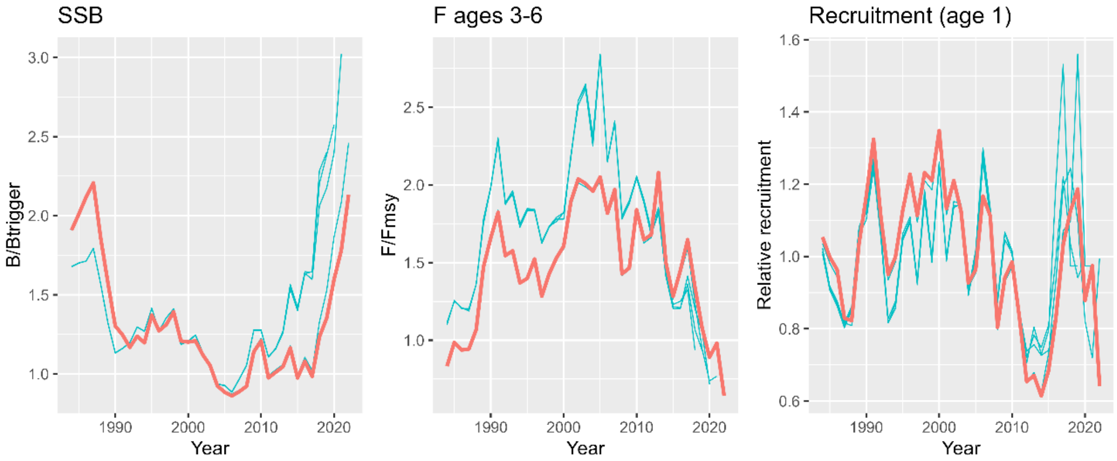


Figure 5.2.13. Megrim (*L. whiffiagonis*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Historical assessment results (final-year recruitment assumptions included for each line) relative to each year's reference points for comparison. In orange is the 2023 assessment results while in blue is for the previous years.

5.3 Four-spot megrim (*L. boscii*) in divisions 7.b–k, 8.a, 8.b, and 8.d

5.3.1 Fishery description

Four-spot megrim (*Lepidorhombus boscii*) in the Celtic Sea, west of Ireland, and in the Bay of Biscay are caught in a mixed fishery predominantly by French followed by Spanish, UK and Irish demersal vessels (see Stock Annex for details).

5.3.2 Summary of ICES Advice for 2023 and Management applicable for 2022 and 2023

5.3.2.1 ICES advice for 2023

In 2022, ICES was requested to provide advice on fishing opportunities for four-spot megrim in divisions 7.b–k, 8.a–b, and 8.d. ICES advised that when the precautionary approach is applied (ICES, 2023a), catches should be no more than 867 t for each of the years 2023, 2024 and 2025.

5.3.2.2 Management applicable for 2022 and 2023

The agreed TAC for the combined species was increased from 20 786 t in 2022 to 23 459 t in 2023.

Management of four-spot megrim and megrim under a combined species TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species. Four-spot megrim constituted 7% of average catches of both species from 2017–2019.

5.3.3 Data

5.3.3.1 Commercial catches and discards

Four-spot megrim was included in the ICES catch and discard data call for the first time in 2018 and data on commercial catch and discard information were made available to WGBIE from France, Ireland, Spain and UK. Historical data on commercial catch and discards, going back to 2003, were requested in the 2020 ICES data call and France, Ireland, Spain and UK responded to this request. Historical Spanish catches were requested again in the 2021 ICES data call but are still unavailable prior to 2017. Belgium provided catch and biological information to WGBIE for the first time in 2021 but no information was provided this year.

Sampling of commercial catches in 2020 and 2021 was negatively impacted by COVID-19 and complete catches of four-spot megrim could not be estimated for these years (ICES, 2022). Commercial landings were reported for 2022 by France, Ireland, Spain and UK. Commercial discards for 2022 were also available from France, Ireland and Spain. Length data for 2022 were only available for Ireland and Spain.

Table 5.3.1. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Commercial catches (in tonnes) of four-spot megrim in 2022 by country and gear type.

	BMS landing	Discards	Landings	Logbook Registered Discard	Total
France	-	-	-	-	-
MIS_MIS_0_0_0	-	-	0	-	0
OTB_CRU_>=70_0_0	-	-	0	-	0
OTB_CRU_100-119_0_0_all	-	-	0	-	0
OTB_CRU_70-99_0_0_all	-	-	0	-	0
OTB_DEF_>=70_0_0	-	0	0	-	0
OTB_DEF_100-119_0_0	-	-	0	-	0
OTB_DEF_70-99_0_0	-	0	0	-	0
OTT_CRU_>=70_0_0	-	0	0	-	0
OTT_CRU_100-119_0_0	-	-	0	-	0
OTT_CRU_70-99_0_0_all	-	-	0	-	0
OTT_DEF_>=70_0_0	-	0	0	-	0
OTT_DEF_100-119_0_0	-	-	0	-	0
OTT_DEF_70-99_0_0	-	-	0	-	0
Ireland	-	-	-	-	-
GNS_DEF_120-219_0_0_all	-	-	1	-	1
MIS_MIS_0_0_0_HC	-	-	0	-	0
OTB_CRU_100-119_0_0_all	-	35	1	-	36
OTB_CRU_70-99_0_0_all	-	219	1	-	220
OTB_DEF_100-119_0_0_all	-	0	16	-	16
OTB_DEF_70-99_0_0_all	-	0	3	-	3
SSC_DEF_100-119_0_0_all	-	1	4	-	5
TBB_DEF_70-99_0_0_all	-	0	8	-	8
Spain	-	-	-	-	-
GNS_DEF_>=100_0_0	-	-	11	0	11
GNS_DEF_120-219_0_0	-	-	4	0	4
GNS_DEF_60-79_0_0	-	-	0	-	0

	BMS landing	Discards	Landings	Logbook Registered Discard	Total
LLS_DEF_0_0_0	-	-	0	-	0
OTB_DEF_>=70_0_0	-	1	39	0	40
OTB_DEF_100-119_0_0	-	-	58	0	58
OTB_DEF_70-99_0_0	0	93	173	0	266
OTB_MCF_>=70_0_0	-	-	2	0	2
OTB_MPD_>=70_0_0	-	0	4	0	4
PTB_DEF_>=70_0_0	-	-	0	-	0
UK (England)	-	-	-	-	-
GNS_DEF_all_0_0_all	-	-	0	-	0
Total	**0**	**348**	**326**	**0**	**673**

Table 5.3.2. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Commercial catches (in tonnes) of four-spot megrim 2003–2022 by year and country. Note: BMS is "Landings below minimum conservation reference size" and LRD is "Logbook Registered Discards".

	France		Ireland		Spain				UK		Belgium		Total
									(England)	(Scotland)			
	Discards	Landings	Discards	Landings	BMS	Discards	Landings	LRD	Landings	Landings	Discards	Landings	
2003	-	0	-	-	-	-	-	-	-	-	-	-	0
2004	-	0	-	-	-	-	-	-	-	-	-	-	0
2005	0	62	-	-	-	-	-	-	-	-	-	-	62
2006	4	1	-	-	-	-	-	-	-	-	-	-	5
2007	3	123	-	-	-	-	-	-	-	-	-	-	126
2008	-	0	-	-	-	-	-	-	-	-	-	-	0
2009	1	2	-	-	-	-	-	-	-	-	-	-	2
2010	8	65	-	-	-	-	-	-	-	-	-	-	73
2011	2	39	31	-	-	-	-	-	-	-	-	-	71
2012	1	2	73	-	-	-	-	-	-	-	-	-	75
2013	3	33	-	-	-	-	-	-	-	-	-	-	36
2014	2	31	-	-	-	-	-	-	-	-	-	-	33
2015	2	131	-	-	-	-	-	-	-	-	-	-	133
2016	8	268	-	-	-	-	-	-	-	-	-	-	275
2017	5	25	288	130	-	273	439	-	-	-	-	-	1160

	France		Ireland			Spain			UK		Belgium		Total
									(England)	(Scotland)			
	Discards	Landings	Discards	Landings	BMS	Discards	Landings	LRD	Landings	Landings	Discards	Landings	
2018	4	16	35	64	-	214	833	0	0	-	-	-	1166
2019	24	380	41	62	0	41	378	0	0	0	-	-	926
2020	0	0	6	51	0	117	437	0	0	0	0	0	611
2021	0	1	120	73	0	155	518	0	0	-	-	-	866
2022	0	0	254	34	0	94	291	0	0	-	-	-	673

5.3.3.2 Biological sampling

Biological sampling data for four-spot megrim were included in the ICES data call for the first time in 2018. Data on length were made available to WGBIE in 2019 from Ireland and Spain (ICES, 2019). Historical data on length, going back to 2003, were requested in the 2019 and 2020 data calls and Ireland, France, Spain and UK responded to this request (the UK has not sampled this species). Historical data were not requested in WGBIE 2022 data call.

Length frequency distributions (LFDs) for landings and discards were not available from all countries for 2020 due to the COVID-19 pandemic (ICES, 2021b) and although this situation improved for the 2021 and 2022 data, there are still sampling issues which affect catch estimation. Spain provided length distributions for 2022 landings and discards, whereas Ireland could only provide information on discard length distribution. France estimates the species composition of the combined megrim landings (*L. whiffiagonis* and *L. boscii*) from samples taken at sea. Sampling levels have declined substantially since 2020. The proportion of *L. boscii* in French landings was around 8.5% in 2019 (ICES, 2020). However, in 2022, no *L. boscii* were encountered in the French samples, resulting in estimated French landings of zero tonnes. WGBIE considers that this is an artefact of reduced sampling levels and considering the large proportion of the landings that are normally taken by France (ICES, 2022), WGBIE considers that the landings during 2020, 2021 and 2022 cannot be accurately estimated.

Age

Age data were made available for the first and only time to WGBIE 2021 from Belgium only (ICES, 2021). Fish from age 4 to age 11 were identified in landings with a modal age of 7 years.

Lengths

Table 5.3.3. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Number of length samples and measurements of four-spot megrim by year and country.

	Number of Length Samples	Number of Length Measurements
France		
2007	140	202
2014	8	124
2015	9	32
2016	14	103
2017	23	39
2019	45	393
2020	0	0
Ireland		
2011	168	2120
2012	184	8352

	Number of Length Samples	Number of Length Measurements
2017	402	34736
2018	171	1198
2019	100	11475
2020	12	1025
2021	52	6868
2022	76	4900
Spain		
2017	424	13396
2018	427	15502
2019	323	7410
2020	116	2023
2021	349	12113
2022	296	11005
Belgium		
2020	21	39

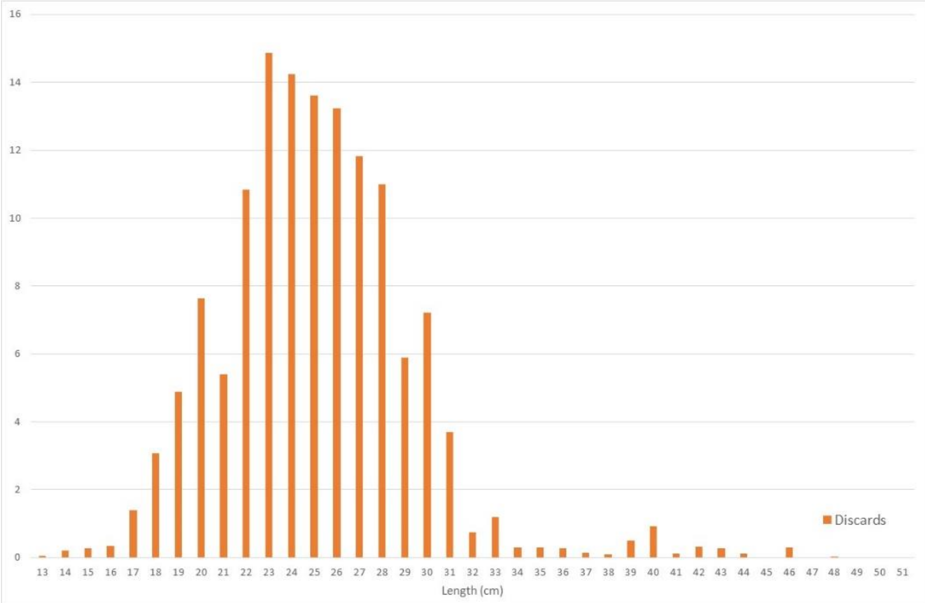


Figure 5.3.1. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Length–frequency distribution of discards from Irish fleets in 2022.

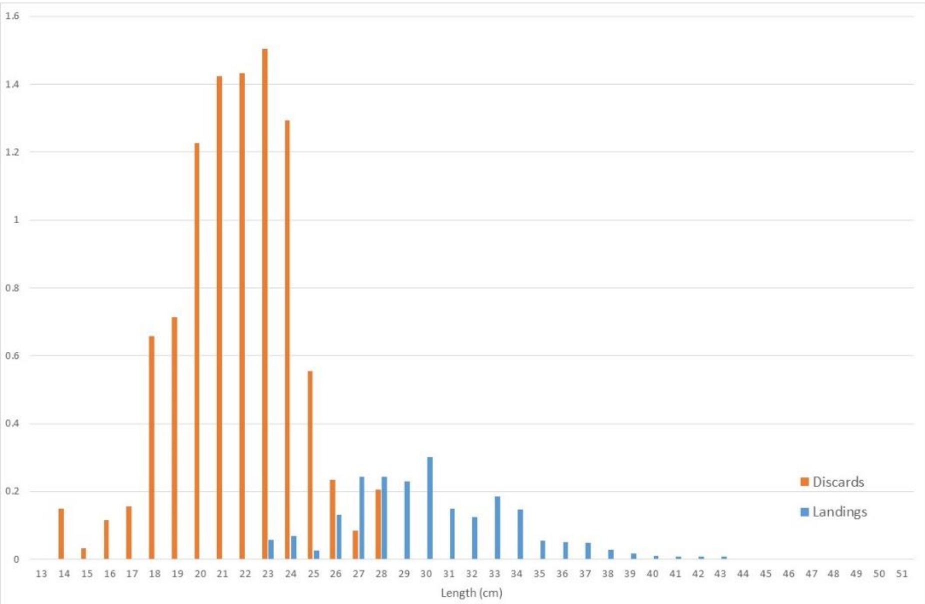


Figure 5.3.2. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Length–frequency distribution of landings and discards from Spanish fleets in 2022.

Natural Mortality

Not included in the assessment.

5.3.3.3 Survey data

Survey data were extracted from DATRAS for Spanish Porcupine Bottom Trawl Survey (SpPGFS-WIBTS-Q3, G5768), Irish Ground Fish Survey (IGFS-WIBTS-Q4, G7212) and French EVHOE Survey (EVHOE-WIBTS-Q4, G9527). French IBTS (EVHOE-WIBTS-Q4, G9527) survey data were not available for 2017 due to major technical vessel problems but recommenced in 2018 (ICES, 2019). The Spanish Porcupine index was initially down weighed by an arbitrary factor of ten because the Baka trawl used was highly more efficient at catching megrim than the GOV (*Grande Ouverture Verticale*) trawl used in the Irish and French surveys. Due to the large differences in catchability between the Baka and GOV gears, it was decided to remove the SpPGFS-WIBTS-Q3 (G5768) survey data from the final index which are based on data from IGFS-WIBTS-Q4 (G7212) and EVHOE-WIBTS-Q4 (G9527) surveys (ICES, 2020; 2021b). This combined French and Irish survey index is referred to by the ICES acronym FR_IE_IBTS. To include Spanish Porcupine Bottom Trawl Survey (G5768) data in the final index will require inter-calibration correction based on a comparison of four-spot megrim catches in the area where the Spanish and Irish surveys overlap. No difference in catchability was found between the Irish (IGFS-WIBTS-Q4, G7212) and the French (EVHOE-WIBTS-Q4, G9527) surveys in the area where they overlap.

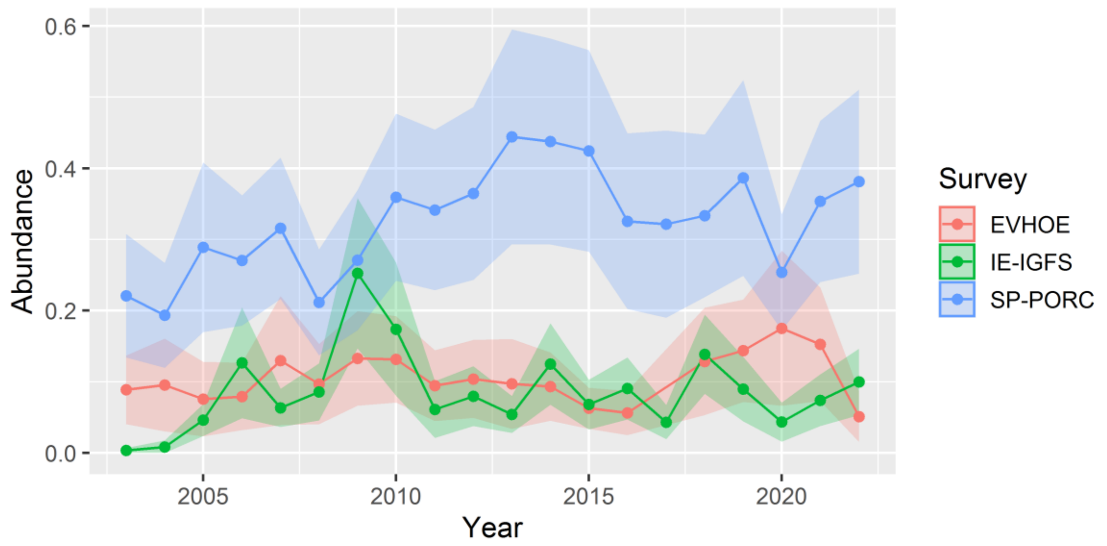


Figure 5.3.3. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Abundance indices of four-spot megrim. from the French EVHOE (EVHOE-WIBTS-Q4, G9527), Irish Ground Fish (IGFS-WIBTS-Q4, G7212) and Spanish Porcupine Bottom Trawl (SpPGFS-WIBTS-Q3, G5768) surveys.

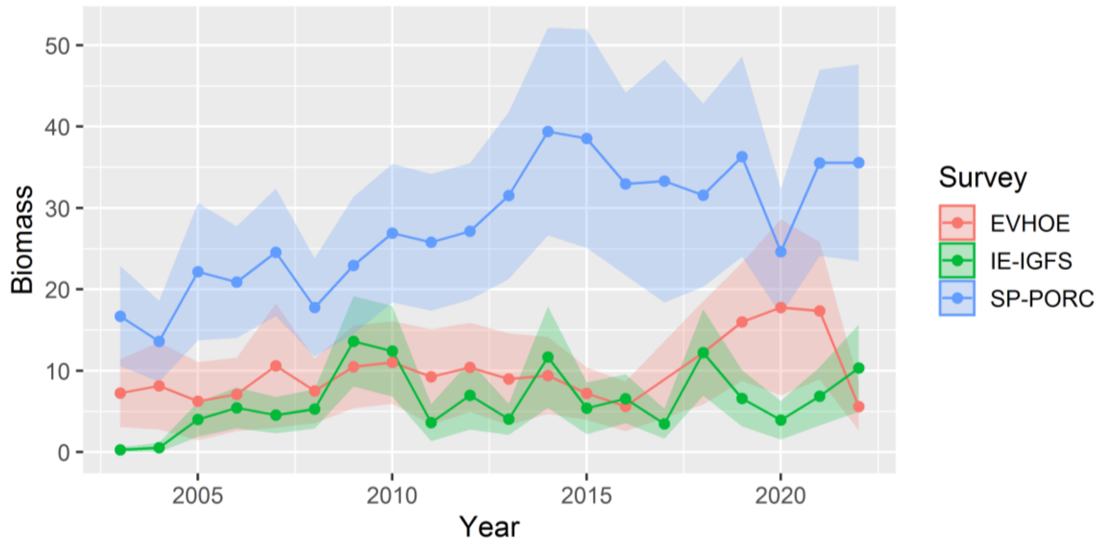


Figure 5.3.4. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Biomass indices of four-spot megrim from the French EVHOE (EVHOE-WIBTS-Q4, G9527), Irish Ground Fish (IGFS-WIBTS-Q4, G7212) and Spanish Porcupine Bottom Trawl (SpPGFS-WIBTS-Q3, G5768) Surveys.

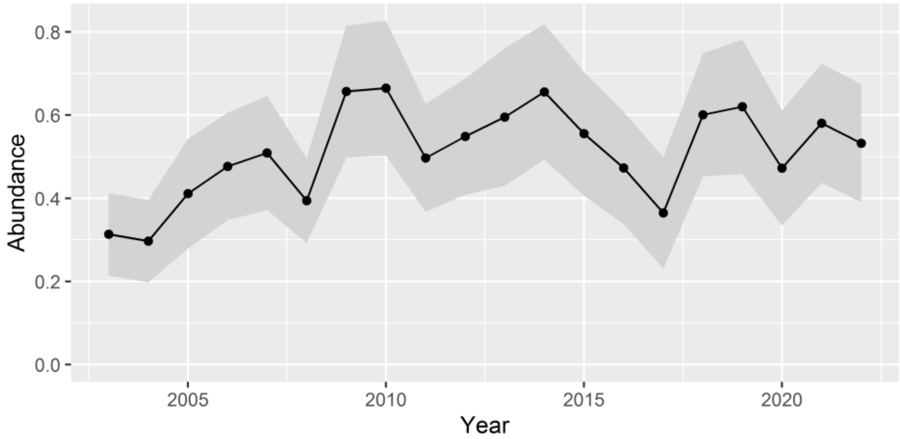


Figure 5.3.5. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Abundance index of four-spot megrim from combined FR_IE_IBTS survey.

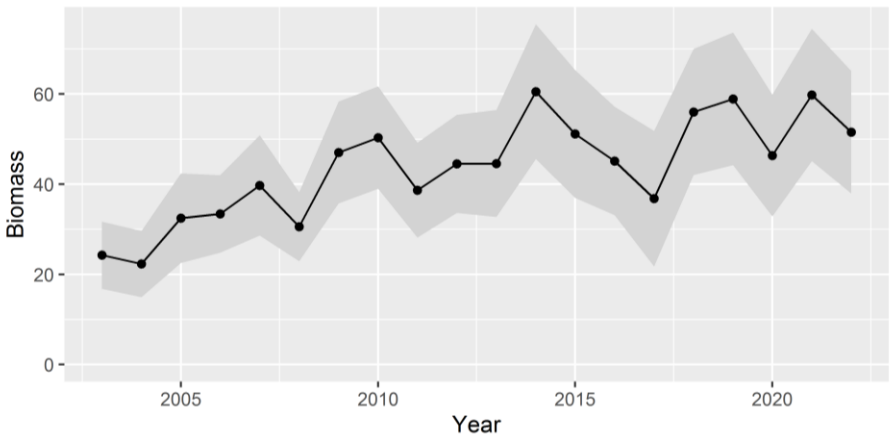


Figure 5.3.6. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Biomass index of four-spot megrim from combined FR_IE_IBTS survey.

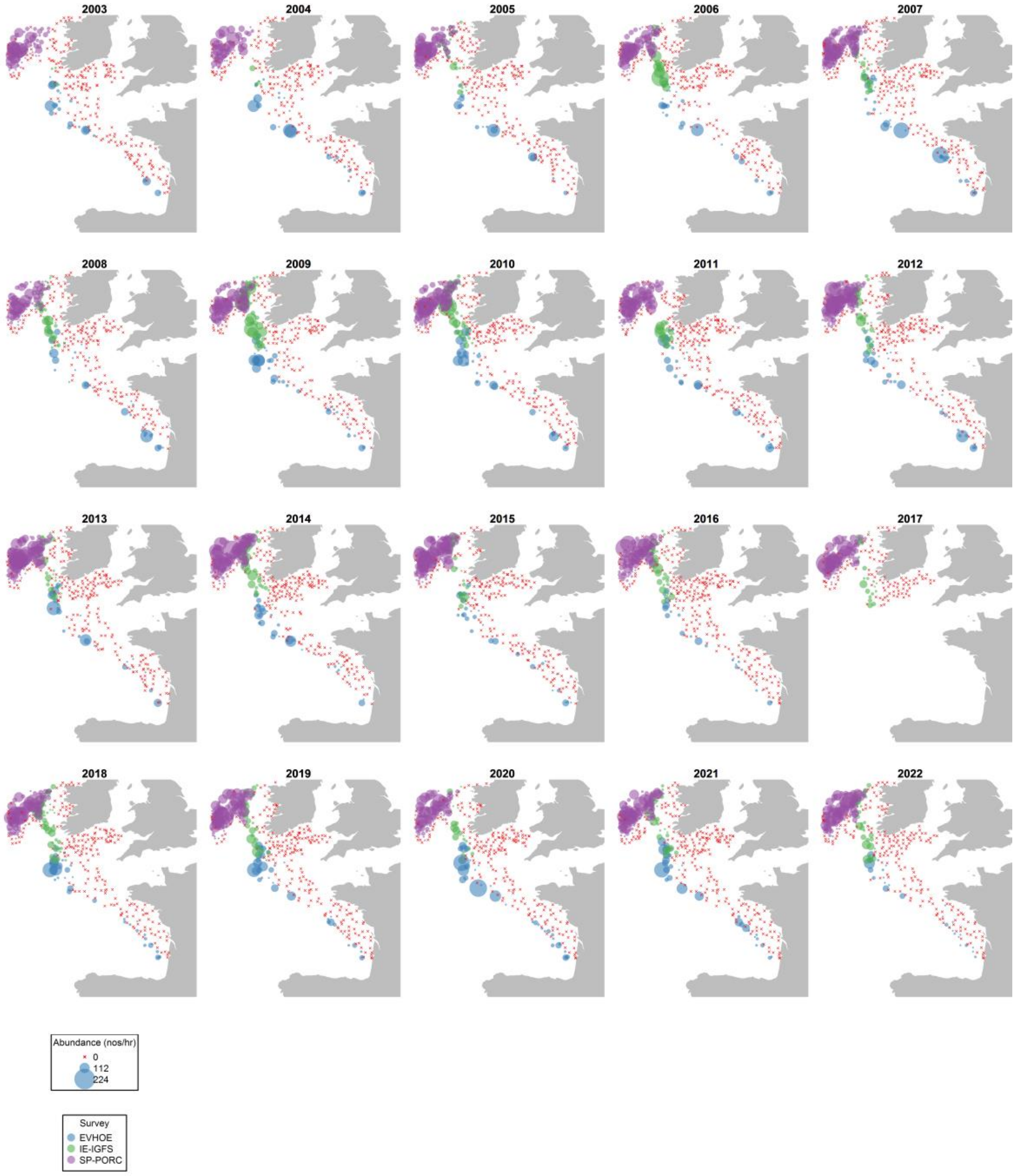


Figure 5.3.7. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Abundance densities distribution of four-spot megrim from the French EVHOE (EVHOE-WIBTS-Q4, G9527), Irish Ground Fish Surveys (IGFS-WIBTS-Q4, G7212) and Spanish Porcupine Bottom Trawl (SpPGFS-WIBTS-Q3, G5768) surveys.

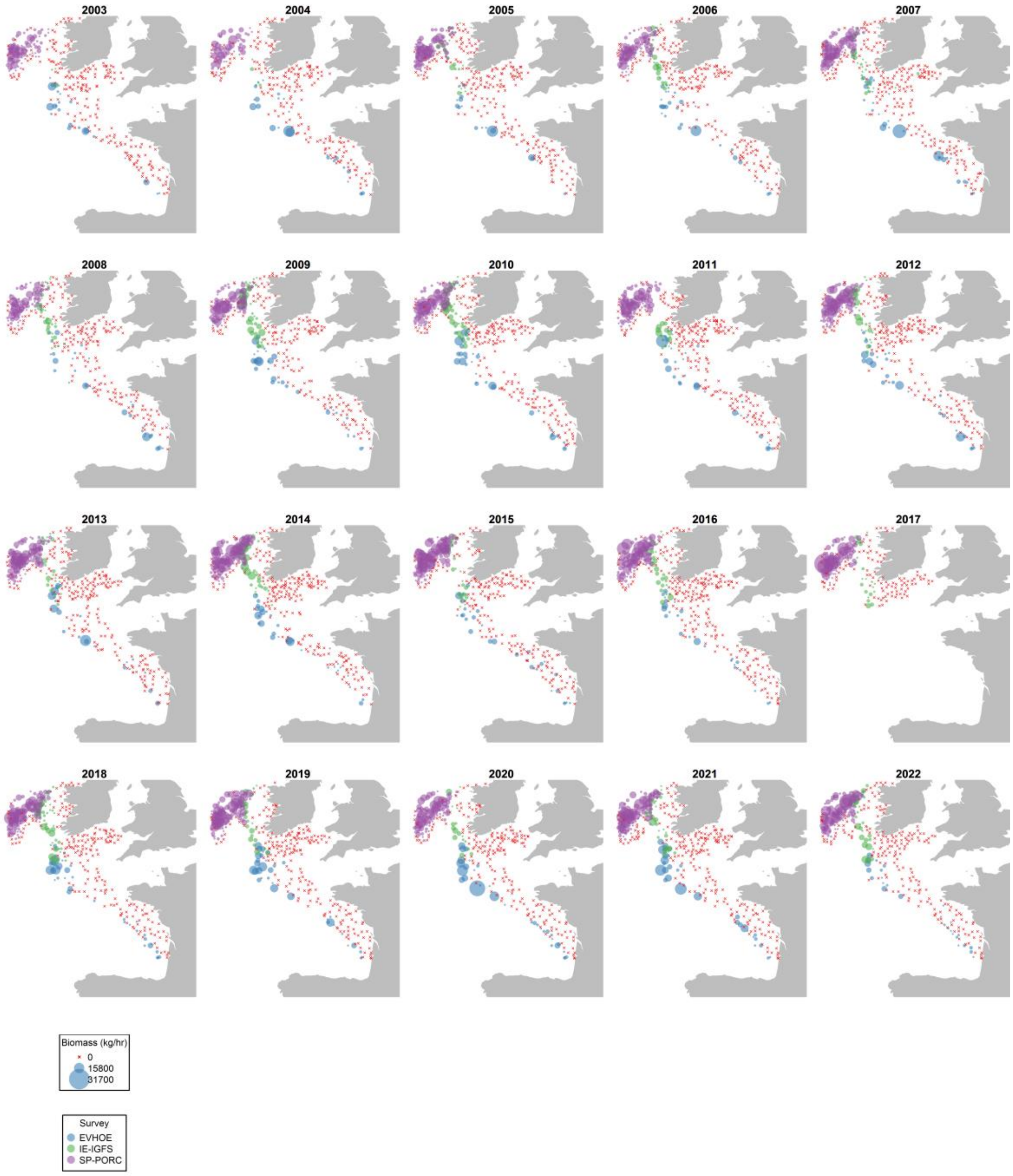


Figure 5.3.8. Four-spot megrim (*L. boscii*) in divisions 7.b–k and 8.a, 8.b, and 8.d. Biomass densities distribution of four-spot megrim from the French EVHOE (EVHOE-WIBTS-Q4, G9527), Irish Ground Fish (IGFS-WIBTS-Q4, G7212) and Spanish Porcupine Bottom Trawl (SpPGFS-WIBTS-Q3, G5768) surveys.

5.3.4 Assessment

No quantitative stock assessment was carried out at WGBIE 2023 although the analysis was updated with the available catch data and biological information from 2022.

5.3.4.1 Data exploratory analysis

The following exploratory analyses were carried out for quality control reasons: sample weights were checked against expected weights (as estimated from length-weight parameters), excessive raising factors (from sample to catch weight) were checked and abundance indices (numbers per hour) were calculated for each survey series using all valid hauls and ignoring the spatial stratification.

5.3.4.2 Model

No model was used in the assessment.

5.3.4.3 Results

The stock status relative to candidate reference points is unknown. The precautionary buffer was last applied in 2021 (ICES, 2021). Discards were not estimated since 2020 due to insufficient sampling, but average discards from the last period of complete catches (2017 to 2019) were estimated to be 27% of the total catch.

5.3.4.4 Retrospective pattern

No retrospective analysis was performed.

5.3.4.5 Short-term forecasts

No short-term forecast was produced.

5.3.5 Biological reference points

No biological reference points were produced at WGBIE 2023.

5.3.6 Conclusions

This was the seventh year that an assessment was carried out for this stock and the sixth year that the stock was included in the ICES data call. This year, catch advice was not requested as advice was provided last year for the period 2023 to 2025.

The times series of this assessment was improved by the addition of another year of commercial landings, discards and length data. However, the incomplete historical (2003–2016) catch data from Spain means that the time-series of commercial catch is not sufficiently long to support the assessment.

There is still a requirement for substantial port samplings to provide an accurate species split for the landings as it is unsure how the survey catches relate to the commercial catches. The Covid-

19 pandemic reduced the availability of samples of landings and discards and meant that catches of four-spot megrim from France could not be estimated. In 2019, France contributed 44% of total landings (403 t) and the absence of these data undermined the confidence in 2020, 2021 and 2022 catch data.

Investigations into Length-Based Indicators were carried out at WGBIE 2021 (LBI; ICES, 2017) and Mean Length-Z (MLZ) as defined in WKLIFE V (ICES, 2015) were carried out using data from SpPGFS-WIBTS-Q3 (G5768). However, it was decided that this survey did not sufficiently cover the stock area to provide catch advice (ICES, 2021). Future work needs to be carried out on combining survey indices and using spatial models such as the Vector Autoregressive Spatio-Temporal (VAST; Thorson, 2019) package[2] in R (R Core Team, 2020).

5.3.7 References

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Thorson, J.T. 2019. Guidance for decisions using the Vector Autoregressive Spatio-Temporal (VAST) package in stock, ecosystem, habitat and climate assessments. Fisheries Research 210: 143–161.

[2] www.github.com/james-thorson/VAST

6 Megrim and four-spot megrim in Cantabrian Sea and Atlantic Iberian waters

meg.27.8c9a and ldb.27.8c9a – *Lepidorhombus whiffiagonis* and *L. boscii* in divisions 8.c and 9.a

6.1 General

6.1.1 Ecosystem aspects

See Stock Annex[1,2] for ecosystem aspects related to megrim assessment (both stock annexes were updated after the WKMEGRIM 2022 benchmark).

6.1.2 Fishery description

See Stock Annex for fishery description.

6.2 Summary of ICES advice for 2023 and management for 2022 and 2023

6.2.1 ICES advice for 2023 (as extracted from ICES advice on fishing opportunities, catch and effort 2022)

The two megrim species (*L. whiffiagonis* and *L. boscii*) are not completely separated in the landings. A single TAC covers both species and species-specific landings are estimated by ICES. ICES considers that management of the two megrim species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species. Therefore, the advice since 2016 is based on the single-species F_{MSY} (ICES, 2022b, 2022c).

A mixed-fisheries analysis covering the stocks in Iberian waters of hake, megrim, four-spot megrim, and white anglerfish is provided in ICES (2022d).

ICES advise that when the EU multiannual plan (MAP; EU, 2019) for Western waters and adjacent waters is applied, catches in 2023 that correspond to the F ranges in the MAP are between 654 and 1456 t for *L. whiffiagonis* and between 1595 and 3421 t for *L. boscii*. According to the MAP, catches higher than those corresponding to F_{MSY} (968 t for *L. whiffiagonis* and 2282 t for *L. boscii*) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying the ICES advice rule.

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[1] ICES. 2022. ICES Stock Annex: Megrim (*Lepidorhombus whiffiagonis*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters). Produced by the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) and updated in August 2022 by the Benchmark workshop for selected megrim stocks (WKMEGRIM 2022).

[2] ICES. 2022. ICES Stock Annex: Four-spot megrim (*Lepidorhombus boscii*) in divisions 8.c and 9.a (south Bay of Biscay and Atlantic Iberian waters East). Produced by the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) and updated in August 2022 by the Benchmark workshop for selected megrim stocks (WKMEGRIM 2022).

6.2.2 Management applicable for 2022 and 2023

The agreed combined TAC for megrim and four-spot megrim in ICES divisions 8.c and 9.a was 2445 t in 2022 and 3250 t in 2023.

6.2.3 References

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj.

ICES. 2022a. Benchmark workshop for selected megrim stocks (WKMEGRIM). ICES Scientific Reports. 4:53. http://doi.org/10.17895/ices.pub.20069000

ICES. 2022b. Four-spot megrim (*Lepidorhombus boscii*) in divisions 8.c and 9.a (southern Bay of Biscay and Atlantic Iberian waters East). *In* Report of the ICES Advisory Committee, 2022. ICES Advice 2022, ldb.27.8c9a, https://doi.org/10.17895/ices.advice.19448036.

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Millar, C., Jardim, E. 2019. a4a: A flexible and robust stock assessment framework. R package version 1.8.2. URL: https://flr-project.org/FLa4a/.

Shepherd, J.G., 1999. Extended survivors' analysis: an improved method for the analysis of catch-at-age data and abundance indices. ICES Journal of Marine Science. Vol. 56, No. 5.pp. 584–591.

6.3 Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a

6.3.1 General

See general section for both species.

6.3.2 Data

6.3.2.1 Commercial catches and discards

WGBIE estimates of landings, discards, and catches for the period 1986 to 2022 are given in Table 6.3.1. From 2011 to 2018, estimates of unallocated or non-reported landings were included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each *métier*. These estimates are considered the best information available at this time. In 2015, data revised for the period 2011–2013 were provided. This revision produced an improvement in the allocation of sampling trips and the revised data are used in the assessment. The total estimated international landings in divisions 8.c and 9.a for 2022 were 310 t. Landings reached a peak of 977 t in 1990, followed by a steady decline until 2002. Some increase in landings has been observed since then, but landings have again decreased annually from 2007 until 2010 to 83 t, the lowest value of the entire time-series. Since 2011, the stock increased again and has then remained stable. Historical landings for both species combined are shown in Figure 6.3.1. The last period shows a decreasing trend since 2014 and in 2022, the international landings were 961 t.

Discards estimates were available from the Spanish "observers' on board sampling programme" for the years displayed in Table 6.3.2(a). In 2020, discards data of the first semester were missing for the reasons previously mentioned and were estimated based on the discard per unit of effort of the second semester applied to the exerted effort in the first semester. Discards represent between 10–47% of the total catch, with the exception of the years 2007 and 2020 when discards were very low and in 2011 when the value observed was extremely high. Following the recommendations, during the WKSOUTH benchmark in 2014 (ICES, 2014), an effort was made to complete the time-series back until 1986 in years without samplings. Total discards, given in tonnes (Table 6.3.1) and numbers-at-age (Table 6.3.2b), were included in the assessment model. Figure 6.3.2 shows the proportion of discards-at-age.

Figures 6.3.3 (a, b and c) show the standardized catches, landings a discards proportion-at-age, where cohort tracking can be observed.

6.3.2.2 Biological sampling

Annual length compositions of total stock landings are provided in Figure 6.3.4 for the whole period and in Table 6.3.3a for 2022. The bulk of sampled specimens corresponds to individuals of 20–35 cm.

Sampling levels for both species are given in Table 1.4.

Mean lengths and mean weights in landings since 1990 are shown in Table 6.3.3b. The mean length and weight values observed in 2013 were the highest in the historic series.

Age compositions of catches are presented in Figure 6.3.5 and weights-at-age of catches from 1986 to 2022 is shown in Figure 6.3.6. These values were also used as the weights-at-age in the stock.

More biological information, the parameters used in the length-weight relationship, natural mortality and maturity ogive are provided in the Stock Annex, where the updates and new information approved in the last benchmark are shown (ICES, 2022).

6.3.2.3 Abundance indices from surveys

Portuguese and Spanish survey indices are summarized in Table 6.3.6.

Two Portuguese surveys, named "Crustacean" (PT-CTS-UWTV-FU28–29, G2913) and "October" (PtGFS-WIBTS-Q4, G8899), provide biomass and abundance indices. In 2012 and for the years, 2019 and 2020, these Portuguese Surveys were not carried out and surveys resumed in 2021 but has been performed in a new vessel

As noted in the Stock Annex, indices from these Portuguese surveys are not considered representative of the megrim abundance due to the very low catch rates. These surveys are not included in the assessment model.

Spanish Groundfish Survey (SP-NSGFS-Q4 (G2784)) survey

The Spanish survey (SP-NSGFS-Q4, G2784) covers the distribution area and depth strata of this species in Spanish waters 8.c and 9.a. Total biomass and abundance indices from this survey were higher during the period 1988 to 1990, subsequently declining to lower mean levels, which were common throughout the rest of the time-series. There has been an overall declining trend in the abundance index after year 2000, with the values for 2008 and 2009 being the two lowest in the entire series. Since then, there is a general increasing trend with the highest value this year (Figure 6.3.7). In 2013, the survey was carried out in a new vessel. This year the abundance indices were high for flatfish and benthic species. Although there was an inter-calibration exercise performed between both vessels, the results were not consistent with the results of the inter-calibration. Therefore, WGBIE decided not to include the abundance index value for that year in the assessment model. Since 2014, the gear used was similar to the gear used in the survey before 2013. A new inter-calibration exercise was conducted in 2014 and the index was considered suitable for inclusion in the assessment. In 2021, the second part of the survey was performed in a different vessels because of technical issues but the gear was the same. It have been assumed the possible effects are minor and the index is appropiate to use in the assessment.

The Spanish survey recruitment index for age 1 (Recruitment age) indicates an extremely weak year class in 1994, which improved in the following years. From 2000 to 2014, low values of year classes were observed except in 2010. However, since 2015, there was a considerable increase in age 1 with the highest value of the time-series in 2022 (Figure 6.3.8). Figure 6.3.8 displays a bubble plot of log (survey abundance-at-age), with each age standardised separately over the years. The figure indicates that the survey is quite good at tracking cohorts through time.

Figure 6.3.9 shows the internal consistency of the standardized index. The survey is a bit noisy for older ages, but still quite consistent.

Type	Name	Year range	Age range	Used in the assessment
Spanish Groundfish Survey	SpGFS-WIBTS-Q4 (G2784)	1983–present	1–6	Yes
Portuguese October Groundfish Survey	PtGFS-WIBTS-Q4 (G8899)	1990-present	Biomass index	No
Portuguese Crustacean Survey	PT-CTS -UWTV -FU 28-29 (G2913)	1997–present	1–6	No

6.3.2.4 Commercial catch-effort data

The commercial LPUE and effort data of the Portuguese trawlers fishing in Division 9.a and of two Spanish fishing ports operation in métier OTB_DEF_>=55_0_0 in 8.c and 9.a are available and cover the period 1986–2022. Figure 6.3.10 shows the LPUE series and the increasing trends in recent years.

The use of commercial LPUEs was rejected during the WKMEGRIM benchmark in 2022 (ICES, 2022) due to concerns about changes in efficiency, targeting behaviour, quota restrictions, technical measures, discarding and compliance. However, these trends can be used as supplementary information by WGBIE.

6.3.3 Assessment

An assessment was conducted, according to the Stock Annex specifications. Assessment years are from the period 1986–2022 and for ages 1–7+ individuals.

The a4a (Millar and Jardim, 2019) stock assessment model is selected and implemented for the assessment of the stock. It is a non-linear catch-at-age model implemented in R (R Core Team,

2022) and FLR (Kell *et al*., 2007), and using ADMB (Fournier *et al*., 2012), that can be applied rapidly to a wide range of situations with low parameterization requirements[3].

6.3.3.1 Input data

Following the Stock Annex, discards and landed numbers-at-age were incorporated resulting in catch numbers-at-age as input data from 1986 to 2022 and the year 2022 was added to the Spanish SpGFS-WIBTS-Q4 (G2784) survey index.

6.3.3.2 Model

Model Specification

Software used: R package Fla4a (version 1.8.2) in R (version 4.1.2), (see Stock Annex for details):

The model structure is defined by submodels, which are the different parts that require structural assumptions. There are five submodels in operation:

1. model for F-at-age,
2. model for the initial age structure,
3. model for recruitment,
4. (list) of model(s) for abundance indices catchability-at-age,
5. list of models for the observation variance of catch-at-age and abundance indices.

These submodels were defined as:

```
fmodel: ~factor(replace(age, age > 6, 6)) + factor(year)
srmodel: ~factor(year)
n1model: ~factor(age)
qmodel: list(~I(1/(1 + exp(-age))))
vmodel:
catch:        ~s(age, k = 3)
SpGFS-WIBTS-Q4:    ~1
```

The F model is a separable model. The shape of the F-at-age pattern is independently estimated for each age except for ages 6 and 7+, which are assumed to have the same Fs. This F pattern is then independently scaled up and down for each year.

Stock–recruit model: Freely estimated for each year.

Catchability models:

For the SpGFS-WIBTS-Q4 (G2784) survey, catchability is assumed to increase asymptotically.

N1 model (population in the first year of the time-series): default value a4aSCA function (independently estimated for each age)

Vmodel (the shape of the observation variances): default value a4aSCA function: smooth function for the catch numbers-at-age and 'flat' for the index.

An FLStock object is needed and it was adapted from XSA (Shepherd, 1999) input data. This object includes catches, landings, discards, weights-at-age, natural mortality (M), maturity, harvest before spawning and mortality before spawning.

Model Settings

- F_{bar} is set to ages 2–4.

[3] http://www.flr-project.org/doc/Statistical_catch_at_age_models_in_FLa4a.html

For more settings see the Stock annex.

Data screening

Figure 6.3.3a shows catch proportions-at-age where larger proportions can be observed for ages 1 to 3. Figure 6.3.3b shows landings proportions at age, indicating that the bulk of the landings consisted of ages 1 and 2 before 1994 then shifted mostly to ages 2 to 4 since the mid-1990s. The proportions-at-age decreases for ages 1 and 2 while increasing for the older ages. Some weak and strong cohorts can be observed in this figure, particularly around the mid-1990s and in the last period. In 2010, an increase in landings of older ages, especially ages 5 to 7+, was observed. In the last period, the high abundances of age 1 in the Spanish SpGFS-WIBTS-Q4 (G2784) survey in some years since 2010 can be tracked in the following years (Figure 6.3.8). Figure 6.3.3c shows discards proportions-at-age, being more abundant for age 1 from 2000 onwards. Before this year, discarding was higher for age 2 individuals.

Final run

The a4a framework (Millar and Jardim, 2019) was selected for use as in assessment model for the stock. Model description and settings are detailed in the Stock Annex.

6.3.3.3 Assessment results

Figure 6.3.11 shows the patterns in F-at-age and catchability estimated by the model. F is estimated to be low for age 1, then increases for age 5 and decreases again for ages 6 and 7+ (F is forced to be the same for ages 6 and 7+). The catchability (Q) of the Spanish (SpGFS-WIBTS-Q4, (G2784) survey increase along a logistic function.

The log residuals of catch and abundance index by age are shown in Figure 6.3.12. showing a slight trend in catch, overestimating catch in recent years.

The summary plots of the assessment are shown in Figure 6.3.13 and the summary results are presented in Table 6.3.5.

F decreases in the last year and although the general trend is decreasing, higher values have been observed in the last 10 years but still the lowest in the series. Catches show a slight increase with a value around the average of the last 10 years. The SSB values in 2001 and 2002 were the lowest in the series. Since 2017, values were significantly higher and there is an increasing trend especially in the most recent years. Since 2015, recruitment (age 1) has presented the highest values in the time-series.

The retrospective analysis shows a small but consistent pattern of SSB overestimation and F underestimation in recent years with Monn's Rho values of -0.463 for F, 0.734 for SSB and 0.127 for R (Figure 6.3.14).

6.3.4 Biological reference points

Biological reference points were established during the WKMEGRIM benchmark (ICES, 2022).

Methods

- Model used: Eqsim
- Software used: R packages msy (version 0.1.19), FLCore (version 2.6.18) in R (version 4.1.2) and icesAdvice (version 2.0.0)

	Type	Value	Technical basis
MSY approach	MSY $B_{trigger}$	725 t	B_{pa}

	Type	Value	Technical basis
	F_{MSY}	0.173	Stochastic simulations (*EqSim*) based on the recruitment period 1986–2020
	B_{lim}	532 t	B_{loss}, biomass in 2001 as estimated in 2022
Precautionary approach	B_{pa}	725 t	$B_{lim} \times \exp(1.645 \times 0.142)$
	F_{lim}	0.619	The F that results in long-term probability (SSB < B_{lim}) = 50%; calculated by stochastic simulation (*EqSim*) using a segmented regression with B_{lim} as the breakpoint and no error
	F_{pa}	0.45	$F_{p.05}$ with AR: The F that provides a 95% probability for SSB to be above B_{lim}.
EU Management plan (MAP; EU, 2019)	MAP MSY $B_{trigger}$	725 t	MSY $B_{trigger}$
	MAP B_{lim}	532 t	B_{lim}
	MAP F_{MSY}	0.173	F_{MSY}
	MAP range F_{lower}	0.112	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY
	MAP range F_{upper}	0.284	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY

6.3.5 Short-term projections

Methods

- Model used: stf() and fwd() functions in R packages FLasher and FLCore.
- Software used: R packages icesTAF (version 3.6.0) and FLasher (version 0.6.7) in R (version 4.1.2)
- Settings and assumptions for Interim Year and for Forecast are described in the Stock Annex and have been followed to calculate the projections.
- Recruitment in last year was replaced by the geometric mean of 1998-2020
- Recruitment-at-age 1 assumed equal in intermediate year and all the projection as the geometric mean (GM) from 1998 to final assessment year minus 2.
- $F_{status\ quo}$: Average F_{bar} for the last three years.

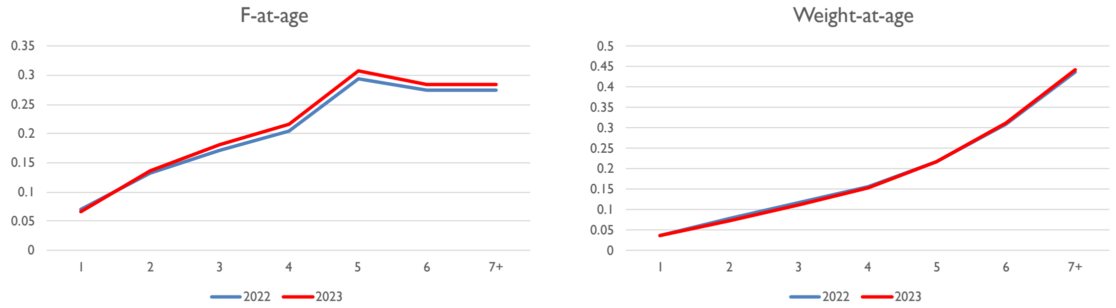
The values for the forecast and for the interim year, basis of the catch scenarios, are shown in Table 6.3.6. Management options for catch prediction are in Table 6.3.7.

Changes in advice

Current advice is 31% higher than last year advice. In order to explain the increase in advice, some comparison have been made. First, a matrix comparing the current estimates of numbers at age to the previous year's estimates to get a quick overview of how the estimate of stock size at age has changed. Also, two plots with selectivity and weight at age comparing the current and last year's selectivity/weights. Two tables with the values used in the interim year in the current and last year's assessments are also shown and finally, the Spanish survey abundance index (SpGFS-WIBTS-Q4 (G2784)) by age.

Age / length	2019	2020	2021	2022	2023
1	0.95	1.67	1.81	5.02	Na
2	0.81	0.94	1.65	1.80	Na
3	0.78	0.79	0.92	1.61	Na
4	0.82	0.75	0.76	0.89	Na
5	0.81	0.78	0.72	0.73	Na
6	0.80	0.76	0.73	0.68	Na
7	0.81	0.76	0.71	0.69	Na

Number estimated in current assessment / number estimated previous assessment



Selectivity and weight at age of the current and last year's assessment.

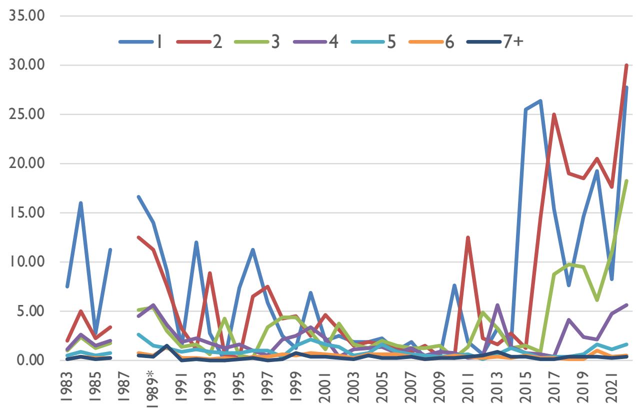
2023

Variable	Value	Notes
F[ages 2-4] (2023)	0.104	Fsq = average F (2020–2022).
SSB (2024)	6207	Short-term forecast (STF); in tonnes.
R[age 1] (2023, 2024)	3910	Geometric mean 1998–2020; in thousands.
Total catch (2023)	699	STF; in tonnes.
Projected landings (2023)	656	STF assuming average landings ratio at age 2018–2022; in tonnes.
Projected discards (2023)	43	STF assuming average landings ratio at age 2018–2022; in tonnes.

2022

Variable	Value	Notes
Fages 2–4(2022)	0.106	Fsq = average F (2019–2021).
SSB (2023)	4650	Short-term forecast (STF); in tonnes.
Rage 1 (2022–2023)	3760	Geometric mean 1998–2019; in thousands.
Total catch (2022)	553	STF using Fsq ; in tonnes.
Projected landings (2022)	531	STF assuming average landings ratio at age 2019–2021; in tonnes.
Projected discards (2022)	22	STF assuming average discards ratio at age 2019–2021; in tonnes.

The values for the forecast and for the interim year of the current and last year's assessment.



the Spanish survey abundance index (SpGFS-WIBTS-Q4 (G2784)) by age.

The advice for 2024 is 31% higher than the advice for 2023. They main reason for this is the increase in numbers at age [ages 1-4 in year 2022] estimated in current assessment. In addition, there is an increase in the abundance index from the Spanish survey, with the highest value of the time series. All ages contribute to this increase, especially the youngest. The comparison of the exploitation patterns and weights at age from the last assessment with the ones from the current assessment do not explain the increase in advice because there are no appreciable differences between them.

6.3.6 Comments on the assessment

The use of the new a4a (Millar and Jardim, 2019) assessment model and the definition of new reference points, estimated following the standard ICES approach (ICES, 2021a), gave new relative values in relation to the reference points for SSB, F and R. Figure 6.3.15 shows historical assessment results (final-year recruitment assumptions included for each line) relative to each year's reference points for comparison. Last year's assessment is in orange while previous year's assessment results (ICES, 2021c) are in blue.

The model results has been accepted and although it shows a retrospective pattern with some peels which are out of bounds, the 2023 advice was drafted following the WKFORBIAS decision tree (ICES, 2020) as SSB>>MSY $B_{trigger}$ and F_{HCR}<<F_{pa}.

6.3.6.1 Interbenchmark proposal

In 2022 this stock was benchmarked during the WKMEGRIM (ICES, 2022) and the change of assessment model to the a4a (Millar and Jardim, 2019) model led to an improvement and progress due to the replacement of the XSA (Shepherd, 1999) deterministic assessment model which includes some uncertainties (ICES, 2021c). However, one of the problems that already existed in the deterministic model remains unsolved (ICES, 2021c). A strong retro bias (SSB overestimation and F underestimation) still remains despite the change in assessment method (ICES, 2022).

During the WKMegrim benchmark (ICES, 2022), it was not possible to find a4a experts to participate during the meeting who may have provided guidelines or advice to resolve these issues. Due to this outstanding modelling problem, WGBIE still supports the organization of an interbenchmark as soon as possible, with an objective of soliciting the participation of a4a experts in order to explore, improve and validate other model configurations and obtain better and robust retrospective pattern fits.

6.3.7 Management considerations

Megrim, *L. whiffiagonis,* is caught in mixed fisheries. There is a common TAC for both megrim species (*L. whiffiagonis* and *L. boscii*), so the status of both stocks should be taken into consideration when formulating management advice. Megrims are caught as bycatch in mixed fisheries that generally target white fishes. Therefore, the F of megrims could be influenced by some restrictions imposed on demersal mixed fisheries that aim to preserve and rebuild the overexploited southern hake and *Nephrops* stocks.

This is a small stock (average stock SSB since 1986 is 1258 t). Fishery management geared on decreasing F of megrim stock to low values could cause serious difficulties for the exploitation of other stocks in the mixed fishery (i.e. choke species effect). Both Iberian megrim stocks are assessed separately but managed together, a situation that may produce inconsistencies when these stocks are considered in a mixed fisheries management approach. This effect was already observed in the results of the mixed fisheries analysis developed for Iberian stocks by the WGMIXFISH-ADVICE (ICES, 2021b). Of course, any F that will be applied for the management of megrim must conform with the precautionary approach.

WGBIE considered that this stock could be just "the tail" of a much larger megrim stock in ICES Subarea 7 and divisions 8.a, 8.b, and 8.d and suggested reconsidering the stock limits and its inclusion with the Northern megrim stock. This option was studied during the Stock Identification Methods Working Group (SIMWG) in 2015 and the conclusion was that SIMWG did not find any strong evidence to support the combination of the northern with southern area stock. Furthermore, SIMWG recommends that the current stock definition should be kept until more supportive and conclusive studies are developed (ICES, 2015).

6.3.8 References

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6.3.9 Tables and figures

Table. 6.3.1. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Landings, discards and catch in tonnes.

	Spain landings			Portugal landings	Unallocated	Total landings	Discards	Total catch
Year	8c	9a*	Total	9a				
1986	508	98	606	53		659	46	705
1987	404	46	450	47		497	40	537
1988	657	59	716	101		817	42	859
1989	533	45	578	136		714	47	761
1990	841	25	866	111		977	45	1022
1991	494	16	510	104		614	41	655
1992	474	5	479	37		516	42	558
1993	338	7	345	38		383	38	421
1994	440	8	448	31		479	13	492
1995	173	20	193	25		218	40	258
1996	283	21	305	24		329	44	373
1997	298	12	310	46		356	52	408
1998	372	8	380	66		446	36	482
1999	332	4	336	7		343	43	386
2000	238	5	243	10		253	35	288
2001	167	2	169	5		175	19	193
2002	112	3	115	3		117	19	137
2003	113	3	116	17		134	15	148
2004	142	1	144	5		149	11	159
2005	120	1	121	26		147	19	166
2006	173	2	175	35		210	16	226
2007	139	2	141	14		155	0.4	155
**2008	114	2	116	17		133	11	144
2009	74	2	77	7		84	11	94
2010	66	8	74	10		83	5	88
^2011	242	0	242	34	26	302	69	371
^2012	151	11	161	18	83	262	31	293
^2013	128	3	131	11	90	231	18	250
2014	225	5	231	30	116	377	23	399
2015	188	2	190	23	63	276	21	297
2016	171	1	172	15	48	235	63	298
2017	189	4	193	16	39	247	41	288
2018	227	8	234	7	74	315	37	352
2019	226	7	233	6		239	51	289
2020	278	26	305	10		315	5	320
2021	236	16	252	10		262	32	294
2022	261	25	285	24		310	40	350

^Data revised in WG2015

*9a is without Gulf of Cádiz till 2016

** Data revised in WG2010

*** Official data by country and unallocated landings

Table. 6.3.2a. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Discard/Total Catch ratio and estimated CV for Spain from on-board sampling.

Year	1994	1997	1999	2000	2003	2004	2005	2006	2007	2008	2009
Weight Ratio	0.03	0.14	0.12	0.13	0.11	0.07	0.14	0.08	0.00	0.08	0.13
CV	50.83	32.23	33.4	48.41	19.93	29.24	43.17	31.62	55.01	58.8	52.9
Number Ratio	0.10	0.38	0.34	0.45	0.26	0.16	0.28	0.21	0.01	0.20	0.36

Year	2010	2011*	2012	2013	2014	2015	2016	2017	2018	2019	2020
Weight Ratio	0.06	0.23	0.12	0.07	0.06	0.07	0.21	0.14	0.10	0.17	0.02
CV	61.6	23.7	28.8	30.3	44.7	49.8	57.1	28.9			
Number Ratio	0.27	0.57	0.37	0.24	0.20	0.29	0.47	0.34	0.26	0.37	0.05

Year	2021	2022
Weight Ratio	0.11	0.11
CV		
Number Ratio	0.23	0.24

All discard data revised in WG2011

*Data revised in WG2013

Table. 6.3.2b. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Discards in numbers-at-age (thousands) for Spanish trawlers.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	138	138	138	138	138	138	138	138	104	138	138	41	138	270	27
2	339	339	339	339	339	339	339	339	93	339	339	453	339	471	611
3	425	425	425	425	425	425	425	425	136	425	425	857	425	284	160
4	130	130	130	130	130	130	130	130	51	130	130	142	130	197	73
5	10	10	10	10	10	10	10	10	3	10	10	1	10	26	19
6	4	4	4	4	4	4	4	4	1	4	4	5	4	6	0
7	1	1	1	1	1	1	1	1	0	1	1	3	1	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*	2012	2013	2014	2015
1	10	10	0	4	20	0	0	0	96	16	12	8	330	442	624
2	338	338	239	164	223	19	11	126	142	119	2044	808	53	94	10
3	82	82	57	28	61	108	0	86	21	6	346	85	13	16	4
4	31	31	12	6	38	115	0	8	15	1	1	41	5	2	1
5	9	9	4	5	11	28	0	5	7	2	2	2	0	0	0
6	1	1	0	3	4	13	0	2	7	0	0	1	0	0	0
7	1	1	0	2	1	4	0	0	3	1	0	1	0	0	0

	2016	2017	2018	2019	2020	2021	2022
1	1074	492	203	487	42	80	67
2	373	410	387	337	54	316	276
3	3	43	110	135	3	128	287
4	1	0	28	40	0	11	30
5	0	0	1	6	0	4	5
6	0	0	1	0	0	2	0
7	0	0	0	0	0	2	0

Table 6.3.3a. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Annual length distribution of landings in 2022.

Length (cm)	Total
10	
11	
12	
13	
14	
15	
16	766
17	104
18	9203
19	27445
20	103366
21	119220
22	201084
23	217144
24	226129
25	223890
26	185558
27	154243
28	144394
29	113522
30	98445
31	77544
32	66368
33	43562
34	36939
35	26900
36	17280
37	12694
38	12499
39	6102
40	4378
41	4134
42	2580
43	849
44	1356
45	701
46	593
47	602
48	206
49	96
50+	96
Total	2139993

Table 6.3.3b. Mean lengths and mean weights in landings since 1990.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Mean length (cm)	22.3	23.5	24.6	23.4	25.1	24.7	24.6	24.6	24.7	25.3	25.8	25.1	26
Mean weight (g)	105	108	129	108	124	121	120	118	119	127	134	124	137

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Mean length (cm)	25.7	26.1	25.32	26.15	26.68	26.64	27.58	29.4	27.63	28.2	29.39	28.6	28.72
Mean weight (g)	134	137	127	137	148	146.8	163.2	187.4	159.5	163.2	187.5	170.7	172.3

Year	2016	2017	2018	2019	2020	2021	2022
Mean length (cm)	26.81	26.41	27.18	26.71	28.53	26.67	26.49
Mean weight (g)	145.7	134.1	147.8	139.9	169.1	147.3	144.8

Table 6.3.4. Megrim (*L. whiffiagonis*) divisions 8.c and 9.a. Biomass, Abundance and Recruitment indices from Portuguese and Spanish surveys.

	Biomass Index						Abundance index					Recruitment index		
	Portugal (k/h)			Spain (k/30 min)			Portugal (n/h)		Spain (n/30 min)			At age 1	At age 0	At age 1
												Portugal (n)	Spain (n/30 min)	
	October	Crustaceans	s.e	Mean	s.e.		Crustaceans	s.e.	Mean	s.e.		October		
1983				0.96	0.14	1983			14.0	2.45	1983		1.88	7.72
1984				1.92	0.34	1984			28.0	4.57	1984		0.32	16.08
1985				0.89	0.15	1985			9.0	1.34	1985		0.10	2.74
1986				1.65	0.2	1986			33.0	6.22	1986		13.78	11.19
1987				ns		1987			ns		1987		ns	ns
1988				3.52	0.64	1988			43.0	8.82	1988		0.65	16.60
1989				3.13	0.5332	1989			42.0	7.04	1989		2.90	13.96
1990	0.08			3.08	0.86	1990			28.0	5.5	1990	5	0.11	9.13
1991	0.11			1.22	0.17	1991			10.0	1.67	1991	5	1.26	1.38
1992	0.11			1.39	0.2	1992			18.0	3.35	1992	8	0.01	12.03
1993	0.04			1.46	0.24	1993			15.0	3.23	1993	1	0.00	2.76
1994	0.05			1.02	0.2	1994			8.0	1.87	1994 +		0.60	0.05
1995	0.01			1.03	0.16	1995			11.0	1.86	1995 +		0.41	7.38
A,1996 +				1.64	0.22	A,1996			21.0	3.6	A,1996 +		0.45	11.26
1997 +		1.41	1.04	1.79	0.25	1997	7.22	4.82	20.0	3.26	1997 +		0.15	5.91
1998	0.01	0.20	0.09	1.47	0.23	1998	1.09	0.51	14.8	2.64	1998 +		0.02	2.56
A,B,1999 +		0.11	0.11	1.59	0.29	A,B,1999	0.57	0.53	15.5	3.05	A,B,1999 +		0.56	1.26
2000 +		0.06	0.05	1.8	0.35	2000	0.27	0.17	19.4	4.46	2000 +		0.05	6.92
2001	0	0.04	0.03	1.45	0.28	2001	0.07	0.04	12.8	2.77	2001 +		0.19	1.97
2002	0.04	0.07	0.04	1.26	0.24	2002	0.21	0.10	12.1	2.65	2002 +		0.08	2.53
A,2003	0.01	0.07	0.05	0.82	0.16	A,2003	0.16	0.08	7.2	1.26	A,2003	0.05	0.05	1.91
A,2004	0.01	ns		1.08	0.2	A,2004	ns		8.44	1.39	A,2004 +		0.14	1.83
2005	0.01	0.37	0.20	1.29	0.21	2005	0.71	0.35	9.76	1.73	2005 +		0.08	2.21
2006	0.02	0.29	0.18	1.03	0.18	2006	0.43	0.24	6.38	1.16	2006		0.00	0.89
2007	0	0.15	0.09	1.13	0.24	2007	0.49	0.37	6.87	1.52	2007		0.01	1.87
2008	0	0.25	0.11	0.68	0.15	2008	1.49	0.71	4.33	1.07	2008		0.00	0.23
2009	0.00	*0.05	0.03	0.80	0.12	2009	*0.19	0.10	4.17	0.59	2009		0.19	0.20
2010	0.01	0.20	0.10	0.89	0.16	2010	0.56	0.23	10.15	1.97	2010		0.01	7.63
2011	0.00	0.84	0.67	1.83	0.35	2011	1.75	1.30	17.45	3.86	2011		0.00	1.94
2012	ns	ns	ns	1.38	0.19	2012	ns	ns	9.07	1.29	2012		0.03	0.58
**2013	0	0.20	0.13	2.44	0.39	2013	0.43	0.22	15.89	2.58	2013		0.02	3.24
2014	0.02	0.30	0.18	1.34	0.21	2014	0.81	0.41	9.04	1.26	2014		0.40	1.32
2015	0.06	0.27	0.14	1.86	0.26	2015	0.89	0.39	30.75	5.64	2015		0.28	25.46
2016	0.06	0.26	0.13	2.71	0.28	2016	0.90	0.35	43.10	5.35	2016		0.02	26.31
2017	0.06	0.21	0.09	3.75	0.39	2017	2.04	1.37	50.23	6.04	2017		0.00	15.42
2018	0.04	0.18	0.11	3.42	0.30	2018	1.49	1.01	41.45	4.37	2018		0.05	7.62
2019	ns	ns	ns	3.93	0.43	2019	ns	ns	46.19	5.86	2019		0.09	14.58
2020	ns	ns	ns	3.79	0.49	2020	ns	ns	51.00	6.34	2020		0.04	19.20
***2021	0.12	0.07	0.03	3.34	0.36	2021	0.18	0.08	43.48	5.06	2021		0.13	8.22
2022	0.09	0.39	0.29	5.78	0.73	2022	0.94	0.07	84.19	10.79	2022		0.09	27.72

+ less than 0.04
ns no survey
A Portuguese October Survey with different vessel and gear (Capricórnio and CAR net)

B Portuguese Crustacean Survey covers partial area only with a different Vessel (Mestre Costeiro)
* Revised in WG2011
** Since 2013 new vessel for Spanish survey (Miguel Oliver)
*** From 2021 new vessel for Portuguese surveys (Mário Ruivo) with changes in the gear used in the october survey

Table 6.3.5. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Summary of catches and a4a results.

Summary

YEAR	LANDINGS	DISCARDS	CATCH	CatEst	TSB	SSB	SsbCv	RECRUITS Age 1	RecrCv	FBAR 2-4	FbarCv
1986	659	46	705	667.29	2053.32	1478.05	0.077	7221.05	0.122	0.445	0.119
1987	497.1	39.9	537	369.32	1743.23	1176.48	0.075	8693.58	0.118	0.278	0.129
1988	816.5	41.5	858	651.36	2063.31	1442.28	0.069	8909.43	0.118	0.439	0.115
1989	713.6	47.4	761	657.87	2293.47	1562.54	0.067	10696.55	0.118	0.396	0.115
1990	977.3	44.7	1022	747.07	2218.72	1572.51	0.064	8492.75	0.115	0.483	0.116
1991	614.3	40.7	655	619.65	1753.36	1331.77	0.067	5550.58	0.116	0.487	0.115
1992	515.9	42.1	558	597.69	1750.90	1271.84	0.074	11541.50	0.113	0.474	0.109
1993	382.9	38.1	421	379.42	1568.67	1153.11	0.073	5055.48	0.115	0.302	0.121
1994	479.1	12.9	492	508.00	1294.40	1108.38	0.073	1663.57	0.112	0.512	0.108
1995	218.5	39.5	258	238.53	1169.56	784.46	0.083	7421.27	0.112	0.264	0.124
1996	329	44	373	288.48	1407.27	897.13	0.076	8037.57	0.111	0.261	0.119
1997	355.9	52.1	408	292.56	1372.13	982.37	0.072	6751.09	0.116	0.267	0.116
1998	445.9	36.1	482	517.82	1431.55	1144.37	0.072	4485.09	0.120	0.485	0.104
1999	342.7	43.3	386	393.25	1021.20	860.07	0.075	2316.29	0.117	0.485	0.115
2000	253.2	34.8	288	267.24	814.51	648.54	0.090	3431.02	0.116	0.400	0.124
2001	175.2	18.8	194	197.43	721.51	526.15	0.100	2928.67	0.112	0.340	0.143
2002	116.8	19.2	136	144.22	727.83	571.59	0.121	2324.89	0.109	0.221	0.147
2003	134.1	14.9	149	147.99	863.31	668.90	0.118	2768.59	0.110	0.192	0.145
2004	149.1	10.9	160	185.36	870.52	626.65	0.108	3560.90	0.112	0.257	0.145
2005	146.8	19.2	166	182.32	882.38	660.04	0.111	2597.73	0.115	0.241	0.138
2006	210.3	15.7	226	259.60	928.75	717.94	0.108	2449.45	0.116	0.341	0.129
2007	154.6	0.4	155	185.34	860.95	639.84	0.111	2544.52	0.111	0.254	0.140
2008	133.5	10.5	144	150.30	759.77	637.84	0.115	1443.89	0.109	0.206	0.143
2009	84.4	10.6	95	97.14	751.73	665.55	0.113	1225.97	0.106	0.124	0.140
2010	83.5	4.5	88	92.56	963.67	671.68	0.106	7159.14	0.108	0.104	0.135
2011	301.6	69.4	371	328.45	1204.38	884.56	0.084	3796.00	0.109	0.333	0.115
2012	262.2	30.8	293	327.75	1148.49	961.42	0.078	2267.52	0.114	0.351	0.116
2013	231.9	18.1	250	244.44	1043.65	884.73	0.079	2520.32	0.119	0.266	0.120
2014	376.2	22.8	399	375.85	958.56	816.11	0.079	1682.40	0.121	0.463	0.108
2015	276	21	297	321.86	958.36	596.98	0.086	8700.72	0.126	0.502	0.111
2016	234.8	63.2	298	264.17	1249.86	691.40	0.092	8474.40	0.128	0.320	0.131
2017	247.3	40.7	288	245.92	1523.62	1015.47	0.100	7397.38	0.140	0.220	0.145
2018	315.3	36.7	352	485.27	1773.99	1209.97	0.108	11026.19	0.160	0.399	0.175
2019	238.4	50.6	289	311.60	2345.40	1438.19	0.144	16258.92	0.196	0.177	0.195
2020	314.8	5.2	320	436.26	3955.97	2404.22	0.159	23795.21	0.255	0.147	0.230
2021	261.8	32.2	294	337.41	4022.28	3116.53	0.183	13083.24	0.375	0.092	0.228
2022	309.9	40.1	350	365.36	5348.79	4253.24	0.199	18895.82	0.795	0.071	0.229
2023*	NA	NA	NA	NA	NA	NA	NA	3909.99	NA	0.104	NA

Table 6.3.6. Megrim (*L. whiffiagonis*) in Div. 8c and 9a. The values for the forecast and for the interim year.

Variable	Value	Notes
F[ages 2-4] (2023)	0.104	Fsq = average F (2020–2022).
SSB (2024)	6207	Short-term forecast (STF); in tonnes.
R[age 1] (2023, 2024)	3910	Geometric mean 1998–2020; in thousands.
Total catch (2023)	699	STF; in tonnes.
Projected landings (2023)	656	STF assuming average landings ratio at age 2018–2022; in tonnes.
Projected discards (2023)	43	STF assuming average landings ratio at age 2018–2022; in tonnes.

Table 6.3.7. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Catch forecast: management options table.

Basis	Total catch 2024	Wanted catch 2024	Unwanted catch 2024	F[total] (ages 2-4) (2024)	F[wanted] (ages 2-4) (2024)	F[unwanted] (ages 1-2) (2024	SSB 2025	% SSB change
MSY approach: F[MSY]	1271	1229	42	0.173	0.138	0.057	5575	-10.2
F=MAP F[MSY lower]	859	831	28	0.112	0.089	0.037	6070	-2.2
F=MAP F[MSY upper]	1915	1850	65	0.280	0.224	0.093	4809	-23
F=0	0	0	0	0.000	0.000	0.000	7102	14.4
F[pa]	2757	2660	97	0.450	0.360	0.149	3814	-39
F[lim]	3417	3292	124	0.619	0.494	0.204	3042	-51
SSB (2025)=B[pa]	5487	5250	237	1.771	1.415	0.585	725	-88
SSB(2025)=B[lim]	5677	5425	252	2.045	1.634	0.676	532	-91
SSB(2025)=MSY B[trigger]	5487	5250	237	1.771	1.415	0.585	725	-88
SSB(2024) = SSB (2025)	744	720	24	0.096	0.077	0.032	6207	0
F[2023]	799	773	26	0.104	0.083	0.034	6141	-1.05
Roll-over TAC	968	936	32	0.128	0.102	0.042	5938	-4.3

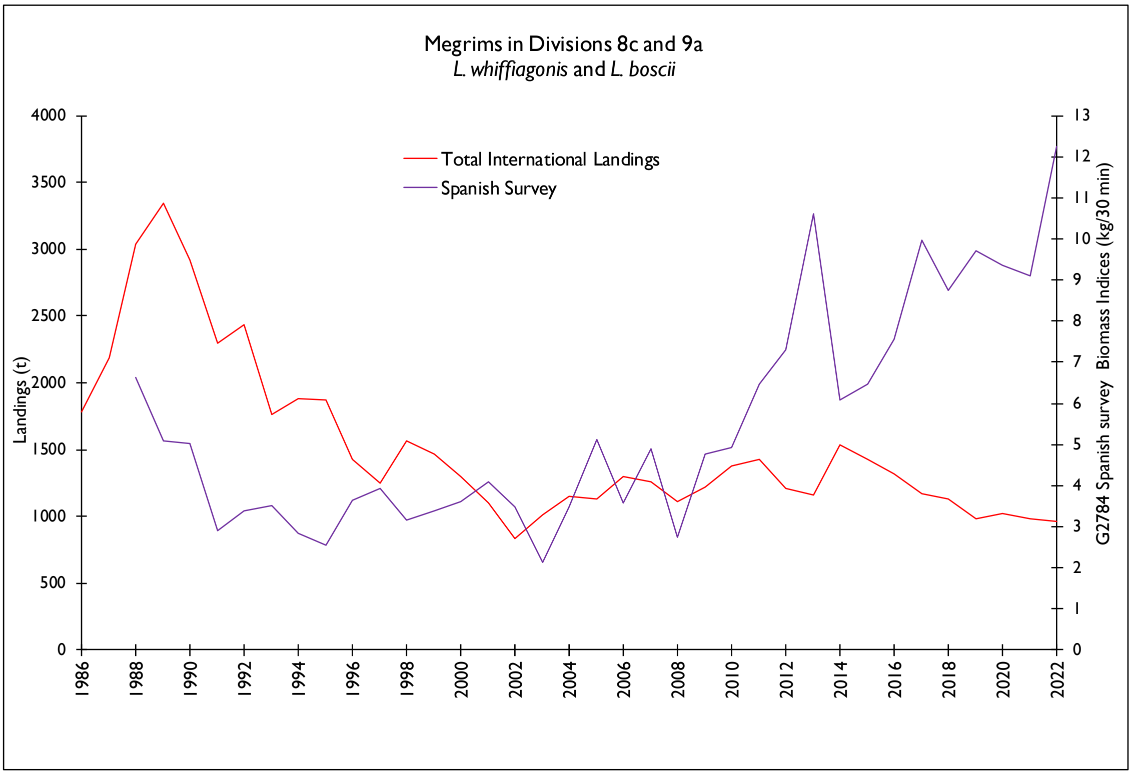

Figure 6.3.1. Historical landings and biomass indices of combined megrim stocks from the Spanish SpGFS-WIBTS-Q4 (G2784) survey.

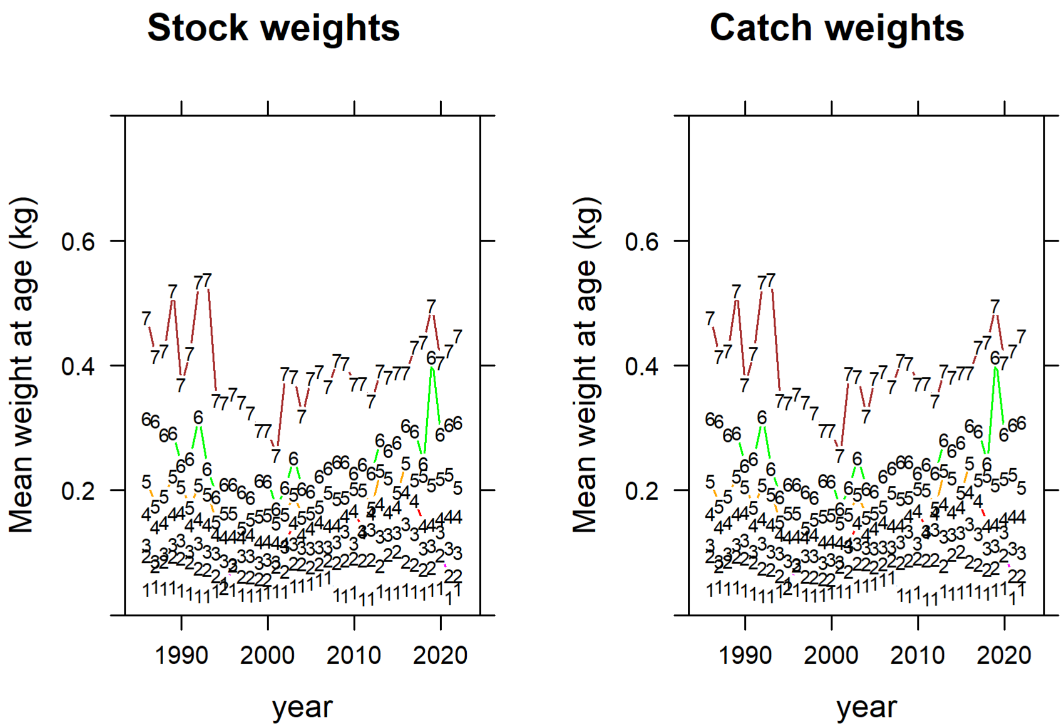

Figure 6.3.2. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Discards proportions-at-age.

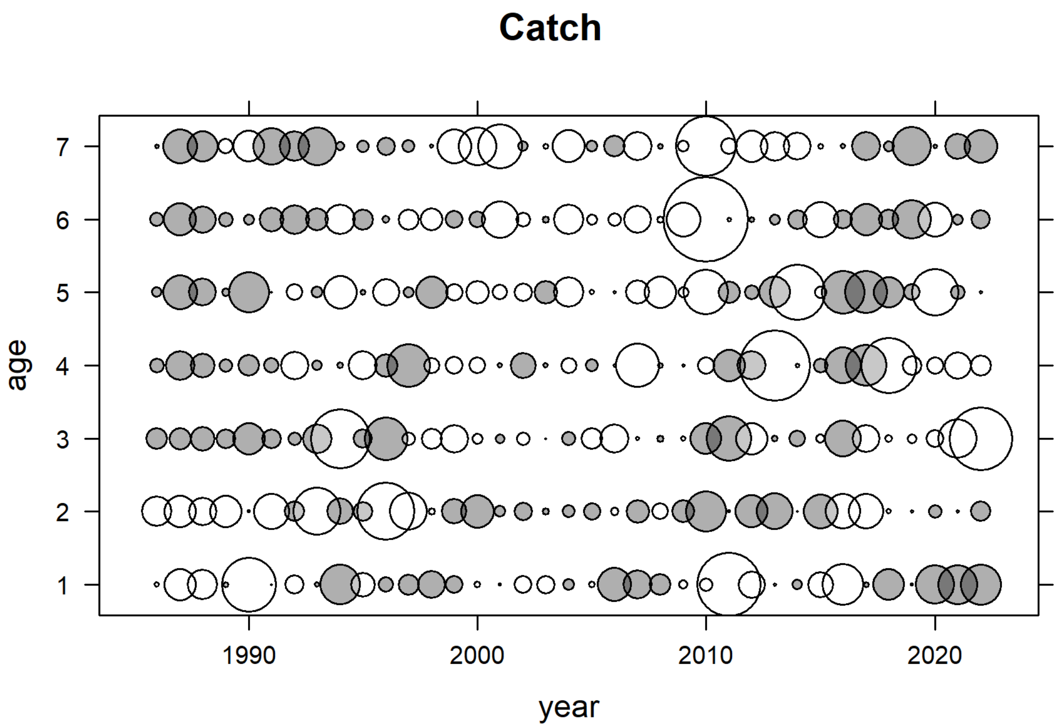

Figure 6.3.3a. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized catches proportions-at-age.

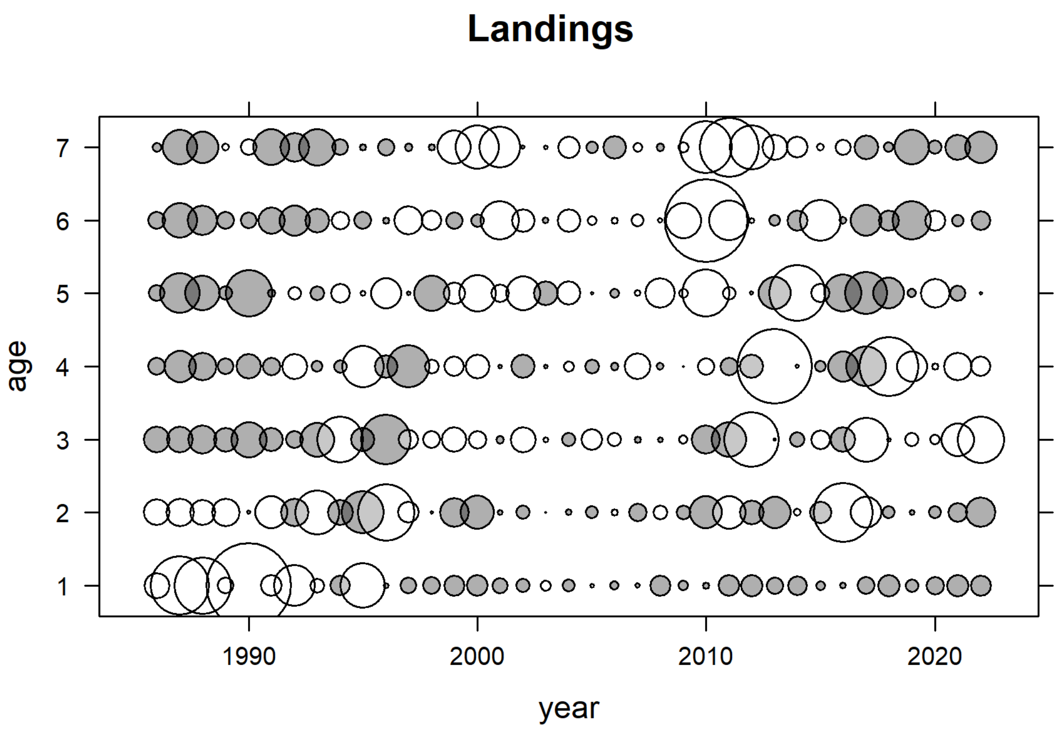

Figure 6.3.3b. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized landings proportions-at-age.

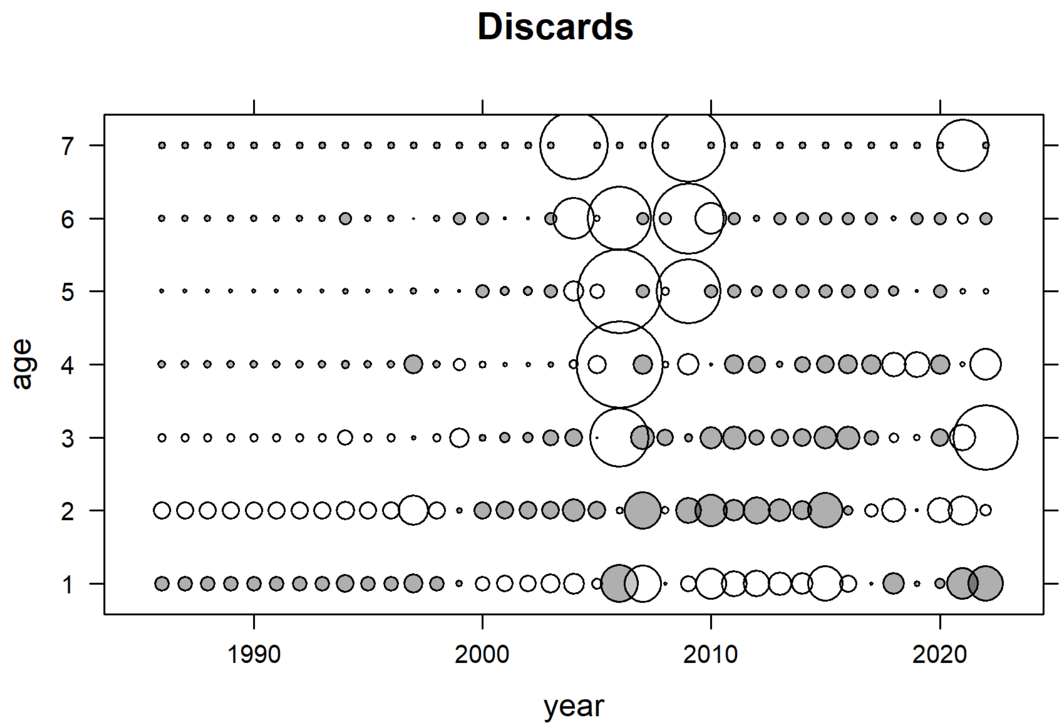

Figure 6.3.3c. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized discards proportions-at-age.

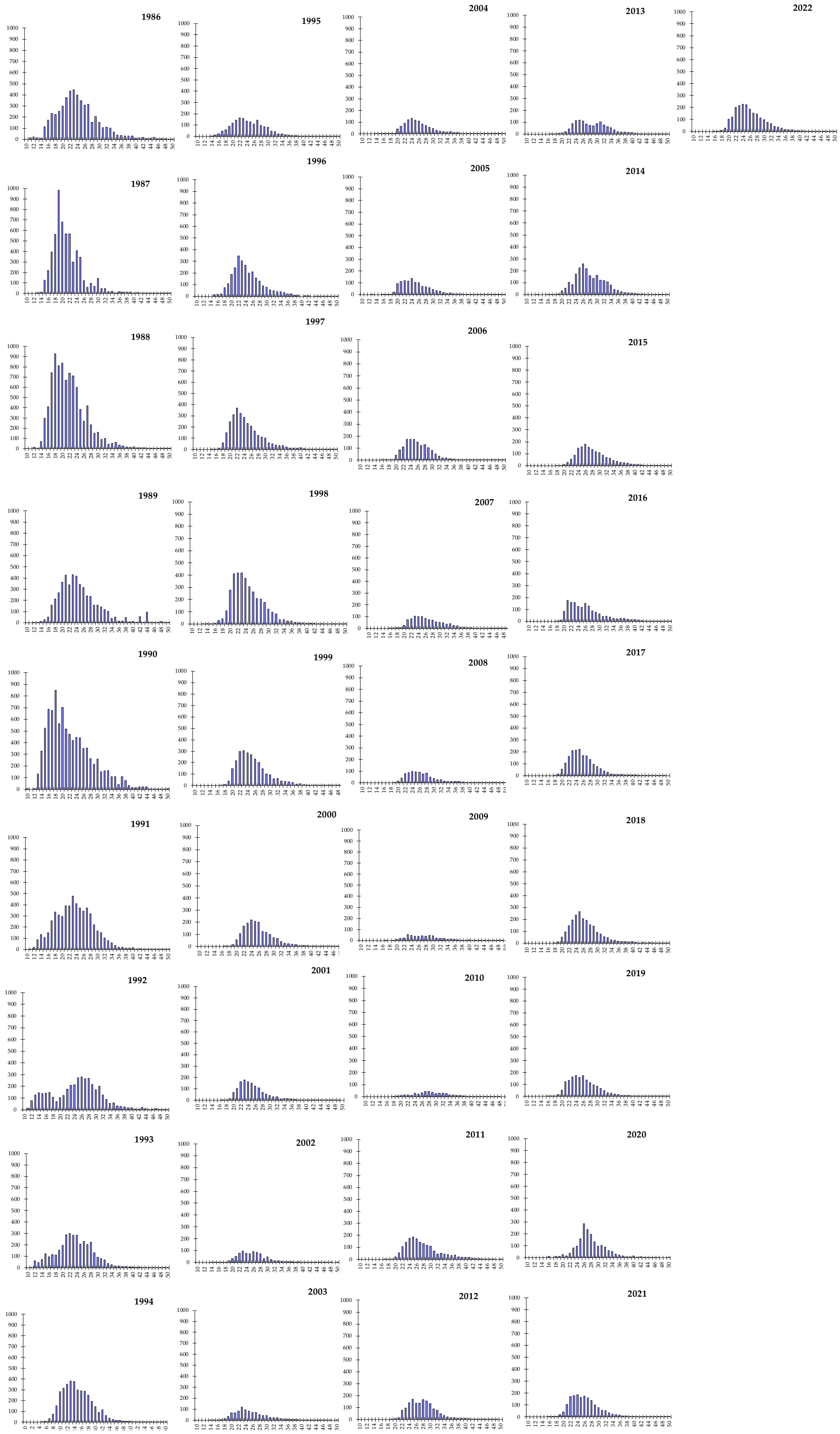

Figure 6.3.4. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Annual length compositions of landings ('000).

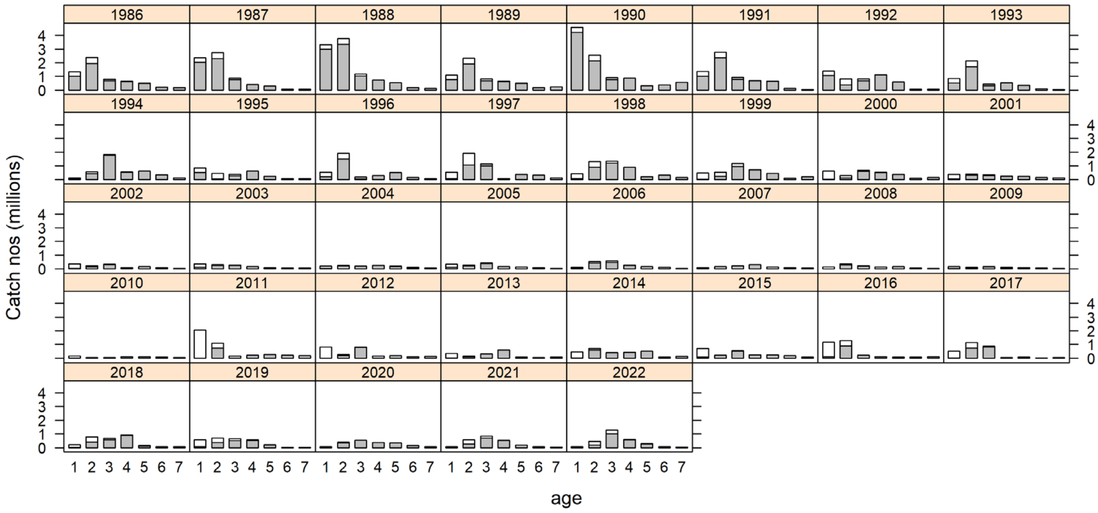

Figure 6.3.5. Megrim (*L.whiffiagonis*) in divisions 8.c and 9.a. Age composition of catches.

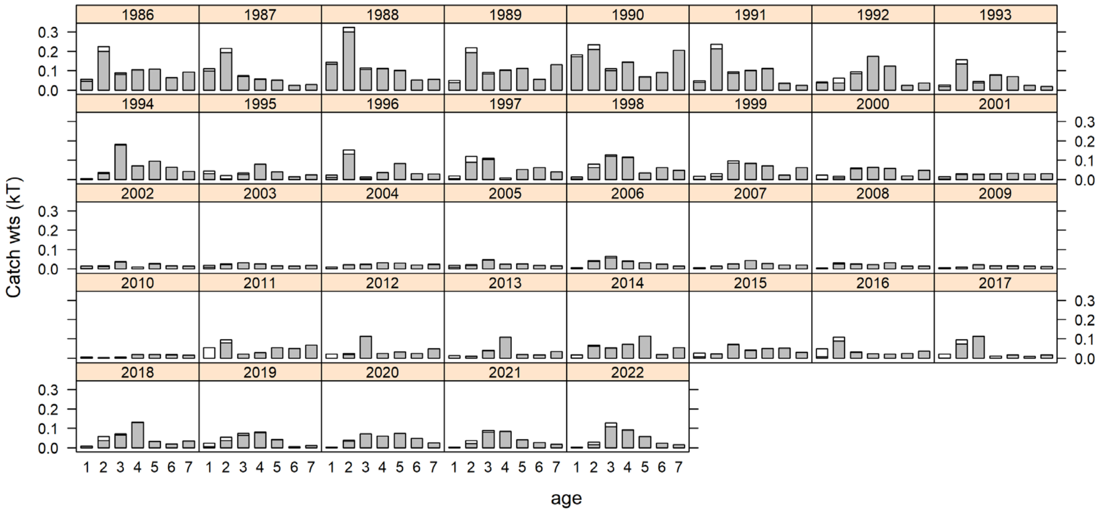

Figure 6.3.6. Megrim (*L.whiffiagonis*) in divisions 8.c and 9.a. Weights-at-age of catches.

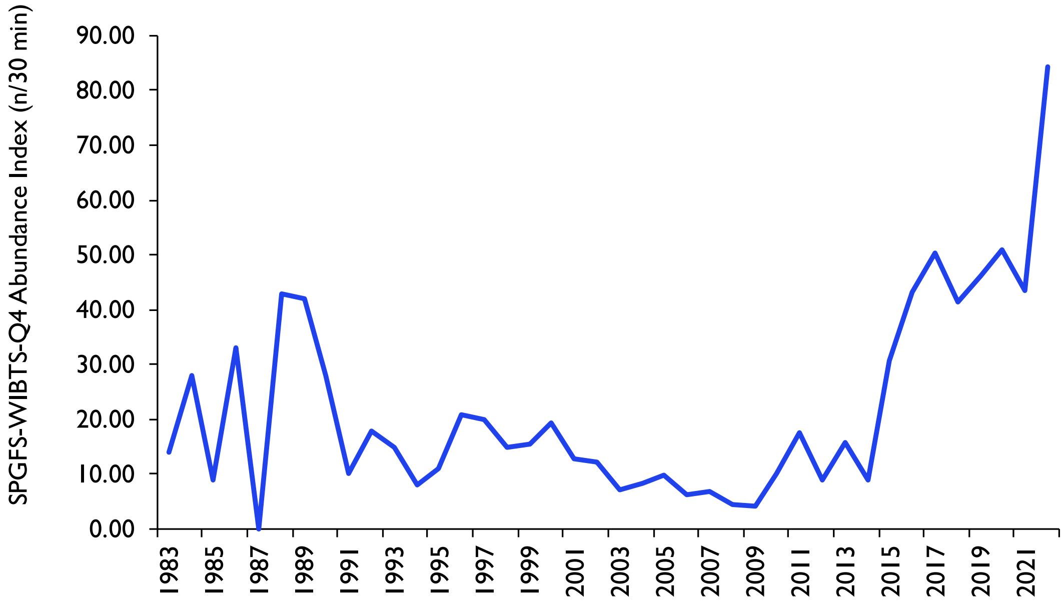

Figure 6.3.7. Megrim (*L.whiffiagonis*) in divisions 8.c and 9.a. Abundance Index from the SP-NSGFS-Q4 (G2784) survey.

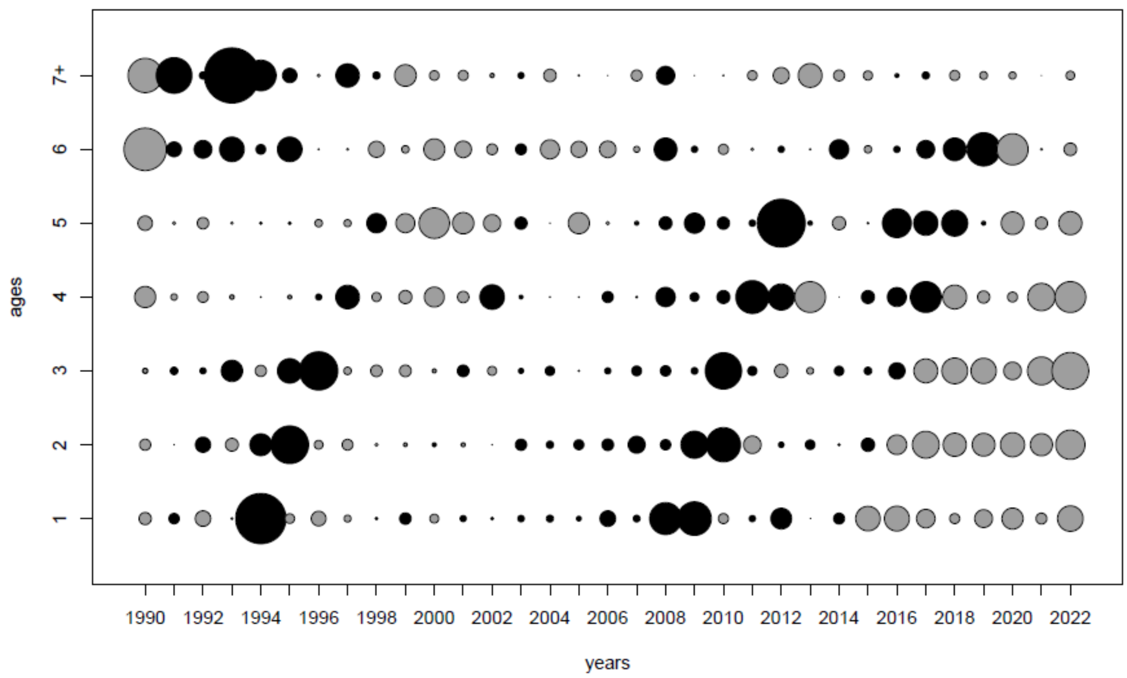

Figure 6.3.8. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized log (abundance index at age) from the SP-NSGFS-Q4 (G2784) survey.

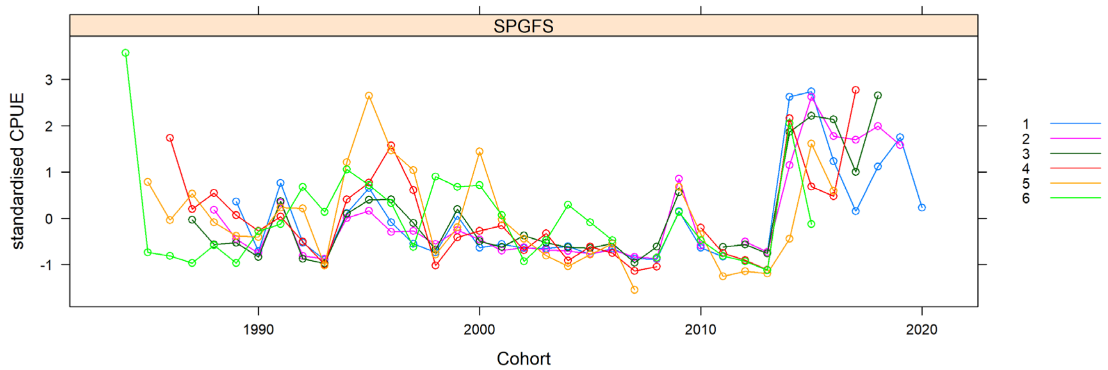

Figure 6.3.9. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Internal consistency of the standardized CPUE index from the SP-NSGFS-Q4 (G2784) survey.

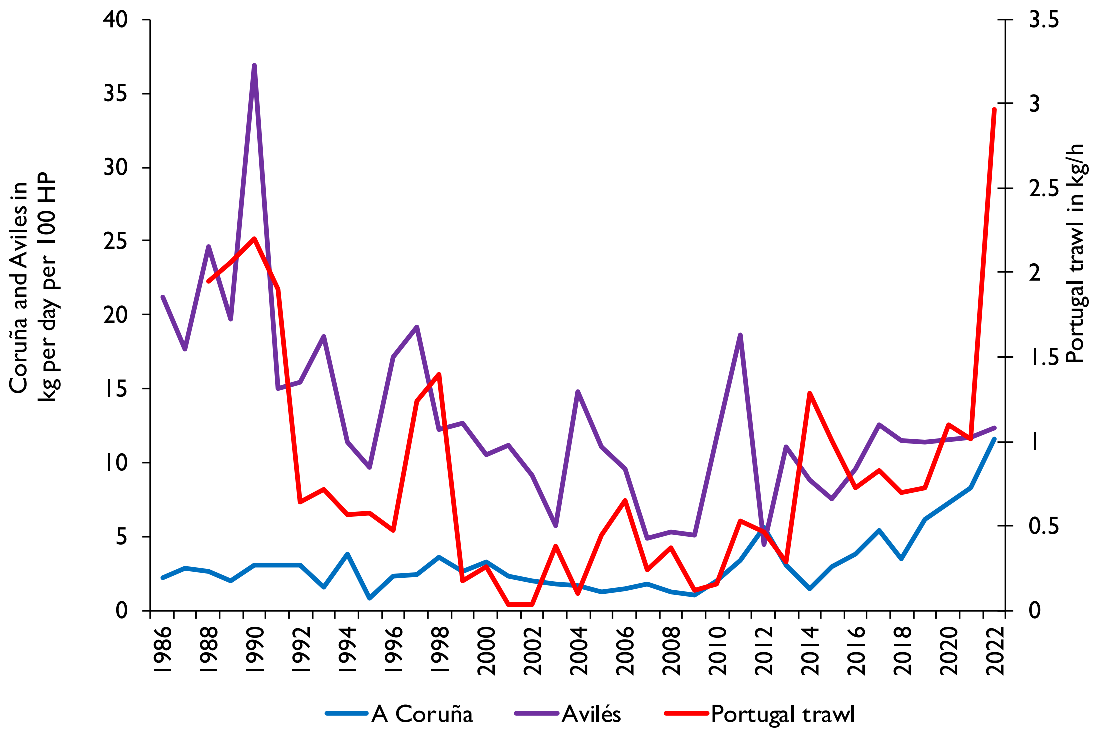

Figure 6.3.10. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. LPUE indices for Spanish and Portuguese commercial fleets.

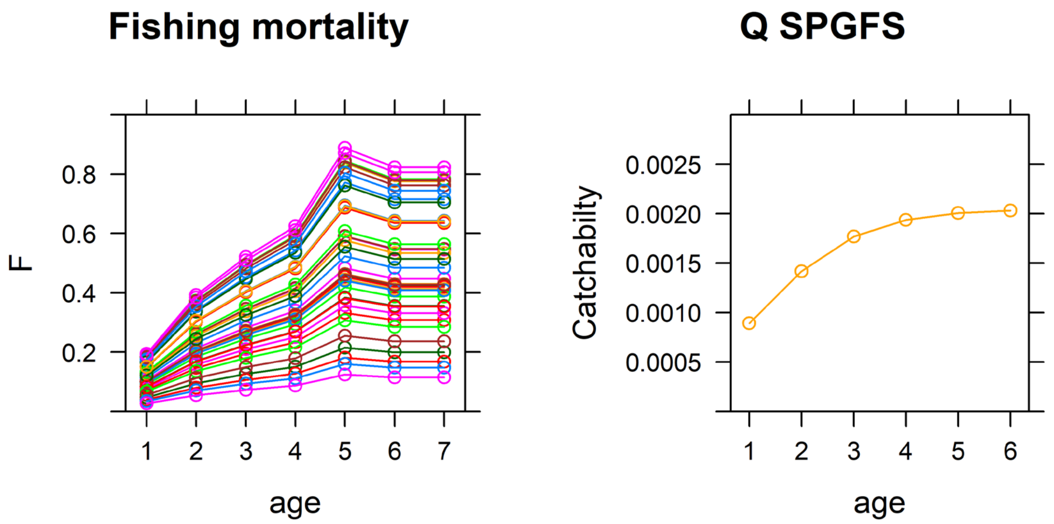

Figure 6.3.11. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. F-at-age (left; colours indicate years) and catchability-at-age (right) patterns of the SP-NSGFS-Q4 (G2784) survey.

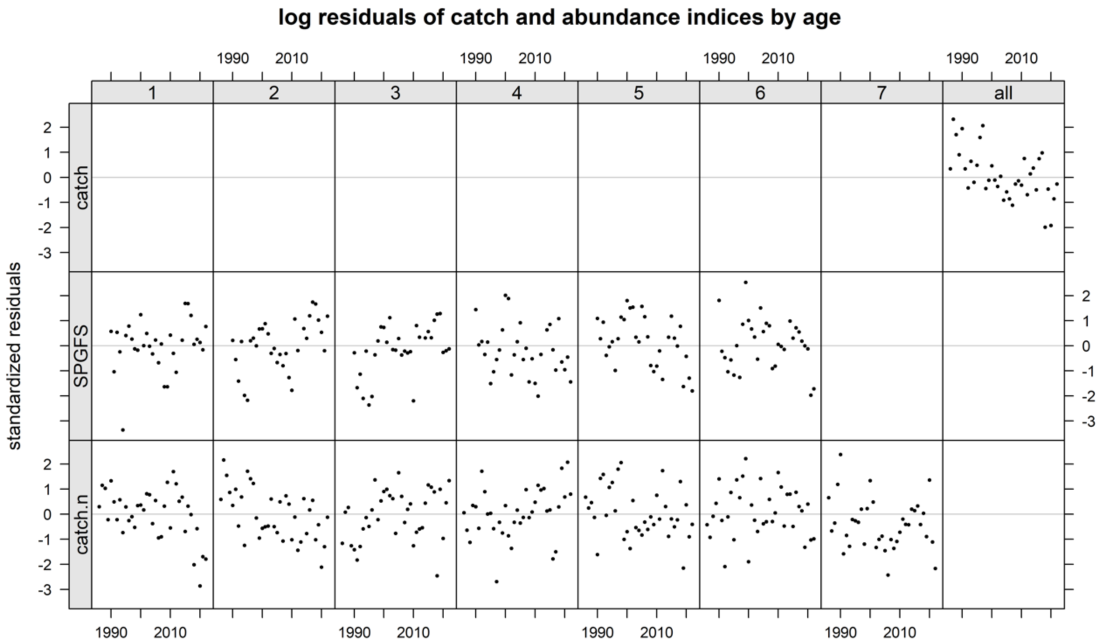

Figure 6.3.12. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized residuals of the catch and the SP-NSGFS-Q4 (G2784) survey.

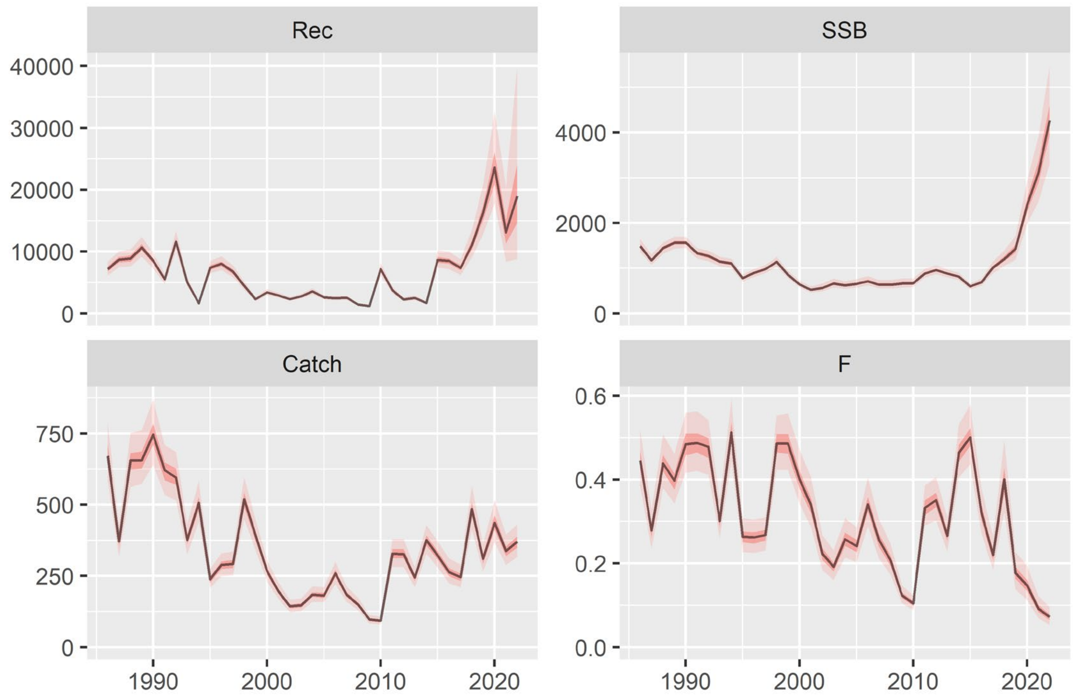

Figure 6.3.13. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Summary plots of the a4a assessment outputs.

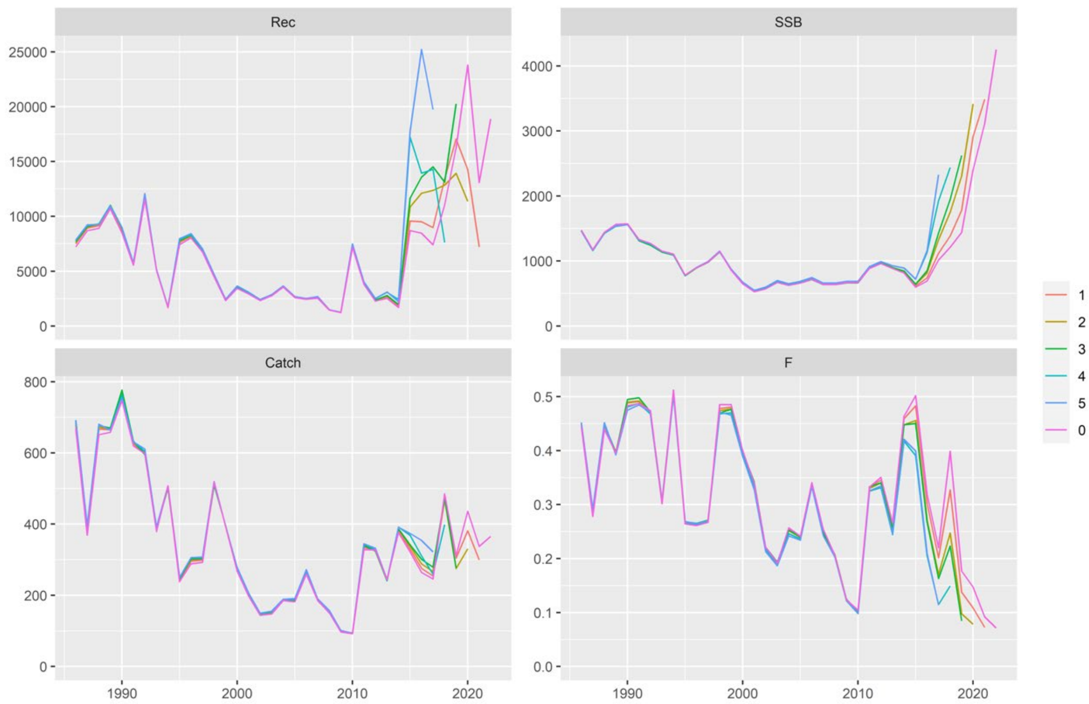

Figure 6.3.14. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Retro plots.

Figure 6.3.15. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Historical assessment results. Last year of geometric mean recruitment included. The assessment model and the reference points were revised in 2022 during the WKMEGRIM (ICES, 2022).

6.4 Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a

6.4.1 General

See general section for both species.

6.4.2 Data

6.4.2.1 Commercial catches and discards

WGBIE estimates of four-spot megrim international landings, discards, and catches for the period 1986 to 2022 are given in Table 6.4.1. From 2011 to 2018, estimates of unallocated or non-reported landings were included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each métier. Currently, these estimates are considered the best information available for the stock. In 2015, revised data for the period 2011–2013 were provided. This revision produced an improvement in the allocation of sampling trips and, consequently, were used in the assessment. Landings reached a peak of 2629 t in 1989 and have generally declined since then to their lowest value of 720 t in 2002. There has been some increase observed in the following years. Landings in 2014 are 1531 t, the highest value after 1995. In 2022, a landings value of 644 t was observed and is the lowest of the whole time-series.

Discards estimates were available from the "observers' on board sampling programme" for Spain in the years displayed in Table 6.4.2a. Discard / Total Catch ratio and CV are also presented, where discards represent between 21–67% of the total catch. Following the ICES recommendations in the advice sheet and using the same methodology described for *L. whiffiagonis* in section 6.3.2.1, discards missing data were also estimated for *L. boscii* in the WKSOUTH benchmark in 2014 (ICES, 2014). Spanish discards in numbers-at-age are shown in Table 6.4.2b that indicates that the bulk of discards (in numbers) is for ages 1 to 3. Total discards in tonnes) are summarized in Table 6.4.1 Figure 6.4.1 shows the proportion of discards-at-age.

Figures 6.4.2 (a, b, and c) show the standardized catches, landings a discards proportion-at-age, where cohort tracking can be observed.

6.4.2.2 Biological sampling

Annual length compositions of total stock landings are provided in Figure 6.4.3 for the period 1986–2022 and in Table 6.4.3a for the year 2022.

Mean length and mean weight in landings since 1990 are provided in Table 6.4.3b.

Age compositions of catches are presented in Figure 6.4.4. Weights-at-age of catches (given in Figure 6.4.5) were also used as weights-at-age in the stock. There are some variabilities of the weights-at-age through the historical time-series.

More information of the stock's biological data are provided in the Stock Annex, which includes in details the updates and new information approved in the WKMEGRIM benchmark (ICES, 2022a).

6.4.2.3 Abundance indices from surveys

Portuguese and Spanish survey indices are summarized in Table 6.4.4.

Two Portuguese surveys, named "Crustacean" (NepS (FU 28–29), G2913) and "October" (PtGFS-WIBTS-Q4, G8899), provide biomass and abundance indices. In 2012 and the years, 2019 and 2020, the Portuguese Surveys were not carried out and only resumed in 2021 but had been performed using a new vessel.

Portuguese "October" (PtGFS-WIBTS-Q4 (G8899)) survey

The October survey was conducted with a different vessel and gear in 2003 and 2004. Excluding these two years, the biomass index from this survey in 2021 was the highest observed since 1994, whereas the value in 2010 is the second-lowest in the series. Portuguese October index is not considered to be representative of the four-spot megrim abundance due to the very low catch rates.

Portuguese "Crustacean" (NepS (FU 28–29) (G2913)) survey

This survey covers part of the distribution of the four-spot megrim in Portuguese waters in the South of Division 9.a and was accepted as a survey series to be included in the assessment during the WKMEGRIM benchmark (ICES, 2022a). As the survey was performed using a new vessel since 2021, the continuity of the series must be analysed. Also to note a lower spatial coverage in 2021 (Moura, 2022; WD 05 in ICES, 2022b) and bad weather condition affecting the survey in 2022. For these reasons, these last two years of the survey were not included in the assessment. In 2018, both the biomass and abundance indices from the Crustacean NepS (FU 28–29) (G2913) survey were the highest values in the time-series. The abundance index from the Crustacean NepS (FU 28–29) (G2913) survey is shown in Figure 6.4.6. Age-length keys (ALKs) from the Spanish SP-NSGFS-Q4 (G2784) survey were applied for this survey, for which ages are not available. Figure 6.4.7 shows the bubble plot of log(abundance index at age) standardized by subtracting the mean and dividing by the standard deviation over the years (1997–2018) and where some cohorts can be identified. Figure 6.3.8 shows a "slight noise" in the internal consistency of the standardized indices of this survey and the Spanish (SP-NSGFS-Q4, G2784) one.

Spanish Groundfish Survey (SP-NSGFS-Q4 (G2784)) survey

Total biomass, abundance and recruitment indices from the Spanish Groundfish Survey (SP-NSGFS-Q4 (G2784)) are also presented in Table 6.4.4. Total biomass indices from this survey generally remained stable after a maximum level from 1988 until 2003. In 2003, a very low value was obtained and as such, the 2003 index has been excluded from the assessment (as done in previous years) due to its significant contradiction with the rest of the time-series. Since then, this was followed by a period of higher values until the present days, with the exception of 2008. For the same reason as that for *L. whiffiagonis*, the abundance value of 2013 was not included in the assessment model. In 2017, the survey presented the second-highest value in both biomass and abundance indices, remaining at high levels in 2019 and 2020. The abundance index is shown in Figure 6.4.9. In 2021, the second part of the survey was performed on a different vessel but with the same sampling gear as the standardly used vessel suffered some technical issues. It was assumed that this change in vessel would have an impact but was considered as minor which validated the use of the 2021 index as appropiate for use in the assessment. The recruitment indices for age 0 in 2005, 2009 and 2014 were very high. A value below average was estimated for the year 2022. The high indices in 2009 and 2014 applies to all ages and not just the recruitment (see Figure 6.4.10, which is a bubble plot of log(abundance index at age) standardized by subtracting the mean and dividing by the standard deviation over the years). Since 2009, almost all ages appears to be above average. From Figure 6.4.10, the survey results appear to have been quite good in tracking cohorts during the last ten years and where the stronger cohorts for the years 2005, 2009 and 2014 can be followed, especially the last two.

Type	Name	Year range	Age range	Used in the assessment
Spanish Groundfish survey	SpGFS-WIBTS-Q4 (G2784)	1983-present	1–6	Yes
Portuguese October Groundfish survey	PtGFS-WIBTS-Q4 (G8899)	1990-present	Biomass index	No
Portuguese Crustacean survey	NepS (FU 28–29) (G2913)	1997-present	1–6	Yes

6.4.2.4 Commercial catch-effort data

The commercial LPUE and effort data of the Portuguese trawlers fishing in Division 9.a and of one Spanish fishing ports operation in *métier* OTB_DEF_>=55_0_0 in 8.c and 9.a are available and cover the period 1986–2022. Figure 6.4.11 show the LPUEs whose trends have been increasing till the last years where a decrease can be observed.

The use of commercial LPUEs was rejected during the WKMEGRIM benchmark in 2022 (ICES, 2022a) due to concerns about changes in efficiency, targeting behaviour, quota restrictions, technical measures, discarding and compliance. However, these trends can be used as supplementary information by WGBIE.

6.4.3 Assessment

An assessment was conducted according to the Stock Annex specifications. Assessment years are 1986–2022 and ages 0–7+.

The a4a (Millar and Jardim, 2019) stock assessment model is selected and implemented for the assessment of the stock. It is a non-linear catch-at-age model implemented in R (R Core Team, 2022) and FLR (Kell *et al*., 2007), and using ADMB (Fournier *et al*., 2012), that can be applied rapidly to a wide range of situations with low parameterization requirements[4].

6.4.3.1 Input data

Following the Stock Annex, discards and landed numbers-at-age were incorporated resulting in catch numbers-at-age as input data from 1986 to 2022. The year 2022 was added to the index of

[4] http://www.flr-project.org/doc/Statistical_catch_at_age_models_in_FLa4a.html

the Spanish SP-NSGFS-Q4 (G2784) survey and the index from the Portuguese Crustacean NepS (FU 28–29) (G2913) survey from 1997 to 2018 was included in the model.

6.4.3.2 Model

Model Specification

Software used: R package Fla4a (version 1.8.2) in R (version 4.1.2), (see Stock Annex for details):

The model structure is defined by submodels, which are the different parts that require structural assumptions. There are five submodels in operation:

1. model for F-at-age,
2. model for the initial age structure,
3. model for recruitment,
4. (list) of model(s) for abundance indices catchability-at-age,
5. list of models for the observation variance of catch-at-age and abundance indices.

These submodels were defined as:

```
fmodel: ~factor(replace(age, age > 6, 6)) + factor(year)
srmodel: ~factor(year)
n1model: ~factor(age)
qmodel: list(~I(1/(1 + exp(-age)))+s(replace(age, age > 5, 5), k = 5),
        ~I(1/(1 + exp(-age))))
vmodel:
 catch:        ~s(age, k = 3)
 SpGFS-WIBTS-Q4:    ~1
 PT-CTS-UWTV -FU 28–29:    ~1
```

The F model is a separable model. The shape of the F-at-age pattern is independently estimated for each age except for ages 6 and 7+, which are assumed to have the same Fs. This pattern in F is then independently scaled up and down for each year.

Stock–recruit model: Freely estimated for each year.

Catchability models:

For the SpGFS-WIBTS-Q4 (G2784) survey, catchability is assumed to increase asymptotically but ages 5 and 6 are bound (i.e. same catchability for these two ages). This configuration was selected in order to solve a residuals issue in this survey.

For the NepS (FU 28–29) (G2913) survey, catchability is assumed to increase asymptotically.

N1 model (population in the first year of the time-series): default value a4aSCA function (independently estimated for each age)

Vmodel (the shape of the observation variances): default value a4aSCA function: smooth function for the catch numbers-at-age and 'flat' for the indices

An FLStock object is needed and it was adapted from the XSA (Shepherd, 1999) input data. This object includes catches, landings, discards, weights-at-age, natural mortality, maturity, harvest before spawning and mortality before spawning.

Model Settings

- F_{bar} is set to ages 2–4.

The preliminary runs showed a trend in the residuals of age 0 in catch. As the first period of the discards time-series was estimated, it was decided to set age 0 in the catch to NA for the early years.

stock@catch.n['0',as.character(1986:1998)] <- NA

Data screening

Figures 6.4.2a, b and c are bubble plots corresponding to standardized catch, landings and discards proportions-at-age, respectively. These are used to show which one corresponding to the landings is the best to follow cohorts. These plots clearly indicate that the bulk of the landings generally corresponds to ages 2 to 4 and the discards to ages 1–2. However, during the last years, there seems to be an increase in age 5 and a decrease in age 2. Very weak cohorts corresponding to year classes of 1993 and 1998 can be clearly identified from the standardized landing proportions-at-age matrix and stronger cohorts corresponding to year classes of 1991, 1992, 1995, 2005, 2009 and 2014 can also be tracked.

Final run

a4a model (assessment for all) was selected for use in this assessment. Model description and settings are detailed in the Stock Annex.

6.4.3.3 Assessment results

Figure 6.4.12 shows the patterns in F-at-age and catchability estimated by the model. F is estimated to be low for age 1, then increases over ages to age 5 then decreases again for ages 6 and 7+ (F is forced to be the same for ages 6 and 7+). The catchability (Q) of the Portuguese survey (NepS (FU 28–29), G2913) increases along a logistic function while the Q of the Spanish (SpGFS-WIBTS-Q4, G2784) survey is assumed to increase asymptotically but ages 5 and 6 are bound.

The log residuals of catch and abundance index by age are shown in Figure 6.4.13. Some patterns in the residuals of age 0 in the catch were removed and were set to NA the first years of discards data because they had been estimated. Total catch residuals show a trend to overestimate catches in recent years.

Assessment results are summarized in Table 6.4.5 and Figure 6.4.14.

SSB decreased gradually from 1989 to 2002, with the lowest value in the series, and has since gradually increased, accentuating in recent years. In 2022, the SSB was estimated at 13 957 t, the highest of the time-series.

Recruitment has fluctuated around 46 million fish during all the series. Very weak year classes were observed in 1993 and 1998. Since 2014, when the maximum value of the time-series was reached, the recruitment has been decreasing until this year, which shows a small increase.

Estimates of F values show two different periods: an initial one with higher values from 1986 to 2001 and a second period at a lower level, with oscillating values. Since 2015, F has been decreasing, with only a very small increase in the last year.

The retrospective analysis shows no particular worrying features with Monn’s Rho values of -0.035 for F, -0.050 for SSB and -0.348 for R (Figure 6.4.15).

AIC	BIC	Mohn's Rho	Mohn's Rho	Mohn's Rho
		(Retro_F)	(Retro_SSB)	(Retro_R)
1112.798	1540.195	-0.035	-0.050	-0.348

6.4.4 Biological reference points

Biological reference points were established during the WKMEGRIM benchmark (ICES, 2022a).

- Model used: Eqsim
- Software used: R packages msy (version 0.1.19), FLCore (version 2.6.18) in R (version 4.1.2) and icesAdvice (version 2.0.0)

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	2932 t	B_{pa}
	F_{MSY}	0.176	Stochastic simulations (*EqSim*) based on the recruitment period 1986–2020
	B_{lim}	2321 t	B_{loss}, biomass in 2001 as estimated in 2022
Precautionary	B_{pa}	2932 t	$B_{lim} \times \exp(1.645 \times 0.142)$
Approach	F_{lim}	0.56	The F that results in long-term probability (SSB < B_{lim}) = 50%; calculated by stochastic simulation (*EqSim*) using a segmented regression with B_{lim} as the breakpoint and no error
	F_{pa}	0.46	$F_{p.05}$ with AR: The F that provides a 95% probability for SSB to be above B_{lim}.
EU Management plan (MAP; EU, 2019)	MAP MSY $B_{trigger}$	2932 t	MSY $B_{trigger}$
	MAP B_{lim}	2321 t	B_{lim}
	MAP F_{MSY}	0.176	F_{MSY}
	MAP range F_{lower}	0.119	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY
	MAP range F_{upper}	0.28	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY

6.4.5 Short-term projections

- Model used: stf() and fwd() functions in R packages FLasher and FLCore.
- Software used: R packages ices TAF (version 3.6.0) and FLasher (version 0.6.7) in R (version 4.1.2)
- Settings and assumptions for the interim year and for the forecasts are described in the Stock Annex and have been the basis for the calculation of the projections.
- Recruitment-at-age 0 is assumed equal in the intermediate year and all the projections used the GM from 1990 to final assessment year minus 2.
- Fsq: Average Fbar for the last three years.

The values for the forecast and for the interim year, basis of the catch scenarios, are shown in Table 6.4.6. Management options for catch prediction are in Table 6.4.7.

6.4.6 Comments on the assessment

The use of the new a4a (Milar and Jardim, 2019) assessment model and the definition of new reference points, estimated following the standard ICES approach (ICES, 2021a), gave new relative values in relation to reference points for SSB, F and R. Figure 6.4.16 shows historical assessment results (final-year recruitment assumptions included for each line) relative to each year's reference points for comparison. Last year's assessment is in orange while the previous year's assessment results (ICES, 2021c) is in blue.

6.4.7 Management considerations

As with *L. whiffiagonis,* it should be noted that four-spot megrim (*L. boscii*) is caught in mixed fisheries, and management measures applied to this species may have implications for other stocks. Both species of megrims are subject to a common TAC, so the joint status of these species should be taken into account when formulating management advice.

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6.4.9 Tables and figures

Table. 6.4.1 Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Landings, discards and catch in tonnes.

	Spain landings			Portugal landings	Unallocated	Total landings	Discards	Total catch
Year	8c	9a*	Total	9a				
1986	799	197	996	128		1124	284	1408
1987	995	586	1581	107		1688	333	2021
1988	917	1099	2016	207		2223	363	2586
1989	805	1548	2353	276		2629	408	3037
1990	927	798	1725	220		1945	409	2354
1991	841	634	1475	207		1682	447	2129
1992	654	938	1592	324		1916	437	2353
1993	744	419	1163	221		1384	438	1822
1994	665	561	1227	176		1403	517	1920
1995	685	826	1512	141		1652	406	2058
1996	480	448	928	170		1098	368	1466
1997	505	289	794	101		896	308	1204
1998	725	284	1010	113		1123	378	1501
1999	713	298	1011	114		1125	317	1442
2000	674	225	899	142		1041	373	1414
2001	629	177	807	124		931	290	1221
2002	343	247	590	130		720	308	1028
2003	393	314	707	169		876	191	1067
2004	534	295	829	177		1006	348	1354
2005	473	321	794	189		983	375	1358
2006	542	348	891	201		1092	335	1427
2007	591	295	886	218		1104	292	1396
**2008	546	262	808	172		980	202	1182
2009	577	342	919	215		1134	279	1413
2010	616	484	1100	197		1297	265	1562
^2011	390	384	774	181	172	1128	269	1397
^2012	240	239	479	98	374	952	369	1321
^2013	338	283	621	80	230	931	496	1427
2014	427	313	739	142	273	1154	788	1942
2015	460	255	715	137	296	1148	597	1745
2016	403	276	679	105	303	1087	332	1419
2017	346	265	611	144	172	926	246	1173
2018	381	231	612	130	72	814	92	906
2019	385	240	625	118		742	201	943
2020	346	224	569	141		711	81	792
2021	368	222	590	132		723	109	831
2022	334	231	566	78		644	119	763

^Data revised in WG2015

*9a is without Gulf of Cádiz till 2016

** Data revised in WG2010

* Official data by country and unallocated landings

Table. 6.4.2a. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Discard/Total Catch ratio and estimated CV for Spain from on-board sampling.

Year	1994	1997	1999	2000	2003	2004	2005	2006	2007
Weight Ratio	0.30	0.28	0.24	0.29	0.21	0.30	0.32	0.27	0.25
CV	23.2	11.2	14.4	16.5	10.2	23.1	24.0	48.4	18.3
Number Ratio	0.50	0.63	0.59	0.61	0.47	0.55	0.55	0.42	0.47

Year	2008	2009	2010	2011*	2012	2013	2014	2015	2016
Weight Ratio	0.20	0.23	0.19	0.24	0.39	0.35	0.41	0.34	0.23
CV	22.6	21.1	18.8	16.0	15.5	23.2	17.8	20.1	16.4
Number Ratio	0.42	0.39	0.62	0.50	0.52	0.63	0.67	0.60	0.47

Year	2017	2018	2019	2020	2021	2022
Weight Ratio	0.21	0.10	0.21	0.10	0.13	0.16
CV	15.2					
Number Ratio	0.39	0.24	0.41	0.21	0.26	0.30

**All discard data revised in WG2011

*Data revised in WG2013

Table. 6.4.2b. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Discards in numbers-at-age (thousands) for Spanish trawlers.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	1289	1289	1289	1289	1289	1289	1289	1289	678	1289	1289	256	1289
1	3322	3322	3322	3322	3322	3322	3322	3322	2741	3322	3322	3273	3322
2	4322	4322	4322	4322	4322	4322	4322	4322	4134	4322	4322	6099	4322
3	2211	2211	2211	2211	2211	2211	2211	2211	2710	2211	2211	2108	2211
4	605	605	605	605	605	605	605	605	581	605	605	146	605
5	94	94	94	94	94	94	94	94	189	94	94	90	94
6	20	20	20	20	20	20	20	20	55	20	20	3	20
7	4	4	4	4	4	4	4	4	11	4	4	0	4

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
0	2933	354	208	208	238	33	10	1	100	202	2	2879	30
1	3954	6148	5673	5673	4479	6393	3515	1233	3248	2342	1525	10362	5132
2	2734	1207	1750	1750	989	3053	5482	2497	4541	2374	2490	1301	3595
3	1815	1888	1025	1025	495	693	609	1445	757	1384	1970	696	544
4	1088	1218	477	477	50	163	183	486	105	52	480	283	174
5	3	171	67	67	2	27	56	168	44	10	51	83	37
6	0	12	4	4	0		23	22	7	3	7	11	1
7	1	2	1	1			6	9	1	3		1	

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
0	682	275	0	157	2	0	0	0	0	0	3
1	5313	5499	5645	2437	1606	526	209	717	180	79	118
2	2480	4379	11089	7061	5506	2116	1066	1183	628	872	677
3	1057	3030	2139	4588	785	2305	638	2192	622	891	854
4	15	707	582	532	232	363	297	446	252	258	455
5	5	39	161	26	70	29	16	86	34	62	116
6	2	12	11	4	30	1	3	1	2	5	5
7	0	2	0	0	1	0	0	0	0	1	5

Table 6.4.3a. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Annual length distribution of landings in 2022.

Length (cm)	Total
10	
11	
12	
13	
14	
15	
16	1544
17	12720
18	64678
19	195938
20	564760
21	719347
22	745133
23	622820
24	567764
25	412137
26	347995
27	258157
28	188700
29	134004
30	92773
31	73154
32	48269
33	31398
34	20536
35	11884
36	16357
37	11092
38	6290
39	2607
40	4036
41	1594
42	73
43	2096
44	996
45	779
46	839
47	22
48	45
49	45
50+	43
Total	5160623

Table 6.4.3b. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a Mean lengths and mean weights in landings since 1990.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Mean length (cm)	23.1	23.5	23.8	24.2	23.3	22.3	23	23.3	23.3	23.5	24.2	23.8
Mean weight (g)	116	118	122	128	111	96	107	112	109	113	121	114

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Mean length (cm)	23.1	22.9	22.7	22.7	22.9	23.5	23.6	23.6	24.1	23.7	23.7	23.9
Mean weight (g)	105	101	98	97.0	99.4	109.1	109.7	110.7	118.4	112.2	112.0	114.0

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Mean length (cm)	24.2	24.1	24.2	23.7	24.0	23.8	23.5	23.8	24.1
Mean weight (g)	117.8	117.4	118.6	111.8	115.6	112.5	110.6	118.9	124.6

Table 6.4.4. Four-spot megrim (*L. boscii*) divisions 8.c and 9.a. Biomass, Abundance and Recruitment indices from Portuguese and Spanish surveys.

	Biomass Index							Abundance index					Recruitment index		
	Portugal (k/h)				Spain (k/30 min)			Portugal (n/h)		Spain (n/30 min)			At age 1	At age 0	At age 1
													Portugal (n)	Spain (n/30 min)	
	October	SE	Crustacean	var	Mean	SE		Crustacean	var	Mean	SE		October		
1983					0.67	0.13	1983			11.80	1.80	1983		0.98	5.74
1984					0.76	0.08	1984			15.80	2.00	1984		1.80	7.83
1985					0.71	0.11	1985			14.00	1.74	1985		0.15	7.45
1986					1.68	0.28	1986			32.60	3.82	1986		2.99	16.36
1987					ns	-	1987			ns	-	1987		ns	ns
1988					3.10	0.33	1988			59.20	6.49	1988		2.90	24.64
1989					1.97	0.28	1989			40.75	6.24	1989		8.49	16.68
1990	0.26				1.93	0.14	1990			40.30	3.00	1990	153	0.44	19.06
1991	0.18				1.67	0.17	1991			27.70	2.62	1991	26	2.53	9.25
1992	0.14				1.98	0.20	1992			49.10	5.20	1992	42	2.37	35.00
1993	0.11				2.07	0.25	1993			43.30	5.39	1993	8	0.30	21.38
1994	0.16				1.82	0.23	1994			26.90	3.63	1994	2	3.48	2.94
1995	0.08				1.51	0.12	1995			32.30	2.78	1995	4	1.92	19.58
A,1996	0.10				2.00	0.19	A,1996			44.80	4.05	A,1996	16	3.57	20.56
1997	0.06		4.04	3.19	2.17	0.22	1997	41.77	251.67	43.50	3.84	1997	1	3.54	13.34
1998	0.04		2.62	0.28	1.80	0.20	1998	28.05	72.57	34.30	4.45	1998	+	0.27	9.57
A,B,1999	+		0.03	0.00	1.93	0.24	A,B,1999	0.66	0.03	29.30	3.22	A,B,1999	+	0.94	7.46
2000	0.08		1.15	0.11	1.89	0.28	2000	11.10	11.72	33.00	4.56	2000	16	1.07	13.96
2001	0.09		1.35	0.14	2.65	0.25	2001	14.22	13.01	42.70	3.35	2001	25	0.59	16.95
2002	0.02		2.63	0.30	2.21	0.22	2002	38.90	43.23	34.60	3.33	2002	1	1.04	9.95
A,2003	1.36		3.71	0.34	1.32	0.16	A,2003	60.82	98.16	16.90	1.54	A,2003	8	0.65	4.95
A,2004	1.27		2.79	0.35	2.40	0.24	A,2004	42.59	90.21	43.94	3.71	A,2004	5	1.19	21.10
2005	0.05		2.62	0.41	3.84	0.41	2005	31.72	71.08	62.89	6.16	2005	+	4.71	17.70
2006	0.10		1.82	0.07	2.56	0.24	2006	32.81	35.01	41.47	3.02	2006		0.59	14.70
2007	0.14	0.06	3.08	0.37	3.75	0.35	2007	46.74	69.87	51.10	4.30	2007		0.88	11.30
2008	0.07	0.03	3.08	0.25	2.08	0.22	2008	32.86	34.41	32.20	3.00	2008		0.37	8.13
2009	0.06	0.02	1.77	0.16	3.96	0.32	2009	14.68	14.68	52.83	3.97	2009		3.37	7.42
2010	0.03	0.01	4.91	0.93	4.04	0.38	2010	80.59	360.69	72.75	6.82	2010		0.65	34.22
2011	0.14	0.06	4.24	0.89	4.64	0.39	2011	65.44	182.87	69.26	5.72	2011		0.91	8.90
2012	ns	ns	ns	ns	5.92	0.47	2012	ns	ns	82.14	5.98	2012		1.71	11.58
**2013	0.10	0.03	2.37	0.47	8.17	1.13	2013	36.91	96.36	119.99	17.48	2013		1.32	25.86
2014	0.12	0.03	2.15	0.44	4.75	0.28	2014	32.40	123.72	67.42	3.72	2014		3.72	12.32
2015	0.13	0.04	2.22	0.06	4.62	0.48	2015	37.35	32.35	78.00	7.47	2015		1.12	33.18
2016	0.12	0.04	2.65	0.10	4.84	0.32	2016	53.47	19.96	86.70	5.19	2016		2.43	18.06
2017	0.22	0.07	2.82	0.67	6.21	0.96	2017	54.03	215.08	111.24	13.61	2017		1.03	23.69
2018	0.11	0.03	8.98	###	5.35	0.45	2018	146.28	6409.79	88.04	7.05	2018		0.46	6.36
2019	ns	ns	ns	ns	5.77	0.48	2019	ns	ns	102.03	8.21	2019		0.94	20.46
2020	ns	ns	ns	ns	5.56	0.49	2020	ns	ns	97.85	7.88	2020		1.42	15.66
***2021	1.20	0.24	2.33	1.18	5.75	0.50	2021	27.92	147.17	94.90	8.18	2021		0.53	11.42
2022	0.72	0.22	1.51	0.02	6.47	0.56	2022	26.83	3.65	97.14	7.90	2022		0.88	11.28

+ less than 0.04
ns no survey
A Portuguese October Survey with different vessel and gear (Capricórnio and CAR net)
B Portuguese Crustacean Survey covers partial area only with a different Vessel (Mestre Costeiro)
* Revised in WGHMM2011
** From 2013 new vessel for Spanish survey (Miguel Oliver)
*** From 2021 new vessel for Portuguese surveys (Mário Ruivo) with changes in the gear used in the october survey

Table 6.4.5. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Summary of catches and a4a results.

YEAR	LANDINGS	DISCARDS	CATCH	CatEst	TSB	SSB	SsbCv	RECRUITS Age 0	RecrCv	FBAR 2- 4	FbarCv
1986	1124	284	1408	1397.28	5118.74	3088.18	0.068	63887.66	0.085	0.424	0.095
1987	1688	333	2021	1681.84	6941.16	3881.89	0.066	42536.24	0.088	0.383	0.092
1988	2223	363	2586	2309.90	7617.46	4907.07	0.067	54582.26	0.089	0.458	0.085
1989	2629	408	3037	2863.28	7754.52	5126.99	0.070	54738.08	0.086	0.588	0.082
1990	1945	409	2354	2116.48	6645.61	4457.22	0.079	35096.50	0.087	0.467	0.087
1991	1682	447	2129	2016.02	6894.58	4487.16	0.076	75412.74	0.092	0.440	0.087
1992	1916	437	2353	2715.96	7239.85	4692.70	0.083	65061.62	0.087	0.625	0.077
1993	1384	438	1822	2099.79	6458.11	4018.64	0.078	20482.47	0.091	0.500	0.083
1994	1403	517	1920	2085.74	6433.45	4045.35	0.067	49219.82	0.090	0.511	0.084
1995	1652	406	2058	1991.37	5792.75	3719.01	0.072	58179.04	0.085	0.564	0.081
1996	1098	368	1466	1519.36	4919.72	2853.93	0.083	44177.57	0.080	0.498	0.085
1997	896	308	1204	962.26	4120.61	2592.54	0.087	29039.39	0.085	0.343	0.094
1998	1123	378	1501	1598.87	5253.62	3734.28	0.080	18992.15	0.086	0.432	0.094
1999	1125	317	1442	1446.68	4734.92	3545.48	0.087	30309.53	0.088	0.414	0.093
2000	1041	373	1414	1313.77	4215.69	2897.75	0.095	34606.42	0.089	0.458	0.091
2001	931	290	1221	1370.46	4005.18	2543.25	0.110	30400.43	0.082	0.548	0.096
2002	720	308	1028	964.72	4287.73	2573.29	0.117	37973.20	0.082	0.345	0.106
2003	876	191	1067	997.93	5055.32	2953.13	0.104	42133.62	0.088	0.303	0.107
2004	1006	348	1354	1286.77	5178.24	3042.98	0.098	38300.50	0.088	0.388	0.103
2005	983	375	1358	1185.97	5167.80	3087.16	0.094	63677.56	0.087	0.353	0.107
2006	1092	335	1427	1493.25	6425.36	3754.17	0.101	54143.82	0.087	0.364	0.107
2007	1104	292	1396	1449.32	6257.81	3749.52	0.104	39068.97	0.089	0.346	0.122
2008	980	202	1182	1231.74	6946.78	4757.92	0.114	29060.10	0.090	0.232	0.120
2009	1134	279	1413	1554.61	7149.69	5298.19	0.121	59782.32	0.088	0.278	0.117
2010	1297	265	1562	1540.55	7359.18	5682.28	0.128	42750.50	0.087	0.255	0.119
2011	1128	269	1397	1456.70	7118.95	5145.03	0.136	47413.87	0.091	0.262	0.120
2012	952	369	1321	1375.41	8542.69	5505.51	0.130	60099.64	0.101	0.227	0.123
2013	931	496	1427	1631.39	7714.98	5586.74	0.136	48754.28	0.111	0.275	0.120
2014	1154	788	1942	1838.54	8366.17	5920.72	0.141	80539.73	0.117	0.290	0.122
2015	1148	597	1745	1928.55	9178.18	5963.35	0.151	58616.12	0.117	0.304	0.131
2016	1087	332	1419	1400.63	9732.96	6491.83	0.156	77433.83	0.117	0.188	0.149
2017	927	246	1173	1333.46	10421.22	7084.03	0.160	51214.20	0.117	0.164	0.151
2018	814	92	906	945.99	10454.76	8146.43	0.163	54743.91	0.127	0.101	0.155
2019	742	201	943	1250.22	12430.57	10294.20	0.164	51477.47	0.158	0.109	0.142
2020	711	81	792	1018.88	13470.16	11241.78	0.159	33962.36	0.245	0.080	0.138
2021	722	109	831	1224.23	15014.71	13100.08	0.157	22650.90	0.367	0.085	0.136
2022	644	119	763	1253.37	15556.48	13957.25	0.151	29913.87	0.620	0.084	0.146
2023*	NA	NA	NA	NA	NA	NA	NA	44431.04	NA	0.083	NA

Table 6.4.6. Four-spot megrim (*L. boscii*) in Div. 8c and 9a. The values for the forecast and for the interim year.

Variable	Value	Notes
F[ages 2-4] (2023)	0.083	Fsq = average F (2020–2022).
SSB (2024)	13130	Short-term forecast (STF); in tonnes.
R[age 0] (2023, 2024)	44431	Geometric mean 1990–2020; in thousands.
Total catch (2023)	1220	STF; in tonnes.
Projected landings (2023)	1136	STF assuming average landings ratio at age 2018–2022; in tonnes.
Projected discards (2023)	84	STF assuming average landings ratio at age 2018–2022; in tonnes.

Table 6.4.7. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a catch forecast: management options table.

Basis	Total catch 2024	Wanted catch 2024	Unwanted catch 2024	F[total] (ages 2-4) (2024)	F[wanted] (ages 2-4) (2024)	F[unwanted] (ages 0-2) (2024)	SSB 2025	% SSB change	% Advice change
MSY approach: F[MSY]	2351	2186	165	0.176	0.113	0.049	11371	-13.4	3
F=MAP F[MSY lower]	1640	1526	114	0.119	0.076	0.033	12126	-7.6	3
F=MAP F[MSY upper]	3537	3284	253	0.280	0.179	0.078	10117	-23	3
F=0	0	0	0	0.000	0.000	0.000	13877	5.7	-100
F[pa]	5291	4902	389	0.460	0.295	0.129	8277	-37	132
F[lim]	6107	5651	456	0.560	0.357	0.156	7428	-43	168
SSB (2025)=B[pa]	10564	9677	886	1.430	0.914	0.400	2932	-78	360
SSB(2025)=B[lim]	11203	10238	965	1.660	1.060	0.460	2321	-82	390
SSB(2024) = SSB (2025)	699	651	48	0.049	0.031	0.013	13130	0	-69
SSB(2025)=MSY B[trigger]	10564	9677	886	1.430	0.914	0.400	2932	-78	360
F[2023]	1166	1085	81	0.083	0.053	0.023	12632	-3.8	-49
Roll-over TAC	2282	2122	160	0.170	0.109	0.048	11444	-12.8	0

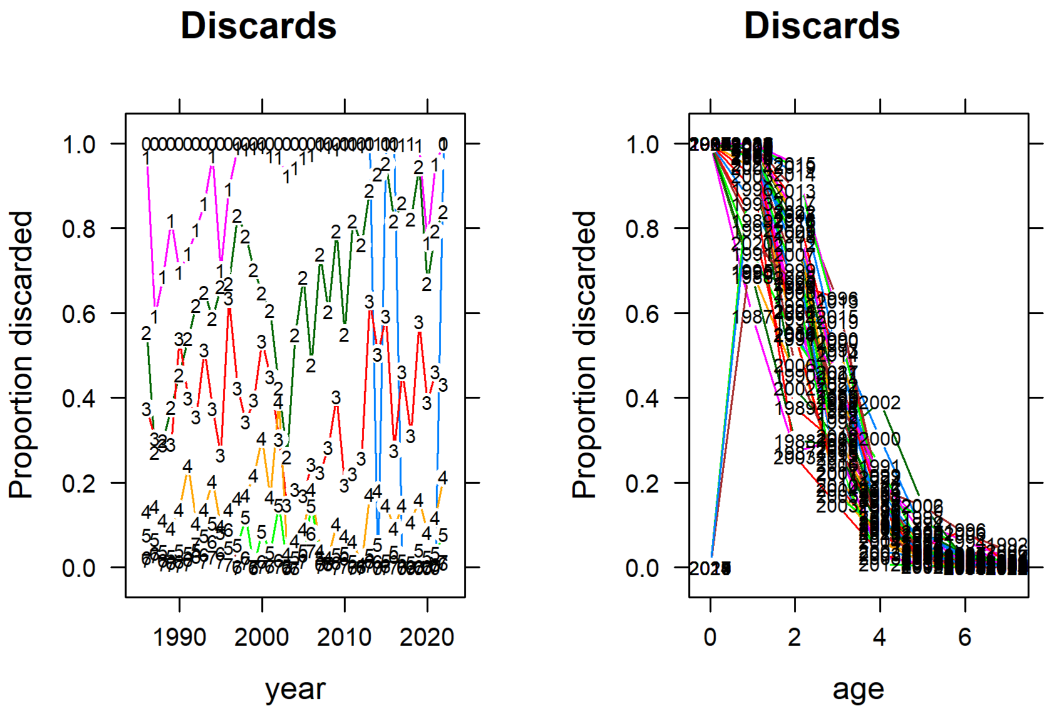

Figure 6.4.1. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Discards proportions-at-age.

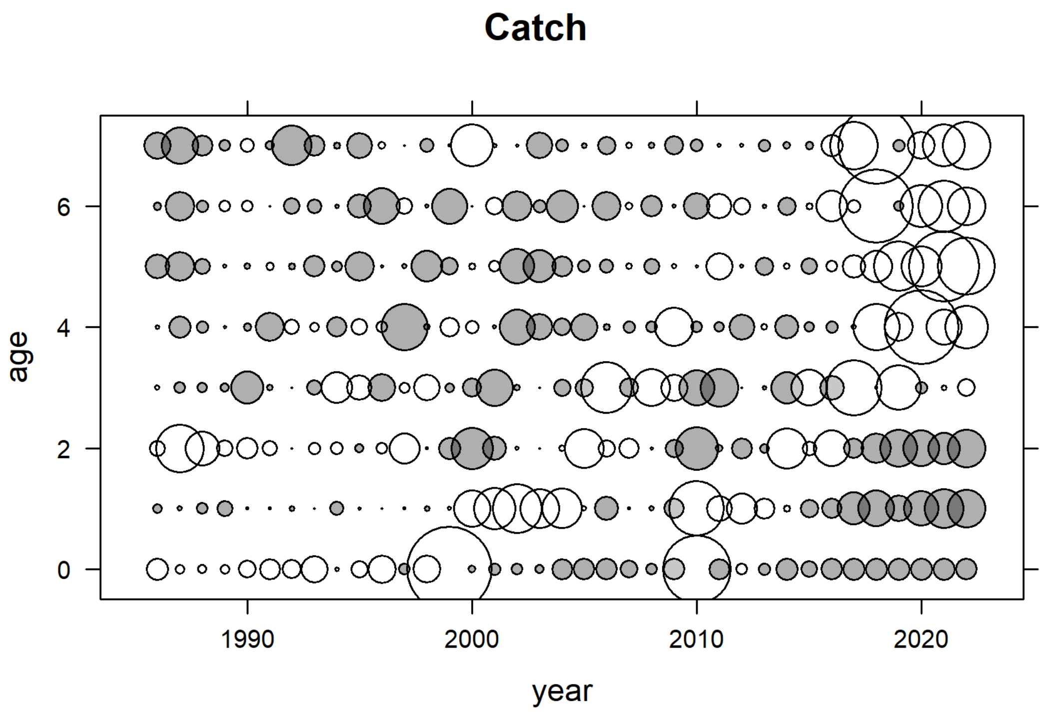

Figure 6.4.2a. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized catches proportions-at-age.

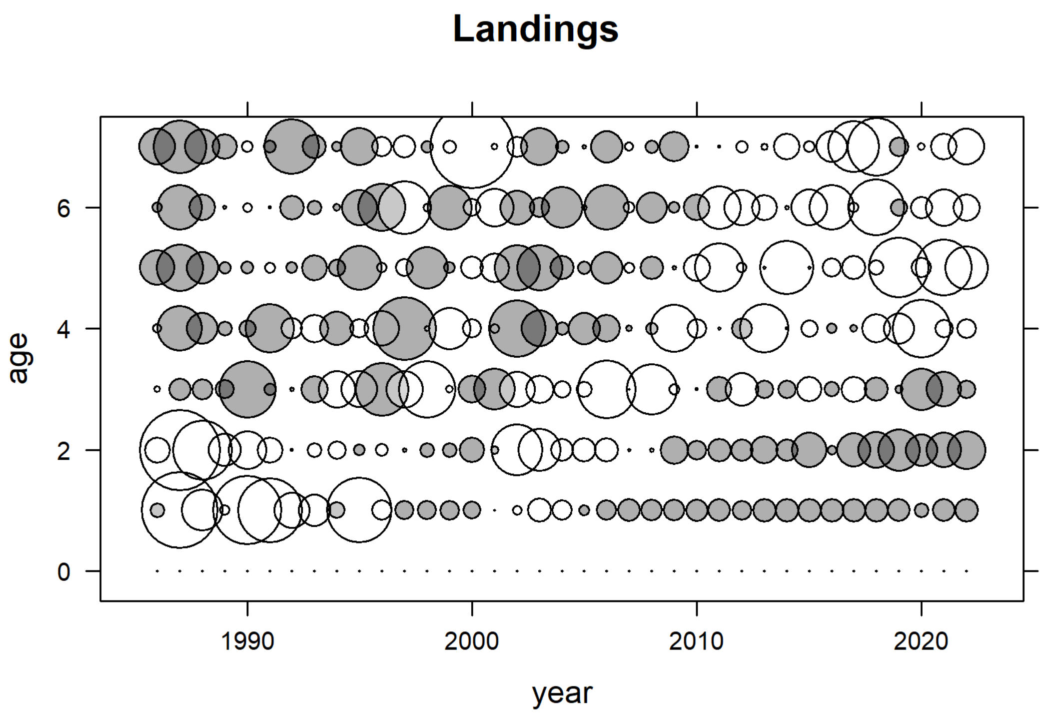

Figure 6.4.2b. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized landings proportions-at-age.

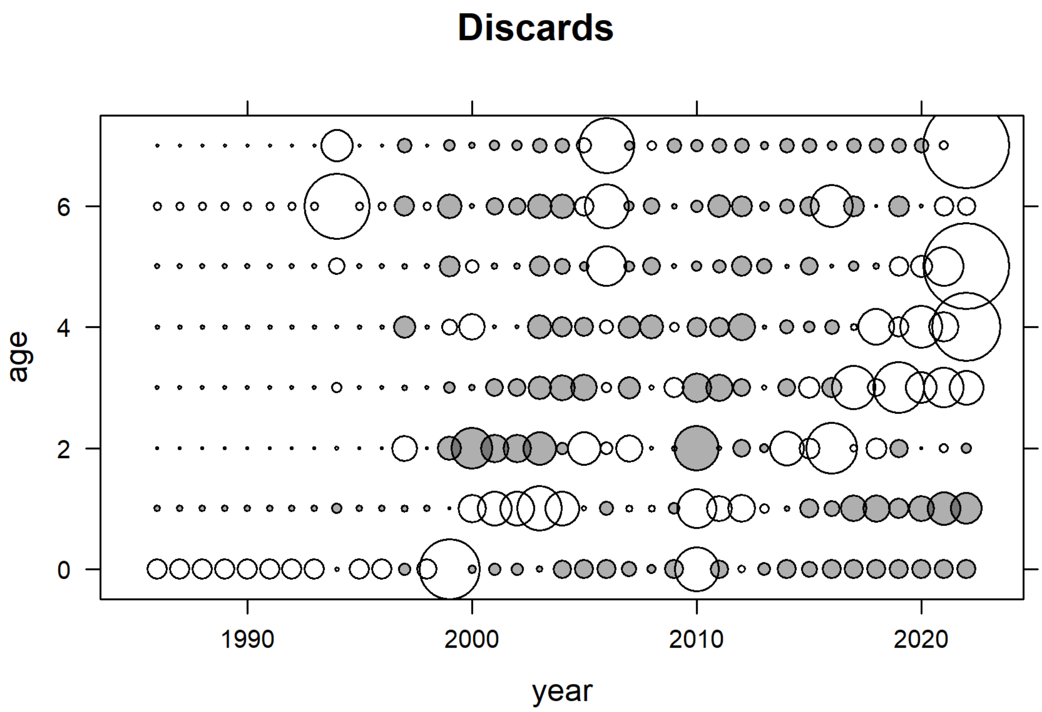

Figure 6.4.2c. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized discards proportions-at-age.

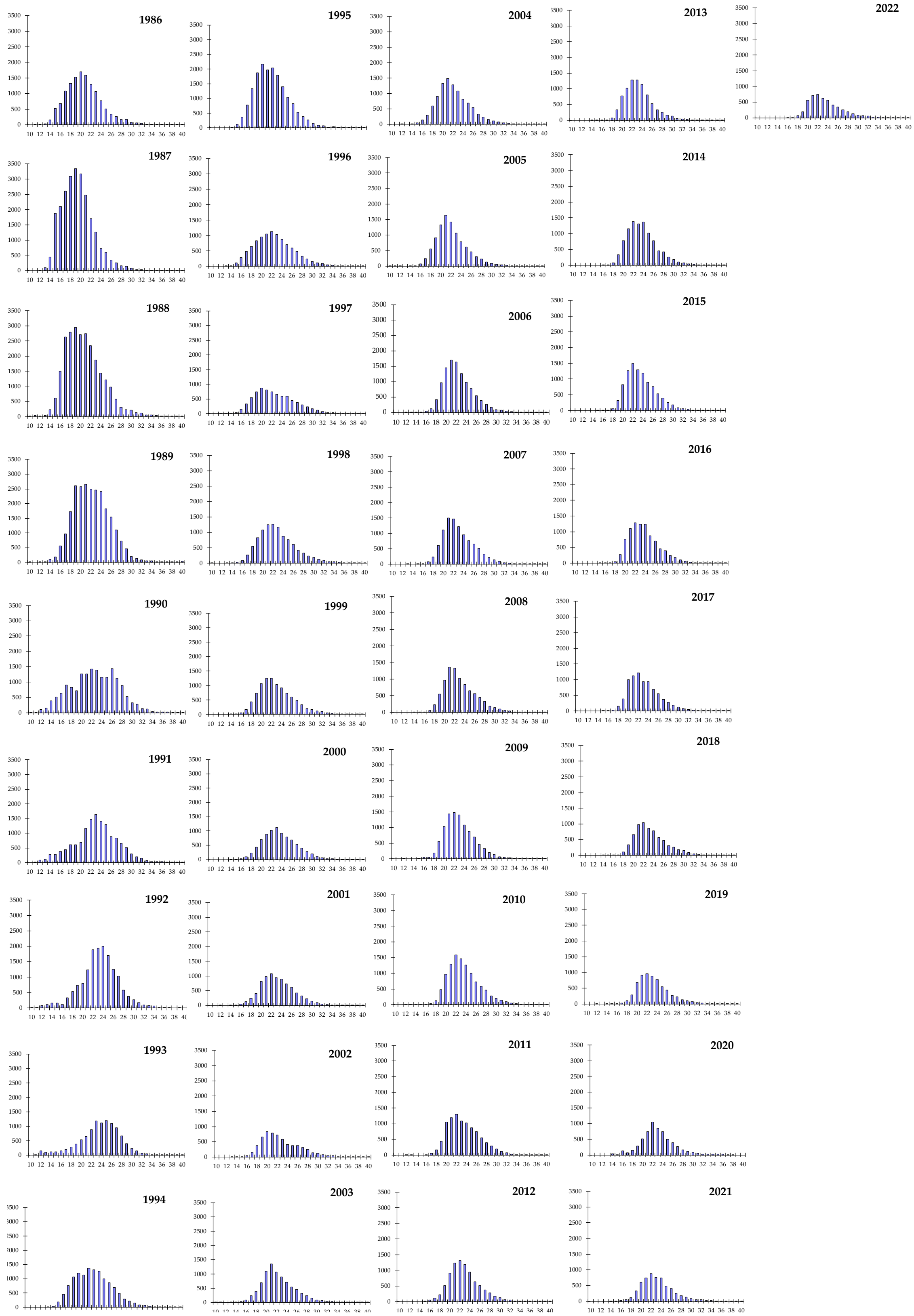

Figure 6.4.3. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Annual length compositions of landings ('000).

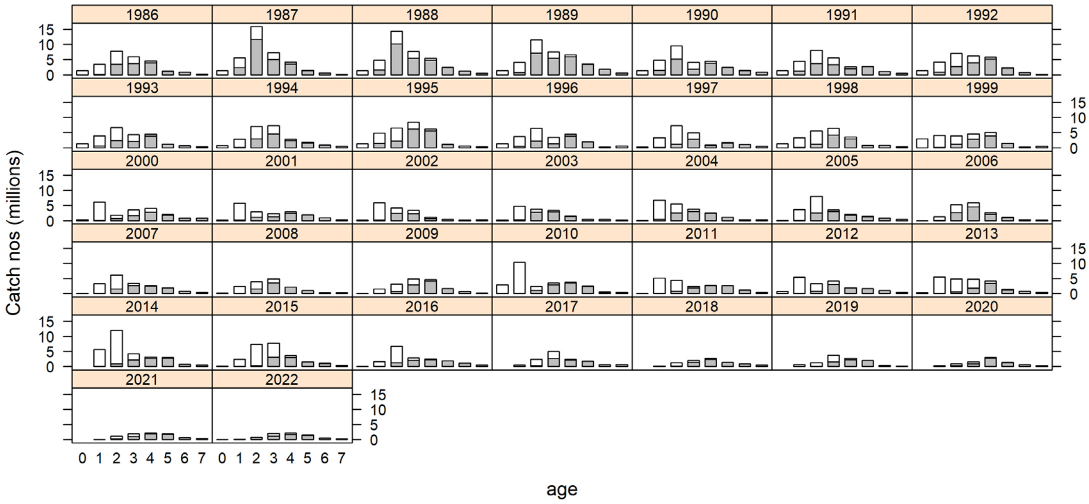

Figure 6.4.4. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Age composition of catches.

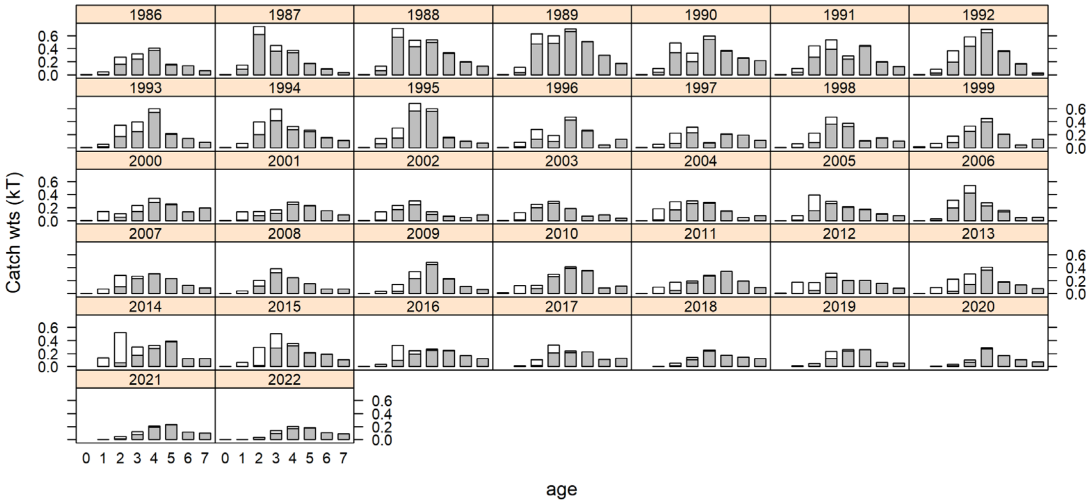

Figure 6.4.5. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Weights-at-age of catches.

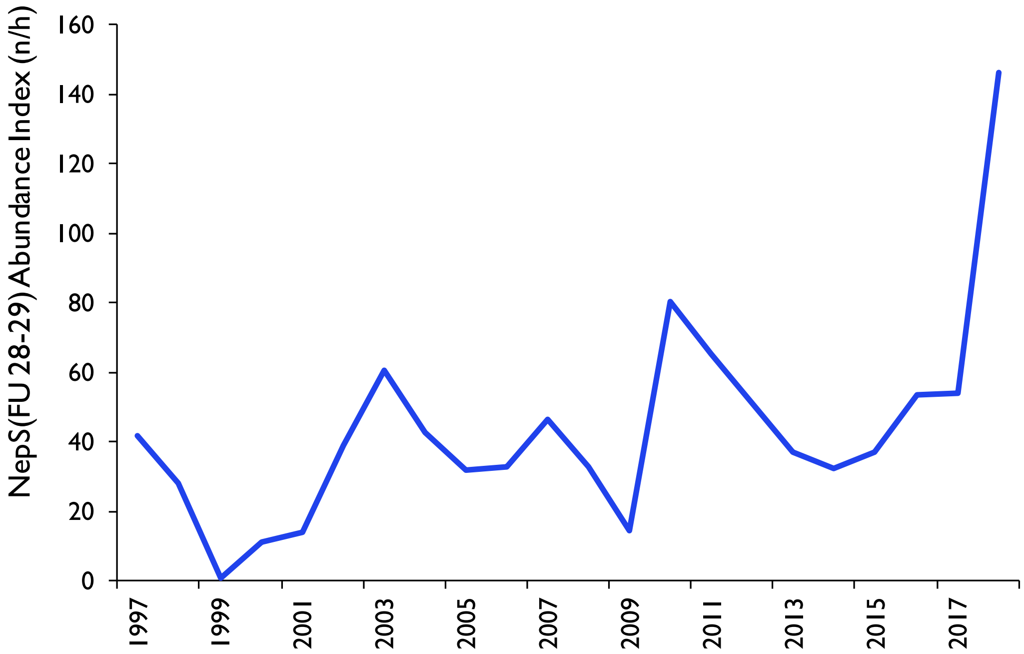

Figure 6.4.6. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Abundance Index from the portuguese NepS (FU 28–29) (G2913) survey for the years included in the assessment.

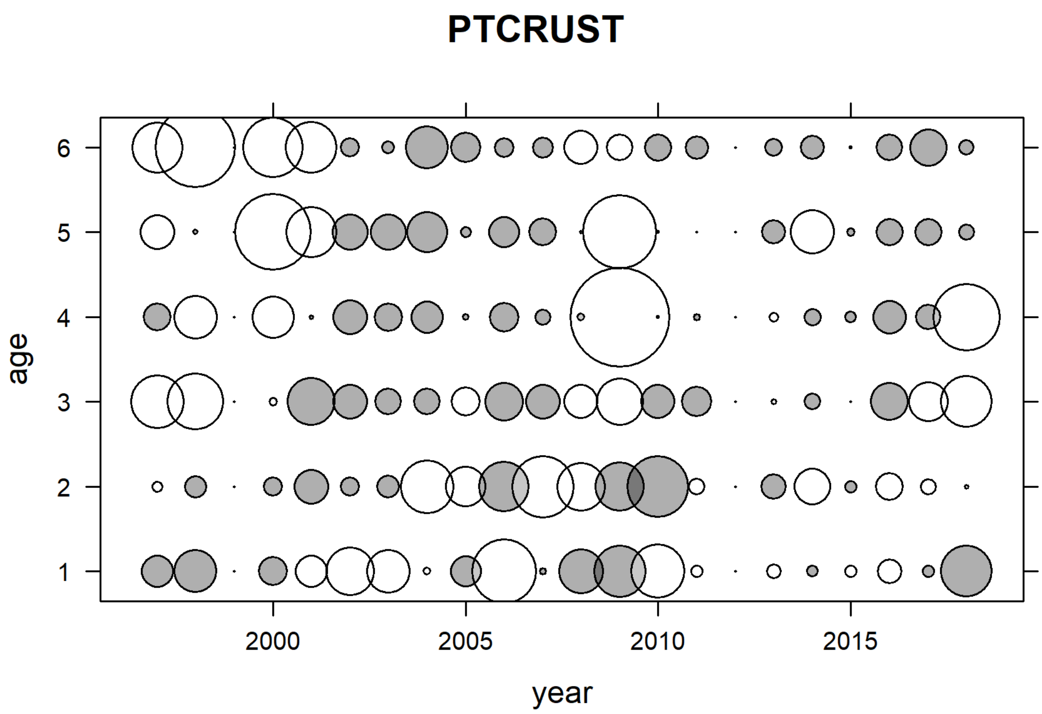

Figure 6.4.7. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized log (abundance index at age) from the portuguese NepS (FU 28–29) (G2913) survey.

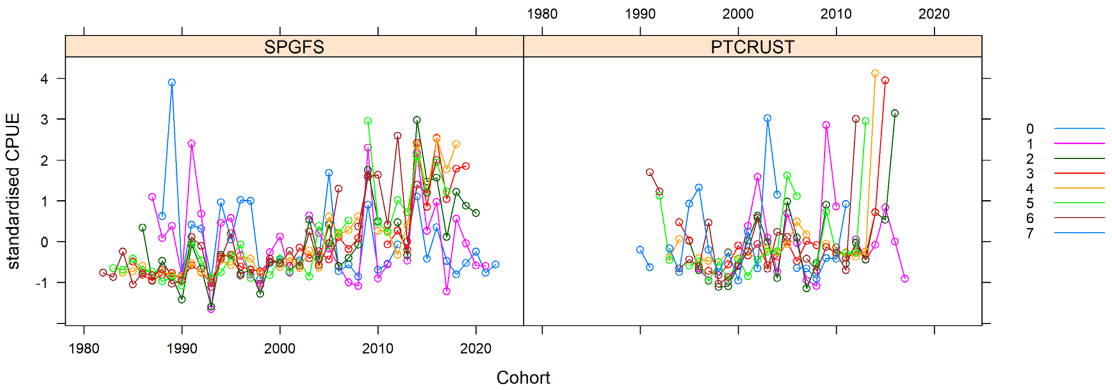

Figure 6.4.8. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Internal consistency of the standardized CPUE index from the SP-NSGFS-Q4 (G2784) and the NepS (FU 28–29) (G2913) surveys.

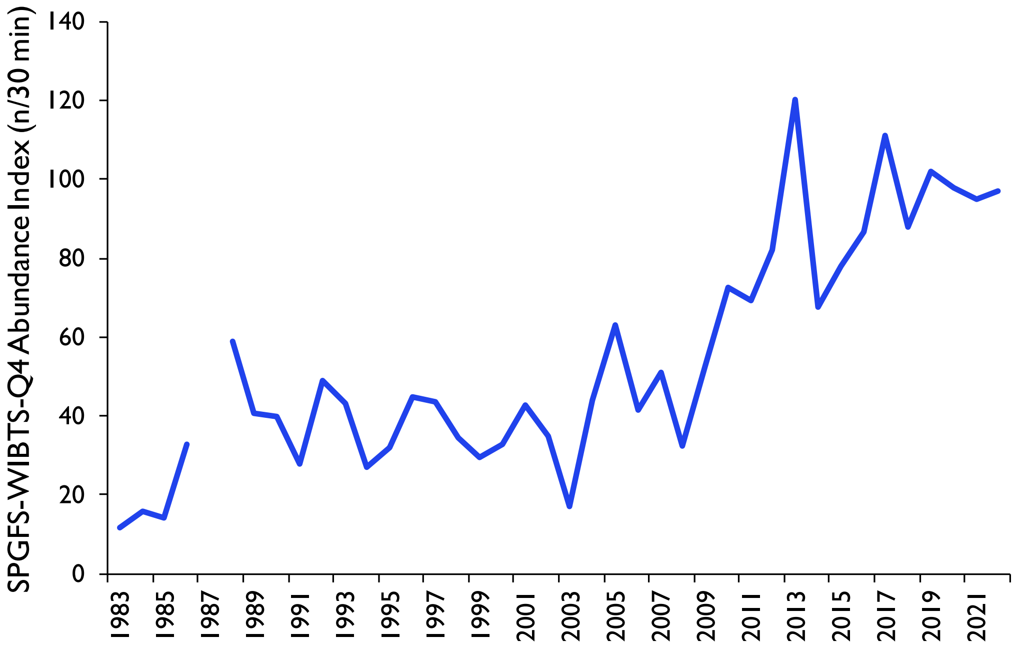

Figure 6.4.9. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Abundance Index from survey SP-NSGFS-Q4 (G2784).

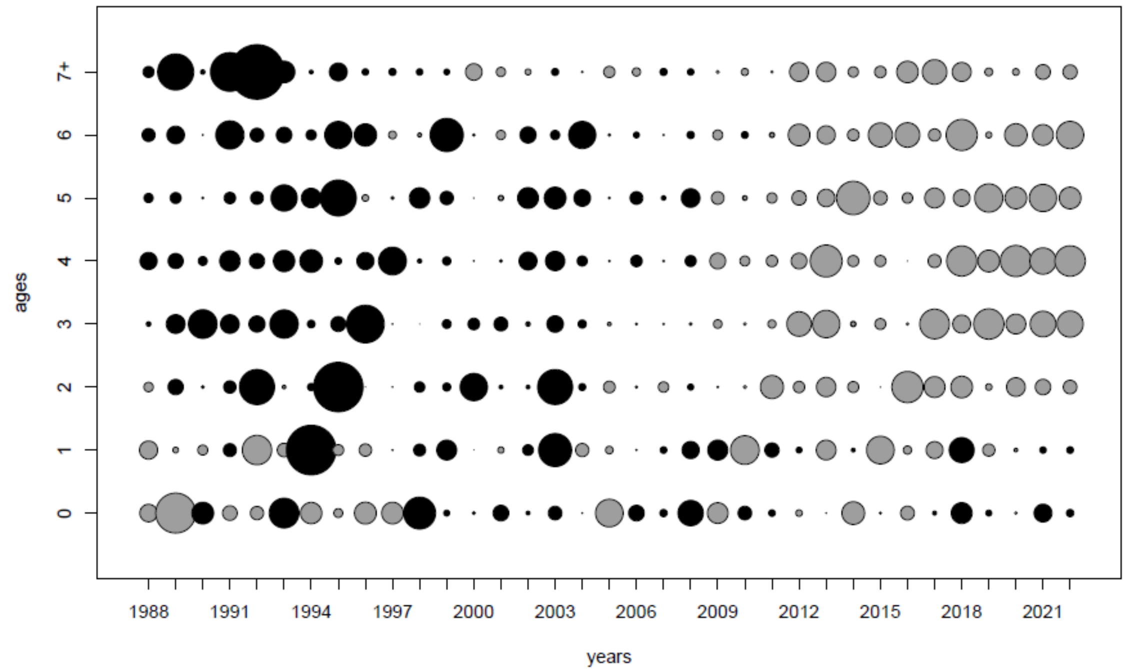

Figure 6.4.10. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized log (abundance index at age) from survey SP-NSGFS-Q4 (G2784) .

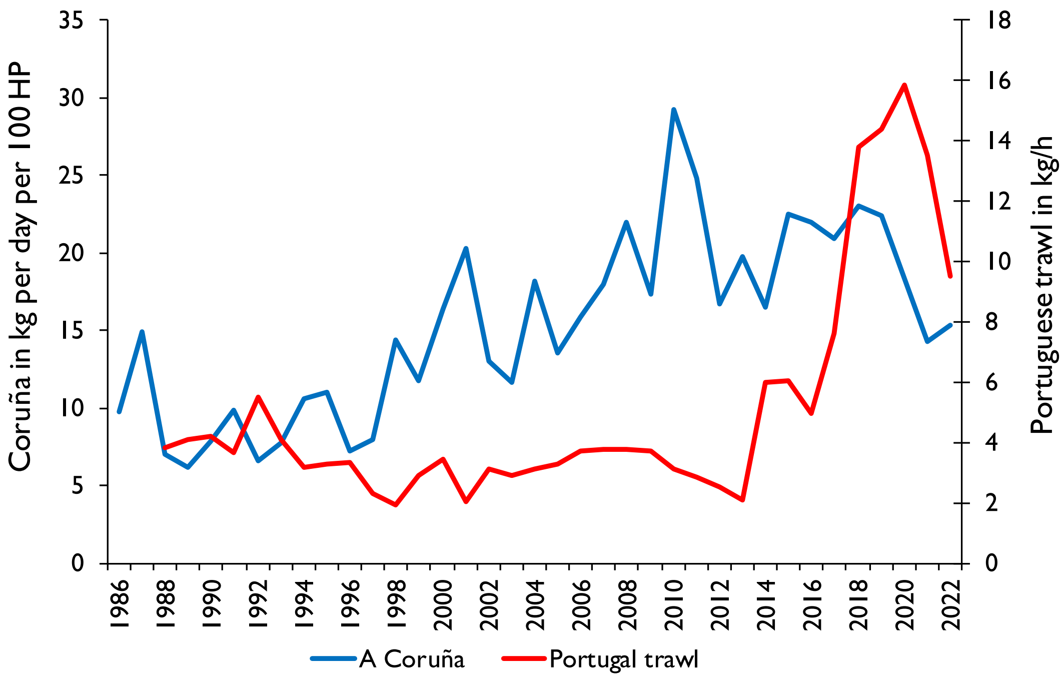

Figure 6.4.11. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. LPUE indices for Spanish and Portuguese commercial fleets.

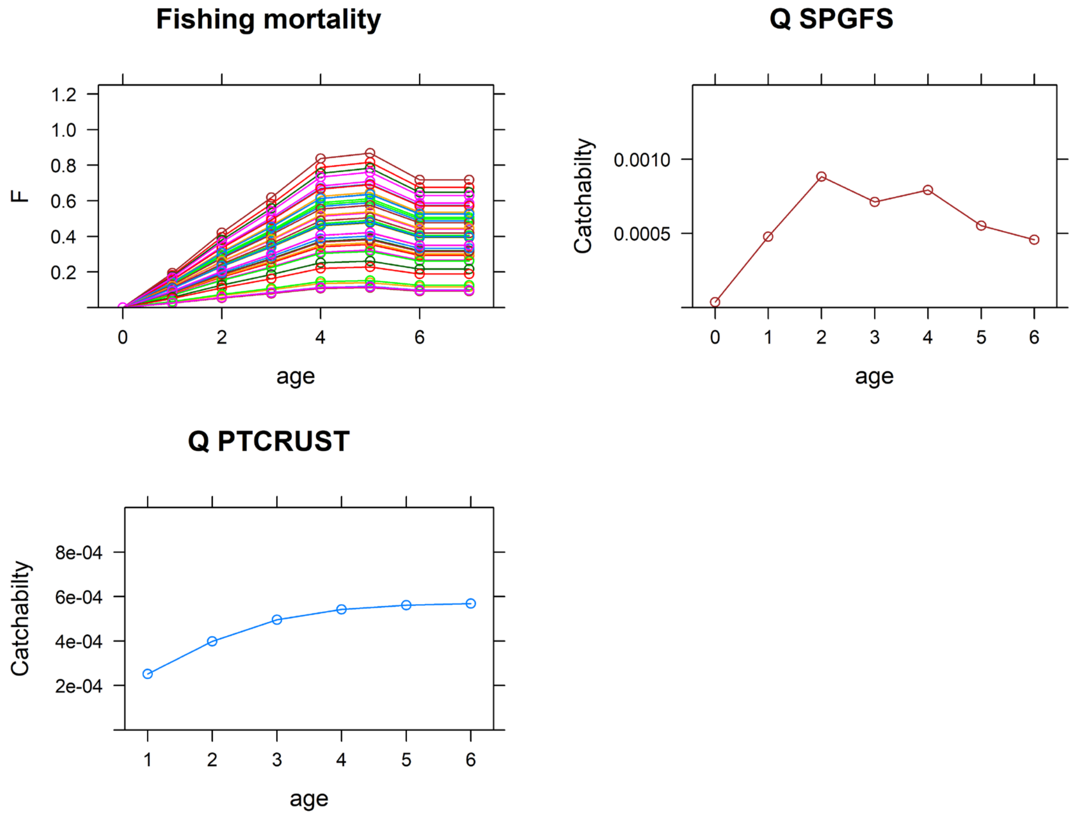

Figure 6.4.12. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. F-at-age (colours indicate years) and catchability-at-age pattern of the SP-NSGFS-Q4 (G2784) and PT-CTS UWTV-FU28–29 (G2913) surveys.

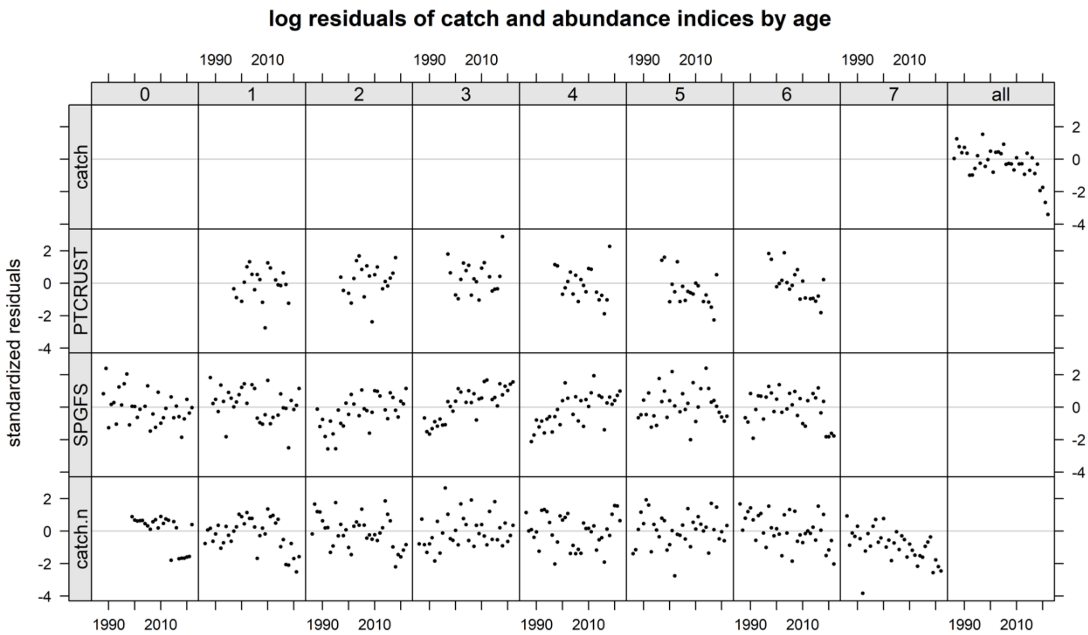

Figure 6.4.13. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized residuals of the catch and the SP-NSGFS-Q4 (G2784) and PT-CTS UWTV-FU28–29 (G2913) surveys.

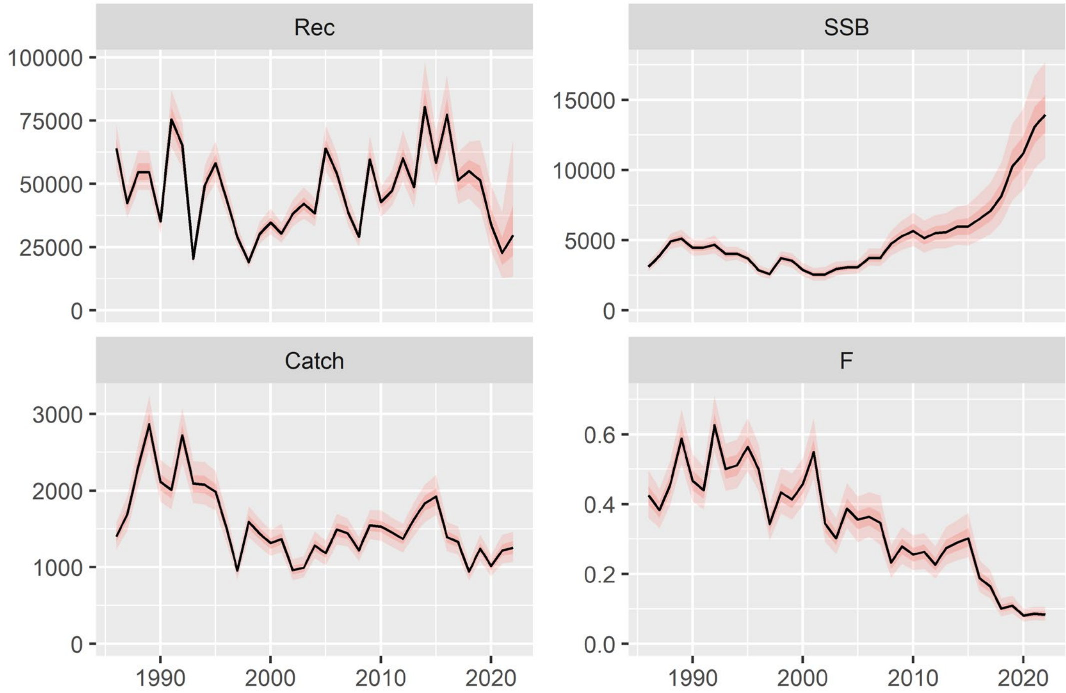

Figure 6.4.14. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Summary plots of the a4a assessment outputs.

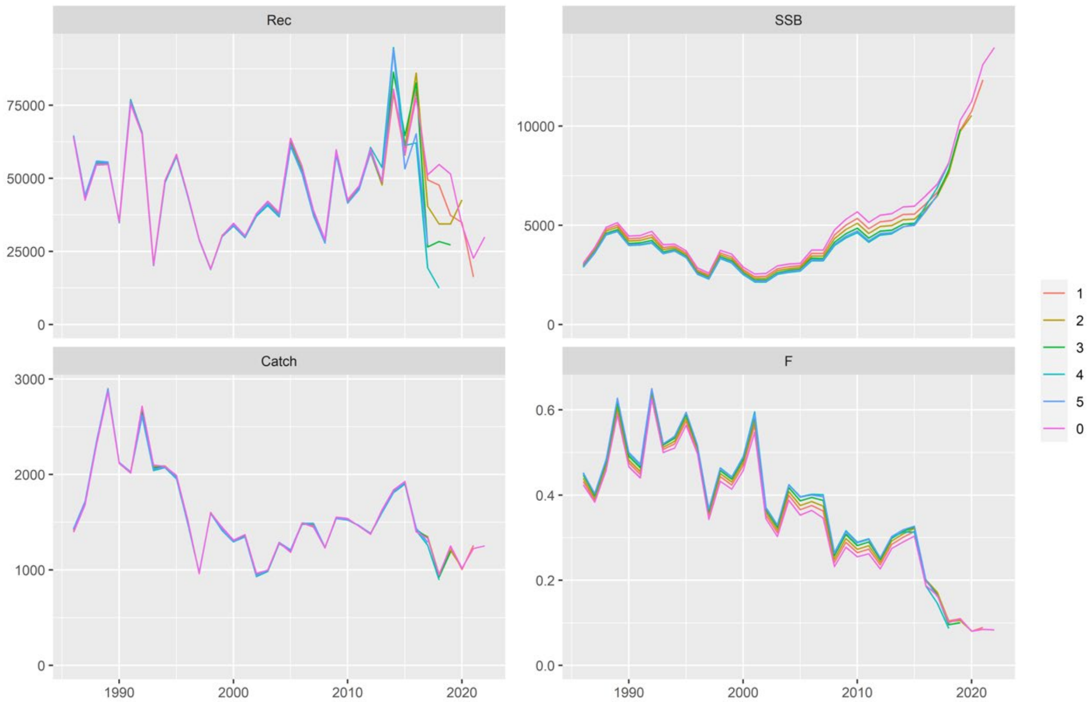

Figure 6.4.15 Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Retro plots.

Figure 6.4.16 Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Historical assessment results. Last year of geometric mean recruitment included. The assessment model and the reference points were revised in 2022 during the WKMEGRIM benchmark (ICES, 2022a).

6.5 Combined forecast for megrim stocks (*L. whiffiagonis* and *L. boscii*)

Figure 6.5.1 plots total international landings and estimated stock trends for both species of megrim in the same graph, in order to facilitate comparisons. The two species of megrims are included in the landings from ICES divisions 8.c and 9.a. Both are taken as bycatch in mixed bottom-trawl fisheries.

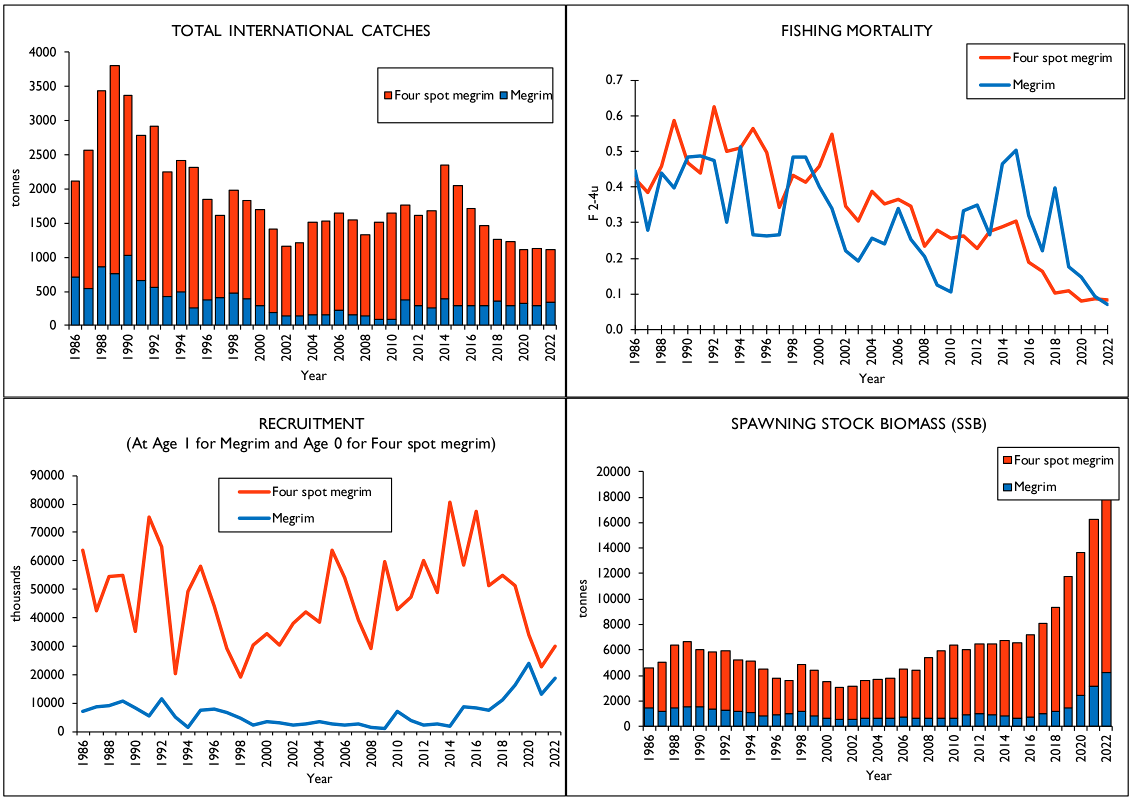

Figure 6.5.1. Stock trends for both stocks. Megrim and four-spot megrim in divisions 8.c and 9.a.

7 Northern and central Bay of Biscay sole

sol.27.8ab – *Solea solea* in divisions 8.a-b

7.1 General

7.1.1 Type of assessment in 2023

Update. Age-structured Extended Survivors Analysis (XSA; Shepherd, 1999) model. Category 1 stock (ICES, 2023a).

7.1.2 Ecosystem aspects

See Stock Annex.

7.1.3 Fishery description

See Stock Annex.

7.1.4 Summary of ICES advice for 2023 and management applicable to 2022 and 2023

7.1.4.1 ICES advice for 2023

ICES advises that when the EU multiannual plan (MAP; European Parliament and Council Regulation; EU, 2019) for Western waters and adjacent waters is applied, catches in 2024 that correspond to the F ranges in the MAP are between 1 454 and 2 685 t. According to the MAP, catches higher than those corresponding to F_{MSY} can only be taken providing SSB is greater than MSY $B_{trigger}$.

7.1.4.2 Management applicable to 2022 and 2023

The Bay of Biscay sole landings are subject to a TAC regulation. The TAC was set at 2 233 and 2 685 t for 2022 and 2023, respectively.

The minimum landing size (MLS) is 24 cm and the minimum mesh size is 70 mm for trawls and 100 mm for fixed nets when directed at the Bay of Biscay sole. Since 2002, the hake recovery plan has increased the minimum mesh size for trawls to 100 mm in a large part of the Bay of Biscay (EU, 2002). However, trawlers using a square mesh panel were allowed to use 70 mm mesh size in this area since 2006.

Since the end of 2006, the French vessels must have a European Fishing Authorization when their Bay of Biscay sole annual landing is above 2 t or be allowed to have more than 100 kg on board (EU, 2006). The Belgian vessel owners get a monthly non-transferable individual quota for the Bay of Biscay sole and the amount is related to the capacity of the vessel.

A regulation establishing a multiannual plan (MAP) for Western waters and adjacent waters was adopted in March 2019 (EU, 2019). One of the objectives is to maintain or restore populations of harvested species at levels that can produce the maximum sustainable yield (MSY) in the context of mixed fisheries. The target fishing mortality (F) corresponds to the objective of reaching and maintaining MSY as ranges of values that are consistent with achieving MSY (F_{MSY}). The F_{MSY}

upper limit is set at the level that the probability of the stock falling below B_{lim} is no more than 5%. ICES considers that the F_{MSY} range for this stock used in the MAP is precautionary.

In addition to this MAP, the French industry implemented a mesh size restriction of > = 80 mm for the bottom trawls for the periods from 1 January to 31 May and from 1 October to 31 December. A seasonal closure was also applied during the spawning period, 1 January to 31 March, for the directed fishery for the Bay of Biscay sole: at least a 15-day fishing activity suspension during the first quarter for netters. In 2022, the French industry increased the MLS for all French fleets from 24 cm to 25 cm for the second semester of 2022.

7.1.5 Data

7.1.5.1 Commercial catches and discards

WGBIE estimates of landings and catches are shown in Table 7.1. Over 90% of the total landings are caught by France while Belgium catches about less than 10%. There are some incidental landings by other countries such as Spain (less than 1% of the total landings).

The official landings are lower than the WGBIE landings estimates before 2008 but became higher from 2009. This discrepancy in estimates until 2008 and 2009–2010 was due to a change in the method implemented to calculate the French official landings (Demaneche, *et al.* 2010). This important discrepancy in 2009–2010 values was likely caused by some assumptions in the algorithm implemented to calculate French official landings for these 2 years, which was again modified in 2011 (Berthou, *et al.* 2009). Consequently, the official and the WGBIE landings estimates are closely similar since 2011. This latest WG method for evaluating landings is considered appropriate in providing the best available estimates of the landing series (Demaneche, *et al.* 2021).

In 2002, landings increased to 5 486 t due to very favourable weather conditions for the fixed nets fishery (frequent strong swell periods in the first quarter).

The 2022, landings (2 306 t) represent a 97% consumption of the TAC_{2022}.

Discards estimates were provided for the French offshore trawler fleet from 1984 to 2003 using the Ifremer FR-RESSGASC survey (G2537) programme. The monitoring halted in 2004 and the discards are no longer used in the assessment. However, these surveys showed that discards from offshore trawlers are low at age 2 and above.

These low discard rates were confirmed by observations at sea in recent years. These observations have also shown that discards of beam trawlers and gillnetters are generally low but that the inshore trawler fleets may have occasionally high discards of the Bay of Biscay sole. Unfortunately, these are difficult to estimate because the effort data of inshore trawlers are not precise enough to allow estimation by relevant areas.

The analysis of discards with data from OBSMER (SIH Harmonie, 2003) shows that the overall discard rate for the Bay of Biscay sole is less than 5% (2.2% average discard ratio over the period 2015–2022).

7.1.5.2 Biological sampling

The quarterly French samplings for length composition are by gear (trawl or fixed net) and by boat length (below or over 12 m long). The split of the French landings by métier and length class is described in the Stock Annex. The observed split between fleets is presented in Table 7.2.

French, Belgian and Spanish data were extracted from InterCatch for 2022.

Although age reading from otoliths now uses the same method in France and Belgium (see Stock Annex), the discrepancy between French and Belgian mean weight-at-age observed during the preceding WGBIE assessments is still present (ICES, 2022). Work was carried out at the beginning of 2012 by the ICES Planning Group on Commercial Catches, Discards and Biological Sampling (PGCCDBS) to compare the age-reading methods (ICES, 2013a). The conclusion was the absence of bias between readers from the two countries using otoliths prepared with the same staining technique. All readers produced the same age estimates (i.e. no bias) of otoliths with or without staining. However, a likely effect of the weight-at-age determination process may also be presumed (weight-length relationship used in France and direct estimates in Belgium) and should be investigated. International age compositions are estimated using the same procedure as in previous years, as described in the Stock Annex. International mean weights-at-age of the catch are French-Belgian quarterly weighted mean weights. The catch and landings numbers-at-age are shown in Table 7.3 and Figure 7.1, respectively, and the mean catch weight-at-age in Table 7.4.

7.1.6 Abundance indices from surveys

Since 2007, a beam trawl survey (ORHAGO, B1706) is carried out by Ifremer (France) to provide a Bay of Biscay sole abundance index. This survey is coordinated by the ICES WGBEAM (ICES, 2023b). During the 2013 WGBEAM meeting, several CPUE series were compared (ICES, 2013b). The index found to be the most appropriate was the one based on all the reference stations and carried out during the daytime. This was used to provide the abundance index for sole in divisions 8.a and 8.b. The 2013 WGHMM assessment was carried out according to the 2013 revised Stock Annex, which adds the ORHAGO (B1706) survey to the tuning files. This was a consequence of the IBP during the WGHMM 2013 which considered that the addition of the survey tuning fleet appears to be useful to the assessment (ICES, 2013c). In 2015, the survey vessel was changed. However, the gear configuration and method remained the same as in the previous years and the conclusion of WGBEAM 2016 was: “this change has had no consequence on the gear configuration” (ICES, 2016c). On this basis, WGBIE agreed to retain the ORHAGO (B1706) abundance index for the assessment. Figures 7.2 and 7.3 show the tuning fleets time-series and the internal consistency of this survey. The ORHAGO survey (B1706) was strongly affected by bad weather conditions in 2022 (Lecomte, 2023a in ICES, 2023b). As a result, half of the hauls are missing to derive the abundance index for the year 2022. An analysis assessing the impact of the missing hauls and the abundance index was presented during 2022 WGBIE (Lecomte, 2023b). Based on these analyses the WGBIE decided not to use the 2022 beam trawl survey (ORHAGO, B1706) in the 2023 assessment.

The ORHAGO (B1706) survey index trend shows a decrease since 2014 with some annual fluctuations. It is particularly true, for ages 2 and 3 in recent years (Figure 7.2). It is worth noting that an important decrease in the ORHAGO survey index was observed in 2019 for ages 2 and 3, and slight increasing trends were observed since 2021 for both age 1 and age 2. Indices from the ORHAGO survey is consistent among ages and allow for cohort tracking (Figure 7.3).

7.1.7 Commercial catch-effort data

The French La Rochelle (FR-ROCHELLE) and Les Sables d’Olonne (FR-SABLES) trawler series of commercial fishing effort data and LPUE indices were completely revised in 2005. A selection of fishing days (or trips before 1999) was implemented with a double threshold (Bay of Biscay sole landings > 10% and *Nephrops* landings < = 10%) for a group of vessels. The process is described in the Stock Annex.

The risk that the Bay of Biscay sole 10% threshold may lead to an underestimation of the decrease in stock abundance was pointed out by the Review Group in 2010 (M. Lissardy, Ifremer, pers. comm.). This general point is acknowledged by WGBIE. However, in this particular case and based on the fishery knowledge, this threshold was set to avoid the effect of changing target species which may also affect the LPUE trend. Indeed, the choice of target species may affect effort repartition between the stock optimal habitats and peripheral areas where the Bay of Biscay sole abundance is lower. According to fishers, a minimum of 10% in catch for Bay of Biscay sole was implemented when carrying out mixed-species trawling on common sole grounds to ensure that the Bay of Biscay sole LPUEs are not driven by a fishing strategy evolution (i.e. specifically when targeting cephalopods).

The FR-ROCHELLE LPUE series showed a decreasing trend from 1990 to 2001 followed by the absence of any clear trend since 2002 where only some oscillating variations occurred (Figure 7.2). The FR-SABLES LPUE series also showed a declining trend up to 2003. Thereafter, a short increase in 2004–2005 was observed followed by a flat trend from 2005 onwards.

Two new tuning series were added to the assessment according to the WKFLAT in 2011 (ICES, 2011): the Bay of Biscay offshore trawler fleet (14–18 m) in the second quarter (FR-BB-OFF-Q2) and the Bay of Biscay inshore trawler fleet (10–12 m) in the fourth quarter (FR-BB-IN-Q4) for the period 2000 to last year. A selection of fishing days was made by a double threshold (Bay of Biscay sole landings > 6% and *Nephrops* landings <= 10%). The process is described in the Stock Annex.

Unfortunately, the fishing effort for the FR-BB-OFF-Q2 is no longer available since 2013. This is due to the use of electronic logbooks for which the fishing effort is not a required value. Since 2013, these data are not well exported from the official database and the majority of the fishing effort value is equal to 1. Therefore, the commercial LPUE could not be calculated for this fleet.

However, LPUE for the inshore trawler FR-BB-IN-Q4 fleet is still available from paper logbooks which are still used by this fleet. The computation of the FR-BB-IN-Q4 was not affected by the COVID-19 restrictions because fishing occurred during the fourth quarter of 2020.The FR-BB-IN-Q4 tuning fleet index shows a decrease trend since 2010 for age 3 with some annual fluctuations. For ages 4, 5 and 6 increasing trends is observed with a decrease for all ages in 2022. The FR-BB-IN-Q4 fleet index is consistent among ages and allows for cohort tracking (Figure 7.4).

7.2 Assessment

7.2.1 Input data

See Stock Annex.

7.2.2 Model

The model used in 2023 to assess the Bay of Biscay sole is the R FLXSA package (Kell, 2020) in R (R Core Team, 2020). The age range in the assessment is 2–8+, similar to last year's assessment (ICES, 2022). The year range used is 1984–2022. The main difference from the 2022 assessment is that the FR-ORHAGO index do not include the terminal year (2022) because of missing data in the ORHAGO survey (B1706) last year (Lecomte, 2023a; b).

7.2.2.1 Result of XSA runs

The final XSA model used the same settings as in last year's assessment run (ICES, 2022). Figure 7.1 shows the landings-at-age distribution, which consists mainly of ages 3 and 4-year-old individuals, similar to last year's landings.

			2022 XSA		2023 XSA
Catch data year range			1984–2020		1984–2021
Catch age range			2–8+		2–8+
Fleets	FR – SABLES	1991–2009	2–7	1991–2009	2–7
	FR – ROCHELLE	1991–2009	2–7	1991–2009	2–7
	FR-BB-IN-Q4	2000–2020	3–7	2000–2022	3–7
	FR-BB-OFF-Q2	2000–2012	2–6	2000–2012	2–6
	FR-ORHAGO	2007–2020	2–7	2007–2021	2–7
Taper			No		No
Ages catch dep. stock size			No		No
Q plateau			6		6
F shrinkage se			1.5		1.5
Year range			5		5
Age range			3		3
Fleet se threshold			0.2		0.2
F bar range			3–6		3–6

The log-catchability residuals are shown in Figure 7.5 and Table 7.9. Retrospective results are available in Figure 7.6. The retrospective pattern shows a good estimation of F_{3-6} and SSB for past years. Table 7.5 gives the results of Mohn's rho (Mohn, 1999) calculation from the most recent assessments and five retrospective assessments with terminal years (2018–2022). Mohn's Rho value is -0.034 for the recruits, 0.0044 for SSB and 0.0083 for F_{3-6}.

The estimated survivors at age 2 are only based on the ORHAGO (B1706) survey index. Estimates of recruits at age 2 shows uncertainty in the past years (2013-2017 and 2020), but relatively small residuals for 2019 and 2021 (Figure 7.5).

F values and stock numbers-at-age are given in Table 7.6 and Table 7.7, respectively. The results are summarized in Table 7.8. Trends in yield, F_{3-6}, SSB and recruitment are plotted in Figure 7.7. F_{3-6} in 2022 is estimated by XSA (Shepherd, 1999) to have been at 0.26. F_{3-6} was 0.32 in 2021, and 0.36 in 2020.

7.2.2.2 Estimating year-class abundance

In this year's assessment, the retrospective analyses show that from 2013 the recruitment was well estimated by the XSA model. The retrospective analysis shows that the recruitment for the last two years (2019 and 2020) was revised at a higher level with the incorporation of the 2021 data. The recruitment assumed for projections is computed as the geometric mean (GM) of the estimated recruitment over the period 2019–2021, which is equal to 10 038 thousand recruits.

7.2.2.3 Historic trends in biomass, fishing mortality, and recruitment

A full summary of the XSA time-series results is given in Table 7.8 and illustrated in Figure 7.7. Since 1984, F_{3-6} gradually increased, peaked in 2002 and decreased substantially in the following two years. It increased since 2005 then stabilized at around F_{3-6} = 0.4. In 2017, the value was below F_{MSY} (0.33) but increased in the period 2018–2020 above this level. In 2021, F_{3-6} is at F_{MSY} level. The SSB trend in earlier years increased from 12 300 t in 1984 to 16 300 t in 1993. Afterwards, it showed a continuous decline, reaching 9 600 t in 2003. After an increase in SSB observed between 2004 and 2006, the values remained close to 11 000 t from 2007 to 2009. Although above the MSY $B_{brigger}$ (10 600 t) from 2004, SSB has been decreasing since 2012. SSB values for 2014 to 2016 were below the B_{pa} then above since 2017. The 2021 estimated SSB is above MSY $B_{trigger}$ and B_{pa} (both equal to 10 600 t). The recruitment values decreased since 1993. Between 2004 and 2008, recruitment was stable at around 17 or 18 million then increased in 2009 to the highest value of the series since 1992. After a short increase, the recruitment declined again since 2015, with the lowest recorded values in the whole series of 11 816, 10 698 and 8 003 million estimated in 2019, 2020 and 2021 respectively. From 1984 to recent years, a clear declining trend in the recruitment is estimated (Figure 7.7).

7.2.3 Catch options and prognosis

The exploitation pattern is the mean over the period 2020 to 2022, scaled to the F_{3-6} of 2022. The F_{3-6} for the intermediate year is used and set at F_{3-6} = 0.26 in 2022. The recruits-at-age 2 from 2022 to 2024 are assumed equal to the geometric mean of 2019–2021 ($GM_{2019–2021}$). Stock numbers-at-age 3 and above are the XSA survivor estimates. Weights-at-age in the landings are the 2020–2022 mean weights.

7.2.3.1 Short-term predictions

Input values for the catch forecast are given in Table 7.10. For the intermediate year (2023), the mean over the period 2020 to 2022, scaled to the F_{3-6} of 2022 was used to perform the short-term predictions in 2023 (F_{3-6} = 0.26).

In 2020, WGBIE was concerned by the decrease in recruitment over the past two decades. The time-series period used to compute the recruitment GM was shortened to account for the low recruitment observed in the past 10 years and only considered the period from 2004 to 2017 (ICES, 2020). In 2021, WGBIE decided to shorten the period previously used during WGBIE 2020 (ICES, 2020) used to compute the GM of the recruitment for the period 2016–2021 (ICES, 2021b). In 2023, the trend in the recruitment is still decreasing with the lowest recruitment estimates observed since 1983 for the years 2019 to 2022. WGBIE decided to shorten again the period for computing the GM of the recruitment to 2019 to 2021. The shorter period considered to compute the GM of the recruitment for the last two years is considered more precautionary than the longer period used in previous stock assessments (ICES, 2020, 2021b, 2022). Furthermore, WGBIE decided to not include the 2022 recruitment estimates in the GM because of the issue on the significantly incomplete 2022 ORHAGO survey data that provided an inaccurate index for 2022 (Lecomte, 2023a; b; ICES, 2023c).

Assuming recruitment at $GM_{2019–2021}$, the SSB is predicted to increase from 9 350 t in 2023 to 9 405 t in 2024, and it will decrease at $F_{3-6} = F_{MSY} \times SSB_{2023}$/MSY $B_{trigger}$, to reach 9 263 t in 2025 and will remain under B_{pa} and MSY $B_{trigger}$ (Tables 7.10 and 7.11).

ICES (2016a) and the WKMSYREF4 that estimated the MSY approach reference points (ICES, 2016b) are given below as a technical basis with the values adopted for the precautionary approach reference points.

The F_{3-6} pattern is known, with low uncertainty, because of the limited discards and the satisfactory sampling level of the catches.

7.2.4 Biological reference points

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	10 600	B_{pa}; in tonnes.	ICES (2016a)
	F_{MSY}	0.33	Stochastic simulations using a segmented regression stock–recruitment model.	ICES (2016a)
Precautionary approach	B_{lim}	7600	$B_{lim} = B_{pa} / \exp(\sigma \times 1.645)$; σ = 0.20; in tonnes.	ICES (2016b)
	B_{pa}	10 600	Lowest SSB with good recruitment and increase of SSB; in tonnes.	ICES (2016b)
	F_{lim}	Undefined	F_{lim} (0.6) is no longer considered appropriate given the estimate of F_{pa}.	ICES (2016b)
	F_{pa}	0.88	$F_{p.05}$ with Advice Rule (AR): The F that provides a 95% probability for SSB to be above B_{lim}.	ICES (2016b, 2023a)
Management plan	MAP MSY $B_{trigger}$	10 600	MSY $B_{trigger}$; in tonnes.	ICES (2016a), EU (2019)
	MAP B_{lim}	7600	B_{lim}; in tonnes.	ICES (2016a), EU (2019)
	MAP F_{MSY}	0.33	F_{MSY}	ICES (2016a), EU (2019)
	MAP range F_{lower}	0.180	Consistent with ranges, resulting in no more than 5% reduction in long-term yield compared with MSY.	ICES (2016a), EU (2019)
	MAP range F_{upper}	0.49	Consistent with ranges, resulting in no more than 5% reduction in long-term yield compared with MSY.	ICES (2016a), EU (2019)

7.2.5 Comments on the assessment

7.2.5.1 Sampling

The sampling level for this stock is considered to be satisfactory. The ORHAGO (B1706) survey provides information on several year classes from age 2. For other ages, it is particularly useful to have a tuning fleet in the tuning file because the recent use of electronic logbooks has caused some obvious misreporting of effort which limits the available commercial tuning data in 2012 and 2013, coupled with the lack of FR-BB-OFF-Q2 abundance indices since 2013. Stopping the use of fleets of La Rochelle and Les Sables l'Olonne tuning series led to a paucity of information at age 2 in 2013, which were only provided by the Offshore Q2 tuning fleet (when data were available). That is no longer the case with the incorporation of the ORHAGO (B1706) survey in the assessment. The same age reading method is now adopted by France and Belgium. However, a discrepancy still exists between French and Belgian weights-at-age which requires further investigation.

7.2.5.2 Discarding

Available data on discards have shown that discards may be important at age 1 for some trawlers. Discards at age 2 were assumed to be low in the past due to the high commercial value of the Bay of Biscay sole catches. Recently, there are evidences of high-grading practices due to the landing limits adopted by some producers' organizations. Overall, discards remain low in recent years (average discard ratio of 2.2% over 2015–2022) and are used to produce catch advice but not used in the assessment. However, discards could be included in the assessment during the next benchmark.

7.2.5.3 Consistency

Since the 2013 assessment, the ORHAGO (B1706) survey has been included in the tuning fleets (ICES, 2013c). This survey is the only tuning fleet that provides a recruitment index series for the more recent period. The GM is only used for recruitment predictions (2022–2025). The retrospective pattern in F_{3-6} shows that F_{2018} is well estimated (Figure 7.6). The definition of reference groups of vessels and the use of thresholds on species percentage to build the French series of commercial fishing effort data and LPUE indices are considered to provide a LPUE index representative of changes in stock abundance by limiting the effect of long-term change in fishing power (technological creep) and change in fishing practices in the Bay of Biscay sole fishery.

7.2.5.4 Misreporting

Misreporting is likely to be limited for this stock but this may be underestimated as fishing of the smallest market sized category for some years may have occurred. There are some reports of high grading practices due to the landing limits adopted by some producers' organizations.

7.2.5.5 Industry input

The traditional meeting with representatives of the French fishing industry was organized in France prior to the WGBIE meeting to obtain and present the data that will be used to assess the state of the Bay of Biscay sole stock during the 2023 WGBIE. The French fishing industry is concerned about the recent decrease in the recruitment estimates and considers that environmental factors could play a major role in this recent decline, given the significant effort of the industry to reduce its exploitation impact on the Bay of Biscay juvenile sole. In this context, the representatives of the French fishing industry are in favour of performing a benchmark for this stock as soon as possible, as well as an analysis on environmental factors affecting the recruitments and natural mortality for this stock prior to performing a benchmark (Annex 4). This stock is accepted for a benchmark in 2024.

Since 2015, the French sole fishery in the Bay of Biscay (ICES divisions 8.a and 8.b) has been subjected to additional management measures aimed at reducing F and improving the stock recruitment level. Since 2016, these measures include a fishing closure of at least 15 days during the first quarter for netters and a reinforcement of the selectivity for at least 8 months of the year (including the first quarter) for trawlers.

In addition to the European measures of the management plan (EU, 2006b) and the harvest control rules (Merzéréaud *et al.*, 2013) for the Bay of Biscay sole stock as defined in the framework of the South West Waters Advisory Council, France has set up a national management regime towards the French sole fishery in the Bay of Biscay since 2015. In 2023, this management regime provides for:

- A mandatory 15-day fishing activity suspension per period of five consecutive days during the first quarter of the year, for netters holding a European fishing authorization for the Bay of Biscay sole. From 2016 to 2018, these vessels were subjected to a 21-day fishing activity suspension per period of 7 consecutive days during the first quarter;

- A national scheme for assisted temporary cessation of fishing activities: the possibility for all vessels which depends on the Bay of Biscay sole catches (10% on their revenues in 2019 and 2020) to a minimum of 45-day and a maximum of 90-day of fishing activity assisted suspension.
- The obligation to use a mesh size greater than or equal to 80 mm (the regulatory mesh size being 70 mm) from 1 January to 31 May and for at least 3 consecutive months from 1 June to 31 December, for bottom trawlers holding a European fishing authorization for the Bay of Biscay sole. The actual effectiveness of these management measures is not fully assessed;
- Suspension of netters from fishing during the months with the highest yields should significantly reduce landings. A quantitative study made by Ifremer in 2015 showed that closing the fishery 5 days per month during the first quarter would correspond to a reduction of 16% of the annual landings of the netters compared to identical conditions of activity elsewhere;
- The increase in the mesh size of the bottom trawls should also limit catches of the Bay of Biscay sole that have not reached maturity (26 cm). A study made by AGLIA (AGLIA, 2009) showed that size compositions of trawl catches differed between 70 and 80 mm mesh sizes and catches of the Bay of Biscay sole measuring < 28 cm are considerably reduced.
- The increase of the MLS for all French fleets from 24 to 25 cm for the second semester of 2022.

7.2.5.6 Management considerations

The assessment indicates that SSB reached a peak in 1993 (16 300 t) followed by continuous decreased to 9 600 t in 2003 which then increased to 14 200 t in 2011. After another decrease from 2012 to 2015, SSB increased from 2016 to 2017 followed by a decreasing trend since 2018 to reach a value of 9 350 t in 2023. The SSB in 2023 is under B_{pa} and MSY $B_{trigger}$ (10 600 t), and remains below these reference points, assuming a recruitment value of 10 038 t for 2022. A slight increase of SBB is predicted in the short-term forecast in 2024 (9 405 t), a value still below B_{pa} and MSY $B_{trigger}$ (Table 7.11).

The 7% decrease in the advice is mainly due to low recruitment estimates from 2019 to 2021 and a decrease of the resulting SSB. A general decreasing trend of the recruitment is observed since 2009, the last peak of recruitment observed in the entire series (Figure 7.7 and Table 7.8).

In 2006, a management plan (EU, 2006) was agreed for the Bay of Biscay sole but a long-term target for F was not set. This plan was not evaluated by ICES.

7.2.5.7 Benchmark proposal

The common sole stock in divisions 8.a and 8.b was last benchmarked in 2011 (ICES, 2011). WGBIE is highly favourable for a benchmark of this stock given the availability of the recent information indicated in this report. A benchmark workshop for this stock was recently approved and the Bay of Biscay sole stock will be a part of the upcoming FLATFISH1 benchmark workshop process. For this stock, the main aims for a benchmark are to evaluate (1) the use of a new assessment model that will replace the current deterministic assessment model (XSA) and (2) the integration of a standardized nominal LPUEs in the assessment. Migrating from a deterministic to a stochastic assessment model with standardized LPUEs will be an important improvement to the current assessment. A working document was presented during the WGBIE 2022 meeting showing the intersessional progress made on the development of a statistical approach to standardize French commercial LPUEs (Tellier *et al.*, 2022)[1]. Furthermore, the

[1] WD 02 in the WGBIE 2022 report.

evaluation of data revisions of some biological parameters such as the maturity ogive, which has not been updated since 2000, will also be considered. Lastly, it will also be an opportunity to evaluate the introduction of new data in the assessment such as French scientific surveys covering the Bay of Biscay sole nurseries from 2016 to the present.

7.2.5.8 Deviation from Stock Annex

The 2022 ORHAGO (B1706) survey was not used in the current assessment because half of the hauls were missing due to bad weather (ICES, 2023c). A working document presenting the impact of the missing hauls and proposals for addressing the issue of the missing hauls for the 2023 stock assessment was presented during the working group (Lecomte, 2023a). Figure 7.8 shows the alternative scenario tested to include the 2022 ORHAGO (B1706) survey data. Two alternative scenario were tested using (1) ORHAGO (B1706) survey index from 2007 to 2021 without the 2022 data and (2) consider two ORHAGO (B1706) survey indices where one is computed from 2007 to 2017 with all hauls sampled and another index computed from 2018 to 2022 using hauls only sampled in 2022. The WGBIE decided not to use the 2022 ORHAGO (B1706) survey for the 2023 assessment and advice based on the results from the scenario tested and discussed in the above-mentioned working document. For the 2024 WGBIE stock assessment, a revised ORHAGO (B1706) survey index will be proposed using a statistical approach such as the vector autoregressive spatiotemporal (VAST; Thorson 2019), which was used in the case of Black-bellied anglerfish in Subarea 7 and divisions 8.a–b and 8.d (ank.27.78abd) in WGBIE 2019 (Gerritsen and Minto, 2019 -WD 01 in ICES, 2019) to fill in the EVHOE-WIBTS-Q4 (G9527) missing survey data.

WGBIE decided to change the period used to compute the GM of the recruitment to account for a more realistic recruitment value for the short-term projection. The years used to compute the GM are 2019 to 2021 instead of 2016 to 2022 (GM used during WGBIE 2022; ICES, 2022) as indicated in the stock annex. The rationale for using a $GM_{2019-2021}$ in this year's assessment are (1) to account for the low recruitment estimates in recent years by removing the 2016 to 2018 recruitment estimates when values observed are larger than the 3 last years and (2) a rapid solution to compensate for the incomplete 2022 ORHAGO (B1706) survey data to avoid the introduction of an uncertainty in the 2022 recruitment estimates, which consequently led to the WGBIE decision of removing the 2022 recruitment estimates from the GM computation.

7.2.6 References

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7.2.7 Tables and figures

Table 7.1. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. International landings and catches (in tonnes) used by WGBIE. Official landings were revised in 2023 from 2006 to 2022.

Year	Belgium	France	Spain	Total	ICES land-ings	discards	ICES catches
1979	0	2376	62	2443	2619	-	-
1980	33	2549	107	2689	2986	-	-
1981	4	2581	96	2694	2936	-	-
1982	19	1618	57	1746	3813	-	-
1983	9	2590	38	2669	3628	-	-
1984	0	2968	40	3183	4038	99	4137
1985	25	3424	308	3925	4251	64	4315
1986	52	4228	75	4567	4805	27	4832
1987	124	4009	101	4379	5086	198	5284
1988	135	4308	0	4443	5382	254	5636
1989	311	5471	0	5782	5845	356	6201

Year	Belgium	France	Spain	Total	ICES landings	discards	ICES catches
1990	301	5231	0	5532	5916	303	6219
1991	389	4315	3	4707	5569	198	5767
1992	440	5928	0	6359	6550	123	6673
1993	400	6096	13	6496	6420	104	6524
1994	466	6627	2	7095	7229	184	7413
1995	546	5326	0	5872	6205	130	6335
1996	460	3842	0	4302	5854	142	5996
1997	435	4526	0	4961	6259	118	6377
1998	469	3821	0	4334	6027	127	6154
1999	504	3280	0	3784	5249	110	5359
2000	451	5293	5	5749	5760	51	5811
2001	361	4350	0	4912	4836	39	4875
2002	303	3680	2	3985	5486	22	5508
2003	296	3805	4	4105	4108	21	4129
2004	324	3739	9	4072	4002	-	-
2005	358	4003	10	4371	4539	-	-
2006	393	4008	9	4432	4793	-	-
2007	401	3724	9	4410	4363	-	-
2008	305	3018	11	4134	4299	-	-
2009	364	4372	0	3334	3650	-	-
2010	451	4372	0	4736	3966	-	-
2011	386	4549	0	4823	4632	-	-
2012	385	3849	0	4935	4321	-	-
2013	312	4188	0	4234	4235	-	-
2014	329	3903	10	4500	3928	-	-
2015	302	3486	8	4242	3644	62	3706
2016	288	3054	4	3796	3232	134	3366
2017	267	2957	8	3346	3249	55	3304
2018	295	3165	8	3232	3308	79	3332

Year	Belgium	France	Spain	Total	ICES land-ings	discards	ICES catches
2019	328	3036	24	3468	3376	88	3464
2020	299	2902	21	3388	3219	74	3293
2021	246	2791	20	3222	3069	41	3110
2022	192	2111	21	3063	2306	37	2343

Table 7.2. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Total landings by different fleets (in tonnes).

Year	Offshore trawlers	Inshore trawlers	Offshore gillnetters	Inshore gillnetters	Belgian Beam trawlers
1997	1874	667	1927	1356	435
1998	1826	605	1674	1414	463
1999	1261	289	2094	1105	499
2000	1197	474	2510	1114	459
2001	994	411	1947	913	368
2002	968	373	2760	1054	311
2003	992	329	1736	749	296
2004	898	369	1710	686	319
2005	923	326	2053	788	365
2006	923	373	2117	896	393
2007	920	392	1768	870	401
2008	813	238	2085	856	305
2009	745	235	1615	692	363
2010	792	323	1733	667	451
2011	807	327	2197	915	386
2012	744	365	1938	889	385
2013	744	313	2052	814	312
2014	716	345	1811	748	307
2015	537	263	1786	748	302
2016	471	259	1522	687	288
2017	514	245	1545	663	274
2018	470	230	1667	725	295
2019	457	227	1589	759	322

Year	Offshore trawlers	Inshore trawlers	Offshore gillnetters	Inshore gillnetters	Belgian Beam trawlers
2020	437	226	1520	723	299
2021	422	158	1469	764	224
2022	336	131	1132	513	194

Table 7.3 Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Catch number-at-age.

Year	2	3	4	5	6	7	8
1984	5901	3164	2786	2034	1164	880	1181
1985	8493	4606	2479	1962	906	708	729
1986	6126	4208	2673	2301	1512	1044	1235
1987	3794	5634	3578	2005	1482	690	714
1988	4962	5928	4191	2293	1388	874	766
1989	4918	6551	3802	3147	2046	967	499
1990	7122	6312	4423	2833	972	1018	870
1991	4562	6302	4512	2083	1113	1063	981
1992	4640	7279	4920	2991	2236	1124	951
1993	1897	7816	6879	3661	1625	566	708
1994	2603	5502	8803	5040	1968	970	696
1995	3249	5663	6356	3644	1795	843	986
1996	3027	5180	5409	2343	1697	1366	1319
1997	3801	9079	5380	3063	1578	692	877
1998	4096	5550	6351	2306	1237	785	1188
1999	2851	5113	4870	2764	1314	902	977
2000	5677	7015	5143	2542	955	421	444
2001	3180	6528	4948	1776	899	513	486
2002	5198	4777	4932	3095	1269	615	432
2003	4274	6309	2236	1220	729	377	250
2004	3411	5415	3291	917	661	272	333
2005	3976	3464	3738	2309	991	461	508
2006	3535	4436	2747	2012	1030	530	1537
2007	3885	5181	2615	1419	1262	686	946

Year	2	3	4	5	6	7	8
2008	3173	4794	2886	1353	938	892	1193
2009	2860	3986	2233	1501	946	541	960
2010	2084	7707	3758	1272	484	269	284
2011	1516	5222	8347	1019	570	275	516
2012	1302	4680	4264	3787	1008	225	517
2013	2312	2939	3777	3205	1450	286	635
2014	3767	3198	1769	2426	1810	791	522
2015	2531	3365	1742	2057	1305	939	636
2016	1144	3368	2682	1193	762	759	867
2017	1492	3608	2199	1023	606	587	949
2018	1736	3497	2448	1823	885	484	933
2019	1092	3554	2803	1654	1142	575	821
2020	1498	2171	3115	1555	949	505	974
2021	979	1803	1799	1420	914	611	971
2022	947	1158	1173	916	748	629	1191

Table 7.4. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Catch weight-at-age (in kg).

Year	2	3	4	5	6	7	8
1984	0.130	0.180	0.228	0.288	0.352	0.394	0.614
1985	0.109	0.179	0.260	0.322	0.402	0.471	0.719
1986	0.104	0.176	0.250	0.334	0.417	0.508	0.670
1987	0.144	0.206	0.292	0.385	0.479	0.509	0.699
1988	0.135	0.192	0.274	0.360	0.499	0.507	0.609
1989	0.137	0.189	0.259	0.356	0.439	0.546	0.803
1990	0.132	0.180	0.242	0.349	0.438	0.603	0.857
1991	0.146	0.196	0.265	0.331	0.445	0.545	0.728
1992	0.146	0.196	0.262	0.341	0.404	0.490	0.715
1993	0.145	0.197	0.267	0.341	0.439	0.569	0.678
1994	0.147	0.195	0.251	0.325	0.422	0.570	0.775
1995	0.160	0.206	0.253	0.309	0.404	0.485	0.660

Year	2	3	4	5	6	7	8
1996	0.159	0.204	0.268	0.319	0.399	0.453	0.625
1997	0.143	0.194	0.257	0.321	0.408	0.504	0.681
1998	0.162	0.214	0.259	0.338	0.414	0.506	0.706
1999	0.177	0.219	0.246	0.305	0.404	0.533	0.582
2000	0.172	0.208	0.278	0.345	0.455	0.577	0.760
2001	0.154	0.222	0.268	0.344	0.432	0.524	0.625
2002	0.173	0.211	0.266	0.324	0.472	0.599	0.689
2003	0.181	0.227	0.309	0.363	0.490	0.661	0.646
2004	0.192	0.229	0.293	0.395	0.498	0.650	0.818
2005	0.192	0.229	0.303	0.373	0.437	0.475	0.666
2006	0.198	0.245	0.286	0.352	0.426	0.461	0.540
2007	0.176	0.226	0.299	0.327	0.389	0.420	0.512
2008	0.174	0.229	0.287	0.352	0.392	0.401	0.519
2009	0.173	0.218	0.279	0.322	0.367	0.454	0.610
2010	0.179	0.206	0.273	0.338	0.415	0.478	0.769
2011	0.194	0.224	0.254	0.344	0.434	0.491	0.609
2012	0.182	0.225	0.258	0.308	0.370	0.415	0.586
2013	0.210	0.242	0.274	0.306	0.371	0.522	0.525
2014	0.179	0.243	0.283	0.299	0.351	0.397	0.581
2015	0.198	0.226	0.318	0.314	0.389	0.367	0.520
2016	0.188	0.238	0.286	0.352	0.372	0.382	0.526
2017	0.219	0.239	0.301	0.376	0.434	0.427	0.523
2018	0.191	0.251	0.285	0.357	0.407	0.382	0.444
2019	0.200	0.248	0.288	0.334	0.332	0.372	0.424
2020	0.205	0.245	0.296	0.314	0.353	0.376	0.456
2021	0.204	0.264	0.335	0.380	0.386	0.470	0.628
2022	0.258	0.310	0.313	0.346	0.350	0.378	0.435

Table 7.5. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Mohn's rho for $F_{3\text{-}6}$, SSB and $R_{age\ 2}$.

Variable	Mohn's rho

SSB	0.0044
Mean F	0.0083
Recruits	-0.0340

Table 7.6. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Fishing mortality-at-age.

Year	2	3	4	5	6	7	8
1984	0.30	0.24	0.34	0.35	0.32	0.34	0.34
1985	0.36	0.35	0.27	0.37	0.23	0.29	0.29
1986	0.26	0.27	0.32	0.39	0.48	0.40	0.40
1987	0.17	0.36	0.35	0.37	0.41	0.38	0.38
1988	0.22	0.40	0.43	0.35	0.42	0.40	0.40
1989	0.20	0.44	0.43	0.60	0.53	0.52	0.52
1990	0.27	0.39	0.53	0.58	0.33	0.48	0.48
1991	0.14	0.35	0.46	0.45	0.42	0.64	0.64
1992	0.15	0.32	0.46	0.57	1.11	0.88	0.88
1993	0.08	0.35	0.50	0.65	0.62	0.84	0.84
1994	0.11	0.33	0.76	0.75	0.78	0.83	0.83
1995	0.16	0.33	0.68	0.73	0.58	0.81	0.81
1996	0.12	0.36	0.53	0.51	0.80	1.08	1.08
1997	0.18	0.52	0.68	0.58	0.69	0.80	0.80
1998	0.21	0.40	0.74	0.61	0.43	0.79	0.79
1999	0.13	0.39	0.64	0.75	0.76	0.57	0.57
2000	0.27	0.48	0.77	0.72	0.56	0.51	0.51
2001	0.22	0.51	0.66	0.58	0.54	0.59	0.59
2002	0.25	0.53	0.81	1.02	0.97	0.77	0.77
2003	0.20	0.48	0.44	0.42	0.62	0.77	0.77
2004	0.24	0.38	0.44	0.29	0.37	0.44	0.44
2005	0.27	0.36	0.44	0.56	0.52	0.43	0.43
2006	0.23	0.47	0.47	0.40	0.46	0.52	0.52
2007	0.27	0.54	0.50	0.43	0.42	0.57	0.57
2008	0.20	0.54	0.59	0.46	0.49	0.52	0.52

Year	2	3	4	5	6	7	8
2009	0.09	0.37	0.46	0.62	0.60	0.52	0.52
2010	0.09	0.35	0.64	0.46	0.36	0.30	0.30
2011	0.08	0.32	0.69	0.31	0.34	0.32	0.32
2012	0.10	0.34	0.41	0.69	0.50	0.20	0.20
2013	0.19	0.32	0.45	0.55	0.54	0.23	0.23
2014	0.26	0.40	0.29	0.52	0.60	0.57	0.57
2015	0.16	0.35	0.35	0.56	0.52	0.65	0.65
2016	0.08	0.30	0.45	0.38	0.37	0.57	0.57
2017	0.10	0.33	0.29	0.28	0.30	0.48	0.48
2018	0.12	0.31	0.34	0.38	0.36	0.37	0.37
2019	0.10	0.34	0.38	0.37	0.38	0.38	0.38
2020	0.16	0.27	0.51	0.34	0.33	0.26	0.26
2021	0.14	0.26	0.33	0.41	0.30	0.33	0.33
2022	0.12	0.21	0.24	0.25	0.35	0.31	0.31

Table 7.7. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Stock number-at-age (start of year). Numbers in thousands.

Year	2	3	4	5	6	7	8
1984	24135	15395	10260	7270	4469	3244	4340
1985	29491	16225	10920	6633	4644	2937	3015
1986	28258	18606	10300	7523	4136	3340	3936
1987	24854	19742	12832	6777	4618	2304	2376
1988	26701	18880	12504	8208	4225	2769	2418
1989	28082	19440	11444	7327	5245	2503	1285
1990	32032	20731	11358	6739	3637	2800	2382
1991	35634	22209	12754	6070	3403	2366	2171
1992	35279	27904	14101	7248	3511	2020	1696
1993	24838	27508	18324	8079	3714	1050	1304
1994	26129	20670	17456	10037	3828	1814	1293
1995	23499	21166	13469	7421	4288	1591	1848
1996	29311	18172	13765	6141	3248	2172	2078

Year	2	3	4	5	6	7	8
1997	23704	23642	11515	7310	3328	1325	1668
1998	22576	17833	12756	5302	3701	1510	2270
1999	24362	16531	10856	5501	2604	2172	2341
2000	24942	19332	10094	5191	2348	1106	1161
2001	16894	17168	10819	4242	2279	1216	1146
2002	24656	12261	9325	5083	2149	1207	842
2003	24251	17365	6551	3746	1655	737	485
2004	16932	17878	9711	3800	2229	804	981
2005	17888	12076	11025	5656	2566	1388	1523
2006	18074	12403	7632	6420	2922	1379	3982
2007	17418	12991	7003	4293	3896	1664	2283
2008	18234	12065	6826	3849	2534	2324	3094
2009	33492	13480	6357	3432	2196	1401	2474
2010	24533	27584	8406	3628	1677	1087	1144
2011	20396	20216	17628	4031	2072	1057	1978
2012	13822	17013	13325	8010	2678	1333	3057
2013	13753	11268	10942	8001	3646	1465	3244
2014	17303	10245	7400	6308	4191	1920	1260
2015	17622	12073	6228	5013	3400	2070	1394
2016	16169	13537	7723	3979	2579	1835	2086
2017	16991	13542	9045	4437	2465	1609	2590
2018	15983	13955	8821	6093	3042	1654	3177
2019	11816	12810	9301	5653	3779	1910	2717
2020	10698	9653	8211	5750	3542	2333	4488
2021	8003	8255	6669	4466	3723	2303	3649
2022	8562	6309	5755	4323	2690	2500	4719

Table 7.8. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Summary.

Year	Recruits (in thousands)	SSB (in t)	Landings (in t)	Mean F (age 3–6)
1984	24135	12308	4038	0.31

Year	Recruits (in thousands)	SSB (in t)	Landings (in t)	Mean F (age 3–6)
1985	29491	13347	4251	0.31
1986	28258	14450	4805	0.37
1987	24854	15433	5086	0.37
1988	26701	15296	5382	0.40
1989	28082	14392	5845	0.50
1990	32032	14726	5916	0.46
1991	35634	14664	5569	0.42
1992	35279	15864	6550	0.61
1993	24838	16261	6420	0.53
1994	26129	15721	7229	0.65
1995	23499	14114	6205	0.58
1996	29311	13685	5854	0.55
1997	23704	13203	6259	0.62
1998	22576	13120	6027	0.55
1999	24362	12225	5249	0.63
2000	24942	11741	5760	0.63
2001	16894	10500	4836	0.57
2002	24656	9760	5486	0.83
2003	24251	9559	4108	0.49
2004	16932	11026	4002	0.37
2005	17888	11362	4539	0.47
2006	18074	11912	4793	0.45
2007	17418	10836	4363	0.47
2008	18234	10727	4299	0.52
2009	33492	10512	3650	0.51
2010	24533	12338	3966	0.45
2011	20396	14138	4632	0.41
2012	13822	13860	4321	0.49
2013	13753	13015	4235	0.46

Year	Recruits (in thousands)	SSB (in t)	Landings (in t)	Mean F (age 3–6)
2014	17303	10462	3928	0.45
2015	17622	10229	3644	0.44
2016	16169	10530	3232	0.38
2017	16991	11411	3244	0.30
2018	15983	12097	3517	0.35
2019	11816	11534	3400	0.37
2020	10698	10685	3219	0.36
2021	8003	10748	3069	0.32
2022	10038	9405	2306	0.26

Table 7.9: XSA tuning diagnostics.

```
## Fleet =  FR-SABLES
##
##  Catchability residuals:
##
##    1991  1992  1993  1994  1995
## 2 -0.24 -0.14 -0.39 -0.41 -0.09
## 3  0.10 -0.20  0.15 -0.12 -0.18
## 4  0.12 -0.28 -0.10  0.35  0.13
## 5  0.06 -0.18 -0.13  0.21 -0.02
## 6 -0.21  0.15 -0.40  0.02 -0.25
## 7 -0.06 -0.15 -0.26  0.19  0.08
##    1996  1997  1998  1999  2000
## 2 -0.21 -0.13 -0.04 -0.19  0.19
## 3 -0.03  0.20 -0.02 -0.43  0.38
## 4  0.00  0.00  0.43 -0.24  0.12
## 5 -0.14 -0.25  0.14  0.27 -0.11
## 6  0.23 -0.04 -0.41  0.43 -0.03
## 7  0.50  0.01  0.11  0.55  0.13
##    2001 2002  2003  2004  2005
## 2 -0.18 0.22 -0.13  0.30  0.49
## 3  0.06 0.25  0.01 -0.30 -0.18
## 4 -0.07 0.12 -0.31 -0.18 -0.15
## 5 -0.30 0.33 -0.19 -0.52  0.24
## 6 -0.25 0.33  0.04 -0.36  0.14
## 7 -0.18 0.05  0.06 -0.11  0.05
##    2006  2007 2008  2009 2010
## 2  0.83  0.27 0.15 -0.31   NA
## 3  0.01 -0.01 0.17  0.14   NA
## 4 -0.47  0.09 0.38  0.07   NA
## 5 -0.74  0.35 0.37  0.61   NA
## 6 -0.51  0.27 0.35  0.52   NA
## 7 -0.17  0.72 0.38  0.37   NA
##   2011 2012 2013 2014 2015 2016
## 2   NA   NA   NA   NA   NA   NA
## 3   NA   NA   NA   NA   NA   NA
## 4   NA   NA   NA   NA   NA   NA
## 5   NA   NA   NA   NA   NA   NA
## 6   NA   NA   NA   NA   NA   NA
## 7   NA   NA   NA   NA   NA   NA
##   2017
## 2   NA
## 3   NA
## 4   NA
## 5   NA
## 6   NA
## 7   NA
##
```

```
##
##  Mean log catchability and standard error of ages with
##  independant of year class strength and constant w.r.t time:
##
##                  2        3
## Mean log q -15.0623 -14.5069
## S.E. log q   0.3205   0.2010
##                  4        5
## Mean log q -14.4584 -14.6347
## S.E. log q   0.2413   0.3355
##                  6        7
## Mean log q -14.6250 -14.6250
## S.E. log q   0.3114   0.2981
##
##
##  Regression Statistics:
##
##   Model used? slope  Intercept
## 2 "No"        "6.07" "40.42"
## 3 "No"        "1.05" "14.74"
## 4 "No"        "0.89" "13.9"
## 5 "No"        "1.29" "16.36"
## 6 "No"        "1.5"  "17.95"
## 7 "No"        "0.73" "12.56"
##   RSquare Num Pts Reg s.e
## 2 "0.03"  "19"    "1.55"
## 3 "0.63"  "19"    "0.22"
## 4 "0.69"  "19"    "0.22"
## 5 "0.33"  "19"    "0.44"
## 6 "0.25"  "19"    "0.46"
## 7 "0.78"  "19"    "0.18"
##   Mean Q
## 2 "-15.06"
## 3 "-14.51"
## 4 "-14.46"
## 5 "-14.63"
## 6 "-14.62"
## 7 "-14.51"
##
##
##
##
## Fleet =  FR-ROCHELLE
##
##  Catchability residuals:
##
##    1991  1992  1993  1994  1995
## 2 -0.09 -0.19 -0.46 -0.40 -0.04
## 3  0.19 -0.05 -0.02 -0.22 -0.12
## 4  0.43  0.11 -0.23  0.28  0.29
## 5  0.44  0.16 -0.10  0.18  0.20
## 6  0.10  0.32 -0.27  0.10 -0.36
## 7  0.01  0.07 -0.02  0.00 -0.05
##    1996  1997  1998  1999  2000
## 2  0.32 -0.07  0.19 -0.03  0.18
## 3  0.05  0.10 -0.11 -0.50 -0.28
## 4 -0.16 -0.08  0.47 -0.27 -0.13
## 5 -0.37 -0.37  0.00  0.18 -0.19
## 6 -0.12 -0.02 -0.54  0.53 -0.29
## 7 -0.08 -0.09  0.03  0.23 -0.18
##    2001  2002  2003  2004  2005
## 2 -0.24  0.70  0.16  0.37  0.13
## 3 -0.09  0.18  0.23 -0.09 -0.38
## 4  0.13 -0.34 -0.08 -0.23 -0.21
## 5 -0.08 -0.08 -0.08 -0.49  0.33
## 6  0.06 -0.04  0.10 -0.22  0.38
## 7  0.16 -0.11 -0.25 -0.02  0.18
##    2006  2007 2008  2009 2010
## 2  0.01  0.07 0.21 -0.83   NA
## 3 -0.23  0.60 0.59  0.16   NA
## 4 -0.29 -0.15 0.40  0.03   NA
## 5 -0.29 -0.26 0.32  0.50   NA
## 6 -0.03 -0.23 0.16  0.37   NA
## 7 -0.03 -0.14 0.26  0.23   NA
##   2011 2012 2013 2014 2015 2016
## 2   NA   NA   NA   NA   NA   NA
## 3   NA   NA   NA   NA   NA   NA
```

```
## 4   NA   NA   NA   NA   NA   NA
## 5   NA   NA   NA   NA   NA   NA
## 6   NA   NA   NA   NA   NA   NA
## 7   NA   NA   NA   NA   NA   NA
##   2017
## 2   NA
## 3   NA
## 4   NA
## 5   NA
## 6   NA
## 7   NA
##
##
##  Mean log catchability and standard error of ages with
##  independant of year class strength and constant w.r.t time:
##
##                   2       3
## Mean log q -14.9966 -14.5482
## S.E. log q   0.3382   0.2875
##                   4       5
## Mean log q -14.7612 -15.1085
## S.E. log q   0.2644   0.2902
##                   6       7
## Mean log q -15.1617 -15.1617
## S.E. log q   0.2809   0.1458
##
##
##  Regression Statistics:
##
##   Model used? slope  Intercept
## 2 "No"        "1.99" "19.87"
## 3 "No"        "1.29" "15.95"
## 4 "No"        "0.86" "13.99"
## 5 "No"        "1"    "15.09"
## 6 "No"        "1.67" "19.95"
## 7 "No"        "0.83" "13.84"
##   RSquare Num Pts Reg s.e
## 2 "0.13"  "19"    "0.65"
## 3 "0.36"  "19"    "0.37"
## 4 "0.67"  "19"    "0.23"
## 5 "0.51"  "19"    "0.3"
## 6 "0.27"  "19"    "0.45"
## 7 "0.91"  "19"    "0.11"
##   Mean Q
## 2 "-15"
## 3 "-14.55"
## 4 "-14.76"
## 5 "-15.11"
## 6 "-15.16"
## 7 "-15.15"
##
##
##
##
## Fleet =  FR-BB-IN-Q4
##
##  Catchability residuals:
##
##    2000  2001  2002  2003 2004
## 3  0.39 -0.25  0.39  0.82 0.38
## 4  0.43 -0.49 -0.66  0.16 0.38
## 5  0.02 -0.41 -0.18 -0.79 0.44
## 6 -0.47 -0.05  0.56 -0.35 0.82
## 7 -0.18 -0.10  0.53  0.26 0.22
##    2005  2006  2007  2008  2009
## 3 -0.14  0.09  0.13  0.27 -0.02
## 4  0.15 -0.46  0.27  0.62 -0.31
## 5  0.19 -0.56  0.19  0.20 -0.01
## 6 -0.04  0.05  0.03  0.00  0.19
## 7 -0.15  0.45 -0.49 -0.20 -0.30
##    2010  2011 2012  2013  2014
## 3 -0.10 -0.38 0.26 -0.33  0.09
## 4  0.42 -0.08 0.52  0.11 -0.52
## 5  0.14 -0.10 0.79 -0.22 -0.27
## 6 -0.40 -0.16 0.05  0.38 -0.15
## 7 -0.76 -0.32 0.05  0.02 -0.56
##    2015  2016  2017  2018  2019
```

```
## 3 -0.21 -0.08  0.15 -0.88 -0.57
## 4 -0.29 -0.35 -0.21 -0.34 -0.03
## 5  0.09  0.06 -0.61 -0.04  0.13
## 6 -0.10 -0.02 -0.03  0.00 -0.10
## 7  0.13 -0.32  0.14 -0.04  0.24
##    2020  2021  2022
## 3 -0.40  0.33  0.04
## 4  0.27  0.35  0.06
## 5  0.11  0.55  0.28
## 6  0.03  0.03 -0.28
## 7 -0.06 -0.31  0.03
##
##
##  Mean log catchability and standard error of ages with
##  independant of year class strength and constant w.r.t time:
##
##                    3        4
## Mean log q -14.5828 -14.9328
## S.E. log q   0.3744   0.3766
##                    5        6
## Mean log q -15.1027 -15.0394
## S.E. log q   0.3702   0.2884
##                    7
## Mean log q -15.0394
## S.E. log q   0.3254
##
##
##  Regression Statistics:
##
##   Model used? slope  Intercept
## 3 "No"        "0.93" "14.23"
## 4 "No"        "0.92" "14.44"
## 5 "No"        "0.9"  "14.44"
## 6 "No"        "0.89" "14.25"
## 7 "No"        "1.19" "16.61"
##   RSquare Num Pts Reg s.e
## 3 "0.45"  "23"    "0.36"
## 4 "0.38"  "23"    "0.35"
## 5 "0.35"  "23"    "0.34"
## 6 "0.51"  "23"    "0.26"
## 7 "0.45"  "23"    "0.38"
##   Mean Q
## 3 "-14.58"
## 4 "-14.93"
## 5 "-15.1"
## 6 "-15.04"
## 7 "-15.11"
##
##
##
##
## Fleet =  FR-BB-OFF-Q2
##
##  Catchability residuals:
##
##    2000  2001 2002  2003  2004
## 2  0.42  0.45 0.89  0.93  0.44
## 3 -0.44 -0.15 0.20  0.16  0.18
## 4  0.34  0.22 0.13 -0.03 -0.07
## 5  0.70  0.43 0.77 -0.21 -0.94
## 6  0.69  1.10 1.33  0.37 -0.53
##    2005  2006  2007  2008  2009
## 2  0.40 -0.24  0.57  0.93 -1.68
## 3 -0.18 -0.17  0.79  0.42 -0.10
## 4 -0.02 -0.65 -0.35  0.07 -0.18
## 5  0.26 -0.57 -0.98  0.04 -0.07
## 6 -0.78  0.32 -0.02 -0.77 -0.31
##    2010  2011  2012 2013 2014
## 2 -1.43 -1.95  0.28   NA   NA
## 3  0.01 -0.72 -0.01   NA   NA
## 4  0.30  0.44 -0.19   NA   NA
## 5  0.37 -0.32  0.53   NA   NA
## 6 -1.26  0.19 -0.33   NA   NA
##   2015 2016 2017
## 2   NA   NA   NA
## 3   NA   NA   NA
## 4   NA   NA   NA
```

```
## 5   NA   NA   NA
## 6   NA   NA   NA
##
##
##  Mean log catchability and standard error of ages with
##  independant of year class strength and constant w.r.t time:
##
##                    2        3
## Mean log q -15.8950 -14.4916
## S.E. log q   1.0159   0.3769
##                    4        5
## Mean log q -14.7164 -15.3144
## S.E. log q   0.3013   0.5827
##                    6
## Mean log q -15.8277
## S.E. log q   0.7641
##
##
##  Regression Statistics:
##
##   Model used? slope   Intercept
## 2 "No"        "-1.35" "1.84"
## 3 "No"        "2.37"  "21.08"
## 4 "No"        "0.67"  "12.89"
## 5 "No"        "0.58"  "12.45"
## 6 "No"        "0.91"  "15.13"
##   RSquare Num Pts Reg s.e
## 2 "0.03"  "13"    "1.31"
## 3 "0.09"  "13"    "0.86"
## 4 "0.74"  "13"    "0.19"
## 5 "0.38"  "13"    "0.34"
## 6 "0.09"  "13"    "0.73"
##   Mean Q
## 2 "-15.9"
## 3 "-14.49"
## 4 "-14.72"
## 5 "-15.31"
## 6 "-15.83"
##
##
##
##
## Fleet =  FR-ORHAGO
##
##  Catchability residuals:
##
##    2007  2008  2009  2010  2011
## 2  0.10 -0.25  0.39 -0.20  0.04
## 3  0.14  0.22  0.29  0.06 -0.39
## 4  0.13  0.01 -0.19 -0.24 -0.53
## 5  0.35 -0.82 -0.47 -1.29 -1.35
## 6  0.25 -0.64 -0.64 -3.48 -0.94
## 7 -1.20 -0.37 -2.06 -0.90 -0.06
##    2012  2013  2014  2015  2016
## 2 -0.39 -0.36  0.46  0.19  0.18
## 3  0.10 -0.21 -0.04 -0.16  0.39
## 4  0.12  0.47 -0.09 -0.05 -0.04
## 5  0.36  0.30  0.47  0.47  0.59
## 6  0.17  0.98  1.06  0.95  0.53
## 7  0.10  0.39  0.89  0.83  0.49
##   2017  2018  2019  2020  2021
## 2 0.01  0.18 -0.01 -0.34 -0.01
## 3 0.27 -0.16 -0.10 -0.53  0.10
## 4 0.00  0.08  0.17 -0.01  0.16
## 5 0.11  0.48  0.31 -0.07  0.55
## 6 0.94  0.47  0.22 -0.02  0.16
## 7 0.94  0.99  0.42 -0.12  0.27
##   2022
## 2   NA
## 3   NA
## 4   NA
## 5   NA
## 6   NA
## 7   NA
##
##
##  Mean log catchability and standard error of ages with
```

```
##  independant of year class strength and constant w.r.t time:
##
##                  2       3
## Mean log q -9.0733 -9.4260
## S.E. log q  0.2641  0.2592
##                  4        5
## Mean log q -9.7507 -10.1254
## S.E. log q  0.2236   0.6632
##                   6        7
## Mean log q -10.4361 -10.4361
## S.E. log q   1.1449   0.8720
##
##
##  Regression Statistics:
##
##   Model used? slope  Intercept
## 2 "No"        "0.76" "9.22"
## 3 "No"        "0.95" "9.43"
## 4 "No"        "1.18" "9.87"
## 5 "No"        "0.43" "9.2"
## 6 "No"        "0.24" "8.58"
## 7 "No"        "0.48" "8.85"
##   RSquare Num Pts Reg s.e
## 2 "0.77"  "15"    "0.19"
## 3 "0.59"  "15"    "0.25"
## 4 "0.56"  "15"    "0.27"
## 5 "0.57"  "15"    "0.25"
## 6 "0.68"  "15"    "0.19"
## 7 "0.29"  "15"    "0.41"
##   Mean Q
## 2 "-9.07"
## 3 "-9.43"
## 4 "-9.75"
## 5 "-10.13"
## 6 "-10.44"
## 7 "-10.4"
##
##
##
##
```

Table 7.10. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Short-term forecasts input parameters.

Variable	Value	Notes
$F_{age\ 3–6}$ (2023)	0.26	Average selection pattern from 2020 to 2022, scaled to the F of 2022.
SSB (2024)	9405	Short-term forecast (STF); in tonnes.
$R_{age\ 2}$ (2023–2024)	10038	Geometric mean (2019–2021); in thousands.
Projected landings (2023)	2190	STF using an F 2023 assuming average exploitation pattern of 2022; in tonnes.
Projected discards (2023)	48	Computed using the average discard ratio (2.2%) over 2015–2022 but not used in the assessment; in tonnes.

Table 7.11. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Management options table. Annual catch scenarios (all weights are in tonnes).

Basis	Total catch* (2024)	Landings (2024)	Discards (2024)	$F_{3–6}$ Projected landings (2024)	SSB (2025)	% SSB change#	% TAC change##	% advice change###
ICES advice basis								
EU MAP^ :	2489	2435	54	0.29	9263	−1.5	−7.3	−7.3

$F = F_{MSY} \times SSB_{2024}/MSY\ B_{trigger}$								
EU MAP^ : $F = F_{MSY\ lower} \times SSB_{2024}/MSYB_{trigger}$	1454	1422	31	0.16	10278	9.3	−45.9	−7^^
Other scenarios								
MSY approach = F_{MSY}	2784	2724	60	0.33	8975	−4.6	3.7	3.7
F = 0	0	0	0	0	11708	24.5	−100	−100
F_{PA}	5935	5807	128	0.88	5910	−37.2	121	121
$SSB_{2025} = B_{lim}$	4192	4102	90	0.54	7600	−19.2	56.1	56.1
$SSB_{2025} = B_{pa} = MSY\ B_{trigger}$	1126	1102	24	0.12	10600	12.7	−58.1	−58.1
$SSB_{2025} = SSB_{2024}$	2344	2294	50	0.27	9405	0	−12.7	−12.7
$F = F_{2023}$	2261	2212	49	0.26	9487	0.9	−15.8	−15.8
Landings 2023 = landings from TAC of 2 685 t	2744	2685	59	0.32	9014	−4.2	2.2	2.2
Total catch equal to TAC_{2023}	2684	2626	58	0.32	9073	−3.5	0	0

*** Total catch is calculated based on projected landings and the assumed projected discard ratio (2.2%).**

 # SSB_{2025} relative to SSB_{2024}.

Total catch in 2024 relative to TAC in 2023 (2685 t)

Advice value for 2024 relative to advice value for 2023 (2685 t).

^ The EU multiannual plan (MAP; EU, 2019).

^^ Advice value for 2024 relative to the advice value for 2023 for the MAP $F_{MSY\ lower}$ (1563 t).

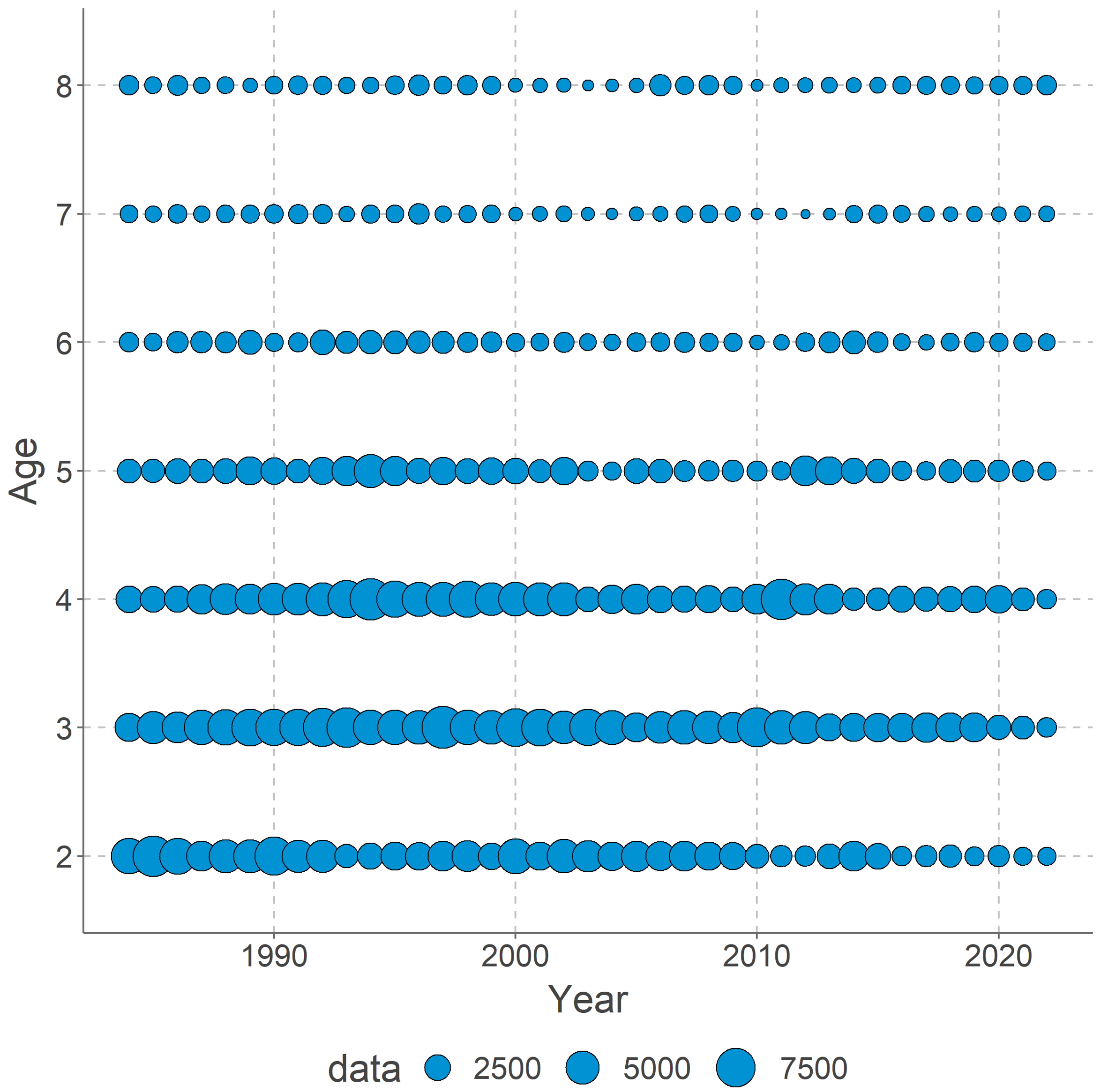

Figure 7.1. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Landings-at-age distributions.

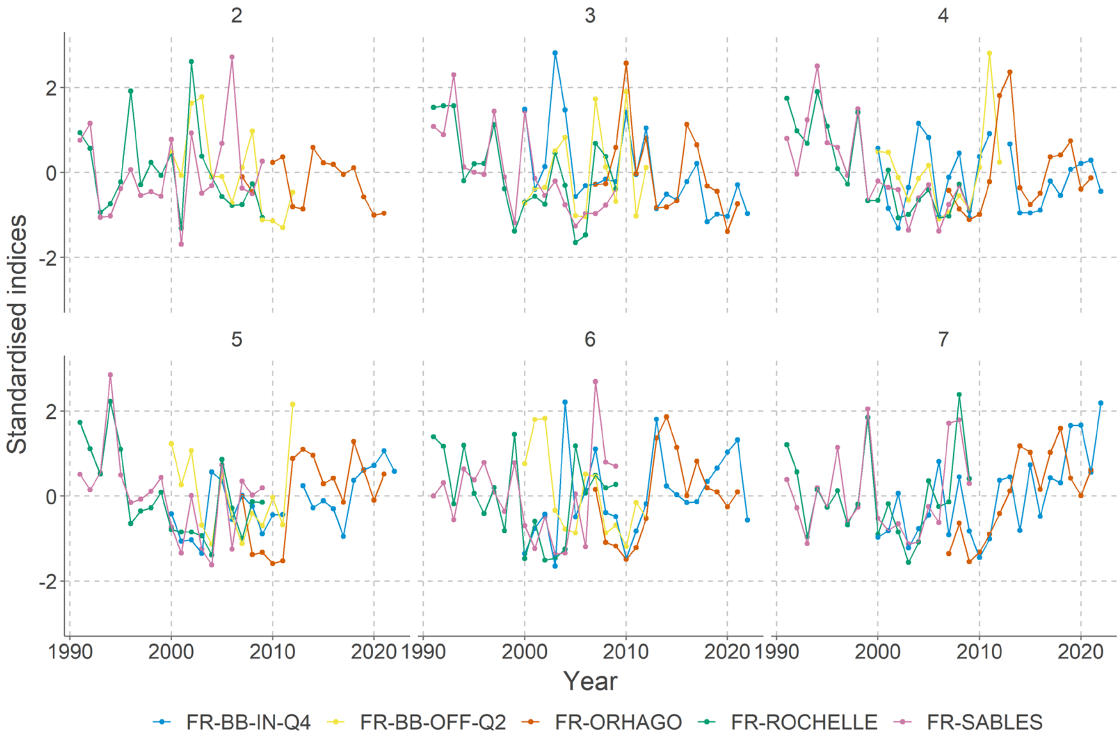

Figure 7.2. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Time-series of standardized indices per age class. Colours represent tuning fleets.

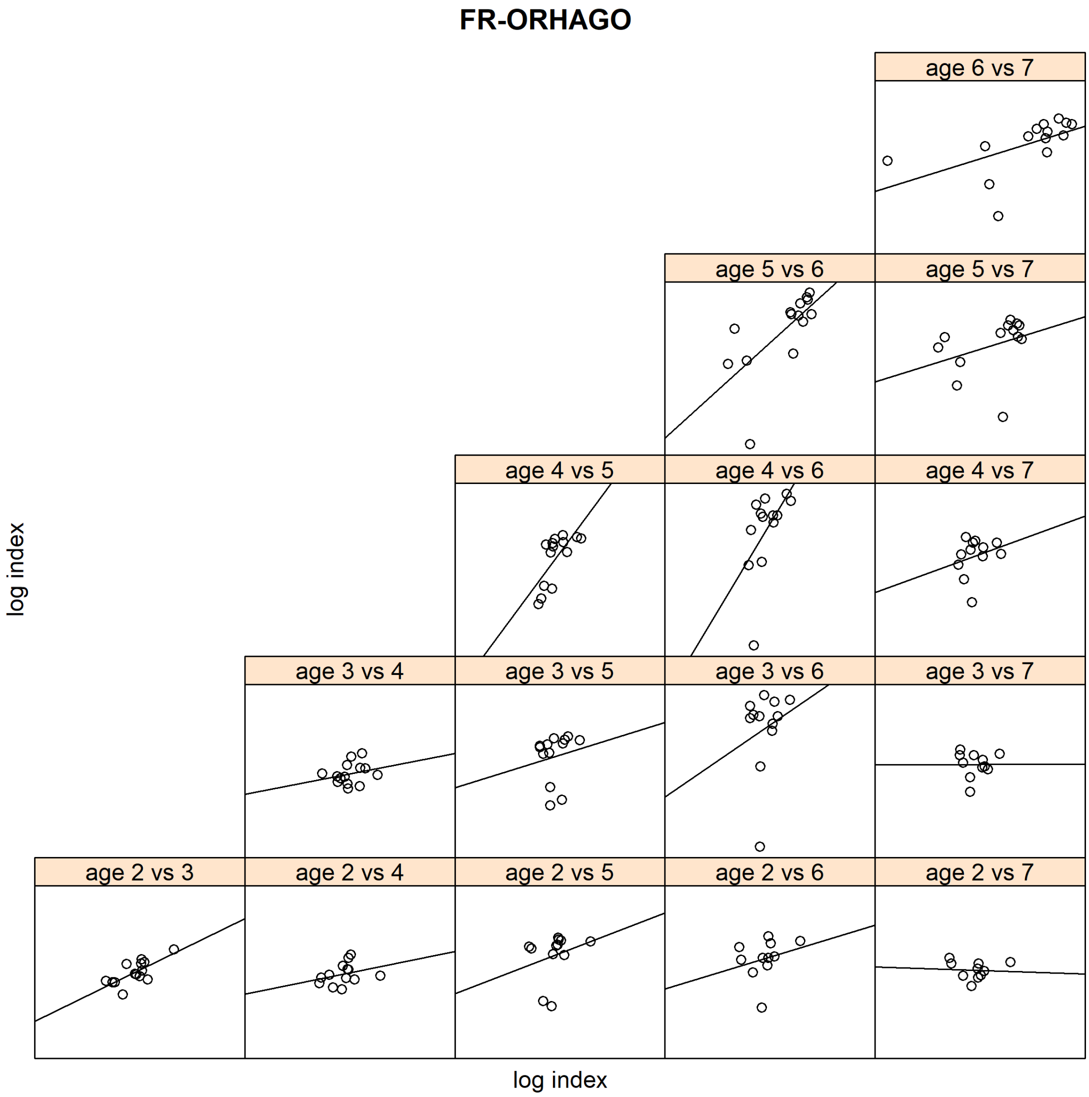

Figure 7.3. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b.Internal consistency of the ORHAGO (B1706) survey indices.

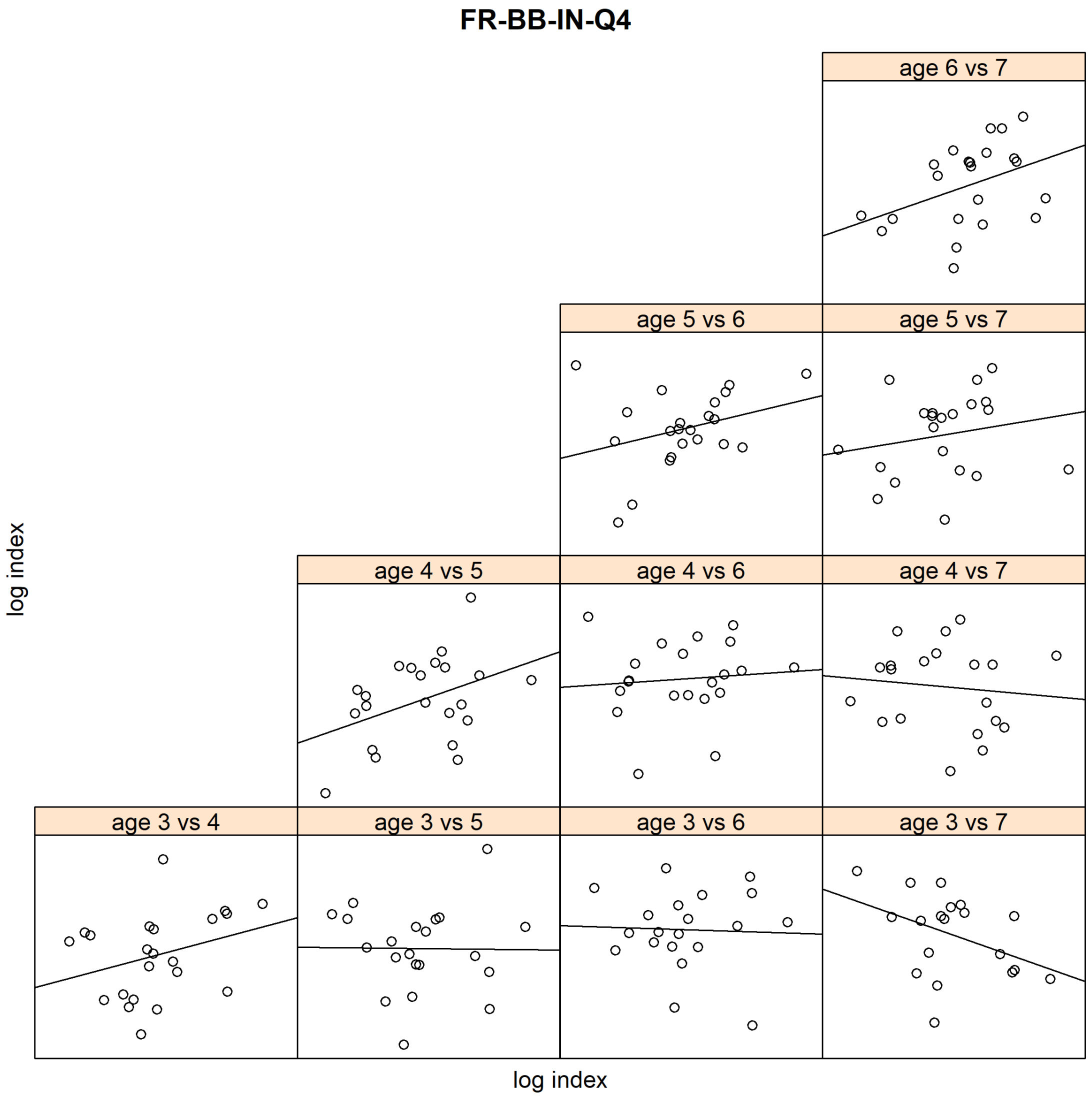

Figure 7.4. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Internal consistency of the Bay of Biscay inshore (FR-BB-IN-Q4) commercial tuning fleet.

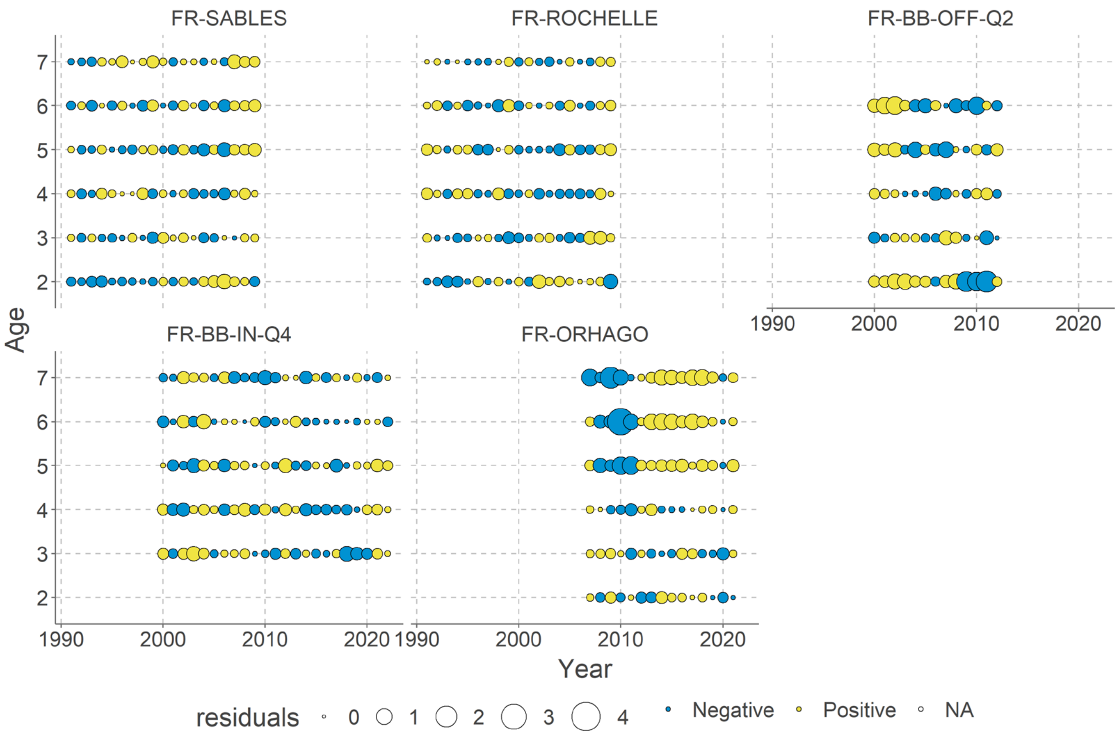

Figure 7.5. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. XSA assessment residuals (No Taper, mean q, s.e. shrink = 2.5, s.e. min = 2).

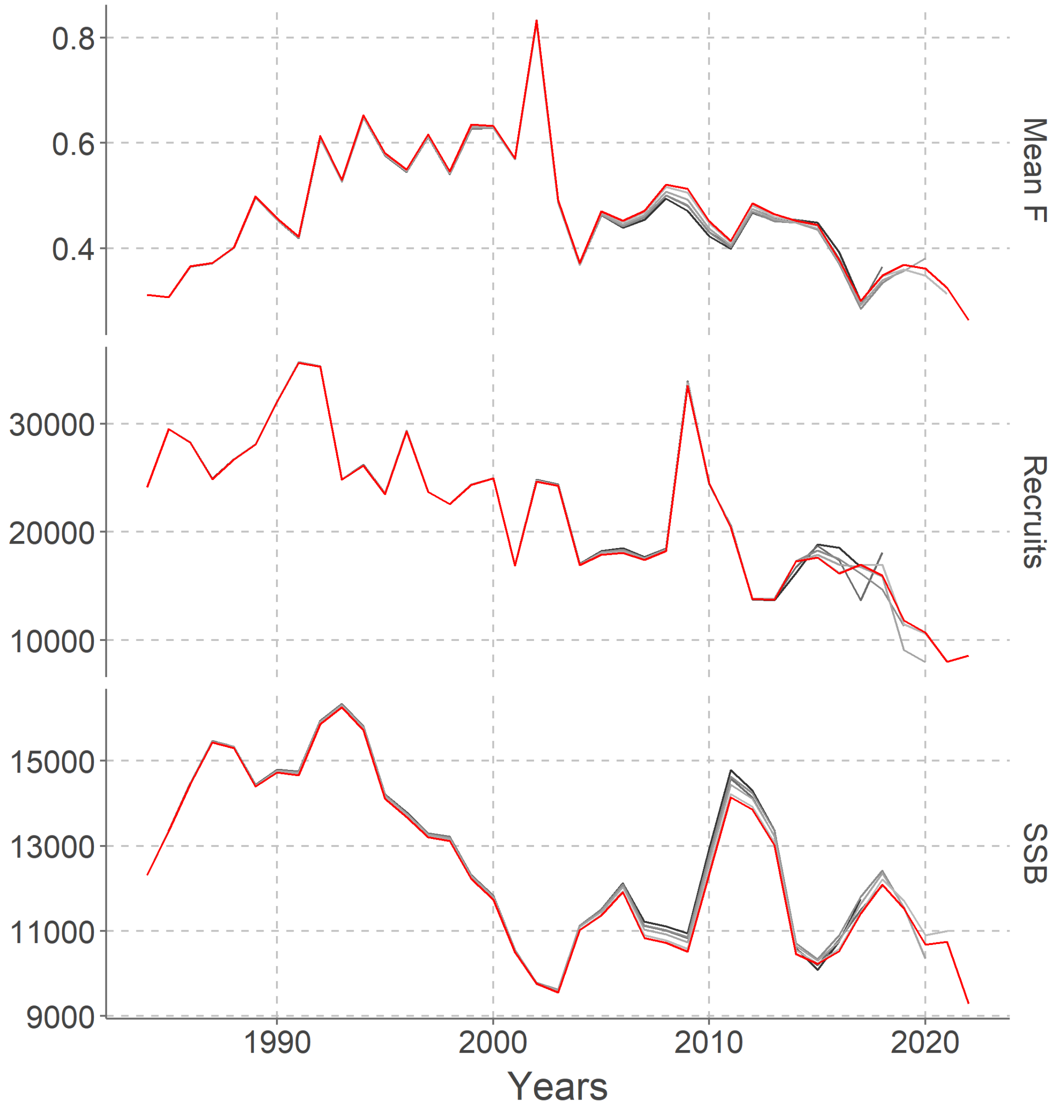

Figure 7.6. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Retrospective patterns (No taper, q indep. stock size all ages, q indep. of age > = 6, shr. = 1.5).

Figure 7.7. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Trends for $F_{3\text{-}6}$, recruitment$_{\text{age 2}}$, SSB and total catch data. Recruitment$_{\text{age 2}}$ is in thousands while SSB and total catch are in tonnes.

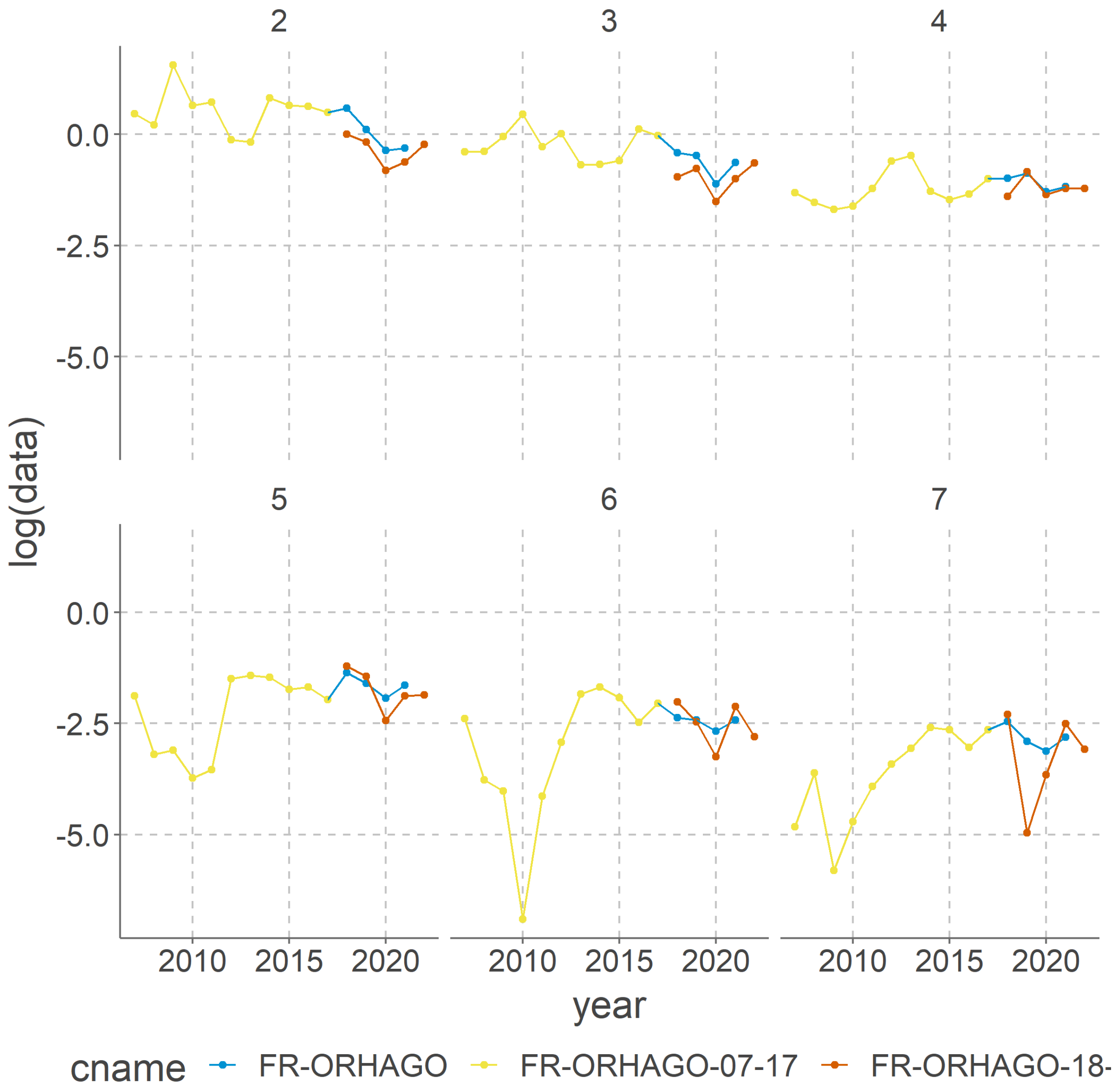

Figure 7.8. Time series comparisons of the standardized ORHAGO (B1706) survey index per age classes. Colours represent the different index. Blue ORHAGO index from 2007 to 2021 without 2022 data, Yellow ORHAGO index computed from 2007 to 2017 with all hauls sampled, Orange index computed from 2018 to 2022 using hauls only sampled in 2022. Before 2017, the blue and yellow lines have the same values.

8 Sole in Cantabrian Sea and Atlantic Iberian waters

sol.27.8c9a – *Solea solea* in divisions 8.c and 9.a

8.1 General biology

Common sole (*Solea solea*) spawning takes place in winter/early spring and varies with latitude starting earlier in the south (Vinagre, 2007). Larvae migrate to estuaries where juveniles concentrate until they reach approximately 2 years of age and move to deeper waters. In Portuguese waters, sole length at first maturity is estimated as 25 cm for males and 27 cm for females (Jardim *et al.,* 2011). Sole is a nocturnal predator and, therefore, more susceptible to be captured in the fisheries at night than in daytime. It feeds on polychaetes, molluscs and amphipods. *S. solea* is abundant in the Tagus estuary and uses this habitat as its nursery ground (Cabral and Costa, 1999).

Growth studies based on *S. solea* otoliths readings in the Portuguese coast indicate L_{inf} of 52.1 cm for females and 45.7 cm for males. The growth coefficient estimated for females (k = 0.23) is slightly higher than for males (k = 0.21) and t_0 was estimated at −0.11 and 1.57 for females and males, respectively (Teixeira and Cabral, 2010). Maximum length observed between 2004 and 2011 from the landings sampling program (PNAB-DCF) attained 60 cm. According to Vinagre (2007), *S. solea* off the Portuguese coast presents higher growth-rates compared with the northern European coasts.

8.2 Stock identity and possible assessment areas

There is no clear information to support the definition of the common sole stock for ICES subdivisions 8.c and 9.a.

8.3 Advice

ICES advises that when MSY approach is applied, catches should be no more than 209 t for each of the years 2024 and 2025 (ICES, 2023). The catch advice is 35% lower than the previous advice (320 t; ICES, 2021b). The change in advice is due to the decline in the biomass index and the low biomass safeguard.

8.4 Management regulations (TACs, minimum landing size)

The minimum conservation reference size (MCRS) of sole is 24 cm (EU, 2019). There are other regulations regarding the mesh size for trammel and trawl nets, fishing grounds and vessels size (EU, 2020). Sole is under the Landing Obligation in divisions 8.a, 8.b, 8.d, and 8.e (all bottom-trawls, mesh sizes between 70 mm and 100 mm, all beam trawls, mesh sizes between 70 mm and 100 mm and all trammel and gillnets, mesh size larger or equal to 100 mm) and in Division 9.a (all trammelnets and gillnets, mesh size larger or equal to 100 mm) since 2013 (EU, 2013). In Portugal, all sole catches from all gears and mesh sizes are under the Landing Obligation (EU, 2013) which is more restrictive than required by European regulations.

Management of all sole species is made under a combined species division which prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. For the period 2011–2022, *S. solea* represented on average 55% of the total catches of sole species, while *S. senegalensis* represented on average 26%, *Pegusa lascaris* 26%, and *Solea* spp. only <1% (Table 8.1).

8.5 Fisheries data

Table 8.2 presents common sole catches for divisions 8.c and 9.a., as well as landings for the other sole species (*S. senegalensis, P. lascaris,* and *Solea* spp.). Discards are considered negligible (< 1%) and therefore, from there on, the words catch or landings can be used indistinctly.

There is evidence of misidentification problems in Portuguese official statistics regarding sole species (i.e. *S. solea*, *S. senegalensis,* and *P. lascaris*) (Dinis *et al*., 2020). During the WKWEST benchmark (ICES, 2021a), using data from the Data Collection Framework (DCF) sampling program, Portuguese catches were proportionally divided by sole species applying the species weight proportion to the total weight of *Soleidae* in each year, landing port, and semester and using a simple random sampling estimator, following Figueiredo *et al*. (2020). Details on data available and catch estimation procedures can be found in Annex 2 of the working document Pennino *et al*. (2021 in ICES, 2021a). At that moment, the new Portuguese catches are considered reliable.

Reviewed catches reported in InterCatch are now available from 2009 to 2022 by Spain and France and from 2011 to 2022 by Portugal (Figure 8.1). Information on discards indicates that discarding can be considered negligible (< 1%) (Figure 8.2). Presently, only damaged specimens are discarded, while specimens under the MCRS are landed under the landing obligation (in negligible numbers).

The majority of catches are from ICES Division 9.a (Figure 8.3). The two main fleets that target this stock are the polyvalent fleet from Portugal (i.e., "MIS_MIS_0_0_0") and the trammel net fleet from Spain (i.e., "GRT_DEF_60-79_0_0") (Figure 8.4). The distribution of the catches is almost homogenous along the year in Portugal and Spain, as well as for the main fleets.

In InterCatch, data on length-frequency distribution (LFD) are available for the years 2011–2022 (Figure 8.5). The majority of the data are from the polyvalent fleet (i.e. *métier* "MIS_MIS_0_0_0") from Portugal and the LFD seem to be homogeneous in the last years. Market sampling in Portuguese ports in 2020 was affected by the COVID-19 pandemic, resulting in the sampling suspension during the period March-June and resumption after that. In order to overcome the decrease in the amount of data collected by the National sampling program PNAB/DCF, samples collected under the Project "Pequena Pesca na Costa Ocidental Portuguesa - PPCENTRO" (ref: MAR-01.03.02-FEAMP-0007) were also used to estimate landings by species and LFD. This information was also used for the year 2021 (ICES, 2021a; b).

For the WKWEST benchmark (ICES, 2021a) an official data call was issued for this stock to acquire all available data, not only for the common sole (*S. solea*) but also for the other sole species, i.e. *S. senegalensis, P. lascaris,* and *Solea* spp. (Figure 8.6) considering the misidentification problems identified in official statistics.

Since the benchmark, data on catches for each of these species are reported and now Spanish landings of *S. senegalensis, P. lascaris* and *Solea* spp. are available for the period 2009–2022, while from Portugal for 2011 to 2022. No French data on these species are available.

For Portugal, catches of *S. solea*, as well as those of *S. senegalensis, P. lascaris* and *Solea* spp. were proportionally divided applying the species weight proportion to the total weight of *Soleidae* for each year, landing port, and semester and using a simple random sampling estimator, following Figueiredo *et al*. (2020) and was applied for the first time during the WKWEST workshop (ICES, 2021a) and since the WGBIE meeting in 2021 (ICES, 2021c).

8.5.1 Biomass indices

Two biomass indices are available for this stock. A standardized commercial LPUE from Portugal and a standardized biomass index from the Spanish IBTS-Q4 bottom-trawl survey (G2784). Both indices were presented and accepted during the WKWEST (ICES, 2021a) and was consequently used in the WGBIE assessment of this stock since then (ICES, 2021c).

8.5.1.1 Standardized biomass index from the Spanish IBTS-Q4 bottom trawl survey (G2784)

Common sole data were collected during the Spanish IBTS-Q4 bottom trawl survey (G2784) performed by the Instituto Español de Oceanografía (IEO) in autumn (September and October) between 2000 and 2022. Surveys were conducted on the northern continental shelf of the Iberian Peninsula (ICES divisions 8.c and the northern part of 9.a) which has a total surface area of almost 18 000 km^2. Surveys were performed using a stratified sampling design based on depth with three depth strata: 70–120 m, 121–200 m, and 201–500 m. Sampling stations consisted of 30 min trawling hauls located within each stratum at the same fixed positions every year. The gear used is the baka 44/60 and the survey follows the protocol of the International Bottom Trawl Survey Working Group (IBTSWG) of ICES (ICES, 2017a).

However, the common sole is a species with a biological bathymetric range between 0 and 200 meters in the Iberian Atlantic waters. The Spanish IBTS-Q4 (G2784) only covers partially the common sole bathymetric range and the resulting abundance index is probably underestimated. For this reason and with the aim of correcting this sampling bias, a hurdle Bayesian spatio-temporal was applied to this dataset (Pennino et al., 2022).

Two response variables were analysed in order to characterize the spatio-temporal behaviour of common sole individuals. Firstly, a presence/absence variable was considered to measure the probability of the species occurrence. Secondly, the weight per haul (kg) was used as an indicator of the conditional-to-presence abundance of the species.

As an environmental variable, we used depth. Bathymetry values were retrieved from the European Marine Observation and Data Network (EMODnet, http://www.emodnet.eu/) with a spatial resolution of 0.02 x 0.02 decimal degrees (20 m).

Models were fitted using the integrated nested Laplace approximation approach INLA (Rue *et al*., 2009) in the R software (R Core Team, 2021). The spatial component was modelled using the spatial partial differential equations (SPDE) module (Lindgren *et al*., 2011) of INLA and implementing a multivariate Gaussian distribution with zero mean and a Matérn covariance matrix (Muñoz *et al*., 2013).

As spatio-temporal structure, we used the progressive one (Paradinas *et al*., 2017; 2020), which contains an autoregressive ϱ parameter that controls the degree of autocorrelation between consecutive years. This ϱ parameter is bounded to [0, 1], where parameter values close to 0 represent more opportunistic behaviours and parameter values close to 1 represent more persistent distributions over time. In addition, an extra-temporal effect g(t) was added using a second-order random walk (RW2) before allowing non-linear effects. In the presence of bathymetric and spatial autocorrelation terms, g(t) can be regarded as a spatially standardized stock size temporal trend.

Occurrence (Y_{st}) was modelled using a Bernoulli distribution and conditional-to-presence abundance (Z_{st}) using a gamma distribution, which is a probability distribution that captures the overdispersion of continuous data. The means of both variables were modelled through the logit and log link functions respectively to the bathymetric and spatio-temporal effects as:

$$Y_{st} \sim Ber(\pi_{st}) \quad (1)$$

$$Z_{st} \sim Gamma(\mu_{st}, \phi)$$

$$logit(\pi_{st}) = \alpha(Y) + f(ds) + g(t) + U_{st}(Y)$$

$$log(\mu_{st}) = \alpha(Z) + \theta\, f(ds) + \eta\, g(t) + U_{st}(Z)$$

where π_{st} represents the probability of occurrence at location *s* at time *t* and μ_{st} and ϕ are the mean and dispersion of common sole conditional-to-presence abundance. The linear predictors, which contain the effects that link the parameters π_{st} and μ_{st}, include: $\alpha(Y)$ and $\alpha(Z)$, terms that represent the intercepts of each variable respectively; ds corresponds to the depth at location s, being f(ds) the bathymetric effect modelled as a second-order random walk (RW2) smooth function parameterized as unknown values f = (f0,… fi-1)t at *i* = 14 equidistant values of ds, with hyperparameter σ representing the variance of the f(ds) model. In the same way, g(t) corresponds to the temporal trend fitted through a RW2 effect over the years. The terms f(ds) and g(t) are shared between both predictors and multiplied by θ and η in the conditional-to-presence abundance model to allow for differences in scales between both predictors (i.e. the logit transformed probability and the logarithm of the conditional-to-presence abundance); $U_{st}(Y)$ and $U_{st}(Z)$ refer to the progressive spatio-temporal structures of common sole occurrence and conditional-to-presence abundance respectively.

Following the Bayesian approach, penalised complexity priors (i.e. PC priors, weak informative priors; Simpson *et al.*, 2017) were assigned so that the probability of the spatial effect range being smaller than 0.5 degrees was 0.05, and the probability of the spatial effect variance being larger than 0.5 was 0.5. PC priors were also used for the variance of the bathymetric and the temporal trend RW2 effects. Specifically, the size of these effects was constrained by setting a 0.05 probability that sigma was greater than 0.5 and 1 respectively. Sensitivity analysis for the selection of priors was performed by testing different priors and verifying that the posterior distributions were consistent and concentrated comfortably within the support of the priors.

From this analysis, we obtained a new spatio-temporal abundance index for the period 2001-2022 (Figure 8.7).

8.5.1.2 Landings-per-unit-effort (LPUE) from Portugal

Portuguese LPUE estimates rely on fishery-dependent data derived from the polyvalent fleet and are based on the estimated *S. solea* landed weight by fishing trip. The analysis was restricted to the most important landing ports in terms of *S. solea* landed weight: Viana do Castelo, Matosinhos, Aveiro, Peniche and Setúbal. The Portuguese polyvalent fleet segment comprises multi-gear/multispecies fisheries, usually licensed to operate with more than one fishing gear (most commonly gill and trammelnets, longlines and traps), that can be deployed in the same trip, targeting different species. The period considered in the present study extends from 2011 to 2022.

The dataset was subset to trips with positive landings of the species. The LPUE standardization procedure was done via the adjustment of a General Linear Model (GLM) to the matrix data, where the response variable was the *S. solea* landed weight by trip (unit effort) and was fitted with a Gamma distribution. Several variables were evaluated as a candidate to be included in the model: region, landing port, year, semester, quarter, month and vessel size group (< 9 m and > 9 m).

All the explanatory variables were considered categorical variables. The function "*bestglm*" implemented in R software, used to select the best subset of explanatory variables (McLeod and Xu, 2010), is based on a variety of information criteria and their comparison following a simple exhaustive search algorithm (Morgan and Tatar, 1972). The diagnostic plots, distribution of residuals and the quantile-quantile (Q-Q) plots, were used to assess model fitting. Changes in deviance explained by the selected model and the proportions of deviance explained to the total explained deviance were determined and used as indicative of r^2. Finally, annual estimates of LPUE and the corresponding standard error were determined using estimated marginal means with the R package "*emmeans*" (Lenth, 2016; 2020).

The final model explained 86% of the variability and included as explanatory variables the year, the month, the landing port and the vessel size. The final LPUE index is presented in Figure 8.8. Finally, it is worth mentioning that sensitivity tests were carried out on this dataset to assess the sensibility of the model to a possible increase or reduction of the weight per trip by 25% for data from 2022. Results highlighted that the model performed well and consequently consistent outputs were obtained with the original dataset.

8.6 Biological sampling

Existing biological sampling is based on samples from commercial vessel landings.

8.6.1 Population biology parameters and a summary of other research

S. solea maturity ogives by sex, length-weight relationship, sex-ratio by length are based on port sampling and are available from 2012 for Division 9.a (Jardim, *et al.*, 2011).

8.7 Assessment

8.7.1 Length-based indicators (LBI) method

The assessment of this stock is provided using the Length Based Indicators (LBI; ICES 2017b) method, as approved during the recent benchmark (ICES, 2021). Length-based indicators are calculated from LFDs obtained from the catches or landings which are then compared to appropriate reference levels derived from life-history parameters. These indicators are related to conservation, optimal yield and length distribution relative to expectations under maximum sustainable yield (MSY) and, thus, can provide an overall perception of the stock status (ICES, 2018).

For the LBI implementation, life-history parameters considered were:

- M/K = 1.41, derived from M = 0.31 (from Cerim *et al.*, 2020) and K = 0.22 (assuming the mean value of both sexes with K = 0.23 for females and K = 0.21 for males from Teixeira and Cabral (2010)).
- L_∞ = 48.9 cm (corresponding to the mean of females L_∞ = 52.1 cm and males L_∞ = 45.7 cm, from Teixeira and Cabral (2010)).
- L_{mat} or L_{50} = 26 cm (the mean L_{50} was computed with males L_{50} = 25 cm and females L_{50} = 27 cm from Jardim *et al.* (2011)).
- Length–weight relationship parameters a = 0.00759 and b = 3.06 (Bayesian length-weight model based on LWR estimates for this species (Fröese *et al.*, 2014)).

The LBI method (ICES, 2017b) was adjusted using the above values and defined as the reference model. A sensitivity analysis of the parameters L_∞, M/K and $L_{50\%}$ (around the literature/reference values) was also carried out overestimating and underestimating them by 5 and 10%.

From the reference model, we can conclude that the stock is exploited at the MSY level and the optimal yield is attained (Table 8.3 and Figure 8.9). Immature individuals are well preserved whereas the proportion of mega-spawners is low, although it has been increased in the last years.

Finally, the sensitivity analysis shows that (Figure 8.10):

- L_{∞}: overestimation of this parameter leads to a decrease in the proportion of mega-spawners and also affects the MSY indicator, although this indicator is red for some years it is not worrisome since its values are close to 1. Underestimation leads to the opposite situation, the proportion of mega-spawners increases attaining values above the threshold of 0.3.
- M/K: the conclusions are similar to the ones derived from the reference model (although under overestimation the proportion of mega-spawners increase and is larger or close to the threshold of 0.3).
- L_{50}: overestimation leads to a decrease in the values of the indicators related to the conservation of immatures.

8.7.2 Harvest control rule for length-based approaches

During the WKWEST benchmark in 2021 (ICES, 2021a), it was decided that the LBI (L_{mean} / $L_{F=M}$) was best suited to reflect the status of the stock. Using this method as basis, the ICES framework for category 3 stocks (ICES, 2023) is applied where the '*rfb*' rule (Method 2.1 in ICES, 2022) is used to provide the MSY advice (Annex III of WKLIFE VIII in ICES, 2020). As a stock biomass index, it is used as a weighted sum of the Portuguese LPUE and the Spanish Bayesian survey index with weights varying by year according to the percentage of catches of each of the countries (i.e. Spain and Portugal). In this setting, the two indices are standardized before their application (for details on the combined index for the period 2011-2022, see Table 8.4):

Indexyear = ½ *[S-BayesianIndexyear/mean(S-BayesianIndex) + P-LPUEyear/(mean(P-LPUE)]

The catch rule is defined as:

$$A_{y+1}=m*A_y*r*f*b,$$

where the advised catch for next year A_{y+1} is based on the most recent catch advice (A_{2023} = 320 t) adjusted by the following components:

- r: The rate of change in the index, based on the average of the two most recent years of data (y−2 to y−1) relative to the average of the three years prior to the most recent two (y−3 to y−5), and termed the "2-over-3" rule (r = 0.86 / 1.01 = 0.85).
- f: The ratio of the mean length in the observed catch that is above the length of first capture relative to the target reference length (mean length/target reference length). The target reference length is $L_{F=M}=(1-a)*L_c+a*L_{inf}$, being a=1/(2*(M/k)+1) and L_c the length at 50% of modal abundance. Note that the "mean length" (numerator of the ratio) is derived from LBI estimate of L_{mean} (mean length of individuals > L_c) in the year y-1. $L_{F=M}$ value is also equal to the LBI estimate for year y-1 (f = 34.52 / 33.10 = 1.04)
- b: Adjustment to reduce catch when the most recent index data I_{y-1} is less than $I_{trigger}=1.4*I_{loss}$ such that b is set equal to $I_{y-1}/I_{trigger}$. I_{loss} is generally defined as the lowest observed index value for that stock (minimum of the hold time series index). For advice in 2023, the lowest observed index value was 2011 (0.78), hence $I_{trigger}$= 1.4 * 0.78 = 1.09; I_{2022} = 0.89; b = 0.82.

m: Multiplier applied to the harvest control rule to maintain the probability of the biomass declining below B_{lim} to less than 5%. May range from 0 to 1.0. Medium-lived stocks with k between 0.20 and 0.32 (in our case, K=0.22) should apply a multiplier of 0.90 to next year's estimated catch.

$$A_{2024,\,2025} = 0.9 * 320 * 0.85 * 1.04 * 0.82 = 209 \text{ t},$$

This catch advice for each of the years 2024 and 2025 is 35% lower than that provided in 2021 for each of the years for 2022 and 2023 (ICES, 2021c).

8.7.3 Other indicators

Although in the WKWEST benchmark (ICES, 2021a) it was advised that the LBI is the preferred method for this stock, the LBSPR and MLZ (ICES, 2015) were also computed to check if all the data-poor methods agree on the stock status. However, results of the LBI, LBSPR and MLZ should be taken with caution as not all the assumptions of these methods are fully covered by this stock. ICES (2015), on the other hand, considers that LBSPR and MLZ indicators are preferred over LBI.

Length-based spawning potential ratio (LBSPR)

The values of the life-history parameters derived from a literature review are the following ones:

- M = 0.31 (by Cerim *et al.*, 2020), K = 0.22 (from Teixeira and Cabral, 2010, assuming the mean value of both sexes, as mentioned for LBI method) and consequently M/K = 1.41.
- L_∞ = 48.9 cm (see LBI method).
- L_{50} = 26 cm (see LBI method).
- L_{95} = 27.5 cm (derived from Bay of Biscay sole, i.e. sol.27.8ab Stock Annex).

The LFDs are the same as those used for the LBI method (ICES, 2017b).

The SPR values for this stock vary from a minimum of 0.28 in 2015 to a maximum of 0.44 in 2022 (Figure 8.11). The SPR value for 2022 is 0.44. Overall, the SPR trend is increasing and within the recommended range of 0.30–0.40.

Mean length-based mortality estimators (MLZ)

The Then *et al.* (2018) MLZ method was applied for this stock. Then *et al.* (2018) developed a new formulation of the Gedamke-Hoenig estimator (Gedamke and Hoenig, 2006), which uses additional information from a time-series of fishing effort to estimate the catchability coefficient q and the natural mortality rate (M) and, thus, obtaining a year-specific total (Z) and fishing mortality (F) rates.

The values of the life-history parameters derived from a literature review are the following:

- K = 0.22 (see LBI method).
- L_∞ = 48.9 cm (see LBI method).

The effort time-series was derived from the ratio of the catch and the Portuguese commercial LPUE series. It is worth to note that this effort time-series only covers Portugal and, thus, it is not representative of the total effort applied to this stock.

The output from the model indicates that the F estimates range from a maximum of 0.21 at the beginning of the time-series (2012) to a minimum of 0.11 in 2022 (Figure 8.12). Overall, the F time-series shows a decreasing pattern.

In addition, the Yield-Per-Recruit (YPR) estimations produce a F_{max} value of 1.04 and a $F_{0.1}$ value of 0.32 (Figure 8.13).

8.8 General problems

S. solea (SOL) is officially reported to ICES from Spain and France to WGBIE through InterCatch by Division since 2009 by Spain and since 2011 by Portugal. For the other *Soleidae* species distributed in 8.c and 9.a, namely *S. senegalensis*, *P. lascaris* and *Solea* spp., the information is not officially reported to ICES but was obtained as a data call requirement for the WKWEST benchmark of the *S. solea* in 2021 (ICES, 2021a). The advice is provided for *S. solea* while for the others species, the reported landings for the period 2011 to 2020 were revised during the WKWEST benchmark (ICES, 2021a).

8.9 References

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8.10 Tables and figures

Table 8. 1. Percentage of *S. Solea*, *S. senegalensis*, *P. lascaris* and *Solea spp.* in the total landed weight of sole species from 2009–2022.

Year	*S. solea*	*S. senegalensis*	*P. lascaris*	*Solea* spp.
2009*	100	0	0	0
2010*	100	0	0	0
2011	48	28	22	2
2012	47	25	26	2
2013	52	20	26	2
2014	53	28	18	1
2015	66	20	13	1
2016	69	18	13	0
2017	65	20	14	1
2018	62	25	13	1
2019	54	25	21	0
2020	50	29	21	0
2021	49	26	25	0
2022	46	22	32	0

Table 8. 2. Catches (in tonnes) of *S. Solea, S. senegalensis, P. lascaris* and *Solea* spp. from 2009–2022.

Year	*S. solea*	*S. senegalensis*	*P. lascaris*	*Solea* spp.	Total catch
2009*	190				190
2010*	236				247
2011	447	261	206	14	928
2012	354	191	200	14	759
2013	448	171	219	17	855
2014	456	243	156	10	867
2015	521	161	101	5	787
2016	485	126	94	2	707
2017	491	147	107	5	751
2018	430	171	92	5	698

Year	*S. solea*	*S. senegalensis*	*P. lascaris*	*Solea* spp.	Total catch
2019	399	186	159	1	745
2020	430	248	183	1	864
2021	372	199	188	2	760
2022	301	144	208	2	654

*** No Portuguese data available in 2009 and 2010.**

Table 8.3. Sole (*S. solea*) in divisions 8c and 9a. Traffic light indicator table for the LBI analysis.

Year	Conservation				Optimizing Yield	MSY
	L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{max5\%}/L_{\infty}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
2011	1.10	1.10	0.94	0.13	1.00	0.99
2012	0.83	1.02	0.90	0.17	0.96	1.12
2013	1.02	1.10	0.89	0.14	0.99	1.01
2014	1.02	1.10	0.91	0.15	0.99	1.02
2015	1.06	1.10	0.88	0.12	0.98	0.98
2016	0.87	0.98	0.93	0.17	0.95	1.08
2017	1.10	1.13	0.91	0.15	1.02	1.00
2018	1.02	1.10	0.93	0.18	1.00	1.03
2019	1.13	1.17	0.94	0.23	1.05	1.01
2020	1.06	1.10	0.89	0.20	1.03	1.03
2021	1.10	1.13	0.93	0.18	1.03	1.01
2022	1.06	1.17	0.94	0.24	1.04	1.04

Table 8.4. Sole (*S. solea*) in divisions 8c and 9a. Combined stock biomass index from commercial Portuguese LPUE and the Spanish North bottom trawl survey (IBTS Q4 [G2784]) for the period 2011-2022.

Year	Combined biomass index
2011	0.78
2012	0.79
2013	1.21
2014	1.10
2015	1.17
2016	1.15
2017	1.12

Year	Combined biomass index
2018	1.05
2019	1.01
2020	0.96
2021	0.83
2022	0.89

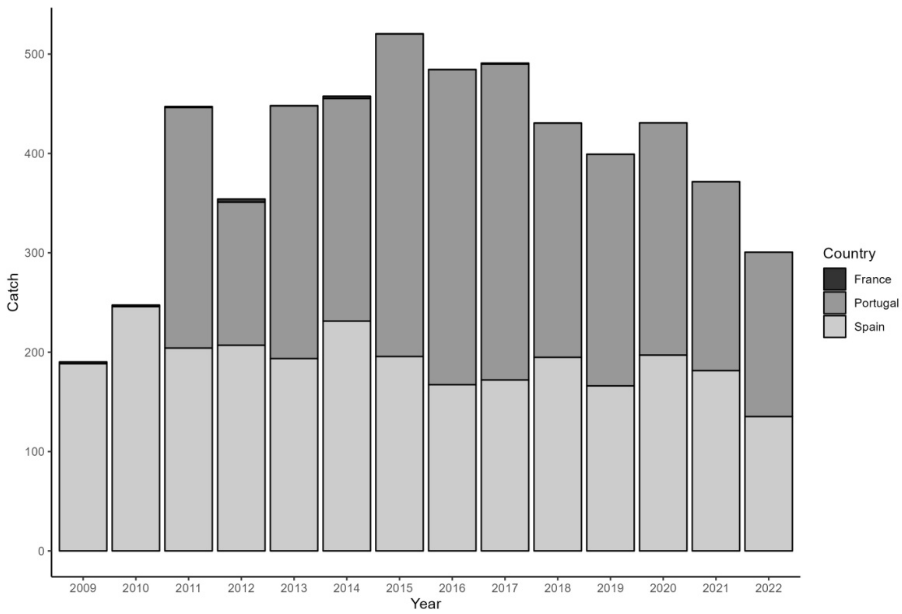

Figure 8.1. Sole (*S. solea*) in divisions 8c and 9a. Catches (in tonnes) by country from 2009 to 2022. Source: InterCatch. Note that in 2009–2010 no Portuguese data were available.

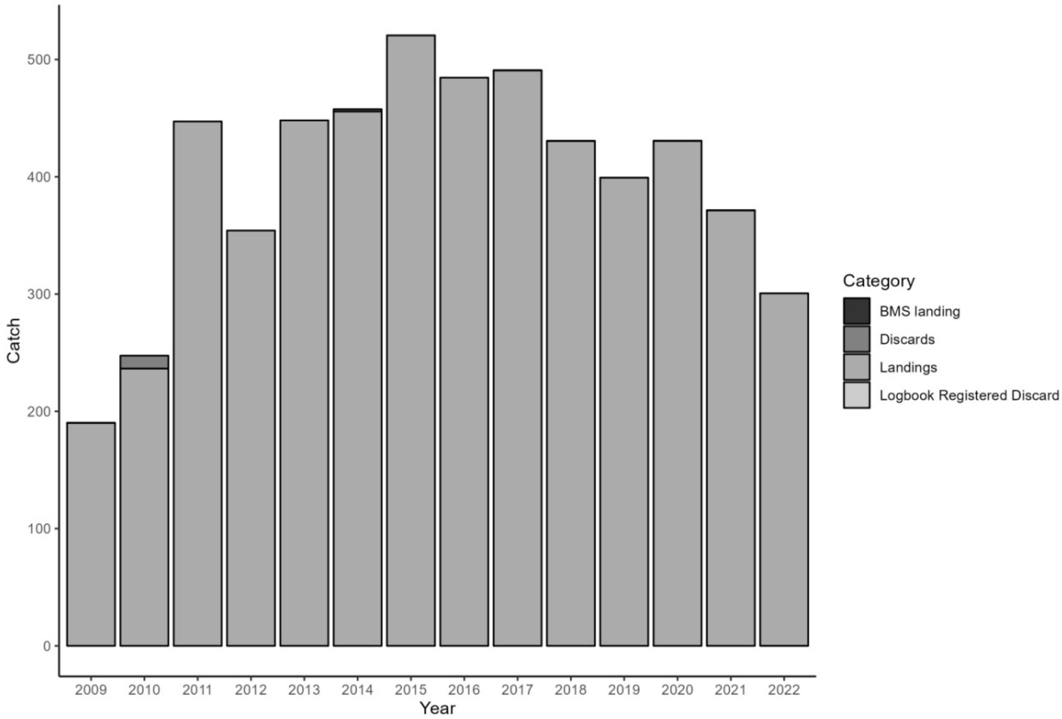

Figure 8.2. Sole (*S. solea*) in divisions 8c and 9a. Catches (in tonnes) by category (landings, discards, and BMS landing) in the ICES divisions 8.c and 9.a for Spain and France (2009–2022) and Portugal (2011–2022). Source data: InterCatch.

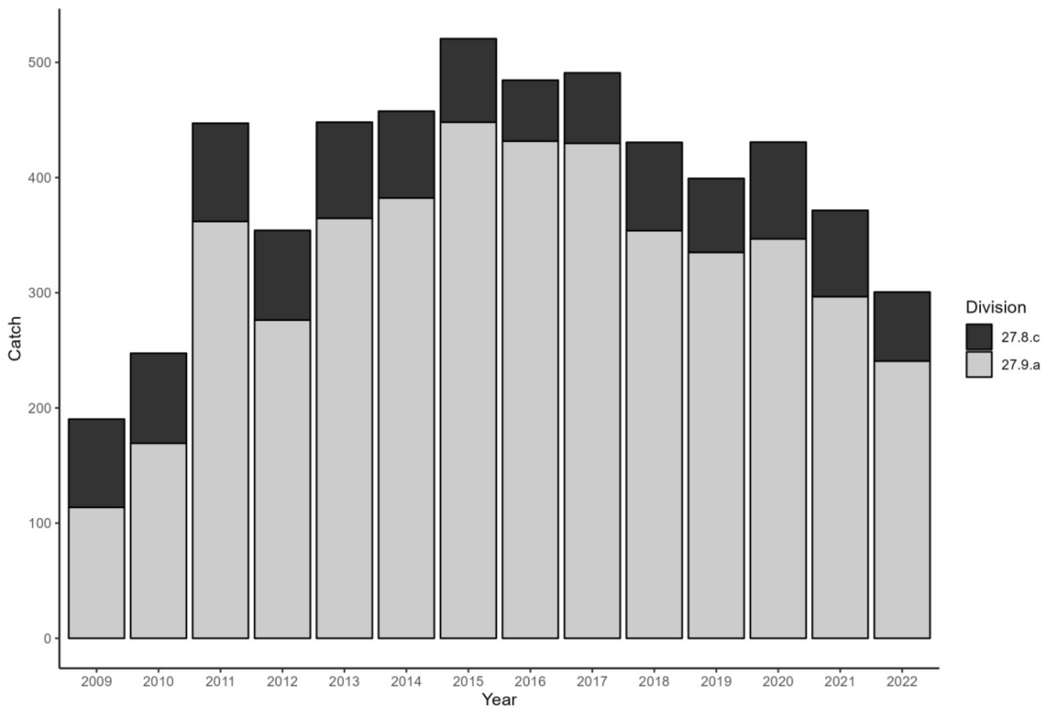

Figure 8.3. Sole (*S. solea*) in divisions 8c and 9a. Catches (in tonnes) for Spain and France (2009–2022) and Portugal (2011–2022). Source data: InterCatch.

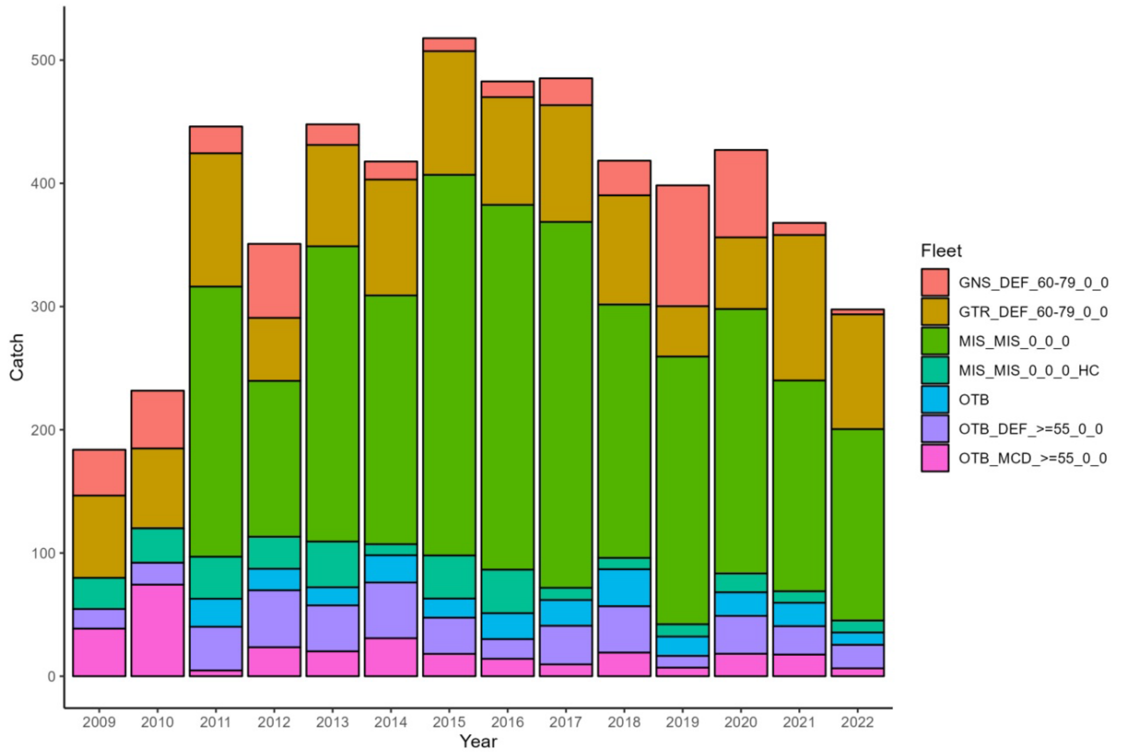

Figure 8.4. Sole (*S. solea*) in divisions 8c and 9a. Catches per main fleet in the ICES divisions 8.c and 9.a for Spain and France (2009–2022) and Portugal (2011–2022). Source data: InterCatch.

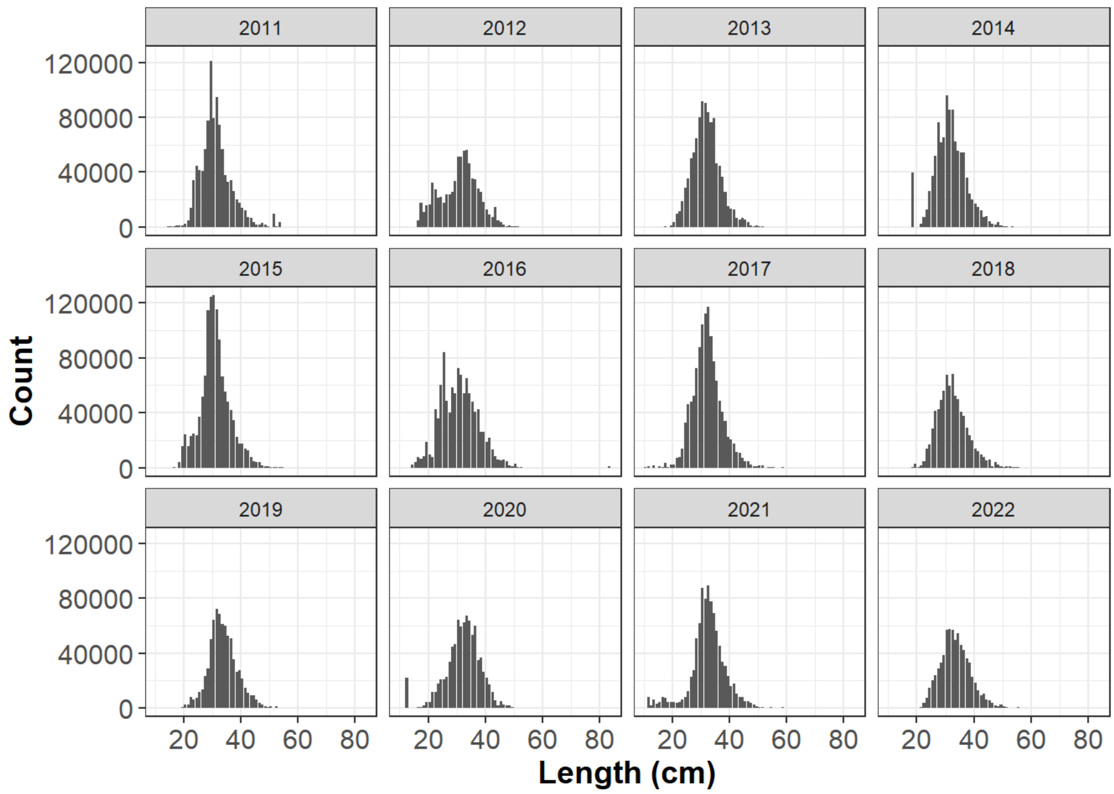

Figure 8.5. Sole (*S. solea*) in divisions 8c and 9a. Annual length-frequency distribution of catches for the period 2011–2022, for Portugal and Spain. Source data: InterCatch.

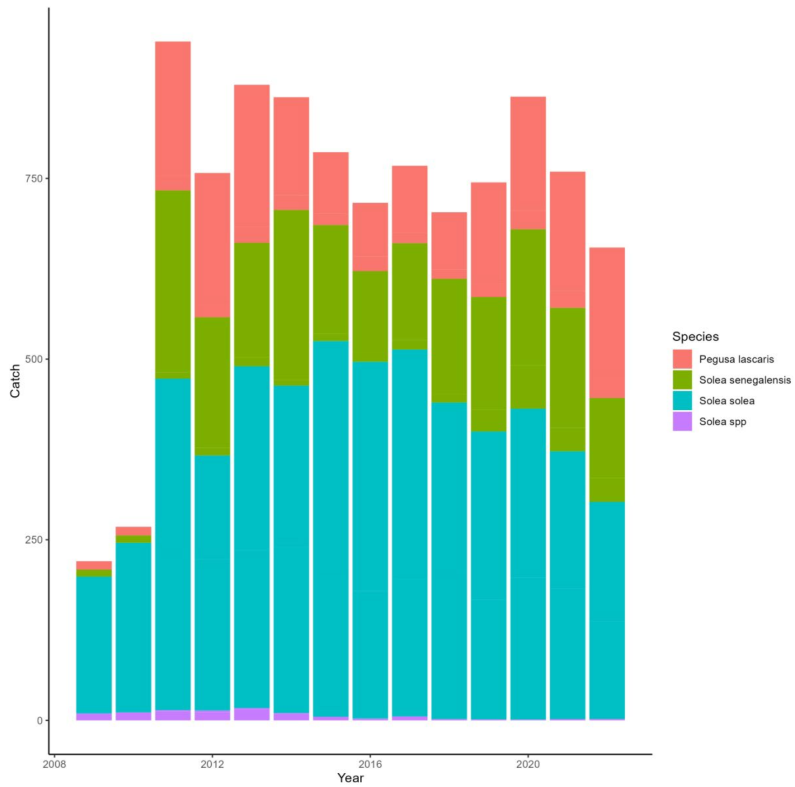

Figure 8.6. Sole (*S.solea*) in divisions 8c and 9a. Combined landings (in tonnes) from Spain and Portugal for the period 2009–2022. Please note that in 2009–2010 no Portuguese data were available.

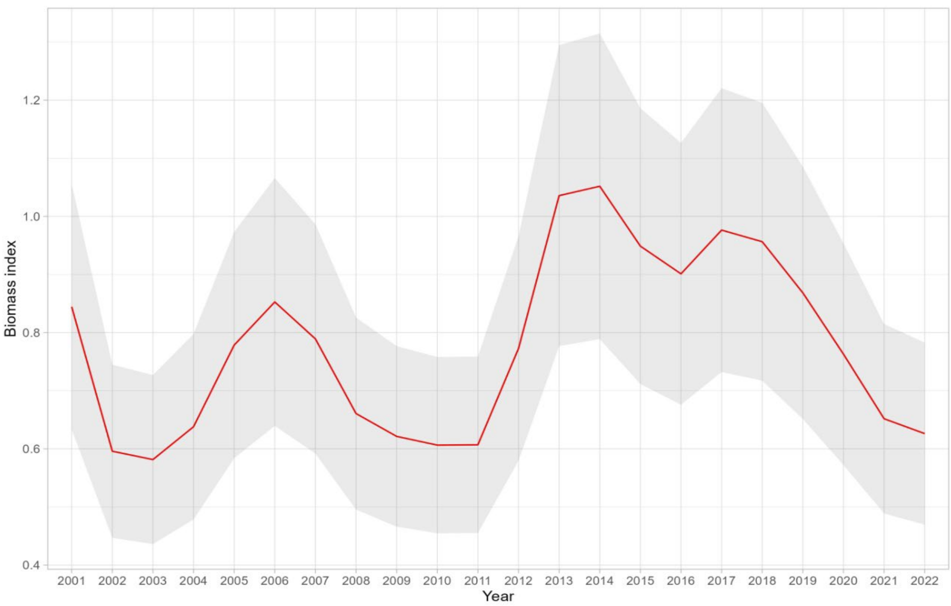

Figure 8.7. Sole (*S. solea*) in divisions 8c and 9a. Temporal trend of the spatio-temporal biomass index for the Spanish IBTS-Q4 bottom-trawl (G2784) survey for the period 2001-2022.

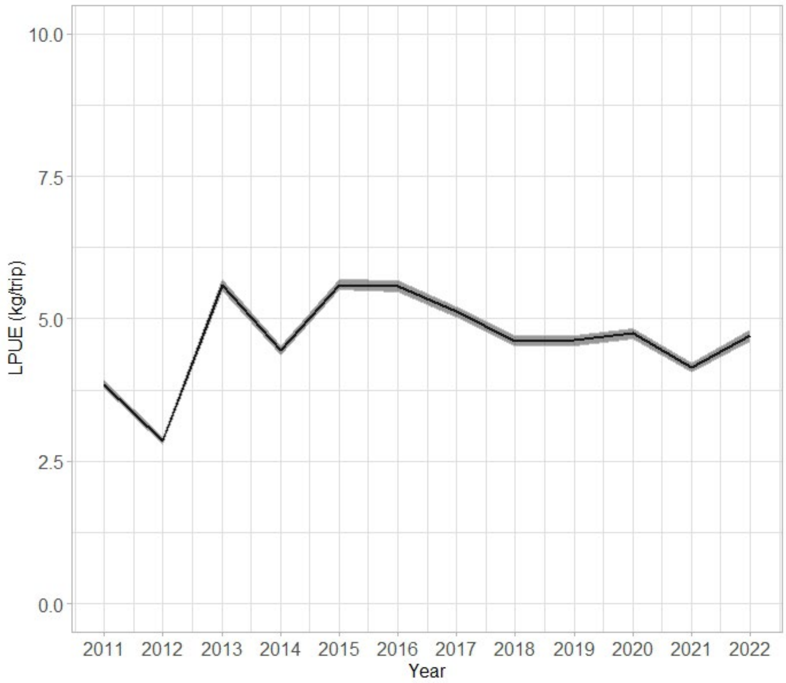

Figure 8.8. Sole (*S. solea*) in divisions 8c and 9a. Standardized commercial LPUE of the Portuguese polyvalent fleet in ICES Subdivision 9.a for the period 2011–2022.

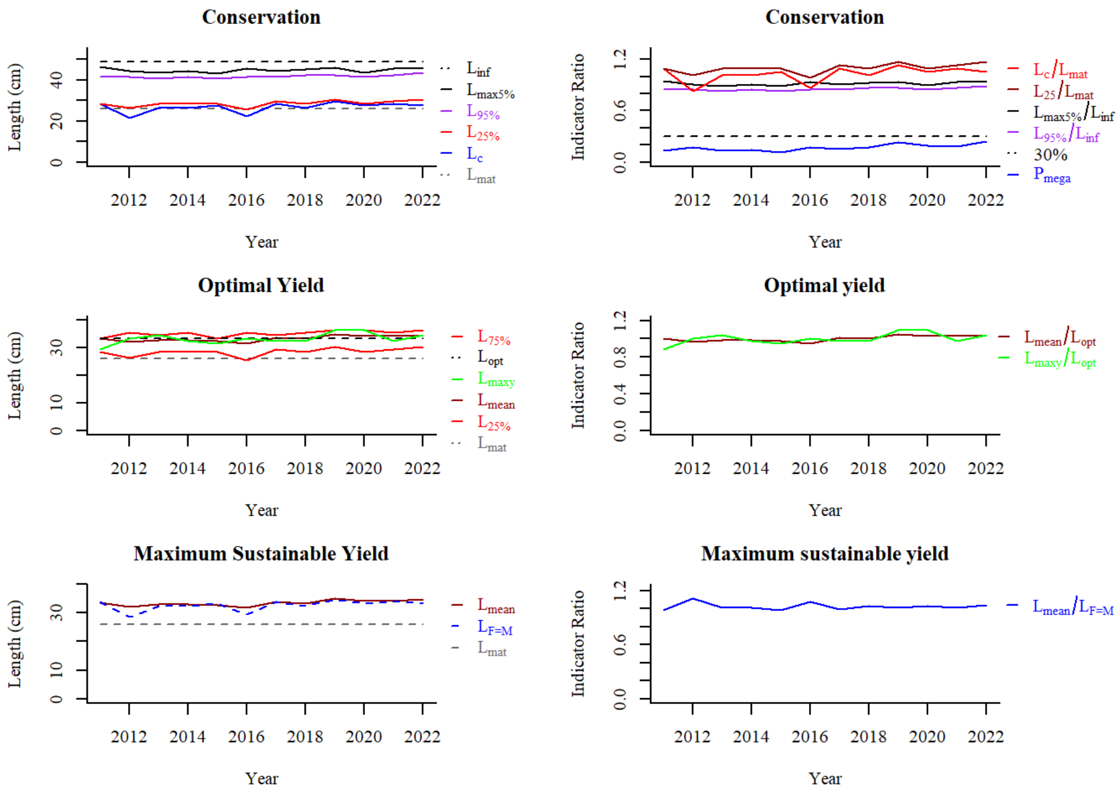

Figure 8.9. Sole (*S. solea*) in divisions 8c and 9a. LBI indicators for the period 2011–20212.

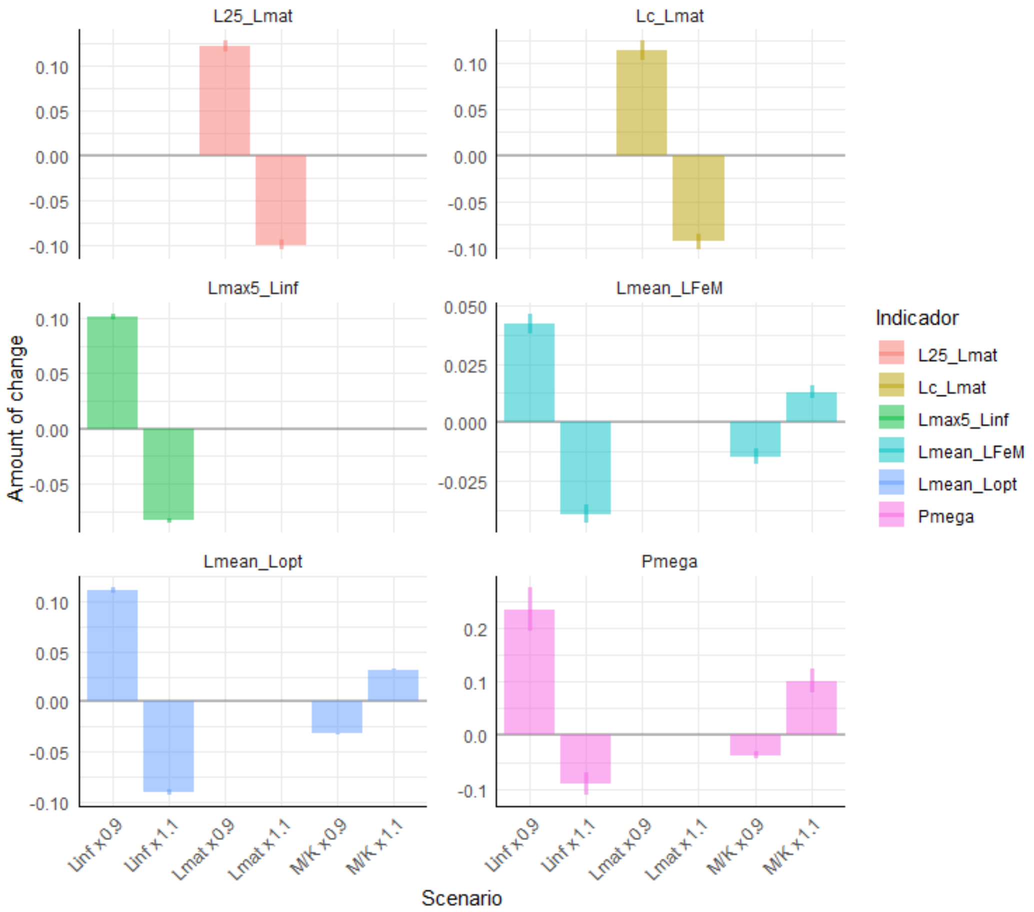

Figure 8.10. Sole (*S. solea*) in divisions 8c and 9a. LBI sensitivity analysis using both the underestimation and overestimation of L_{inf}, M/K and L_{50} parameters with respect to the selected model values. The 95% confidence limits are represented by a vertical line.

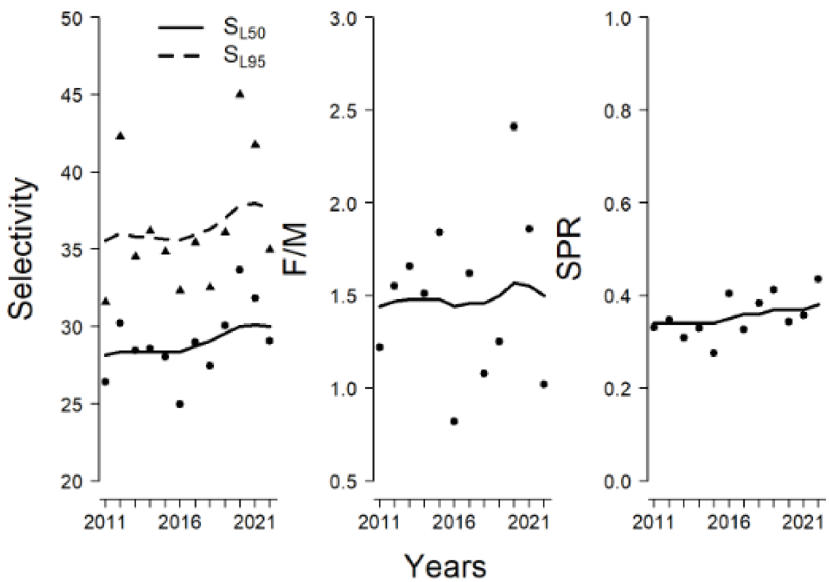

Figure 8.11. Sole (*S. solea*) in divisions 8c and 9a. Results of the LBSPR analysis for the period 2011–2022.

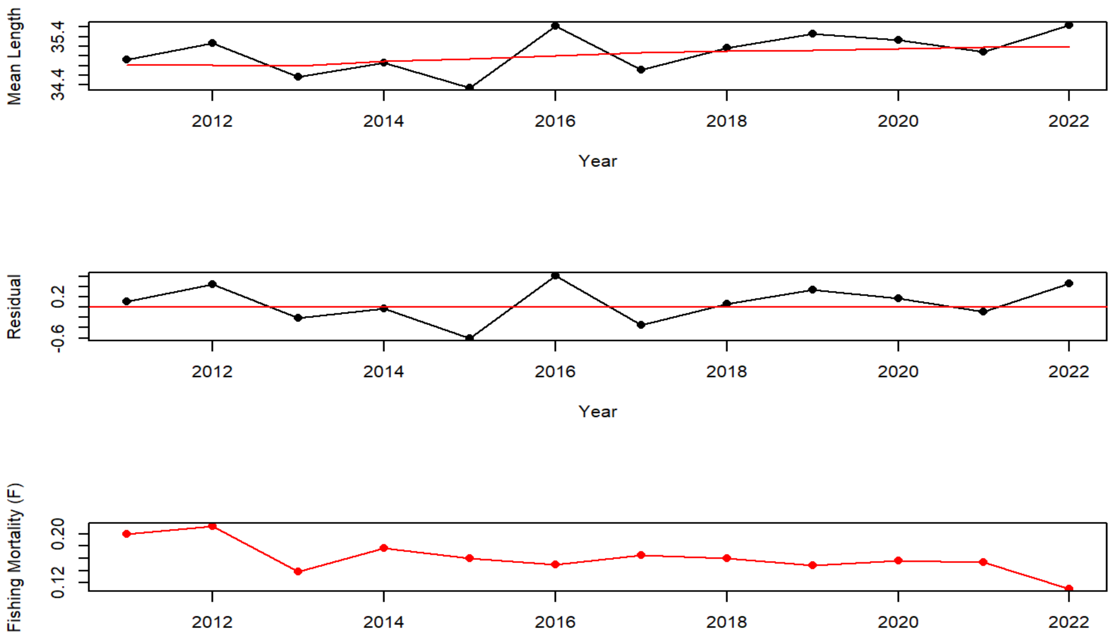

Figure 8.12. Sole (*S. solea*) in divisions 8c and 9a. Fishing mortality trend computed using the MLZ model for the period 2011–2022.

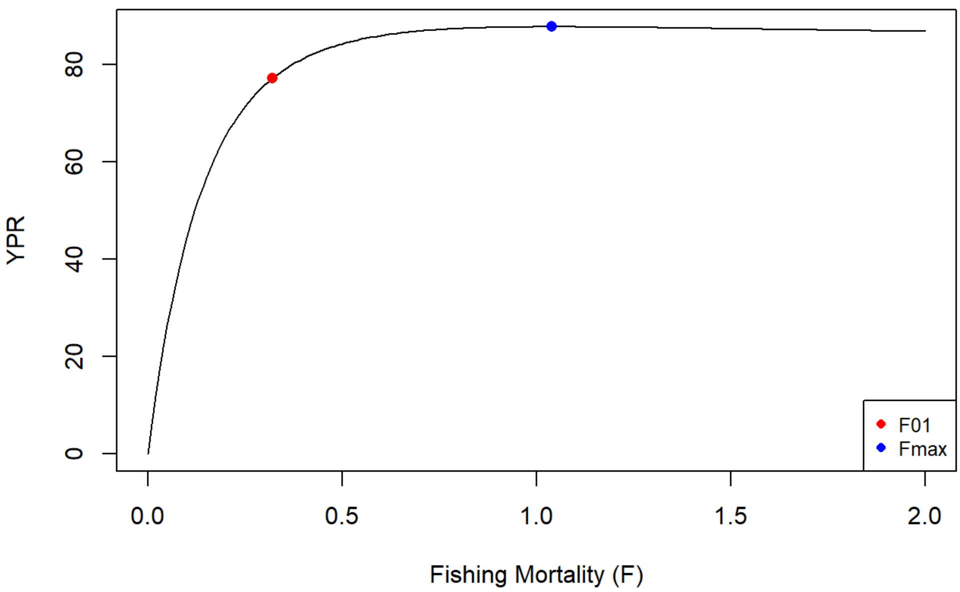

Figure 8.13. Sole (*S. solea*) in divisions 8c and 9a. Yield-per-recruits approximation obtained from the MLZ analysis for the period 2011–2022.

9 Hake in Greater North Sea, Celtic Seas, and the northern Bay of Biscay

hke.27.3a46-8abd – *Merluccius merluccius* in subareas 4, 6, and 7, and divisions 3.a, 8.a-b, and 8.d, Northern stock

9.1 General

9.1.1 Stock definition and ecosystem aspects

This section is described in the Stock Annex which was updated after the WKANGHAKE benchmark[1] (ICES, 2023a).

9.1.2 Fishery description

The general description of the fishery is now presented in the Stock Annex.

9.1.3 Summary of ICES advice for 2023 and historical management

9.1.3.1 ICES advice for 2023

The stock was considered to be above any potential MSY $B_{trigger}$. Following the ICES MSY framework implies that fishing mortality (F) should be maintained at 0.24, resulting in landings of 76 360 t and total catches of 83 130 t in 2023.

Like the other EU main fish stocks, northern hake is managed by a TAC and quotas. The TACs for recent years are presented in the table below. The TAC corresponds to northern stock (subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d), plus division 2.a (EU zone only; from 2021 onwards UK only), and divisions 3.b–d (except for 2019 onwards). There is no agreed TAC for Norwegian waters of subarea 4.

TAC(t)	2017	2018	2019	2020	2021	2022	2023
3.a, 3.b,c-d (EC Zone)	3 371	3 136	4 286	3 403	2 974	2 379	2 490
2.a (EC Zone), 4	3 928	3 653	4 994	3 940	3 443	2 754	2 883
5.b (EC Zone), 6, 7	67 658	62 536	79 762	63 325	55 335	44 268	46 335
8.a-b,d-e	44 808	42 460	52 118	42 235	36 906	29 525	31 422
Total northern stock	119 765	111 785	141 160	112 903	98 658	78 926	83 130

[1] ICES. 2022. ICES Stock Annex: 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). Produced by the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) and updated in August 2022 by the Benchmark workshop on anglerfish and hake (WKANGHAKE; ICES 2023a).

9.1.3.2 Historical management

The minimum legal sizes for fish caught in subareas 4, 6, 7 and 8 is set at 27 cm total length (30 cm in division 3.a) since 1998 (Council Reg. no 850/98 [EU, 1998]).

The 14th of June 2001, an Emergency Plan was implemented by the Commission for the recovery of the Northern hake stock (Council Regulations N 1162/2001 [EU, 2001a], 2602/2001 [EU, 2001b] and 494/2002 [EU, 2002]). In addition to a TAC reduction, two technical measures were implemented. First, a 100 mm minimum mesh size was implemented for otter-trawlers when hake comprises more than 20% of the total amount of marine organisms retained onboard. This measure did not apply to vessels less than 12 m in length and which return to port within 24 hours of their most recent departure. Furthermore, two areas were defined, one in subarea 7 and the other in subarea 8, where a 100 mm minimum mesh size is required for all otter trawlers, whatever the amount of hake caught.

In 2004, explicit management objectives for the recovery of this stock were implemented under the EC Reg. No 811/2004 (EU, 2004). It was aimed at increasing the quantities of mature fish to values equal to or greater than 140 000 t (the B_{pa} value at that time). This could be achieved by limiting F to 0.25 and by allowing a maximum change of 15% in TAC between years. According to the ICES advice for 2012, due to the change of the historical perspective of stock trends following from the migration to a new assessment method, the previously defined precautionary reference points are no longer appropriate. In particular, the absolute levels of spawning biomass, fishing mortality, and recruitment have shifted to different scales. As a consequence, the TAC corresponding to the recovery plan (EC Reg. No. 811/2004 [EU, 2004], repealed by EC Reg. No. 2019/472 [EU, 2019]) should no longer be considered, because the plan uses target values based on precautionary reference points that are no longer appropriate.

The TACs from 2016 to 2019 were slightly below the ICES advised catch (Figure 9.1). The difference was due to the way the STECF calculated the TAC adjustments for stocks subject to the landing obligation. In 2021, ICES proposed a decrease in the 2022 catch advice of a 27%, from 102 888 to 75 052 t. The agreed TAC limited the interannual variability to 20% (TAC = 78 926 t). In 2023, the agreed TAC was set to the ICES advised catch (83 130 t), which implied a 5% increase relative to the previous year TAC.

9.2 Data

9.2.1 Commercial catches and discards

Total landings from the Northern hake stock by area for the period 1961-2022, as used by WGBIE, are given in Table 9.1. They include landings from subareas 4, 6, and 7, and from divisions 3.a, 8.a–b, and 8.d, as reported to ICES. Unallocated landings are also included in Table 9.1 and shows that these values were high over the first decade (1961-1970), when the uncertainties in the fisheries statistics were also high. In the years 2011 and 2012, they have increased again due to the differences between official statistics and scientific estimations. In 2014 and 2015, the differences between scientific and official landings decreased significantly which produced a big decrease in unallocated landings. The 2016 unallocated landings were reported by area. In 2017, no unallocated landings were reported such that these disappeared in Table 9.2. Table 1 of the Stock Annex provides a historical perspective of the aggregation level at which landings have been available to WGBIE.

Except for 1995, landings decreased steadily from 59 100 t in 1989 to 31 900 t in 1998. Up to 2003, landings fluctuated at around 40 000 t. Since then, with the exception of 2006, landings have been increasing up to 107 500 t in 2016, the highest in the whole time-series. The landings from 2009 to 2015 and the catches in 2016 were above the TAC advice. Since 2016, the catches have decreased every year and these have been below the TAC and the catch advice.

The discards had an increasing trend until 2011 that decreased steadily afterwards. The increase was general to all the fleets. In the case of gillnetters, discarding did not occur before 2012 and since then they have had a high level of discards. In 2016, the discards increased for all the fleets except for Spanish trawlers. In 2017, the total discards decreased for all the fleets, except for the Spanish trawlers in division 8.a-b and 8.d, with an overall decrease of 36%. The increase in the Spanish trawlers was equal to 28%. In 2018, the discards increased in Spanish trawlers in area 7 and in the gillnetters fleet but decreased in all the rest of the fleets. In the following years the discards follow this decreasing trend.

Discards data sampling and availability are presented in the Stock Annex. Table 9.2 presents discards, landings and the number of samples collected for each of the fleets considered in the assessment model since 2013. The numbers of samples and measured fishes are relatively stable every year, except for the TRAWLOTH fleet which shows high variability over time. In 2020, a decrease in both the number of samples and measured fishes was observed. The decrease is especially marked for the LONGLINE fleet and the discards sampling in SPTRAWL7 fleet. Spain contributes the most to the LONGLINE samplings. In 2020, some issues in the Spanish samplings were encountered due to the COVID-19 disruptions coupled with other national data administrative problems. In 2021, Spain's sampling intensity returned to the previous levels.

9.2.2 Biological sampling

Table 9.3 shows the countries that contribute to the total catch of each Fishery Unit (FU) (see Stock Annex, under "Fishery", for FUs description) and provides the LFDs.

In 2022, landings length compositions by FU and quarter were provided mainly by Ireland, France, Spain, UK(England and Wales), Scotland and Denmark, while some other countries also provided some data.

Length composition samples are not available for all FUs in each country where landings are observed (see Stock Annex). Only the main FUs are sampled (Table 9.3).

9.2.3 Abundance indices from surveys

Five surveys provide relative indices of hake abundance over time: (1) the French surveys in the Bay of Biscay (FR-RESSGACQ [G2537]) conducted from 1978 to 2002, (2) the French Southern Atlantic Bottom Trawl Survey (EVHOE-WIBTS-Q4 [G9527]) covering the Bay of Biscay and the Celtic Sea with a new design since 1997, (3) the Spanish Porcupine Bottom Trawl Survey (SpPGFS-WIBTS-Q3 [G5768]) conducted in the Porcupine Bank since 2001, (4) the Irish Groundfish Survey (IGFS-WIBTS-Q4 [G7212]) carried out in the west of Ireland and the Celtic Sea since 2003, and (5) the Irish Anglerfish and Megrim Survey (IE-IAMS [G3098]) in division 6.a and area 7 since 2016. A brief description of each survey is given in the Stock Annex and in Section 2 of this report. Figure 9.2 presents the abundance indices obtained from these surveys.

The FR-RESSGASC (G2537) survey was a French offshore trawl monitoring programme done by Ifremer from 1984 to 2003 which was completely halted in 2004 (Battaglia, 2002). The annual survey indices from 1985 until 2002 showed a slightly decreasing trend. The 2002 index is considered not reliable and, thus, not presented on Figure 9.2.

Throughout the available time-series, the abundance index provided by EVHOE-WIBTS-Q4 (G9527) survey showed six peaks in 2002, 2004, 2008, 2012, 2016 and 2019. The index obtained in 2012 was the highest value of the series, 192% higher than the previous year. In 2013 and 2014, the index accumulated a decrease of 78%. In 2015 and 2016, it increased and the 2016 index value was 2.5 times higher than the 2015 value. In 2017, the index was not available since the survey was not conducted due to major vessel technical issues. In 2018, the index value decreased relative to the 2016 value and was around the value observed in 2015. It increased again in 2019 then decreased in 2020 to a historical minimum level for the whole time-series, followed by an increase in 2021 and a new decrease in 2022, being currently in one of the lowest levels of the series.

The abundance index provided by the IGFS-WIBTS-Q4 (G7212) survey is consistent with EVHOE WIBTS-Q4 (G9527) survey over recent years. The IGFS-WIBTS-Q4 (G7212) survey index showed four peaks that coincide with those observed in the EVHOE-WIBTS-Q4 (G9527) survey index but to a lesser extent. In 2012, the index achieved the highest value of the series, 231% higher than the previous year's index. The accumulated decrease in 2013 and 2014 was equal to 84%. The index increased moderately from 2015 to 2017. However, the increase in 2016 was not as significant as that observed with the EVHOE-WIBTS-Q4 (G9527) survey index. The index decreased in 2018 and the observed variation has been low during the last two years. Currently, the index is around its historical minimum level.

The abundance index from SpPGFS-WIBTS-Q4 (G5768) survey follows an increasing trend since 2003, reaching its highest value in 2009 and slightly decreasing in 2010 and 2011. After two years of an increasing trend, with an accumulated increase of 126%, the index decreased considerably in 2015 followed by a subsequent but moderate decline in 2016. The peaks detected by EVHOE-WIBTS-Q4 (G9527) and IGFS-WIBTS-Q4 (G7212) were also detected in this survey but had occurred a year later, confirming the sharp increase observed in 2017. This is consistent with the fact that this survey catches bigger individuals. In the last three years, the index has decreased to a value comparable to that observed in 2003-2005.

The biomass index from IE-IAMS (G3098) survey also follows the trends of the rest of the other surveys, with a peak in 2017.

The spatial distribution of the EVHOE-WIBTS-Q4 (G9527), SpPGFS-WIBTS-Q4 (G5768), IGFS-WIBTS-Q4 (G7212) and IE-IAMS (G3098) respective survey catch rates (Kg/h) are provided in Figure 9.3 since 2007. It should be noted that EVHOE-WIBTS-Q4 (G9527) and IGFS-WIBTS-Q4 (G7212) surveys use similar gears while the SpPGFS-WIBTS-Q4 (G5768) and IE-IAMS (G3098) employ quite different gears with different catchabilities, which consequently the surveys are not directly comparable in the figure maps. The SpPGFS-WIBTS-Q4 (G5768) survey catch rate shows a homogenous spatial distribution in the sampled area throughout the time-series. Among the four surveys, the SpPGFS-WIBTS-Q4 (G5768) shows the higher biomasses values in the maps, confirming that this survey catches bigger individuals. A contraction of the spatial distribution is visible in some years, with the year 2018 showing the greatest contraction (Figure 9.3). In 2017, the EVHOE-WIBTS-Q4 (G9527) survey was only carried out partially due to some major vessel technical issues, consequently, the index and length data were not included in the model for that year (ICES, 2018). For the IGFS-WIBTS-Q4 (G7212) survey, the spatial distribution of the catch rates was stable throughout the time-series, with a slight decrease in 2018. The southern region of the sampled area showed a higher catch rate in recent years. For the IGFS-WIBTS-Q4 (G7212) survey, high biomass concentration seems to occur in areas closer to the continental French shelf. The IE-IAMS (G3098) survey showed variable abundance values along the years, with a remarkable increase in 2019. Overall, for all surveys combined, a contraction of the spatial distribution is visible since 2015.

The EVHOE-WIBTS-Q4 (G9527) and IGFS-WIBTS-Q4 (G7212) surveys catch mainly young individuals below 25 cm while the SpPGFS-WIBTS-Q4 (G5768) and IE-IAMS (G3098) capture larger sized individuals (30 – 75 cm) (Figure 9.4). In the case of the EVHOE-WIBTS-Q4 (G9527) survey, the distribution is quite homogeneous year after year, with the mode around 12 cm. In the case of the IGFS-WIBTS-Q4 (G7212) survey, most of the individuals were around 25 cm with almost no individuals around 12 cm (which is the distribution mode for most of the years in the series) for the years 2018 and 2020. The LFDs from the SpPGFS-WIBTS-Q4 (G5768) survey are quite flat, varying between 40 and 65 cm (with a peak around 20 cm) which is associated with the previous year's recruitment. This peak was very high in 2017. In the case of the IE-IAMS (G3098) survey, the LFDs are also quite flat, varying between 30 and 75 cm. The variability of the shape of LFDs of these three latter indices could be motivated by the limited sampling area covered compared with the index estimated from the EVHOE-WIBTS-Q4 (G9527) that covers a bigger survey area.

9.3 Assessment

This is an update assessment in relation to the assessment carried out during the Benchmark workshop on anglerfish and hake (WKANGHAKE; ICES, 2023a) in 2022. During this benchmark, a new model was developed using the Stock Synthesis (SS) framework (Methot Jr. and Wetzel, 2013). This new model includes an additional fleet (OTHER fleet disaggregated in trawlers and non-trawlers since 2013) and a new survey, the IE-IAMS (G3098), compared to the previous model used by WGBIE in 2021 (ICES, 2021). The population dynamics are now sex-separated with sex-dependent growth and natural mortality (M). Other changes in the assessment this year included the estimation of the steepness by the model, the selectivity is kept random since 1998 for all fleets (previously blocks were defined in some fleets based on observed selectivity changes motivated by changes in legislation and other factors) and the LFDs have been downweighed.

9.3.1 Input data

See Stock Annex (under "Input data for SS"). The catch contribution of the commercial fleets used in the configuration of the model has changed over time (Figure 9.1). At the beginning of the time-series more than 75% of the catch was caught by trawler fleets. However, their contribution declined to around 25% of the total catch in the last years. On the contrary, the combined catches of longliners and gillnetters was relatively small in the past. Currently however, the contribution of each of these fleets has increased and is now similar to the contribution of trawlers at the beginning of the time-series. The increase in the biomass of the stock in the last decade has resulted in a high increase in the catch of the OTHER fleet. Nowadays, the annual catch of the trawlers outside the Bay of Biscay and Celtic Sea (TRAWLOTH) is similar to the catch of trawlers in the Bay of Biscay and the Celtic Sea.

The quarterly LFDs for recent landings and discards are given in Figure 9.5. For most of the fleets, the LFDs of landings is quite stable over time. The fleets in Area 8 catch smaller individuals. For trawlers, discards occur in the lower part of the distribution while for gillnetters and TROTH fleet this is observed indiscriminately over the whole distribution range. The data collection from the commercial fishery and research surveys during 2020 were affected by COVID-19 restrictions to varying degrees across member states. Spanish discard data and LFDs in SPTRAWL7 fleet were missing for some quarters. The 2020 LONGLINE fleet sampling was also lower compared to previous years with a corresponding odd shaped LFDs. Previous years' LONGLINE fleet sampling LFDs had a smooth and well-defined shape.

9.3.1.1 Data revisions

No data revisions have been provided in 2023.

9.3.2 Model

The SS assessment model (Methot Jr. and Wetzel, 2013) is used for this stock. The model description and settings are presented in the Stock Annex (under "Current assessment" for model description and "SS settings (input data and control files)" for model settings).

9.3.3 Model results

Residuals of the fit to the surveys log(abundance indices) are presented in Figure 9.6. The upward trend in relative abundance observed until 2017 for all EVHOE-WIBTS-Q4 (G9527), SpPGFS-WIBTS-Q4 (G5768) and IGFS-WIBTS-Q4 (G7212) trawl surveys, has been captured by the model. In the last five and four years, the model estimates are higher than the observed values for the IGFS-WIBTS-Q4 (G7212) and SpPGFS-WIBTS-Q4 (G5768) surveys, respectively.

The Pearson residuals of the EVHOE-WIBTS-Q4 (G7212) survey LFDs have a "fairly random" pattern with no general trend or lack of fit. This can be observed in Figure 9.7, where blue and red circles denote positive and negative residuals, respectively. However, the current model has difficulties in explaining the peaks in small individuals observed in the SpPGFS-WIBTS-Q4 (G5768) and IE-IAMS (G3098) surveys as well as the lack of small individuals in IGFS-WIBTS-Q4 (G7212) index for some years (i.e. 2018, 2020 and 2021).

Residuals of the LFDs of the commercial fleets' landings and discards (not presented in this report, but available on the GitHub repository[2]) show some patterns, similar as in previous assessments.

The assessment model includes estimation of size-based selectivity functions (selection pattern-at-length) for commercial fleets and for population abundance indices (surveys). For commercial fleets, total catch is subsequently partitioned into discarded and retained portions. Figure 9.8 presents the selectivity for the total catch and Figure 9.9 the retention functions by fleet estimated by the model. The selection curve is assumed constant over the whole period for GILLNET, LONGLINE and OTHER fleets. For the North Sea trawlers, two different selectivity functions are estimated. One is for the period 1978-2012 and the other is varying from year to year since 2013. For the other fleets, both selection and retention curves are considered constant until 1997 and varying for the rest of the assessment period (1998-2021). The change in retention in 1998 for Spanish trawl fleets was clearly observed when examining the LFDs of the landings and might be due to a more rigorous enforcement of the minimum landing size. The most recent change in the retention of Spanish trawl fleet in area 7 was motivated by the observed change in the mean size of discards from 23.6 cm before 2010 to 28.8 cm after that year. The variation is modelled using a random walk as described in the Stock Annex. The selection pattern has gradually changed over the years, such as the retention ogives. However, both the selection patterns and retention ogives in 2021 and 2022 are almost identical (Figures 9.8 and 9.9). Residuals of the LFDs of the commercial fleets landings and discards (not presented in this report, but available on the GitHub repository[3]) show some patterns, similar to those seen in previous assessments (ICES, 2022).

The retrospective analysis (Figure 9.10) shows that for the three summary indicators ($F_{1\text{-}7}$, SSB and Recruitment) the model results are sensitive to the exclusion of recent data, especially for SSB and $F_{1\text{-}7}$. The inclusion of new data affected the recruitment estimates especially in the most recent years, the SSB was generally revised downwards, while the $F_{1\text{-}7}$ was revised upwards. The

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[2] https://github.com/ices-taf/2023_hke.27.3a46-8abd_assessment

[3] https://github.com/ices-taf/2023_hke.27.3a46-8abd_assessment

inclusion of new data also overestimated the large incoming recruitments in the first years but the impact on the last years' estimates shows the absence of a clear trend. These cancellation effects reduced the value of the Mohn's rho (Mohn, 1999) for the recruitment (at -0.11). However, the systematic overestimation of SSB and underestimation of $F_{1\text{-}7}$ removed the cancellation effects and the obtained Mohn's rho values observed were higher (Figure 9.11). Although, only some of time series were within the confidence intervals estimated by the model (Figure 9.10), according to the WKFORBIAS guidelines (ICES, 2020), the observed retrospective pattern is acceptable to provide advice (see Figure 9.12). The Mohn's rho values for SSB and $F_{1\text{-}7}$ are outside the bounds (0.30 > 0.20 for SSB and -0.19 < -0.15 for $F_{1\text{-}7}$) with three of the five recent peels outside the envelope. Consequently, these latest patterns observed will be investigated further inter-sessionally before the WGBIE in 2024. However, as the retrospective pattern is close to the retrospective limit (if the last 3 peels are considered) while the SSB is well above MSY $B_{trigger}$ and the $F_{1\text{-}7}$ is well below Fp_{05}, WGBIE is confident that it is possible to give an advice based on the assessment model presented in this report. The inclusion of the 2022 data has led to a reduction to the retrospective patterns compared to those observed during the WKANGHAKE benchmark (ICES, 2023a), as two of the three recent peels for SSB and $F_{1\text{-}7}$ in this year's assessment are still inside the envelope.

Summary results from the SS assessment are given in Table 9.4 and Figure 9.13.

Recruitment values (age 0) estimated by the model are provided in Table 9.4. For recruitment, fluctuations appear to be without substantial trend over the whole series. The recruitment in 2007 was the highest in the whole series with 2 177 millions of individuals and the ones in 2020-2022 were below the geometric mean (GM; 722 millions). From high levels at the start of the series (92 412 t in 1980), the SSB decreased steadily to a low level at the end of the 1990s (29 600 t in 1998). Since then, SSB has increased to the highest value of the series in 2015 (293 823 t) and decreased progressively until 2023 (163 204 t).

The F is calculated as the average annual F for ages 1–7. Values of $F_{1\text{–}7}$ increased from values around 0.30-0.38 in the late 1970s and early 1980s to values around 0.60 during the 1990s. Between 2006 and 2013, $F_{1\text{–}7}$ declined sharply. Since 2009, $F_{1\text{–}7}$ remains below F_{MSY} (0.24). The $F_{1\text{–}7}$ estimate for 2021 (0.189) is well below F_{MSY}.

The 90% confidence intervals are wider than before (Figure 9.4). These intervals correspond to the uncertainty estimated by the SS model and do not include all the existing uncertainty. For example, it does not include all of the uncertainty in the input data. However, during the last WKANGHAKE benchmark (ICES, 2023a), the data weighting in SS was revisited in order to get more realistic confidence intervals. Specifically, the weight of the LFDs in the likelihood components has been reduced by multiplying them by 0.1.

9.4 Catch options and prognosis

9.4.1 Assumption on recruitment

In the 2020 and 2021 assessments, recruitment estimates for the last two data years (2018-2019 and 2019-2020, respectively), were replaced by the GM. The 2020 recruitment was close to the GM. However, the 2019 estimate was well above that level. The assessment model overestimated the three abundance indices available in the last two years. Furthermore, the model has revised the most recent recruitments downwards. Hence, replacing the recruitment estimates for the last two years was considered more reliable and precautionary for projections. In 2022, the recruitment estimates were not replaced. However, the new methodology agreed upon during the WKANGHAKE benchmark (ICES, 2023a) was to replace the recruitment estimates for the last two data years with the recruitment predicted from SS stock-recruit relationship, but only in cases when WGBIE believes these are not accurately estimated.

This year, the recruitment estimates for the last two years (2022 and 2021) were not replaced. The 2021 and 2022 recruitments were below the GM. The assessment model overestimated two of the four abundance indices available in the last two years. If we focus on the indices that give information on smaller individuals, the assessment overestimates values for the IGFS-WIBTS-Q4 (G7212) survey in both years, whereas these values were underestimated for the EVHOE-WIBTS-Q4 (G9527) survey only in 2021 and quite precisely estimated in 2022. Hence, not replacing the recruitment estimates for the last two years was considered more reliable for projections.

Recruitment in the projection years (2023-2024) was estimated by the model based on fitted Beverton-Holt stock-recruitment relationship.

9.4.2 Short–term projection

SS has a forecast module which provides the capability to do a projection for a user-specified number of years that is directly linked to the model ending conditions, associated uncertainty, and to a specified level of fishing intensity. This was the tool used to carry out the short-term projections, as defined during the WKANGHAKE benchmark (ICES, 2023a) and as described in the Stock Annex.

For the current projection, unscaled F is used, corresponding to $F_{1–7}$ = 0.189. Recruitment short-term projection assumption values are given in Table 9.5. Landings in 2024 and SSB in 2025 predicted for various levels of $F_{1–7}$ in 2024 are also given in Table 9.5 and Figure 9.14.

Maintaining *status quo* $F_{1–7}$ in 2024 is expected to result to a decrease in both the catch and the SSB with respect to 2023, at around -6% and -8%, respectively.

When we compare present year short-term forecast outcomes with previous year ones, we see that the catches, the fishing mortality, and the recruitment assumed last year for 2022 and 2023 have been revised downwards this year, leading to a minor reduction of the SSB (Figure 9.15). Both the selectivity and retention curves are quite stable (Figure 9.15). However, the numbers at age are lower for individuals of below 6-year-old and higher for the older ones. The expected reduction of the SSB is likely for an exploitation at F_{MSY} levels as the stock is currently well above MSY Btrigger.

9.4.3 Yield and biomass per recruit analysis

Long-term projections were carried out using SS. These calculate the equilibrium level of spawner-per-recruit (SPR) and yield-per-recruit (YPR) that would occur if fishing according to a trial level of fishing intensity and based on this SPR and the unfished level (SPR_0) calculate the absolute level of recruitment, spawning biomass, and yield that would occur if fishing intensity were maintained at this rate (Methot Jr. and Wetzel, 2013).

Results of equilibrium yield and SSB-per-recruit are presented in Table 9.6 and Figure 9.18. The F-multiplier in Table 9.6 is with respect to maximum equilibrium yield-per-recruit (F_{max}).

Considering the yield and SSB-per-recruit curves, *status quo* F (F_{sq} = average F_{1-7} in the final 3 assessment years, 2020-2022), $F_{0.1}$, $F_{35\%}$, $F_{30\%}$ and F_{MSY} are respectively estimated to be 150%, 150%, 120%, 140%, and 200% of F_{max}. The maximum equilibrium yield-per-recruit is similar to the equilibrium yield at F_{sq}.

9.5 Biological reference points

Biological reference points for the stock of northern hake were recalculated in 2022 during the WKANGHAKE benchmark (ICES, 2023a) based on the new model settings. The reference points in use for the stock are as follows:

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	78405	B_{pa}; females only, in tonnes.
	F_{MSY}	0.24	Stock Synthesis simulations.
Precautionary approach	B_{lim}	61563	The breakpoint of the segmented regression stock–recruitment relationship; females only, in tonnes.
	B_{pa}	78405	exp(1.654 ×σ) × B_{lim}, with σ = 0.147; females only, in tonnes.
	F_{lim}	0.73	The F that provides a 50% probability for SSB to be above B_{lim}.
	F_{pa}	0.54	F_{P05} with advice rule (AR): the F that provides a 95% probability for SSB to be above B_{lim}.
Management plan	F_{mgt}	Not defined	
	SSB_{mgt}	Not defined	
	MAP MSY $B_{trigger}$	78405	MSY $B_{trigger}$; females only, in tonnes.
	MAP B_{lim}	61563	B_{lim}; females only, in tonnes.
	MAP F_{MSY}	0.24	F_{MSY}
	MAP range F_{lower}	0.147	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY.
	MAP range F_{upper}	0.37	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY.

9.6 Comments on the assessment

The current model presents SSB for females only, which is considered as an improvement since egg production is considered a good metric of reproductive potential and female SSB is a better proxy of egg production than total mature biomass. The reference points were calculated relative to the female SSB (ICES, 2023a).

Actual assessment estimates cannot be compared with the assessment estimates prior to 2022 as the assessment model configuration was changed as a result of the WGANGHAKE benchmark (ICES, 2023a) and the perception of the stock changed relative to these new reference points.

The retrospective pattern shows a general trend to correct SSB downwards and $F_{1–7}$ upwards. The causes of this pattern are not yet well understood and should be further explored to identify the causes for this bias.

The sample size provided for the LFDs should be related to the yearly available samples as model results are sensitive to these sample values and can be especially important in years with lower sampling intensity, such as in 2020 when sampling levels declined due to COVID-19 disruptions.

9.6.1 Sensitivity runs

The inclusion of the 2022 data led to a slight reduction of the retrospective patterns in the latest years, relative to those observed in last year's assessment (ICES, 2022). However, this still gave values outside the ICES recommended bounds (ICES, 2020), with Mohn's rho values at 0.30 (>0.20) for SSB and -0.19 (<-0.15) for F_{1-7}. However, given the ICES guidelines, it was possible to give advice.

Given the fact that the estimated recruitments for the interim (Rec2023 = 862 millions) and advice year (Rec2024 = 855 millions) were above the GM recruitment (722), the short-term forecast was carried out replacing these values by the GM recruitment.

The advice for the stock under F_{MSY} (0.24) would imply catches at 72 310 t (when replacing the recruitment by the GM) and for the lower and upper ranges at 46 396 t and 102 105 t, respectively. Very similar to those obtained when using the values from the stock-recruitment relationship fitted by the model.

9.7 Future benchmark

A follow-up IBP was recommended and supported by WGBIE last year (ICES, 2022) to update the biological component of the model based on available data and explore alternative configurations that could further improve the quality of the current northern hake assessment model fit. With the new benchmark process (ICES, 2023b), the update of the biological parameters could be done in the framework of the working group, if it is considered a minor change, or could require external review, if the changes are not considered minor or the impact in the results is relevant. For major changes, a full benchmark process by intersessional work would be required.

The following points should be explored and revised:

- Biological parameters. Revise some biological parameters to obtain stable stock-specific, sex-disaggregated, and time-varying model estimates which can mitigate overestimated stock productivity (ICES, 2022). For example, actual values of M integrated in the model were taken from a study of some fish stocks in the Mediterranean (GCFM, 2019a; 2019b), length-weight parameters have been inherited from the WGBIE southern hake stock while the growth parameters are not sex-specific.
- Weighting options. Further explore and perform sensitivity analyses of the model estimates to better calibrate the weighting of the likelihood components with the adequate weights defined. Furthermore, there is a need for a standardised protocol to determine the effective sample size needed when updating data in the model in order to account for significant data sampling changes.
- Retrospective patterns. Further investigate and identify the contributing factors to the increasing retrospective patterns observed in the current assessment model.

9.8 Management considerations

Although there has been a general decrease in the retrospective patterns for the latest years, there is still a tendency to revise SSB downwards while $F_{1\text{-}7}$ upwards (ICES, 2023a). This may result in an inflated advised catch but still needs to be tested.

Since 2017, the observed catches have been significantly below the TAC and the catch advice, which may indicate an overestimation of stock productivity.

It should be noted that the ICES catch advice provided for this year is for the whole hake stock, including those fished in Norwegian waters (subarea 4). However, the sum of the TACs since 2019 indicated in this report are only for the EU member states and the UK, excluding subarea 4.

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9.10 Tables and figures

Table 9.1. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Estimates of catches (in '000 t) by ICES area for 1961-2022 (L: landings and D: discards).

Year	Landings (t)[1]										Discards (t)[2]							Catches(t)[3]
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Unal-lo-cated	L_{Total}	D_3	D_4	D_5	D_6	D_7	D_8	D_{Total}	Total
1961									95.6	95.6								95.6
1962									86.3	86.3								86.3
1963									86.2	86.2								86.2
1964									76.8	76.8								76.8
1965									64.7	64.7								64.7
1966									60.9	60.9								60.9
1967									62.1	62.1								62.1
1968									62.0	62.0								62.0
1969									54.9	54.9								54.9
1970									64.9	64.9								64.9
1971			8.5				19.4	23.4	0.0	42.8								42.8
1972			9.4				14.9	41.2	0.0	56.1								56.1
1973			9.5				31.2	37.6	0.0	68.8								68.8
1974			9.7				28.9	34.5	0.0	63.4								63.4
1975			11.0				29.2	32.5	0.0	61.7								61.7
1976			12.9				26.7	28.5	0.0	55.2								55.2
1977			8.5				21.0	24.7	0.0	45.7								45.7
1978			8.0				20.3	24.5	-2.2	42.6								42.6
1979			8.7				17.6	27.2	-2.4	42.4								42.4
1980			9.7				22.0	28.4	-2.8	47.6								47.6
1981			8.8				25.6	22.3	-2.8	45.1								45.1
1982			5.9				25.2	26.2	-2.3	49.1								49.1
1983			6.2				26.3	27.1	-2.1	51.3								51.3
1984			9.5				33.0	22.9	-2.1	53.8								53.8
1985			9.2				27.5	21.0	-1.6	46.9								46.9

Year	Landings (t)[1]										Discards (t)[2]							Catches(t)[3]
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Unal-located	L_{Total}	D_3	D_4	D_5	D_6	D_7	D_8	D_{Total}	Total
1986			7.3				27.4	23.9	-1.5	49.8								49.8
1987			7.8				32.9	24.7	-2.0	55.6								55.6
1988			8.8				30.9	26.6	-1.5	56.0								56.0
1989			7.4				26.9	32.0	0.2	59.1								59.1
1990			6.7				23.0	34.4	-4.2	53.3								53.3
1991			8.3				21.5	31.6	-3.4	49.8								49.8
1992			8.6				22.5	23.5	2.1	48.1								48.1
1993			8.5				20.5	19.8	3.3	43.7								43.7
1994			5.4				21.1	24.7	0.0	45.8								45.8
1995			5.3				24.1	28.1	0.1	52.3								52.3
1996			4.4				24.7	18.0	0.0	42.8								42.8
1997			3.3				18.9	20.3	-0.1	39.2								39.2
1998			3.2				18.7	13.1	0.0	31.9								31.9
1999			4.3				24.0	11.6	0.0	35.6								35.6
2000			4.0				26.0	12.0	0.0	38.0								38.0
2001			4.4				23.1	9.2	0.0	32.3								32.3
2002			2.9				21.2	15.9	0.0	37.2								37.2
2003			3.3				25.4	14.4	0.0	39.9							1.4	41.3
2004			4.4				27.5	14.5	0.0	42.0							2.6	44.6
2005			5.5				26.6	14.5	0.0	41.1							4.6	45.7
2006			6.1				24.7	10.6	0.0	35.3							1.2	36.6
2007			7.0				27.5	10.6	0.0	38.1							2.2	40.2
2008			10.7				22.8	14.3	0.0	37.2							3.4	40.5
2009			13.1				25.3	20.4	0.0	45.7							11.0	56.8
2010			14.2				33.5	25.1	0.0	58.6							12.1	70.7
2011			18.8				18.6	16.6	32.0	87.5							13.9	101.4
2012			22.4				22.2	16.7	19.3	85.6							14.9	100.5
2013			0.3	10.7		5.2	50.1	19.9	0.0	86.1	0.3	2.9		1.5	6.6	4.1	15.4	101.6

Year	Landings (t)[1]										Discards (t)[2]							Catches(t)[3]
	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Unal-lo-cated	L_{Total}	D_3	D_4	D_5	D_6	D_7	D_8	D_{Total}	Total
2014			0.4	12.1		11.4	40.5	25.6	0.0	89.9	0.3	3.1		1.0	4.0	1.5	9.8	99.8
2015			0.4	14.6	0	7.1	44.4	28.5	0.0	95.0	0.1	3.4		0.1	4.2	3.1	10.9	106.0
2016			0.7	19.6	0	11.4	49.4	26.5	0.0	107.5	0.1	4.2	0	0.3	2.3	4.2	11.1	118.7
2017			0.8	19.7	0	9.6	45.7	28.9	0.0	104.7	0.1	1.8	0	0.3	1.2	3.7	7.1	111.8
2018			0.7	18.9	0	7.3	36.9	25.9	0.0	89.7	0.3	1.3		0.3	2.1	3.1	7.0	96.7
2019	0	0.8	0.7	15.6	0	6.8	36.9	21.5	0.0	82.3	0.2	0.9		0.3	1.4	2.1	4.9	87.2
2020			0.6	13.1	0	4.1	35.1	19.7	0.0	72.6	0.3	0.3		0.3	1.1	2.0	4.0	76.5
2021			0.8	9.3	0	3.8	33.4	20.8	0.0	68.1	0.1	0.3		0.6	0.9	1.1	3.1	71.1
2022			1.1	11.1	0	3.8	27.7	23.7	0.0	67.4	0.1	0.2		0.1	0.3	1.2	2.0	69.4

[1]Divisions 3.a and 4.b,c are included in columns 3, 4 and 6 only after 1976. There are some unallocated landings (moreover for the period 1961-1970).

[2]Discard estimates from observer programmes. In 2003-2022 partial discard estimates are available and used in the assessment. For the remaining years for which no values are present, some estimates are available but not considered valid and, thus, not used in the assessment.

[3]From 1978 total catches used for the Working Group.

Table 9.2. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Discards and landings (in tonnes), number of length samples per catch category (NLgSp_D and NLgSp_L) and number of fishes measured per catch category (NLgMs_D and NLgMs_L) since 2013 for the fleets used in the assessment model.

Year	ss_fleet	Discards	Landings	NLgSp_D	NLgSp_L	NLgMs_D	NLgMs_L
2013	FRNEP8	1475	1219	0	0	0	0
2014	FRNEP8	391	1566	0	0	0	0
2015	FRNEP8	1134	1197	0	0	0	0
2016	FRNEP8	2310	973	39	51	1414	1627
2017	FRNEP8	1819	1124	31	53	1073	1360
2018	FRNEP8	889	1029	26	92	832	3495
2019	FRNEP8	816	1131	26	75	811	2365
2020	FRNEP8	1193	1076	20	42	551	1031
2021	FRNEP8	144	711	5	36	412	1460
2022	FRNEP8	478	773	20	51	941	1506
2013	GILLNET	1257	15671	0	31	0	12133
2014	GILLNET	65	22549	27	412	164	27691
2015	GILLNET	857	16876	29	501	218	28777
2016	GILLNET	1175	25017	475	855	4964	49702
2017	GILLNET	653	25299	228	574	2406	32823
2018	GILLNET	1014	25848	459	526	3339	38290
2019	GILLNET	333	24800	219	536	1803	34874
2020	GILLNET	444	23003	139	516	3364	20521
2021	GILLNET	626	24138	329	717	1960	25992
2022	GILLNET	396	25474	359	539	1816	24166
2013	LONGLINE		14516		51		24319
2014	LONGLINE	1	26289	0	77	0	37386
2015	LONGLINE	559	36881	0	59	0	26655
2016	LONGLINE	2	31390	0	126	0	42003
2017	LONGLINE	1	29728	0	113	0	28754
2018	LONGLINE	4	20710	0	101	0	33141
2019	LONGLINE	0	19112	0	99	0	30853
2020	LONGLINE	0	18869	0	17	0	1693

Year	ss_fleet	Discards	Landings	NLgSp_D	NLgSp_L	NLgMs_D	NLgMs_L
2021	LONGLINE	0	18663	0	65	0	23197
2022	LONGLINE	0	15024	0	62	0	25332
2013	NSTRAWL	4788	9680	130	152	7103	7898
2014	NSTRAWL	4268	11124	211	415	8109	7017
2015	NSTRAWL	3566	13498	197	411	10932	6460
2016	NSTRAWL	4621	17159	484	463	10706	16643
2017	NSTRAWL	2239	15142	392	405	8942	11714
2018	NSTRAWL	1808	13478	485	505	14992	14899
2019	NSTRAWL	1448	13014	394	427	11436	13380
2020	NSTRAWL	906	8575	209	315	5651	10975
2021	NSTRAWL	1067	6956	249	382	7836	15667
2022	NSTRAWL	376	7822	297	503	2226	20177
2013	OTHERS	1499	35324	15	176	179	12556
2014	OTHERS	739	15041	77	448	1835	13881
2015	OTHERS	589	10016	60	484	232	6588
2016	OTHERS	66	15940	46	371	432	17774
2017	OTHERS	87	16229	21	172	396	6017
2018	OTHERS	136	14918	36	297	2032	12364
2019	OTHERS	368	13423	32	169	5021	9496
2020	OTHERS	418	11120	32	201	3257	7737
2021	OTHERS	412	8666	48	163	1464	8999
2022	OTHERS	32	9671	42	190	291	11906
2013	SPTRAWL7	3495	1948	300	61	2518	13864
2014	SPTRAWL7	1467	1991	310	77	1433	17568
2015	SPTRAWL7	2064	1975	268	52	2125	13773
2016	SPTRAWL7	616	2099	357	48	1208	10898
2017	SPTRAWL7	651	1711	340	56	3014	18703
2018	SPTRAWL7	903	1850	324	57	3063	19211
2019	SPTRAWL7	318	1891	193	51	1340	14001

Year	ss_fleet	Discards	Landings	NLgSp_D	NLgSp_L	NLgMs_D	NLgMs_L
2020	SPTRAWL7	157	2351	48	5	113	1243
2021	SPTRAWL7	87	1729	202	48	151	10641
2022	SPTRAWL7	38	1377	215	47	59	10181
2013	SPTRAWL8		1988		38		5138
2014	SPTRAWL8	183	2720	287	44	1610	7360
2015	SPTRAWL8	589	4405	0	43	0	9181
2016	SPTRAWL8	656	3647	95	43	3008	9482
2017	SPTRAWL8	906	4622	296	45	9240	9859
2018	SPTRAWL8	347	3467	280	53	3748	10526
2019	SPTRAWL8	586	2956	299	58	5390	5829
2020	SPTRAWL8	310	2768	213	47	2825	5652
2021	SPTRAWL8	153	2094	291	79	1746	10914
2022	SPTRAWL8	318	1951	232	168	2968	15778
2013	TRAWLOTH_CRU	745	483	0	0	0	0
2014	TRAWLOTH_CRU	23	644	17	26	8	229
2015	TRAWLOTH_CRU	236	330	28	23	1176	985
2016	TRAWLOTH_CRU	102	334	348	168	10453	6081
2017	TRAWLOTH_CRU	15	337	53	103	423	2688
2018	TRAWLOTH_CRU	103	245	576	103	30872	1668
2019	TRAWLOTH_CRU	109	170	48	14	2488	777
2020	TRAWLOTH_CRU	70	94	80	77	816	920
2021	TRAWLOTH_CRU	77	99	125	7	1243	453
2022	TRAWLOTH_CRU	84	160	56	6	904	361
2013	TRAWLOTH_DEF	2191	5319	0	0	0	0
2014	TRAWLOTH_DEF	2695	8015	461	791	24064	7612
2015	TRAWLOTH_DEF	1328	9862	353	381	10473	5781
2016	TRAWLOTH_DEF	1567	10987	1019	1255	26737	29927
2017	TRAWLOTH_DEF	729	10478	116	492	12694	9044
2018	TRAWLOTH_DEF	1834	8150	960	729	40645	19380

Year	ss_fleet	Discards	Landings	NLgSp_D	NLgSp_L	NLgMs_D	NLgMs_L
2019	TRAWLOTH_DEF	961	5800	360	512	11246	10422
2020	TRAWLOTH_DEF	458	4722	108	193	6667	6040
2021	TRAWLOTH_DEF	519	5001	236	226	10432	9694
2022	TRAWLOTH_DEF	230	5179	170	316	5991	11066

Table 9.3: Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Catches (C) and length-frequency distribution (LFD) by Fishery Unit (FU) provided in 2022. See Stock Annex for FU definition.

FU	Quarter	Denmark	France	Ireland	Others	Spain	UK (England)	UK(Scotland)
FU1-2	1	0	C	0	0	C+LFD	C	0
FU1-2	2	0	C	0	0	C+LFD	0	0
FU1-2	3	0	C	0	0	C+LFD	C	0
FU1-2	4	0	C	0	0	C+LFD	0	0
FU03	1	0	C	C+LFD	0	C+LFD	C+LFD	0
FU03	2	0	C	C+LFD	0	C+LFD	C+LFD	0
FU03	3	0	C+LFD	C+LFD	C	C+LFD	C+LFD	0
FU03	4	0	C	C+LFD	0	C+LFD	C+LFD	0
FU4-6	1	C	C+LFD	C+LFD	C	C+LFD	C+LFD	0
FU4-6	2	0	C+LFD	C+LFD	C+LFD	C+LFD	C+LFD	0
FU4-6	3	0	C+LFD	C+LFD	C+LFD	C+LFD	C+LFD	0
FU4-6	4	0	C+LFD	C+LFD	C+LFD	C+LFD	C+LFD	0
FU8	1	0	C	C+LFD	C	0	C	0
FU8	2	0	C	C+LFD	C	0	C	0
FU8	3	0	C	C+LFD	C	0	C	0
FU8	4	0	C	C+LFD	C	0	0	0
FU9	1	0	C	0	0	0	0	0
FU9	2	0	C	0	0	0	0	0
FU9	3	0	C	0	0	0	0	0
FU9	4	0	C	0	0	0	0	0
FU10+14	1	C	C+LFD	0	0	C+LFD	0	0
FU10+14	2	0	C+LFD	0	0	C+LFD	0	0
FU10+14	3	0	C+LFD	0	0	C+LFD	0	0
FU10+14	4	0	C+LFD	0	C	C+LFD	0	0
FU12	1	0	C	0	0	C+LFD	0	0
FU12	2	0	C+LFD	0	0	C+LFD	0	0
FU12	3	0	C+LFD	0	0	C+LFD	0	0

FU	Quarter	Denmark	France	Ireland	Others	Spain	UK (England)	UK(Scotland)
FU12	4	0	C	0	0	C+LFD	0	0
FU13	1	0	C+LFD	0	0	C+LFD	0	0
FU13	2	0	C+LFD	0	0	C+LFD	0	0
FU13	3	0	C+LFD	0	0	C+LFD	0	0
FU13	4	0	C+LFD	0	0	C+LFD	0	0
FU15	1	0	C	C+LFD	C	0	C	0
FU15	2	0	C	C+LFD	C	0	C	0
FU15	3	0	C	C+LFD	C	0	C	0
FU15	4	0	C	C+LFD	C	0	C	0
FU16	1	C+LFD	C+LFD	C+LFD	C+LFD	C+LFD	C	C+LFD
FU16	2	C+LFD	C+LFD	C+LFD	C	C+LFD	C	C+LFD
FU16	3	C+LFD	C+LFD	C+LFD	C+LFD	C+LFD	C	C+LFD
FU16	4	C+LFD	C+LFD	C+LFD	C+LFD	C+LFD	C	C+LFD

Table 9.4: Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Summary of landings (model fit) and assessment results.

Year	Recruits Age 0 ('000')	Total Biomass ('000')	Female-only SSB (t)	Landings (t)	Discards (t)	Catch (t)	Yield/SSB (%)	F_{1-7}
1978	683384	165738	79678	50551		50551	0.63	0.30
1979	694062	171170	90001	51096		51096	0.57	0.32
1980	838409	166483	92412	57265		57265	0.62	0.38
1981	1178220	152523	84415	53918		53918	0.64	0.38
1982	613194	154552	76401	54994		54994	0.72	0.36
1983	376535	162446	78605	57507		57507	0.73	0.37
1984	625493	155039	82363	63286		63286	0.77	0.44
1985	1110400	128744	70232	56099		56099	0.80	0.48
1986	650651	119970	55495	57092		57092	1.03	0.53
1987	854130	124285	50024	63369		63369	1.27	0.59
1988	775284	127134	51496	64823		64823	1.26	0.60
1989	712232	129229	50794	66473	68	66541	1.31	0.60
1990	683428	123210	51031	59954		59954	1.17	0.54
1991	456869	118656	50914	58129		58129	1.14	0.55
1992	618270	108215	47844	56617		56617	1.18	0.60
1993	910533	93303	41172	52144		52144	1.27	0.64
1994	519549	93170	33741	51259	356	51615	1.53	0.65
1995	308226	97494	35832	57621		57621	1.61	0.71
1996	840607	84850	36444	47210		47210	1.30	0.66
1997	412236	78932	30619	42465		42465	1.39	0.62
1998	732870	80941	29600	35060		35060	1.18	0.50
1999	366861	90687	36011	39814	349	40163	1.12	0.52
2000	443510	95478	39077	42026	77	42103	1.08	0.52
2001	758858	91748	40777	36675		36675	0.90	0.45
2002	592672	97105	40143	40107		40107	1.00	0.48
2003	446780	102157	41882	43162	2110	45272	1.08	0.51
2004	1103400	103335	44512	46417	2548	48965	1.10	0.54
2005	572275	107635	42954	46550	4676	51226	1.19	0.55

Year	Recruits Age 0 ('000')	Total Bio-mass ('000')	Female-only SSB (t)	Landings (t)	Discards (t)	Catch (t)	Yield/SSB (%)	F_{1-7}
2006	1194990	125772	45709	41467	1816	43283	0.95	0.40
2007	2177390	155753	63972	45028	2191	47219	0.74	0.32
2008	1705790	215564	82017	47739	3248	50987	0.62	0.25
2009	544279	331546	125263	58818	10590	69408	0.55	0.21
2010	936255	422679	201808	72799	9978	82777	0.41	0.185
2011	1073530	457676	253369	87540	14156	101696	0.40	0.190
2012	2030650	453682	253728	85677	12680	98357	0.39	0.173
2013	931884	470317	248746	77343	11098	88441	0.36	0.159
2014	654020	510863	267045	89940	12131	102071	0.38	0.171
2015	830926	517217	293823	95043	14446	109489	0.37	0.185
2016	1155580	482595	288515	107547	16041	123588	0.43	0.22
2017	1009600	430998	251115	104670	10488	115158	0.46	0.23
2018	693924	393243	218651	89695	9934	99629	0.46	0.22
2019	728183	374384	205621	82298	6966	89264	0.43	0.21
2020	419888	358379	199765	72579	6946	79525	0.40	0.192
2021	534789	337996	194941	68061	6738	74799	0.38	0.183
2022	439104	310282	183432	67433	3241	70674	0.39	0.191
2023	862134	280323	163204					
Arithmetic mean	800040	216380	109678	61008	6786	64627	0.84	0.40

Table 9.5: Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Catch option table.

Rec 2023	$F_{1\text{-}7}$ 2023	Catch 2023	Land 2023	SSB 2024	Rec 2024
862,134	0.189	64,096	60,388	147,052	855,364

$F_{multiplier}$	$F_{1\text{-}7}$ catch (2024)	$F_{1\text{-}7}$ landings (2024)	$F_{1\text{-}7}$ discards (2024)	Catch (2024)	Landings (2024)	Discards (2024)	SSB (2025)
0.0	0.00	0.00	0.00	0	0	0	176,869
0.1	0.0123	0.0115	0.00082	4,271	3,988	283	174,037
0.2	0.031	0.029	0.0021	10,548	9,844	703	169,883
0.3	0.049	0.046	0.0033	16,672	15,554	1,119	165,840
0.4	0.068	0.063	0.0046	22,649	21,120	1,529	161,906
0.5	0.086	0.080	0.0059	28,481	26,547	1,934	158,077
0.6	0.105	0.098	0.0072	34,174	31,839	2,335	154,350
0.7	0.129	0.120	0.0089	41,552	38,690	2,862	149,536
0.8	0.148	0.137	0.0102	46,931	43,680	3,252	146,036
0.9	0.168	0.156	0.0117	52,729	49,052	3,677	142,276
1.0	0.187	0.173	0.0131	57,857	53,798	4,059	138,960
1.1	0.20	0.190	0.0145	62,862	58,427	4,436	135,732
1.2	0.22	0.21	0.0159	67,749	62,941	4,808	132,590
1.3	0.24	0.22	0.0173	72,520	67,343	5,177	129,530
1.4	0.26	0.24	0.0187	77,179	71,638	5,541	126,551
1.5	0.28	0.26	0.020	81,728	75,827	5,901	123,651
1.6	0.30	0.28	0.022	86,171	79,913	6,257	120,826
1.7	0.32	0.29	0.023	90,509	83,900	6,610	118,076
1.8	0.33	0.31	0.024	94,747	87,789	6,958	115,398
1.9	0.35	0.33	0.026	98,885	91,583	7,302	112,789
2.0	0.37	0.34	0.027	102,928	95,285	7,643	110,248

Table 9.6: Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Yield-per-recruit (YPR) table.

SPR-level	$F_{multiplier}$	F_{1-7}	YPR-catch	SSB-PR
1.00	0.0	0.0000	0.0000	0.780
0.93	0.1	0.0078	0.0098	0.720
0.80	0.2	0.0250	0.0270	0.620
0.74	0.3	0.0330	0.0340	0.580
0.60	0.5	0.0600	0.0510	0.470
0.54	0.6	0.0760	0.0590	0.420
0.50	0.7	0.0870	0.0630	0.390
0.44	0.8	0.1070	0.0690	0.340
0.43	0.9	0.1140	0.0710	0.330
0.40	1.0	0.1240	0.0730	0.310
0.36	1.1	0.1430	0.0760	0.280
0.35	1.2	0.1510	0.0780	0.270
0.31	1.4	0.1730	0.0800	0.240
0.29	1.5	0.1890	0.0820	0.220
0.25	1.7	0.2200	0.0840	0.197
0.24	1.8	0.2300	0.0840	0.189
0.22	2.0	0.2500	0.0850	0.174
SPR-level	$F_{multiplier}$	F_{1-7}	YPR-catch	SSB-PR
0.29	1.5	0.189	0.082	0.220
0.29	1.5	0.189	0.082	0.220
0.35	1.2	0.151	0.078	0.270
0.31	1.4	0.173	0.080	0.240
0.22	2.0	0.250	0.085	0.174

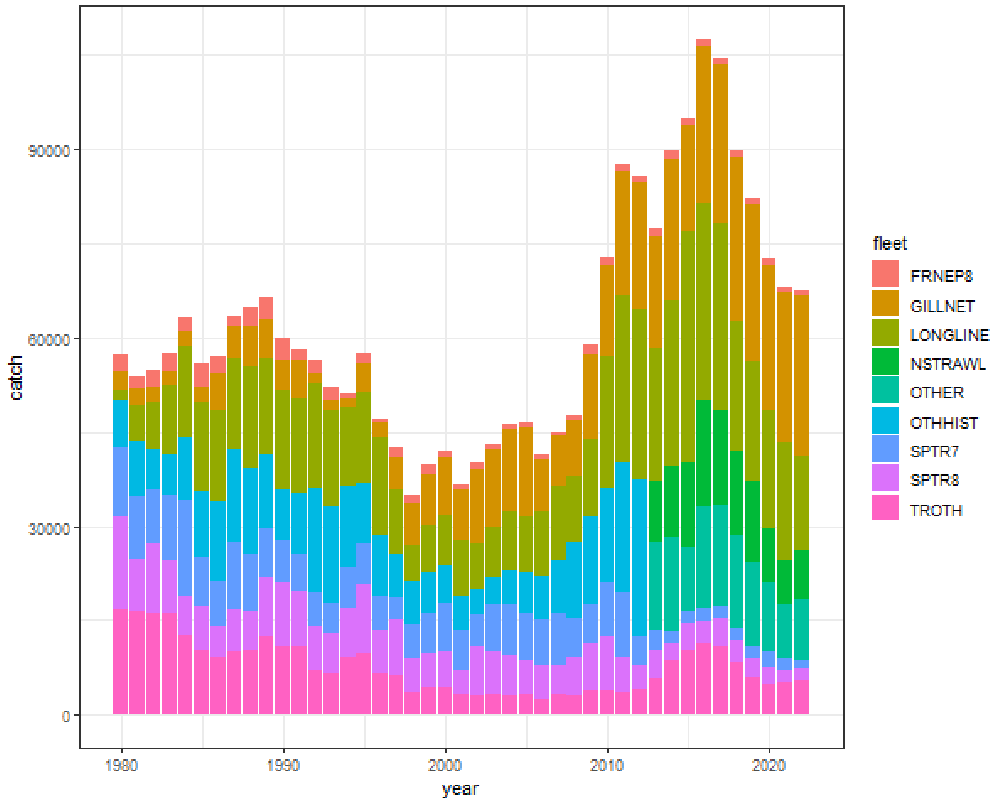

Figure 9.1. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Total catch (in tonnes) over time, the colours correspond to the fleets used in the assessment model configuration.

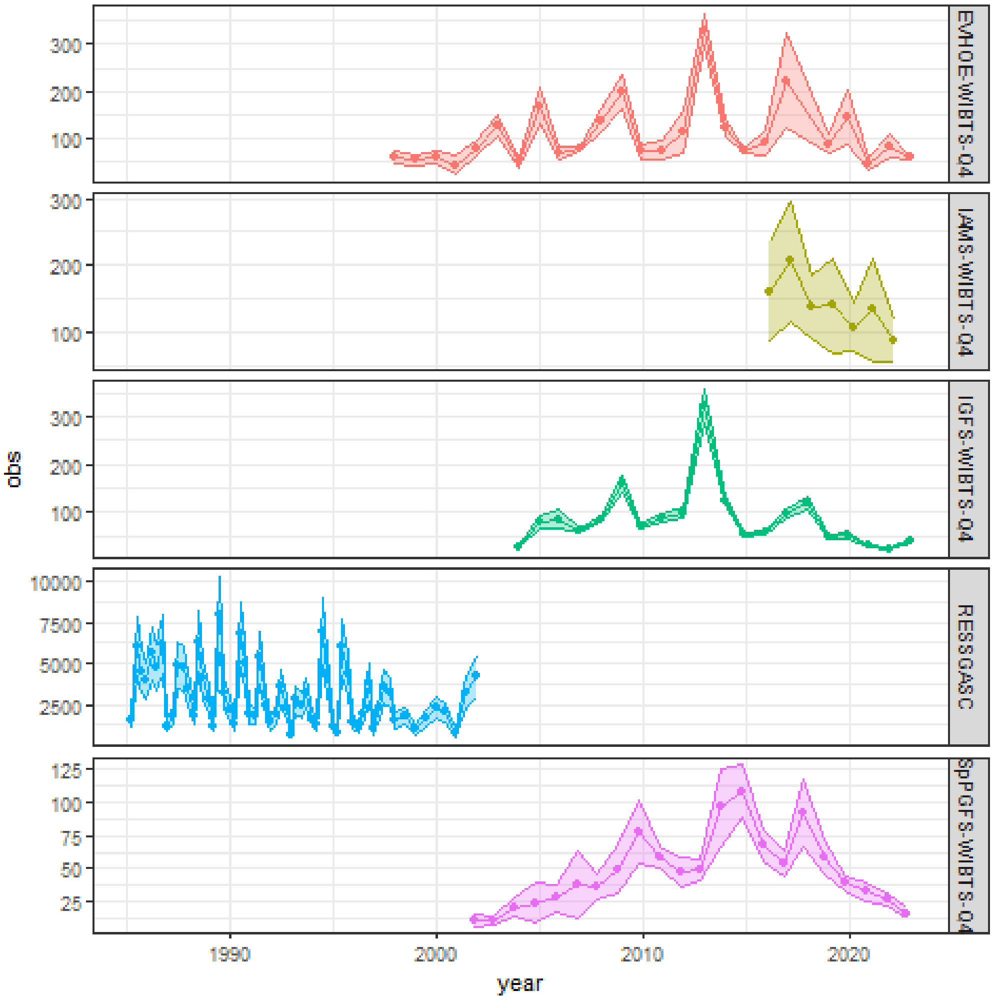

Figure 9.2: Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Abundance indices from surveys.

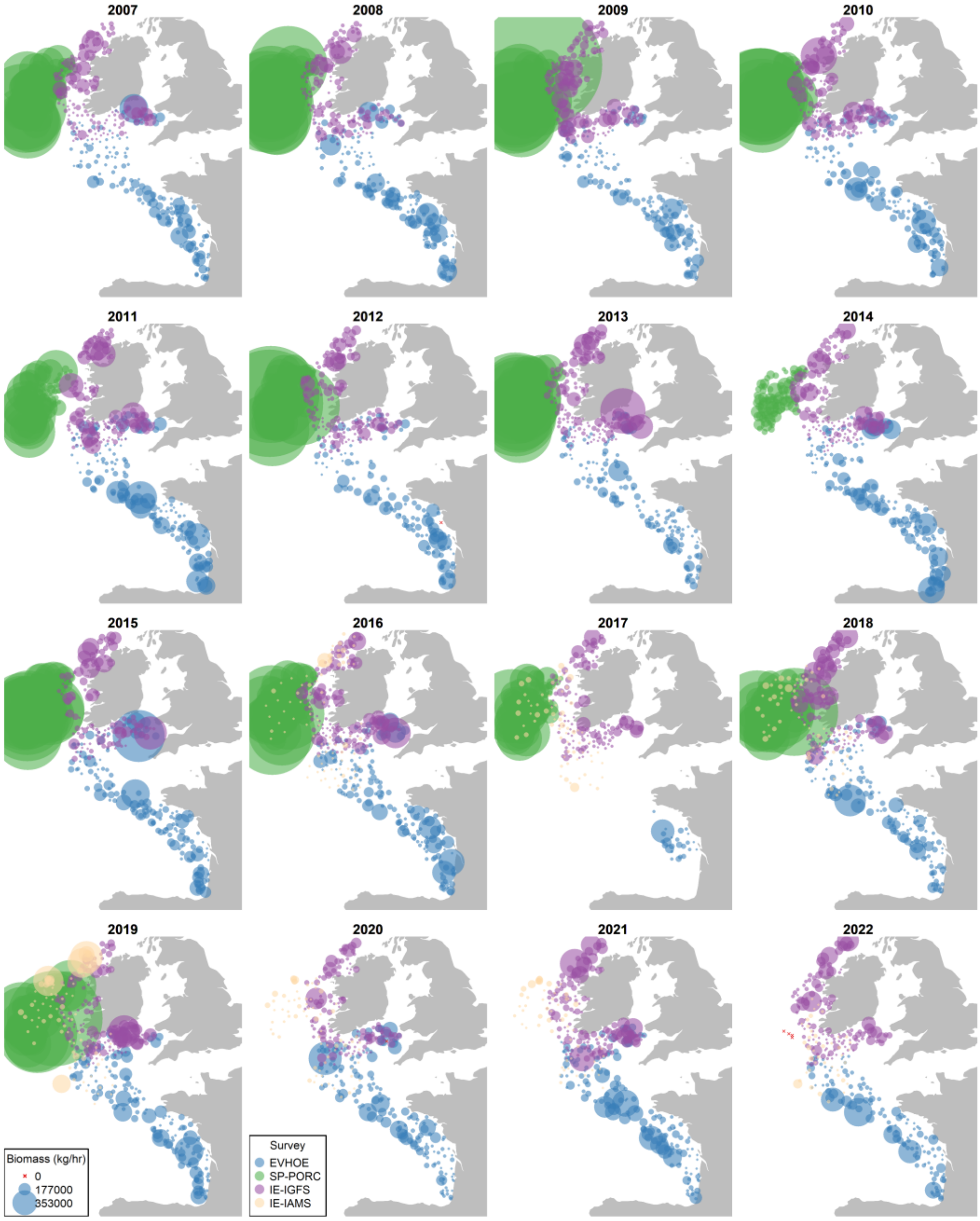

Figure 9.3. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Spatial distribution of the EVHOE-WIBTS-Q4 (G9527), IGFS-WIBTS-Q4 (G7212) and SpPGFS-WIBTS-Q4 (G5768) surveys' biomass (Kg/h) indices from 2006 to 2022. Note that surveys are not directly comparable due to the use of different gears with different catchabilities.

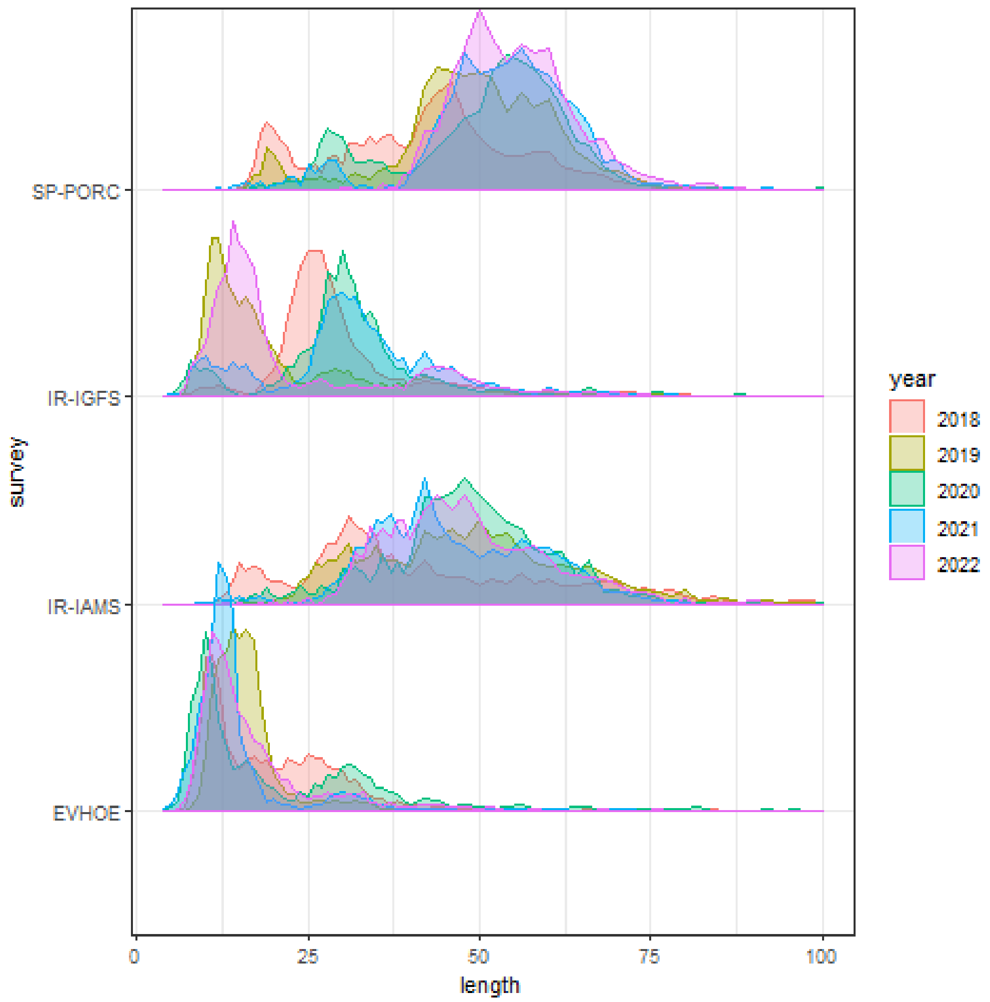

Figure 9.4: Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Length-frequency distribution of surveys in the most recent years, from 2017 to 2022.

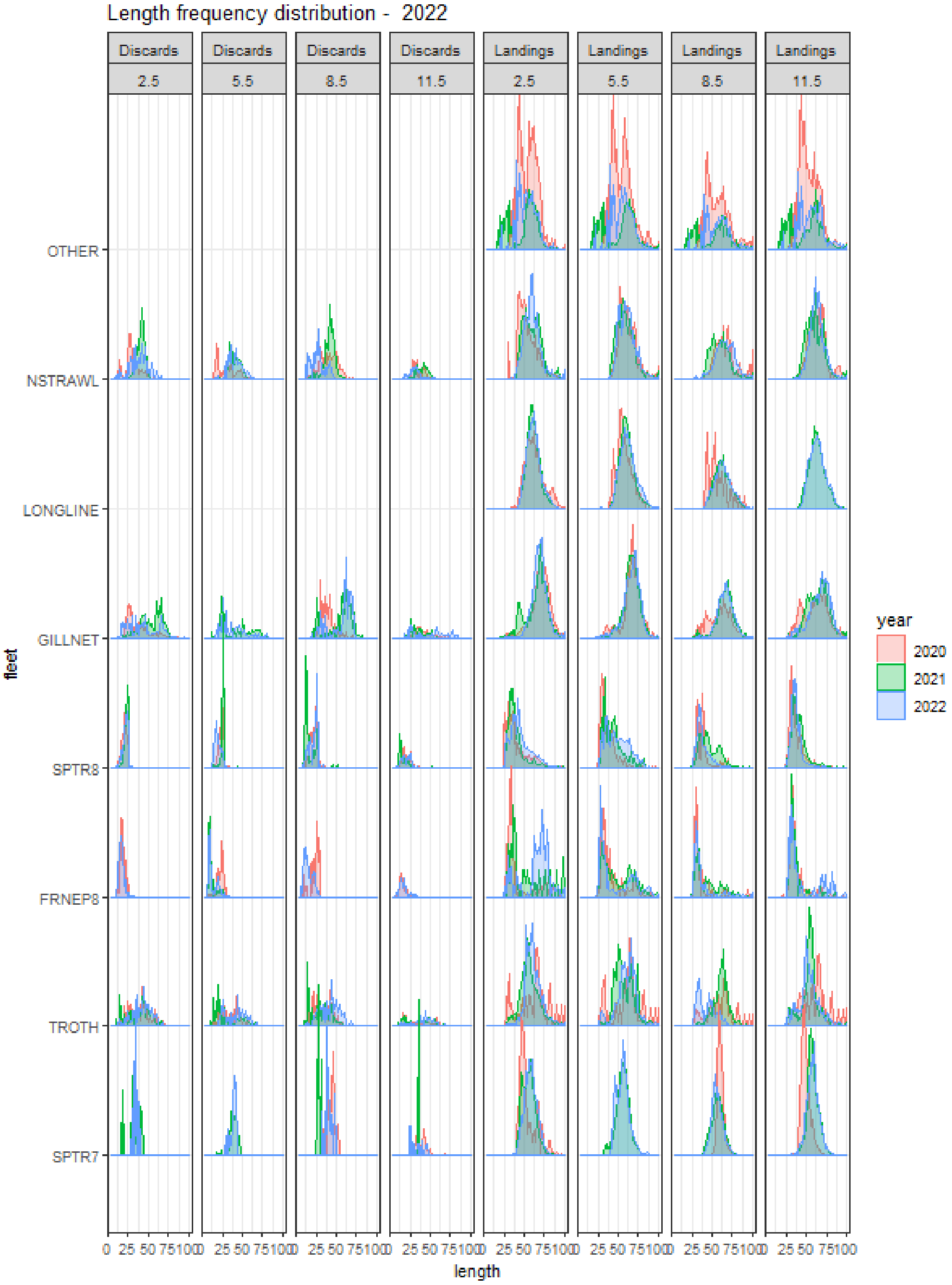

Figure 9.5. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Length-frequency distribution for landings and discards by fleet and by season (columns) in the most recent years, from 2019 to 2022, with the fleet as used in the assessment model configuration.

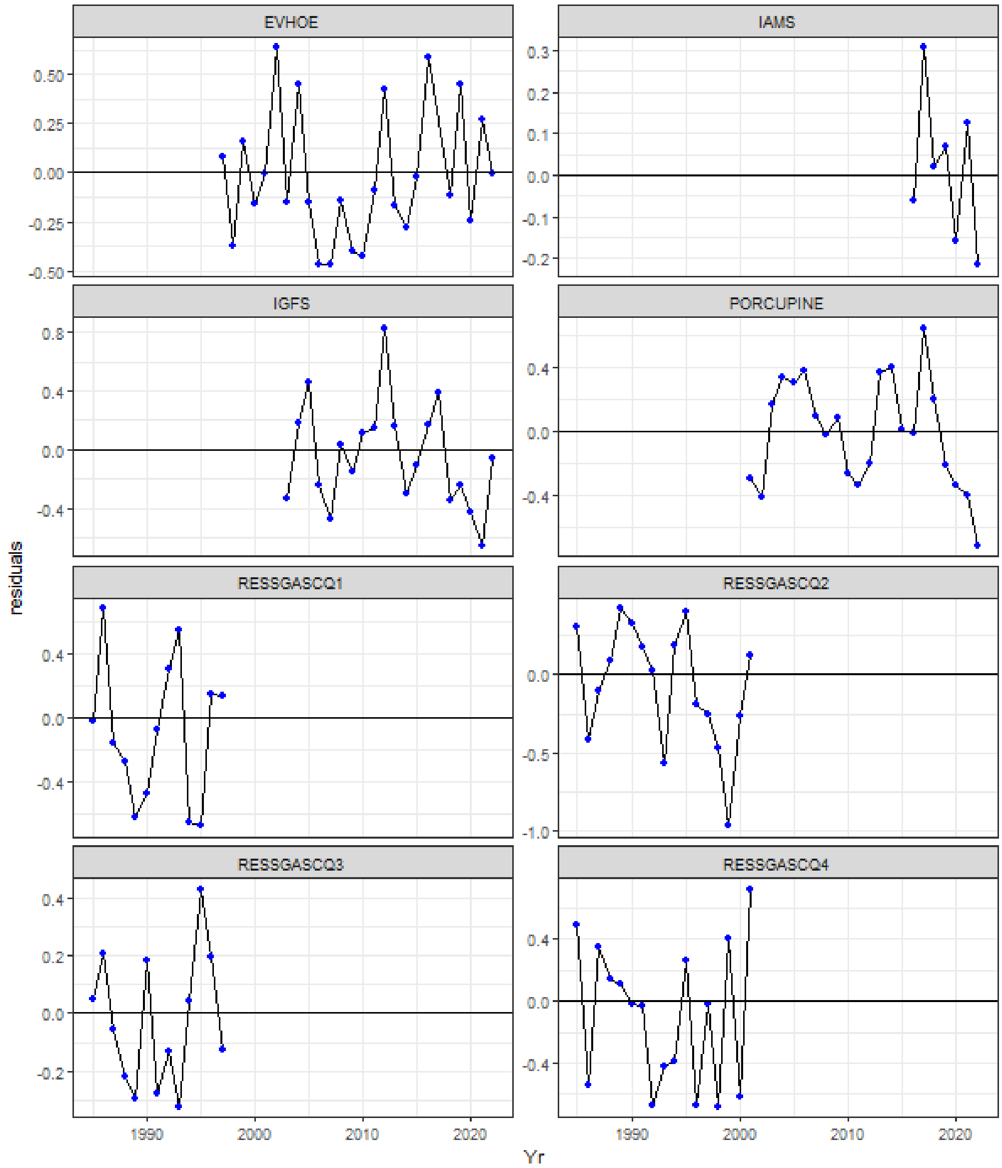

Figure 9.6. **Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Residuals of the fits to the surveys' log(abundance indices) for FR-RESSGASC (G2537), EVHOE-WIBTS-Q4 (G9527), SpPGFS-WIBTS-Q3 (G5768) and IGFS-WIBTS-Q4 (G7212) surveys. Fits are by quarter and sex.**

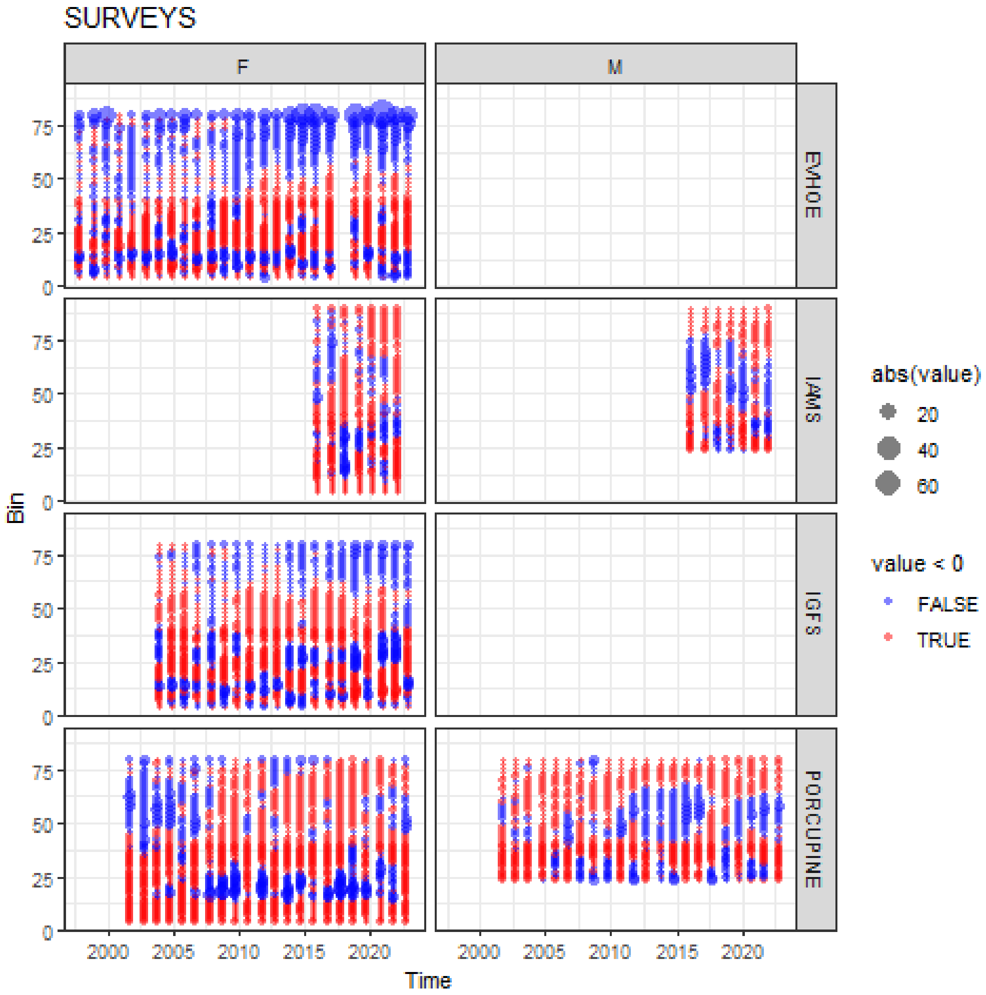

Figure 9.7. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Pearson residuals of the fit to the length distributions of the surveys' abundance indices by sex (F = females, M = males) for EVHOE (EVHOE-WIBTS-Q4), PORCUPINE (SPGFS-WIBTS-Q3, G576) and IGFS (IGFS-WIBTS-Q4, G5768). Fits are by quarter and sex.

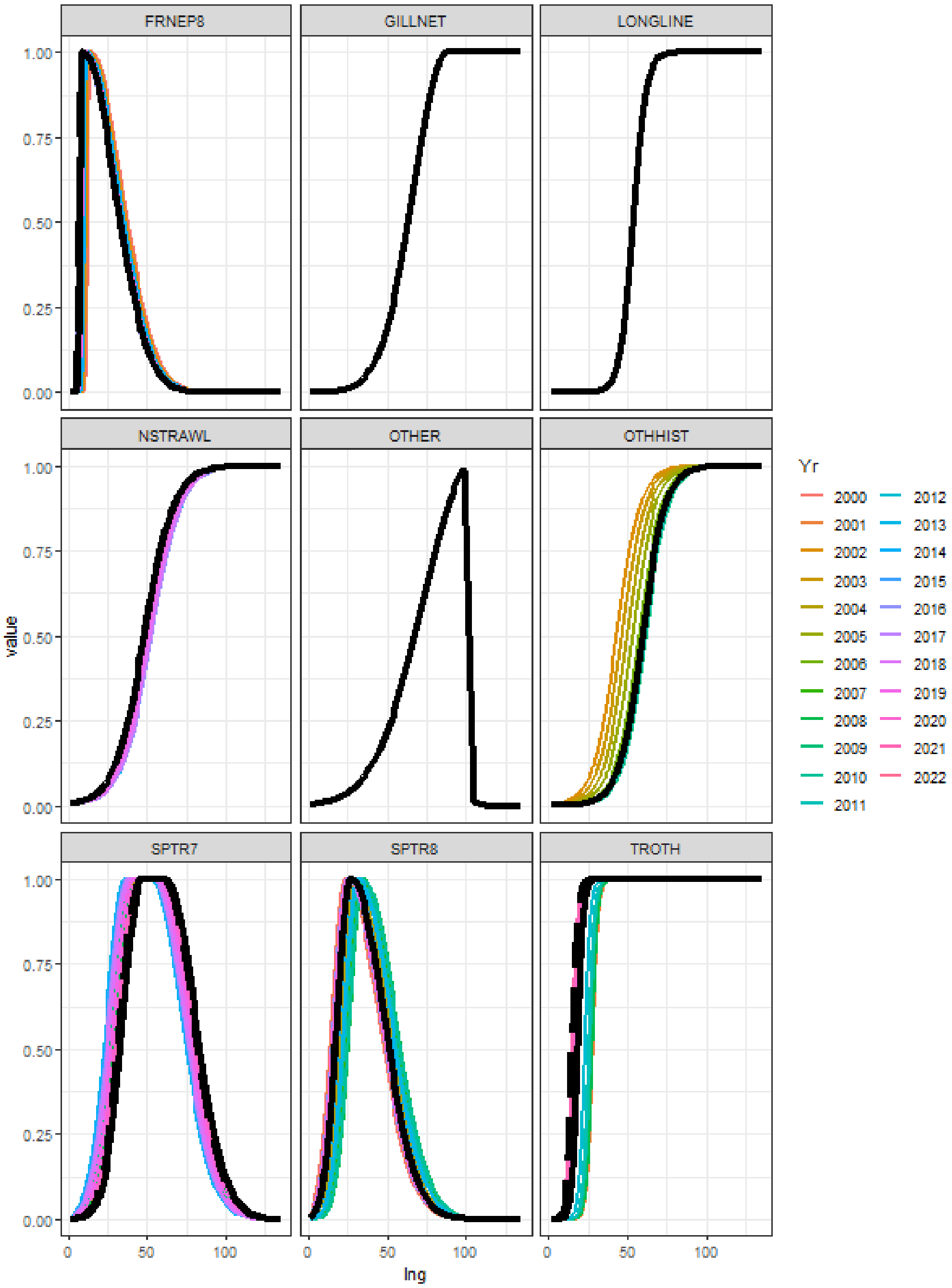

Figure 9.8. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Selection curves, by commercial fleet, estimated by the SS model. Selectivity trends for 2021 (dashed black line) and 2022 (solid black line).

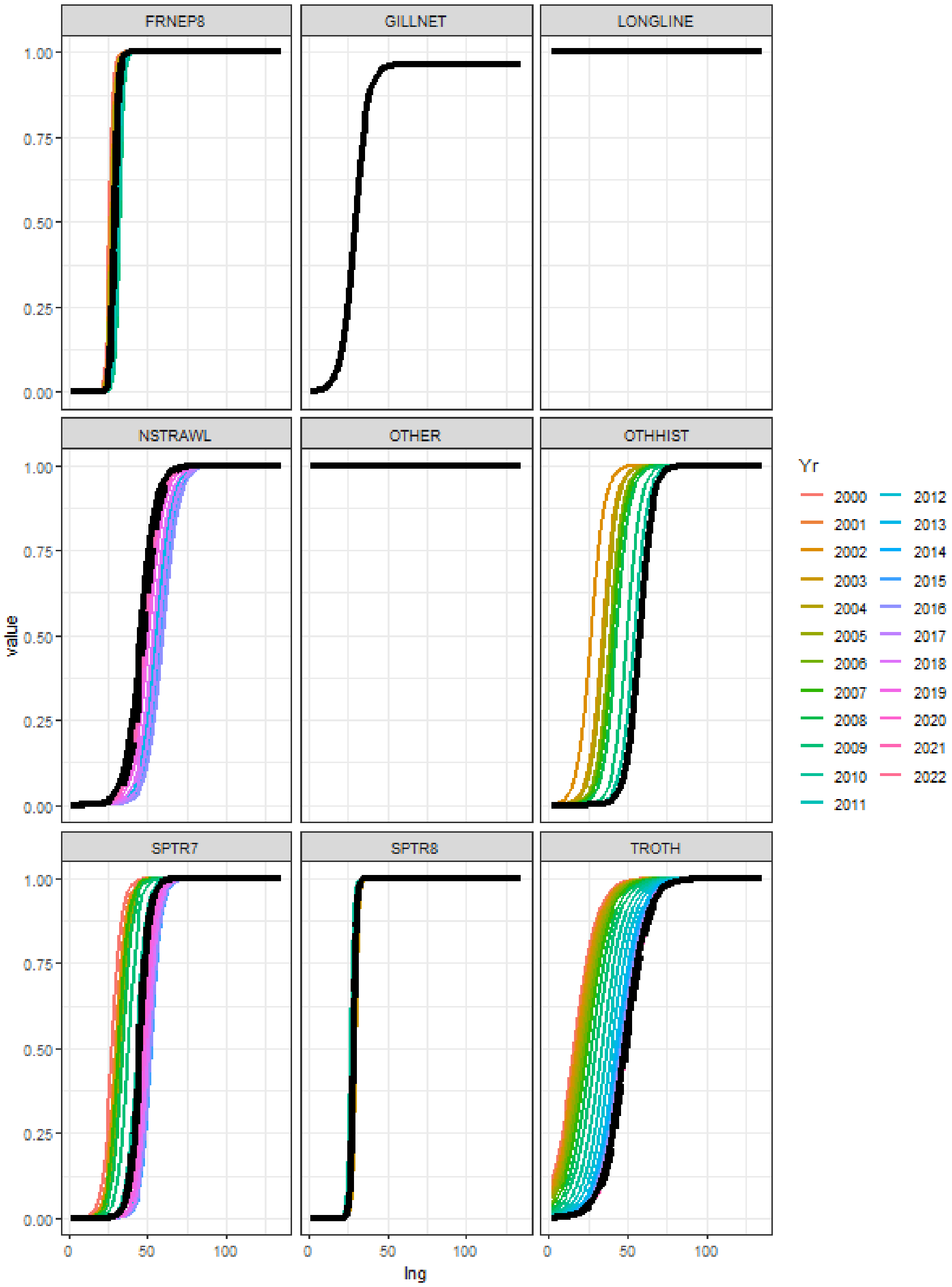

Figure 9.9. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Retention curves, by commercial fleet, estimated by the SS model. Retention trends for 2021 (dashed black line) and 2022 (solid black line).

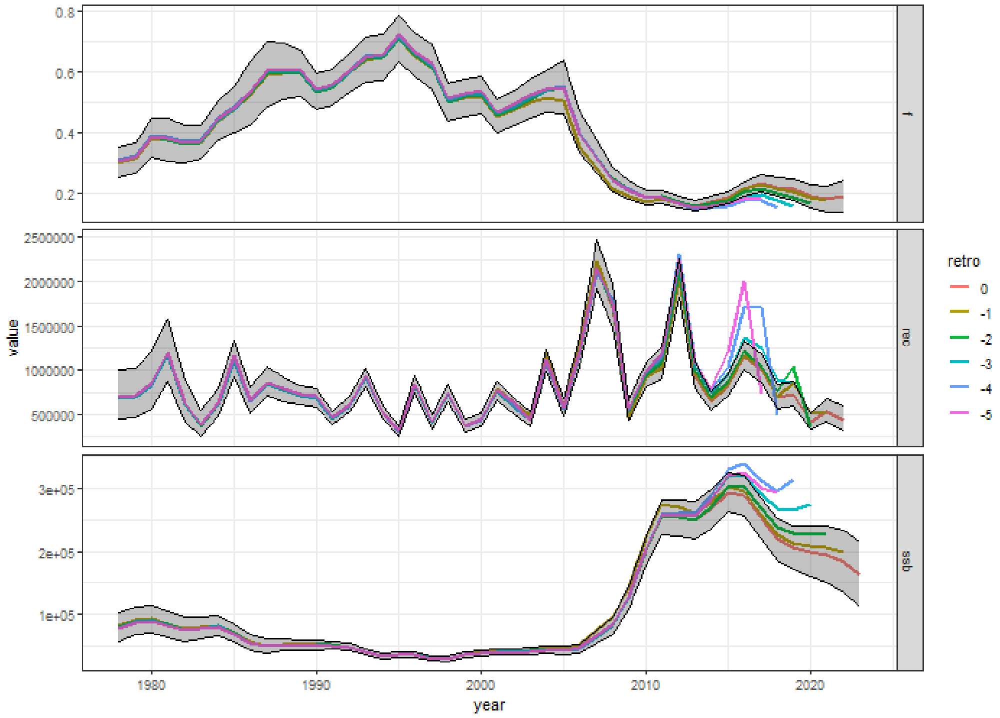

Figure 9.10. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Retrospective plot from the SS assessment model including the confidence intervals (CIs, grey trends).

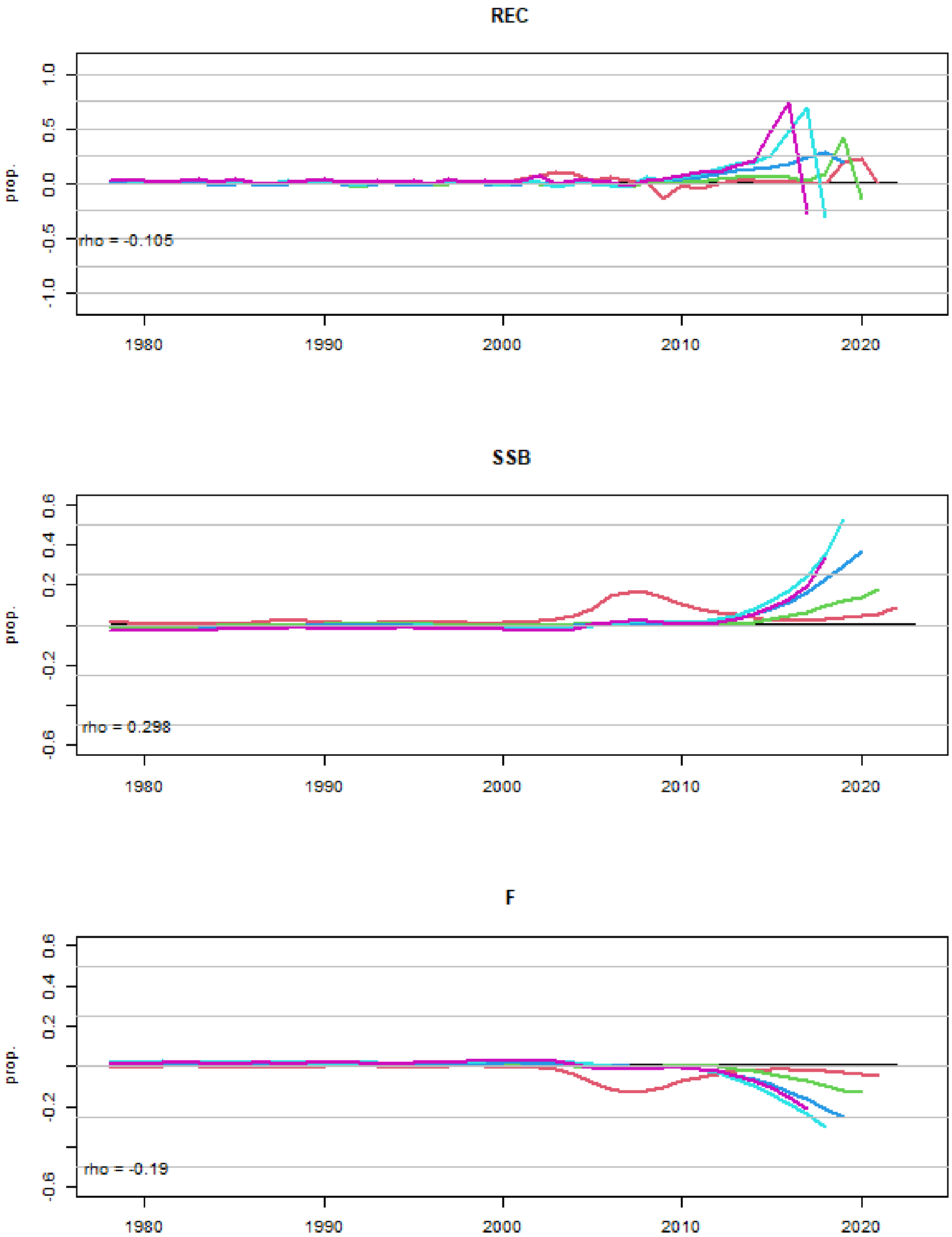

Figure 9.11. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Differences between the time-series in the retrospective analysis plot from the SS model for 2017-2022 using the configuration agreed during the WKANGHAKE benchmark (ICES, 2023a). The value in the bottom-left of each plot corresponds to the Mohn's rho estimates for 2022.

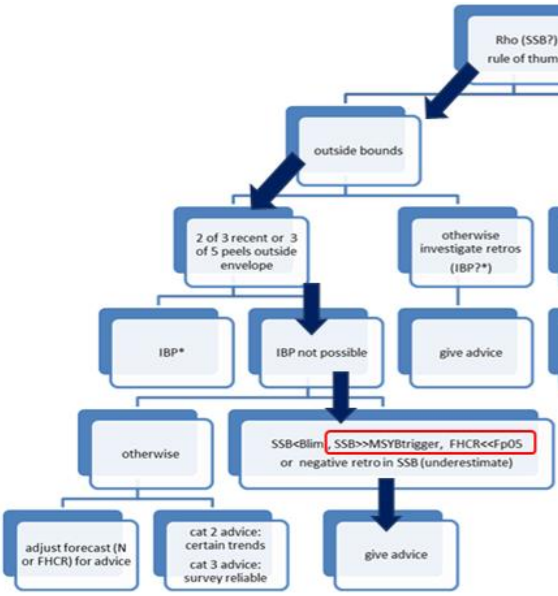

Figure 9.12. Schematic diagram from WKFORBIAS (ICES, 2020). Stepwise procedure pattern (solid blue arrows) implemented to produce the northern hake advice based on the SS assessment model for a given retrospective pattern.

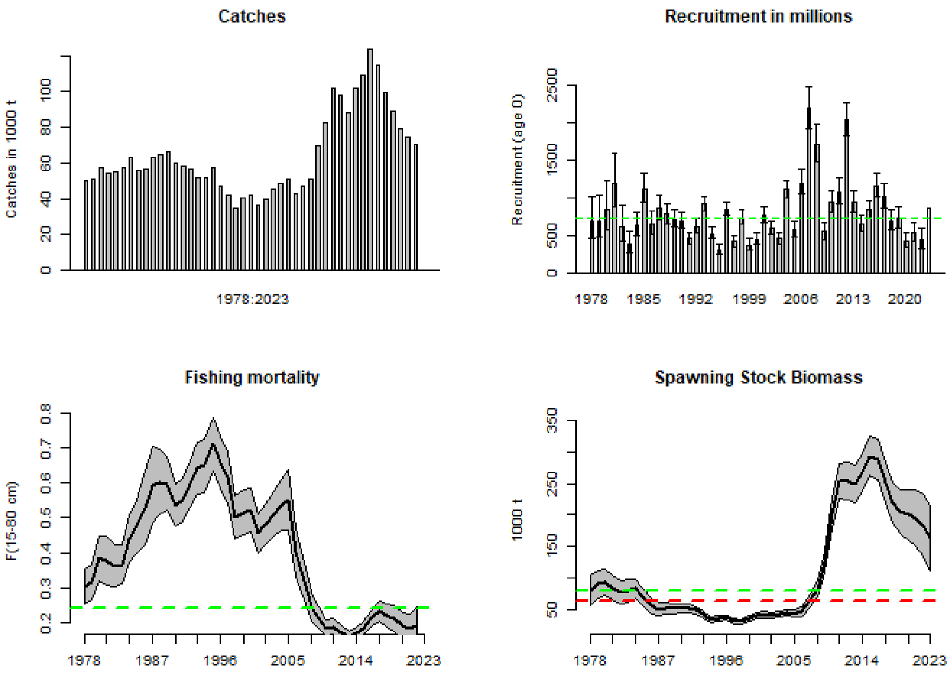

Figure 9.13. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Summary plot of the stock trends. Green dashed lines correspond to the geometric mean (GM) for recruitment (upper right), F_{MSY} (lower left) and, B_{lim} (lower right). Red dashed line (lower right) corresponds to B_{pa}.

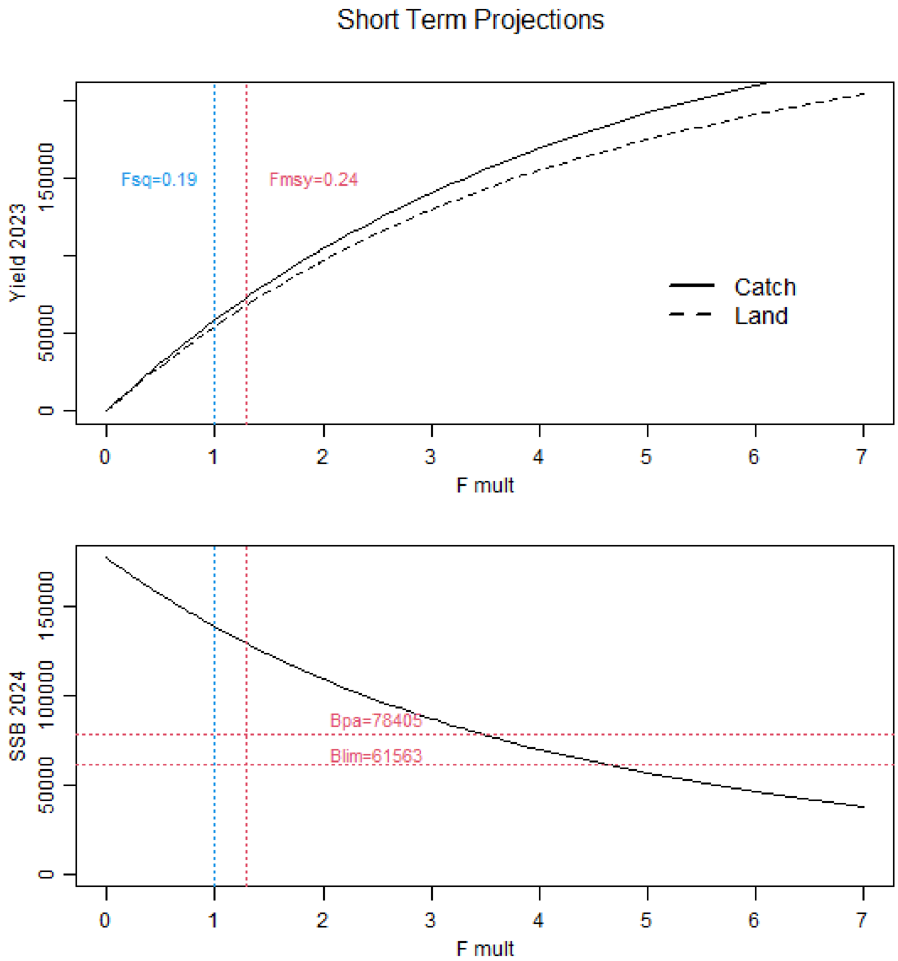

Figure 9.14. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Short term projections for yield and SSB. Vertical lines correspond to F_{MSY} (red) and the assumed $F_{statusquo}$ (blue). Red horizontal lines to B_{lim} and B_{pa}.

Figure 9.15: Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Summary plot of stock trends in the short-term forecast in the two latest assessments. Green lines correspond to current year assessment (solid line) and short-term forecast (dashed line) and red lines correspond to previous year ones (WGBIE2022; ICES, 2022).

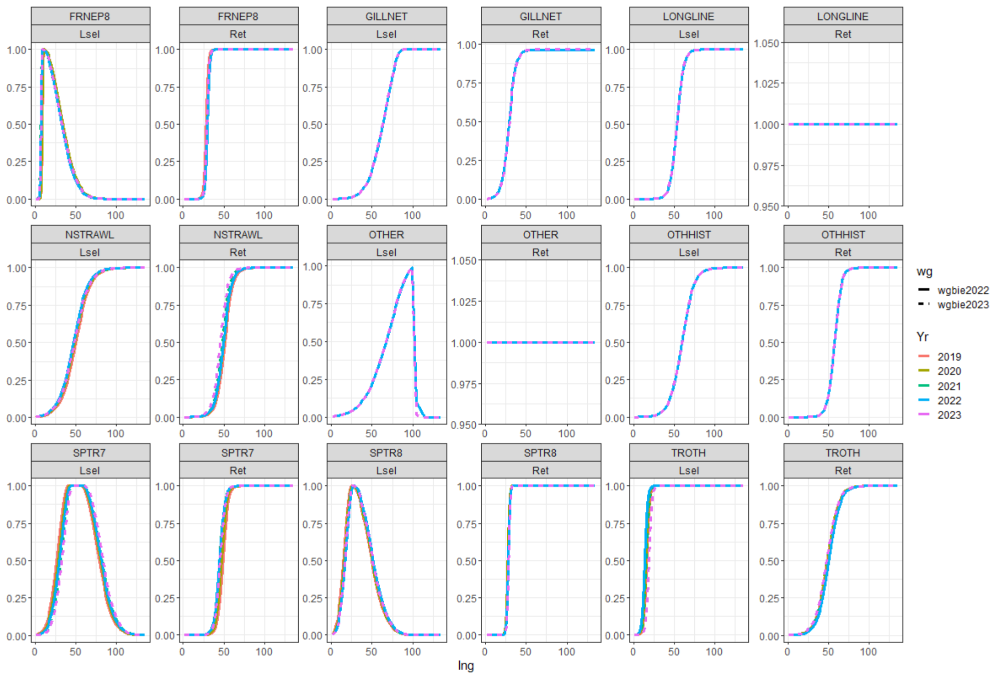

Figure 9.16: Hake (Merluccius merluccius) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Selectivity-at-length (Lsel) and retention (Ret) for the modelled fleets estimated by the current year assessment model (wgbie2023) and last year one (wgbie2022; ICES, 2022).

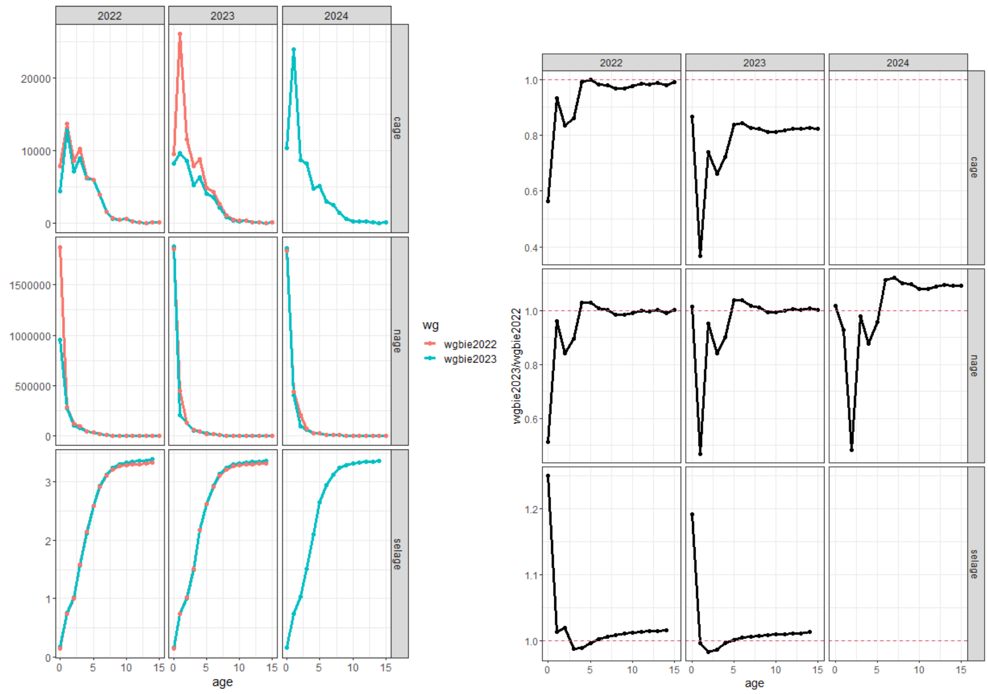

Figure 9.17. Hake *(Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Left plot: numbers-at-age in the catches (cage), in the population (nage) and selectivity-at-age estimated in the current year short-term forecast (wgbie2023, green) and in the year before (wgbie2022, red; ICES, 2022) Right: plot relative values (wgbie2023/wgbie2022).

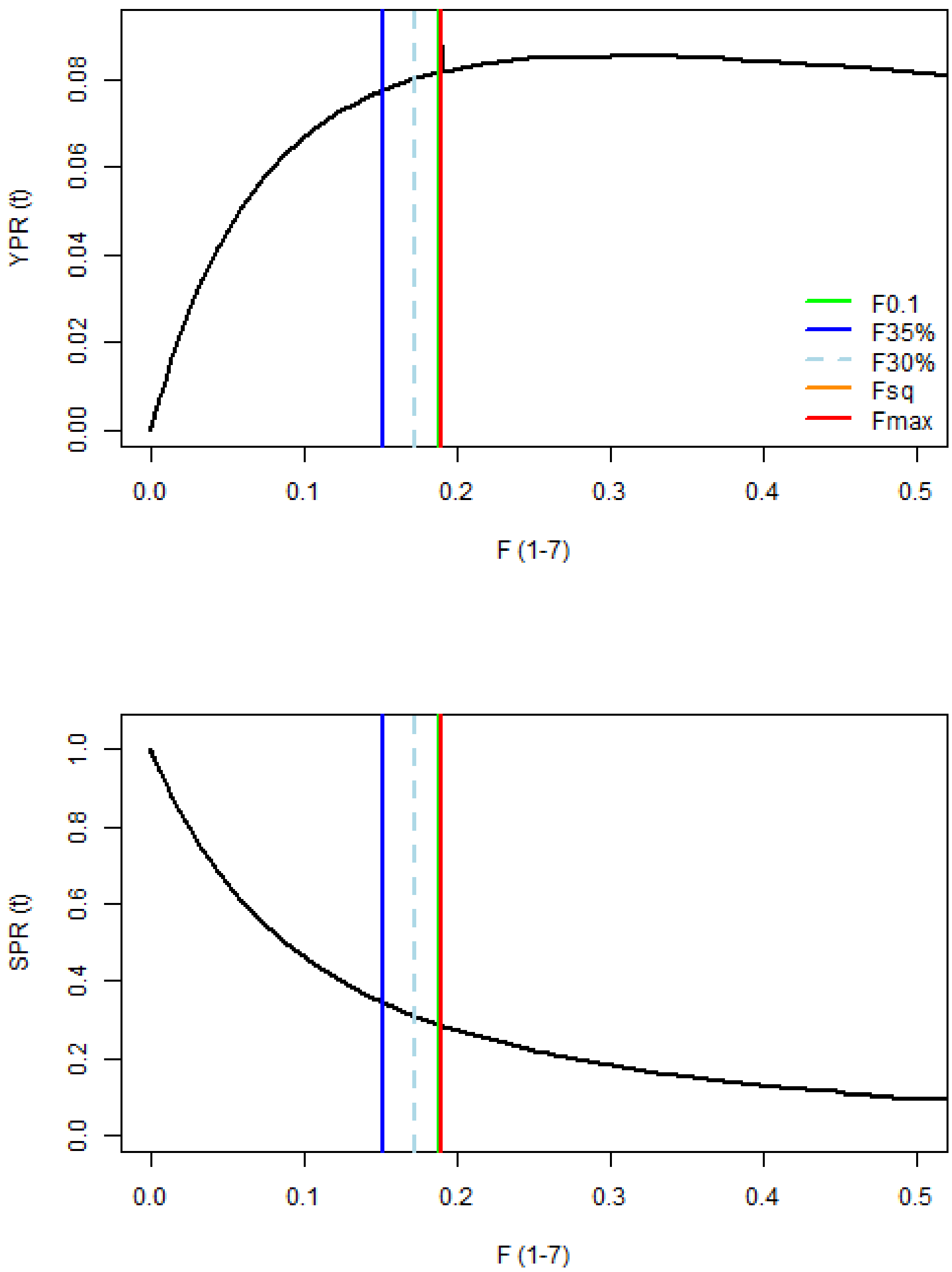

Figure 9.18. Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock. Yield-per-recruit analysis. Vertical lines correspond to $F_{0.1}$, $F_{35\%}$, $F_{30\%}$, F_{sq} and F_{max}.

10 Hake in Cantabrian Sea and Atlantic Iberian waters

hke.27.8c9a – *Merluccius merluccius* in divisions 8.c and 9.a, Southern stock

10.1 General

The assessment is carried out with the Stock Synthesis (SS) model developed in the most recent benchmark (ICES, 2023).

The assessment includes the 2022 data and minor revisions of surveys length frequency distribution or how these had been imputed in the SS model data file. More precisely, the 2020 length frequency distribution of the SPGFS-caut-WIBTS-Q4 (G4309) and SPGFS-cspr-WIBTS-Q1 surveys has been corrected after detecting some inconsistencies in the data. On the other hand, some inconsistencies in the SS data file length frequency distributions of the PtGFS-WIBTS-Q4 (G8899) and SpGFS-WIBTS-Q4 (G2784) have been detected too. More precisely, we noticed that the frequencies of the lengths smaller than 20 cm were the number of undetermined individuals instead of the sum of females, males and undetermined individuals. Hence, in our updated SS model this inconsistency has been corrected. Additionally, we also corrected an inconsistency in the females length distribution of SpGFS-WIBTS-Q4 (G2784) which consisted in a 2 positions displacement in length distribution frequencies, that is the frequency value assigned to 1cm was actually the one that corresponded to 3cm and so on. Finally, an inconsistency was also detected in the *nsamp* SS parameter (numbers of hauls) associated to the PtGFS-WIBTS-Q4 (G8899), specifically, the *nsamp* for years 2016, 2018 and 2021 have been revised from 86, 65, 102 to 85, 53 and 93, respectively.

10.1.1 Fishery description

The fishery description is available in the Stock Annex. Some minor inconsistencies in writing up the Stock Annex with respect to what was agreed upon in the WKANGHAKE benchmark (ICES, 2023) have been identified. These minor errors have now been corrected so that the Stock Annex exactly follows WKANGHAKE (modifications have been documented with track changes).

10.1.2 ICES advice for 2023 and management applicable to 2022 and 2023

10.1.2.1 ICES advice for 2023

ICES advises that when the EU multiannual plan (MAP) for the Western Waters and adjacent waters is applied, catches in 2023 that correspond to the F ranges in the plan are between 8322 tonnes and 15 925 tonnes. According to the MAP, catches higher than those corresponding to FMSY (11 791 tonnes) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying ICES advice rules.

10.1.2.2 Management applicable for 2022 and 2023

Hake is managed by a TAC, effort control and by technical measures. The agreed TAC for Southern Hake in 2022 was 7836 t but ICES received a special request from the European Commission to update the catch advice for 2022 based on the most recent data available for the stock assessment conducted in 2022. The last available Stock Synthesis (SS) model that was applied to give the 2023 southern hake advice using catch data until 2021 (ICES, 2023) was used to project catch scenarios for 2022. The settings for these projections are the same as those used for the 2023 advice, as described in the Stock Annex (ICES, 2023), with the exception of those related with the intermediate year F and the recruitment in 2023, which in this case are not needed, since there is no intermediate year. The updated TAC of 14429 was only published at the end of 2022 (ICES, 2022b) and therefore there was not enough time for the new TAC to have an impact on 2022 catches. The agreed TAC for Southern Hake in 2023 is 15925.

Southern hake is included in the EU MAP for Western Waters and adjacent waters (EU, 2019a). The target fishing mortality (F), in line with F_{MSY} ranges, should have been achieved by 2020.

This stock is under the landing obligation since 2016 with a *de minimis* exemption (a regulation establishing the exceptions of the landing obligation). Ongoing studies to evaluate the impact of *de minimis* exemption for the southern hake stock are being carried out by regional scientific and administration bodies with the collaboration of the SWWAC (South Western Waters Advisory Council).

Technical measures applied to this stock include: (i) a minimum conservation reference size (MCRS) of 27 cm, (ii) protected areas (seasonal or closed to some gears), and (iii) a minimum mesh size. These measures are set, depending on areas and gears, by several national regulations (EU, 2019b).

According to the Spanish Regulations progressively implemented after 2011 AAA/1307/2013, the Spanish quota is shared by individual vessels. This regulation was updated in 2015 (AAA/2534/2015) including a fishing plan for trawlers. Between 2007 and until 2018, Portuguese regulations also determined the distribution of the Portuguese hake quota by individual vessels.

10.2 Data

10.2.1 Commercial catch: landings and discards

Southern hake catches by country and gear for the period 1972–2022, as estimated by WGBIE, are given in Table 10.1. Since 2011, estimates of unallocated or non-reported landings have been included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) multiplied by the total effort for each *métier*. Given the small differences between official and estimated amounts, in 2022 no unallocated values were assumed.

Overall landings decreased from 8 214 t in 2021 to 6 986 t in 2022. Portuguese official landings decreased from 1 963 t in 2021 to 1 583 t in 2022. Spanish official landings decreased from 6 161 t in 2021 to 5 270 t in 2022. Non-reported landings were estimated as 0 t in 2022, as in 2021. Total discards in 2021 were 851 t and decreased to 595 t in 2022. Total catches were 9 065 t in 2021 and decreased to 7 582 in 2022. The TAC for 2021 was 8517 t.

In the Portuguese on-board sampling program, no trips were sampled from the OTB_DEF and OTB_CRU fleets. For this reason, Portuguese discards were estimated based on the average discard per unit effort (DPUE in Kg/hour) of the most recent 3 data collection years (2017–2019) (Fernandes, 2021; WD 7 in ICES, 2021). In this approach, the estimated average of DPUE obtained is then multiplied by the fishing effort (in hours) of each fleet in 2022 to obtain the annual discard estimate.

Length distributions for 2021 landings and discards are presented in Figure 10.1 and in Table 10.2. Mean size in the landings has been stable from 35.3 in 2020 to 35.0 in 2021 and 36.5 in 2022. Mean size in the catch is quite stable too with 29.8 cm in 2020, 28.5 in 2021 and 29.2 in 2022.

10.2.2 Growth, length-weight relationship, maturity, and M

All these parameters were revised in the benchmark (ICES, 2023) and presented in Figure 10.2. New growth parameters and M are now sex-specific, and only female maturity is used. All biological parameters are now time invariant.

Growth is estimated as a von Bertalanffy model with female L_{inf} = 110 cm and male L_{inf} = 73.73 cm and the same k (0.14 $year^{-1}$) for males and females. The first year (age 0) is modelled linearly with a parameter (size at age 1) estimated by the model equally for males and females. All parameters are constant in time.

The length-weight relationship is estimated as a power model following $W = a * L^b$, where a = 0.00000377 and b = 3.16826. All parameters are constant in time.

Maturity at length is estimated as a time-invariant logistic with L_{50} = 42.36 cm and slope = −0.265.

Natural mortality is variable at age, with breakpoints at ages 0, 1, 5 and 15, with different values for females (1.19, 0.64, 0.34 and 0.2) and males (1.19, 0.64, 0.4 and 0.27). All parameters are constant in time.

10.2.3 Abundance indices from surveys

Biomass, abundance and recruitment indices for the Portuguese and Spanish surveys are presented in Table 10.3 and Table 10.4, respectively. Recruitment and biomass indices are shown in Figure 10.3 for the Spanish SpGFS-WIBTS-Q4 (G2784), SPGFS-caut-WIBTS-Q4 (G4309) and for the Portuguese PtGFS-WIBTS-Q4 (G8899). These three surveys together cover the whole geographic area of the stock and are conducted simultaneously in autumn to minimize sources of variability. They are part of the IBTS survey group (ICES, 2017c), which further ensures the use of the same methodology.

The Portuguese Autumn survey (PtGFS-WIBTS-Q4-G8899) was not carried out in 2019 or 2020. The time-series showed variable abundance indices with maximum historical values observed in 2008–2010, 2013 and 2015 and a minimum in 1993. Low values for biomass and abundance were observed in the early 2000s and then increased after 2004. Values in 2016, 2017, 2018, 2021 and 2022 were rather stable and near the historical mean. The Spanish groundfish survey SpGFS-WIBTS-Q4 (G2784) shows a similar trend with low values for biomass and abundance in the early 2000s. These values increased after 2004 reaching a maximum in 2009–2012, 2015 and 2022. The estimates for 2020 and 2021 are very similar and around the historical mean whereas the value at 2022 is around the historical maximum. The Spanish SPGFS-caut-WIBTS-Q4 (G4309) was not carried out in 2021. The biomass time shows a similar trend to that observed in the PtGFS-WIBTS-Q4-G8899 and SpGFS-WIBTS-Q4 (G2784) with low values for biomass and abundance in the early 2000s. These values increased after 2004 reaching maximum values in 2013 and 2015. The estimates for 2020 and 2022 are almost the same and around the historical average.

Figure 10.3 shows that the recruitment indices of the SpGFS-WIBTS-Q4 (G2784), SPGFS-caut-WIBTS-Q4 (G4309) and PtGFS-WIBTS-Q4 (G8899) were highly variable in the past. In 2014, the 3 surveys decreased below historical means, but in 2015 the PtGFS-WIBTS-Q4 reached a historical maximum, while both SpGFS-WIBTS-Q4 and SPGFS-caut-WIBTS-Q4 returned to above-average values. In the latest years, all surveys show the same trends with a peak in 2015 followed by a decreasing trend afterwards, except for SPGFS-caut-WIBTS-Q4 which reached a historical maximum in 2019. In 2022, the value from SPGFS-caut-WIBTS-Q4 (G4309) was below the historical mean, PtGFS-WIBTS-Q4 (G8899) and SpGFS-WIBTS-Q4 (G2784) were a little above the historical mean.

Recruitment indices values of SPGFS-caut-WIBTS-Q4 (G4309) and SPGFS-cspr-WIBTS-Q1 (G7511) in 2020 were updated in Table 10.3 after detecting and correcting their length frequency distributions. More precisely, SPGFS-caut-WIBTS-Q4 (G4309) recruitment value of 34.7 has been changed to 32.8 whereas the SPGFS-cspr-WIBTS-Q1 (G7511) recruitment value has been changed from 42.1 to 34.6 according to the correction made in the corresponding length frequency distributions for 2020.

10.2.4 Commercial catch-effort data

Catch per unit effort indices were reviewed in the benchmark process (ICES, 2023). Two new standardized indices were accepted and incorporated in the assessment model, one from three different Spanish trawl métiers targeting medium size fish (SpTrawl) and other for large fish combining gillnetters and longliners (SpVolpal). These are presented in Figure 10.4 and Table 10.5. A Portuguese CPUE was also proposed but some technical problems precluded its use for assessment purposes.

The combined CPUE for trawlers (SpTrawl) shows the evolution of biomass from 2003 to 2022.

The index increases from the beginning of the series, peaking in 2010 and 2011 and decreasing thereafter with figures slightly below the mean in 2022. The combined CPUE VolPal (SpVolpal, 2009–2022) peaks at the beginning of the series (2009 and 2010) and decreases thereafter with a value softly below the mean in 2022.

10.3 Assessment

10.3.1 Preliminary model considerations

Hake in divisions 8.c and 9.a is caught in a mixed fishery mainly by the Spanish and Portuguese fleets (although there is a small percentage of French catches). In the SS model, the different fleets presented in Table 10.1 are grouped according to similar selectivity patterns:

1. Trawls (Spanish baka, pairtrawlers and Portuguese trawlers).
2. Volpal (Spanish gillnets and longliners).
3. Artisanal (Spanish, Portuguese and French artisanal fleets).
4. CdTrw (Cádiz trawlers).

10.3.2 Model diagnostics

Availability of input data time-series (catches, abundance indices, length compositions, size compositions and discards by year for each fleet) is summarized in Figure 10.5 providing an overview of the data considered in the model and hence of the required model diagnostics.

Convergence is a main issue for the southern hake SS model. The final model in WKANGHAKE (ICES, 2023) was chosen as the best one (minimum likelihood, convergence level, and positive definite hessian) among those performed in the jitters (model runs with different starting values). Therefore, after updating the model by adding 2022 data, jittering was again carried out to ensure that our final updated model reports the minimum likelihood.

Figure 10.6 shows the likelihood values of those jittered runs with a positive definite hessian. In total, the plot shows 25 valid runs from a total of 50 runs. The likelihood of our final model (blue line) coincides with the minimum likelihood attained by 8 of the 25 runs, supporting then the correct convergence of our updated proposed model. Its likelihood value is 2444.26 and the convergence level (final gradient) is 0.000921514.

Figure 10.7 shows the different comparisons among the observed and modelled values.

Quality of the landings and discards estimates along the years can be analysed in Figure 10.7a which reports the observed and estimated landings and discards along the years. Landings time-series are well estimated by the SS model whereas the discards are systematically underestimated by the model although in the last years (2019, 2021-2022) the underestimation is less marked.

Residuals for surveys (CdSurv, PtSurv and SpSurv are abbreviations of SPGFS-caut-WIBTS-Q4, ptGFS-WIBTS-Q4 (G8899), and SpGFS-WIBTS-Q4 (G2784)) and abundance indices (SpCPUE_trawlers and SpCPUE_volpal) are presented in log scale in Figure 10.7b. In general, the residuals do not show any pattern or trend. Additionally, their magnitude is lower than one which means that the observed and estimated values differ in less than one standard deviation.

Length distribution fit (all years together) is reported in Figure 10.7c. The fit of the commercial fleets (trawlers, volpal, artisanal and cdTrw) can be considered appropriate. On the other hand, the fit of SpSurv (separated length distributions by sex) is also quite accurate, whereas the PtSurv (sex separated) and CdSurv length distributions (sexes combined) fits show some inaccuracies.

In addition to this global overview of the length distributions adjustment grouping all years together, Figures 10.7d–10.7i report the expected and observed length distributions over the years (for commercial fleets the information is also provided by each quarter).

Figure 10.7d reports the observed and expected length distributions for trawlers' landings by year and season. The fit is quite good for all the years and seasons, except in 2020 when the model expected more large fish than those observed. Figure 10.7e reports the same information for the trawlers' discards. In this case, the length distributions are not well fitted and improvements must be addressed in the future.

Figure 10.f reports the observed and expected length distributions for volpal fleet. The fit is quite good, particularly in recent years. The year 2005 has a strange pattern with an excess of small fish in the observed data. This should be deleted from the input data in future uses of the model.

Figure 10.g reports the observed and expected length distributions for the artisanal fleet, and the fit can be considered quite good. On the other hand, Figure 10.h reports the observed and expected length distributions for cdTrw fleet. The fit is poor for some years and seasons, in particular, it seems to have a common pattern in seasons 2 and 4 in which the model expects more small fish than those observed.

Finally, Figure 10.i reports the observed and expected length distributions for the three surveys. The Spanish one (SpSurv) is well fitted over the years, whereas the Portuguese and Cádiz ones (PtSurv and CdSurv) are not well fitted for all the years. This may be because while the Spanish survey has a stable behaviour throughout the years, Cádiz and Portugal surveys are very variable (see Tables 10.3 and 10.4, the data is noisy without a clear explanation for Portugal surveys whereas variable behaviour in Cádiz one is related to the variable behaviour of this area along the years), perhaps time-varying parameters must be explored in future to solve these problems.

10.3.3 Assessment results

10.3.3.1 Estimated parameters

The model estimates selectivity parameters for each fleet, as double normal for all fleets and survey indices, except for volpal fleet (mixture of gillnetters and longliners targeting larger fish) with an assumed logistic selectivity. CPUE selectivity was mirrored to the corresponding fleet selectivity. Selectivity details can be seen in Figure 10.8. According to these estimated selectivity curves, maximum selectivity for SpSurv and CdSurv is attained at 4 cm which is the first length class. This is questionable, and further work is required to better understand the causes.

10.3.3.2 Historic trends in biomass, fishing mortality, yield, and recruitment

Table 10.6 and Figure 10.9 present summary results with estimated annual values and corresponding confidence intervals for fishing mortality (averaged over ages 1–7), recruitment (age 0) and SSB, as well as observed landings and discards for the years 1982–2022. The model was developed starting in 1960, although the reported values in the plots correspond to the years with good information (length distributions and calibration surveys).

Catches range from a minimum of 7 582 t in 2022 to a maximum of 22 950 t in 1983 with a mean of 13 664 if we focus on the period 1982–2022 presented in Figure 10.6. The two more recent years' values are close being 9 065 t and 7 582 t in 2021 and 2022, respectively.

Recruitment (age 0) is highly variable with a minimum of 111 million (2012) and a maximum of 566 million (2005) whereas its mean is around 239 million for the years 1982–2022. Despite these, the last 4 years are quite constant. However, all of the observed values are within the confidence intervals of the previous and following years.

Fishing mortality increased from the beginning of the time-series (F = 0.26 in 1982) peaking in 1995–1997 to around 0.85–0.90; then declining to 0.30 in 2006 and remaining relatively stable until 2016 (F = 0.42). Fishing mortality in the last years has been decreasing reaching 0.16 in 2022, below F_{MSY} (0.221)

The SSB (described period: 1982–2022) was very high at the beginning of the time-series with values around 41 100 t, then decreased to a minimum of 3 036 t in 1998. Since 1998, the biomass has been steadily increasing, peaking in 2011 (20 834 t) and then slightly decreasing until 2017 after which it to increased once again, attaining 21 905 t in 2023.

10.3.3.3 Retrospective pattern for SSB, fishing mortality, yield, and recruitment

Figure 10.10 presents the results of the assessments performed using the retrospective data series from 2021–2017. F estimates for the time-series from 1960 to 2020–2021 are inside the corresponding confidence interval of the time-series estimates of the base model whereas the estimates from 1960 to 2017-2019 are outside of this interval. SSB estimates for the time-series from 1960 to 2021 are inside the corresponding confidence interval of the time-series estimates of the base model whereas the estimates from 1960 to 2017-2020 are outside of this interval. The F and SSB Mohn rho are in line with this behaviour with values of −0.215 and 0.326 for F and SSB, respectively. There is a trend to down-correct the estimated SSBs and to up-correct F. On the other hand, recruitment estimates for series from 1960 to 2017–2019 are not inside the corresponding confidence intervals of the time-series estimates of the base model, contrary to those corresponding to recent years. However, according to the decision tree for handling assessments with retrospective patterns advice can be given (ICES, 2020). Even though, interseasonal work is required to improve these patters next year.

10.4 Catch options and prognosis

10.4.1 Short-term projections

Short-term projections are presented in Figure 10.11 and Table 10.7. The methodology used was developed during the latest benchmark (WKANGHAKE; ICES, 2023), and is also described in the Stock Annex. Recruitment estimates for last year (2022) are accepted as such (due to the small magnitude of the recruitment deviations at last years and the residuals of the surveys indices). Recruitment is then estimated in the projection years by the model, based on its stock–

recruitment relationship (Figure 10.12). The model shows a decreasing trend in F in recent years, although there is a retrospective pattern showing a correction of F upwards every year. For this reason, F_{sq} (the F value assumed for the intermediate year) is determined by the average of the F of commercial fleets in the last three years (2020–2022).

F_{sq} for the intermediate year (2023) is 0.21 with an expected catch of 10 793 t which corresponds to 9 913 t landings and 880 t discards. Recruitment for 2023–2024 is 357 754 and 367 914 thousand, respectively. In 2024 the expected SSB is 24 301 t.

Different 2024 F multipliers have been applied over the average F established in the intermediate year providing management alternatives according to different scenarios included in Table 10.11b.

Under the Multiannual Plan (MAP), with F_{MSY} (F = 0.221) the catches would be 12 919.3 t, landings 11 783.2 t, and discards 1 136.1 t, whereas the SSB would be 26 726 t. The MAP also includes F equal to the lower and upper limits of F_{MSY} for which catches would be 9 119.4 t and 17 445.5 t, respectively.

Additional scenarios over F include F = 0, F = F_{lim}, F = F_{pa} and F equal to F in 2023for which the catches would be 0, 32 757.2 t, 28 044.2 t and 12 221.2 t, respectively. Table 10.7 also includes settings over SSB, in particular, SSB equal to SSB in 2024, B_{lim}, B_{pa} and MSY $B_{trigger}$ for which the catches would be 17 463 t, 54 090.4 t, 50 719.4 t and 50 719.4 t, respectively. Note that the reference point values are specified in the next Section 10.5.

10.5 Biological reference points

Reference points were estimated during WKANGHAKE (ICES, 2023) and the process is described in the stock annex. It is worth noting that the ICES procedure to check whether F_{MSY} and ranges are precautionary cannot be implemented easily in the SS framework. Furthermore, the quarterly length-based dynamic with fleets and sexes separated, and recruitment in different periods cannot be reproduced accurately in the EqSim framework. For this reason, WKANGHAKE (ICES, 2023) decided to transform the model results to EqSim to check only if F_{MSY} and ranges are precautionary and afterwards use F_{MSY} and ranges from SS as reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	7556 t	B_{pa}; females only, in tonnes.	ICES (2023)
	F_{msy}	0.221	SS estimates.	ICES (2023)
Precautionary approach	B_{lim}	6011 t	The breakpoint of the segmented regression stock–recruitment relationship; females only, in tonnes.	ICES (2023)
	B_{pa}	7556 t	exp(1.654 ×σ) × B_{lim}, σ = 0.139; females only, in tonnes.	ICES (2023)
	F_{lim}	0.694	The F that provides a 50% probability for SSB to be above B_{lim}.	ICES (2023)
	F_{pa}	0.558	$F_{p.05}$ with ICES MSY AR: The F that provides a 95% probability for SSB to be above B_{lim}.	ICES (2023)

Framework	Reference point	Value	Technical basis	Source
Management plan	F_{MGT}	Not defined		
	SSB_{MGT}	Not defined		
	MAP MSY $B_{trigger}$	7556 t	MSY $B_{trigger}$; females only, in tonnes.	ICES (2023)
	MAP B_{lim}	6011 t	B_{lim}; females only, in tonnes.	ICES (2023)
	MAP F_{msy}	0.221	F_{msy}	ICES (2023)
	MAP range F_{lower}	0.151	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared to MSY.	ICES (2023)
	MAP range F_{upper}	0.311	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared to MSY.	ICES (2023)

10.6 Comments on the assessment

The current model is quite unstable in terms of its ability to find a global optimum. An additional computation effort was undertaken to ensure the best possible solution. Current results are considered valid in terms of convergence.

Given the quality of catch data as well as the lack of abundance indices and length distributions at the beginning of the time-series, before 1982, the SSB and F estimates for that period should be considered with caution.

The model estimates landings and discards by fleet. Observed and modelled landings are quite similar. The model has a tendency to underestimate discards although they are well fitted in the last three years.

The SS model presents SSB for females only, which is an advance since egg production is considered a good metric of reproductive potential and female SSB, and is a better proxy for egg production than total mature biomass.

10.7 Future work

Future work should focus on the three problems mentioned in the previous section: convergence, old time-series estimation and discards underestimation. In addition to this, further work should be performed to improve the current biological parameters.

10.8 Management considerations

Southern hake is included in the Multiannual Management Plan for Western Waters (EU, 2019a). The target fishing mortality, in line with the ranges of F_{MSY}, should have been achieved by 2020. The current model already provides an F in 2022 that is slightly below F_{MSY}.

The retrospective pattern shows a general trend to correct SSB downwards and F upwards. The causes of this pattern are not yet well understood and should be further explored.

Hake is a top predator eating mainly blue whiting, horse mackerel, and other hake (cannibalism, particularly of juveniles by adults). There may be some impact of this on the rate of recovery of the population, particularly in areas of greater aggregations. The main hake predators in the area are the common and bottlenose dolphins.

10.9 References

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10.1 Tables and figures

Table 10.1. Catch estimates (000' t) by country and gear. ART means Artisanal fleet, Cd-Trw refers to the Cádiz trawler fleet, Gillnet and Longline are the fleets combined in the SS model into one series named volpal. Pa-Ba Trw is a fleet which combines Pa-Trw and Ba-Trw, respectively pairtrawlers and baka (otter) trawlers. DISC and LAND are abbreviations for discards and landings.

	SPAIN									PORTUGAL				FRANCE		TOTAL		
YEAR	ART	GILLNET	LONGLINE	Cd-Trw	Pa-Ba Trw	Pa-Trw	Ba-Trw	DISC	LAND	ART	Trw	DISC	LAND	TOTAL	UNALLOCATED	DISC	LAND	CATCH
1972	7.10	-	-	-	10.20				17.3	4.70	4.10	-	8.8			-	**26.1**	**26.1**
1973	8.50	-	-	-	12.30				20.8	6.50	7.30	-	13.8	0.20		-	**34.8**	**34.8**
1974	1.00	2.60	2.20	-	8.30				14.1	5.10	3.50	-	8.6	0.10		-	**22.8**	**22.8**
1975	1.30	3.50	3.00	-	11.20				19.0	6.10	4.30	-	10.4	0.10		-	**29.5**	**29.5**
1976	1.20	3.10	2.60	-	10.00				16.9	6.00	3.10	-	9.1	0.10		-	**26.1**	**26.1**
1977	0.60	1.50	1.30	-	5.80				9.2	4.50	1.60	-	6.1	0.20		-	**15.5**	**15.5**
1978	0.10	1.40	2.10	-	4.90				8.5	3.40	1.40	-	4.8	0.10		-	**13.4**	**13.4**
1979	0.20	1.70	2.10	-	7.20				11.2	3.90	1.90	-	5.8	-		-	**17.0**	**17.0**
1980	0.20	2.20	5.00	-	5.30				12.7	4.50	2.30	-	6.8	-		-	**19.5**	**19.5**
1981	0.30	1.50	4.60	-	4.10				10.5	4.10	1.90	-	6.0	-		-	**16.5**	**16.5**
1982	0.27	1.25	4.18	0.49	3.92				10.1	5.01	2.49	-	7.5	-		-	**17.6**	**17.6**
1983	0.37	2.10	6.57	0.57	5.29				14.9	5.19	2.86	-	8.0	-		-	**22.9**	**22.9**
1984	0.33	2.27	7.52	0.69	5.84				16.7	4.30	1.22	-	5.5	-		-	**22.2**	**22.2**
1985	0.77	1.81	4.42	0.79	5.33				13.1	3.77	2.05	-	5.8	-		-	**18.9**	**18.9**
1986	0.83	2.07	3.46	0.98	4.86				12.2	3.16	1.79	-	4.9	0.01		-	**17.2**	**17.2**

	SPAIN									PORTUGAL				FRANCE		TOTAL		
YEAR	ART	GILLNET	LONGLINE	Cd-Trw	Pa-Ba Trw	Pa-Trw	Ba-Trw	DISC	LAND	ART	Trw	DISC	LAND	TOTAL	UNALLOCATED	DISC	LAND	CATCH
1987	0.53	1.97	4.41	0.95	3.50				11.4	3.47	1.33	-	4.8	0.03		**-**	**16.2**	**16.2**
1988	0.70	1.99	2.97	0.99	3.98				10.6	4.30	1.71	-	6.0	0.02		**-**	**16.7**	**16.7**
1989	0.56	1.86	1.95	0.90	3.92				9.2	2.74	1.85	-	4.6	0.02		**-**	**13.8**	**13.8**
1990	0.59	1.72	2.13	1.20	4.13				9.8	2.26	1.14	-	3.4	0.03		**-**	**13.2**	**13.2**
1991	0.42	1.41	2.20	1.21	3.63				8.9	2.71	1.25	-	4.0	0.01		**-**	**12.8**	**12.8**
1992	0.40	1.48	2.05	0.98	3.79			0.14	8.7	3.77	1.33	0.33	5.1	-			**13.8**	**13.8**
1993	0.37	1.26	2.74	0.54	2.67			0.24	7.6	3.04	0.87	0.44	3.9	-			**11.5**	**11.5**
1994	0.37	1.90	1.47	0.32		0.82	1.90	0.29	6.8	2.30	0.79	0.71	3.1	-		**1.0**	**9.9**	**10.9**
1995	0.37	1.59	0.96	0.46		2.34	2.94	0.93	8.6	2.56	1.03	1.18	3.6	-		**2.1**	**12.2**	**14.3**
1996	0.23	1.15	0.98	0.98		1.46	2.17	0.91	7.0	2.01	0.76	0.99	2.8	-		**1.9**	**9.7**	**11.6**
1997	0.30	1.04	0.76	0.88		1.32	1.78	1.07	6.1	1.52	0.90	1.20	2.4	-		**2.3**	**8.5**	**10.8**
1998	0.32	0.75	0.62	0.53		0.88	1.95	0.57	5.0	1.67	0.97	1.11	2.6	-		**1.7**	**7.7**	**9.4**
1999	0.33	0.60	0.00	0.57		0.87	1.59	0.35	4.0	2.12	1.09	1.17	3.2	-		**1.5**	**7.2**	**8.7**
2000	0.26	0.85	0.15	0.58		0.83	1.98	0.62	4.7	2.09	1.16	1.21	3.3	-		**1.83**	**7.90**	**9.7**
2001	0.32	0.55	0.11	1.20		1.06	1.12	0.37	4.4	2.02	1.20	1.29	3.2	-		**1.66**	**7.58**	**9.2**
2002	0.22	0.58	0.12	0.88		1.37	0.75	0.38	3.9	1.81	0.97	1.11	2.8	-		**1.49**	**6.70**	**8.2**
2003	0.37	0.43	0.17	1.25		1.36	1.07	0.41	4.7	1.13	0.96	1.05	2.1	-		**1.46**	**6.74**	**8.2**

	SPAIN									PORTUGAL				FRANCE		TOTAL		
YEAR	ART	GILLNET	LONGLINE	Cd-Trw	Pa-Ba Trw	Pa-Trw	Ba-Trw	DISC	LAND	ART	Trw	DISC	LAND	TOTAL	UNALLOCATED	DISC	LAND	CATCH
2004	0.45	0.42	0.13	1.06		1.66	1.13	0.22	4.8	1.27	0.80	0.69	2.1	-		**0.91**	**6.91**	**7.8**
2005	0.72	0.63	0.09	0.88		2.77	1.14	0.38	6.2	1.10	0.96	1.60	2.1	-		**1.98**	**8.30**	**10.3**
2006	0.48	0.71	0.35	0.63		4.70	1.81	2.65	8.7	1.22	0.91	0.61	2.1	-		**3.26**	**10.80**	**14.1**
2007	0.83	1.80	0.89	0.50		6.71	2.07	1.19	12.8	1.41	0.72	1.31	2.1	-		**2.50**	**14.93**	**17.4**
2008	1.12	2.64	1.51	0.53		6.32	2.44	1.45	14.6	1.27	0.94	0.86	2.2	-		**2.31**	**16.77**	**19.1**
2009	1.41	2.92	2.10	0.55		7.37	2.54	0.98	16.9	1.39	0.96	1.96	2.4	-		**2.93**	**19.24**	**22.2**
2010	0.72	1.70	1.88	0.68		6.33	1.71	1.00	13.0	1.61	0.73	0.58	2.3	0.36		**1.580**	**15.729**	**17.3**
2011	0.41	1.09	0.76	0.53		2.18	1.48	1.21	6.5	1.72	0.49	0.74	2.2		8.40	**1.95**	**17.06**	**19.0**
2012	0.34	0.85	1.08	0.50		1.64	1.42	1.35	5.8	1.79	0.81	0.47	2.6		6.14	**1.82**	**14.57**	**16.4**
2013	0.64	1.75	1.11	0.62		1.86	1.16	2.22	7.2	1.93	0.81	0.33	2.7	0.31	1.46	**2.55**	**11.66**	**14.2**
2014	0.75	1.46	1.60	0.54		1.72	1.18	2.02	7.3	1.71	0.66	0.58	2.4	0.14	2.25	**2.60**	**12.01**	**14.6**
2015	0.90	1.11	1.23	0.36		2.01	1.13	2.06	6.8	1.24	0.76	0.23	2.0	0.24	2.8	**2.29**	**11.79**	**14.1**
2016	0.91	1.64	1.30	0.42		2.28	1.51	2.15	8.06	1.22	0.75	0.16	1.97	0.23	2.17	**2.31**	**12.44**	**14.8**
2017	0.69	1.51	1.71	0.27		1.60	1.08	1.43	6.86	0.91	0.57	0.24	1.48	0.07	0.76	**1.68**	**9.17**	**10.8**
2018	0.76	1.64	1.00	0.39		1.54	1.10	1.77	6.44	0.79	0.70	0.18	1.49	0.06	2.19	**1.94**	**10.18**	**12.1**
2019	0.78	1.65	1.12	0.43		1.81	1.49	0.75	7.27	1.11	0.80	0.31	1.92	0.01	2.61	**1.06**	**11.80**	**12.9**
2020	0.73	1.54	1.16	0.44		1.55	1.15	0.21	6.57	1.21	0.70	0.23	1.90	0.05	0.21	**0.44**	**8.73**	**9.17**

	SPAIN									PORTUGAL				FRANCE		TOTAL		
YEAR	**ART**	**GILLNET**	**LONGLINE**	**Cd-Trw**	**Pa-Ba Trw**	**Pa-Trw**	**Ba-Trw**	**DISC**	**LAND**	**ART**	**Trw**	**DISC**	**LAND**	**TOTAL**	**UNALLOCATED**	**DISC**	**LAND**	**CATCH**
2021	0.58	1.55	1.35	0.25		1.31	1.10	0.57	6.16	1.14	0.82	0.28	1.96	0.09	0.00	**0.85**	**8.21**	**9.06**
2022	0.50	1.50	1.14	0.28		0.93	0.93	0.36	5.27	0.98	0.60	0.24	1.58	0.13	0.00	**0.60**	**6.99**	**7.58**

Table 10.2. Catch, landings and discards length compositions (thousands). SOP is the sum of products, i.e. the sum of the products of number of fishes by the mean weight of the corresponding length using the *a* and *b* parameters of the weight-length relationship. NW means nominal weight.

Length (2 cm classes)	Land	Disc	Catch
4	0	0	0
6	0	52	52
8	1	533	534
10	5	903	907
12	16	1216	1232
14	33	802	836
16	31	836	867
18	38	1274	1312
20	43	1733	1776
22	78	1466	1544
24	761	773	1534
26	1465	272	1736
28	1981	125	2106
30	1934	95	2029
32	1720	125	1845
34	1324	95	1419
36	1001	29	1030
38	751	6	757
40	517	1	518
42	407	1	408
44	306	1	307
46	273	1	274
48	217	9	226
50	208	0	209
52	210	0	210
54	215	0	215
56	208	0	208

Length (2 cm classes)	**Land**	**Disc**	**Catch**
58	189	0	189
60	170	0	170
62	147	0	147
64	107	0	107
66	91	0	91
68	72	0	72
70	57	0	57
72	53	0	53
74	30	0	30
76	22	0	22
78	15	0	15
80	12	0	12
82	15	0	15
84	6	0	6
86	7	0	7
88	4	0	4
90	3	0	3
92	2	0	2
94	2	0	2
96	1	0	1
98	8	0	8
TOTAL	**14755**	**10349**	**25104**
Nominal Weight (000' tons)	**6.99**	**0.60**	**7.58**
SOP	**6.86**	**0.57**	**7.42**
SOP / NW	**1.02**	**1.05**	**1.02**
Mean length (cm)	**36.5**	**18.8**	**29.2**

Table 10.3. Portuguese groundfish surveys: biomass, abundance and recruitment indices. Autumn ptGFS-WIBTS-Q4 (G8899) is an input survey in the SS model and termed PtSurv.

Year	Winter (ptGFS-WIBTS-Q1)					Summer					Autumn ptGFS-WIBTS-Q4 (G8899)					
	Biomass (kg/h)		Abundance (N/h)			Biomass (kg/h)		Abundance (N/h)			Biomass (kg/h)		Abundance (N/h)			
	Mean	s.e.	Mean	s.e.	hauls	Mean	s.e.	Mean	s.e.	hauls	Mean	s.e.	Mean	s.e.	n/h < 20 cm (1)	hauls
1979 *						11.7		80.4		55	9.5		na			55
1980 * (**)	11.3		178.1		36	15.4		153.0		63	12.5		108.7			62
1981 (Autumn **)	10.7	0.7	122.4	15.5	67	9.9	1.3	87.8	15.5	69	24.4	0.5	734.8	29.3		111
1982	18.1	2.5	265.6	37.5	69	11.0	2.7	93.0	32.8	70	10.6	1.8	119.5	34.7		190
1983 (Autumn **)	27.0	6.0	530.5	151.0	69	15.1	2.3	120.5	20.8	98	13.4	0.5	121.8	4.8		117
1984																
1985						14.3	0.8	170.7	15.6	101	11.0	0.7	128.7	8.4	86.7	150
1986						27.4	1.8	249.4	15.1	118	17.7	1.2	165.6	28.4	90.2	117
1987											8.6	0.9	37.4	3.7	7.3	81
1988											15.3	1.7	177.8	30.8	111.7	98
1989						11.9	0.9	80.8	8.6	114	8.4	0.5	59.6	4.6	19.8	130
1990						9.8	1.0	95.6	13.5	98	11.8	1.0	157.2	26.3	97.2	107
1991						14.2	1.2	104.2	11.3	119	20.9	4.3	195.3	41.5	92.3	80
1992	14.5	1.2	176.4	32.3	88	10.9	1.1	74.1	11.4	81	11.7	1.7	65.2	11.1	18.8	51
1993	9.0	0.7	78.7	16.8	75	11.3	1.7	105.0	34.7	66	5.5	0.8	54.4	12.9	28.4	58

Year	Winter (ptGFS-WIBTS-Q1)					Summer					Autumn ptGFS-WIBTS-Q4 (G8899)					
	Biomass (kg/h)		Abundance (N/h)		hauls	Biomass (kg/h)		Abundance (N/h)		hauls	Biomass (kg/h)		Abundance (N/h)		n/h < 20 cm (1)	hauls
	Mean	s.e.	Mean	s.e.		Mean	s.e.	Mean	s.e.		Mean	s.e.	Mean	s.e.		
1994											9.9	1.0	98.9	12.1	52.9	77
1995						15.0	1.4	129.3	16.3	81	14.8	1.7	85.8	10.7	7.9	80
1996***											9.2	1.1	109.9	17.8	18.2	63
1997						19.0	1.4	206.5	16.9	86	24.6	9.3	208.0	92.5	62.1	51
1998						10.5	0.8	71.6	8.6	87	15.6	2.0	140.6	21.7	75.9	64
1999***						11.8	0.7	116.2	10.1	65	11.6	1.5	118.3	17.1	14.4	71
2000						16.4	1.6	123.0	15.2	88	11.8	1.8	102.7	19.9	49.2	66
2001						16.6	1.7	132.5	14.2	83	15.6	2.8	164.2	38.5	89.9	58
2002											13.0	2.1	117.6	26.9	60.6	66
2003 ***											9.8	1.0	94.2	8.0	11.9	71
2004 ***											18.4	3.3	402.3	85.2	78.2	79
2005	17.7	2.6	384.0	53.8	68						19.0	1.9	214.2	23.5	131.7	87
2006	16.0	2.0	377.5	55.4	66						16.5	1.8	126.2	11.0	54.7	88
2007	22.4	3.4	609.1	114.1	63						25.8	2.8	370.2	46.7	240.0	96
2008	31.1	4.8	700.6	170.8	67						34.6	4.3	293.6	33.9	87.7	87
2009											37.5	4.4	476.4	75.9	318.6	93

Year	Winter (ptGFS-WIBTS-Q1)					Summer					Autumn ptGFS-WIBTS-Q4 (G8899)					
	Biomass (kg/h)		Abundance (N/h)		hauls	Biomass (kg/h)		Abundance (N/h)		hauls	Biomass (kg/h)		Abundance (N/h)		n/h < 20 cm (1)	hauls
	Mean	s.e.	Mean	s.e.		Mean	s.e.	Mean	s.e.		Mean	s.e.	Mean	s.e.		
2010											38.2	4.3	418.0	49.8	249.8	87
2011											18.7	1.5	272.9	25.2	179.4	86
2012																
2013											35.2	3.4	473.1	62.1	289.0	93
2014											17.1	1.5	195.7	23.9	93.9	81
2015											37.2	4.3	602.1	65.0	393.2	90
2016											18.7	1.5	272.9	25.2	179.4	86
2017											19.7	2.6	256.1	57.9	136.6	89
2018											24.0	4.7	275.4	60.4	165.2	53
2019																
2020																
2021											21.3	2.7	272.5	35.2	161.0	93
2022											20.2	6.9	253.8	104.6	141.2	61

Note: There are no survey data in 2012, 2019 and 2020. Data marked with * relate to 40 mm cod end mesh size, else 20 mm; ** whole area not covered; * R/V Capricórnio, other years R/V Noruega; and (1) n/hour <20 cm converted to Noruega and NCT. Since 2002, tow duration is 30 min for autumn survey. Depth strata: from 1979 to 1988 covers 20–500 m depth; from 1989 to 2004 covers 20–750 m depth; since 2005 covers 20–500 m depth. In 2021, the survey was conducted with a new vessel (R/V Mário Ruivo).**

Table 10.4. Spanish groundfish surveys: biomass, abundances and recruitment indices.

Year	SpGFS-WIBTS-Q4 (G2784) (/30 min)						SPGFS-caut-WIBTS-Q4 (G4309) (/hour)				SPGFS-cspr-WIBTS-Q1 (G7511) (/hour)			
	Biomass index (Kg)		Hauls	Abundance Index (nº)		Recruits (< 20 cm)	Biomass index (Kg)		hauls	Rec (< 20 cm)	Biomass index (Kg)		hauls	Rec (< 20 cm)
	Mean	s.e.		Mean	s.e.	Mean	Mean	s.e.		Mean	Mean	s.e.		mean
1983	7.04	0.65	107	192.4	25.0	177								
1984	6.33	0.60	94	410.4	53.5	398								
1985	3.83	0.39	97	108.5	14.0	98								
1986	4.16	0.50	92	247.8	46.5	239								
1987														
1988	5.59	0.69	101	390.0	67.4	382								
1989	7.14	0.75	91	487.9	73.1	477								
1990	3.34	0.32	120	85.9	9.1	78								
1991	3.37	0.39	107	166.8	15.8	161								
1992	2.14	0.19	116	59.3	5.4	52								
1993	2.49	0.21	109	80.0	8.0	73					3.04	0.53	30	
1994	3.98	0.33	118	245.0	24.9	240					2.68	0.33	30	
1995	4.58	0.44	116	80.9	8.4	68					4.66	1.28	30	71.5
1996	6.54	0.59	114	345.2	40.5	335					7.66	1.14	31	72.7
1997	7.27	0.78	119	421.4	56.5	410	5.28	2.77	27	26.7	3.34	0.52	30	72.5
1998	3.36	0.28	114	75.9	8.7	65	2.66	0.42	34	6.6	2.93	0.67	31	18.6

Year	SpGFS-WIBTS-Q4 (G2784) (/30 min)						SPGFS-caut-WIBTS-Q4 (G4309) (/hour)				SPGFS-cspr-WIBTS-Q1 (G7511) (/hour)			
	Biomass index (Kg)		Hauls	Abundance Index (nº)		Recruits (< 20 cm)	Biomass index (Kg)		hauls	Rec (< 20 cm)	Biomass index (Kg)		hauls	Rec (< 20 cm)
	Mean	s.e.		Mean	s.e.	Mean	Mean	s.e.		Mean	Mean	s.e.		mean
1999	3.35	0.25	116	95.3	10.6	89	2.71	0.44	38	23.9	3.03	0.37	38	44.6
2000	3.01	0.43	113	66.9	7.4	59	2.03	0.61	30	18.6	3.02	0.47	41	39.7
2001	1.73	0.29	113	42.0	7.6	37	2.57	0.45	39	22.7	6.01	0.79	40	72.4
2002	1.91	0.23	110	57.1	8.8	53	3.39	0.78	39	118.6	2.74	0.25	41	22.4
2003	2.61	0.27	112	92.8	11.6	86	1.61	0.28	41	17.5				
2004	3.94	0.40	114	177.0	23.5	170	2.72	0.69	40	85.8	3.65	0.47	40	92.7
2005	6.46	0.53	116	344.8	32.2	335	6.68	1.29	42	100.6	10.77	5.65	40	184.3
2006	5.50	0.39	115	224.5	21.9	211	4.99	2.00	41	212.3	2.15	0.40	41	3.7
2007	4.97	0.43	117	158.2	15.0	150	6.92	1.43	37	200.3	3.22	0.68	41	51.1
2008	4.93	0.46	115	99.3	11.5	81	4.33	0.60	41	64.4	3.48	0.67	41	50.5
2009	9.32	0.94	117	559.7	93.9	789	7.35	0.97	43	95.0	4.24	0.06	40	65.6
2010	8.36	0.65	114	201.0	14.9	175	5.82	0.83	44	46.0	6.91	1.09	36	202.5
2011	8.98	0.68	111	241.5	21.0	216	2.97	0.38	40	48.2	3.75	0.50	42	32.2
2012	8.44	0.75	115	297.3	39.5	280	5.38	0.90	37	44.0	3.49	0.65	33	62.9
2013	5.59	0.78	114	136.9	13.6	118	12.52	2.04	43	285.6	5.50	0.56	40	76.5
2014	3.72	0.44	116	78.0	9.6	68	9.33	1.38	45	63.0	6.01	0.65	40	60.4

Year	SpGFS-WIBTS-Q4 (G2784) (/30 min)						SPGFS-caut-WIBTS-Q4 (G4309) (/hour)				SPGFS-cspr-WIBTS-Q1 (G7511) (/hour)			
	Biomass index (Kg)		Hauls	Abundance Index (nº)		Recruits (< 20 cm)	Biomass index (Kg)		hauls	Rec (< 20 cm)	Biomass index (Kg)		hauls	Rec (< 20 cm)
	Mean	s.e.		Mean	s.e.	Mean	Mean	s.e.		Mean	Mean	s.e.		mean
2015	9.87	0.85	114	316.8	33.7	296	13.67	2.61	43	186.8	6.01	0.69	43	165.3
2016	7.67	0.65	114	211.3	18.3	185	5.90	0.92	45	87.6	6.50	0.76	44	118.5
2017	6.58	0.57	112	158.8	14.5	140	4.74	0.89	44	151.1	3.39	0.52	45	38.0
2018	6.48	0.52	113	300.8	34.8	291	8.00	1.22	45	34.4	5.78	1.48	41	134.6
2019	5.71	0.39	113	166.1	18.4	151	8.03	1.17	43	364.4	5.13	0.90	46	109.7
2020	5.45	0.47	109	131.2	13.2	123	4.54	0.63	44	32.8	5.82	0.93	45	34.6
2021	5.21	0.53	113	142.9	14.9	133								
2022	9.56	0.76	114	246.3	28.1	223	5.44	1.11	45	43.0	4.37	0.83	45	104.4

Note: Since 1997 new depth stratification is considered: 70–120 m, 121–200 m and 201–500 m, previous one was 30–100 m, 101–200 m and 201–500 m. The surveys SpGFS-WIBTS-Q4 (G2784) and SPGFS-caut-WIBTS-Q4 (G4309) are an input in the SS model and named as SpSurv and CdSurv, respectively

Table 10.5. Catch per unit effort and standard error (s.e). Trw CPUE is a weighted mean of 3 Spanish trawlers métiers (pairtrawlers – PTB_MPD_> = 55_0_0, and two otter (baka) trawlers in which the baka fleet of Table 10.1 can be split ("OTB_DEF_> = 55_0_0" and "OTB_MPD_> = 55_0_0"). VolPal CPUE is a weighted mean of Spanish gillnetters and long-liners.

YEAR	Trw CPUE (standardized)	s.e.	VolPal CPUE (standardized)	s.e.
2003	0.506	0.090		
2004	0.332	0.058		
2005	0.546	0.090		
2006	0.788	0.135		
2007	0.885	0.149		
2008	0.919	0.158		
2009	1.018	0.171	1.171	0.120
2010	1.326	0.221	1.174	0.121
2011	1.475	0.238	1.073	0.111
2012	0.898	0.148	0.838	0.086
2013	1.106	0.181	0.769	0.084
2014	0.925	0.154	1.071	0.108
2015	0.932	0.153	0.882	0.088
2016	1.204	0.205	0.897	0.090
2017	0.864	0.142	0.900	0.091
2018	0.736	0.130	0.917	0.092
2019	1.312	0.246	0.865	0.091
2020	0.804	0.205	1.045	0.107
2021	0.847	0.151	1.038	0.105
2022	0.887	0.151	0.907	0.092

Table 10.6. Assessment summary. Recruitment values and corresponding confidence intervals of plus minus 2 standard deviations (rec_value, rec_low, and rec_upp), SSB values and corresponding confidence intervals (ssb val, ssb_low and ssb_upp) and F values and corresponding confidence intervals (F_val, F_low and F_upp). Finally, catch, landings and discards time-series estimates.

Years	rec_low	rec_value	rec_upp	ssb_low	ssb_val	ssb_upp	F_low	F_val	F_upp	catch	landings	discards
1960	429475	474632	519789	156058	181154	206250	0.048	0.060	0.071	16073	16073	0
1961	428907	474094	519281	151997	176692	201387	0.054	0.068	0.081	17655	17655	0
1962	428136	473374	518612	146687	171043	195399	0.056	0.069	0.083	17553	17553	0
1963	427316	472617	517918	141351	165458	189565	0.062	0.078	0.094	19139	19139	0
1964	426298	471688	517078	135130	159060	182990	0.083	0.105	0.126	24658	24658	0
1965	424576	470133	515690	125548	149349	173150	0.101	0.129	0.156	28516	28516	0
1966	422112	467952	513792	113736	137483	161230	0.085	0.110	0.134	23074	23074	0
1967	420238	466343	512448	105989	129810	153631	0.079	0.102	0.125	20771	20771	0
1968	418789	465131	511473	100594	124546	148498	0.076	0.099	0.121	19769	19769	0
1969	417672	464219	510766	96733	120837	144941	0.071	0.092	0.113	18254	18254	0
1970	417017	463706	510395	94570	118842	143114	0.045	0.058	0.072	11707	11707	0
1971	417839	464440	511041	97228	121718	146208	0.042	0.054	0.066	11267	11267	0
1972	418879	465349	511819	100823	125460	150097	0.099	0.127	0.155	26100	26100	0
1973	8451	269433	530415	95065	119647	144229	0.141	0.184	0.227	34800	34800	0
1974	11355	258661	505967	83016	107526	132036	0.101	0.135	0.169	22800	22800	0
1975	13678	249728	485778	76983	101204	125425	0.143	0.200	0.256	29500	29500	0
1976	15806	239094	462382	63566	86932	110297	0.142	0.210	0.278	26100	26100	0

Years	rec_low	rec_value	rec_upp	ssb_low	ssb_val	ssb_upp	F_low	F_val	F_upp	catch	landings	discards
1977	17291	232573	447855	50292	73046	95801	0.092	0.143	0.193	15500	15500	0
1978	18358	237310	456262	43785	66039	88293	0.086	0.133	0.180	13400	13400	0
1979	20781	250445	480109	39403	60843	82282	0.118	0.182	0.245	17000	17000	0
1980	24449	258257	492065	33790	53919	74048	0.151	0.230	0.309	19500	19500	0
1981	63587	313335	563083	27692	46108	64525	0.143	0.211	0.280	16500	16500	0
1982	98538	266061	433584	24586	41100	57614	0.188	0.258	0.329	17592	17592	0
1983	108432	224315	340198	23367	37318	51268	0.268	0.362	0.456	22950	22950	0
1984	114698	231035	347372	19580	30862	42145	0.295	0.409	0.523	22179	22179	0
1985	99731	209495	319259	14644	24126	33609	0.311	0.430	0.548	18941	18941	0
1986	105038	263612	422186	11321	19477	27632	0.331	0.459	0.587	17161	17161	0
1987	32214	159855	287496	8642	15643	22643	0.349	0.497	0.644	16185	16185	0
1988	155254	296976	438698	6727	12400	18073	0.432	0.611	0.790	16653	16653	0
1989	100534	193242	285950	5086	9671	14257	0.396	0.549	0.702	13786	13786	0
1990	159293	249043	338793	4673	8509	12345	0.410	0.560	0.710	13190	13190	0
1991	125910	199547	273184	5167	8301	11436	0.426	0.547	0.668	12827	12827	0
1992	72880	124017	175154	5523	8132	10742	0.517	0.628	0.739	13798	13798	0
1993	109250	142638	176026	5422	7394	9366	0.532	0.641	0.751	11489	11489	0
1994	252909	293734	334559	4746	6199	7652	0.573	0.677	0.780	10859	9865	994

Years	rec_low	rec_value	rec_upp	ssb_low	ssb_val	ssb_upp	F_low	F_val	F_upp	catch	landings	discards
1995	82407	118419	154431	3772	4868	5964	0.772	0.888	1.005	14341	12239	2102
1996	210438	252276	294114	3092	3887	4681	0.771	0.903	1.035	11640	9730	1910
1997	145181	185803	226425	2706	3416	4127	0.721	0.846	0.972	10769	8499	2270
1998	148576	190288	232000	2386	3036	3687	0.621	0.736	0.851	9364	7683	1681
1999	134910	175473	216036	2774	3486	4197	0.468	0.549	0.630	8690	7171	1519
2000	146896	190110	233324	3526	4392	5258	0.510	0.607	0.704	9737	7902	1835
2001	142854	190763	238672	3625	4639	5654	0.435	0.521	0.608	9243	7581	1662
2002	183329	234153	284977	3900	5091	6281	0.355	0.432	0.509	8189	6697	1492
2003	139671	182971	226271	4547	5978	7409	0.290	0.349	0.408	8206	6745	1461
2004	239091	296429	353767	5816	7532	9248	0.256	0.308	0.361	7824	6910	913
2005	474331	565741	657151	7387	9490	11592	0.260	0.314	0.368	10279	8301	1978
2006	177850	238182	298514	8670	11232	13793	0.250	0.296	0.343	14061	10799	3262
2007	339330	419608	499886	12169	15244	18319	0.304	0.361	0.418	17438	14934	2504
2008	297755	374164	450573	15181	18773	22364	0.318	0.376	0.435	19084	16773	2311
2009	244512	310686	376860	15952	19958	23963	0.363	0.430	0.498	22175	19240	2935
2010	150635	198509	246383	15831	20149	24468	0.300	0.354	0.408	17310	15730	1580
2011	278656	333727	388798	16306	20834	25362	0.362	0.430	0.498	19010	17062	1948
2012	78130	111237	144344	13873	18424	22975	0.332	0.392	0.452	16396	14573	1823

Years	rec_low	rec_value	rec_upp	ssb_low	ssb_val	ssb_upp	F_low	F_val	F_upp	catch	landings	discards
2013	247367	301080	354793	12755	17191	21627	0.294	0.349	0.404	14214	11661	2553
2014	155270	203797	252324	11997	16299	20600	0.317	0.380	0.444	14614	12011	2602
2015	202350	251452	300554	10708	14784	18860	0.317	0.384	0.451	14077	11786	2292
2016	180724	233527	286330	10232	14156	18080	0.341	0.420	0.498	14756	12443	2313
2017	249455	310726	371997	9485	13366	17246	0.244	0.309	0.375	10847	9171	1676
2018	155824	211420	267016	10152	14161	18169	0.242	0.304	0.365	12125	10183	1942
2019	107004	151609	196214	11341	15624	19908	0.261	0.331	0.400	12861	11800	1061
2020	162523	224920	287317	12177	16954	21731	0.190	0.244	0.298	8732	8732	670*
2021	178840	245718	312596	12818	18185	23551	0.165	0.215	0.266	9065	8214	851
2022	147959	254527	361095	13192	19089	24986	0.123	0.164	0.204	7582	6986	595
2023				15228	21905	28583						

Table 10.7. Short-term projections. All weights are in tonnes.

a) Intermediate years values.

Variable	Value	Notes
F (2023)	0.21	F_{sq} = Average F (2020–2022).
SSB (2024)	24301	Short-term forecast fishing at status quo (F_{sq}); tonnes.
R_{age0} (2023)	357754	Estimated by the model based on the stock–recruitment relationship; thousands
R_{age0} (2024)	367914	Estimated by the model based on the stock–recruitment relationship; thousands
Total catch (2023)	10793	Short-term forecast using F_{sq} ; tonnes.
Projected landings (2023)	9913	Short-term forecast using F_{sq} ; landings estimated by the model.
Projected discards (2023)	880	Short-term forecast using F_{sq} ; discards estimated by the model.

b) Annual catch scenarios.

Basis	Total catch (2024)	Projected landings (2024)	Projected discards (2024)	F_{total} (2024)	$F_{projected\ landings}$ ^^ (2024)	$F_{projected\ discards}$ ^^ (2024)	SSB (2025)	% SSB change*	% advice change**
ICES advice basis									
EU MAP F = F_{MSY} ^	12919.3	11783.2	1136.1	0.221	0.202	0.019	26726	10 %	10 %
EU MAP F = F_{MSY} lower	9119.4	8329.2	790.2	0.151	0.138	0.013	28771	18 %	10 %
EU MAP F = F_{MSY} upper	17445.5	15882.6	1562.9	0.311	0.283	0.028	24311	0 %	10 %
Other scenarios									
MSY approach = F_{MSY}	12919.3	11783.2	1136.1	0.221	0.202	0.019	26726	10 %	10 %
F = 0	0	0	0	0	0	0	33740	39 %	-100 %
F = F_{lim}	32757.2	29590.8	3166.4	0.694	0.627	0.067	16349	-33 %	178 %
F = F_{pa}	28044.2	25406.2	2638	0.558	0.506	0.052	18756	-23 %	138 %
SSB (2025) = B_{lim}	54090.4	47993.5	6096.9	1.651	1.465	0.186	6011	-75 %	359 %
SSB (2025) = B_{pa}	50719.4	45181.8	5537.6	1.432	1.276	0.156	7556	-69 %	330 %
SSB (2025) = MSY $B_{trigger}$	50719.4	45181.8	5537.6	1.432	1.276	0.156	7556	-69 %	330 %
SSB (2025) = SSB(2024)	17463.2	15898.7	1564.5	0.311	0.283	0.028	24301	0 %	48 %
F = F (2023)	12221.2	11149.5	1071.7	0.208	0.19	0.018	27101	12 %	4 %

Note: * means SSB 2025 relative to SSB 2024, ** Advice values for 2024 relative to the corresponding 2023 values

^ The EU multiannual plan (MAP; EU, 2019a), ^^ F landings and F discards were calculated using the ratios of the projected landings and discards (F_{land} = F_{tot} * Land / Catch; F_{disc} = F_{tot} * Disc / Catch).

Figure 10.1. Length distribution of catches used in the assessment (1994–latest year). Note that discards length distribution is missing in some years.

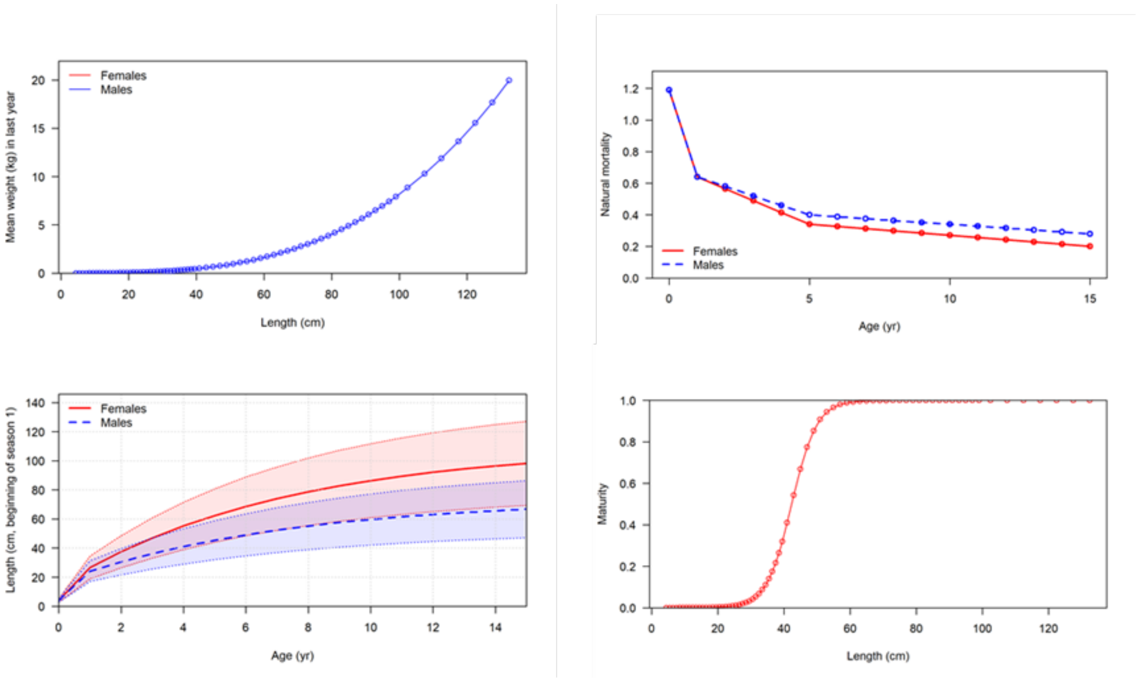


Figure 10.2. Biological plots. Length-weight relationship (upper left), growth by sex (lower left); natural mortality by sex (upper right); and maturity ogive (lower right).

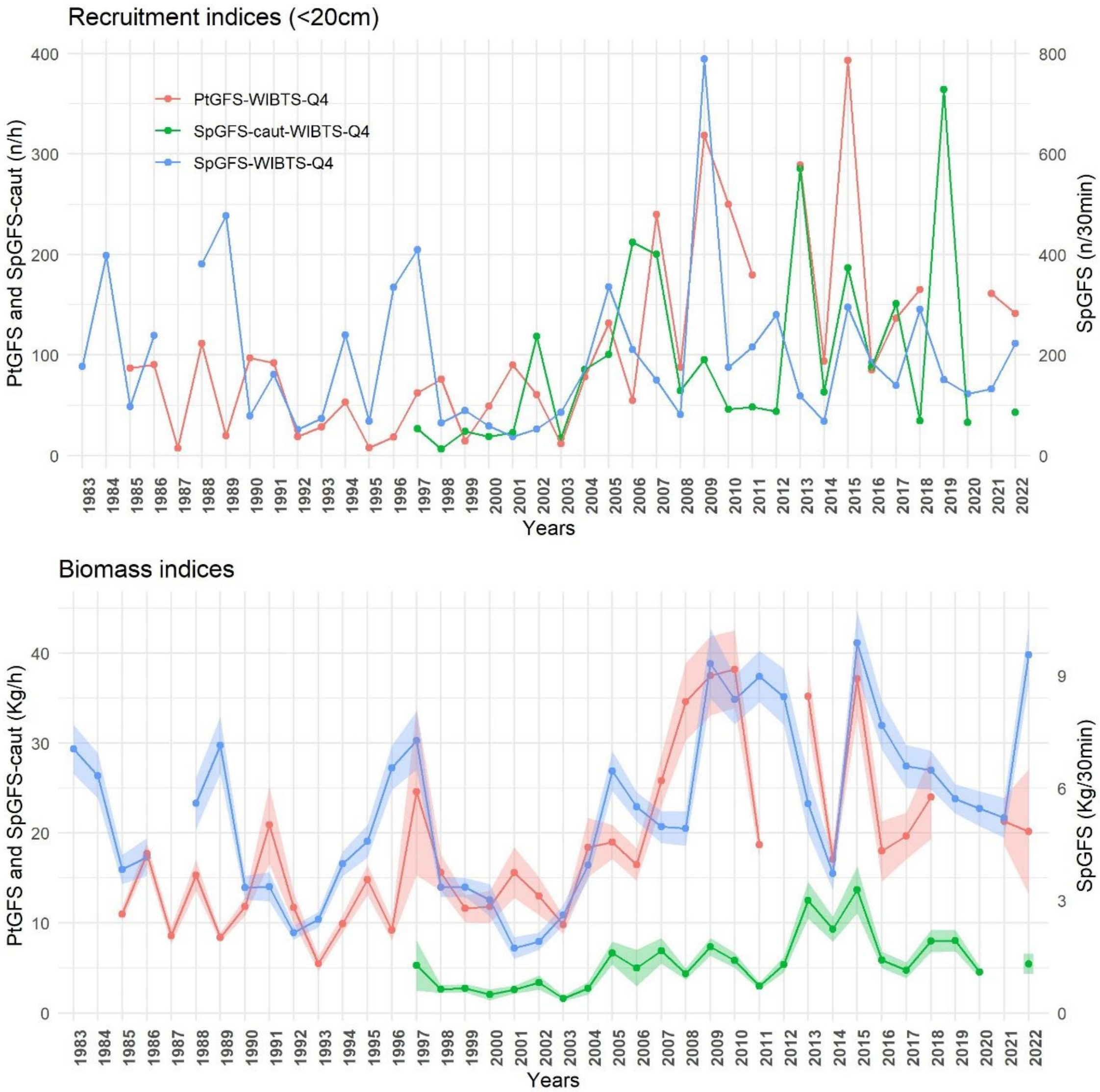
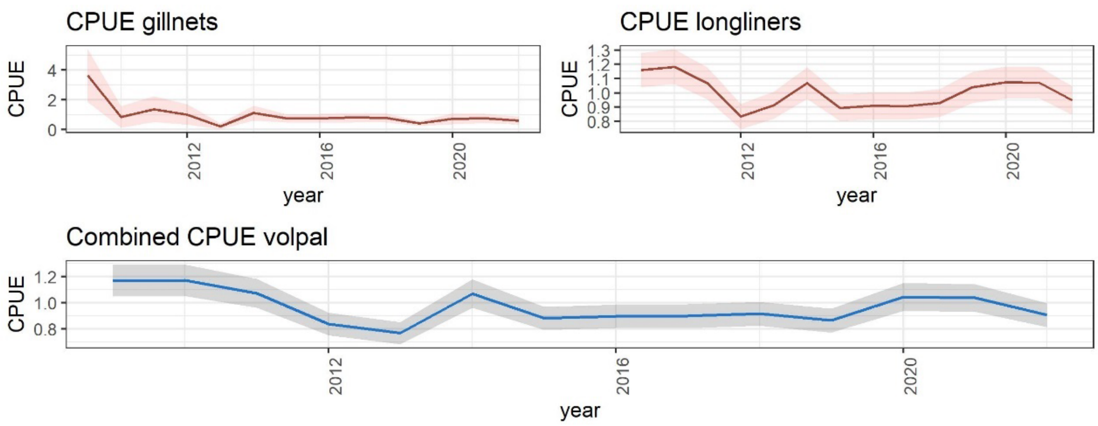


Figure 10.3. Recruitment and biomass indices from groundfish surveys. The surveys SpGFS-WIBTS-Q4 (G2784) and SPGFS-caut-WIBTS-Q4 (G4309) are an input in the SS model and termed SpSurv and CdSurv, respectively. Autumn ptGFS-WIBTS-Q4 (G8899) is an input survey in the SS model and termed PtSurv. Shaded regions are 90% confidence intervals.



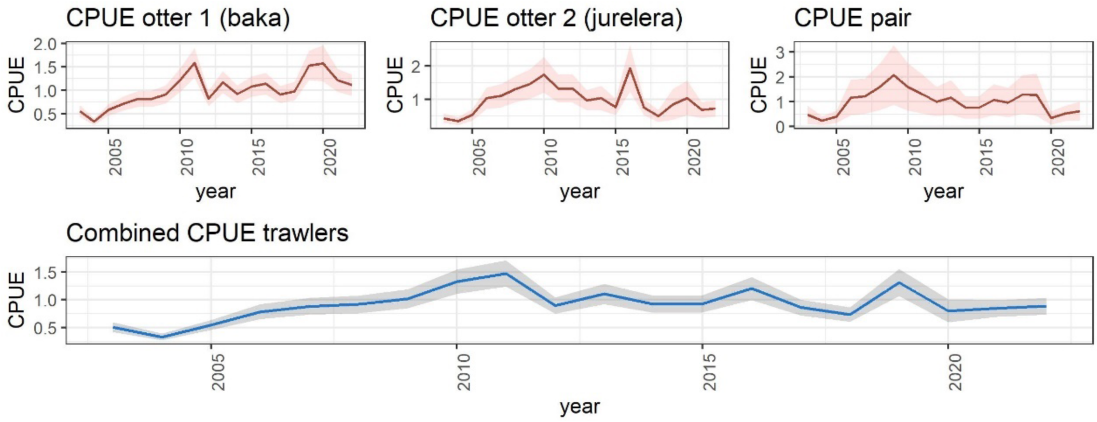


Figure 10.4. CPUE trends for trawlers and volpal. Trawlers CPUE is a weighted mean of 3 Spanish trawlers métiers (pairtrawlers, and two otter (baka) trawlers in which baka fleet of Table 10.1 can be split ("baka" and "jurelera"). VolPal CPUE is a weighted mean of Spanish gillnetters and longliners. Shaded regions are 90% confidence intervals.

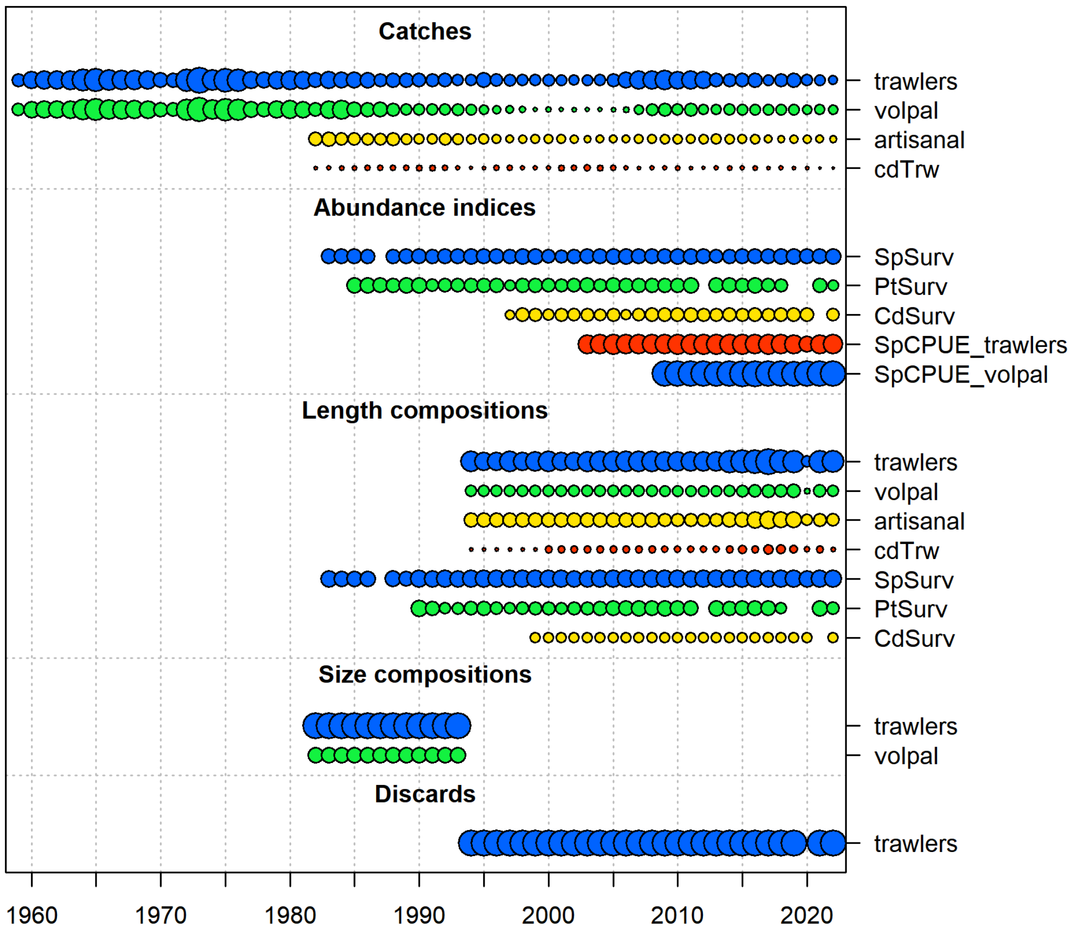


Figure 10.5. Data presence by year for each fleet, where circle area is relative within a data type. Circles are proportional to total catch for catches; to precision for indices, discards, and mean body weight observations; and to total sample size for compositions and mean weight- or length-at-age observations. Note that since the circles are scaled relative to maximum within each type, the scaling within separate plots should not be compared. This is a seasonal model, so scaling is based on either the sum of samples within each year (for things like comps) or the average among observations within a year (for things like index uncertainty).

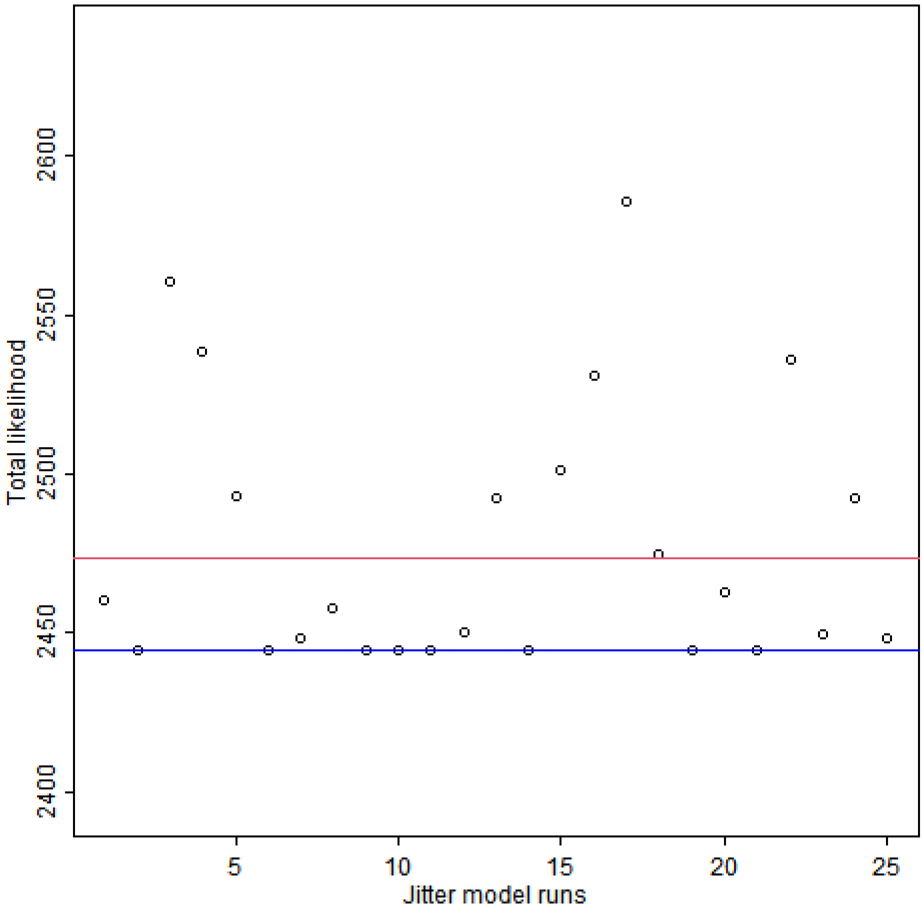


Figure 10.6. Jitter convergence analysis. Blue line represents the final run likelihood. The graph shows the likelihood of those jittered runs that can invert the hessian (25 out of 50). 8 out of 25 got to the same minimum likelihood than the final run. The likelihood of our first run model is in red, after the jitter analysis such model has been changed to one of the jitter model runs in the blue line improving in this way the likelihood.

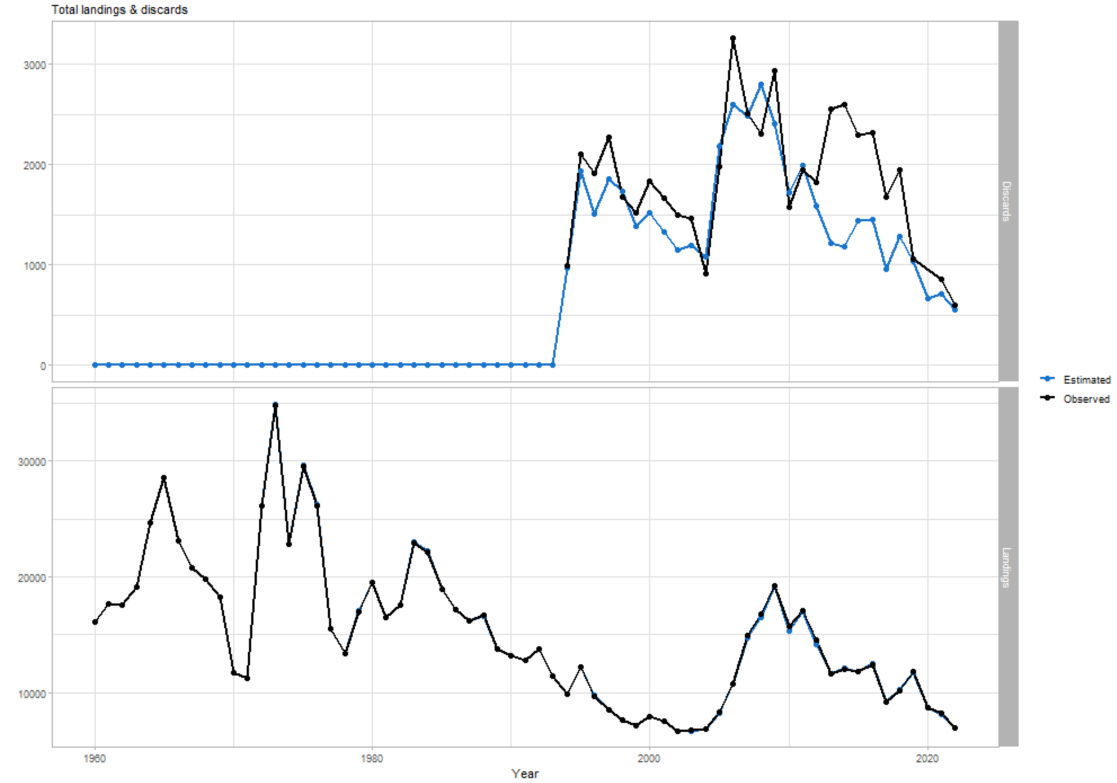


Figure 10.7a. Observed and estimated landings and discards by year.

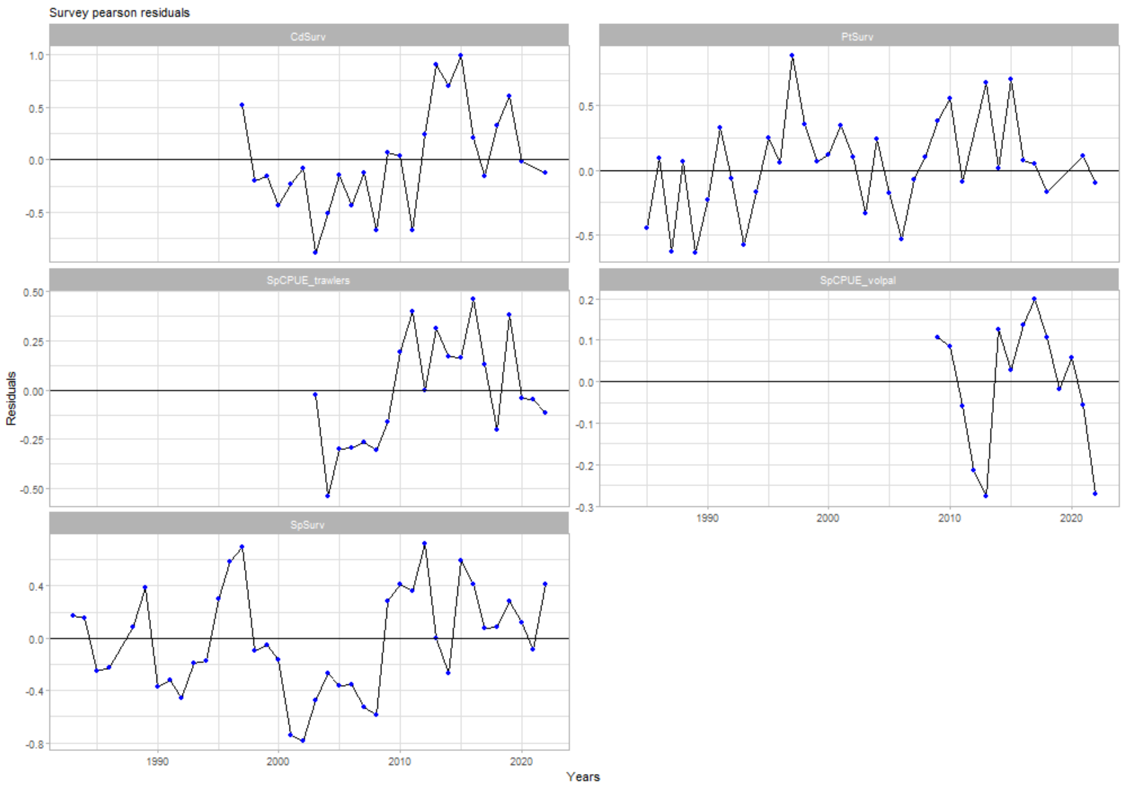


Figure 10.7b. Survey (biomass) and CPUE model residuals in log scale.

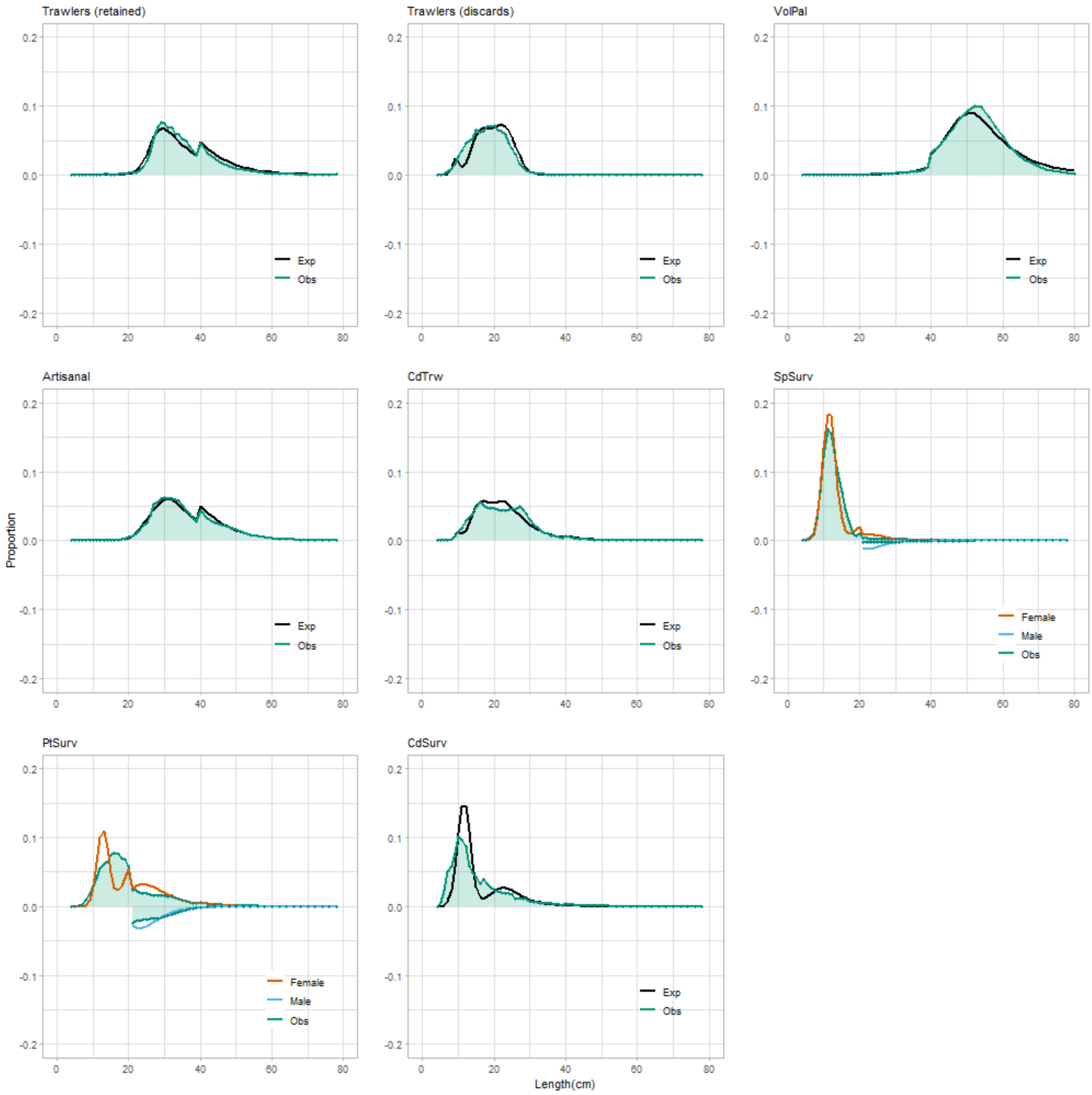


Figure 10.7c. Length distribution fit for all years together. SpSurv and PtSurv provide a separated fit for males and females.

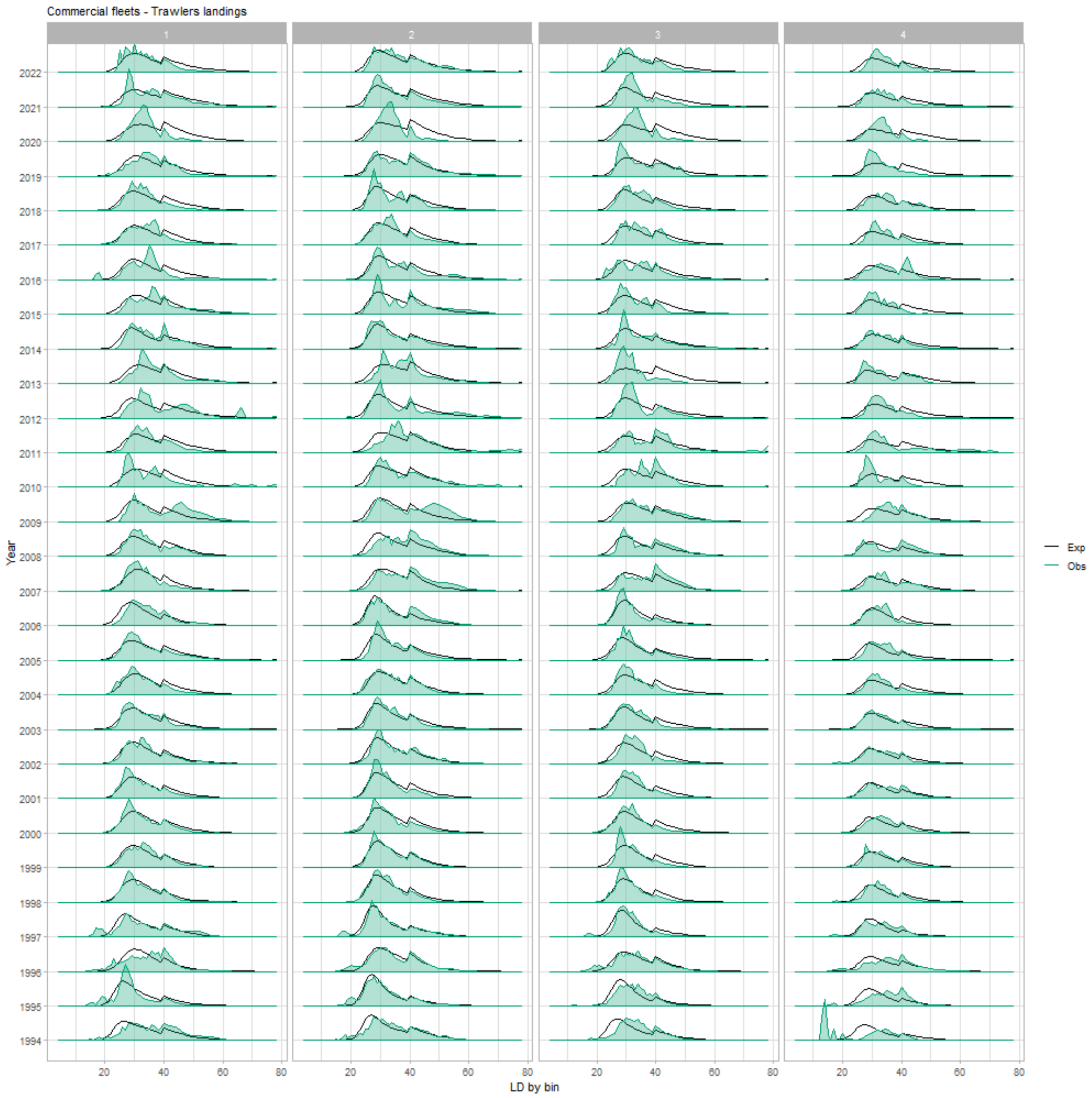


Figure 10.7d. Observed and expected length distribution of trawler landings by year and season.

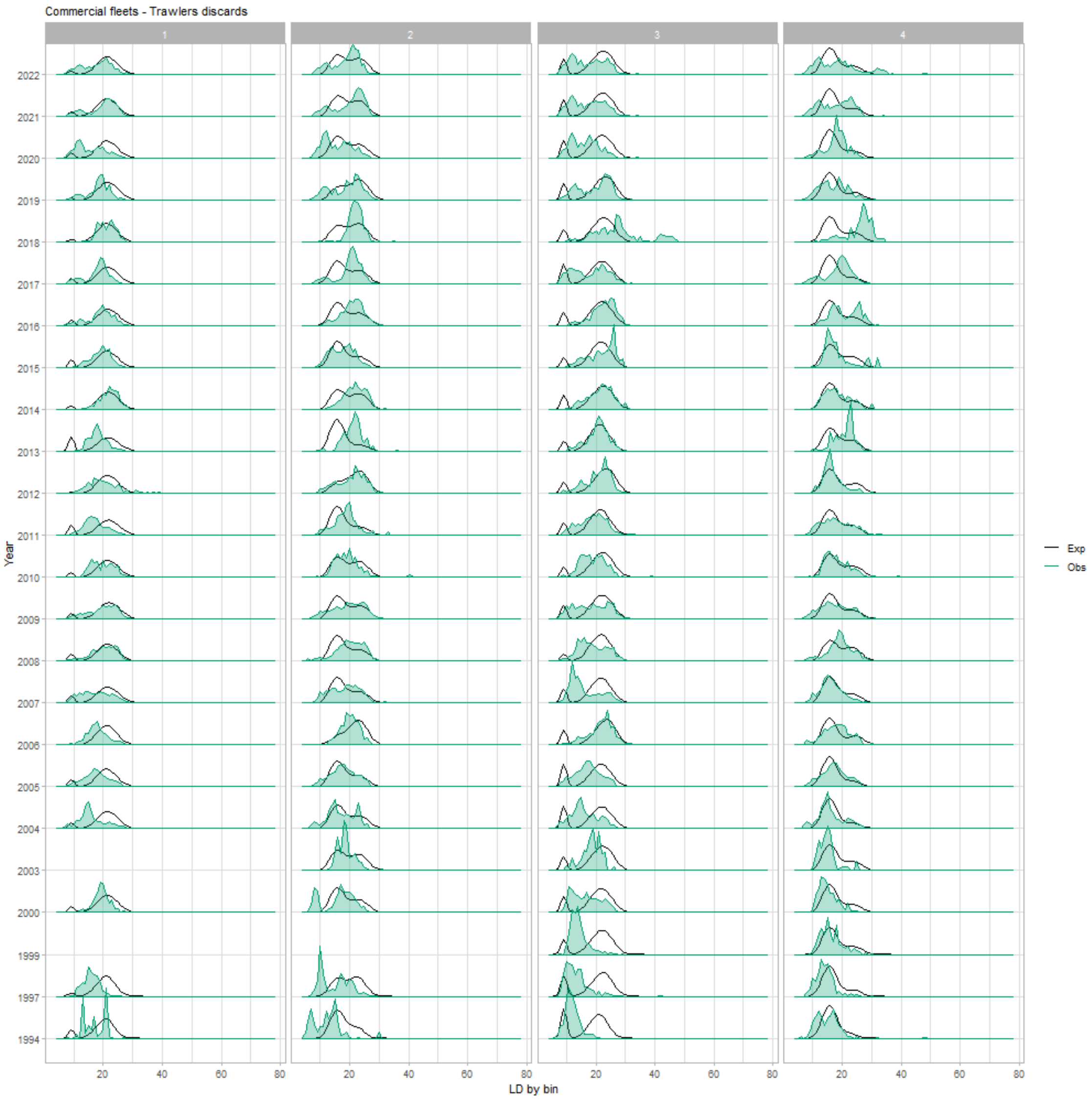


Figure 10.7e. Observed and expected length distribution of trawler discards by year and season.

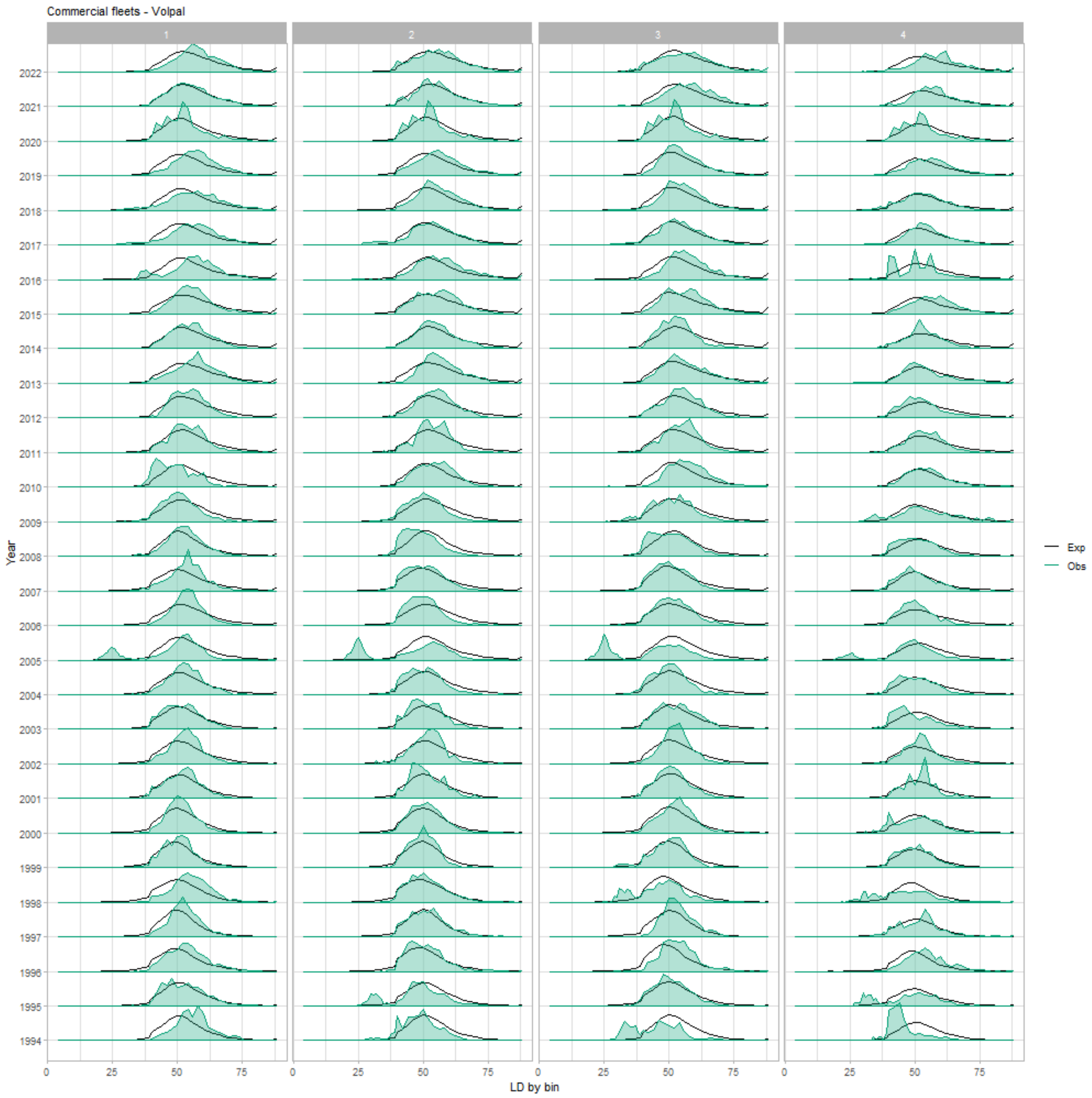


Figure 10.7f. Observed and expected landings length distribution of volpal fleet by year and season.

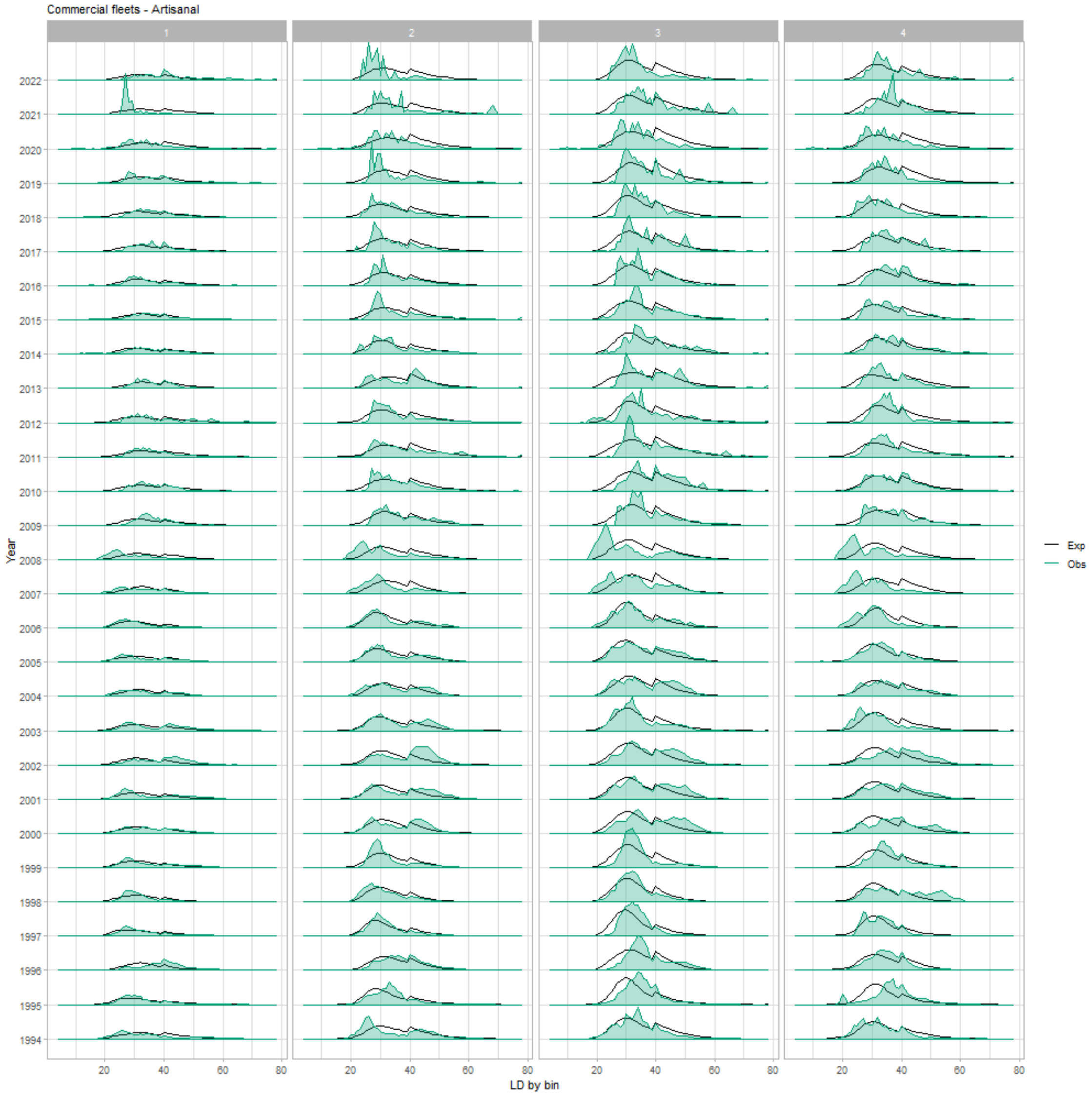


Figure 10.7g. Observed and expected landings length distribution of artisanal fleet by year and season.

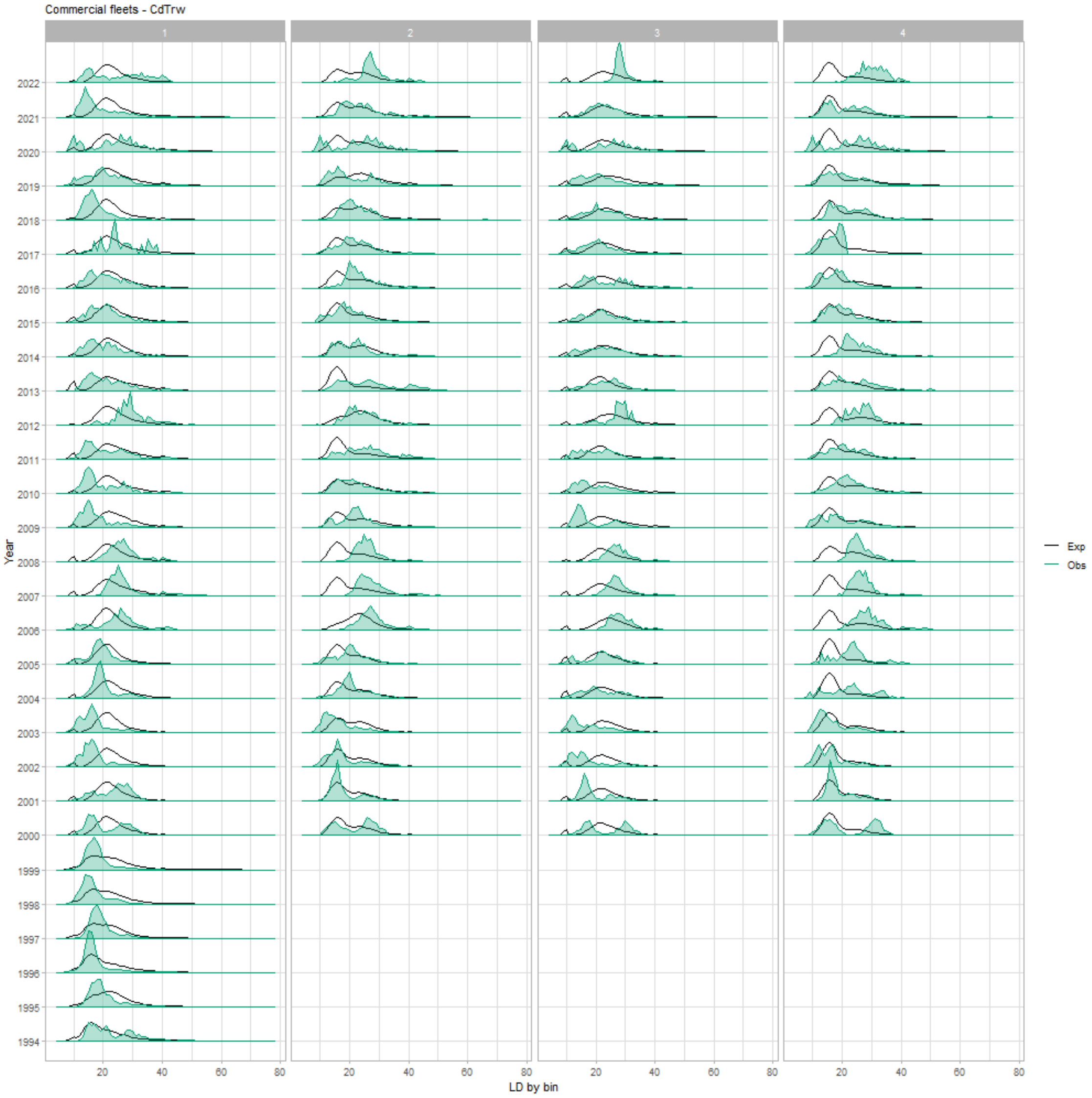


Figure 10.7h. Observed and expected landings length distribution of cdTrw fleet by year and season.

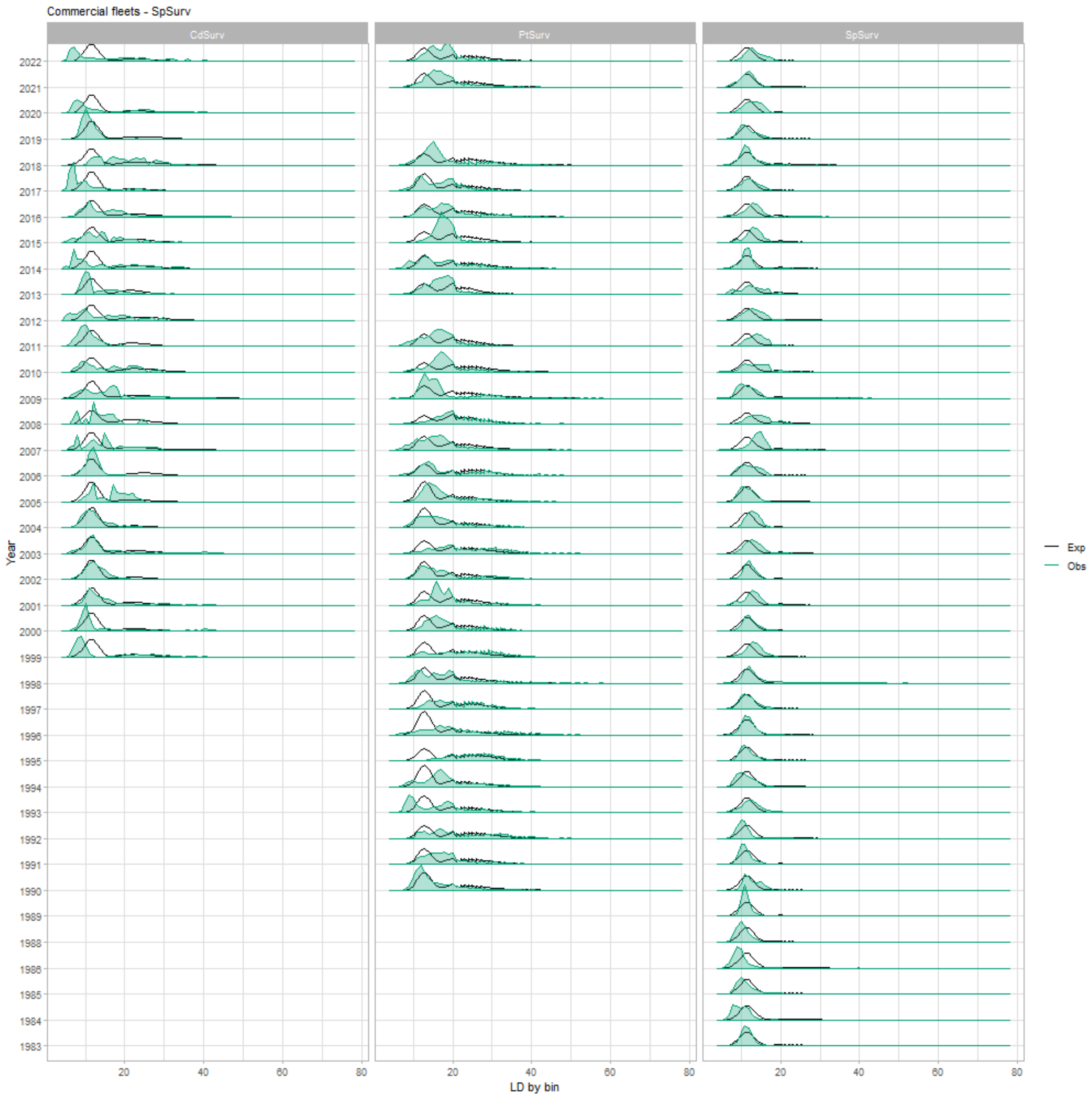


Figure 10.7i. Observed and expected survey length distribution of Cádiz demersal survey (spGFS-caut-WIBTS-Q4), - left; Portuguese demersal survey (PtGFS-WIBTS-Q4 (G8899)), - centre; and North Spain demersal survey (SpGFS-WIBTS-Q4 (G2784)), - right.

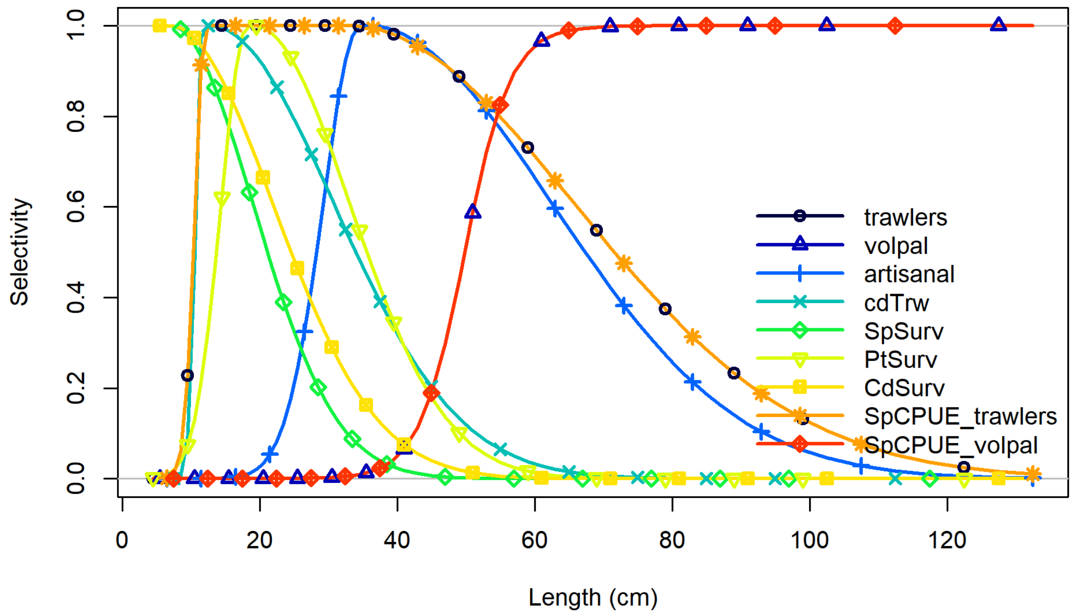


Figure 10.8. Selection pattern for commercial fleets, surveys and abundance indices.

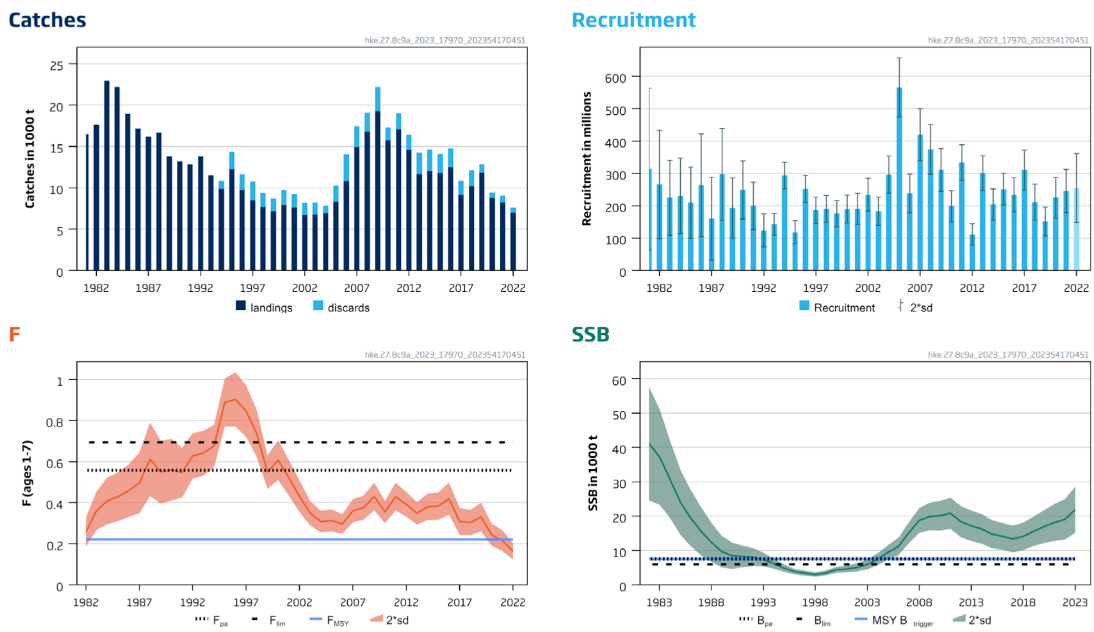


Figure 10.9. Summary plot. SSB (females only) and removals (catch, landings, and discards). Fishing mortality (F) for ages 1–7.

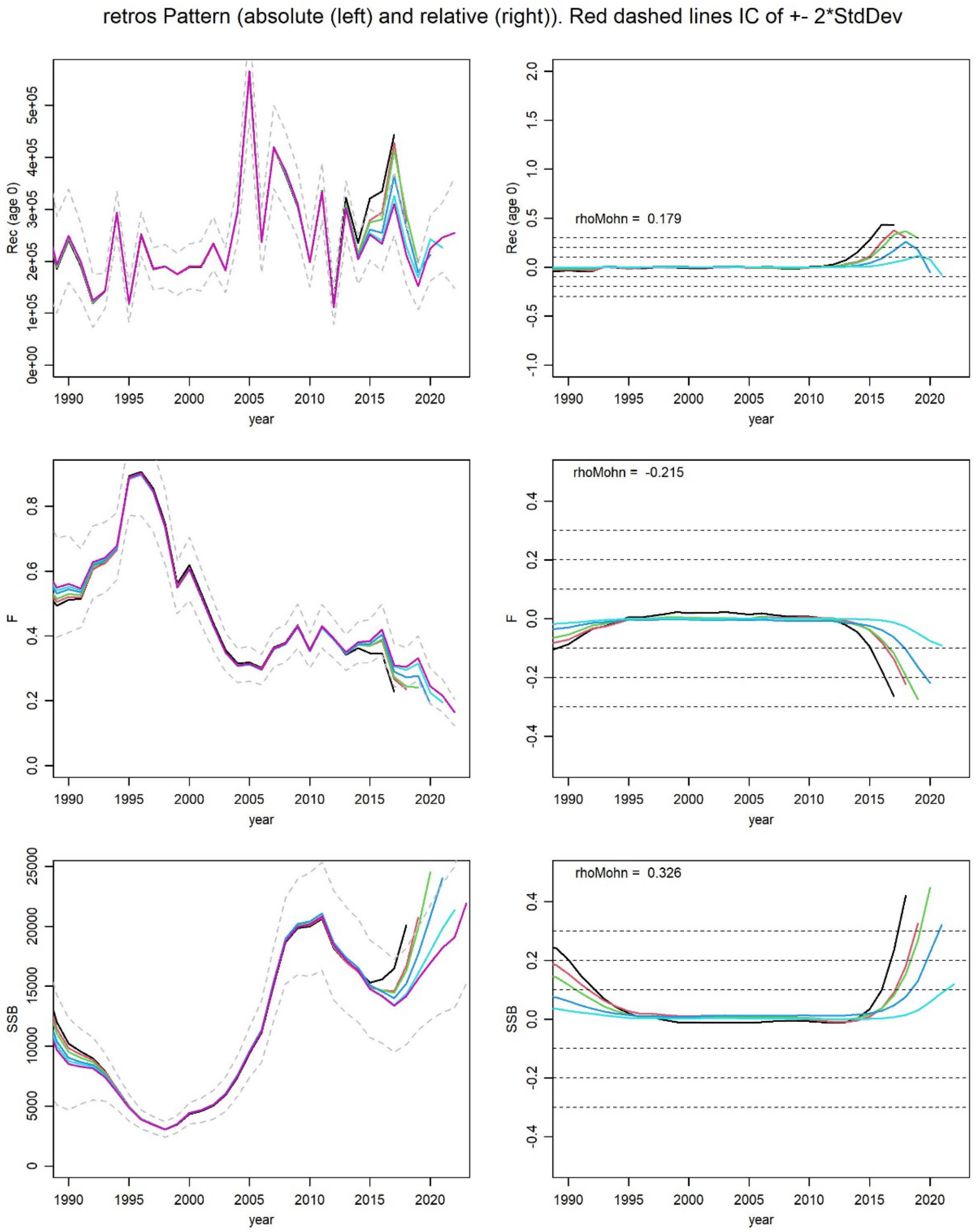


Figure 10.10. Retrospective plots (absolute and relative).

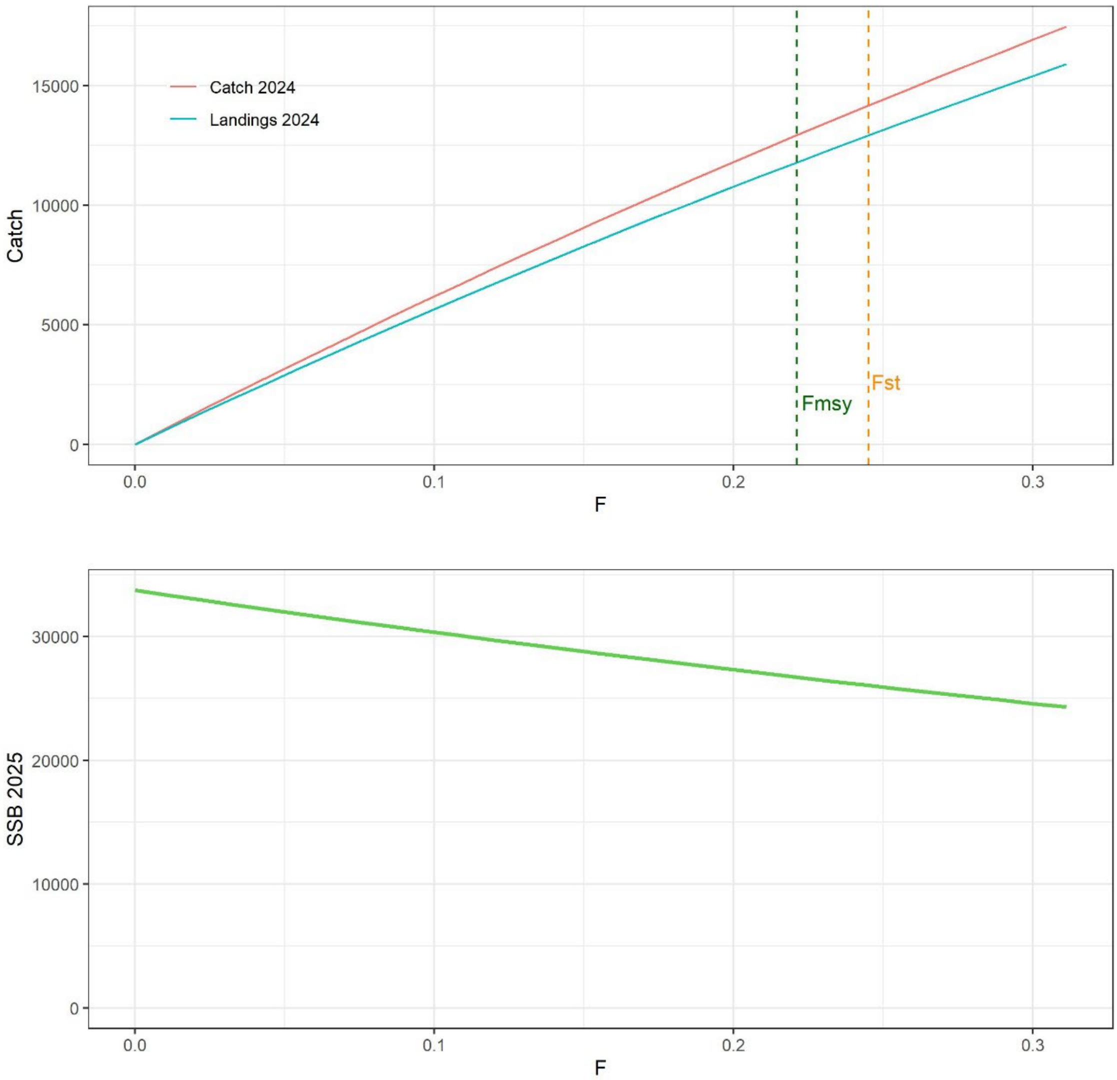


Figure 10.11. Short-term projections for yield and SSB. The vertical red line is the F_{MSY} and the green one is the assumed F_{sq} (F status quo).

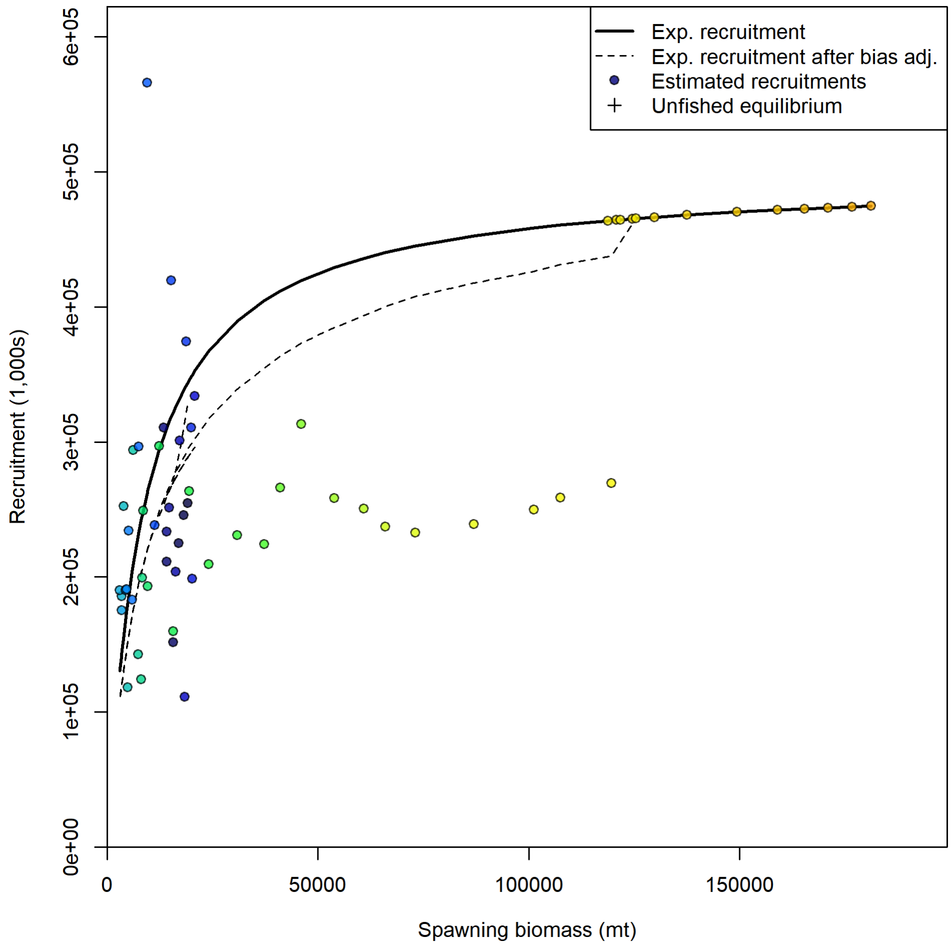


Figure 10.12. Stock-recruitment relationship. Black line shows the Beverton and Holt model. Point colors indicate year, with warmer colors indicating earlier years and cooler colors in showing later years

11 Northern and central Bay of Biscay Norway lobster

nep.fu.2324 – *Nephrops norvegicus* in divisions 8.a and 8.b, FUs 23-24

Type of assessment: Update assessment.

The northern and central Bay of Biscay Norway lobster, *Nephrops norvegicus,* in divisions 8a,b (Functional Units 23-24) is classified as a category 1 stock since 2016 (ICES, 2017a; ICES 2021a).

Advice basis: MSY approach. The advice for this stock is annual.

Data and method revisions

Main changes from the last assessment (ICES, 2020): In 2016, the stock was benchmarked (ICES, 2017a) and assessment based on UWTV survey (ICES code: U6811) conducted since 2014 was validated as an analytical method. Assessment will be updated in September-October 2023, when the UWTV survey results will be available and taken into account.

ICES description: 8.a and 8.b

Functional Units (FU): Bay of Biscay North, 8a (FU 23), Bay of Biscay Central, 8b (FU 24).

11.1 General

11.1.1 ICES Advice for 2023

Previously, advice for this stock was provided biennially under category 3, with only trends of the annual assessment taken into account for the advice. The UWTV survey (U6811), routinely carried out since 2014, was validated as the standard assessment method for this stock during the 2016 benchmark workshop WKNEP (ICES, 2017a). The stock was upgraded to category 1 and the advice is provided annually. The latest ICES advice provided in 2022 recommended that when the MSY approach is applied, catches in 2023 should be no more than 6 734 t, corresponding to 4 631 t of landings considering the revised survival rate for discards to 50% instead of 30% adopted during the WK*Nephrops* (ICES, 2020b).

11.1.2 Management applicable for 2022 and 2023

The *Nephrops* fishery is managed by a TAC [articles 3, 4, 5(2) of Regulation (EC) No 847/96] along with technical measures. The agreed TAC for 2022 was 3 880 t and for 2022, the TAC was set at 4 631 t.

For a long-time, a minimum landing size (MLS) of 26 mm carapace length (CL; 8.5 cm total length) was adopted by the French producer's organisation, which is larger than the EU MLS set at 20 mm CL *i.e.* 7 cm total length. Since December 2005, a new French MLS regulation (9 cm total length) was established. This change significantly impacted the data used by the WG (see report WGHMM in 2007; ICES, 2007).

A mesh size change was implemented in 2000, increasing the minimum codend mesh size (MMS) in the Bay of Biscay to 70 mm, which replaced the 50 mm mesh size implemented in 1990-91. Technical regulations have also been introduced to reduce *Nephrops* by-catch in the Bay of Biscay fishery. In 2002, the European Commission (EC) established technical measures for the recovery of the northern stock of European hake, under which the minimum codend mesh size (MMS) was increased from 70 to 100 mm in the hake box to reduce the high level of hake discarding by

Nephrops trawlers in the Bay of Biscay (EU Reg. 2341/2002). In 2006 and 2007, *Nephrops* trawlers were allowed to fish in the hake box with mesh size smaller than 100 mm once they have adopted a square mesh panel of 100 mm. This derogation was maintained onwards.

As cited in paragraph 24 of the preamble of the European Regulation (EC) No. 41/2007, fixing the fishing opportunities for 2007: "*In order to ensure sustainable exploitation of the hake stocks and to reduce discards, the latest developments on selective gears should be maintained as transitional measures in ICES zones VIIIa, VIIIb and VIIId.*" In agreement with this, the National French Committee of Fisheries (deliberations 39/2007, 1/2008) fixed the rules for trawling activities targeting *Nephrops* in the areas 8a and 8b applicable from the 1st of April 2008. All vessels catching more than 50 kg of *Nephrops* per day must use a selective device from at least one of the following: (1) a ventral panel of 60 mm square mesh; (2) a flexible grid or (3) a 80 mm codend mesh size. The majority of *Nephrops* directed vessels (districts of South Brittany) chose the increase of the MMS whereas the ventral squared panel was adopted by multi-purpose trawlers mainly in harbours outside of Brittany.

A licence system was adopted in 2004 and, since then, there has been a cap of 250 *Nephrops* trawlers operating in the Bay of Biscay. This limit of *Nephrops* trawlers decreased to 160-180 in 2018-2022. In the beginning of 2006, the French producers' organisations adopted regulations (*e.g.*, monthly quotas) which had some effects on fishing effort limitation. From 2017 onwards, some additional decisions were implemented by the producers' organisations, such as spreading landings sales over several days, in order to prevent any excess in productivity and/or quota overshot.

Since the 1st of January 2017, the use of a discarding quick-chute system onboard has become compulsory. There has been an impact on the survival rate of discards which is currently considered higher (50%; Mérillet *et al.*, 2018) than the historical value of 30% (Charuau *et al.*, 1982). This rate was taken into account during the WK*Nephrops* in 2019 (ICES, 2020b) for future assessment and advice of the stock.

11.2 Data

11.2.1 Commercial catches and discards

Total catches, landings and discards, of *Nephrops* in divisions 8a, b for the period 1960-2022 are provided in Table 11.1.

During the mid-1960s, the French landings gradually increased to a peak value of 7 000 t in 1973-1974, then decreased with values fluctuating between 4 500 and 6 000 t during the '80s and the mid-'90s. An increase has been noticeable during the early 2000s. Landings showed a decreasing trend from 3 991 t in 2005 to 2 987 t in 2009. In 2010 and 2011, total landings increased (3 398 and 3 559 t, respectively), followed by a strong reduction in 2012 and 2013 (2 520 and 2 380 t, respectively). During the period 2014-2016, landings increased continuously (2 807 t in 2014; 3 569 t in 2015; 4 091 t in 2016). In 2017, landings decreased again by -17% (3 412 t) due to the implementation of more constraining regulations cited above. The lowest levels of landings in the stock time series were observed in 2018 (2 125 t), 2019 (2 154 t) and 2020 (2 273 t) whereas in 2021 landings increased steeply (3 006 t, +32% compared to 2020). In 2022, a decrease of landings by –10%(2 694 t) occurred.

In 2005, when the northern hake stock was under a recovery plan, the use of dorsal mesh square panels became mandatory for the trawlers targeting *Nephrops* in the Bay of Biscay, as this area is known to be an important nursery area for the hake stock. The implementation of the selective devices previously referred (a ventral panel of 60 mm square mesh or a 80 mm codend mesh size) coincided with a peak of discarded hake in weight and in proportion following a slightly lower proportion of discarded hake in 2006-2007. Similarly in 2008, *Nephrops* length distribution in discards remained unchanged despite the mandatory use of the above mentioned selective modifications (Nikolic *et al.*, 2015). The decrease in discarded *Nephrops* weight in recent years may be due to the decreasing fishing mortality imposed to the stock since 2006 which consequently resulted in lower catches (ICES, 2012b), rather than due to a change in selectivity.

Males usually predominate in the landings with the sex ratio (defined as number of females divided by the total number of both sexes) fluctuating between 0.28 and 0.46 for the overall period (1987-2022) with the historically lowest value in 2017. In 2022, the sex ratio of landings was 0.40. The same predominance, although to a lesser degree, was observed for the removals (sex ratio in the range 0.35-0.49) which shows a sex ratio of 0.42 in 2022. Females are less accessible in winter because of their burrowing behaviour during the egg-bearing period.

Discards represent most of the catches of the smallest individuals as indicated by the available data (Figure 11.1). The average weight of discards per year in the period up to early 2000s (not routinely sampled) is about 1 543 t whereas discards estimate for the most recent sampled years (2003-2022) reached a higher level (1 834 t). This change in the amount of discards could be due to 1) the restriction of individual quotas, 2) the strength of some recruitments in mid-2000s and 3) the change in the MLS (which tends to increase the discards), although improvements in selectivity may contribute to reduce the discards. The relative contribution of each of these three factors remains unknown. In 2019, the minimum level of discards had been observed (59 million individuals, 634 t) since the start of the European Union Data Collection Framework (DCF; Commission Regulations (EC) Nos. 1639/2001 and 199/2008) and the discard rate had decreased (38% against 58% in 2017 and 65% in 2018). In 2020, discards considerably increased up to 154 million individuals (1 908 t; discard rate of 61%) but a reduction was observed in 2021 (106 million; 1 126 t; discard rate of 45%) and 2022 (86 million; 791 t; discard rate of 42%).

11.2.2 Biological sampling

11.2.2.1 Landings

French sampling at auction started in 1984, but only from 1987 onwards can the data be used on a quarterly basis. Since 2003, additional landings data was also provided from onboard routine sampling for estimating discards under the European DCF. As the landed fraction of *Nephrops* is usually size graded, the sampling plan is stratified by time and commercial category *vs.* size. The numbers of sampling units by quarter and year as well as the numbers of sampled landed individuals of *Nephrops* are presented in Tables 11.2 and 11.3, respectively.

During the first two quarters of 2017, the French onshore sampling program at auctions was discontinued due to a planned shift towards a subcontracted program as already performed for the French onboard sampling. The delay in the call for tenders disrupted the onshore sampling collection for six months. Compared to other onshore species, the Bay of Biscay *Nephrops* was less impacted as complementary biological parameters (such as maturity) were collected by other ongoing European projects during the first half of the year which resulted in a satisfactory sampling rate. In order to compensate for the lack of Q1 and Q2 landings data in 2017, a simulation was performed using the method proposed by Quemar *et al.* (2018) to generate missing auction sampling units from onboard samples using stratified estimators (quarter/harbour/commercial category *vs.* size). This method was not specifically developed for the FU23-24 *Nephrops* and only actually sampled units were retained for quarterly and global estimates.

The particular problem of lower sampling rate for landings during the 1st and 2nd quarters 2017 due to the delay on the sampling shift between operators, as explained above, affected the precision of estimates (decrease of the sampling units and of measured *Nephrops* at auction) although it did not change the overall perception for the stock status (LFDs and mean weight for landings). As shown by unpublished studies on recent DCF sampled years (2014-2017), the LFDs for landings by sex did not significantly change their overall shape when the raising is undertaken on the exclusive database from the sampling onboard despite the higher CVs obtained. This problem was resolved in 2018 and 2019 and the global sampling levels were more satisfactory than previously.

In 2020, the auction and onboard samplings were impacted by the COVID-19 pandemic restrictions especially during the first severe lockdown (mid-March/mid-May) enforced in France. The coverage of the most substantial quarter for this fishery (2nd quarter) was consequently reduced to only one month of sampling (June) although a first sensitivity analysis demonstrated that this dataset gap did not strongly modify the LFDs shape when compared with completely sampled data in previous years. Moreover, this procedure did not increase the uncertainties. In 2021 and 2022 more regular conditions for applying the sampling designs at auction as well as onboard were ensured.

11.2.2.2 Discards

Discards data from onboard sampling are available for the years 1987, 1991 and 1998 and then from 2003 onwards. Since the former WGNEPH, for the intermediate years up to 2002, discarded numbers-at-length were derived using the "proportional method" where discards by sex for years with no onboard sampling were estimated by applying identical quarterly LFDs of the preceding sampled year raised to the quarterly landings *i.e.* for years 1992-1997 derivation used quarterly LFDs from 1991. This method was suspected to induce inter-dependence throughout the time series, therefore, lack of contrast for annual recruitment. IBP *Nephrops* 2012 (ICES, 2012a) investigated the probabilistic (logistic) approach developed for the WGHMM since 2007, although it was not conclusive (Table 11.4; see Stock Annex).

Since 2003, discards have been estimated from catch sampling programmes onboard the *Nephrops* trawlers (776 trips and 2 035 hauls have been sampled over 20 years). In spite of improvements in the agreement between logbook declarations and auction hall sales since mid-2000s, the quality of crossed information fluctuates between years. For instances, for years 2007-2022, the percentage of cross-validation item by item between logbooks and sales ranged from 69 to 90% with an improvement in the last period (85% for 2016, 88% in 2017, 90% in 2018, 88% in 2019 and 2020, 92% in 2021, ≈100% in 2022). Therefore, the total number of trips, not well known in the past, is more accurately provided for the recent years and can be reliably used as raising factor for discards. Nevertheless, the number of trips mostly represented by the number of sales at auction is heterogeneous as the boats in the northern part of the Bay of Biscay conduct daily trips whereas in the southern part, trips last 2-3 days with a more diverse profile of catches. Discards sampling from the southern part of the Bay of Biscay fishery was carried out only once in the past (2005), but the sampling plan has been routinely applied since 2010. The numbers of sampled units by quarter and for the whole year and those of discarded sampled *Nephrops* are summarized in Table 11.5. As for the landings, COVID-19 restrictions disrupted the routinely conducted onboard sampling for the major part of the 2nd quarter of 2020. Moreover, the sampling rate onboard during the 1st quarter 2020 was also reduced due to meteorological conditions. In 2021, the 1st quarter's sampling rate onboard also remained low but the situation was improved in 2022.

The length distribution of landings, discards and catches from the DCF sampling since 2003 are presented in Tables 11.6.a-c and in Figure 11.1 (for LFDs from years 1987-2002: see Stock Annex). Combined sex mean lengths are presented for catches, landings and discards in Figure 11.2. Figure 11.3 provides the annual LFDs by sex and their CVs for landings and discards in 2022. Similar information for years 2014-2021 is available in the Stock Annex.

11.2.3 Abundance indices from surveys

11.2.3.1 Trawl survey (LANGOLF)

For many years, abundance indices were not available for this stock. LANGOLF series (see Section 2 of this report and Stock Annex), specially designed survey to evaluate abundance indices of *Nephrops*, started in 2006 being conducted during the most appropriate season (2nd quarter), hours (around dawn and dusk) and fishing gear (twin trawl). This survey occurred once a year in May and its sampling design was stratified based on the sedimentary structure. Therefore, based on the investigations carried out during the IBP *Nephrops* in 2012 (ICES, 2012a), the abundance indices were included in the assessments of WGHMM 2012 and 2013 (ICES, 2012c; ICES, 2013) and WGBIE 2014 (ICES, 2014). Nevertheless, the relative improvement in retrospective analysis did not substantially modify the quality of the stock assessment performed by XSA model. The time series provided by this survey ended in 2013.

11.2.3.2 UWTV survey (LANGOLF-TV; ICES code: U6811)

An experimental survey for counting UWTV burrows, as routinely operated for many *Nephrops* stocks in areas 6 and 7, has been conducted since 2014 on a yearly basis. In the first two years, this UWTV survey, named "LANGOLF-TV", aimed to demonstrate the technical feasibility of such a survey in the local context and to identify the necessary competences and equipment for its sustainable use. Burrow counting was carried out by the Irish research vessel "Celtic Voyager" on the basis of a systematic sampling plan. In this period, UWTV experiments were combined with trawling operations by two commercial vessels applying the same sampling plan (stratified random) and using the same twin trawls (20 mm codend mesh size) as those of the former LANGOLF trawl survey with the purpose of providing *Nephrops* LFDs by sex and estimating the proportion of other burrowing crustaceans (mainly *Munida sp.*) which can induce bias in the burrows counting.

From 2016 onwards, the trawling operations were cancelled as these were considered no longer necessary for further analytical investigations on the stock exclusively based on the UWTV tools. A longer survey duration in the period 2016-2022 allowed to cover the area within the outline of the central mud bank not belonging to any sedimentary stratum (Figure 11.4). This area is not heavily trawled due to the rough sea bottom crossed by muddy channels but concentrates a moderate fishing effort targeting *Nephrops*. Investigations based on stratified statistical estimators (Table 11.7) as well as on geostatistics (Table 11.8; Fig. 11.5 and 11.6) were carried out and then examined during the WKNEP (ICES, 2017a) which validated the UWTV approach. The number of sampled stations decreased between 2016 and 2017 (from 196 validated ones to 124) because a larger area than the Central Mud Bank was covered in 2017 in order to accurately delimit the actual outline of the stock following the recommendations of the WGNEPS in 2016 (ICES, 2017b). In 2018-2021, 184 , 145, 134 and 175 valid stations were respectively sampled in the area. Between 2016 and 2017, the total number of burrows decreased by -19% (3,373 billion in 2017 against 4,167 in 2016) whereas an increase (+12%) was observed in 2018 (3,788 billion) and (+9%) in 2019 (4,113 billion).

The annual survey occurred in different seasons (September 2014, July 2015, May 2016, 2017 and 2019, end April 2018, 2021 and 2022) as sampling period was constrained and determined by the availability of the UWTV equipment and staff from the Marine Institute of Ireland.

In 2020, due to the COVID-19 pandemic, the survey initially scheduled in late April to early May was strongly compromised, before being rescheduled to the end of July. During the 2020 UWTV survey, only two Irish experienced scientists were able to participate in order to respect the social distancing obligation on board. This also led to the reduction of the sampling plan to 134 finally validated stations but still with an acceptable statistical precision level of estimates and all the video interpretations were carried out by a limited number of Ifremer staff in the laboratory after the end of the survey. A first investigation of the footage was undertaken by only one staff member of Ifremer by sampling unit in order to satisfy constraints linked to the stock assessment and advice in late September/early October. The number of burrows was estimated at 3,425 billion (-17% against 2019's survey) and the stock was advised for 2021 on this basis. According to WGNEPS 2020 recommendations (ICES, 2021b), a second reader per sample is needed, and in several cases a third one can be necessary, in case of divergence between experts *vs.* the statistical Lin's concordance correlation coefficient (CCC; Lin, 1989, 2000). The revised estimate 2020 a number of burrows was equal to 3,602 billion (–12% compared to the 2019's estimate).

In 2021, the pandemic constraints remained, althoughin a lesser degree, therefore the survey was conducted in the initially scheduled period (late April) by only two specialized scientists among them the one from Ifremer. The exploration of the recorded samples was also carried out in lab although by a sufficient number of readers as the survey occurred in spring and it was more realistic to anticipate the schedule for reading in lab. The number of burrows was estimated at 3,431 billion (-5% compared to 2020).

A WD was presented in the WGBIE 2022 aiming to more accurately define the polygon surface of this stock by eliminating area with repetitively zero burrows. The WD was examined by the WG and a final version was validated in September 2022 and included in the assessment and advice process 2023. The updated stock surface (14 640 km² instead of 16 164 km² considered by the benchmark workshop 2016) reduced by less than –9% the number of sampling units (in years 2016-2021, 179, 113, 175, 139, 132 and 175 stations are respectively contained in the new stock polygon). The overall perception of the stock abundance remained unchanged : in years 2016-2021, the revised numbers of burrows were respectively 4,189, 3,346, 3,752, 4,030, 3,399 and 3,236 (in billion).

In 2022, COVID-19 constrains also impacted the UWTV survey although the exploration of footage (174 validated stations) was totally realized onboard. On the recently revised surface of the stock the number of burrows is equal to 3872 billion (+20% compared to 2021).

11.2.4 Commercial catch-effort data

Up to 1998, the majority of the vessels were not obliged to keep logbooks because of their size and fishing forms were established by inquiries. Since 1999, logbooks became compulsory for all vessels longer than 10 m. The available logbook data cannot be currently considered as representative for the fishing effort of the whole fishery during the overall time series. Hence, since 2004, attempts to define a better effort index were done.

Effort data indices, landings and LPUE for the “Le Guilvinec District” *Nephrops* trawlers in the 2nd quarter (noted GV-Q2) are available for the overall time series (Table 11.9; Figure 11.7). Effort increased from 1987 to 1992, but there has been a decreasing trend since then. In recent years, the lowest fishing effort value for the whole period was observed.

In 2019, the fishing effort remained almost stable compared to 2018 (-2%) which further decreased in 2020 (-12%) mainly because of the COVID-19 disruptions. In 2021, an increase of the fishing effort was observed (+12%) but a decrease occurred in 2022 (-12%). The overall downward trend in effort can be explained by the reduction in the number of fishing vessels following the decommissioning schemes implemented by the EU. The LPUEs of the GV-Q2 fleet were reasonably stable for a long period, fluctuating around a long-term average of 14.1 kg/h (Figure 11.7), with four peaks (1988, 2001, 2010 and 2017). LPUE reached the historically highest level in the middle of the last decade (2015: 19.5 kg/h; 2016: 19.7 kg/h; 2017: 21.9 kg/h), but declined in 2018 (-22%; 17.0 kg/h) then was reduced again in 2019 (-7%, 15.7 kg/h) and remained at the same level in 2020 (15.6 kg/h), 2021 (15.9 kg/h) and 2022 (16.6 kg/h).

Changes in fishing gear efficiency and individual catch capacities of vessels imply that the time spent fishing may not be a good indicator of effective effort and, hence, the LPUE trends are possibly biased. Since the early ‘90s, the number of boats using twin-trawls increased (10% in 1991, more than 90% in recent years, almost 100% in the northern part of the fishery) and also the number of vessels using rock-hopper gear on the rough sea bottom of the extreme NW part of the central mud bank of the Bay of Biscay. Moreover, an increase in onboard computer technology has occurred. The effects of these changes are difficult to quantify as twin-trawling is not always recorded explicitly in the fisheries statistics and improvement due to computing technology is not continuous for the overall time series.

11.3 Assessment

An analytical assessment based on the adopted UWTV survey was carried out for the first time in November 2016 after the WKNEP benchmark (ICES, 2017a) in order to propose advice 2017 for the stock. An update of the stock data is performed in spring of each year covering the LFDs and mean weights for landings and discards of the three preceding years but the results from the UWTV survey of the same year are not yet available. The estimated *status quo* harvest rates for 2016, calculated as the removals divided by the UWTV abundance, was equal to 7.2% (under the historical value of 30% for the survival rate of discards and after the recalculation of the stock abundance accordingly to the revised surface of the stock polygon (WD09; WGBIE 2022)). After the adoption of the survival rate of 50% as consequence of the compulsory quick chute system for discards since January 2017, the harvest rates for years 2017-2022 on the revised stock surface were 7.3%, 4.3%, 3.1%, 5.2%, 5.7% and 4.1%, respectively which are much below the MSY target (7.7%), with the exception of the year 2017 close to the reference value.

The summary from the assessment 2022 is provided in the table below (ICES, 2022a).

Variable	Value	Source	Notes
Abundance in TV assessment	3872.311	ICES (2022b)*	UWTV 2022 (results available before stock assessment and advice in autumn 2022)
Mean weight in landings	22.633	ICES (2022b)	Average 2019-2021
Mean weight in discards	11.241	ICES (2022b)	Average 2019-2021
Discard rate (total)	47.76%	ICES (2022b)	Average 2019-2021 (proportion by number)
Discard survival rate	50.00%	ICES (2022b)	Only applies in scenarios where discarding is allowed.
Dead discard rate (total)	31.90%	ICES (2022b)	Average 2019-2021 (proportion by number), only applies in scenarios where discarding is allowed.

11.4 Catch options and prognosis

For 2023, the catch options containing updated information on the fishery (mean weight for landings and discards, discard rate, survival rate for discards) is given below.

Variable	Value	Source	Notes
Abundance in TV assessment	autumn 2023	ICES (2023b)*	UWTV 2023 (results available before stock assessment and advice in autumn 2023)
Mean weight in landings	22.953	ICES (2023b)	Average 2020-2022
Mean weight in discards	10.736	ICES (2023b)	Average 2020-2022
Discard rate (total)	49.30%	ICES (2023b)	Average 2020-2022 (proportion by number)
Discard survival rate	50.00%	ICES (2023b)	Only applies in scenarios where discarding is allowed.
Dead discard rate (total)	33.10%	ICES (2023b)	Average 2020-2022 (proportion by number), only applies in scenarios where discarding is allowed.

* This Working Group report, to be updated in October 2022

11.5 Biological reference points

The F_{MSY} reference point (harvest rate of 7.7%; ICES, 2017a) is based on the average realised harvest rates (HR) of *Nephrops* functional units with an observed history of sustainable exploitation, while also taking into account the low harvest rates applied to the FUs 23-24 stock in the recent past. As the WK*Nephrops* 2019 (ICES, 2020b) was not conclusive at the aim of defining new reference points for this stock exclusively based on the SCA outputs and the scenarios under $F_{0.1}$ provided irrelevant results, the current reference value of HR=7.7% was kept.

11.6 Comments on the assessment

The French *Nephrops* trawlers onboard sampling programme avoids the use of “derived” data for missing years (14 over 36 years). Since 2009, there has been a relevant improvement of the sampling design as many trips were sampled in the Southern part of the fishery. Derivations based on the probabilistic approach should improve knowledge on further analytical retrospective investigations on this stock.

The upgrade to category 1 stock is the consequence of a representative sampling survey on the whole Central Mud Bank of the Bay of Biscay as performed in 2016-2022. In addition to the unbiased spatial fishery information, such as the VMS data, these results demonstrate the accurate knowledge of the stock area and of its sedimentary heterogeneous structure.

11.7 Information from the fishing industry

Several meetings were held between scientists and the fishing industry prior to the WG in order to discuss the partnership for the UWTV survey. The scientific methodological and financial supporting project conducted on years 2017-2019 and extended to the period 2020-2022 is replaced from 2023 onwards by a scheme based on the European DCF. Many discussions prior to the WG had underlined the steep decrease of landings in the period 2016-2020 which was considered by the industry as a temporary status and not as a signal of a declining trend. They argued that this situation had already been observed in the recent past: the positive dynamics in 2014-2016 occurred after the downwards moving in 2011-2013. The industry underlined the heterogeneous feature of the whole area of the stock and debated about the overall declining trend for the southern part of the Bay of Biscay considered problematic. Divergent interpretations were advanced for this decline although all of them converge that it might be the consequence of a gradual modification of the sediment nature of this area from a typically muddy to a more mixed one.

The industry was satisfied by the realization of the UWTV surveys in three years 2020-2022 under heavy constraints mainly for the first two ones allowing an actual update on the stock status. The industry praised the efficient and flexible partnership between the French and Irish scientists participating in the survey.

11.8 Management considerations

Some positive signals in the mid-2010s (increase of LPUEs, landings, removals) and relative stability of burrow indices from the 2014-2016 UWTV surveys suggested a stock status within safe limits. However, the oscillating trends of UTWV indices since 2017, *i.e.* the steep decrease in 2017 followed by an increase in 2018-2019 and a slight decline in 2020-2021, in spite of the increase in 2022 combined with the historically lowest landings level in 2018-2020 suggest considering cautiously the current situation which will be examined after including the 2023 UWTV survey results.

11.9 References

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11.10 Tables

Table 11.1. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b). Estimates of catches (t) by FU for 1960-2022.

Year	Landings (1)					Total Discards		Catches
	FU 23-24 (2)	FU 23	FU 24	Unallocated (MA N)(3)	Total VIIIa,b	FU 23-24		Total
	VIIIa,b	VIIIa	VIIIb		used by WG	VIIIa,b		VIIIa,b
1960	3524	-	-	-	3524	-		3524
1961	3607	-	-	-	3607	-		3607
1962	3042	-	-	-	3042	-		3042
1963	4040	-	-	-	4040	-		4040
1964	4596	-	-	-	4596	-		4596
1965	3441	-	-	-	3441	-		3441
1966	3857	-	-	-	3857	-		3857
1967	3245	-	-	-	3245	-		3245
1968	3859	-	-	-	3859	-		3859
1969	4810	-	-	-	4810	-		4810
1970	5454	-	-	-	5454	-		5454
1971	3990	-	-	-	3990	-		3990
1972	5525	-	-	-	5525	-		5525
1973	7040	-	-	-	7040	-		7040
1974	7100	-	-	-	7100	-		7100
1975	-	6460	322	-	6782	-		6782
1976	-	6012	300	-	6312	-		6312
1977	-	5069	222	-	5291	-		5291
1978	-	4554	162	-	4716	-		4716
1979	-	4758	36	-	4794	-		4794
1980	-	6036	71	-	6107	-		6107
1981	-	5908	182	-	6090	-		6090
1982	-	4392	298	-	4690	-		4690
1983	-	5566	342	-	5908	-		5908
1984	-	4485	198	-	4683	-		4683
1985	-	4281	312	-	4593	-		4593
1986	-	3968	367	99	4335	-		4335
1987	-	4937	460	64	5397	1767	*	7164
1988	-	5281	594	69	5875	4123		9997
1989	-	4253	582	77	4835	2634		7470
1990	1	4613	359	87	4972	627		5599
1991	1	4353	401	55	4754	1213	*	5967
1992	0	5123	558	47	5681	1354		7034
1993	0	4577	532	49	5109	1007		6116
1994	0	3721	371	27	4092	741		4833
1995	0	4073	380	14	4452	706		5159
1996	0	4034	84	15	4118	495		4614
1997	2	3450	147	41	3610	805		4415
1998	2	3565	300	40	3865	1453	*	5318
1999	2	2873	337	26	3209	1148		4357
2000	0	2848	221	36	3069	1455		4523
2001	1	3421	309	22	3730	2537		6267
2002	2	3323	356	36	3679	2620		6299
2003	1	3564	322	49	3886	1977	*	5863
2004	na	3223	348	5	3571	1932	*	5503
2005	na	3619	372	na	3991	2698	*	6689
2006	na	3026	420	na	3447	4544	*	7990
2007	na	2881	292	na	3176	2411	*	5587
2008	na	2774	256	na	3030	2123	*	5154
2009	na	2816	212	na	2987	1833	*	4820
2010	na	3153	245	na	3398	1275	*	4673
2011	na	3240	319	na	3559	1263	*	4822
2012	na	2290	230	na	2520	1012	*	3532
2013	na	2195	185	na	2380	1521	*	3900
2014	na	2699	108	na	2807	1326	*	4133
2015	na	3425	144	na	3569	1822	*	5391
2016	na	3873	217	na	4091	2531	*	6622
2017	na	3283	129	na	3412	2387	*	5799
2018	na	2038	86	na	2125	1571	*	3696
2019	na	2065	89	na	2154	634	*	2789
2020	na	2200	73	na	2273	1908	*	4181
2021	na	2925	81	na	3006	1126	*	4132
2022	na	2565	129	na	2694	791	*	3485

(1) WG estimates (2) landings from VIIIa and VIIIb aggregated until 1974 (3) outside FU 23-24

Italic font: revised value between WGBIE 2019 and 2020 (from 1627 t to 1571 t)

Table 11.2. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b). Quarterly and yearly number of sampled units in the landings sampling program.

Year	Q1			Q2			Q3			Q4		
	auction	sea	Σ	auction	sea	Σ	auction	sea	Σ	auction	sea	Σ
2014	96	23	119	122	82	204	107	64	171	106	30	136
2015	119	37	156	119	71	190	123	70	193	114	12	126
2016	108	30	138	139	93	232	112	109	221	142	23	165
2017	26	30	56	27	36	63	63	47	110	92	19	111
2018	70	14	84	90	45	135	86	43	129	70	16	86
2019	86	18	104	92	46	138	64	29	93	80	17	97
2020	68	6	74	30	24	54	31	12	43	28	31	59
2021	30	4	34	73	17	90	54	25	79	19	24	43
2022	26	18	44	71	42	113	78	36	114	23	10	33
Total	629	180	809	763	456	1219	718	435	1153	674	182	856

Table 11.3. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b). Quarterly and yearly number of sampled landed individuals.

year	Q1			Q2			Q3			Q4		
	auction	sea	Σ	auction	sea	Σ	auction	sea	Σ	auction	sea	Σ
2014	3774	855	4629	5400	3662	9062	4957	2321	7278	4642	1115	5757
2015	5347	1488	6835	5520	2760	8280	5695	2835	8530	4905	345	5251
2016	4562	1130	5692	6367	3340	9707	4801	3751	8552	6150	765	6915
2017	951	949	1900	1191	1606	2797	2863	1259	4122	4080	670	4750
2018	3528	554	4082	4285	1911	6196	3630	1661	5291	2991	470	3461
2019	3669	635	4304	3770	1554	5324	2632	819	3451	3257	566	3823
2020	2669	228	2897	1222	970	2192	1217	435	1652	1185	1061	2246
2021	1265	62	1327	3008	698	3706	2283	1018	3301	810	856	1666
2022	1258	723	1981	3261	1491	4752	3637	1309	4946	981	462	1443
Total	27023	6624	33647	34024	17992	52016	31715	15408	47123	29001	6310	35312

Table 11.4. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b). Derivation and estimation of discards.

1987	sampled
1988-1990	from 1987's logistic function of sorting by quarter+density of probability
1991	sampled
1992-1997	from 1991's logistic function of sorting by quarter+density of probability
1998	sampled
1999-2002	from 1998's logistic function of sorting by quarter+density of probability
since 2003	sampled

Table 11.5. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b). Quarterly and yearly discards from onboard sampling program.

year	quarter	sampled FO	total FO	nb_trips	total trips	Nb *Nephrops*
2014	1	7	13	4	2689	377
	2	25	91	13	5615	1146
	3	21	99	12	5274	712
	4	10	27	8	3973	436
	total	63	230	37	17551	2671
2015	1	16	28	7	2785	655
	2	36	124	14	5598	1334
	3	28	131	13	4999	747
	4	7	31	3	3480	194
	total	87	314	37	16862	2930
2016	1	16	39	7	3441	549
	2	40	119	15	6207	1168
	3	46	153	17	5443	1135
	4	15	85	8	3906	256
	total	117	396	47	18997	3108
2017	1	20	97	9	3719	516
	2	29	138	12	6139	932
	3	23	55	9	4850	793
	4	10	26	17	3498	332
	total	82	316	37	18206	2573
2018	1	8	25	6	3015	237
	2	28	65	11	5784	1222
	3	25	67	14	4895	898
	4	9	29	8	3058	215
	total	70	186	39	16752	2572
2019	1	10	24	8	3366	367
	2	24	58	14	5610	1076
	3	16	42	9	4381	360
	4	8	20	5	2791	234
	total	58	144	36	16148	2037
2020	1	3	6	3	2622	118
	2	12	27	8	5178	527
	3	6	14	5	4660	280
	4	16	50	9	2768	476
	total	37	97	25	15228	1401
2021	1	3	15	3	3599	30
	2	9	39	7	5658	386
	3	13	30	7	4426	562
	4	13	30	9	2378	352
	total	38	114	26	16061	1330
2022	1	9	23	5	2719	247
	2	21	41	12	5034	780
	3	19	42	10	4220	644
	4	5	17	5	2104	214
	total	54	123	32	14077	1885

Table 11.6.a. ***Nephrops*** **in FUs 23-24 Bay of Biscay (8a,b) landings length distributions in 2003-2022.**

Landings CL mm/	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17	20	7																		
18	14		25	5	4	12									6					9
19		14	27						1		5				18					50
20	87	47	82	5	4	77	37	14	22	35	31	1	16	21	24	18		81	100	217
21	280	249	270	70	14	191	73	75	6	25	151	74	130	138	320	106	15	232	310	523
22	661	899	771	131	18	208	288	252	11	235	682	180	575	532	368	90	153	230	642	661
23	1614	2194	2588	227	48	322	473	386	111	334	1002	764	1121	772	1155	185	331	480	1458	1399
24	3966	5664	6511	822	188	721	1929	1238	515	1399	3162	1836	2523	1341	1787	410	1166	1479	2279	2269
25	8164	10930	13678	2844	1201	2742	3670	3940	1803	3843	7873	4419	3478	3842	3845	1823	4325	3502	5668	4789
26	13297	13998	17811	6376	5684	6319	8258	8499	4773	7875	13242	7910	6651	7285	9264	4362	8273	7187	9535	8812
27	17614	16094	22006	12010	9439	10891	12759	14173	7520	11079	14926	12869	9702	12566	14413	6905	11811	11125	14067	11170
28	18572	15350	21879	14647	13248	12640	15732	15390	8991	11920	13260	13788	14431	16617	14546	7753	12245	12670	14468	12760
29	16843	14808	18027	14591	12516	12890	13524	15340	9602	11120	13397	14560	13726	18269	17209	9186	11409	10421	13680	12868
30	17264	14143	15570	13690	12219	10726	13271	15736	8821	9636	10296	12662	13690	16596	16695	8812	10076	11320	14357	10261
31	13345	12353	12634	11814	10698	9772	10859	12749	8253	8393	9137	11051	12456	16820	12979	8307	7377	10397	10286	10154
32	11276	10322	9907	9694	9274	8845	9310	11366	6954	7414	7116	10354	12021	13096	12950	6417	6352	7660	9702	11747
33	8253	8020	7800	8421	7859	7436	7086	8851	6175	6069	5558	6509	9882	12519	7752	7079	5178	6198	7770	6395
34	6195	6298	6537	7112	6539	6425	5985	7140	5467	4505	4123	6657	7881	8416	7638	4991	4882	3911	6201	5519
35	4653	4673	5100	5135	6529	5366	4568	5852	4541	3507	2783	4961	6122	6809	5052	3676	4423	3802	4612	4681
36	3818	3308	3369	4104	4735	3867	3697	3626	4260	2649	1978	3264	5219	6474	4829	3537	2292	3126	3502	3062
37	3075	2875	2597	3196	3839	3121	2565	3024	3648	1976	1472	2682	4511	4785	2620	2263	1749	1718	2685	1616
38	2660	2098	2380	2662	2639	2398	1871	2247	3911	1563	998	1783	3311	3342	2005	1890	1189	1684	2204	1158
39	2174	1683	1650	1956	2245	2043	1491	1630	3472	1314	936	1844	2726	2850	2176	1775	946	696	1598	1492
40	1936	1555	1628	1599	1711	1633	1190	1280	3296	1103	518	843	2676	1976	1294	1232	942	788	1157	680
41	1423	1188	1154	1171	1227	1190	878	966	2740	878	438	669	1635	1394	1020	652	530	441	896	978
42	1403	889	953	990	1111	1015	742	742	2497	635	351	412	1284	1185	779	329	329	374	626	694
43	1054	774	842	741	710	805	540	560	2157	558	320	343	883	749	585	388	330	317	479	516
44	810	707	640	633	746	706	473	509	1762	536	249	234	637	658	471	319	129	192	350	304
45	808	613	605	595	518	536	396	442	1177	478	177	206	467	708	442	296	107	151	360	367
46	535	485	415	479	373	405	307	305	1024	441	181	159	236	368	271	153	79	118	205	220
47	456	388	353	440	311	361	262	290	858	378	88	151	216	332	261	86	80	113	238	171
48	339	313	339	382	257	294	245	237	656	381	98	87	149	230	143	80	46	77	159	90
49	206	318	288	319	237	262	196	204	557	212	74	72	200	195	100	51	30	66	146	66
50	253	306	276	287	190	228	156	160	501	160	46	63	108	123	126	68	36	53	107	102
51	170	214	176	246	163	201	115	135	383	132	37	58	68	83	53	32	27	26	78	47
52	150	152	184	201	138	116	110	120	296	128	32	24	46	88	96	36	24	26	56	42
53	120	111	142	137	140	121	98	97	198	96	24	42	33	56	37	21	13	12	33	33
54	80	90	104	156	115	95	63	95	271	93	17	18	29	59	49	18	11	6	31	35
55	57	47	109	137	79	73	75	79	152	58	15	11	26	23	38	10	5	8	8	40
56	23	86	69	117	60	67	54	75	132	46	8	5	15	21	24	8	2	2	3	16
57	47	49	58	134	70	41	31	67	98	48	22	10	18	7	12	6	1	3	1	23
58	22	27	43	134	45	40	48	47	105	52	3	8	5	7	12	11	3	3	2	27
59	10	32	41	85	33	19	23	48	79	33	12	3	3	8	6	1	2	1		14
60	8	10	19	115	33	23	14	42	48	22	3	2	3	5	7	3		3	2	21
61	5	5	28	40	23	7	8	30	39	15	8	1		3	2	1	1		22	13
62	4	3	16	21	9	9	9	16	55	18	1	1	7	3	6	3		2	1	10
63	1	5	9	19	9	7	10	7	23	11	2	1			1	1			3	6
64		8	8	18	10	6	3	16	12	8			1	1	2	72			22	3
65		1	14	11	9	1	3	9	11	7			1	1	3			1		11
66	1	1	6	10	1		2	3	11	3				1	1					3
67		1	5	8	1		2	3	6	1										3
68		2	4	7	3			4	7											6
69	1		1	6	2		1	1	2	2										7
70			2	4				1	2					1	1					7
71	1		1	5				1	1											6
72			1	5											1					6
73				2	1										1					1
74				4					1			1			1					2
75			1	4						1				2	5				2	8
Total	**163771**	**154405**	**179758**	**128777**	**117273**	**115274**	**123504**	**138120**	**108011**	**101424**	**114853**	**121594**	**138920**	**161371**	**143502**	**83463**	**96919**	**100704**	**130114**	**116190**
Weights	**3886**	**3571**	**3991**	**3447**	**3176**	**3030**	**2987**	**3398**	**3559**	**2520**	**2380**	**2807**	**3569**	**4091**	**3412**	**2125**	**2154**	**2273**	**3006**	**2694**

Table 11.6.b. ***Nephrops*** **in FUs 23-24 Bay of Biscay (8a,b) discards length distributions in 2003-2022.**

Total Discards

CL mm/'	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10	28				22		82								26			55		31
11			94		171	38	135	2								23	8		25	136
12	70	363	413	70	202	98	79		237				75	76	54		8		78	216
13	294	1722	1085	234	122	235	177	97	596	532		28	184	76	111	47	110	83	431	554
14	636	3152	3190	1138	900	389	291	83	834	665	229	101	606	327	384	31	428	249	391	1061
15	1198	5548	7287	3102	1288	189	1157	155	941	1425	870	281	1476	578	1228	533	583	457	435	921
16	3386	6784	13528	7810	2959	1027	2315	822	1230	4544	1313	1300	2354	569	1668	1029	606	75	803	2974
17	5927	8836	15094	11655	3636	1832	3059	1333	2430	4737	4179	1647	3242	2717	3697	3499	741	506	1584	3235
18	8078	10161	19795	16139	4590	2626	4843	2309	3630	8066	3372	2808	5073	5207	4175	6531	1456	1598	3169	3122
19	11506	17361	19522	25891	5244	6473	6485	3532	4546	8024	8730	3822	8084	9685	8517	7534	1951	3456	5963	6964
20	12142	19250	22265	39742	8735	11444	12766	5692	7227	10125	9682	6457	9246	9420	13805	9555	3042	5479	9789	6688
21	18597	25898	32409	54220	11585	15630	16772	7699	10393	12145	15281	9195	10952	12022	16601	13562	4330	8770	10652	7911
22	21416	25210	35523	69870	17930	24730	18701	11689	15161	14034	20618	11284	11324	15704	16245	17648	6379	11969	9220	8871
23	28429	26756	40041	70094	24086	27560	21693	13672	13837	12904	26287	15130	14109	18312	20400	20617	6817	17291	11897	9057
24	26501	21343	36279	55408	30615	29638	24105	16963	15551	14889	21750	14000	16820	19435	21961	16825	8875	20577	11417	9293
25	23211	20085	30222	52660	32917	28007	20736	14670	16545	10873	17823	18051	18746	22159	21886	18966	8383	22133	11259	8468
26	17357	12006	19003	38812	27376	23127	14205	11852	10047	7747	10188	11947	15874	24994	21474	12621	6065	21676	8490	7682
27	9680	6436	8498	20124	20567	10129	9188	8558	8127	4304	5439	8155	11931	17139	13660	8548	3506	14931	7107	3642
28	6187	3487	4603	10263	10365	5893	5927	5986	3201	919	2824	5026	8056	11441	11298	5719	2625	8239	5407	1637
29	2537	2115	1201	4188	4464	3225	3163	3360	2086	588	2146	2316	5771	10887	5361	3151	913	5056	2871	1215
30	1605	1901	1600	2578	2868	1923	3261	1876	2011	680	945	1672	4714	5283	5464	1457	885	3741	1345	878
31	1326	1115	1417	1109	1316	925	1824	1274	1246	125	922	1263	2033	4343	3766	1135	517	2567	907	529
32	574	735	526	592	737	454	839	716	492	200	684	1482	1745	2458	2470	513	181	1657	183	99
33	313	503	296	544	484	421	671	350	265	13	365	384	812	3193	814	1014	183	2332	1274	168
34	261	385	553	411	537	1025	830	274	272	145	494	433	1108	1071	1132	744	146	439	547	110
35	176	424	260	230	265	206	332	242	174	24	233	125	147	874	1540	296	163	186	163	68
36	113	108	46	73	336	78	197	55	59	3	260	391	243	774	503	140	74	10	75	147
37	83	74	246	25	299	153	188	162	149	146	130	45	298	573	681	11	8	333	357	14
38	93	31	116	99	40	93	269	16	97	68	81	71	246	576	320	18	8	115	31	14
39	15	139	147		3	369	55	33	24		33	230	65	598	409	60	35		41	30
40	37	73	37	169	47		66	38	25	3		122	175	72	235	39	64	261		52
41	34	60	20		40		8	4				7	46	148	126	40				1
42	4	12	31		20	53		4	157				508	186	139		8	161		15
43	14	13			11		38		4	4		152	199		202	20				15
44		13					14	6					12		164				13	
45	13			36					5				56		38					
46								6					44	77						7
47									6			7			23					1
48							8				36									
49													23							
50					11															14
51																				
52																				
53																				
54																				
55															23					
56																				
57																				
58						39														
59																				
60																				
61																				
62																				
63																				
64																				
65																				
66																				
67																				
68																				
69																				
70																				
71																	3			
72																				
73																				
74																				
75																				
Total	**201841**	**222102**	**315346**	**487288**	**214788**	**198031**	**174480**	**113530**	**121603**	**117935**	**154914**	**117930**	**156400**	**200973**	**200600**	**151926**	**59102**	**154401**	**105925**	**85841**
Weights	**1977**	**1932**	**2698**	**4544**	**2411**	**2123**	**1833**	**1275**	**1263**	**1012**	**1521**	**1326**	**1822**	**2531**	**2387**	**1571**	**634**	**1908**	**1126**	**791**

Table 11.6.c. *Nephrops* in FUs 23-24 Bay of Biscay (8a,b) catches length distributions in 2003-2022.

Total catches CL mm/	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10	28				22		82								26			55		31
11			94		171	38	135	2								23	8		25	136
12	70	363	413	70	202	98	79		237				75	76	54		8		78	216
13	294	1722	1085	234	122	235	177	97	596	532		28	184	76	111	47	110	83	431	554
14	636	3152	3190	1138	900	389	291	83	834	665	229	101	606	327	384	31	428	249	391	1061
15	1198	5548	7287	3102	1288	189	1157	155	941	1425	870	281	1476	578	1228	533	583	457	435	921
16	3386	6784	13528	7810	2959	1027	2315	822	1230	4544	1313	1300	2354	569	1668	1029	606	75	803	2974
17	5947	8843	15094	11655	3636	1832	3059	1333	2430	4737	4179	1647	3242	2717	3697	3499	741	506	1584	3235
18	8092	10161	19820	16144	4593	2638	4843	2309	3630	8066	3372	2808	5073	5207	4181	6531	1456	1598	3169	3132
19	11506	17376	19549	25891	5244	6473	6485	3532	4546	8024	8735	3822	8084	9685	8535	7534	1951	3456	5963	7015
20	12229	19297	22348	39747	8738	11521	12803	5706	7249	10160	9713	6458	9262	9441	13829	9573	3042	5560	9889	6905
21	18877	26146	32679	54289	11598	15820	16845	7775	10398	12170	15433	9269	11082	12160	16921	13668	4346	9001	10962	8434
22	22077	26109	36293	70001	17948	24938	18989	11941	15171	14269	21300	11464	11899	16237	16613	17738	6531	12199	9862	9531
23	30042	28950	42629	70322	24134	27882	22167	14058	13948	13238	27289	15894	15231	19084	21554	20802	7148	17771	13355	10456
24	30467	27006	42790	56230	30803	30359	26034	18202	16065	16288	24913	15836	19343	20775	23747	17236	10041	22055	13696	11562
25	31376	31015	43900	55504	34119	30750	24406	18610	18348	14716	25696	22470	22223	26001	25731	20789	12708	25635	16928	13257
26	30654	26004	36814	45189	33060	29446	22463	20352	14820	15622	23430	19857	22526	32279	30738	16983	14338	28863	18026	16493
27	27294	22530	30504	32134	30006	21020	21948	22730	15647	15383	20365	21024	21633	29705	28073	15453	15317	26056	21174	14811
28	24759	18837	26482	24909	23613	18533	21659	21375	12191	12838	16084	18814	22487	28058	25844	13471	14869	20909	19875	14397
29	19381	16923	19228	18779	16980	16115	16687	18700	11687	11708	15543	16876	19498	29156	22570	12337	12322	15476	16551	14083
30	18868	16044	17170	16268	15087	12649	16531	17612	10832	10315	11241	14334	18403	21879	22159	10269	10961	15061	15702	11139
31	14672	13469	14051	12923	12014	10697	12682	14024	9500	8518	10059	12314	14489	21163	16745	9442	7893	12964	11193	10684
32	11849	11057	10433	10286	10011	9299	10150	12082	7447	7614	7801	11836	13766	15554	15419	6930	6533	9317	9885	11846
33	8566	8523	8095	8965	8343	7857	7757	9201	6440	6082	5923	6892	10695	15712	8566	8093	5362	8530	9044	6563
34	6456	6684	7090	7524	7076	7449	6815	7414	5739	4649	4617	7091	8990	9487	8770	5735	5028	4350	6748	5629
35	4829	5097	5361	5366	6793	5573	4900	6094	4715	3531	3016	5087	6270	7683	6592	3972	4586	3989	4775	4749
36	3931	3416	3415	4177	5071	3945	3894	3681	4319	2652	2237	3654	5462	7247	5332	3677	2366	3136	3577	3209
37	3158	2949	2844	3221	4138	3273	2753	3186	3797	2122	1602	2727	4809	5358	3302	2274	1758	2052	3042	1630
38	2752	2129	2496	2760	2679	2491	2139	2263	4007	1632	1079	1854	3556	3918	2325	1908	1197	1799	2235	1172
39	2189	1822	1797	1956	2247	2412	1546	1662	3496	1314	968	2075	2791	3448	2585	1835	981	696	1639	1523
40	1973	1628	1665	1768	1758	1633	1257	1318	3321	1107	518	965	2851	2048	1529	1271	1006	1049	1157	732
41	1457	1248	1174	1171	1267	1190	886	971	2740	878	438	676	1681	1542	1146	691	530	441	896	979
42	1407	901	984	990	1130	1069	742	746	2654	635	351	412	1792	1370	918	329	337	535	626	709
43	1068	787	842	741	722	805	578	560	2161	563	320	495	1082	749	787	407	330	317	479	531
44	810	719	640	633	746	706	487	515	1762	536	249	234	649	658	636	319	129	192	363	304
45	821	613	605	631	518	536	396	442	1182	478	177	206	523	708	480	296	107	151	360	367
46	535	485	415	479	373	405	307	312	1024	441	181	159	280	445	271	153	79	118	205	227
47	456	388	353	440	311	361	262	290	865	378	88	158	216	332	284	86	80	113	238	173
48	339	313	339	382	257	294	254	237	656	381	134	87	149	230	143	80	46	77	159	90
49	206	318	288	319	237	262	196	204	557	212	74	72	223	195	100	51	30	66	146	66
50	253	306	276	287	201	228	156	160	501	160	46	63	108	123	126	68	36	53	107	116
51	170	214	176	246	163	201	115	135	383	132	37	58	68	83	53	32	27	26	78	47
52	150	152	184	201	138	116	110	120	296	128	32	24	46	88	96	36	24	26	56	42
53	120	111	142	137	140	121	98	97	198	96	24	42	33	56	37	21	13	12	33	33
54	80	90	104	156	115	95	63	95	271	93	17	18	29	59	49	18	11	6	31	35
55	57	47	109	137	79	73	75	79	152	58	15	11	26	23	61	10	5	8	8	40
56	23	86	69	117	60	67	54	75	132	46	8	5	15	21	24	8	2	2	3	16
57	47	49	58	134	70	41	31	67	98	48	22	10	18	7	12	6	1	3	1	23
58	22	27	43	134	45	80	48	47	105	52	3	8	5	7	12	11	3	3	2	27
59	10	32	41	85	33	19	23	48	79	33	12	3	3	8	6	1	2	1		14
60	8	10	19	115	33	23	14	42	48	22	3	2	3	5	7	3		3	2	21
61	5	5	28	40	23	7	8	30	39	15	8	1		3	2	1	1		22	13
62	4	3	16	21	9	9	9	16	55	18	1	1	7	3	6	3		2	1	10
63	1	5	9	19	9	7	10	7	23	11	2	1			1	1			3	6
64		8	8	18	10	6	3	16	12	8			1	1	2	72			22	3
65		1	14	11	9	1	3	9	11	7			1	1	3			1		11
66	1	1	6	10	1		2	3	11	3				1	1					3
67		1	5	8	1		2	3	6	1										3
68		2	4	7	3			4	7											6
69	1		1	6	2		1	1	2	2										7
70			2	4				1	2					1	1					7
71	1		1	5				1	1								3			6
72			1	5											1					6
73				2	1										1					1
74				4					1			1			1					2
75			1	4						1				2	5				2	8
Total	**365612**	**376507**	**495103**	**616065**	**332060**	**313304**	**297984**	**251649**	**229614**	**219358**	**269766**	**239522**	**295318**	**362344**	**344101**	**235388**	**156020**	**255104**	**236037**	**202032**
Weights	**5863**	**5503**	**6689**	**7990**	**5587**	**5154**	**4820**	**4673**	**4822**	**3532**	**3900**	**4133**	**5391**	**6622**	**5799**	**3696**	**2789**	**4181**	**4132**	**3485**

Table 11.7. Total number of burrows (10^6) and CVs by spatial stratum and for the whole Bay of Biscay. Years 2016-2022 after including rough sea bottom (noted RO) contained in the outline of the Central Mud Bank (WK benchmark 2016). The area S_h involves in the revised total surface of the stock (WD9, WGBIE 2022 ; 14 640 km² instead of 16 164 km² previously validated by the WK benchmark 2016).

2016

h	S_h	n_h	Σs_{ih}^2	Σs_{ih}	Σx_{ih}^2	Σx_{ih}	$\Sigma s_{ih}.x_{ih}$	$Cov[s_{ih},x_{ih}]$	$V[s_{ih}]$	$V[x_{ih}]$	Y_h	$\sigma[Y_h]$	CV
CB	2571.6	35	898958	5441.9	138084	1404.5	237404	559.65	1553.94	2403.64	535.25	106.19	19.84
CL	1152.9	22	617859	3599.5	66462	851.5	149838	501.07	1378.38	1595.47	219.95	45.90	20.87
LI	4603.6	61	1643332	9857.0	293757	2850.0	487251	445.32	842.36	2676.69	1073.44	146.78	13.67
RO	2987.0	20	602733	3381.9	79735	755.5	128976	64.43	1624.66	2694.54	538.13	166.95	31.02
VS	633.1	9	270183	1510.1	227625	1267.0	221684	1136.82	2100.35	6157.44	428.34	76.76	17.92
VV	2691.7	32	732177	4706.0	505117	3021.5	483206	1253.39	1293.45	7091.00	1393.69	202.36	14.52
total	14639.9	179	4765242	28496.4	1310780	10150.0	1708358				**4188.80**	**331.12**	**7.90**

2017

h	S_h	n_h	Σs_{ih}^2	Σs_{ih}	Σx_{ih}^2	Σx_{ih}	$\Sigma s_{ih}.x_{ih}$	$Cov[s_{ih},x_{ih}]$	$V[s_{ih}]$	$V[x_{ih}]$	Y_h	$\sigma[Y_h]$	CV
CB	2571.6	22	813364	4177.8	33043	633.5	119573	-34.66	952.63	704.83	314.48	63.22	20.10
CL	1152.9	12	328243	1946.7	29080	510.0	88578	531.28	1131.34	673.14	243.58	35.96	14.76
LI	4603.6	38	1330924	7042.1	102075	1477.5	272743	-28.77	700.09	1206.14	778.94	114.86	14.75
RO	2987.0	19	714364	3591.6	91529	748.0	121830	-1086.90	1969.73	3448.94	501.69	184.60	36.80
VS	633.1	3	59051	416.6	86866	478.0	66548	86.68	602.31	5352.08	585.80	163.68	27.94
VV	2691.7	19	576761	3239.7	163766	1375.5	232348	-121.58	1353.53	3565.93	921.63	182.70	19.82
total	14639.9	113	3822707	20414.4	506357	5222.5	901620				**3346.12**	**335.75**	**10.03**

2018

h	S_h	n_h	Σs_{ih}^2	Σs_{ih}	Σx_{ih}^2	Σx_{ih}	$\Sigma s_{ih}.x_{ih}$	$Cov[s_{ih},x_{ih}]$	$V[s_{ih}]$	$V[x_{ih}]$	Y_h	$\sigma[Y_h]$	CV
CB	2571.6	31	723778	4616.3	97276	1196.0	179278	39.21	1211.35	1704.45	537.30	105.10	19.56
CL	1152.9	16	359325	2353.7	172468	1216.0	184779	393.37	872.64	5336.80	480.35	113.54	23.64
LI	4603.6	60	1397621	8809.1	136681	2046.0	302892	42.37	1767.30	1134.11	862.28	113.55	13.17
RO	2987.0	28	1483862	5412.3	83889	842.0	172404	357.34	16210.44	2169.22	374.75	116.58	31.11
VS	633.1	10	177252	1312.2	177370	1103.5	144600	-21.77	564.18	6177.67	429.35	100.06	23.30
VV	2691.7	30	924623	4973.3	326602	2446.0	383413	-761.35	3453.72	4385.22	1067.60	184.71	17.30
total	14639.9	175	5066461	27476.9	994286	8849.5	1367366				**3751.64**	**307.49**	**8.20**

2019

h	S_h	n_h	Σs_{ih}^2	Σs_{ih}	Σx_{ih}^2	Σx_{ih}	$\Sigma s_{ih}.x_{ih}$	$Cov[s_{ih},x_{ih}]$	$V[s_{ih}]$	$V[x_{ih}]$	Y_h	$\sigma[Y_h]$	CV
CB	2571.6	23	728947	3929.5	46206	697.0	110158	-405.63	2617.78	1140.18	367.86	93.56	25.43
CL	1152.9	8	184678	1189.3	58643	479.5	63229	-1150.31	1126.24	4271.89	374.87	162.23	43.28
LI	4603.6	44	872771	6051.3	128852	1769.5	240385	-69.15	942.77	1341.62	1085.63	155.64	14.34
RO	2987.0	24	551433	3514.6	49144	683.5	100068	-1.09	1597.79	1290.36	468.47	123.43	26.35
VS	633.1	10	268032	1592.4	110618	933.0	142124	-716.34	1606.36	2618.79	299.12	64.20	21.46
VV	2691.7	30	621094	4163.6	385452	2750.5	415613	1168.37	1491.35	4595.77	1433.98	173.77	12.12
total	14639.9	139	3226955	20440.7	778915	7313.0	1071577				**4029.92**	**329.92**	**8.19**

2020

h	S_h	n_h	Σs_{ih}^2	Σs_{ih}	Σx_{ih}^2	Σx_{ih}	$\Sigma s_{ih}.x_{ih}$	$Cov[s_{ih},x_{ih}]$	$V[s_{ih}]$	$V[x_{ih}]$	Y_h	$\sigma[Y_h]$	CV
CB	2571.6	26	706682	4252.2	10224	370.0	61679	46.66	449.65	198.34	180.46	34.61	19.18
CL	1152.9	9	236908	1455.7	33468	344.0	57593	244.30	183.47	2539.94	219.72	94.55	43.03
LI	4603.6	47	1295960	7724.4	126323	1572.0	251552	-147.93	575.20	1603.13	755.55	135.34	17.91
RO	2987.0	15	454630	2581.4	93880	651.5	109358	-197.25	741.68	4684.53	607.95	251.21	41.32
VS	633.1	8	245351	1392.0	263808	1291.5	227853	447.02	448.20	7901.60	473.67	89.58	18.91
VV	2691.7	27	774428	4514.5	363262	2415.0	403498	-11.52	753.23	5663.58	1161.19	191.77	16.51
total	14639.9	132	3713960	21920.2	890964	6644.0	1111534				**3398.54**	**369.27**	**10.87**

2021

h	S_h	n_h	Σs_{ih}^2	Σs_{ih}	Σx_{ih}^2	Σx_{ih}	$\Sigma s_{ih}.x_{ih}$	$Cov[s_{ih},x_{ih}]$	$V[s_{ih}]$	$V[x_{ih}]$	Y_h	$\sigma[Y_h]$	CV
CB	2571.6	30	483080	3757.7	23560	522.0	62692	-92.82	427.59	499.20	288.09	69.80	24.23
CL	1152.9	14	254977	1872.7	28203	468.5	63060	29.97	343.41	963.44	232.60	57.85	24.87
LI	4603.6	60	1035986	7828.6	119160	1732.0	230389	74.64	246.43	1172.25	821.38	124.64	15.17
RO	2987.0	29	463880	3624.4	44107	565.0	70080	-19.03	389.60	1182.10	375.52	123.86	32.98
VS	633.1	9	139495	1108.0	128651	847.0	109535	656.96	384.60	6117.36	390.26	100.99	25.88
VV	2691.7	33	554490	4197.3	227645	2181.0	282939	172.96	644.56	2609.38	1127.93	151.59	13.44
total	14639.9	175	2931907	22388.8	571324	6315.5	818695				**3235.76**	**268.84**	**8.31**

2022

h	S_h	n_h	Σs_{ih}^2	Σs_{ih}	Σx_{ih}^2	Σx_{ih}	$\Sigma s_{ih}.x_{ih}$	$Cov[s_{ih},x_{ih}]$	$V[s_{ih}]$	$V[x_{ih}]$	Y_h	$\sigma[Y_h]$	CV
CB	2571.6	30	435027	3580.7	24310	455.5	55423	36.41	263.53	599.78	263.82	77.37	29.33
CL	1152.9	14	195082	1624.8	35864	494.0	59988	204.38	501.43	1417.91	282.69	78.38	27.73
LI	4603.6	59	908225	7236.4	112704	1746.5	212911	-22.40	356.39	1051.80	896.03	129.71	14.48
RO	2987.0	29	459594	3601.3	32365	543.0	66471	-34.27	442.04	792.78	363.21	102.72	28.28
VS	633.1	10	141224	1171.8	302708	1333.0	142560	-1515.53	435.08	13891.01	580.77	184.34	31.74
VV	2691.7	32	475803	3848.9	447118	2634.5	325319	272.46	415.02	7426.59	1485.80	271.61	18.28
total	14639.9	174	2614955	21063.9	955068	7206.5	862672				**3872.31**	**383.74**	**9.91**

Table 11.8. Estimation of the abundance of *Nephrops* burrows (10^6) by UWTV. Example of years 2014 and 2015 (rough numbers of burrows with no correction by cumulative bias factor equal to 1.24; WKNEP (ICES, 2017a)).

Year	2014		2015	
Number of data	204	204	114	114
Method of estimate for average (A=arithmetic; KO=ordinary kriging)	A	KO	A	KO
Estimation	0.415930	0.425463	0.410321	0.414796
CV geo	0.052829	0.046598	0.180002	0.183475
CV iid	0.072647	-	0.082643	-
Surface (km²)	11 676	11 676	11 676	11 676
Abundance (Estimation * Surface)	4 856	4 968	4 791	4 843

Table 11.9. ***Nephrops*** **in FUs 23-24 Bay of Biscay (8a,b). Effort and LPUE values of commercial fleets.**

	Le Guilvinec District Quarter 2		
Year	Landings(t)	Effort(100h)	LPUE(Kg/h)
1987	603	437	13.81
1988	777	471	16.52
1989	862	664	12.99
1990	801	708	11.31
1991	717	728	9.84
1992	841	757	11.12
1993	805	735	10.96
1994	690	671	10.30
1995	609	627	9.72
1996	715	598	11.97
1997	638	539	11.83
1998	622	489	12.72
1999	505	423	11.93
2000	438	405	10.82
2001	697	417	16.71
2002	527	371	14.20
2003	487	356	13.68
2004	410	321	12.74
2005	455	336	13.57
2006	414	306	13.50
2007	401	291	13.76
2008	410	271	15.15
2009	384	279	13.78
2010	471	253	18.61
2011	422	279	15.13
2012	348	229	15.17
2013	288	224	12.83
2014	252	198	12.73
2015	451	231	19.52
2016	475	241	19.74
2017	520	238	21.88
2018	374	220	16.98
2019	338	216	15.66
2020	296	190	15.61
2021	338	212	15.94
2022	312	188	16.60

12 Norway lobster in southern Bay of Biscay, northern Galicia, and Cantabrian Sea

nep.fu.25 and nep.fu.31 – *Nephrops norvegicus* in Division 8.c, Functional Units (FUs) 25 and 31

12.1 *Nephrops norvegicus* in FU 25 (North Galicia)

12.1.1 General

Up to this date, the status of the FU 25 *Nephrops* stock is considered undesirable (ICES, 2016) with extremely low biomass and zero catch advice has been issued since 2017 (ICES, 2017, 2022).

After the identification of the FU 25 *Nephrops* area using hauling data from the SPGFS-WIBTS-Q4 (G2784) survey (1983–2020), from the Discard Programme (observers on board in commercial fishery;1994–2020) and from the Sentinel fishery observers programme (2017–2020), the area of FU 25 was adjusted, since 2021, including the ICES rectangles 15-16 E0-E1 and 17 E1.

After the WKMSYSPiCT benchmark (ICES, 2021b), FU 25 *Nephrops* stock was upgraded from category 3 (biomass trends-based assessment) to category 2.13 (data rich stock, but with an assessment/forecast that is accepted for trends only and with extremely low biomass with a zero catch advice).

12.1.1.1 Ecosystem aspects

See Stock Annex.

12.1.1.2 Fishery description

Nephrops is caught by the Spanish OTB_DEF_≥55, which is described as the "Northern trawl" fleet in section 2.1.2 of this report. See Stock Annex for more information.

12.1.1.3 Summary of ICES Advice for 2023 and management applicable to 2022 and 2023

ICES advice for 2023

Since 2021 advice for FU 25 is done based on SPiCT outputs (ICES, 2021a). ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in each of the years 2023, 2024 and 2025 for FU 25 *Nephrops* stock.

Management applicable to 2022 and 2023

Since 2011 there is a Spanish regulation that establishes an Individual Transferable Quota system (ITQs) which includes *Nephrops* (ARM/3158/2011, BOE, 2011).

In 2019, a zero TAC was set for *Nephrops* in ICES Division 8.c for 2020, 2021 and 2022.

The advice in 2021 was zero catch for 2022. .

Since 2022, the Total Allowable Catch (TAC) is set by Functional Unit. The TAC for 2022 was zero for FU 25. In 2022, the TAC set was zero for 2023, 2024 and 2025.

Special quotas of 4.3 t in 2017, 2.0 t in 2018, 2019, and 2020 and 1.7 t in 2021 and 2022 were set for *Nephrops* in FU 25 in order to conduct an observers on-board programme (*Nephrops* Sentinel fishery), supervised by the Spanish Oceanographic Institute (IEO) for obtaining a *Nephrops* abundance index and complementary data.

12.1.2 Data

12.1.2.1 Commercial catches and discards

Spanish landings are based on sales notes which are compiled and standardized by IEO. Since 2003, trips data from sales notes are also combined with their respective logbooks. Data are available by statistical rectangle since 2003 and by métier since 2008 (EC, 2008).

Nephrops landings were reported by Spain. The time-series of the commercial landings (Table 12.1.1 and Figure 12.1.1) shows a clear declining trend. From 1975 to 1978, landings were around 600 t. In the period 1979–1993, landings values fluctuated around 400 t. In the period 1993 to 1998, landings decreased by 62%. From 1998 to 2016 (the last year with non-zero *Nephrops* TAC), landings decreased from 103 to 13 t. In 2017, although the annual *Nephrops* TAC was zero, a special quota of 4.3 t was allowed for the FU 25 *Nephrops* Sentinel fishery (special onboard observers' programme in commercial fishing vessels to monitor the status of the stock in this FU). From 2018 to 2020, this special quota was 2 t each yearand in 2021 and 2022 the Sentinel quota was 1.7 t per year. Details on the Sentinel fisheries were presented in working documents to WGBIE (Vila *et al.*, 2018; González Herraiz *et al.*, 2019; González Herraiz *et al.*, 2020). Since 2020, the Sentinel fishery was extended to all *Nephrops* areas of the FU in order to provide information representative of the whole FU and to collect spatial data to detect a possible stock area contraction (Figures 12.1.2b-e, 12.1.7).

Information on landings, discards and length distributions was uploaded to InterCatch. *Nephrops* discards were negligible in FU 25 but in 2022 there were 7 tons (80% of the catch). Estimates for 1994, 1997 and 1999 ranged from 0.4 to 2.4% of the catches by weight. However, as the *Nephrops* TAC is zero in this FU, discards were observed in 2018 (179 kg), 2019 (769 kg), 2020 (921 kg), 2021 (819 kg) and 2022 (6906 kg).

VMS information

VMS data since 2009 for the trawl fleet operating in FU 25 in 2009–2018 provided some information about the spatial distribution of *Nephrops* catches in this FU before the zero-TAC was implemented (2009–2016; Figures 12.1.2a-b) and during the zero-TAC years (2017–2022; Figures 12.1.2b-e). These data were collected from the whole trawl fleet (2009-2016 and "no sentinel" in 2017-2022) and for the two vessels engaged in the Sentinel fishery (2017-2022) (Figure 12.1.7). Logbook data were assigned to VMS pings by vessel, fishing day and statistical rectangle. About 22% of the VMS pings could not be identified in logbooks. Only 27% of the 2009–2016 VMS pings revealed the presence of *Nephrops*.

Nephrops presence/absence maps from the sentinel fishery are represented in Figure 12.1.2.b (2017 and 2018) and in Figure 12.1.2.c (2019, 2020 and 2021) and Figure 12.1.2. d (2022), considering all Sentinel surveys hauls (directed and not directed to *Nephrops*). These maps are compared with the maps showing the distribution of the rest of the commercial fishing fleet activity on the same years. Regular commercial fleet catch data are based on fishing days from logbooks since data by haul are only available for trips with observers on board.

Nephrops presence/absence maps by haul from the sentinel fishery in Figure 12.1.2.e (2017–2022) are represented only for the hauls directed to *Nephrops* (observers on board and VMS data). Some of the red points in the Sentinel maps in Figure 12.1.2.c are not represented in Figure 12.1.2.e because they correspond to non-directed hauls in Figure 12.2.c.

The maps for the years 2017, 2018, 2019, 2020, 2021 and 2022 (Figs. 12.1.2b-e) show that the area covered by FU 25 *Nephrops* Sentinel fishery in the first three years was very small, compared with the area of *Nephrops* commercial fishery in the past. It should be noted that this small area has a high occurrence of *Nephrops* (Figure 12.1.2a and Figure 12.1.2b, 2009–2016). Therefore, FU areas with low or no occurrence of *Nephrops* before the zero TAC implementation (Figure 12.1.2a and Figure 12.1.2b, 2009–2016) were not explored by the Sentinel fishery during the first three years (Figures 12.1.2b-d, 2017–2019).

The comparison of the *Nephrops* area in different years estimated with (i) the positions of the *Nephrops* positive hauls from the whole time-series (1977–2022) of the SPGFS-WIBTS-Q4 (G2784) survey and other surveys, (ii) the onboard observers' discard programme in the commercial fishery (1994–2022) and (iii) the Sentinel fisheries (2017–2022), suggests a contraction of the stock area since 1977 by around 71%.

12.1.2.2 Biological sampling

The biological sampling programme and the Sentinel fishery provided since 1982, the *Nephrops* length–frequency distributions (LFDs) by sex of landings and discards, sex ratio, recruitment proxies and mean sizes. The sampling levels in Division 8.c are shown in Table 1.4. SPGFS-WIBTS-Q4 (G2784) survey also provides LFDs by sex and, therefore, mean sizes and sex ratios since 1983.

Annual length compositions for males and females combined, mean size and mean weight in the landings time-series are presented in Table 12.1.2a and Table 12.1.2b for the period 1982–2022. LFDs are presented in Figure 12.1.3a (1982–1999), Figure 12.1.3b (2001–2016) and Figure 12.1.3c (2017–2022).

Mean sizes in landings (Figure 12.1.1) show an increasing trend in the time-series for both sexes. The maximum values were recorded in 2009. Low mean sizes observed in the years 1983–1986, 1991 and 2013 may suggest years with more recruitment (see also Figure 12.1.4b). Mean carapace length in the 2022 FU 25 *Nephrops* Sentinel catch was 44.7 and 42.0 mm CL for males and females, respectively.

Low quantities of males in a *Nephrops* stock could be related to a high fishing pressure since females are protected in burrows during most of the year (Fariña Pérez, 1996). In the worst cases, low quantities of males could affect mating (ICES, 2013), and consequently, recruitment in subsequent years. The percentage of males in landings in FU 25 from the commercial fleet from 1982 to 2016 has its minimum in 1990 and 2013 (blue line in Figure 12.1.4a).

Recruitment proxies estimated from the SPGFS-WIBTS-Q4 (G2784) survey and the fishery show a decreasing trend up to 2008 in the survey and up to 2011 in the fishery (Figure 12.1.4b).

12.1.2.3 Abundance index from survey

Table 12.1.3 and Figures 12.1.5 show two periods in FU 25 *Nephrops* CPUE (kg/haul) time-series and spatial distribution from SPGFS-WIBTS-Q4 (G2784) survey: the first period with high abundances before 1997 and the other with low abundance since then. Figure 12.1.6 show SPGFS-WIBTS-Q4 (G2784) *Nephrops* CPUE in kg/haul for the period 2019-2022. The high abundance index of 2022 (Table 12.1.3 and Figure 12.1.5) is due to one haul of 5 kg (214 individuals) of *Nephrops* of the SPGFS-WIBTS-Q4 (G2784) survey. The catch of that haul is the 94% of the total catch of the survey in FU 25 in 2022. SPGFS-WIBTS-Q4 (G2784) is a bottom trawl survey carried out every year in October to estimate hake recruitment and to collect information on the relative abundance of demersal species (see survey description in section 2.2.1 of this report referred as the Spanish IBTS survey in 3rd quarter). The survey haul positions are the same every year.

12.1.2.4 Commercial catch-effort data

Fishing effort (trips) and LPUE (kg/trip) data are available for the bottom trawl fleet selling in the port of A Coruña from 1975 to 2022 (Table 12.1.4 and Figure 12.1.1). Until 2008, the effort series was from the Northwestern Spanish OTB fleet (see "Northern trawl" in section 2.1.1) selling in A Coruña (SP-CORUTR8c). Since the implementation of the current Data Collection Framework (DCF) sampling program (EC, 2008) in 2009, the Northern trawl was categorized into two different *métiers*: OTB_DEF_>55_0_0 ("baca", trips targeting demersal fish including *Nephrops*) and OTB_MPD_>55_0_0 ("jurelera", trips targeting pelagic and demersal fish). Since then, only OTB_DEF_>55_0_0 (SP-LCGOTBDEF) data were used for 8.c *Nephrops* (Castro and Morlán, 2015).

The effort and LPUE time-series (Figure 12.1.1) show general decreasing trends.

In trips catching *Nephrops*, the CPUE (both in kg/haul and kg/hour) in rectangle 15E0 used to be half of the CPUE in rectangles 15E1 and 16E1 (source: logbooks 2006–2016).

In Portugal, CPUE of species with an affinity for temperate waters (in opposition to tropical waters) decreased from 1992 to 2009, especially in the case of long-living species such as *Nephrops* (Teixeira *et al*., 2014). CPUE time-series of "temperate" species are directly correlated with rain and inversely with temperature (Teixeira *et al*., 2014). This phenomenon may have occurred and could have affected FU 25 *Nephrops* from 1992 to 2009.

In 2017 the fishing industry presented in WGBIE (Fernández *et al*., 2017 [WD 10]) FU 25 CPUE indices (kg/hour) for 2015 and 2016 estimated from catches and effort data of two trawl vessels (Table 12.1.5) .

An observers' program (FU 25 Sentinel survey) was authorized during August and September since 2017 in order to obtain a *Nephrops* abundance index (Vila *et al*., 2018; González Herraiz *et al*., 2019; González Herraiz, 2020).

In the period 2017–2019 the Sentinel Fishery was carried out in a small area of the FU 25 (Figures 12.1.2b-e). Since 2020, the Sentinel fishery is extended to all *Nephrops* areas of the FU in order to provide information that will be representative of the whole FU and collect spatial data relative to a possible stock area contraction (Figures 12.1.2a-e and Figure 12.1.7). The Sentinel fishery in 2021 and 2022 was carried out only in August. The *Nephrops* Sentinel fishery catch in 2022 was composed of 2163 kg. Data of Sentinel fishery were included in the Spanish data uploaded to InterCatch. The 2017–2022 Sentinel fisheries showed that *Nephrops* no longer occurs in a large part of the area where was previously available (Figures 12.1.7).

Table 12.1.6 shows the *Nephrops* abundance indices (CPUE in kg/hour) estimated for 2017–2022 (in 2017–2019 the area covered was smaller). If we take into account only the small area covered at the beginning of the Sentinels there are CPUE values around 5 kg/hour before 2019 and around 20 kg/hour since 2019. However, this information is not representative of the whole FU 25 (Figure 12.1.2e).

12.1.3 Assessment

2022 advice for FU 25 was zero catch in each of the years 2023, 2024 and 2025, so there is not necessary to carry out the assessment of the stock for 2024. The TAC for 2023 was zero tons. Stakeholder information

The fishing industry presented a WD to WGBIE in 2017 with qualitative and quantitative information about *Nephrops* fishery in FU25 (Fernández *et al*., 2017). The WG considered that the LPUE data provided could be examined as an abundance index of *Nephrops* in a future benchmark as long as the data collection is continued and the time-series is extended to provide longer historical information. Nevertheless relevant details on how these data were collected (e.g. area, months of the year, hour, etc.) were not provided to the WG.

In April 2020, WGBIE received a letter from stakeholders (two Spanish fishing producers' organizations, OPP no. 31 and 07) regarding *Nephrops* in ICES Division 8.c. The document analysed market and sales notes data and the fisheries management measures of the recent years regarding *Nephrops* in Division 8.c. This document was discussed in a subgroup meeting during the WG in 2020. Market and sales notes are part of the data used for the ICES assessment of this stock since the first assessment in 1977. Also fisheries management measures have been always taken into account in the assessment process. So, t he sources of data and the issues mentioned in the document, together with additional sources of data and any other relevant information relative to the *Nephrops* stocks in 8.c, are taken into account by routine each year to make an integral analysis of the stock status and to elaborate a scientifically sound assessment in the WGBIE.

No further stakeholder information was presented to WGBIE since 2020.

12.1.4 Management considerations

Nephrops is taken mainly as a bycatch in the mixed bottom-trawl fishery (*métier* OTB_DEF≥55).

The overall trend in *Nephrops* landings from the North Galicia (FU 25) is strongly declining. Landings have dramatically decreased since the beginning of the series (1975–2016) representing, in 2016, 11% of the 1975 landings. During the period 2017- 2021, the *Nephrops* TAC in division 8c was zero. In 2022 the TAC for FU 25 was zero.

A recovery plan for Southern hake and *Nephrops* stocks in the Cantabrian Sea and Western Iberian Peninsula was established in 2005 (EU, 2005) and repealed in 2019 (EU, 2019).

A Fishing Plan for the Northwest Cantabrian ground was established in 2011 (ARM/3158/2011, BOE, 2011). This new regulation established an Individual Transferable Quota system (ITQs) where *Nephrops* was included.

FU 25 was not included in the multiannual plan for stocks fished in the Western Waters in 2019 (EU, 2019).

An onboard observers' programme in FU 25 supervised by the Spanish Oceanographic Institute (IEO) to obtain a *Nephrops* abundance index ("Sentinel fishery") was carried out from 2017 to 2022 (Vila *et al*., 2018; González Herraiz *et al*., 2019; González Herraiz *et al*., 2020). A special quota allowance for *Nephrops* in FU 25 was set by the EU for this Sentinel fishery (EU, 2022).

12.1.5 References

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12.1.6 Tables and figures

Table 12.1.1. *Nephrops* in FU 25, North Galicia. Catch, landings and discards in tonnes.

Year	Landings	Discards	Catch
1975	743		743
1976	578		578
1977	828		828
1978	706		706
1979	475		475
1980	532		532
1981	318		318
1982	431		431
1983	433		433
1984	515		515
1985	477		477
1986	398		398
1987	412		412
1988	445		445
1989	405		405
1990	335		335
1991	453		453
1992	428		428
1993	274		274
1994	246		246
1995	275		275
1996	209		209
1997	219		219
1998	103		103
1999	124		124
2000	81		81
2001	147		147
2002	143		143
2003	89		89
2004	75		75
2005	63		63
2006	62		62
2007	67		67
2008	39		39
2009	23		23
2010	34		34
2011	46		46
2012	13		13
2013	11		11
2014	10		10
2015	14		14
2016	13		13
2017	2*		2
2018	2*	0	2
2019	2*	1	3
2020	2*	1	3
2021	2*	1	3
2022	2*	7	9

(*) From 2017 to 2022 there was TAC for *Nephrops* Sentinel Fishery (4.3 t in 2017, 2 t each year in 2018-2020 and 1.7 t each year in 2021-2022).

Table 12.1.2a.*Nephrops* in FU 25, North Galicia. Length compositions of landings, mean weight (kg) and mean length (CL, mm) for the period of 1982–2001.

Carapace length (mm)	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
15																				
16																				
17																				
18																				
19	1	8			6							5								
20	1	17		16	1				3			34			1			0		
21	7	31	10							1		49	1	0	2				0	
22	10	99	22	8	50	0						32	1	7	5	5		0		
23	41	144	20	68	68	6	4		6	15		15	10	6	6	7	1	1	0	10
24	53	351	150	198	136	38	1		10	20	13	80	10	19	29	16	2	5	2	
25	105	497	163	300	192	191	16		35	71	19	57	60	64	38	18	6	15	7	10
26	142	511	372	326	279	185	42	1	36	204	26	70	118	78	56	53	12	26	9	19
27	275	749	564	575	299	467	17	3	70	360	102	71	179	109	91	49	16	21	5	20
28	303	733	746	799	495	302	208	25	223	1039	332	105	281	214	179	186	47	67	32	79
29	382	762	1092	943	500	366	175	22	208	851	280	134	262	190	225	178	38	91	24	125
30	648	1070	1422	1253	471	506	537	91	332	1428	565	176	335	427	266	441	92	194	85	112
31	611	1006	1205	1215	603	447	505	103	394	1048	586	152	330	373	342	303	65	136	60	129
32	782	1011	1720	1045	780	619	614	267	640	1321	885	308	410	448	404	492	99	197	127	288
33	874	957	1439	817	812	527	908	397	654	947	833	472	471	436	454	387	69	100	95	319
34	906	783	1298	975	886	742	720	437	536	982	1117	533	507	483	520	695	152	300	219	302
35	927	778	1122	797	764	821	746	673	664	884	979	670	564	712	396	543	193	258	218	265
36	991	758	1057	823	682	946	821	446	673	710	811	549	547	483	360	500	139	241	158	243
37	728	611	700	637	695	846	991	665	534	739	925	563	462	465	341	323	192	208	144	285
38	582	668	496	484	601	453	800	816	513	642	658	546	454	462	329	407	178	211	113	238
39	553	514	392	593	341	491	439	467	377	405	529	362	330	317	257	299	123	138	82	192
40	480	439	481	494	416	478	583	513	416	450	518	336	301	511	233	326	203	202	134	212
41	368	349	351	307	329	284	462	547	364	280	366	230	178	240	166	141	101	110	64	115
42	347	286	448	230	251	226	674	404	281	296	387	243	222	302	145	166	106	106	73	150
43	250	194	203	301	283	312	314	449	292	231	297	175	113	220	122	98	81	58	30	103
44	193	124	220	239	108	286	236	301	216	146	215	173	99	117	82	57	65	61	48	98
45	238	126	223	104	102	125	220	255	188	170	138	158	99	143	74	84	82	72	40	68
46	111	87	105	223	64	302	123	225	111	109	138	124	52	74	55	31	35	42	20	35
47	100	56	86	65	80	137	104	168	93	97	104	43	38	56	55	37	41	23	10	22
48	81	44	197	85	31	108	107	175	84	79	35	69	25	30	37	26	31	26	17	24
49	48	23	97	52	42	93	44	97	43	32	45	23	29	12	21	16	16	16	11	18
50	48	17	61	48	25	41	30	77	31	34	31	25	18	16	21	28	28	41	13	18
51	32	16	70	41	17	9	23	53	26	10	16	17	8	8	12	3	5	6	8	16
52	16	6	4	4	20	19	20	44	28	9	33	26	11	6	6	5	9	9	8	10
53	12	9	7	34	8	21	5	44	21	13	14	20	10	6	11	4	4	4	2	15
54	9	6	27	33	8	1	7	28	10	4	5	2	7	4	7	3	3	5	5	4
55	8	6	27	7	4	3	5	14	11	1	12	10	7	3	5	5	3	7	7	7
56	3	3	27	5	0	10	3	10	3	3	2	2	4	2	3	0	2	4	2	5
57	4	1		6	0	7	4	9	6	3	0		5	1	2	1	0	2	3	0
58	1	3	1	0	11	8		5	1	3	0	0	2	1	5	0	1	2	4	1
59	3	2		2	1		10	2	2	1	0	0	1	1	5	0	1	0	0	1
60	2	2	1	1	0	3	2	9	1	0	1		0	1	3	1	1	0	2	1
61	0	2		1	0			4	2				1	1	2	0	0		2	
62	3	2		1	0			2		1	1		0	1	3	0	0	0	0	0
63	1	1		1		1		1	0	0	0		1	1	1	2	0		0	0
64	2	0		3	0	1	2	3	1				0	1	1	0	0		0	0
65	1	0		0	0	1	12	1	0	2	1		0	0	4				0	0
66	0	1		1	0			1	1					0	1	1	0		0	0
67	1	2		0					1	1			0	0	0	1	0		0	
68	0	1		1			2	0	1				0	0	1	0	0		0	
69	1	0		1			2	1	1				0		1		0		0	
70	0	1		1				0	0	0					1	0	1		1	
71	1	1		0			2		1	0						0	0		0	
72	1	0				1		0				0			0	0	0		0	0
73	0	1		1					1				0		0					
74	0	1		0	0			1		0			0	0	1	1	0		0	0
75	0	1		1					0	0			1		1		0		0	0
76	1	1		0									0		1	0	0			
77	0	0		0		1			0				1	0	0		0			0
78	0	2		1				1		0			0	0	0		0			0
79	0	0		0									0		0					
80	1	0		0				0								0	0		0	
81																				
82																				
83																				
84																				
Total number (thousand)	11289	13872	16626	14167	10463	10431	10542	7858	8147	13641	11017	6661	6567	7054	5388	5939	2243	3004	1888	3562
Total weight (tonnes)	431	433	515	477	364	412	445	405	335	453	428	274	246	275	209	219	103	124	81	147
Mean weight (kg)	0.038	0.031	0.031	0.034	0.035	0.039	0.042	0.052	0.041	0.033	0.039	0.041	0.037	0.039	0.039	0.037	0.046	0.041	0.043	0.041
Mean length (CL, mm)	35.5	33.0	34.0	33.9	34.4	35.8	36.8	39.4	36.6	33.9	35.9	36.4	35.3	35.8	35.5	35.3	37.8	36.5	36.9	36.5

Table 12.1.2b. *Nephrops* in FU 25, North Galicia. Length compositions of landings, mean weight (kg) and mean length (CL, mm) for the period 2002–2021. *Nephrops* TAC in FU 25 was zero in the period 2017-2022, but there was a TAC for Nephrops Sentinel Fishery, 4.3 t in 2017, 2 t each year in 2018-2020 and 1.7 t each year in 2021-2022. Length distributions from FU 25 *Nephrops* Sentinel fishery used for those years with TAC zero.

Carapace length (mm)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*	2018*	2019*	2020*	2021*	2022*
15												7									
16																					
17																					
18																					
19								0	0												
20						0		0	0			0									
21	1	0		0		0		0	0			0	0								0
22			1	1	0	1		0	0			9	0			0					
23	2	0	1	1	1	1		0	0								0				
24	2	1	2	2	1	1	0	0	0					1		0	0				0
25	2	0	7	5	2	1	1	0	0			9	1	2		0	0	0			0
26	5	2	7	8	3	5	1		0			9	0	1		0	0	0	0		0
27	14	3	12	13	9	4	3	0	2	0		0	1	1	0	0	0	0	0	0	0
28	30	2	26	25	15	8	4		2	1	5	10	1	3	0	0	0	0	0		0
29	43	5	28	25	18	11	6	0	2	2	3	2	1	2	2	0	0	0	0	0	0
30	105	14	46	43	25	19	10	1	9	2	5	13	3	18	6	0	0	0	0	0	0
31	102	26	45	56	39	36	10	1	9	3	7	2	2	11	5	0	0	0	0	0	2
32	198	36	60	66	55	44	15	1	18	4	8	3	2	14	8	1	0	1	1	0	0
33	181	51	71	87	69	69	13	3	20	5	8	5	5	25	12	1	0	2	1	0	0
34	272	66	70	83	62	75	16	4	27	14	5	6	8	26	16	2	1	2	1	0	2
35	308	85	91	98	85	90	25	6	34	26	11	20	13	47	31	2	1	3	2	0	1
36	259	110	98	102	88	101	31	7	30	22	9	9	17	26	26	3	2	4	2	1	1
37	236	123	101	88	87	105	37	10	34	24	13	10	13	22	23	3	3	5	3	1	1
38	185	147	98	92	80	101	35	11	26	67	9	7	14	22	33	3	3	5	3	1	4
39	129	130	81	69	67	86	37	11	23	48	3	16	12	12	20	3	2	4	3	1	1
40	186	129	96	81	64	90	47	13	20	82	20	12	14	16	30	3	2	4	3	2	5
41	99	81	78	61	59	73	44	13	23	65	9	8	10	11	16	3	2	3	3	2	2
42	117	79	63	52	49	63	38	12	23	53	9	6	9	12	10	3	3	3	3	2	2
43	67	65	57	47	44	59	35	13	24	55	3	16	9	10	10	2	2	2	2	2	3
44	109	52	39	36	32	46	29	16	22	36	8	7	8	10	6	2	2	2	2	2	6
45	78	46	44	34	30	42	23	15	21	25	7	8	5	6	6	1	1	1	2	2	3
46	65	57	35	26	26	37	22	12	22	18	3	8	6	5	3	1	1	1	1	2	9
47	34	42	26	20	18	30	20	15	22	14	2	2	4	5	3	1	1	1	1	1	7
48	35	37	23	14	17	22	16	10	17	16	1	5	2	3	2	1	1	1	1	1	2
49	23	27	16	13	11	16	14	9	14	18	4	3	2	3	2	1	1	0	1	1	2
50	24	27	19	11	14	18	10	8	13	13	1	2	2	2	2	0	0	0	1	1	4
51	34	20	13	7	9	11	11	7	11	7	3	2	2	2	1	0	0	0	0	1	5
52	18	16	12	8	8	8	9	7	8	8	1	2	1	2	1	0	1	0	0	0	3
53	13	11	9	6	7	7	8	8	9	5	3	2	2	2	1	0	0	0	0	0	3
54	4	9	7	5	4	4	6	6	7	7	1	2	1	1	1	0	0	0	0	0	6
55	9	6	6	5	4	3	6	6	7	6	3	1	1	1	1	0	0	0	0	0	3
56	6	5	5	3	9	3	4	4	4	5	1	1	1	1	0	0	0	0	0	0	3
57	5	7	4	3	4	2	5	4	5	4	1	1	0	0	0	0	0	0	0	0	3
58	9	4	4	3	2	2	4	4	3	5	1	1	1	0	0	0	0	0	0	0	1
59	4	5	3	2	1	1	3	3	2	1	0	1	0	0	0	0	0	0	0	0	2
60	2	2	2	2	1	1	2	3	3	4	0	0	0	0	0	0	0	0	0	0	0
61	1	1	3	1	1	1	2	2	1	3	3		0		0	0	0		0	0	1
62	3	3	2	1	7	1	1	2	1	6	1	1	0	0	0	0	0	0	0		1
63	10	0	2	1	1	1	1	2	1	2	1		0	0	0	0	0		0	0	0
64	0	1	2	1	6	0	1	1	0	2	0	0	0	0	0	0	0			0	0
65	4	1	2	1	1	0	1	1	1	1	1		0		0	0	0	0		0	0
66	1	2	1	1	0	0	1	1	1	1	0	0	0	0	0		0			0	0
67	2	1	1	1	1	0	1	1	0	2	0		0			0	0	0	0	0	1
68	0	1	1	1	0	0	1	1	1	2	0		0	0	0	0	0	0			0
69	0	2	1	1	0	0	1	1	0	0	0	0	0		0	0	0				0
70	2	1	1	1	0	0	0	1	0	1	0		0		0	0	0	0			0
71	0	1	2	0	6	0	0	1	0		0		0		0		0	0			0
72	0	1	1	0	6	0	0	1	0	1	0		0				0				0
73	0	1	1	1	0	0	0	1	0	1	0		0				0			0	0
74	1	0	1	0	0	0		0	0	1	0						0				
75	0	1	0	0	0	0		0			0		0		0	0	0				0
76	0	0	0	0	0	0	0	0			0				0						0
77		0	0	0	0			0			0						0				
78	0	0	0		0	0		0	0		0		0				0				
79			0	0				0	0		0										0
80	0		0	0	0		0	0			0										
81								0	0												
82								0													
83																					
84								0													
Total number (thousand)	3043	1543	1425	1314	1147	1298	612	258	528	686	175	229	175	327	280	38	32	47	37	24	90
Total weight (tonnes)	143	89	75	63	62	67	39	23	34	46	10	11	10	14	13	2	2	2	2	2	7
Mean weight (kg)	0.047	0.058	0.052	0.048	0.054	0.051	0.064	0.089	0.065	0.067	0.057	0.048	0.057	0.043	0.046	0.054	0.063	0.041	0.055	0.071	0.077
Mean length (CL, mm)	37.8	40.6	39.0	37.9	39.6	40	42.2	46.9	42.2	42.6	40.0	41.0	39.9	37.2	38.2	40.1	41.5	39.6	40.5	43.8	47.8

Carapace length (mm)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*	2018*	2019*	2020*	2021*
15												7								
16																				
17																				
18																				
19								0	0											
20						0		0	0			0								
21	1	0		0		0		0	0			0	0							
22			1	1	0	1		0	0			9	0			0				
23	2	0	1	1	1	1		0	0								0			
24	2	1	2	2	1	1	0	0	0					1		0	0			
25	2	0	7	5	2	1	1	0	0			9	1	2		0	0	0		
26	5	2	7	8	3	5	1		0			9	0	1		0	0	0	0	
27	14	3	12	13	9	4	3	0	2	0		0	1	1	0	0	0	0	0	0
28	30	2	26	25	15	8	4		2	1	5	10	1	3	0	0	0	0	0	
29	43	5	28	25	18	11	6	0	2	2	3	2	1	2	2	0	0	0	0	0
30	105	14	46	43	25	19	10	1	9	2	5	13	3	18	6	0	0	0	0	0
31	102	26	45	56	39	36	10	1	9	3	7	2	2	11	5	0	0	0	0	0
32	198	36	60	66	55	44	15	1	18	4	8	3	2	14	8	1	0	1	1	0
33	181	51	71	87	69	69	13	3	20	5	8	5	5	25	12	1	0	2	1	0
34	272	66	70	83	62	75	16	4	27	14	5	6	8	26	16	2	1	2	1	0
35	308	85	91	98	85	90	25	6	34	26	11	20	13	47	31	2	1	3	2	0
36	259	110	98	102	88	101	31	7	30	22	9	9	17	26	26	3	2	4	2	1
37	236	123	101	88	87	105	37	10	34	24	13	10	13	22	23	3	3	5	3	1
38	185	147	98	92	80	101	35	11	26	67	9	7	14	22	33	3	3	5	3	1
39	129	130	81	69	67	86	37	11	23	48	3	16	12	12	20	3	2	4	3	1
40	186	129	96	81	64	90	47	13	20	82	20	12	14	16	30	3	2	4	3	2
41	99	81	78	61	59	73	44	13	23	65	9	8	10	11	16	3	2	3	3	2
42	117	79	63	52	49	63	38	12	23	53	9	6	9	12	10	3	3	3	3	2
43	67	65	57	47	44	59	35	13	24	55	3	16	9	10	10	2	2	2	2	2
44	109	52	39	36	32	46	29	16	22	36	8	7	8	10	6	2	2	2	2	2
45	78	46	44	34	30	42	23	15	21	25	7	8	5	6	6	1	1	1	2	2
46	65	57	35	26	26	37	22	12	22	18	3	8	6	5	3	1	1	1	1	2
47	34	42	26	20	18	30	20	15	22	14	2	2	4	5	3	1	1	1	1	1
48	35	37	23	14	17	22	16	10	17	16	1	5	2	3	2	1	1	1	1	1
49	23	27	16	13	11	16	14	9	14	18	4	3	2	3	2	1	1	0	1	1
50	24	27	19	11	14	18	10	8	13	13	1	2	2	2	2	0	0	0	1	1
51	34	20	13	7	9	11	11	7	11	7	3	2	2	2	1	0	0	0	0	1
52	18	16	12	8	8	8	9	7	8	8	1	2	1	2	1	0	1	0	0	0
53	13	11	9	6	7	7	8	8	9	5	3	2	2	2	1	0	0	0	0	0
54	4	9	7	5	4	4	6	6	7	7	1	2	1	1	1	0	0	0	0	0
55	9	6	6	5	4	3	6	6	7	6	3	1	1	1	1	0	0	0	0	0
56	6	5	5	3	9	3	4	4	4	5	1	1	1	1	0	0	0	0	0	0
57	5	7	4	3	4	2	5	4	5	4	1	1	0	0	0	0	0	0	0	0
58	9	4	4	3	2	2	4	4	3	5	1	1	1	0	0	0	0	0	0	0
59	4	5	3	2	1	1	3	3	2	1	0	1	0	0	0	0	0	0	0	0
60	2	2	2	2	1	1	2	3	3	4	0	0	0	0	0	0	0	0	0	0
61	1	1	3	1	1	1	2	2	1	3	3		0		0	0	0		0	0
62	3	3	2	1	7	1	1	2	1	6	1	1	0	0	0	0	0	0	0	
63	10	0	2	1	1	1	1	2	1	2	1		0	0	0	0	0		0	0
64	0	1	2	1	6	0	1	1	0	2	0	0	0	0	0	0	0			0
65	4	1	2	1	1	0	1	1	1	1	1		0		0	0	0	0		0
66	1	2	1	1	0	0	1	1	1	1	0	0	0	0	0		0			0
67	2	1	1	1	1	0	1	1	0	2	0		0			0	0	0	0	0
68	0	1	1	1	0	0	1	1	1	2	0		0	0	0	0	0	0		
69	0	2	1	1	0	0	1	1	0	0	0	0	0		0	0	0			
70	2	1	1	1	0	0	0	1	0	1	0		0		0	0	0	0		
71	0	1	2	0	6	0	0	1	0		0		0		0		0	0		
72	0	1	1	0	6	0	0	1	0	1	0		0				0			
73	0	1	1	1	0	0	0	1	0	1	0		0				0			0
74	1	0	1	0	0	0		0	0	1	0						0			
75	0	1	0	0	0	0		0			0		0		0	0	0			
76	0	0	0	0	0	0	0	0			0				0					
77		0	0	0	0			0			0						0			
78	0	0	0		0	0		0	0		0		0				0			
79			0	0				0	0		0									
80	0		0	0	0		0	0			0									
81								0	0											
82								0												
83																				
84								0												
Total number (thousand)	3043	1543	1425	1314	1147	1298	612	258	528	686	175	229	175	327	280	38	32	47	37	24
Total weight (tonnes)	143	89	75	63	62	67	39	23	34	46	10	11	10	14	13	2	2	2	2	2
Mean weight (kg)	0.047	0.058	0.052	0.048	0.054	0.051	0.064	0.089	0.065	0.067	0.057	0.048	0.057	0.043	0.046	0.054	0.063	0.041	0.055	0.071
Mean length (CL, mm)	37.8	40.6	39.0	37.9	39.6	40	42.2	46.9	42.2	42.6	40.0	41.0	39.9	37.2	38.2	40.1	41.5	39.6	40.5	43.8

Table 12.1.3. *Nephrops* FU 25, North Galicia. SP-NSGFS Spanish IBTS 4Q trawl survey (G2784). *Nephrops* yield in grammes/haul (1983–2021).

Year	*Nephrops* yield
1983	127
1984	565
1985	281
1986	353
1987	No survey
1988	453
1989	81
1990	249
1991	1267
1992	468
1993	256
1994	153
1995	494
1996	288
1997	59
1998	74
1999	87
2000	57
2001	90
2002	81
2003	29
2004	57
2005	48
2006	11
2007	10
2008	13
2009	28
2010	45
2011	59
2012	37
2013	96
2014	80
2015	36
2016	81
2017	47
2018	37
2019	49
2020	30
2021	36
2022	149

Table 12.1.4. *Nephrops* FU 25, North Galicia. Landings, fishing effort and LPUE from the fleet selling in A Coruña port (1986–2021).

Year	Landings (t)	Effort (trips)		LPUE (kg/trip)	
		SP-CORUTR8c	SP-LCOTBDEF	SP-CORUTR8c	SP-LCOTBDEF
1986	302	5017		60.1	
1987	356	4266		83.5	
1988	371	5246		70.7	
1989	297	5753		51.7	
1990	199	5710		34.9	
1991	334	5135		65.1	
1992	351	5127		68.5	
1993	229	5829		39.2	
1994	207	5216		39.6	
1995	233	5538		42.0	
1996	182	4911		37.0	
1997	187	4850		38.5	
1998	67	4560		14.7	
1999	121	4023		30.1	
2000	77	3547		21.7	
2001	145	3239		44.8	
2002	115	2333		49.5	
2003	65	1804		35.9	
2004	40	2091		18.9	
2005	32	2063		15.5	
2006	33	1699		19.4	
2007	37	2075		17.8	
2008	21	2128		9.9	
2009	11		1355		8.3
2010	22		1164		18.6
2011	35		906		38.4
2012	10		1460		6.8
2013	8		1582		5.3
2014	8		1869		4.5
2015	13		1358		9.3
2016	11		1589		6.6
2017	2*		1152		0.0
2018	2*		883		0.0
2019	2*		824		0.0
2020	2*		844		0.0
2021	2*		975		0.0
2022	2*		1132		0.0

(*) From 2017 to 2022 there was TAC for *Nephrops* Sentinel Fishery (4.3 t in 2017, 2 t each year in 2018-2020 and 1.7 t each year in 2021-2022).

Table 12.1.5. *Nephrops* FU 25, North Galicia. Cpue (kg/hour) estimated by the fishing industry with data of two fishing vessels (2015 and 2016).

Source	Year	Period	Directed CPUE (kg/hour)	Non-directed CPUE (kg/hour)
Fishing Industry (Fernández *et al.*, 2017)	2015	Year	6.46	0.18
	2016	Year	10.81	0.27

Table 12.1.6. *Nephrops* FU 25, North Galicia. CPUE (kg/hour) from Sentinel Fisheries (2017–2022). 2017–2019 Sentinels were limited to a small part of the FU.

	Hauls in August at daytime		
	Hauls	Sampled cells	CPUE (kg/hour)
2017	29	9	8.0
2018	41	13	5.0
2019	24	21	9.1
2020	18	24	8.9
2021	37	25	7.7
2022	57	41	5.4
Total	206	55	7.4

***To avoid the effect of daily variations in the catchability of *Nephrops*, which is a consequence of the changes in their behaviour, the hauls that were carried out in more than 50% of the time between dusk and dawn were considered non-directed to *Nephrops*.**

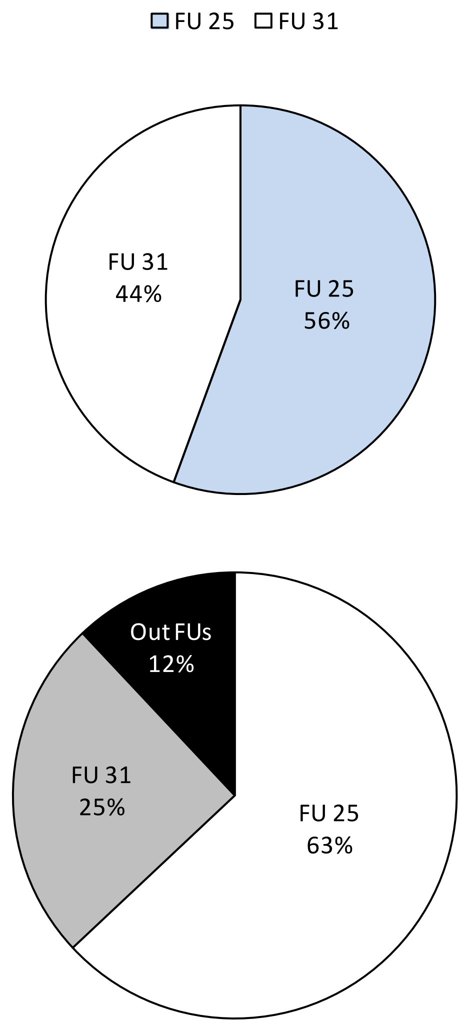


Figure 12.1. ICES Division 8.c *Nephrops* catch by FU (2022).

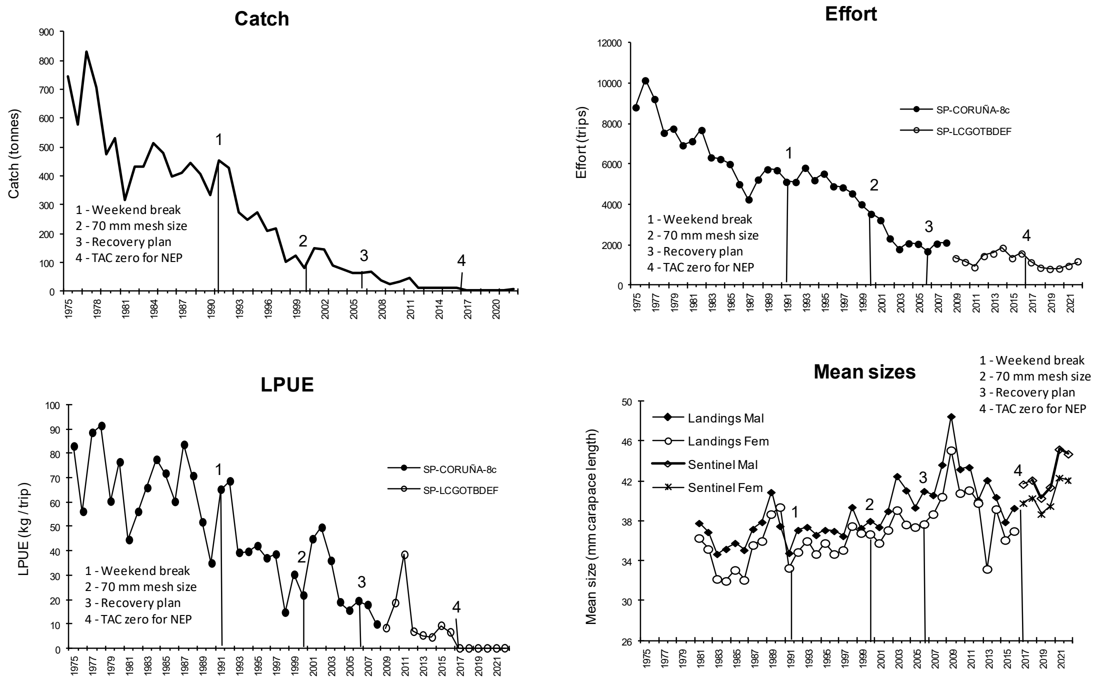


Figure 12.1.1. *Nephrops* FU 25, North Galicia. Long-term trends in landings, effort, LPUE and mean sizes. Catches (in tonnes) and mean sizes from all the selling ports. Effort and LPUE only from the fleet selling in the A Coruña port. *Nephrops* TAC in FUs 25 was zero in the period 2017-2022. Commercial fleet mean sizes information during these years was from the FU 25 *Nephrops* Sentinel fisheries.

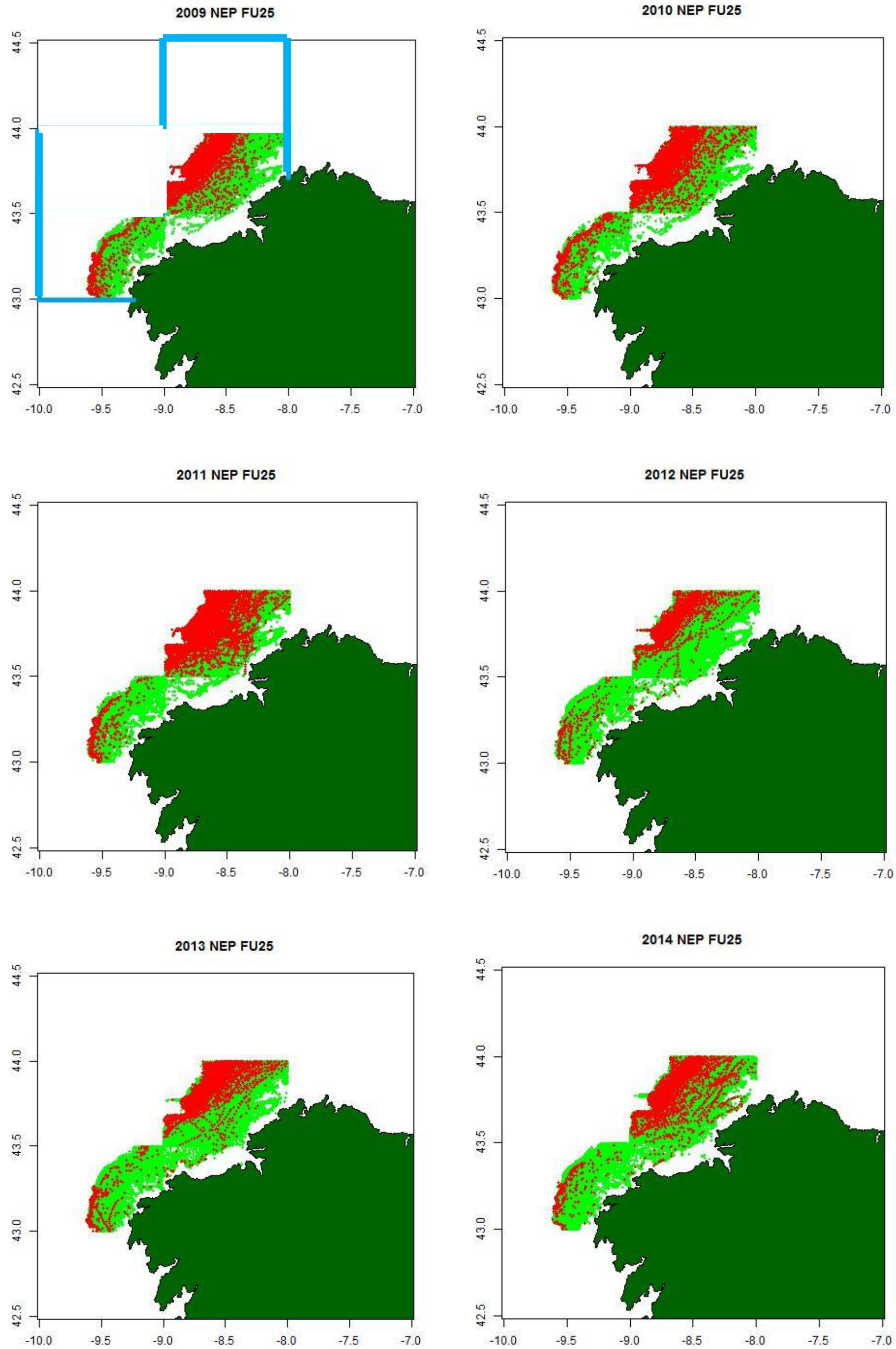


Figure 12.1.2a. *Nephrops* FU 25, North Galicia. *Nephrops* presence/absence distribution from commercial fleet activity (logbooks and VMS data, 2009-2014). Red points: *Nephrops* LPUE > 0 kg/fishing day, green points: *Nephrops* LPUE = 0 kg/fd. Limits of the FU in blue in the 2009 map.

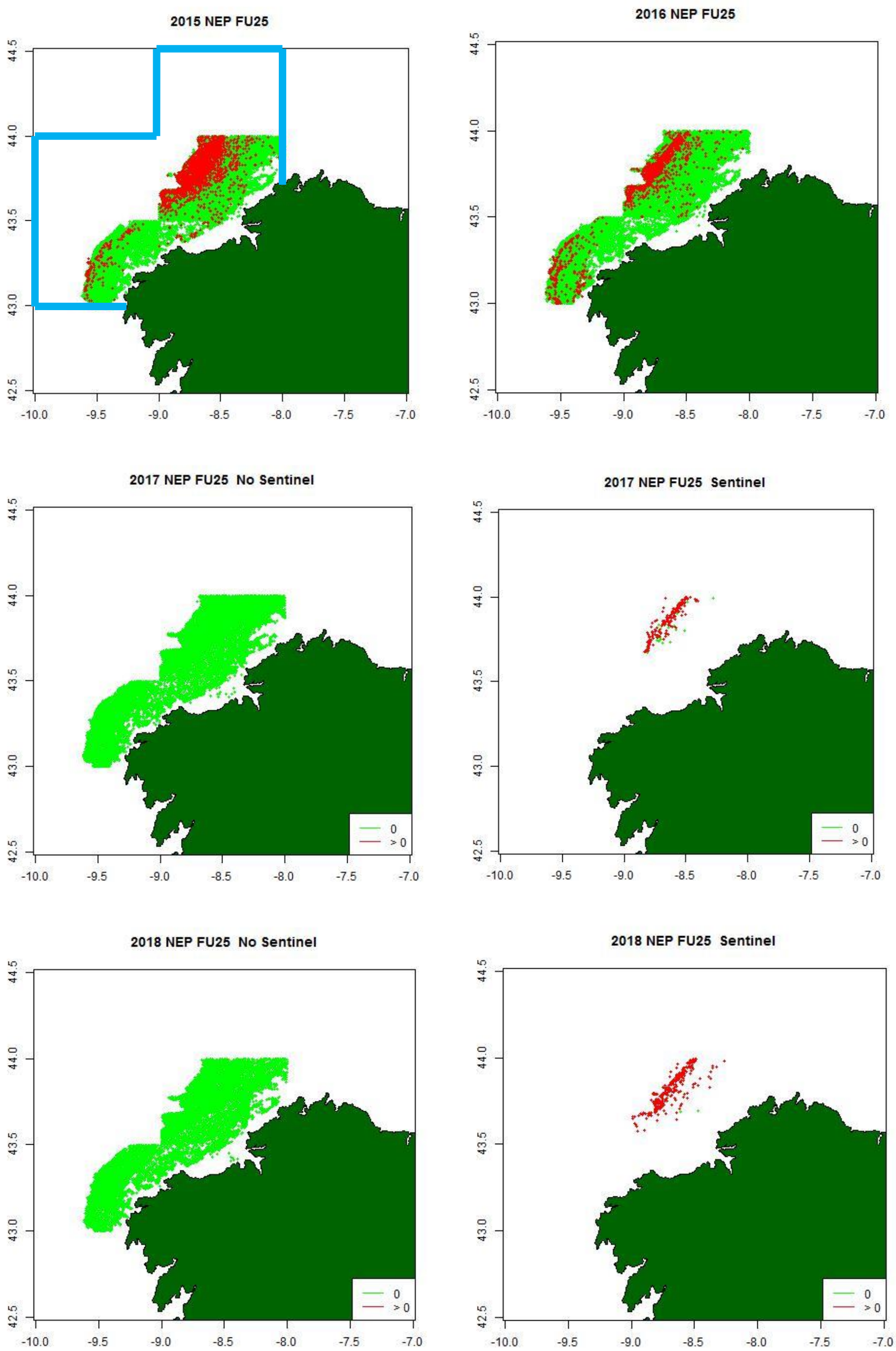


Figure 12.1.2b. ***Nephrops*** **FU 25, North Galicia.** ***Nephrops*** **presence/absence distribution from commercial fleet activity (2015, 2016, 2017 and 2018 "no sentinel" maps) and from Sentinel fishery (2017 and 2018 "sentinel") (logbooks and VMS data). Red points:** ***Nephrops*** **LPUE > 0 kg/fishing day, green points:** ***Nephrops*** **LPUE = 0 kg/fd. Limits of the FU in blue in the 2015 map.**

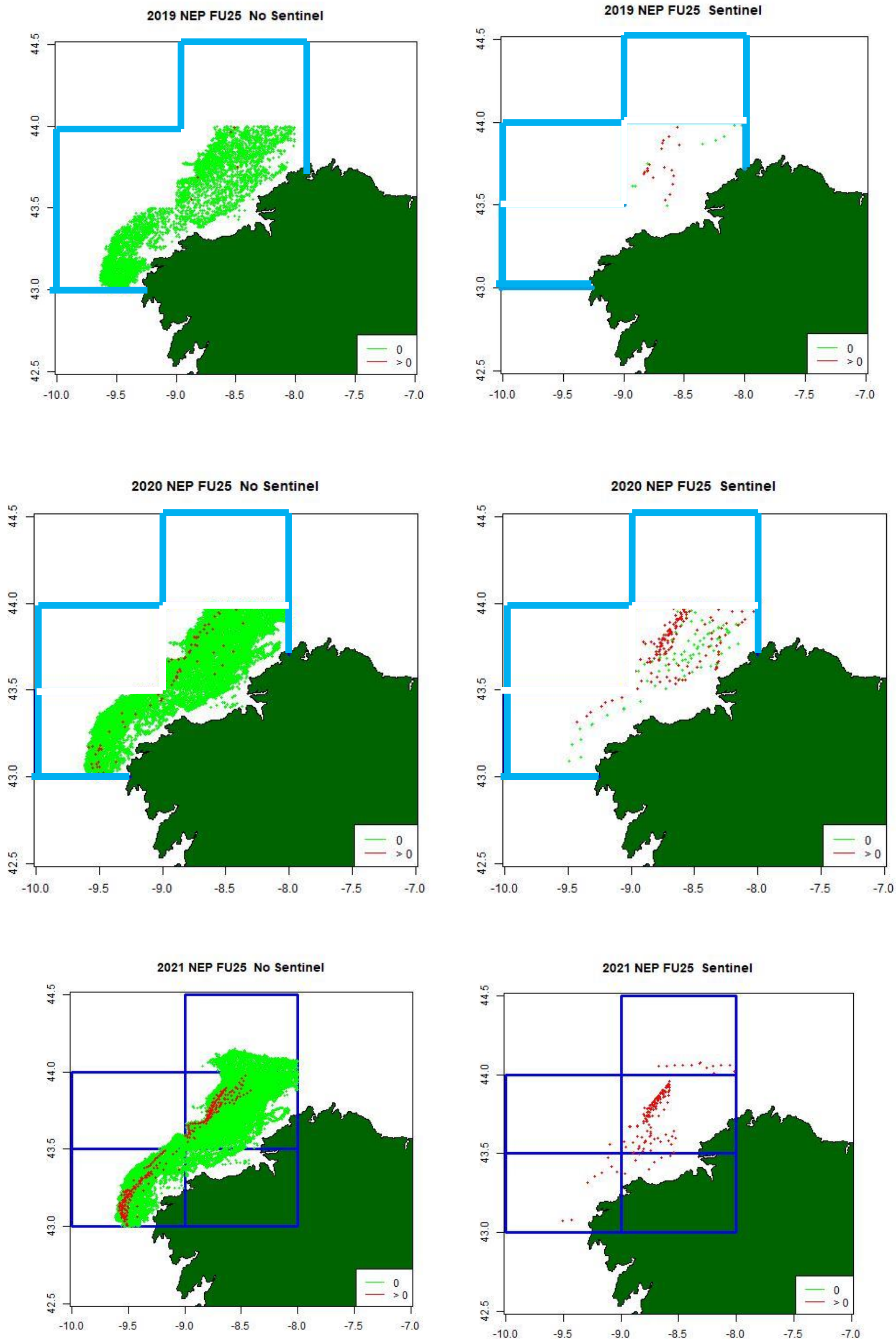


Figure 12.1.2c. *Nephrops* FU 25, North Galicia. *Nephrops* presence/absence distribution from commercial fleet activity ("no sentinel") and from Sentinel fishery ("sentinel") (logbooks and VMS data). Red points: *Nephrops* LPUE > 0 kg/fishing day, green points: *Nephrops* LPUE = 0 kg/fd. Limits of the FU in blue. Since 2020 the sentinel is extended to the whole FU 25 *Nephrops* area.

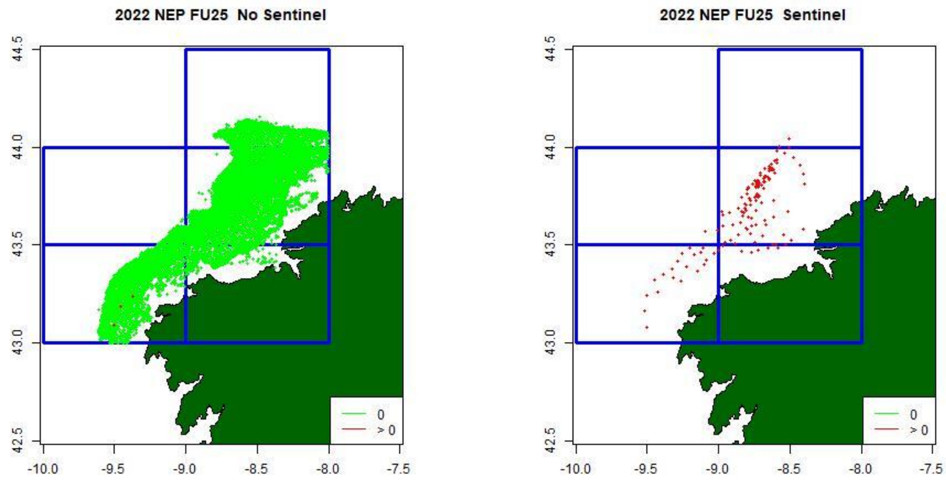


Figure 12.1.2d. *Nephrops* FU 25, North Galicia. *Nephrops* presence/absence distribution from commercial fleet activity ("No sentinel") and from Sentinel fishery ("sentinel") (logbooks and VMS data). Red points: *Nephrops* LPUE > 0 kg/fishing day, green points: *Nephrops* LPUE = 0 kg/fd. Limits of the FU in blue. Since 2020 the sentinel is extended to the whole FU 25 *Nephrops* area.

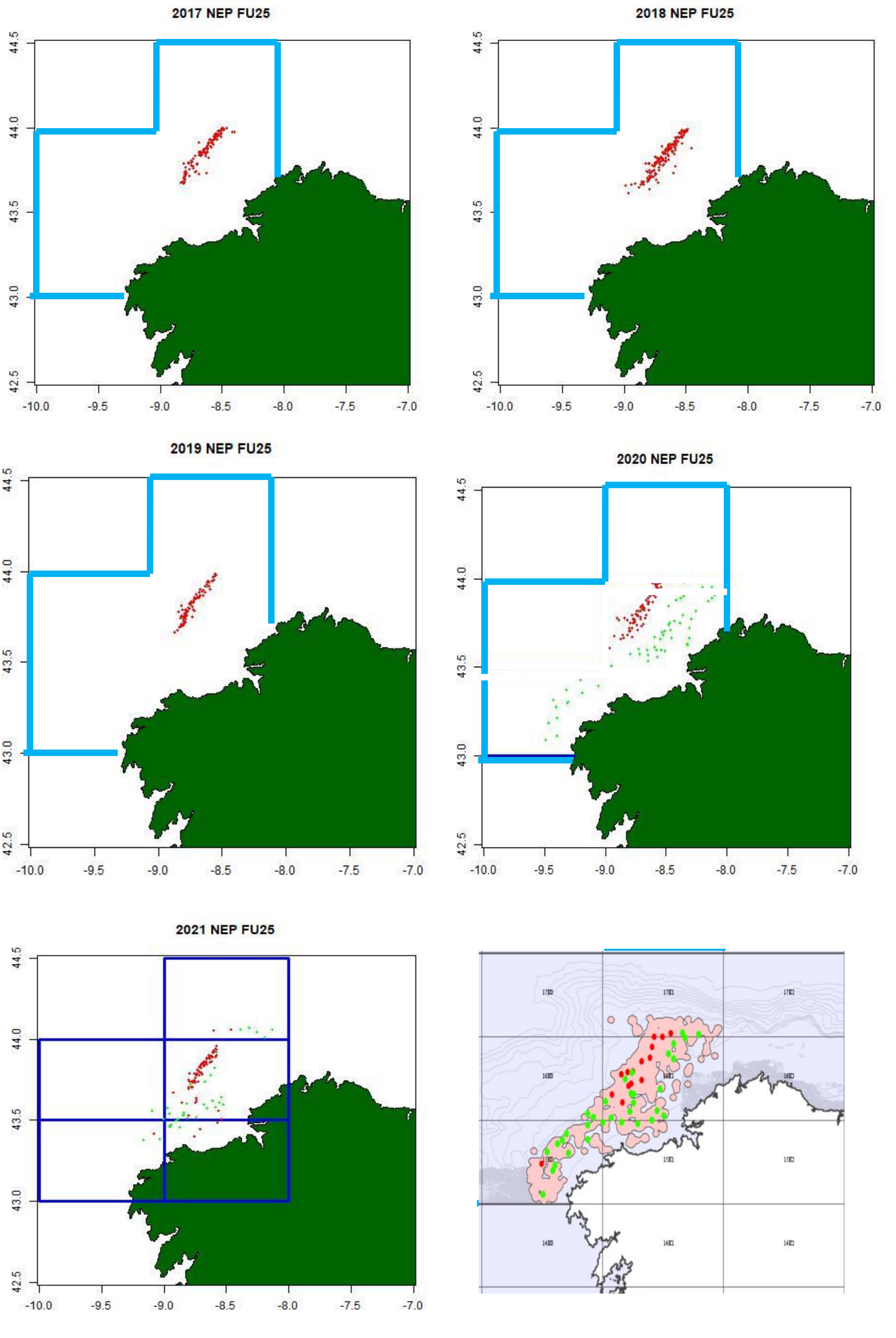


Figure 12.1.2e *Nephrops* FU 25, North Galicia. *Nephrops* presence/absence from Sentinel fishery ("sentinel") (observers on board and VMS data). Only *Nephrops* directed hauls. Red points: *Nephrops* LPUE > 0 kg/haul, green points: *Nephrops* LPUE = 0 kg/haul. Limits of the FU are in blue. Since 2020 the sentinel is extended to the whole FU 25 *Nephrops* area.

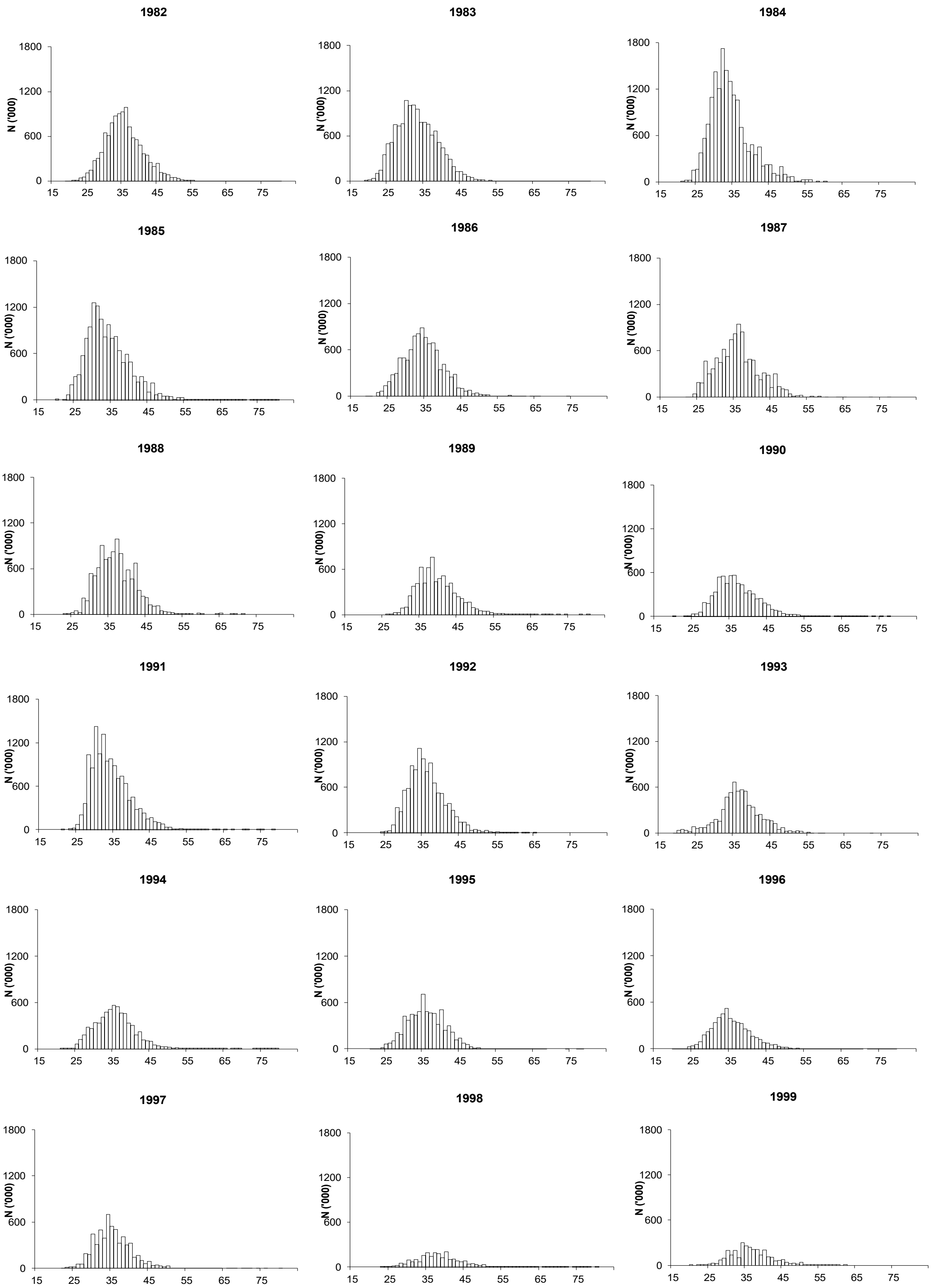


Figure 12.1.3a. *Nephrops* FU 25, North Galicia. Length distributions of landings, 1982–1999. Maximum of y-axis 1800 thousand. Carapace length in mm in the x-axis.

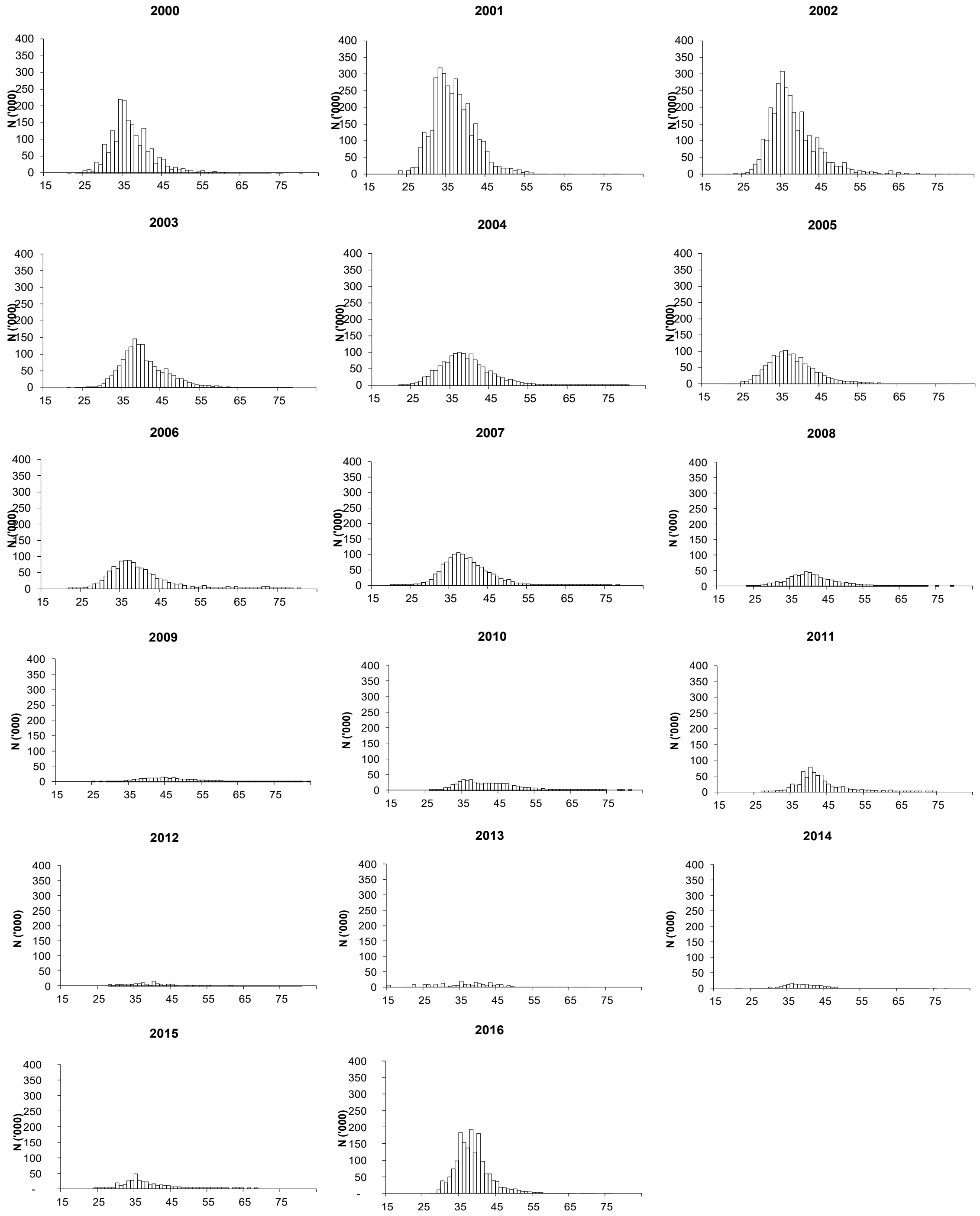


Figure 12.1.3b. *Nephrops* FU 25, North Galicia. Length distributions of landings, 2000–2016. Maximum of y-axis 400 thousand (2000–2016). Carapace length in mm in the x-axis.

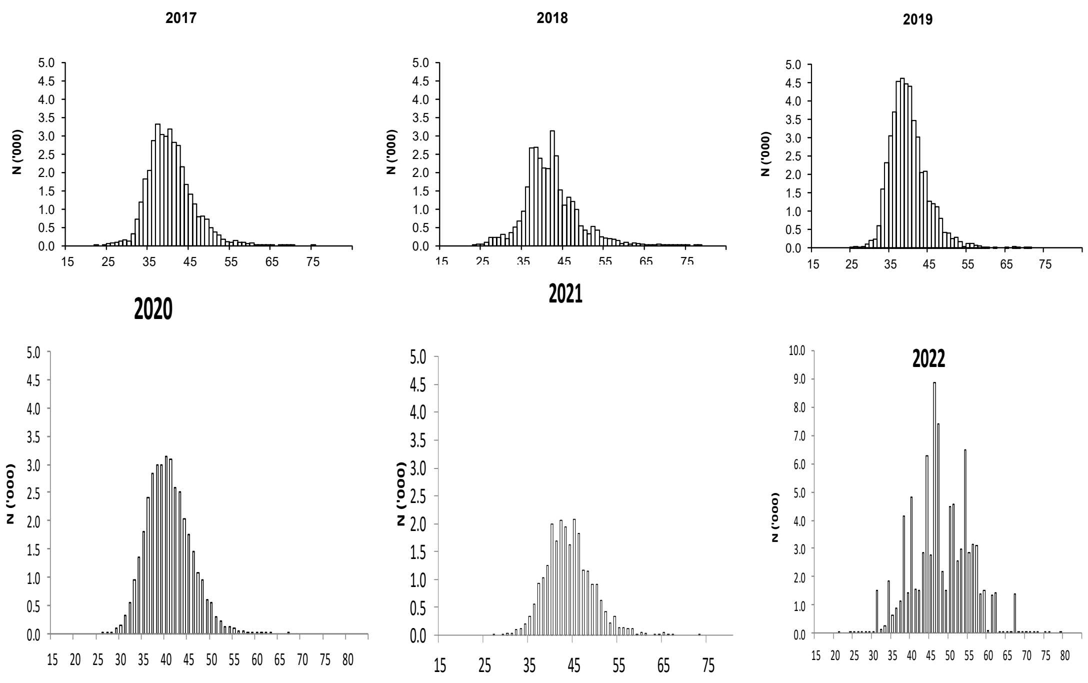


Figure 12.1.3c. ***Nephrops*** **FU 25, North Galicia. TAC in FU 25 was zero for the period 2017-2022. Length distributions of landings for these years were from the** ***Nephrops*** **Sentinel fishery in FU 25 (TAC for Sentinels were 4.3 t in 2017, 2 t each year in 2018-2020 and 1.7 t each year in 2021-2022). Maximum of y-axis 5 thousand. 2022 length distribution is from Sentinel fishery and discards. Manimum of y-axis in 2022 10 thousand. Carapace length in mm in the x-axis. The number of measured individuals: 7266 (2017), 8524 (2018), 4633 (2019), 6316 (2020), 3005 (2021) and 7880 (2022).**

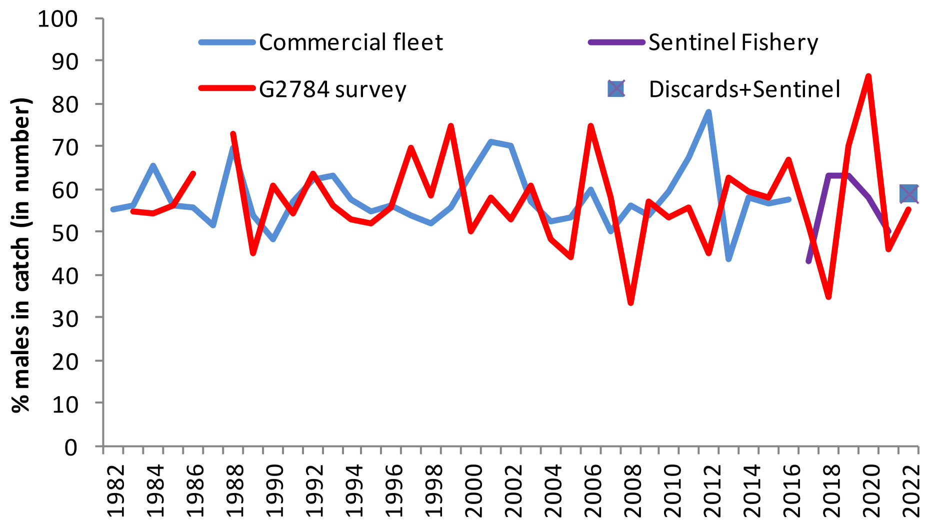


Figure 12.1.4a. ***Nephrops*** **FU 25, North Galicia. Proportion of males in catches for the period 1982–2022. Commercial fleet (1982–2016), Sentinel fishery (2017–2021), SPGFS-WIBTS-Q4 (G2784) survey (1983–2022) and Sentinel+discards (2022).**

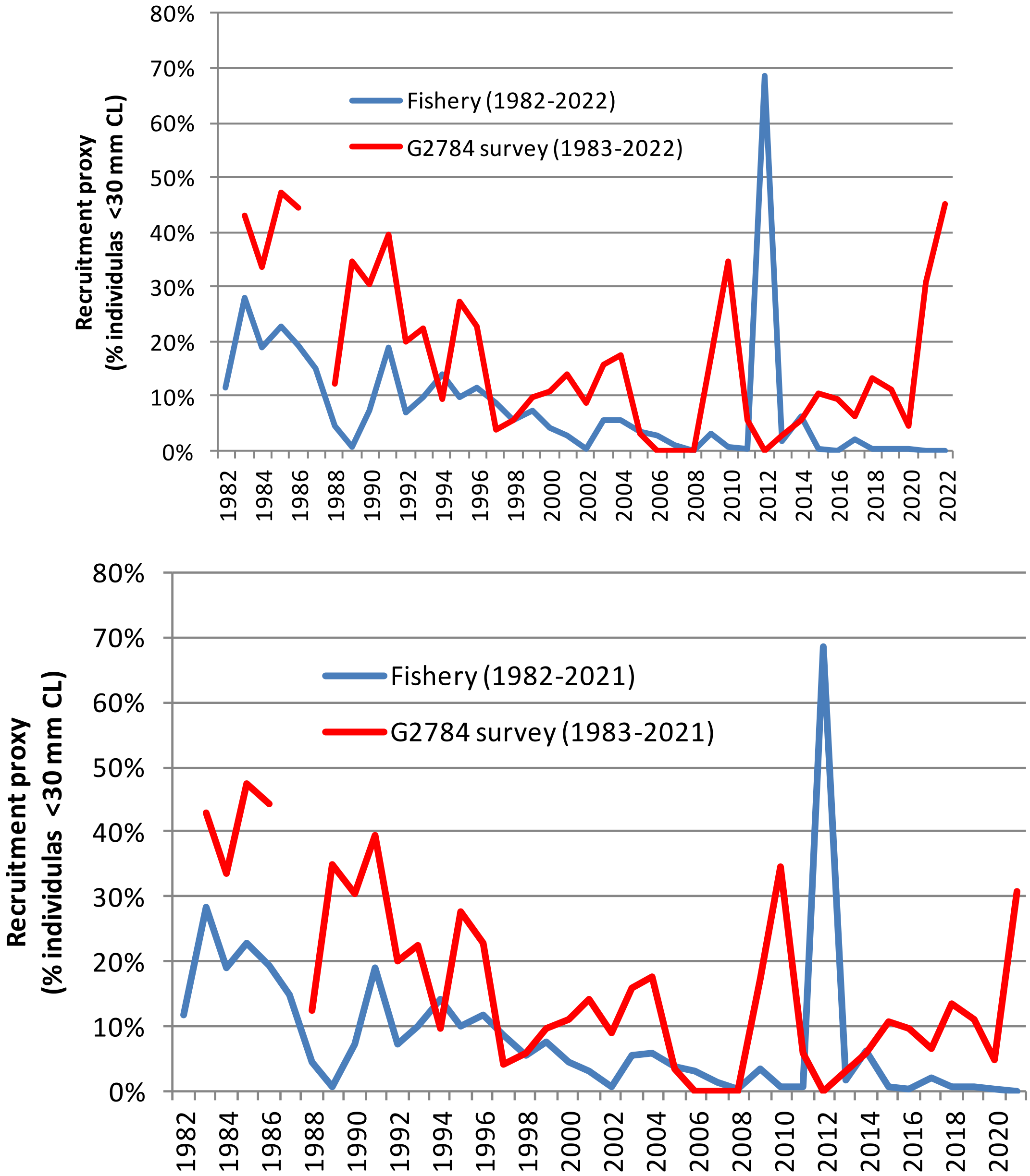


Figure 12.1.4b. *Nephrops* FU 25, North Galicia. Recruitment proxy. Blue line = Commercial fleet (1982–2016) and Sentinel fleet (2017–2021), Sentinel+Discards (2022). Red line = SPGFS-WIBTS-Q4 (G2784) survey (1983–2021)

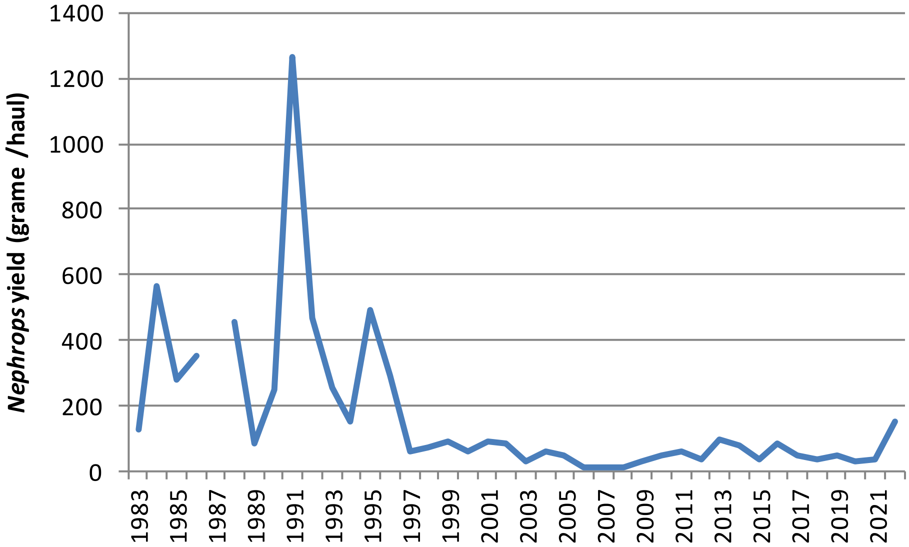
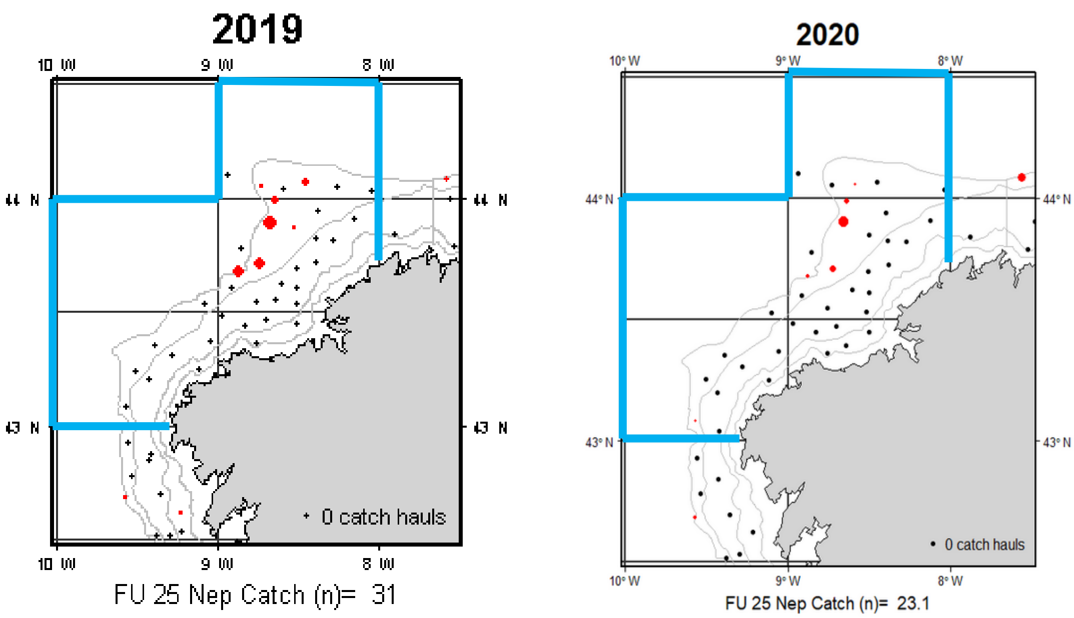


Figure 12.1.5. ***Nephrops*** **FU 25, North Galicia. CPUE (grammes/haul) from SPGFS-WIBTS-Q4 (G2784) survey (1983–2022). No survey was carried out in 1987. Only hauls in the** ***Nephrops*** **area have been used.**



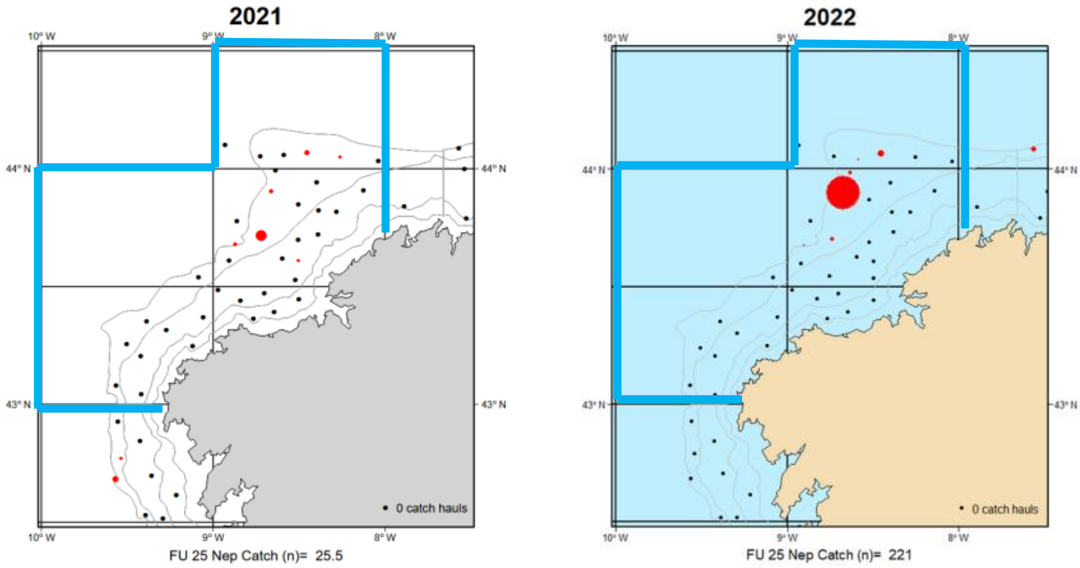


Figure 12.1.6. ***Nephrops*** **FU 25, North Galicia. CPUE (kg/haul) from SPGFS-WIBTS-Q4 (G2784) survey (2019–2022). Black points: zero kg of** ***Nephrops*****/haul. Limits of FU 25 in blue.**

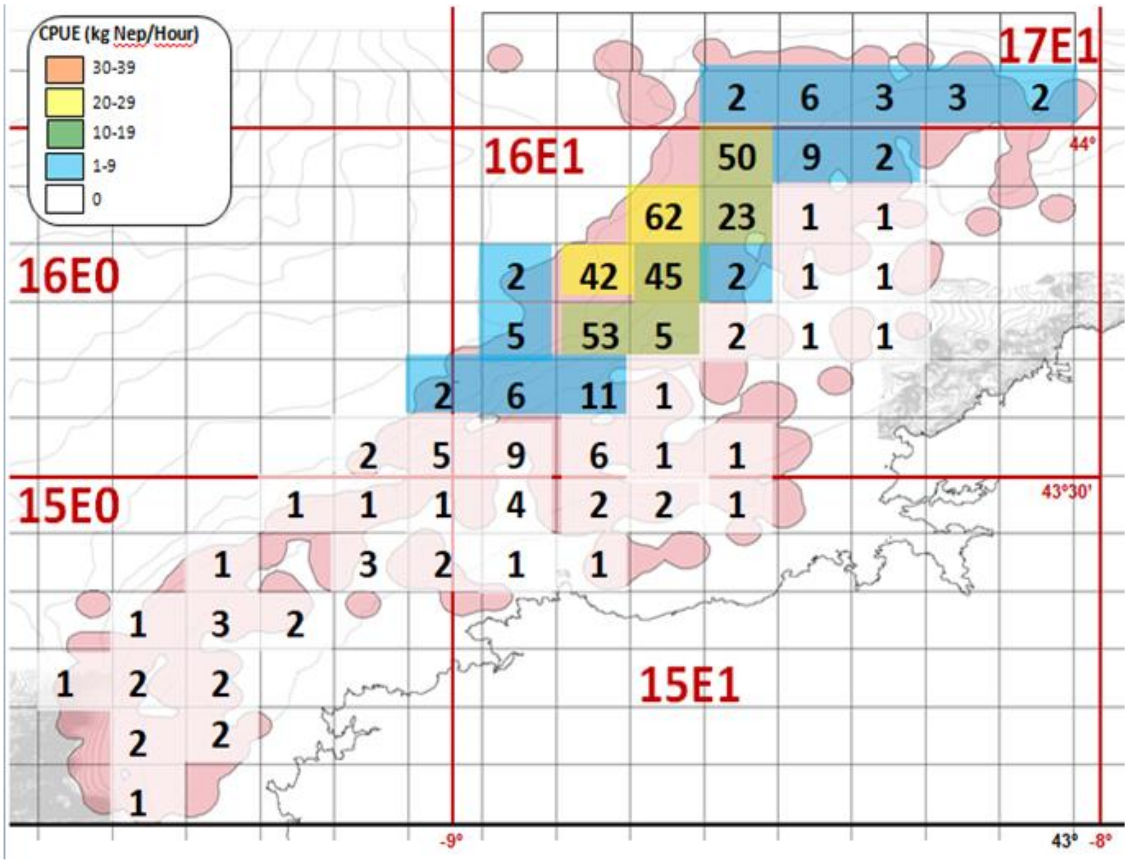


Figure 12.1.7. ***Nephrops*** **FU 25, North Galicia. Sentinel fishery CPUE (kg Nep/Hour) by cell from diurnal hauls with bottom trawl gear done in August (2017–2022). Numbers in the map correspond to the number of hauls that operated in each cell. Nephrops TAC for Sentinel fisheries were 4.3 t in 2017, 2 t each year in 2018-2020 and 1.7 t in 2021-2022.**

12.2 *Nephrops norvegicus* in FU 31 (Cantabrian Sea)

12.2.1 General

FU 31 *Nephrops* stock is a category 2.12 stock (data rich stock, but with an assessment/forecast that is accepted for trends only and with biomass < $MSYB_{trigger}$).

After the identification of the FU 31 *Nephrops* area using hauling data from the SPGFS-WIBTS-Q4 (G2784) survey (1983–2020), Discard Programme observers on board in commercial fishery (1994–2020) and the Sentinel fishery observers on board (2017–2020), the FU 31 area was updated in 2022 WG including the ICES rectangles 16–17 E2-E7 and 15 E4–7.

12.2.1.1 Ecosystem aspects

See Stock Annex.

12.2.1.2 Fishery description

FU 31 *Nephrops* is caught by the Spanish OTB_DEF_≥55, which is described as the "Northern trawl" fleet in section 2.1.2 of this report. See also Stock Annex for more information.

12.2.1.3 Summary of ICES advice for 2023 and management applicable to 2022 and 2023

ICES advice for 2023

Since 2021 advice for FU 31 is done based on SPiCT outputs (ICES, 2021a). The advice for FU 31 *Nephrops* stock is annual and valid for 2023. ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 17 tonnes.

Management applicable to 2022 and 2023

Since 2011, there is a Spanish regulation that established an Individual Transferable Quota system (ITQs) which includes *Nephrops* (ARM/3158/2011, BOE, 2011).

In 2019, a zero TAC was set for *Nephrops* in ICES Division 8.c for the years 2020, 2021 and 2022.

The advice in 2021 stated that catches in 2022 should be no more than 20 tonnes. Since 2022, the TAC is set by Functional Unit in division 8c. The FU 31 TAC was 20 tons for 2022 and 17 tons for 2023.

A special quota of 0.7 t for 2019, 2020 and 2021 was set for *Nephrops* in FU 31 in order to conduct an observer's onboard programme ("*Nephrops* Sentinel Fishery") supervised by the Spanish Oceanographic Institute (IEO) to obtain a *Nephrops* abundance index and complementary data.

12.2.2 Data

12.2.2.1 Commercial catches and discards

Spanish landings are based on sales notes which are compiled and standardized by IEO. Since 2003, trips sales notes are also combined with their respective logbooks. Data are available by statistical rectangle since 2003 and by *métier* since 2008 (EC, 2008). A revision of the 2000–2020 FU 31 *Nephrops* landings and discards was carried out in 2022 based on the definition of the new *Nephrops* assessment area. This identification was made based on the positions of the hauls with *Nephrops* catch from SPGFS-WIBTS-Q4 (G2784) survey (1983–2020), observers on board the

Discard Programme in commercial fishery (1994–2020) and observers on board the Sentinel fishery (2019–2020).

Nephrops landings from FU 31 were reported by Spain (Table 12.2.1 and Figure 12.2.1) and are available for the period 1983–2022. The highest landings were recorded in 1989 and 1990, 177 t and 174 t, respectively. Since 1996, landings have declined sharply to 4 t in 2016, the last year with non-zero *Nephrops* TAC. When the FU 31 included only four statistical rectangles, about 39% of *Nephrops* landings in FU 31 comes from the statistical rectangle 16E7 (Basque Country), 36% from 16E4 (Asturias region), 18% from 16E6 (Cantabrian region) and 8% from 16E5 (logbooks 2003–2016).

In the period 2017- 2021, FU 31 *Nephrops* TAC was zero, landings were zero, but 814, 552 and 700 kg of landings were obtained in the 2019, 2020 and 2021 FU 31 Sentinel fishery, respectively (special onboard observers' programme in commercial vessels to monitor the FU stock status), which was granted a special quota. More details were provided to this WG in 2020 (González Herraiz *et al.*, 2020).

Information on landings, discards and length distributions was uploaded to InterCatch. *Nephrops* discards were negligible in FU 31, nevertheless, when the *Nephrops* TAC were zero, estimated discards amounted to 31.4 kg, 7 t, 5.7 t, 9.9 t and 8 t for years 2017, 2018, 2019, 2020 and 2021, respectively. In 2022 the TAC was 20 tons, the landings 7 tons, and discards 0 kg.

VMS information

VMS data from 2009–2018 from FU 31 trawl fleet (Figure 12.2.2a) were used to provide some information about the spatial distribution of *Nephrops* catches in the FU when TAC was higher than zero (2009–2016). Figure 12.2.2a also shows the catch spatial distribution under zero TAC (2017–2018). Figure 12.2.2b shows the presence and absence of *Nephrops* in the Sentinel and no-sentinel fishery (2019-2021). Logbook data were assigned to VMS pings by vessel, fishing day and statistical rectangle. About 28% of the VMS pings could not be identified in logbooks while only 9% of the 2009–2016 VMS pings revealed the presence of *Nephrops*. The CPUE by cells in Sentinel fisheries is shown in Figure 12.2.2d. The occurrence *of Nephrops* in the commercial fishery in 2022 is represented in Figure 12.2.2.c.

12.2.2.2 Biological sampling

The biological sampling programme from 1988 to 2016 and the Sentinel fishery in 2019-2021 provided length–frequency distributions (LFDs) by sex of *Nephrops* landings and discards, sex ratio, recruitment proxies and mean sizes. No LFDs was available for FU 31 in 2017 and 2018 because the *Nephrops* TAC was zero. The sampling levels in Division 8.c are shown in Table 1.4. SPGFS-WIBTS-Q4 (G2784) survey also provides LFDs by sex and, therefore, mean sizes and sex ratio since 1983. The number of *Nephrops* individuals from the SPGFS-WIBTS-Q4 (G2784) survey was insufficient in 2017 and 2018 to provide a reliable estimate of mean length.

Mean sizes series show increasing trends until 2009 (Figure 12.2.1), the year where the mean size for males was observed at 55.8 mm CL and 45.9 mm CL for females. Mean sizes decreased in the years 1991, 2002, and 2011 which could suggest years with more recruitment.. Mean size in 2016 was 52.1 mm CL for males and 45.8 mm CL for females. Mean sizes from Sentinel fishery were 45.4, 49.2 and 47.0 mm CL for males and 41.4, 44.1 and 43.0 for females, for the years 2019, 2020 and 2021, respectively. Mean size in 2022 from the commercial fleet were 50.6 mm CL for males and 43.9 mm CL for females.

Low quantities of males in a *Nephrops* stock could be related to a high fishing pressure since ovigerous females are protected in burrows during most of the year (Fariña Pérez, 1996). In worst cases, low quantities of males could affect mating (ICES, 2013), and consequently, recruitment in subsequent years. The minimum percentages of males in FU 31 in the SPGFS-WIBTS-Q4 (G2784) survey time-series were recorded in 1996 and 2010 (red line in Figure 12.2.2e) and in 1994 in the fishery (blue line).

Recruitment proxies from the SPGFS-WIBTS-Q4 (G2784) survey and the fishery show a decreasing trend up to 2009 in the survey and up to 2016 in the fishery (Figure 12.2.2f).

12.2.2.3 Abundance index from survey

Figures 12.2.3, 12.2.4a-d show two periods in FU 31 *Nephrops* CPUE (kg/haul) time-series and spatial distribution from SPGFS-WIBTS-Q4 (G2784) survey (1983–2021): the first period with high abundance was observed until 1993 and another with low abundance since 1994. A bottom trawl survey is carried out every year in October to estimate hake recruitment and to collect information on the relative abundance of demersal species (see Spanish IBTS survey in 3rd quarter description in section 2.2.1 of this report). The survey hauls positions are the same each year. The survey index has passed from 58 grams/haul in 2021 to 170 grams/haul in 2022.

12.2.2.4 Commercial catch-effort data

The fishing effort and CPUE dataseries include bottom trawl fleets operating in the Cantabrian Sea selling in the harbours of Santander, Gijón and Avilés. In recent years, the information from the different fleets is intermittent. A combined effort series that includes Santander, Avilés and Gijón from 2009 onwards are presented in Figure 12.2.1. In order to standardize the effort units, the unit considered for this series is the trip. All the available effort time-series show decreasing trends from 1983–2016 (Figure 12.2.1). The increase in the use of other gears (HVO and pair trawl) resulted in the reduction of the baca trawl fleet effort. The combined Santander-Gijón-Avilés effort values decreased since 2014 (Figure 12.2.1). The effort in 2022 was 636 trips.

The Santander LPUE series shows fluctuations and a general downward trend (Figure 12.2.1) until 2013 (2.3 kg/fishing days). The combined Santander-Gijón-Avilés LPUE series also shows a decreasing trend. The CPUE in 2016 was 4.3 kg/trip. The LPUE of *Nephrops* was zero during the period with TAC zero (2017-201). The LPUE in 2022 was 7.5 kg/trip, value similar to the values of 2010 and 2011.

In Portugal, CPUE of species with an affinity for temperate waters (in opposition to tropical waters) decreased from 1992 to 2009, especially in long-lived species as *Nephrops* (Teixeira *et al*., 2014). CPUE time-series of "temperate" species are directly correlated with rain and inversely with temperature (Teixeira *et al*., 2014). Similar processes could have affected the FU 31 *Nephrops* from 1988 to 2010.

The FU 31 fishing sector requested a Sentinel fishery in that area in order to obtain a *Nephrops* abundance index. ICES delivered a Special Request Advice (ICES, 2019b) establishing the technical requirements and the Sentinel fishery was carried out in July 2019 (González Herraiz *et al*., 2020). However, in 2020 the Sentinel fishery was delayed to August due to administrative reasons. The *Nephrops* CPUE obtained in this fishery was 19.9, 17.1, 30.0 grammes/kWhour in 2019–2021. The 2020 CPUE was multiplied by a factor of 1.37 in order to compare with the value estimated for the July 2019 CPUE. This ratio was obtained from the CPUE time-series 2006–2016 from logbooks (ICES, 2019b). The high CPUE of 2021 could be related to a less representative fishing hauls distribution in the 2021 Sentinel fishery than in 2019–2020. The *Nephrops* retained catch was 735 kg in 2019 and 552 kg in 2020 and 1478 in 2021. *Nephrops* discards were negligible (79 kg in 2019, 11 kg in 2020 and 45 kg in 2021). Sentinel fishery data were included in the Spanish data uploaded to InterCatch.

12.2.3 Assessment

The SPiCT model (Pedersen and Berg, 2017) was considered suitable for the assessment of the FU 31 *Nephrops* stocks since, unlike other data-limited stocks (DLSs) methods, this method takes into account the history of the fishery and does not use a long list of life-history parameters that usually come with high uncertainty.

12.2.3.1 SPiCT model

The SPiCT model for FU 31 was accepted in the WKMSYSPiCT (ICES, 2021a). In WGBIE 2022 in order to obtain normal distributed catch residuals, the same model configuration of 2021 assessment was used though adding inp$stdevfacC=c(rep(1,34),4,4,4,4) to increase uncertainty to the catches of the years with TAC zero (2018–2021). The same code was used in WGBIE 2023. Catch data in 2017 has not been included because it was zero and SPiCT deletes the zero data.

Input data:

- Catches (1983–2022; Table 12.2.1)
- SpGFS-WIBTS-Q4 (G2784) survey index (1983–2022; Table 12.2.2, Figure 12.2.3)

SPiCT settings:

- Euler time-step (years): 1/12
- Medium level of exploitation before the beginning of the time-series
- Fixed shape parameter *n* to 2
- Intrinsic growth parameter *r* mean 0.2 and coefficient of variation 0.2
- Priors on the standard deviation of the catches and the F process noise inp$priors$logsdc=c(log(0.1), 0.2, 1)
  inp$priors$logsdf=c(log(3), 0.5, 1)
- High uncertainty for the 1983–1994 catches and for 2018–2021

12.2.3.2 Assessment diagnostics

The SPiCT diagnostics (Figure 12.2.7) and the retrospective plots (Figures 12.2.5 and 12.2.6) did not show major problems, B_t/B_{MSY} and F_t/F_{MSY} Mohn's rho values are inside the range -2 to 2.

12.2.3.3 Assessment results

SpiCT results are presented in Tables 12.2.3 and 12.2.4 and Figure 12.2.7. The stock biomass (B) decreased since 1989, reaching the lowest value in 2011. After 2011, biomass increased until 2016 and has a decreasing trend since then. Biomass has been below $B_{trigger}$ since 2007 and below B_{lim} in the period 2010–2012. Fishing mortality (F) has been below F_{MSY} since 2009.

The biomass at the end of 2022 was 37% of the B_{MSY} and F was 39% of the F_{MSY} (Table 12.2.3).

12.2.3.4 Short-term projections

SpiCT-predicted catch and stock status for 2024 are shown in Table 12.2.5.

12.2.3.5 Biological reference points

No reference points are defined for this stock in terms of absolute values. The SPiCT-estimated values of the ratios F/F_{MSY} and B/B_{MSY} are used to estimate stock status relative to the MSY reference points. The table on the next page presents these relative reference points used in the assessment.

Framework	Reference point	Relative value *	Technical basis	Source
MSY approach	MSY $B_{trigger}$	0.5	Relative value. B_{MSY} proxy is estimated directly from the assessment model and changes when the assessment is updated.	ICES (2021)
	F_{MSY}	1	Relative value. The F_{MSY} proxy is estimated directly from the assessment model and changes when the assessment is updated.	ICES (2021)
Precautionary approach	$B_{lim\ proxy}$	0.3 × B_{MSY}	Relative value (equilibrium yield at this biomass is 50% of the MSY proxy).	ICES (2021)
	B_{pa}	Not defined		
	F_{lim}	1.7 × F_{MSY}	Relative value (the F that drives the stock to the proxy of B_{lim}).	ICES (2021)
	F_{pa}	Not defined		

12.2.4 Stakeholders information

In April 2020, WGBIE received a letter from stakeholders (two Spanish fishing producers' organizations, OPP no. 31 and 07) regarding the *Nephrops* fishery in ICES Division 8.c. The document analysed market and sales notes data and the fisheries management measures taken in recent years directed at *Nephrops* in Division 8.c. This document was discussed in a subgroup meeting during the WGBIE in 2020. Market and sales notes are part of the data used for the ICES assessment of this stock since the first assessment in 1997. Also fisheries management measures have been always taken into account in the assessment process. So, the data sources and the issues mentioned in the document, together with additional data and any other relevant information relative to the 8.c *Nephrops* stocks, are taken into account by routine each year to make an integral analysis of the stock status and elaborate a scientifically sound assessment in the WGBIE.

No further stakeholder information was presented to WGBIE since 2020.

12.2.5 Management considerations

Nephrops is taken as bycatch in the mixed bottom-trawl fishery. In 2022 98% of the Spanish *Nephrops* landings are from the bottom trawlers and 2% from nets in FU 31.

The TAC for *Nephrops* in this FU was zero for the period 2017-2021. In 2022 the TAC was 20 t. The overall trend in *Nephrops* catches from the Cantabrian Sea (FU 31) was strongly declining up to 2017. Landings dramatically decreased since the beginning of the series (1983–2016), representing in 2016 less than 2% of the 1989 maximum observed value. Catches have a slight increase since 2017 to 2020 and decreased in 2021 and 2022.

A recovery plan for Southern hake and *Nephrops* stocks in the Cantabrian Sea and Western Iberian Peninsula was established in 2005 (EU, 2005) and repealed in 2019 (EU, 2019).

A Fishing Plan for the Northwest Cantabrian ground was established in 2011 (ARM/3158/2011, BOE, 2011). This new regulation established an Individual Transferable Quota system (ITQs) and includes the *Nephrops*.

FU 31 was not included in the multiannual plan for stocks fished in the Western Waters in 2019 (EU, 2019).

A *Nephrops* Sentinel Fishery in FU 31 supervised by the IEO was carried out in 2019, 2020 and 2021 to obtain a *Nephrops* abundance index (González Herraiz *et al*., 2020). This fishery followed the technical requirements established by a specific ICES Special Request Advice (ICES, 2019).

12.2.6 References

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12.2.7 Tables and figures

Table 12.2.1. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. Landings and discards in tonnes.

Year	Landings	Discards	Catch
1983	63		63
1984	100		128
1985	128		173
1986	127		175
1987	118		159
1988	151		193
1989	177		353
1990	174		347
1991	109		217
1992	94		188
1993	101		188
1994	148		212
1995	94		160
1996	129		129
1997	98		98
1998	72		84
1999	48		48
2000	37		37
2001	27		27
2002	27		27
2003	35		35
2004	29		29
2005	48		48
2006	37		37
2007	43		43
2008	29		29
2009	13		13
2010	9		9
2011	7		7
2012	10		10
2013	10		10
2014	5		5
2015	4		4
2016	4		4
2017	0		0
2018	0	7	7
2019	1*	6	6
2020	1*	10	11
2021	1*	8	9
2022	7	0	7

* Nephrops TAC was zero in 8c (FU 25 & FU 31) in the period 2017-2021, but in 2019, 2020 and 2021 there were *Nephrops* Sentinel fisheries in FU 31.

Table 12.2.2. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. Yield from the SpGFS-WIBTS-Q4 survey (G2784) for the period 1983–2022.

Year	*Nephrops* yield (grams/haul)
1983	116
1984	307
1985	341
1986	428
1987	No survey
1988	837
1989	132
1990	240
1991	200
1992	405
1993	295
1994	252
1995	171
1996	199
1997	133
1998	127
1999	111
2000	210
2001	118
2002	83
2003	129
2004	143
2005	93
2006	66
2007	86
2008	59
2009	41
2010	23
2011	72
2012	80
2013	128
2014	133
2015	171
2016	99
2017	54
2018	95
2019	108
2020	99
2021	58
2022	170

Table 12.2.3. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. SPiCT summary results.

Parameter estimates

Parameter	estimate	cilow	ciupp	log.est
alpha	1.2277	0.4709	3.2007	0.2052
beta	0.1964	0.1188	0.3246	-1.6278
r	0.1798	0.1236	0.2617	-1.7157
rc	0.1798	0.1236	0.2617	-1.7157
rold	0.1798	0.1236	0.2617	-1.7157
m	69.1288	34.2526	139.5161	4.2360
K	1537.6308	733.0175	3225.4463	7.3380
q	0.0020	0.0005	0.0082	-6.2057
sdb	0.2349	0.1219	0.4524	-1.4487
sdf	0.4863	0.3537	0.6687	-0.7209
sdi	0.2884	0.1917	0.4337	-1.2435
sdc	0.0955	0.0668	0.1365	-2.3487

Stochastic reference points

Reference points	estimate	cilow	ciupp	log.est	rel.diff.Drp
Bmsys	639.5263	301.6037	1356.0642	6.4607	-0.2022
Fmsys	0.0762	0.0503	0.1153	-2.5750	-0.1807
MSYs	46.9238	20.7602	106.0609	3.8485	-0.4732

MSY $B_{trigger}$ = 319.76 t B_{lim} = 191.86 t

Estimated states

	estimate	cilow	ciupp	log.est
B_2022.92	234.6187	62.0810	886.6784	5.4580
F_2022.92	0.0297	0.0058	0.1518	-3.5166
B_2022.92/Bmsy	0.3669	0.0942	1.4283	-1.0028
F_2022.92/Fmsy	0.3900	0.0808	1.8819	-0.9416

Table 12.2.4. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. SPiCT estimates for B/B_{MSY} and F/F_{MSY}.

	B/B_{MSY}			F/F_{MSY}		
	CI_lower	values	CI_upper	CI_lower	values	CI_upper
1983	0.7462	1.2082	1.9563	0.5449	1.2355	2.8012
1984	0.6396	1.2677	2.5125	0.7251	1.7788	4.3638
1985	0.565	1.3295	3.1283	0.6952	1.8964	5.1735
1986	0.4974	1.4234	4.0735	0.5645	1.6875	5.0448
1987	0.4537	1.4589	4.6915	0.5443	1.7257	5.4716
1988	0.4355	1.5443	5.4762	0.6191	2.1256	7.2986
1989	0.4078	1.5793	6.1162	0.6851	2.5252	9.3076
1990	0.3535	1.5183	6.522	0.6183	2.2961	8.5266
1991	0.3015	1.218	4.9208	0.4876	1.7721	6.4403
1992	0.2803	1.1321	4.572	0.4557	1.6735	6.1458
1993	0.2769	1.1282	4.5975	0.5511	2.1274	8.2119
1994	0.2701	1.221	5.52	0.5468	2.2529	9.2822
1995	0.2325	1.0827	5.0417	0.5324	2.1367	8.5746
1996	0.218	1.0053	4.6353	0.6333	2.713	11.6225
1997	0.1843	0.898	4.3749	0.5162	2.2529	9.8327
1998	0.1563	0.773	3.8229	0.4275	1.842	7.9369
1999	0.137	0.6469	3.0541	0.3431	1.4519	6.1436
2000	0.127	0.5981	2.8164	0.2534	1.0964	4.7433
2001	0.1227	0.5783	2.7251	0.2043	0.893	3.9033
2002	0.1207	0.6049	3.0325	0.2773	1.1446	4.7247
2003	0.1212	0.5555	2.5464	0.3177	1.272	5.092
2004	0.1152	0.496	2.1352	0.3387	1.3965	5.7583
2005	0.1128	0.5342	2.5303	0.4084	1.8155	8.0705
2006	0.0998	0.5014	2.5193	0.4406	1.8882	8.0918
2007	0.0877	0.4218	2.0287	0.4861	2.1942	9.9039
2008	0.0713	0.3556	1.7744	0.2904	1.334	6.1286
2009	0.058	0.2963	1.5136	0.2091	0.8802	3.7063
2010	0.0536	0.243	1.1025	0.1993	0.7497	2.8206
2011	0.0526	0.2088	0.8291	0.1995	0.7248	2.6337
2012	0.0582	0.2183	0.8183	0.1822	0.7416	3.0182
2013	0.0681	0.3188	1.4921	0.0868	0.3874	1.7289
2014	0.0769	0.3794	1.8711	0.0432	0.2032	0.9559
2015	0.0857	0.4679	2.5553	0.0249	0.1206	0.5854
2016	0.091	0.4927	2.6686	0.0179	0.0816	0.373
2017	0.0915	0.4727	2.4432	0.0308	0.134	0.5828
2018	0.0943	0.427	1.9336	0.0627	0.2735	1.1929
2019	0.0961	0.3967	1.6386	0.0826	0.3617	1.5845
2020	0.0956	0.4324	1.9557	0.0968	0.4321	1.9296
2021	0.0947	0.4426	2.0693	0.0928	0.4094	1.8067
2022	0.0932	0.4052	1.7616	0.0808	0.39	1.8819
2023	0.0944	0.3698	1.4479	0.0619	0.39	2.4557
2024	0.0973	0.4061	1.695	0.0491	0.39	3.0976
2025	0.1007	0.4447	1.9635			

Table 12.2.5. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. *Nephrops* SPiCT predicted catch and states for 2024.

	C	B/Bmsy	F/Fmsy	B/Bmsy.lo	B/Bmsy.hi	F/Fmsy.lo	F/Fmsy.hi
1. F=0	0.0	0.46	0.00	0.11	1.96	0.00	0.00
2. F=Fsq	8.0	0.44	0.39	0.10	1.96	0.05	3.15
3. F=Fmsy	16.5	0.43	0.81	0.09	1.97	0.10	6.57
4. F=Fmsy_C_fractile	12.4	0.44	0.60	0.10	1.97	0.07	4.88

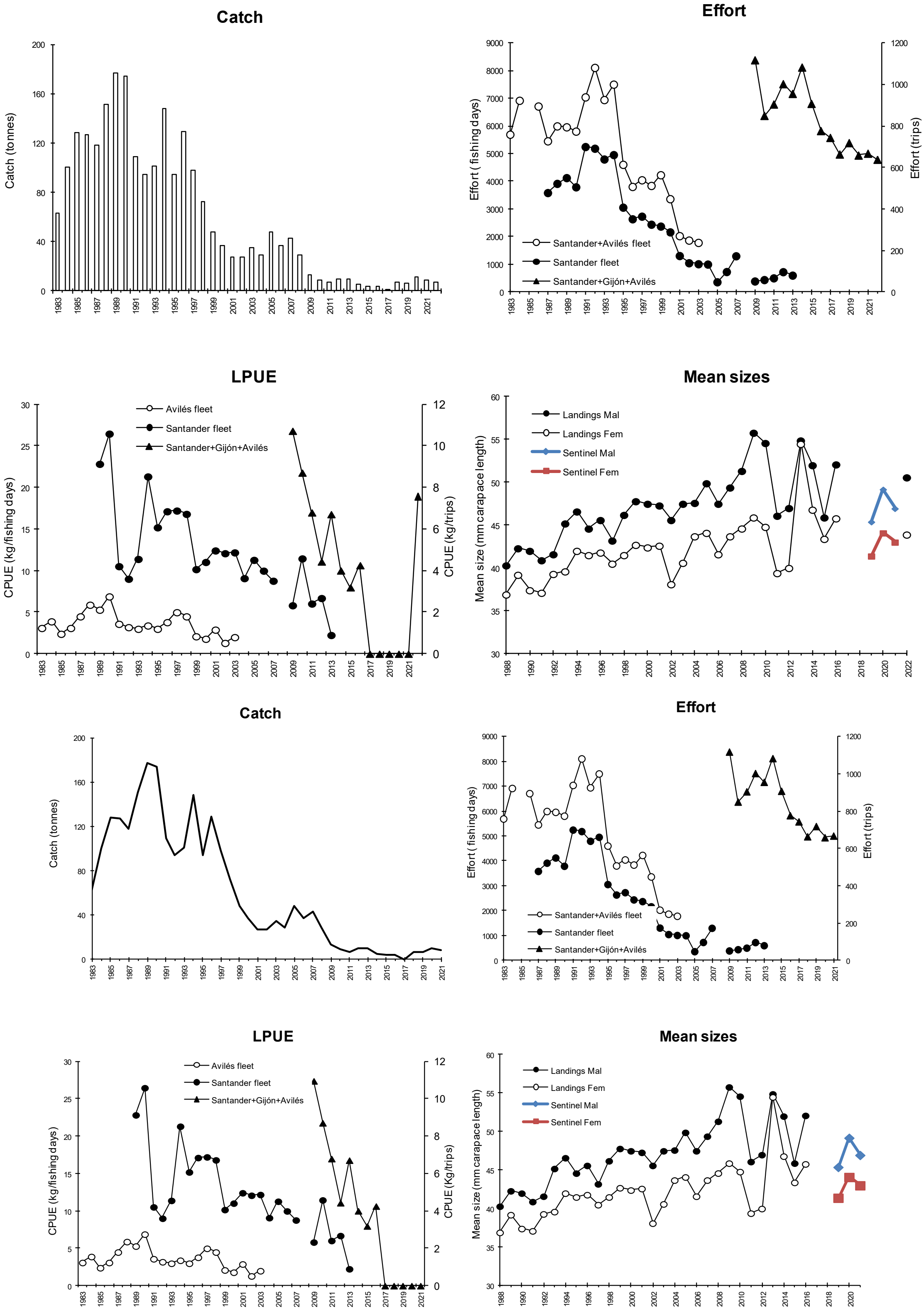

Figure 12.2.1. ***Nephrops*** **in FU 31, southern Bay of Biscay and Cantabrian Sea. Long-term trends in catch, effort, LPUE and mean sizes. Catch and mean sizes of** ***Nephrops*** **from the whole FU 31. Effort and LPUE for the "bacas" (métier OTB_DEF≥55) selling in the ports of Santander, Gijón and Avilés.** ***Nephrops*** **in 8.c (FUs 25 + 31) had TAC zero in 2017–2021.**

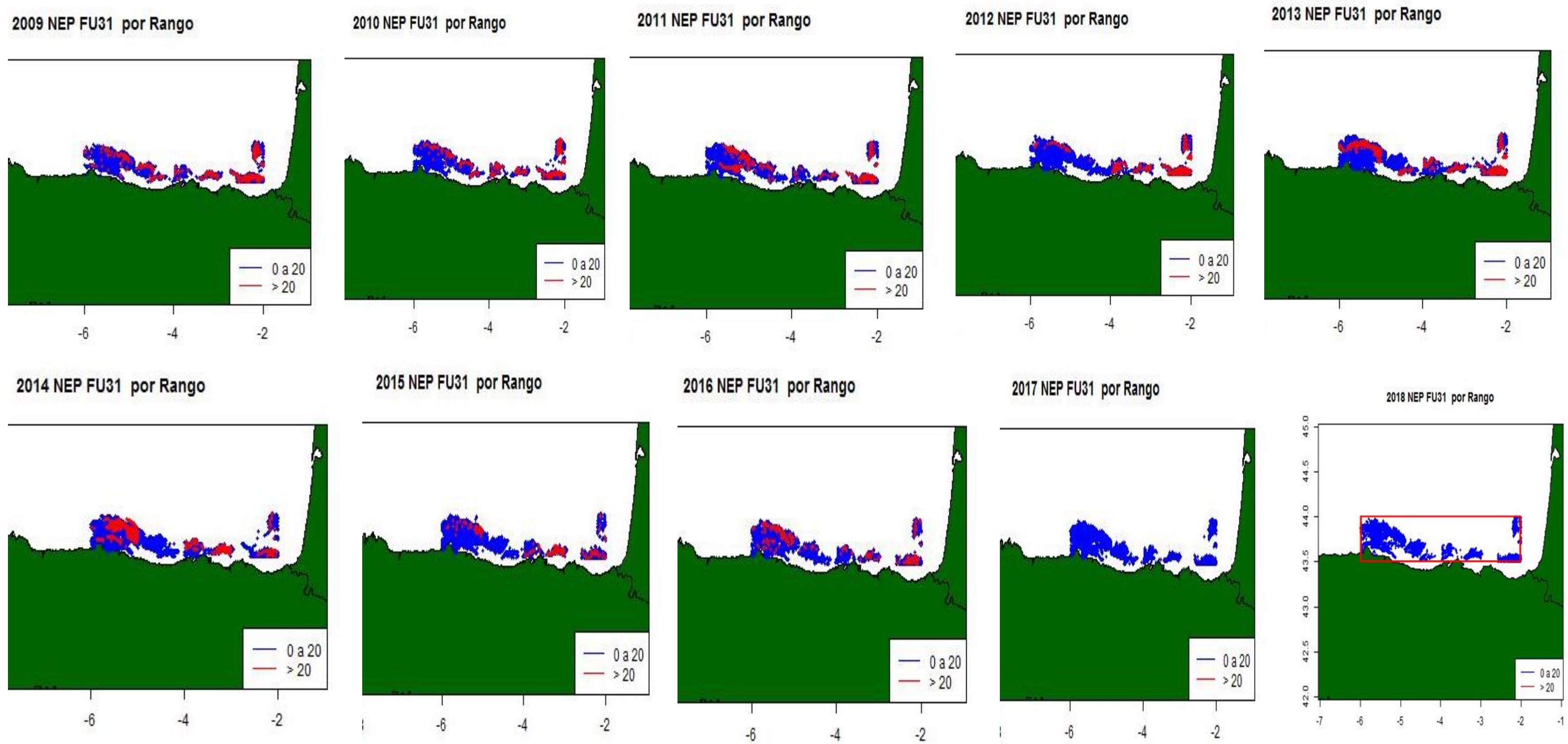

Figure 12.2.2a. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. Distribution of FU 31 *Nephrops* LPUE (kg/fishing day) (logbooks and VMS data). FU 31 limits indicated in red in the 2018 map. Red points: *Nephrops* LPUE > 20 kg/fishing day, blue: *Nephrops* LPUE ≤20 kg/fd. FU 31 TAC was zero in the period 2017-2021.

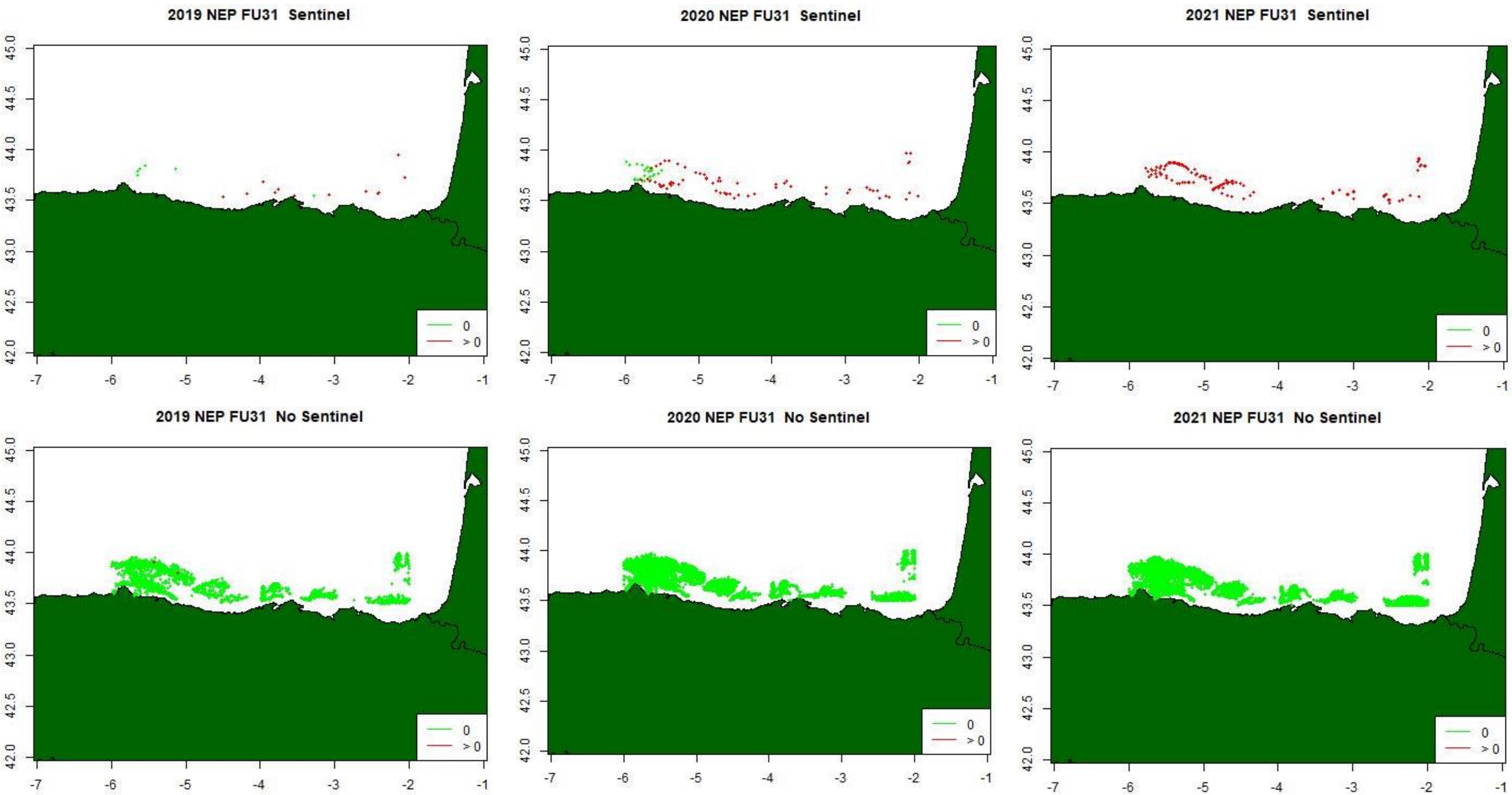

Figure 12.2.2b. ***Nephrops*** **in FU 31, southern Bay of Biscay and Cantabrian Sea. Distribution of FU 31** ***Nephrops*** **LPUE (kg/fishing day) (logbooks and VMS data). FU 31 limits indicated in red in the 2018 map in Figure 12.2.2a. Red points:** ***Nephrops*** **LPUE > 0 kg/fishing day, green:** ***Nephrops*** **LPUE = 0 kg/fd. FU 31 TAC was zero for the period 2017-2021.**

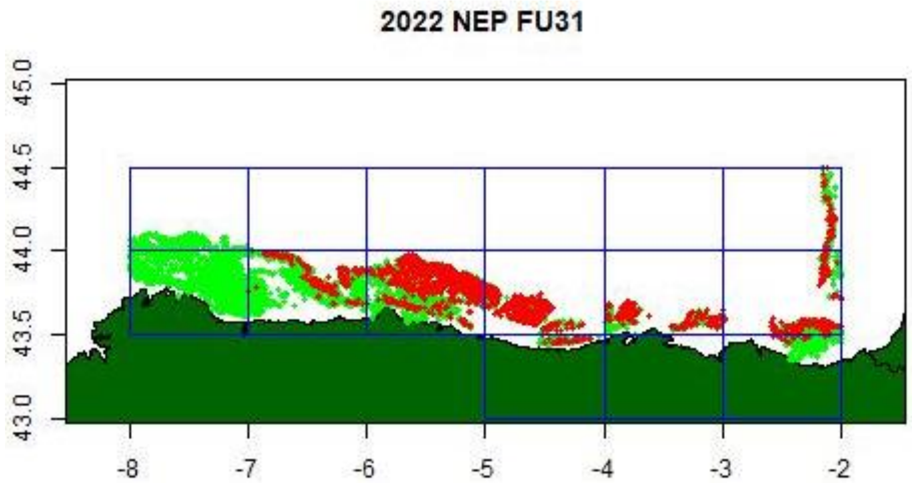

Figure 12.2.2c. ***Nephrops*** **in FU 31, southern Bay of Biscay and Cantabrian Sea. Distribution of FU 31** ***Nephrops*** **LPUE (kg/fishing day) (logbooks and VMS data). Red points:** ***Nephrops*** **LPUE > 0 kg/fishing day, green:** ***Nephrops*** **LPUE = 0 kg/fishing day.**

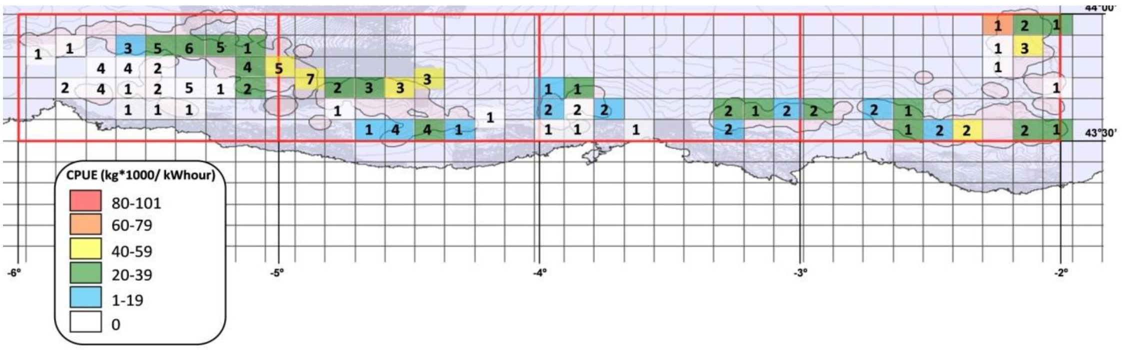

Figure 12.2.2d. ***Nephrops*** **in FU 31, southern Bay of Biscay and Cantabrian Sea. Sentinel Fishery 2019–2021. Numbers in the cells: number of hauls with observed on board carried out in each cell. Colors of the cells:** ***Nephrops*** **CPUE in grammes/kWhour. Pink patches:** ***Nephrops*** **area.**

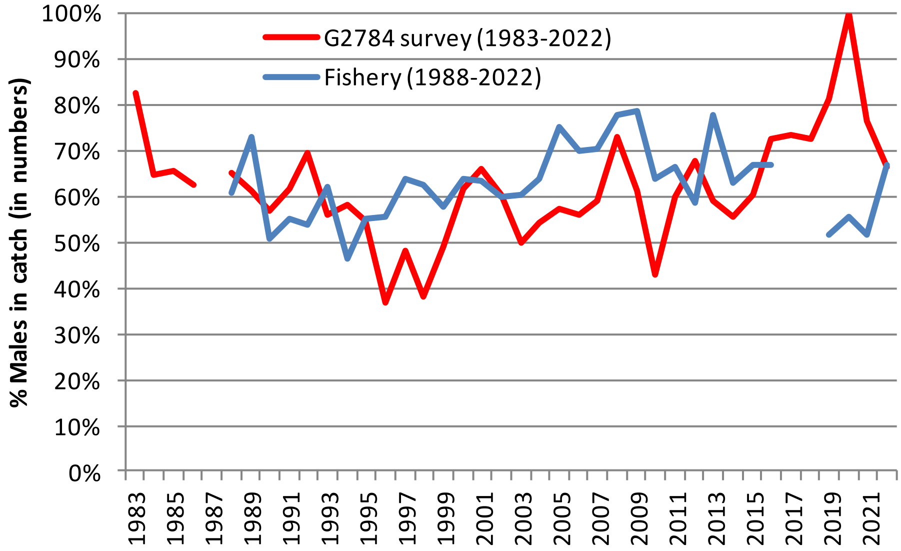

Figure 12.2.2e. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. Catches proportion of males (1983–2021) from the SpGFS-WIBTS-Q4 (G2784) survey (red) and from the commercial and Sentinel fishery (blue).

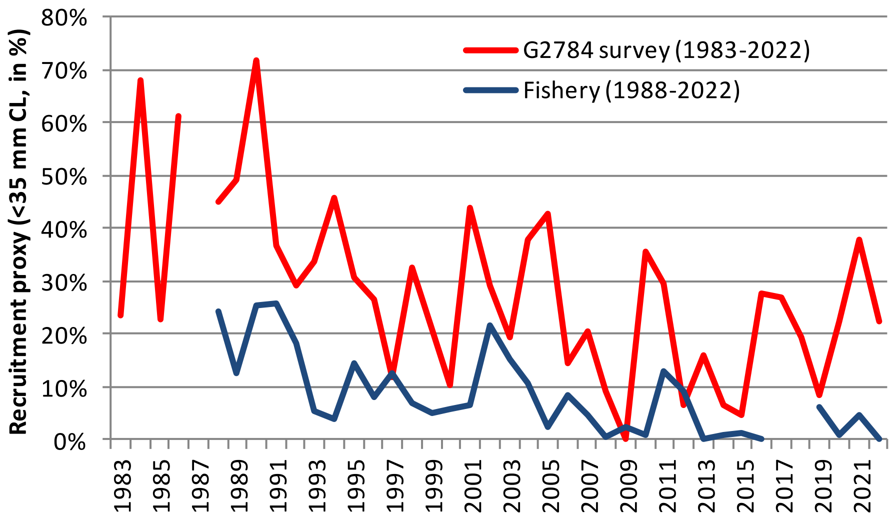

Figure 12.2.2f. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. Recruitment proxy. Blue line = Commercial fleet (1988–2016) and Sentinel fleet (2019–2021). Red line = SpGFS-WIBTS-Q4 (G2784) survey (1983–2021).

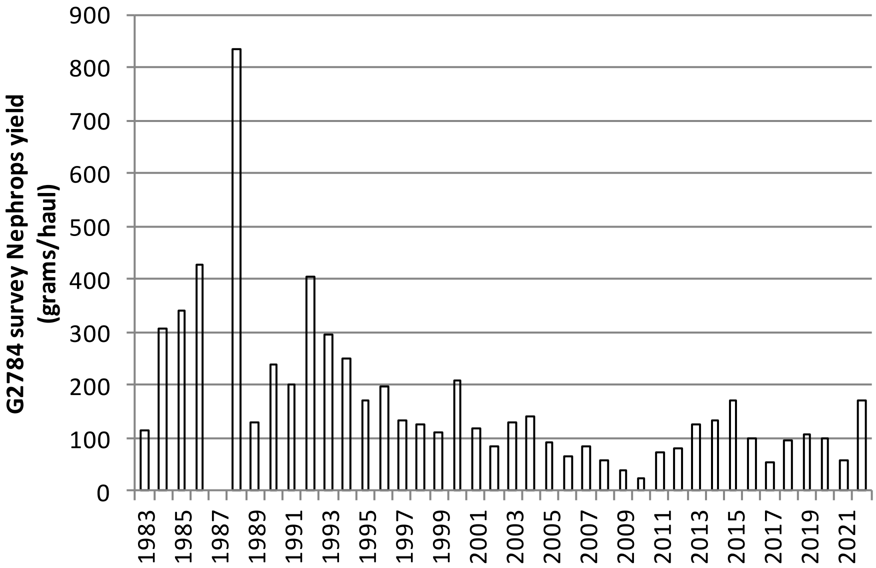

Figure 12.2.3. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. *Nephrops* CPUE (grammes/haul) from SpGFS-WIBTS-Q4 (G2784) survey (1983–2022). No survey was carried out in 1987.

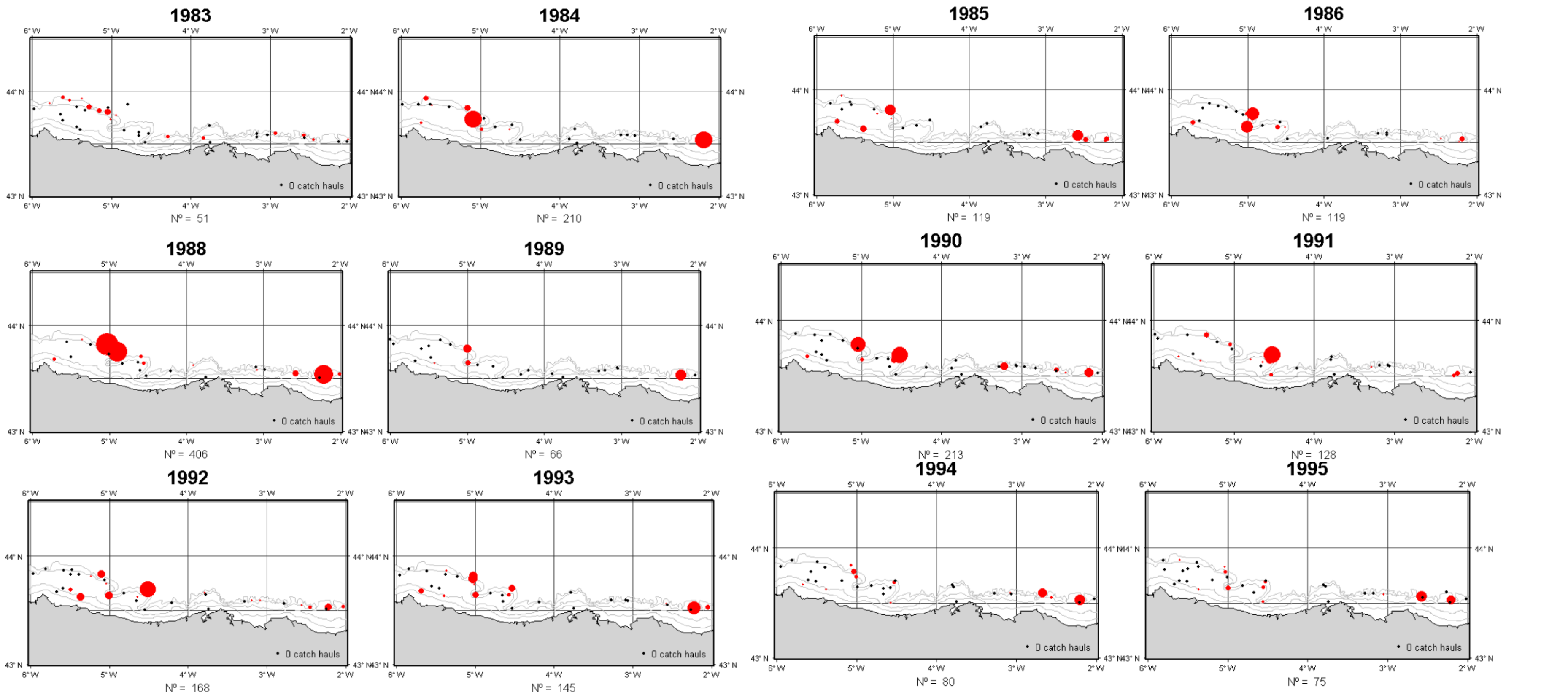

Figure 12.2.4a. ***Nephrops*** **in FU 31, southern Bay of Biscay and Cantabrian Sea. CPUE (kg/haul) from SpGFS-WIBTS-Q4 (G2784) survey. Black points: zero kg of** ***Nephrops*** **by haul. No survey was carried out in 1987. Higher CPUEs period (1983–1995).**

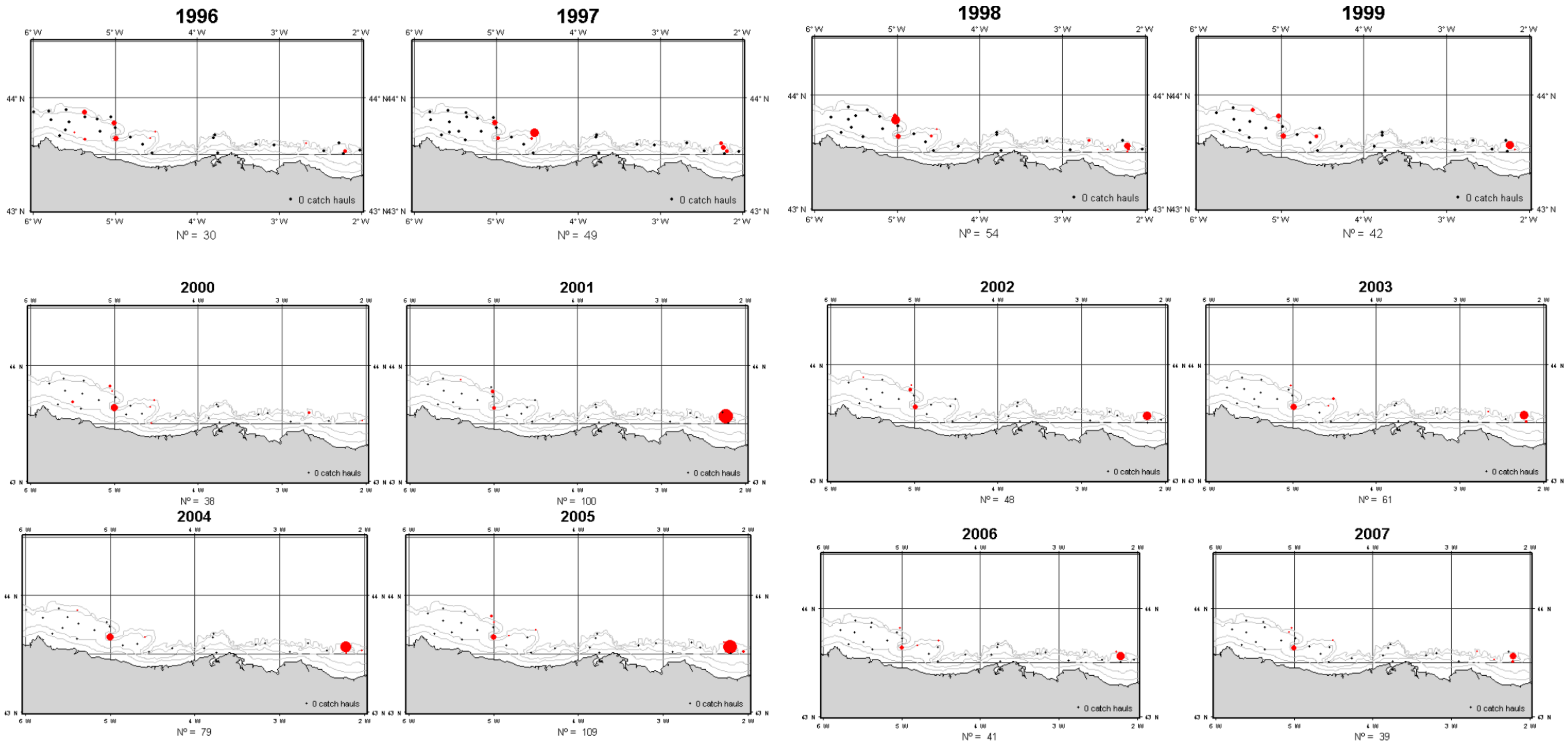

Figure 12.2.4b. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. CPUE (kg/haul) from SpGFS-WIBTS-Q4 (G2784) survey. Black points: zero kg of *Nephrops* by haul. Lower CPUEs, eastern patch prevalence.

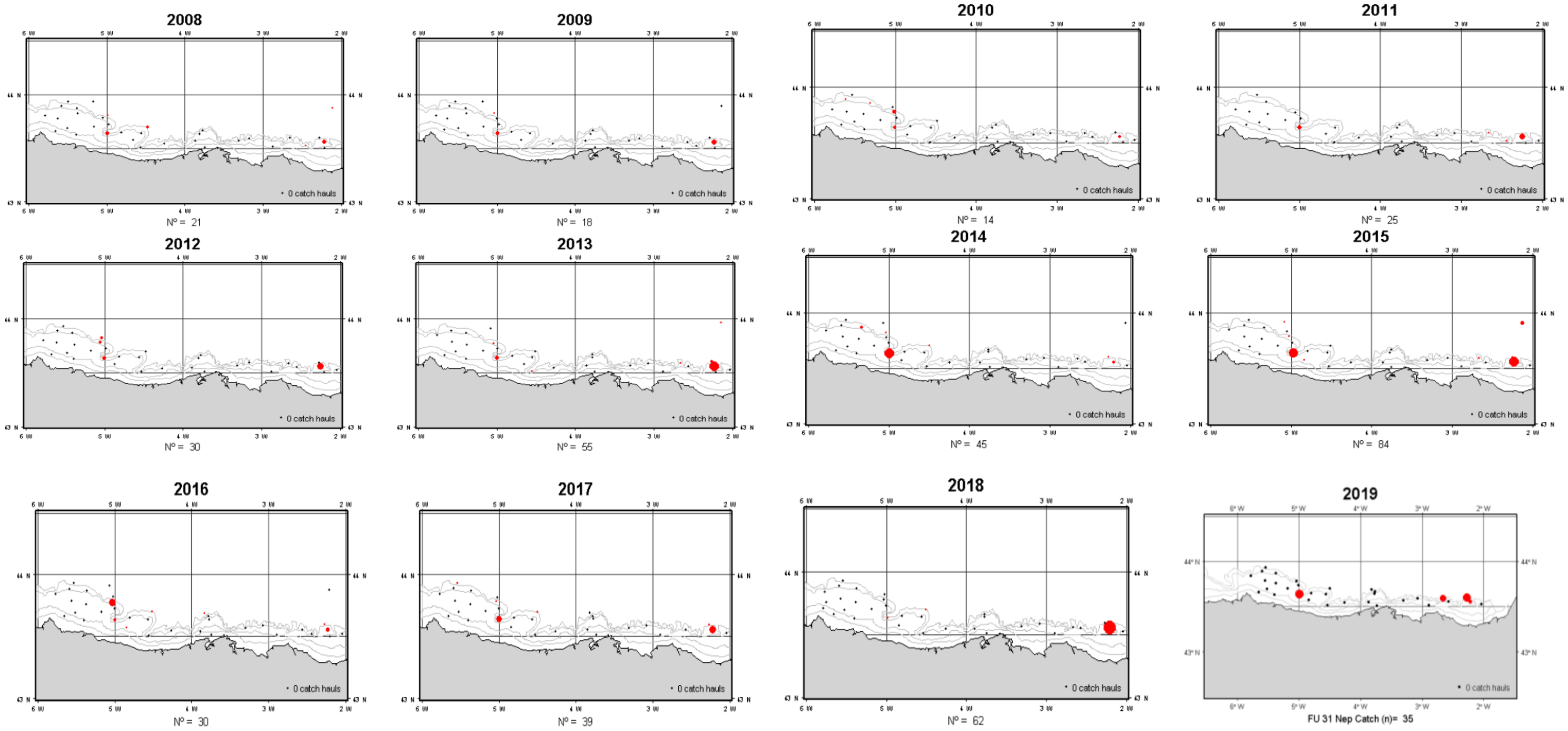

Figure 12.2.4c. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. CPUE (kg/haul) from SpGFS-WIBTS-Q4 (G2784) survey. Black points: zero kg of *Nephrops* by haul. Lower CPUEs.

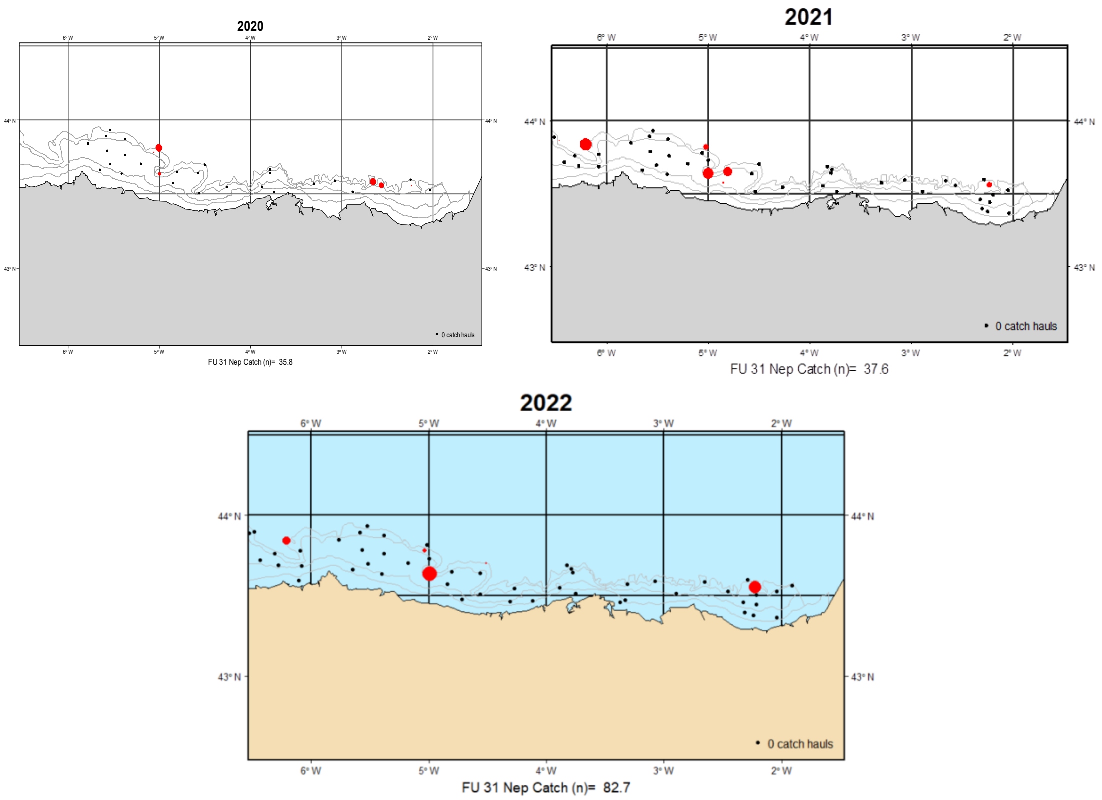

Figure 12.2.4d. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. CPUE (kg/haul) from SpGFS-WIBTS-Q4 (G2784) survey. Black points: zero kg of *Nephrops* by haul. Lower CPUEs.

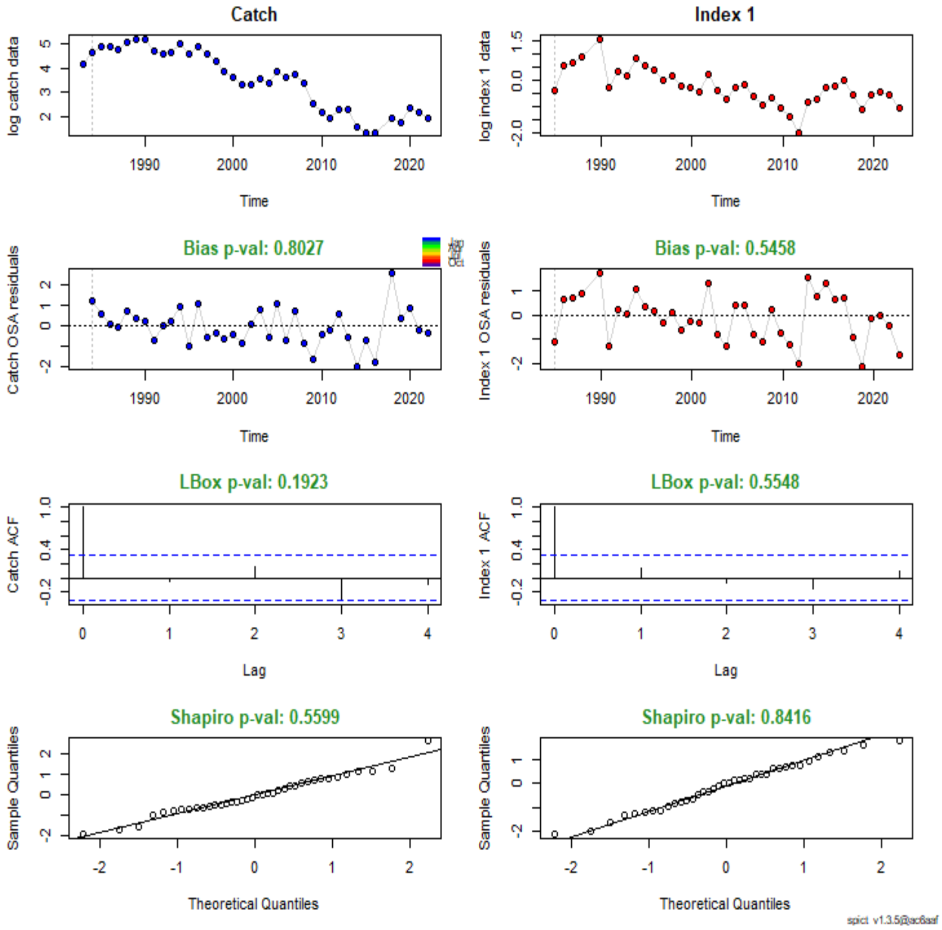

Figure 12.2.5. *Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. SPiCT diagnostics. Row1: Log of the input dataseries. Row 2: OSA residuals with the p-value of a test for bias. Row 3: Empirical autocorrelation of the residuals with tests for significant autocorrelation. Row 4: Tests for normality of the residuals, QQ-plot and Shapiro test.

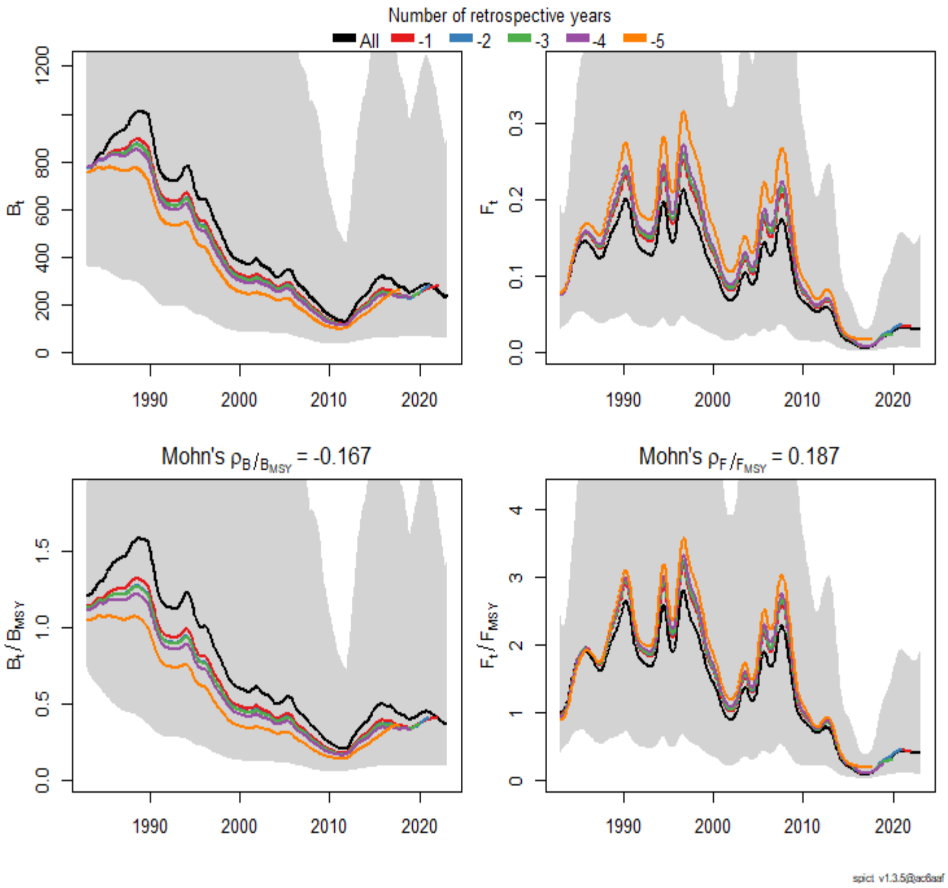

Figure 12.2.6. ***Nephrops*** **in FU 31, southern Bay of Biscay and Cantabrian Sea. Retrospective patterns.**

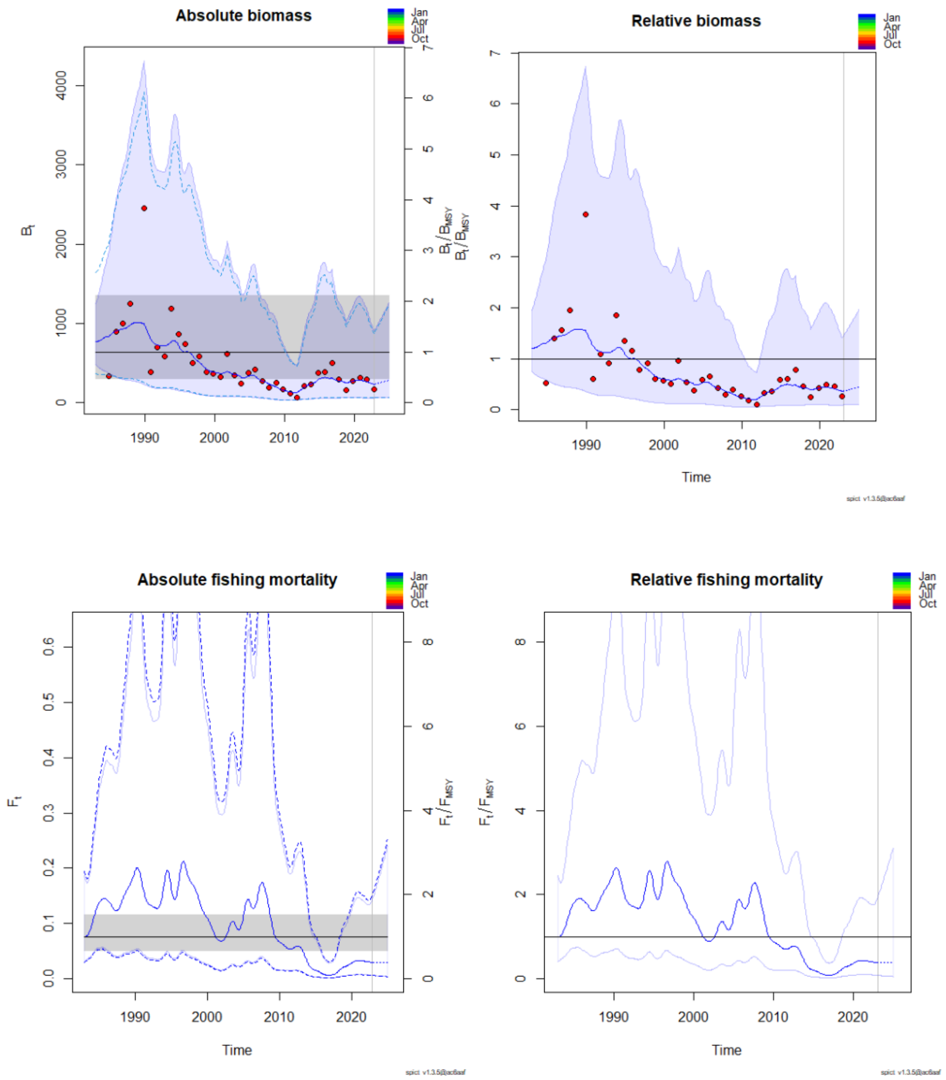

Figure 12.2.7.*Nephrops* in FU 31, southern Bay of Biscay and Cantabrian Sea. Absolute and relative biomass and fishing mortality. Solid (blue) lines indicate median values and shaded areas indicate 95% confidence intervals (CI). Horizontal lines denote fisheries reference points.

12.3 Summary for Division 8.c

Atlantic *Nephrops* landings from the Iberian Peninsula (ICES divisions 8.c and 9.a) have been decreasing by about 93% from 1978 to 2014 (Figure 12.3.1). Separate 8.c and 9.a landings have different magnitudes but present similar trends in the period 1983–1999 (Figure 12.3.2).

Division 8.c includes FU 25 (North Galicia) and FU 31 (southern Bay of Biscay and Cantabrian Sea) and is shown in Figure 1.2. In 2022 FU 25 accounts for 56% of the Spanish *Nephrops* catch in Division 8c (Table 12.3.1 and Figure 12.1).

The significantly low levels of catches from FU 25 and FU 31 coupled with the decreasing LPUE trends indicate that both stocks are in very poor condition. TAC in Division 8.c was zero catch for the period 2017–2021. For 2022, *Nephrops* in FU 25 has zero TAC and in FU 31 a TAC of 20 t. However, special quotas were authorized for FU 25 since 2017 to 2022 and FU 31 since 2019 to

201 for the Sentinel fishery to collect some data for the estimation of a commercial abundance index.

Low quantities of males in a *Nephrops* stock could be related to high fishing pressure since females are protected in burrows for most of the year (Fariña Pérez, 1996). In worst cases, low quantities of males could affect mating (ICES, 2013) and consequently recruitment in subsequent years. The percentage of males in the Spanish "Demersales" trawl survey (SpGFS-WIBTS-Q4 (G2784)) in Division 8.c from 1983 to 2018 fluctuates around 55%, with the lowest values observed in 1998 and 2004 (Figure 12.3.3).

Increase in mean length could be related to poor recruitment. In Division 8.c, *Nephrops* mean length from SpGFS-WIBTS-Q4 (G2784) showed an increasing trend from 1983 to 2008 (Figures 12.3.4, 12.1.4b and 12.2.3e). Atlantic Iberian Northern *Nephrops* stocks mean length in landings also showed an increasing trend until 2009–2011 (Figures 12.1.1, 12.14b, 12.2.2 and 12.2.3e). Both the landings and CPUE decreased in the fisheries. The decreasing F together with an increase in mean size could be related to global processes (e.g. Teixeira *et al*., 2014) occurring in this division. The resilience of the different stocks to these processes could be related to their different population and/or fishery characteristics (fishing pressure, stock density and size, etc.) and local/punctual events (*Nephrops* larvae mortality, etc.).

12.3.1 References

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12.3.2 Table and figures

Table 12.3.1. *Nephrops* in Division 8.c. Landings and discards (tonnes). *Nephrops* TAC in 8.c was zero for the years 2017–2022.

Year	FU25		FU 31		8c Outside FUs		Total 8c
	Landings	Discards	Landings	Discards	Landings	Discards	
1975	743						743
1976	578						578
1977	828						828
1978	706						706
1979	475						475
1980	532						532
1981	318						318
1982	431						431
1983	433		63				496
1984	515		100				615
1985	477		128				605
1986	398		127				525
1987	412		118				530
1988	445		151				596
1989	405		177				582
1990	335		174				509
1991	453		109				562
1992	428		94				522
1993	274		101				375
1994	246		148				394
1995	275		94				369
1996	209		129				338
1997	219		98				317
1998	103		72				175
1999	124		48				172
2000	81		37				118
2001	147		27				174
2002	143		27				170
2003	89		35		30		154
2004	75		29		10		114
2005	63		48		12		123
2006	62		37		11		110
2007	67		43		2		112
2008	39		29		1		69
2009	23		13		0		36
2010	34		9		5		47
2011	46		7		1		54
2012	13		10		2		25
2013	11		10		4		25
2014	10		5		0		15
2015	14		4		1		19
2016	13		4		3		20
2017*	2*		0		0		2
2018*	2*	0	0	7	0	0	10
2019*	3*	1	1*	6	0	3	12
2020*	2*	1	1*	10	0	0	13
2021*	2*	1	1*	8	0	0	12
2022*	2*	7	7	0	0	0	15

* *Nephrops* TAC was zero in 8c (FU 25 & FU 31) in 2017-2021 and in 2022 for FU 25 but there were *Nephrops* Sentinel Fisheries in FU 25 in 2017-2022 and FU 31 in 2019-2021.

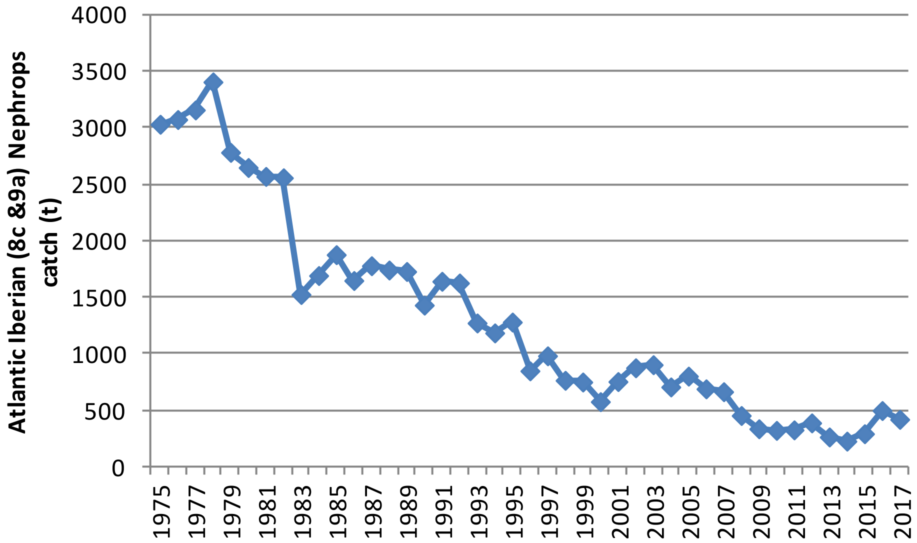

Figure 12.3.1. Atlantic Iberian (8.c+9.a) *Nephrops* landings (t) for the period 1975–2017.

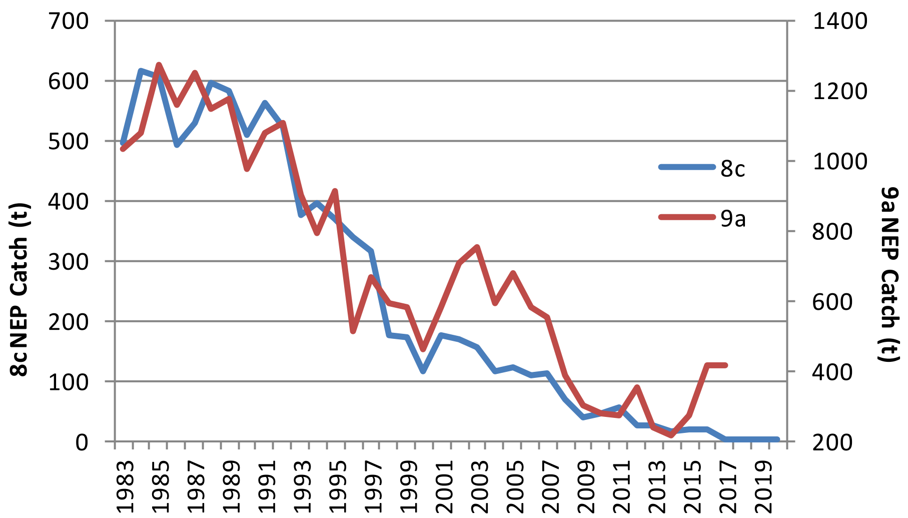

Figure 12.3.2. 8.c and 9.a *Nephrops* landings (t) for the period of 1983–2020.

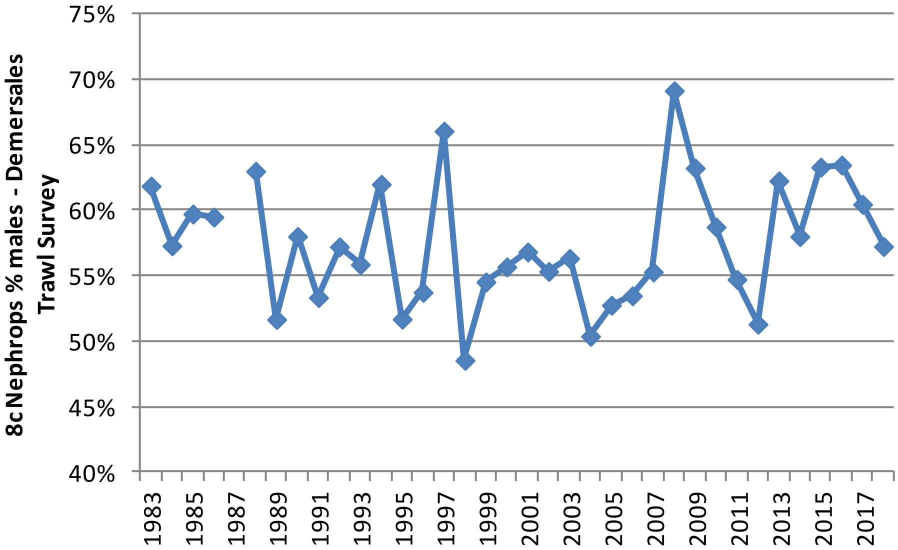

Figure 12.3.3. *Nephrops* in Division 8.c. Percentage of males from the whole Spanish "Demersales" Trawl Survey, SpGFS-WIBTS-Q4 (G2784), for the period of 1983–2018.

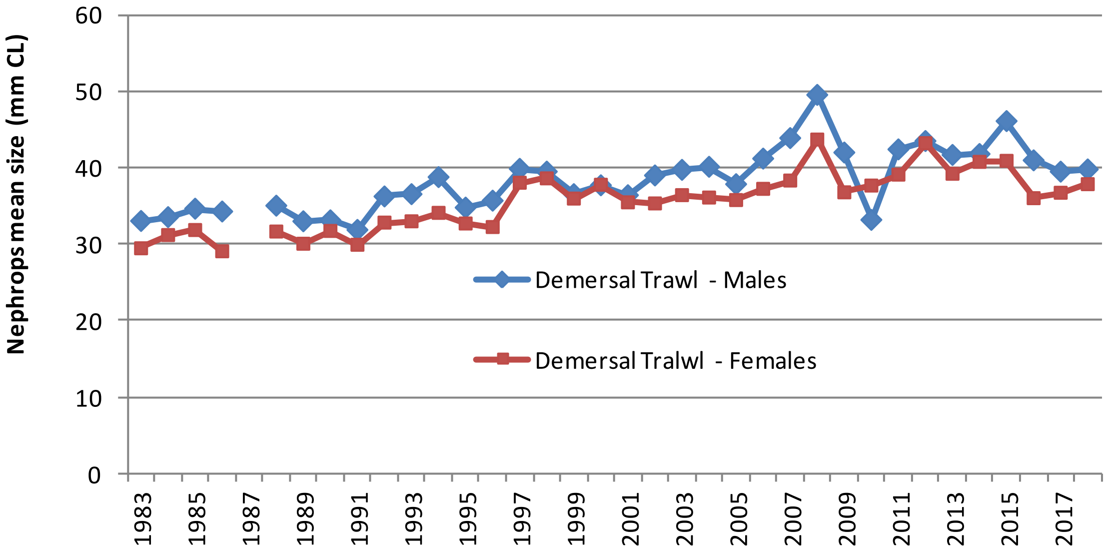

Figure 12.3.4. *Nephrops* in Division 8.c. Mean sizes from the whole Spanish "Demersales" Trawl Survey (SpGFS-WIBTS-Q4 (G2784)) from 1983 to 2018.

13 Norway lobster in Atlantic Iberian waters East, western Galicia, northern, southwestern and southern Portugal, and Gulf of Cádiz

nep.fu.2627 , nep.fu.2829 , and nep.fu.30 – *Nephrops norvegicus* in Division 9.a, Functional Units 26–30

The ICES Division 9.a has five Nephrops Functional Units (FUs): FU 26, West Galicia; FU 27 North Portugal; FU 28, Alentejo, Southwest Portugal; FU 29, Algarve, South Portugal; and FU 30, Gulf of Cádiz.

13.1 *Nephrops* in western Galicia and northern Portugal (FUs 26–27)

Nephrops in FUs 26–27 was recently benchmarked during the WKMSYSPiCT in 2021 (ICES, 2021a). The Surplus Production in Continuous Time (SPiCT) model (Pedersen and Berg, 2017) was implemented and accepted to produce MSY advice, thus upgrading the stock to a category 2.

13.1.1 General

13.1.1.1 Ecosystem aspects

See the Stock Annex.

13.1.1.2 Fishery description

See the Stock Annex.

13.1.2 ICES advice for 2023, 2024 and 2025 and management applicable to 2022 and 2023

13.1.2.1 ICES advice for 20232, 2024 and 2025

For *Nephrops* in FUs 26–27, ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch for each of the years 2023, 2024 and 2025.

13.1.2.2 Management applicable to 2022 and 2023

A recovery plan for the southern hake and Iberian *Nephrops* stocks has been implemented since the end of January 2006. The aim of the recovery plan was to rebuild the stocks within 10 years, with a reduction of 10% in F relative to the previous year and the TAC set accordingly (EU, 2005). This plan was based on the precautionary reference points for the southern hake stock. In March 2019, the European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019a) and repealed the previous recovery plan. This plan applies to demersal stocks including *Nephrops* in ICES Division 9.a, which cover the *Nephrops* in FUs 26-27.

In order to further reduce F on *Nephrops* stocks in this division, seasonal fishing restrictions were imposed on the trawl and creel fisheries during the peak of the *Nephrops* fishing season in two boxes located in FUs 26 and 28. These boxes are closed for *Nephrops* direct fishing from June to August and from May to August, respectively (EU, 1998 amended by EU, 2005). A new regulation on technical measures was implemented in 2019 (EU, 2019b) which repealed the CR(EC) No 850/98 (EU, 1998) but kept the fishing restrictions in the two boxes, thus, the *Nephrops* is only fished as bycatch.

The TAC set for the whole Division 9.a was 355 t for 2022 and 298 t for 2023, respectively. However, no catch is allowed in 2022 and 2023 in FUs 26 and 27. In FU 30, *Nephrops* fishing is allowed but not more than 50 t in 2022 and 32 t in 2023. In the current Management Plan for Western Waters that was applied from 2020 onwards, no effort limitations were established.

A Fishing Plan for the Northwest Cantabrian ground was established in 2013 (BOE, 2013) and modified in 2014 (BOE, 2014). These regulations establish a quota assignment system for several stocks (including *Nephrops*) by vessel.

13.1.3 Data

13.1.3.1 Commercial catches and discards

Spanish landings are based on sales notes which are compiled and standardized by IEO-CSIC. Since 2013, trips from sales notes were combined with their respective logbooks which allowed the georeferencing of catches. During the same year, the Spanish concurrent sampling is used to raise the FUs 26–27 observed landings to total effort by *métier*. When the estimated landings exceed the official landings, the difference is provided to InterCatch as non-reported landings.

Landings in these FUs are reported by Spain and, in minor quantities, by Portugal. The catches are taken by the Spanish fleets fishing along the coast of western Galicia (FU 26) and northern Portugal (FU 27) fishing grounds, and by the artisanal Portuguese fleet fishing on FU 27. *Nephrops* represents a minor percentage in the composition of total trawl landings and can be considered as bycatch despite being considered a very valuable species.

Considering the whole 1975–2022 landings time-series for both FUs and countries combined, two periods can be distinguished (Figure 13.1.1). During 1975–1989, the mean landing was 680 t fluctuating approximately between 575 and 800 t. From 1990 onwards, there has been a marked downwards trend in landings, being above 50 t from 2005 to 2011 and below 10 t since 2012. Landings remained minimal and not even reaching 10 t since that year. The lowest value (2 t) of the whole series was recorded in 2015 and 2018. Landings in 2022 were 4 t.

Table 13.1.1 shows the total landings time-series in FUs 26 and 27 by FU and country. Information about discards sampling was sent to WGBIE through InterCatch although no discards are recorded in these FUs. Differences between landings in both FUs diminished with FU 27 recording higher landings despite remaining stable at low levels. Landings in FU 27 represent in the last three years 74%, 81% and 98% in 2020, 2021 and 2022, respectively.

The landings time series consists mainly from removals by mostly the Spanish fleets in FU 26, coupled with smaller quantities taken from FU 27. However, no distinction was made between these two FUs before 1996 and, therefore, these FUs were combined together. Overall, Spanish landings recorded in both FUs has been continuously decreasing in the time-series. From 2005 onwards, Spanish landings from both FUs were of the same order of magnitude. In 2022, Spanish landings were less than 1 t in each of the FU.

Total Portuguese landings from FU 27 increased in the 1984-1988 period. Afterwards, landings have decreased from almost 100 t in 1988 to 17 t in 1996. During the 1997–2004 period, landings decreased to a mean value of 7 t but a slight increase was observed from 2005 to 2009 (mean value of 11 t). From 2010 onwards, landings decreased to the lowest values in 2018 (ranging from 0 to 3 t). Portuguese landings in 2019 increased to 4 t which then decreased to 2 t for each of the years 2020 and 2021. In 2022, Portuguese landings in FU 27 increased to about 50% in relation to previous years (4 t).

13.1.3.2 Biological sampling

The sampling levels for 2022 are shown in section 1 of this report.

Mean size (carapace length, CL) for both sexes showed an increasing trend from 2001 to 2010 with the highest value recorded in 2010 for both males (52.0 mm CL) and females (43.7 mm CL) (Figure 13.1.1). In contrast, mean CL declined in both sexes in the period 2011–2013 (40.1 mm CL and 31.6 mm CL in 2013 for males and females, respectively). However, mean sizes show an oscillating trend again since 2014. No length frequencies distributions (LFDs) for both sexes were available in 2017 and 2018. Sampling was only partially conducted in 2020 because of the COVID-19 disruptions and administrative issues (ICES, 2021b). Only two of *Nephrops* samplings were carried out during the third quarter of 2020. Information obtained from these samples were deemed not representative of the stock size composition and, therefore, were not considered (ICES, 2021b). In 2022, the mean size for males was 54.0 mm CL and for females 45.2 mm CL, the highest value recorded in the time-series. The continuous increase of the mean sizes in both sexes indicates a possible failure in the recruitment. Annual length compositions for males and females combined, mean size and mean weight in landings for the period 1988–2022 are given in Tables 13.1.2a and 13.1.2b and Figures 13.1.2a and 13.1.2b, respectively.

13.1.3.3 Commercial catch-effort data

Fishing effort and LPUE estimates are available for the Marin trawl fleet (SP-MATR) for the period 1990–2022 (Table 13.1.3; Figure 13.1.1). It was not possible to estimate the LPUE in 2020 because of the COVID-19 pandemic disruptions and administrative problems which affected the sampling programs (ICES, 2021b). However, it should be noted that the overall trends for the SP-MATR effort and LPUE time-series are decreasing. Fishing effort has remained at very low levels since 2010 and values below 400 trips since 2015. LPUE indices are also very low since 2012, with values lower than 1 $kg.trip^{-1}$ since 2014, indicating that the biomass of the stock in these FUs is very low. The fishing effort for 2022 was 352 trips, the lowest value recorded in the time series and LPUE was about 1 $kg.trip^{-1}$ for each of the years 2021 and 2022.

Time-series of fishing effort and LPUE of the bottom trawl fleets landing their catches in the Spanish local ports of Muros (1984–2003), Riveira (1984–2004) and Vigo (1995–2008 and 2010) are also available. These data are plotted in Figure 13.1.1 for complementary information.

13.1.4 Biomass index from surveys

13.1.4.1 International bottom trawl surveys

The Spanish International Bottom Trawl Survey-Q4 (SpGFS-WIBTS-Q4, G2784) covers the northern Spanish shelf in ICES Division 8.c and the northern part of 9.a, including the Cantabrian Sea and off Galicia waters from 70 m to 500 m of depth (Figure 13.1.3). This survey usually starts at the end of the third quarter (September) and finishes in the fourth quarter of the year. Time-series is available for the period 1984–2022. No survey was carried out in 1987. This survey is designed to estimate demersal species abundance but it could be used for the analysis of the *Nephrops* abundance trends. In the past, the abundance index survey was estimated for the whole surveyed area and not by FU. Data from this survey was used to estimate a *Nephrops* index for all ICES statistical rectangles (14E0, 13E0, 13E1) in FU 26 (West Galicia). This survey index time-series was presented for the first time in WGBIE 2020 (ICES, 2020) and it was expressed as the mean biomass or abundance per haul (mean kg per haul and mean number of individuals per haul). During the WKMSYSPiCT workskop (ICES, 2021a) in 2021, this index was not considered appropriate as depth was not considered in the estimation which raised an uncertainty issue as to the quality of the index. Based on the depth stratification and the total area in FU 26, a new survey index was estimated and standardized to one hour based on the SpGFS-WIBTS-Q4 (G2784) data during the WKMSYSPiCT benchmark (ICES, 2021a) in 2021.

This survey index shows an increasing trend from 1986 to 1991 (Figure 13.1.4) and was the period when the highest value was recorded (3.5 kg/h). The *Nephrops* index decreased in 1994 (0.1 kg/h) and fluctuated up to 2001 (0.6 kg/h). In 2002, the biomass index decreased and remained at very low levels onwards. The mean value in the 2001–2022 period was 0.05 kg/haul. In 2022, no *Nephrops* was caught in any of the hauls conducted during the SpGFS-WIBTS-Q4 (G2784) survey, so the biomass index was zero (Table 13.1.4 and Figure 13.1.4).

The Portuguese International Bottom Trawl Survey Q4 (PtGFS-WIBTS-Q4, G8899) is carried out in Division 9.a during autumn (October), covering the Portuguese continental waters from 20 to 500 m of depth (Figure 13.1.3). The abundance index is available from 1989 to 2022. The survey was not carried out in 2019 as a consequence of external administrative issues then again in 2020 as a result of the COVID-19 disruptions (ICES, 2021b). The main objective of the PtGFS-WIBTS-Q4 (G8899) survey is to estimate the abundance of the most important commercial fish species in the Portuguese trawl fishery. *Nephrops* biomass index in FU 27 from the depth-stratified PtGFS-WIBTS-Q4 (G8899) survey, was estimated using hauls included in the ICES statistical rectangles corresponding to FU 27 (6E0–12E0) during the WKMSYSPiCT benchmark (ICES, 2021a).

The biomass index was almost zero g/h at the beginning of the time-series (1985–1988 period). After that, the *Nephrops* biomass index increased but has greatly fluctuated up to 2000. In 2001, the PtGFS-WIBTS-Q4 (G8899) survey index decreased and it has remained at about zero g/h until the only peak in the time series, although not very high, was observed in 2015 (Table 13.1.4 and Figure 13.1.4). In 2022, the biomass index had increased slightly. It should be noted that a few amounts of *Nephrops* was caught in a unique haul during the survey in the Berlengas (BER) strata.

Figure 13.1.5 shows the sector areas from Spanish (SpGFS-WIBTS-Q4, G2784) and Portuguese (PtGFS-WIBTS-Q4, G8899) IBTS-Q4 surveys occur, covering FUs 26 and 27, respectively. *Nephrops* is mainly distributed in the Miño-Fisnisterre sector (GAL) in FU 26 from about 100 to 700 m depth and the Caminha sector (CAM) in the northern part of FU 27 from 100 to 500 m depth (Table 13.1.4). In the rest of the FU 27, *Nephrops* patches occur particularly in the deepest stratum of the Figueira da Foz sector (FIG) and in a higher bathymetric range of the Berlengas sector (BER). In the Lisbon sector (LIS), *Nephrops* is present in a small patch in front of Cascais where water depth is about 350 m.

The annual spatial distribution of *Nephrops* biomass index in FUs 26–27 for the entire time-series is shown in Figure 13.1.6a and Figure 13.1.6b where a declining trend of the biomass index since 1983 as well as of the *Nephrops* patches in FUs 26–27 are clearly apparent.

A new depth-stratified biomass index was estimated from the combined Spanish (SpGFS-WIBTS-Q4, G2784) and Portuguese (PtGFS-WIBTS-Q4, G8899) IBTS surveys-Q4. This combined IBTS-Q4 index survey, referred to by the ICES code G2784_ G8899, was estimated based on the area and depth strata for the total area covering FUs 26–27 during the WKMSYSPiCT benchmark (ICES, 2021a) and considers the following area/sectors: Miño-Finisterre (GAL), Caminha (CAM), Matosinhos (MAT), Aveiro (AVE), Figueira da Foz (FIG), Berlengas (BER) and Lisbon (LIS) (Figure 13.1.4; Table 13.1.4) as parts of a unique survey and taking into account the area corresponding to each stratum of depth. *Nephrops* weight by haul was standardized to one hour.

It should be noted that the Spanish (SpGFS-WIBTS-Q4, G2784) and Portuguese (PtGFS-WIBTS-Q4, G8899) IBTS-Q4 surveys each use different vessels and gears so catchability could also be different for some species. The Portuguese (PtGFS-WIBTS-Q4, G8899) survey is not suitable for flatfish, anglerfish and probably *Nephrops*. However, no weight has been applied to each of these surveys in order to standardize the *Nephrops* biomass index. Fishery knowledge suggests that the main *Nephrops* fishing grounds are in FU 26 and a small part in north Portugal near the Spanish border, in FU 27, which are exploited by the Spanish trawl fleet. Therefore, the combined biomass index trend should not be very different.

The combined G2784_ G8899 IBTS-Q4 survey index increased from 1983 to 1991, when the highest value of the time-series (0.17 g/h) was recorded. Then a decreasing trend was observed from 1992 to 1994 (0.01 g/h). In 1995, *Nephrops* biomass index increased again and after that, it has fluctuated at low levels up to 2001 (0.03 g/h). The combined G2784_ G8899 IBTS-Q4 survey biomass index value has been at a minimal level since 2002.

13.1.4.2 Trawl surveys with the fishing industry

Marine Fishing Industry (Productores de Pesca Fresca del Puerto y la Ría de Marín; OPROMAR) did a survey using a commercial vessel with an observer onboard under the IEO supervision in order to estimate *Nephrops* abundance index in FU 26. The survey is hereinafter referred to as GALNEP-26. From 2019 to 2021, this survey was conducted in summer (July–August) since this is the peak of the *Nephrop*s fishing season when both males and females are accessible to the gear as a result of their reproductive behaviour. No survey was conducted in 2022 when the zero-TAC advice for *Nephrops* was applied and fishery was closed. The survey design followed a systematic sampling over a 5x5 nm grid over the historical *Nephrops* distribution area estimated using VMS linked to logbooks and sediment information (Vila *et al.*, 2020). In 2019, the GALNEP-26 survey index was estimated at 0.74±0.58 kg/h with a 95% confidence interval. This index increased (1.82±1.86 Kg/h) in 2020 then decreased (0.95 ± 1.31 Kg/h) again in 2021. Figure 13.1.7 shows the *Nephrops* biomass index spatial distribution in FU 26. *Nephrops* represented about 1% of the total retained catch while the discard rate was zero for each of the years 2019 and 2020 then was considered negligible in 2021. The spatial analysis of the survey index indicates that *Nephrops* is concentrated in a small area on the Northwestern half of the original distribution area of FU 26 (Figure 13.1.7). Despite the very low catches in 2021, the *Nephrops* spatial distribution has spread to the southern part of the survey area. The mean lengths were similar to values observed in 2019 and 2020 for both sexes (39.9 mm CL for females and 43.9 mm CL for males) (ICES, 2021b). However, a slight decline of the females mean size was observed in 2021 (Table 12.1.5). Figure 13.1.8 shows the LFDs by sex for the entire time-series.

13.1.5 Assessment

This stock was benchmarked during the WKMSYSPiCT workshop in February 2021 (ICES, 2021a). The Surplus Production in Continuous Time (SPiCT) model (Pedersen and Berg, 2017; Mildenberger et al., 2020) was implemented and this assessment model was accepted to produce an advice based on the MSY approach, upgrading the stock to category 2. The latest advice for a category 2 stock was given in 2022 and is considered valid for each of the years 2023, 2024 and 2025 (ICES, 2023). The stock data were updated with the new information for 2022 and the assessment process was done following the new ICES guidelines for category 2 stocks (ICES, 2022a). The 2023 assessment indicates that *Nephrops* in FUs 26 and 27 is depleted, similar in 2022. Therefore, the perception of the stock did not change since the assessment in 2022 (ICES, 2022b).

13.1.6 Quality considerations

The combined G2784_ G8899 IBTS-Q4 survey biomass index was estimated using a Bayesian hierarchical model that takes into account the spatial-temporal analysis. This work was presented during the WKMSYSPiCT benchmark in 2021 (ICES, 2021a). However, the model-based index used an autoregressive process to estimate the time-trend which implies that the resulting indices by year are not independent of each other, thus, giving an appearance of a smoother time-series as opposed to when the year effects are treated independently. Using such index as data in an assessment model that assumes that each data point is independent of the others is undesirable. Therefore, it was recommended to use the independent year effects to estimate the index in a model-based approach. A simpler approach to estimating a new combined G2784_ G8899 IBTS-Q4 index survey based on area and depth was used during the 2023 WGBIE assessment.

13.1.7 Management Considerations

Nephrops is taken as bycatch in a mixed bottom-trawl fishery. Landings of *Nephrops* have substantially declined since 1995. Recent landings represent less than 1% of the average landings in the early period of the time-series (1975–1992). Fishing effort in FUs 26–27 has decreased throughout the time-series.

There is a seasonal fishing closure (June–August) for *Nephrops* in a *box* within West Galicia (FU 26) fishing grounds which was amended in the Council Regulation (EC) No 850/98 (EU, 1998). A regulation on technical measures issued in 2019, Regulation (EU) No 2019/1241 (EU, 2019b), replaced and repealed the CR (EC) No 850/98 but kept the *box* previously defined that allowed only the bycatch fishing of *Nephrops*.

A multiannual management plan (MAP) for the Western Waters has been published by the European Parliament and the Council (EU, 2019a). This plan applies to demersal stocks including *Nephrops* in FUs 26–27 in ICES Division 9.a.

A Fishing Plan for the Cantabrian and Northwest fishing grounds was established in 2013 (BOE, 2013) and modified in 2014 (BOE, 2014). These regulations establish a quota assignment system for several stocks (including *Nephrops*) by vessel.

Unwanted catches from *Nephrops* are regulated by the discard plan for demersal fisheries in southwestern waters for the period 2019–2023 (EU, 2018) which was replaced in 2019 (EU, 2019c) then in 2020 (EU, 2020). Here, an exemption from the landing obligation is applied based on this species' high survival rates. This exemption applies to all bycatches of Norway lobster from ICES subareas 8 and 9 by bottom trawls which are immediately retrieved and released from all discards in the area where they were caught.

13.1.8 References

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13.1.9 Tables and Figures

Table 13.1.1. *Nephrops* in FUs 26–27. Landings (in tonnes) by FU and country.

Year	Spain		Portugal	Total
	FU 26*	FU 27	FU 27	FU 26–27
1975				622
1976				603
1977				620
1978				575
1979				580
1980				599
1981				823
1982				736
1983				786
1984	603		14	617
1985	731		15	746
1986	655		37	692
1987	670		71	741
1988	631		96	727
1989	577		88	665
1990	402		48	450
1991	515		54	569
1992	584		52	636
1993	472		50	522
1994	428		22	450
1995	501		10	511
1996	264	50	17	331
1997	359	68	6	433
1998	294	42	8	344
1999	192	48	6	246
2000	102	21	9	132

Year	Spain		Portugal	Total
	FU 26*	FU 27	FU 27	FU 26–27
2001	105	21	6	132
2002	59	24	4	87
2003	39	26	8	73
2004	38	24	9	71
2005	16	16	11	43
2006	15	17	12	44
2007	20	17	10	47
2008	17	12	13	42
2009	10	17	10	37
2010	9	13	4	26
2011	7	8	4	19
2012	2	4	1	7
2013	1	<1	1	3
2014	<1	<1	1	3
2015	<1	<1	<1	2
2016	1	<1	3	5
2017	<1	<1	2	3
2018	<1	1	0	2
2019	3	1	4	7
2020	1	2	2	5
2021	<1	2	2	4
2022	<1	<1	4	4

Table 13.1.2a. *Nephrops* in FUs 26–27. Length compositions, mean weight (Kg) and mean size (mm CL) in landings for the period 1988–2022. Data were not available in 2017, 2018 and 2020.

Lenght (mm)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
12	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	71	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	69	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	451	110	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	191	289	13	0	0	0	0	0	0	0	0	3	17	0	0	0	0	0	0	0	0	0	0	0
17	0	128	518	17	0	0	7	0	0	0	0	0	3	11	0	0	0	0	0	0	0	0	0	0	0
18	0	683	898	25	0	0	2	1	0	0	0	0	16	19	0	4	0	0	0	0	0	0	0	0	0
19	0	679	1502	38	0	0	0	0	0	0	0	0	38	52	0	4	0	0	0	0	0	0	0	0	0
20	27	1057	2044	97	6	5	10	7	25	3	0	0	86	151	3	29	0	0	0	0	0	0	0	0	0
21	27	1260	2489	199	12	24	19	8	78	0	0	0	119	236	3	27	0	0	1	0	0	0	0	0	0
22	39	1657	2642	398	48	99	84	47	202	12	1	0	129	348	11	11	1	0	1	0	0	0	0	0	0
23	109	1901	3063	568	103	99	77	151	373	26	6	0	127	518	16	31	0	0	0	0	1	0	0	0	0
24	198	1626	2736	1216	284	222	169	338	550	46	7	3	93	466	22	17	1	2	1	0	2	0	0	0	0
25	290	2212	1802	1477	541	381	199	672	906	113	45	15	134	441	35	28	1	2	1	0	3	1	0	0	0
26	574	1675	1451	1516	829	542	289	709	960	184	40	43	145	365	56	22	7	2	2	1	2	1	0	0	0
27	854	1878	1333	1351	926	904	409	933	746	306	80	68	129	419	106	40	18	8	5	2	3	1	0	0	0
28	1272	1560	1319	1940	1079	1017	524	1298	842	402	138	109	123	274	74	46	23	12	8	6	9	4	0	0	0
29	1487	1716	913	1797	1023	987	613	1223	706	489	191	134	143	266	86	60	20	15	13	7	7	9	0	0	0
30	1615	1510	845	1501	1069	1140	767	1371	792	681	295	195	172	252	118	90	31	25	20	12	13	11	0	2	1
31	1960	1106	632	1450	1180	890	802	1378	609	719	359	239	182	209	105	102	27	21	21	13	16	9	1	2	0
32	1951	1472	772	1484	1197	912	847	1491	601	888	411	292	285	220	160	95	49	29	35	23	27	11	2	5	2
33	2288	1313	601	1126	1378	878	898	1444	517	780	525	377	176	201	167	84	56	26	40	47	23	11	2	3	2
34	1581	1299	572	1160	1001	849	853	1255	542	745	551	376	192	156	131	83	56	31	51	43	37	22	5	3	2
35	1487	952	518	1044	915	855	745	963	506	637	569	432	200	148	96	91	53	26	48	46	25	18	4	5	2
36	1161	634	407	879	776	901	611	744	433	527	484	360	176	120	110	85	56	21	42	36	22	15	4	4	1
37	838	545	284	651	627	736	546	580	348	484	417	321	175	143	106	111	70	31	51	49	31	17	7	2	2
38	1196	608	294	616	545	682	621	542	346	534	425	308	128	110	76	72	86	35	61	38	28	20	6	2	2
39	837	451	226	600	505	510	475	425	285	406	292	240	128	85	95	79	65	27	43	36	21	14	6	8	3
40	501	325	199	450	666	573	412	455	284	466	393	218	115	65	76	60	90	24	55	39	32	21	7	7	4
41	428	288	165	375	431	385	321	321	213	399	312	182	112	58	88	48	60	21	40	32	23	16	8	6	4
42	367	287	144	220	362	375	314	214	182	360	249	210	66	57	81	54	101	22	47	43	26	14	6	7	6
43	433	296	156	203	425	307	293	188	165	325	292	219	64	36	76	47	73	25	38	49	25	13	9	7	4
44	164	277	87	136	301	251	200	152	127	290	207	193	61	44	52	33	62	20	32	38	36	13	10	7	4
45	165	286	58	110	303	219	178	125	118	218	196	162	58	42	44	34	56	17	18	29	17	12	8	10	5
46	96	135	23	90	350	153	129	116	94	191	178	152	40	28	49	26	29	20	18	24	18	8	10	11	3
47	94	117	45	82	228	104	92	84	56	123	120	84	38	47	42	31	38	26	18	28	17	8	8	9	4
48	71	100	25	49	222	58	96	55	70	117	147	96	23	18	22	13	28	18	12	15	16	7	7	7	3
49	73	76	29	42	148	84	71	46	23	60	105	64	21	16	15	16	18	13	11	14	9	5	7	7	3
50	83	127	14	46	63	81	69	29	31	81	95	54	17	12	12	15	16	15	13	14	9	9	10	14	3
51	15	48	9	14	71	27	59	13	21	43	59	21	17	6	7	15	7	15	7	7	9	6	4	5	3
52	20	75	14	33	71	21	59	18	22	43	55	30	18	6	7	10	12	10	8	10	9	6	5	5	3
53	23	34	13	26	34	20	28	6	13	30	37	33	5	5	6	10	5	7	6	8	4	6	5	6	2
54	14	10	11	23	23	14	12	6	15	42	28	27	8	3	2	8	4	11	10	6	7	4	5	4	3
55	6	27	1	6	13	17	12	1	9	25	26	12	6	7	3	4	5	8	3	6	6	5	7	5	1
56	6	9	1	5	5	10	5	1	9	14	14	14	7	4	3	5	3	4	2	3	6	6	4	5	1
57	10	5	1	2	6	5	10	0	4	8	12	6	5	3	3	2	2	3	2	4	5	5	3	2	0
58	11	5	1	4	6	5	14	0	3	6	11	5	4	5	4	3	3	4	4	4	5	5	4	2	0
59	7	0	4	0	7	2	7	0	0	2	1	5	3	3	0	1	4	3	1	3	2	2	1	3	1
60	2	0	2	0	4	3	3	0	0	1	2	3	2	2	2	2	7	4	2	1	3	3	4	3	1
61	4	0	1	0	3	2	12	0	0	0	2	0	3	2	0	2	1	14	1	2	1	1	3	2	1
62	2	0	1	0	1	0	7	0	0	0	0	0	1	5	0	2	2	4	2	1	3	2	1	1	1
63	1	0	1	0	3	0	5	0	0	1	0	0	3	3	0	2	1	2	1	1	1	1	2	2	0
64	2	0	1	0	3	1	4	0	0	0	1	0	2	2	0	2	1	1	1	1	2	3	2	2	0
65	2	0	1	0	1	0	2	0	0	0	0	0	1	1	1	1	2	2	1	1	1	2	2	2	0
66	3	0	1	0	1	0	2	0	0	0	1	0	2	2	0	1	0	1	1	1	1	1	1	1	1
67	2	4	1	0	1	1	1	0	0	0	1	0	3	1	0	2	1	2	1	1	1	1	1	1	0
68	2	11	1	0	2	2	6	0	0	0	0	0	2	1	0	2	1	1	2	2	2	1	2	2	0
69	1	4	1	0	1	1	0	0	0	0	0	0	2	1	0	1	1	1	2	1	1	1	1	1	1
70	12	25	1	2	12	6	8	0	1	0	3	0	11	1	1	5	4	8	1	1	4	1	1	1	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	2	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total number (thousand)	22409	31275	29319	23087	17811	15360	12003	17411	11828	10827	7383	5302	3822	5712	2169	1666	1257	638	800	752	569	355	191	191	81
Total weight (t)	727	708	450	603	636	522	448	511	331	432	344	246	132	132	87	72	70	42	44	46	36	25	19	20	8
Mean weight (kg)	0.032	0.023	0.015	0.026	0.036	0.034	0.037	0.029	0.028	0.040	0.047	0.046	0.035	0.023	0.040	0.043	0.056	0.066	0.057	0.061	0.063	0.071	0.099	0.105	0.098
CL Mean length (mm)	34.0	29.1	25.9	31.4	34.5	34.3	35.2	32.9	31.9	36.2	38.1	38.1	33.5	29.5	36.0	36.2	40.2	42.0	40.0	41.3	41.5	42.6	48.4	46.5	46.1

(Continue in the next page)

Table 13.1.2b. *Nephrops* in FUs 26–27. Length compositions, mean weight (Kg) and mean size (mm CL) in landings for the period 1988–2022. Data were not available in 2017, 2018 and 2020 (continued from the previous page).

Lenght (mm)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
12	0									
13	0									
14	0									
15	0									
16	0									
17	0									
18	0									
19	0									
20	0									
21	0									
22	1								0	
23	0								0	
24	0	1							0	
25	0	2	0	1			0		0	
26	0	1	0	0			0		0	
27	0	1	0	0			0		0	
28	0	2	0	1			0		0	
29	0	2	0	2			0		0	
30	1	4	0	4			2		0	
31	1	1	0	0			1		0	
32	1	1	0	2			1		0	
33	1	0	1	2			1		0	
34	1	5	1	3			3		0	
35	1	5	2	5			2		1	1
36	1	2	1	2			3		0	0
37	1	3	1	2			3		0	0
38	1	1	1	3			2		0	2
39	1	2	1	2			3		0	1
40	1	4	3	5			4		1	2
41	1	1	1	1			3		1	2
42	1	1	1	2			2		1	2
43	1	1	2	1			6		1	1
44	0	3	1	3			3		0	3
45	0	3	1	6			5		3	1
46	0	1	0	1			2		1	2
47	0	1	0	3			3		1	1
48	1	1	0	2			3		1	0
49	0	1	0	2			3		1	0
50	0	2	0	3			3		4	1
51	0	0	0	1			1		1	2
52	0	0	0	1			1		1	1
53	0	0	0	1			2		1	1
54	0	1	0	1			1		1	2
55	0	1	0	2			1		2	1
56	0	0	0	0			1		1	0
57	0	0	0	0			0		2	1
58	0	1	0	0			1		0	1
59	0	0	0	0			1		1	0
60	0	1	0	1			1		1	0
61	0	0	0	1			0		1	1
62	0	0	0	0			1		0	1
63	0	0	0	0			1		0	1
64	0	0	0	0			0		0	1
65	0	0	0	0			0		0	1
66	0	0	0	0			0		0	0
67	0	0	0	0			0		0	0
68	0	0	0	0			0		0	1
69	0	0	0	0			0		0	0
70	0	0	0	1			0		0	1
71	0	0	0	0			0		0	1
72	0	0	0	0			0		0	1
73	0	0	0	0			0		1	1
74	0	0	0	0			0		0	1
75	0	0	0	0			0		0	0
76	0	0	0				0		0	0
77	0	0	0				0		0	0
78	0	0	0				0		0	1
79	0	0							0	1
80	0								0	
81	0								0	
82	0								0	
83	0								0	
84	0									
Total number (thousand)	20	60	23	69			72		37	33
Total weight (t)	3	4	2	5			5		4	4
Mean weight (kg)	0.081	0.059	0.087	0.077			0.065		0.118	0.133
CL Mean length (mm)	35.8	39.4	42.0	42.2			45.0		49.7	52

Table 13.1.3. *Nephrops* in FUs 26–27. Landings and LPUE for the SP-MATR fleet.

Year	Landings (t)	trips	LPUE (Kg/trip)
1994	234	2692	87.0
1995	267	2859	93.2
1996	158	3191	49.5
1997	246	3702	66.3
1998	189	2857	66.0
1999	134	2714	49.5
2000	72	2479	28.9
2001	80	2374	33.6
2002	52	1671	31.2
2003	38	1597	24.0
2004	38	1986	19.2
2005	17	1629	10.3
2006	18	1547	11.9
2007	22	1196	18.1
2008	17	980	17.2
2009	7	517	14.1
2010	5	676	7.7
2011	3	513	6.0
2012	1	483	2.1
2013	<1	418	1.0
2014	<1	491	0.8
2015	<1	384	0.8
2016	<1	396	0.8
2017	<1	386	0.3
2018	<1	369	1.1
2019	<1	383	0.3
2020*	na	na	na
2021	<1	381	1.1
2022	<1	352	1.4

***No estimate can be made in 2020 as sampling was only partially conducted as a result of COVID-19 disruptions and administrative issues.**

Table 13.1.4. ***Nephrops*** **in FUs 26–27. Biomass indices from the Spanish (SpGFS-WIBTS-Q4, G2784), the Portuguese (PtGFS-WIBTS-Q4, G8899) IBTS-Q4 surveys in FU26 and FU27, respectively, and the new estimated combined G2784_ G8899 IBTS-Q4 index (in g/h) for both FUs.**

Years	Spanish International Bottom Trawl Survey (G2784)	Portuguese International Bottom Trawl Survey (G8999)							Combined index (G2784-G8999)
	FU26	FU27							FU26-27
	GAL	CAM	MAT	AVE	FIG	BER	LIS	All sectors	
1983	711.11								0.0304
1984	382.53								0.0164
1985	261.67	12.93	4.08	0.00	0.00	12.05	0.00	0.0015	0.0124
1986	866.49	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0371
1987	na	9.20	0.00	0.00	0.00	0.00	0.00	0.0005	na
1988	1488.09	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0636
1989	643.79	53.35	0.00	19.09	0.00	202.68	0.00	0.0144	0.0393
1990	1495.42	293.99	53.66	164.78	5.45	18.31	76.92	0.0322	0.0902
1991	3460.29	377.36	0.00	8.47	0.15	22.69	7.46	0.0218	0.1658
1992	971.21	322.75	0.00	58.89	2.92	23.15	0.00	0.0214	0.0590
1993	239.85	172.87	5.23	10.89	11.36	41.64	0.00	0.0127	0.0206
1994	146.91	5.12	0.00	0.00	0.00	77.87	0.00	0.0044	0.0098
1995	748.55	17.34	0.00	26.54	112.50	592.77	0.00	0.0393	0.0641
1996	117.28	94.06	0.00	0.00	0.00	59.63	0.00	0.0081	0.0116
1997	163.11	187.49	0.00	158.77	1.70	164.28	48.13	0.0294	0.0309
1998	315.49	0.00	0.00	138.11	0.00	56.96	0.00	0.0102	0.0218
1999	359.80	28.00	0.00	0.00	0.00	0.00	0.00	0.0015	0.0166
2000	188.58	35.62	0.00	105.84	2.58	115.32	0.00	0.0136	0.0192
2001	610.60	4.77	0.00	0.00	0.00	63.91	0.00	0.0036	0.0291
2002	59.95	20.00	0.00	0.00	0.00	0.00	0.00	0.0010	0.0034
2003	88.02	35.99	0.00	0.00	9.11	0.00	0.00	0.0024	0.0057
2004	44.56	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0019
2005	15.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0007
2006	78.31	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0033
2007	28.34	0.00	0.00	0.00	4.79	0.00	0.00	0.0003	0.0014
2008	46.64	18.87	0.00	0.00	0.00	0.00	0.00	0.0010	0.0028
2009	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0013
2010	135.44	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0058
2011	20.04	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0009
2012	9.47	na	na	na	na	na	na	na	0.0004
2013	81.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0035
2014	21.39	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0009
2015	28.70	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0012
2016	62.34	0.00	0.00	0.00	0.00	27.32	347.44	0.0197	0.0187
2017	61.16	0.00	0.00	0.00	0.00	88.73	0.00	0.0047	0.0064
2018	54.76	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0023
2019	56.06	na	na	na	na	na	na	na	0.0024
2020	19.89	na	na	na	na	na	na	na	0.0009
2021	20.62	5.25	0.00	0.00	23.32	0.00	0.00	0.0015	0.0021
2022	0.00	0.00	0.00	0.00	0.00	50.06	0.00	0.0026	0.0021

Table 13.1.5. ***Nephrops*** **in FUs 26–27. Biomass index and mean sizes by sex from the GALNEP-26 survey in FU 26.**

	Biomass survey index		Mean size		
Year	K/h	nº indiv/h	Males	Females	Combined
2019	0.74	11.4	43.98	39.95	42.00
2020	1.82	30.18	43.4	39.31	41.51
2021	0.95	15.07	41.90	35.00	37.5

*** No survey was conducted in 2022 because of this survey is carried out in a commercial vessel and zero catch in FU26-27 was set for each of the years 2023, 2024 and 2025.**

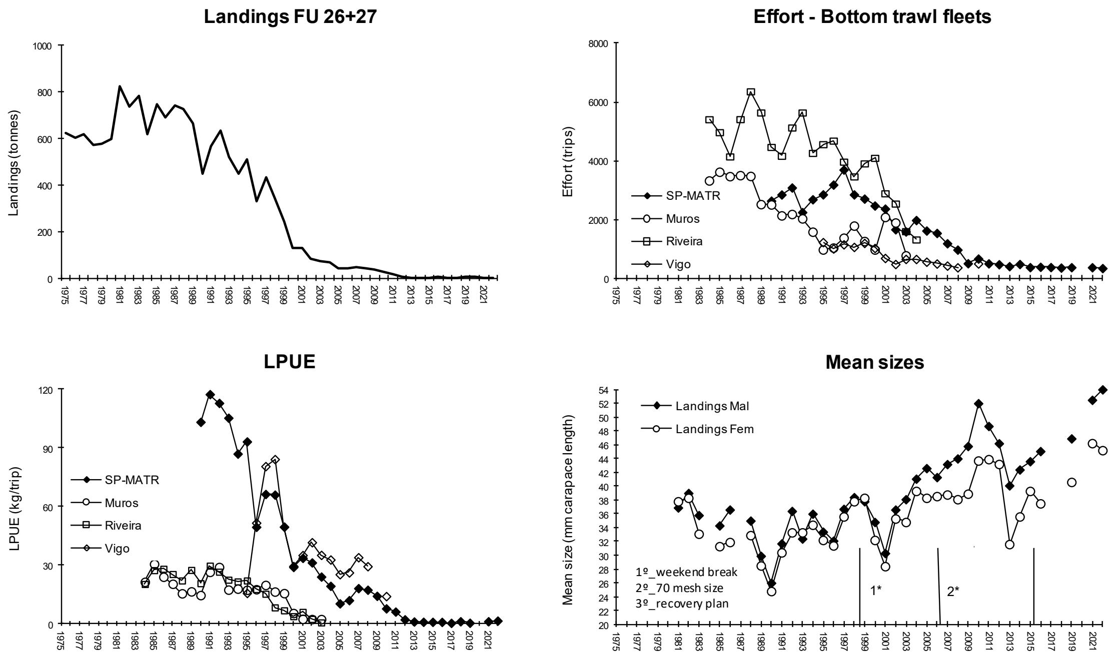

Figure 13.1.1. ***Nephrops*** **in FUs 26–27. Long-term trends in landings (in tonnes), LPUE (Kg/trip) and mean sizes (mm CL). Effort, LPUE and mean sizes for 2020 are not available.**

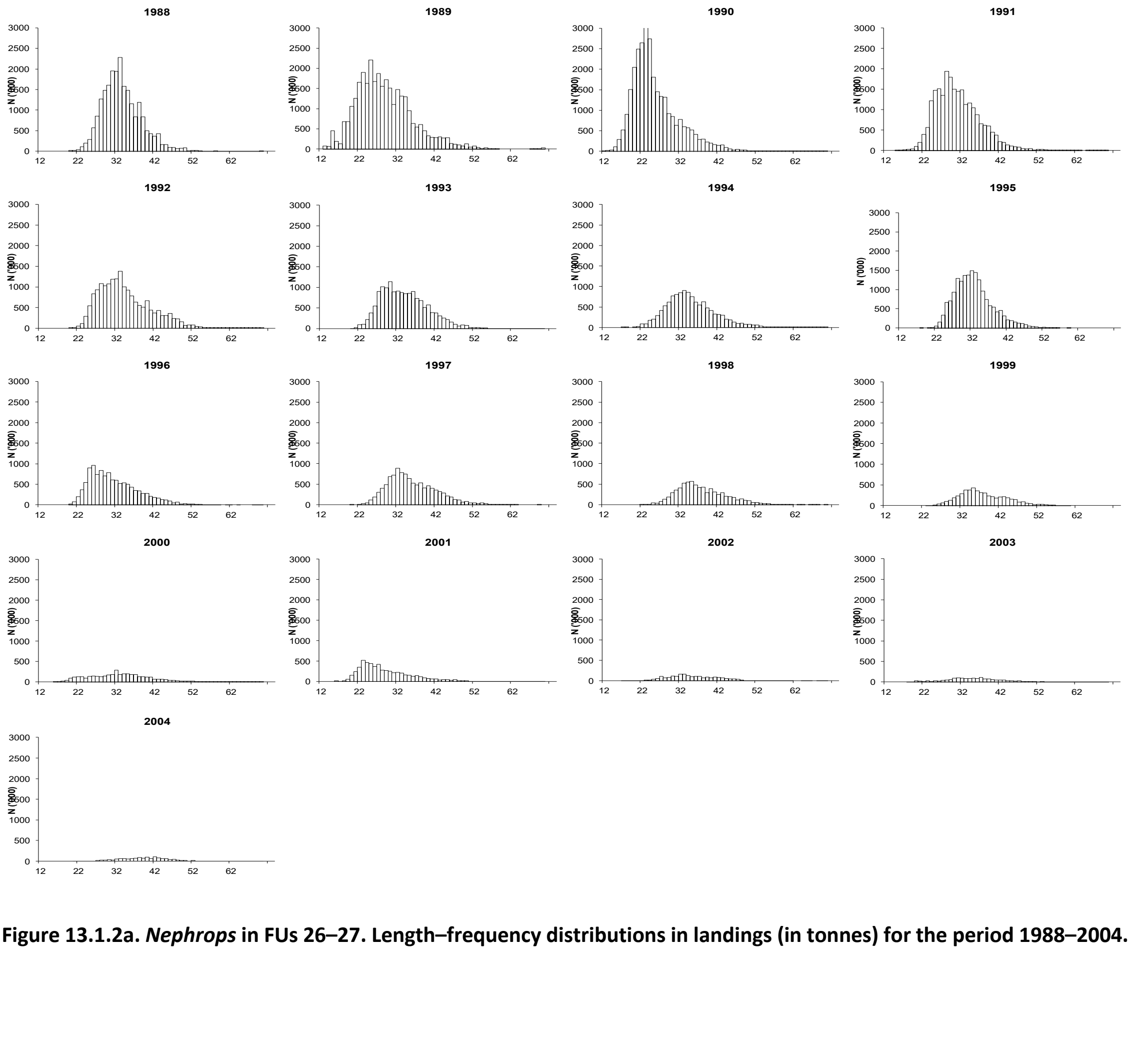

Figure 13.1.2a. ***Nephrops*** **in FUs 26–27. Length–frequency distributions in landings (in tonnes) for the period 1988–2004.**

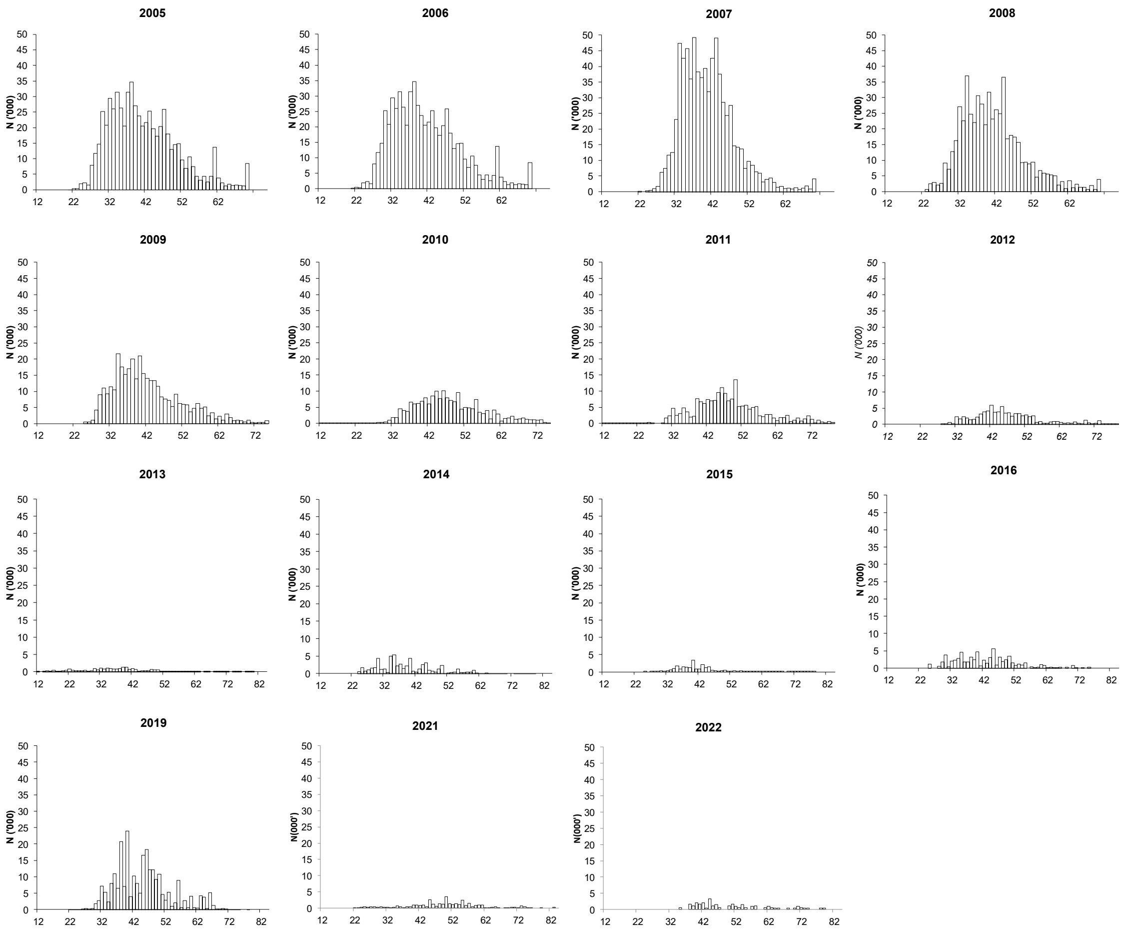

Figure 13.1.2b. *Nephrops* in FUs 26–27. Length–frequency distributions in landings (in tonnes) for the period 2005–2022. Data not available for 2017, 2018 and 2020.

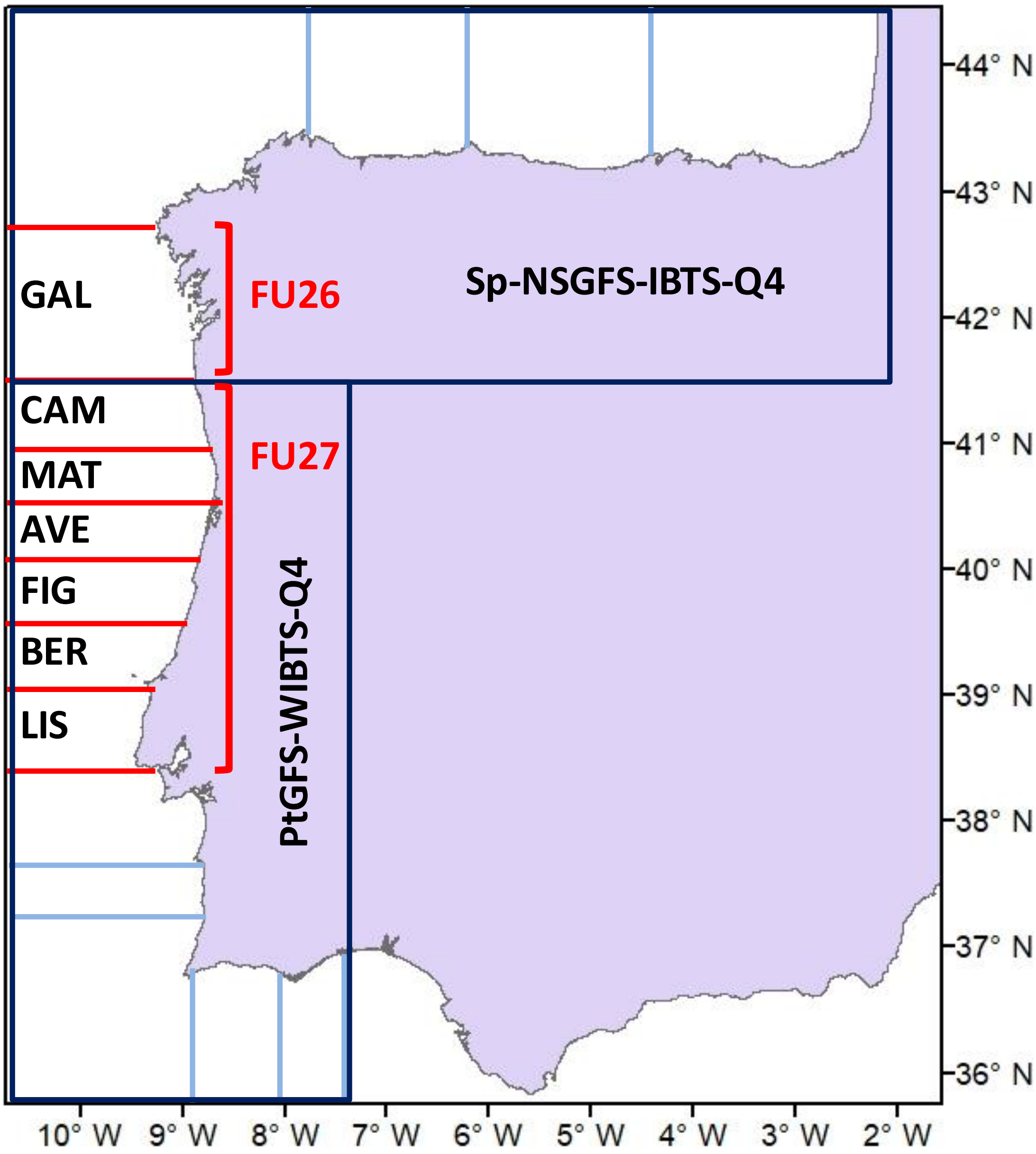

Figure 13.1.3. *Nephrops* in FUs 26–27. Area sectors covered by the Spanish (SpGFS-WIBTS-Q4, G2784) and Portuguese (PtGFS-WIBTS-Q4, G8899) IBTS-Q4 surveys in FU26 and FU27, respectively. (GAL:Miño-Finisterra; CAM: Caminha; MAT: Matosinhos; AVE: Aveiro; FIG: Figueira da Foz; BER: Berlengas; LIS: Lisbon).

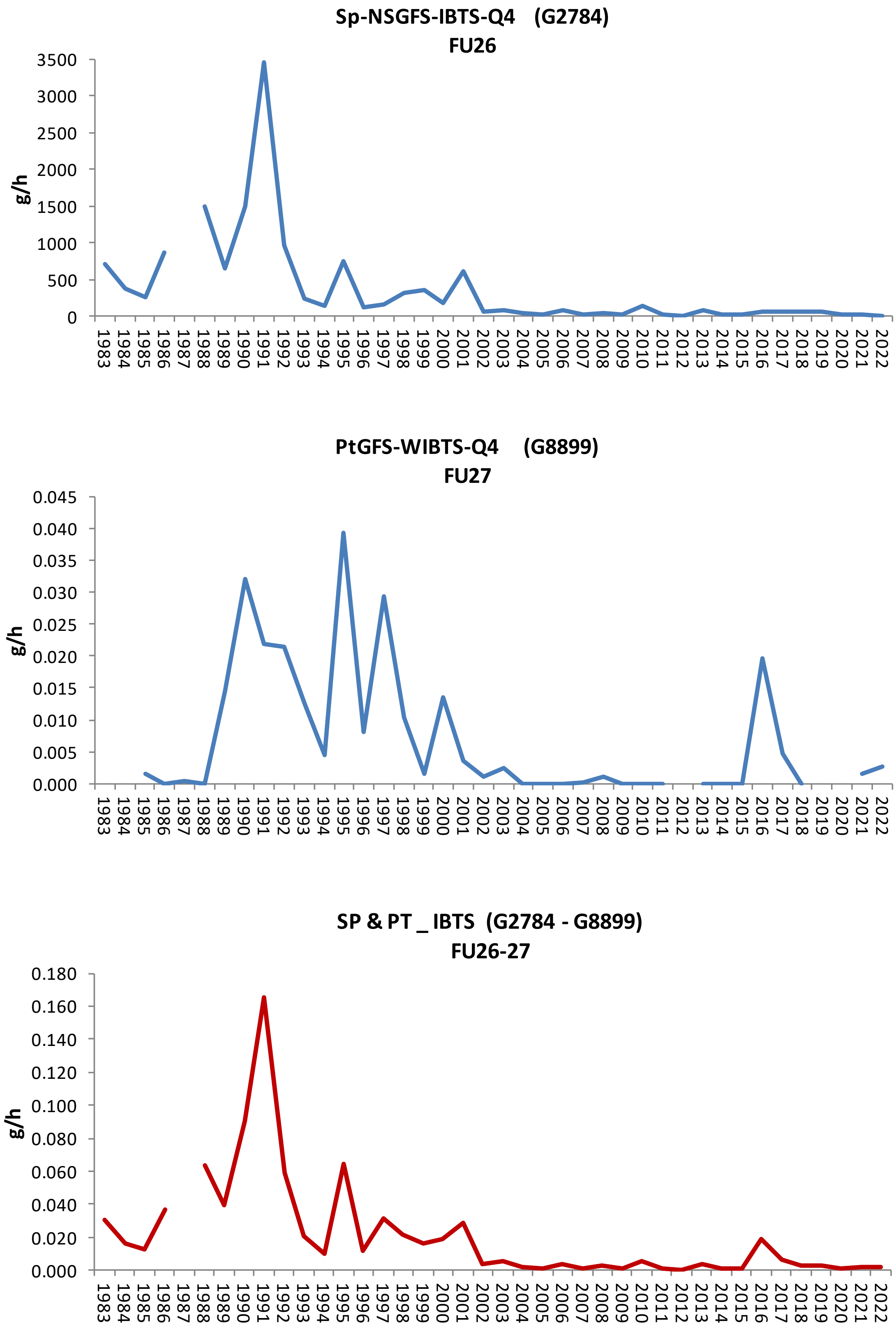

Figure 13.1.4. ***Nephrops*** **in FUs 26–27. Biomass indices (g/h) from the Spanish IBTS-Q4 (SpGFS-WIBTS-Q4, G2784) in FU 26 (top panel), the Portuguese (PtGFS-WIBTS-Q4, G8899) in FU 27 (middle panel) IBTS-Q4 surveys and the new combined (G2784_G8899) IBTS index in FUs 26–27 (bottom panel).**

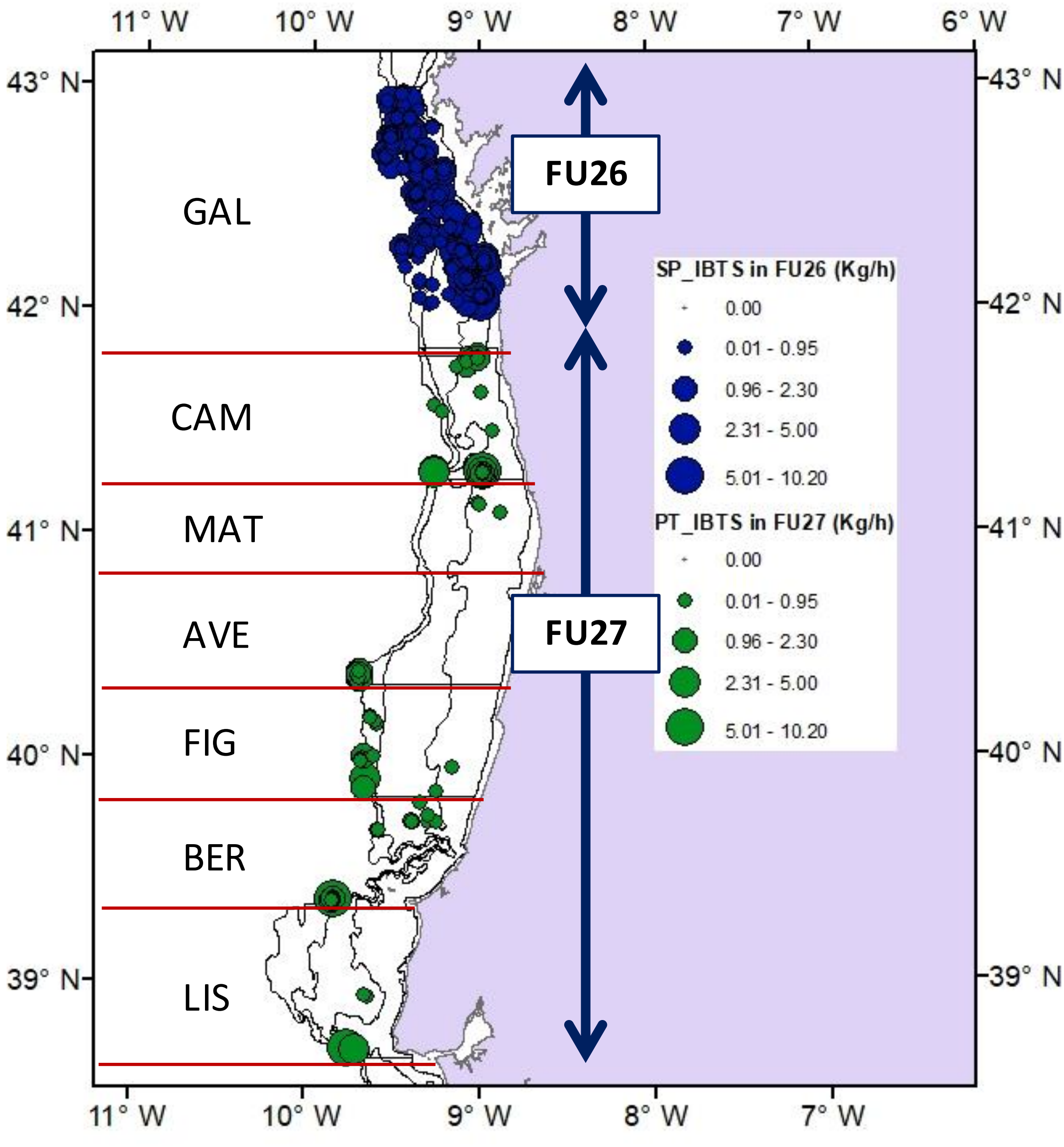

Figure 13.1.5. *Nephrops* in FU 26–27. *Nephrop*s spatial distribution in FUs 26–27 from the Spanish (SpGFS-WIBTS-Q4, G2784) and the Portuguese (PtGFS-WIBTS-Q4, G8899) IBTS-Q4 surveys (blue and green, respectively) for the entire period 1983–2021. (GAL:Miño-Finisterra; CAM: Caminha; MAT: Matosinhos; AVE: Aveiro; FIG: Figueira da Foz; BER: Berlengas; LIS: Lisbon).

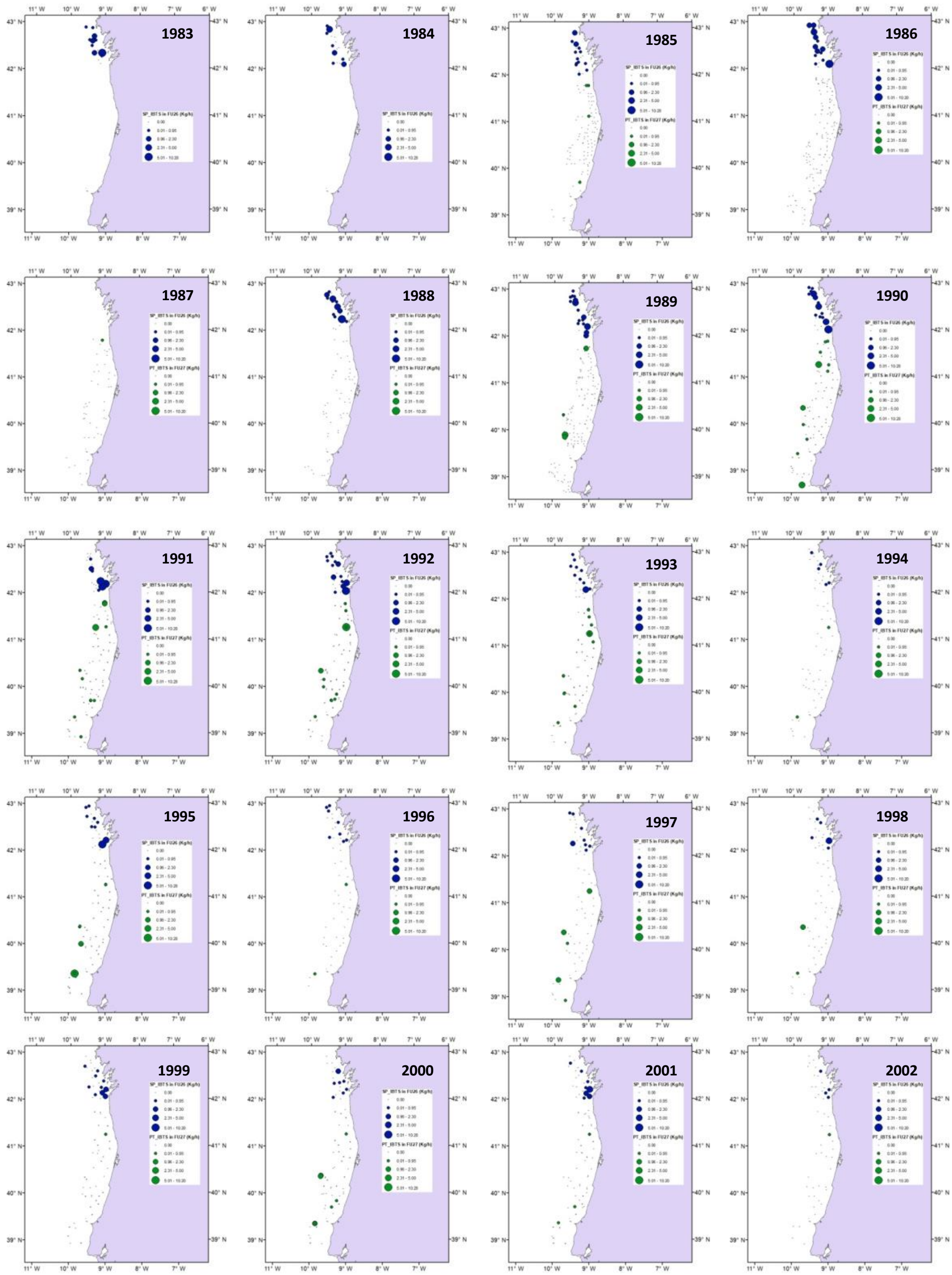

Figure 13.1.6a. ***Nephrops*** **in FUs 26–27. Annual** ***Nephrop*****s spatial distribution from the Spanish (SpGFS-WIBTS-Q4, G2784) and Portuguese (PtGFS-WIBTS-Q4, G8899) IBTS-Q4 surveys (blue and green, respectively) for the period 1983–2002.**

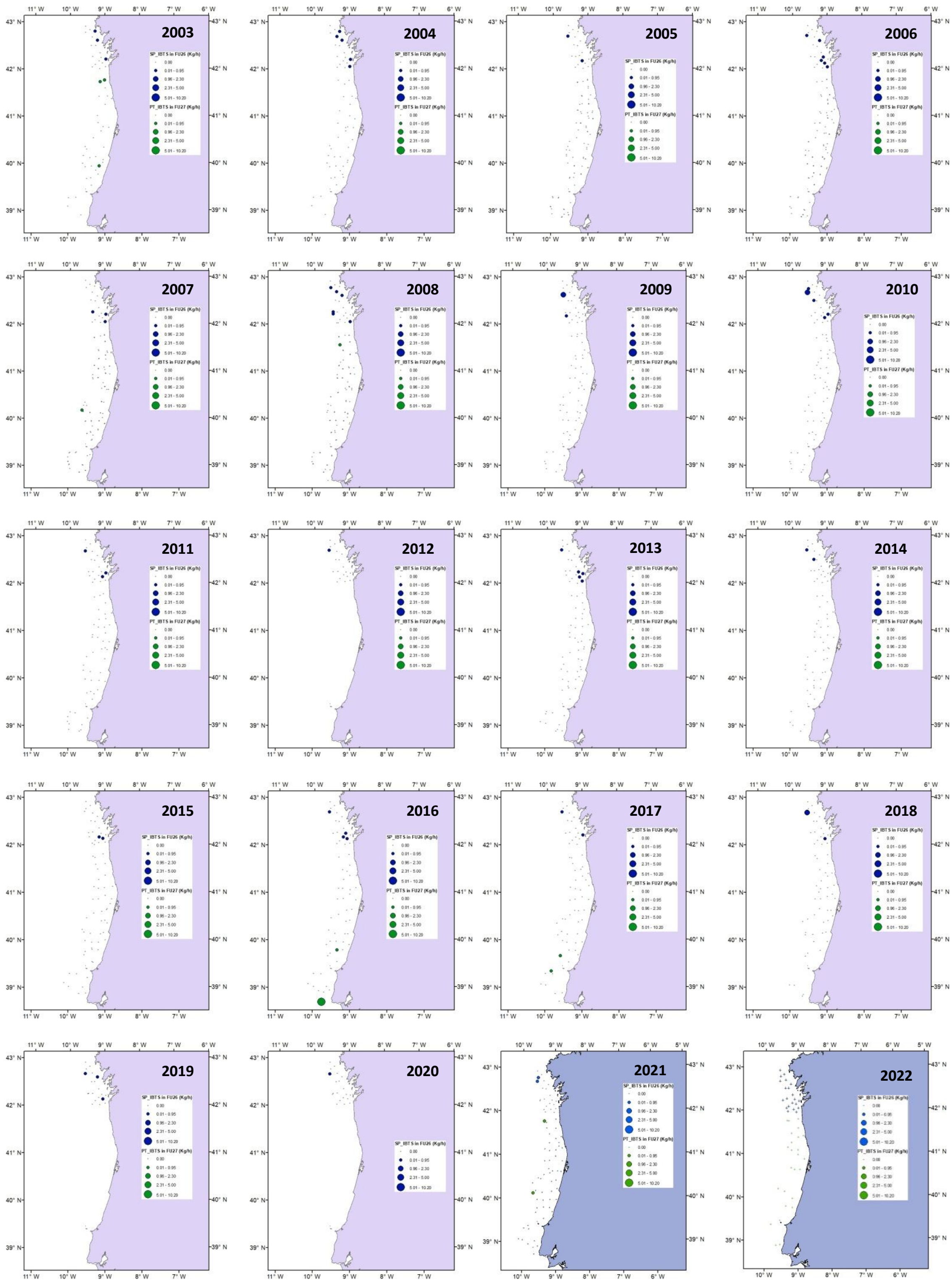

Figure 13.1.6b. *Nephrops* in FUs 26–27. Annual *Nephrop*s spatial distribution from the Spanish (SpGFS-WIBTS-Q4, G2784) and Portuguese (PtGFS-WIBTS-Q4, G8899) IBTS-Q4 surveys (blue and green, respectively) for the 2003–2022 period.

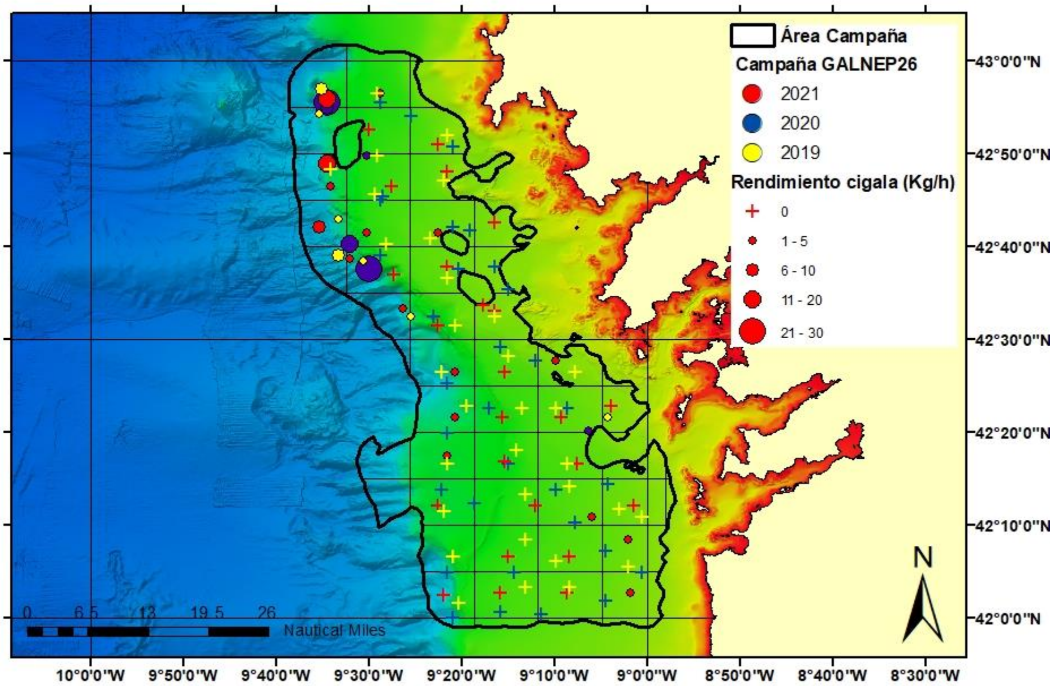

Figure 13.1.7. ***Nephrops*** **in FUs 26–27.** ***Nephrops*** **biomass spatial distribution for the years 2019 (yellow bubble), 2020 (blue bubble) and 2021 (red bubble) from the GALNEP_26 survey in FU 26.**

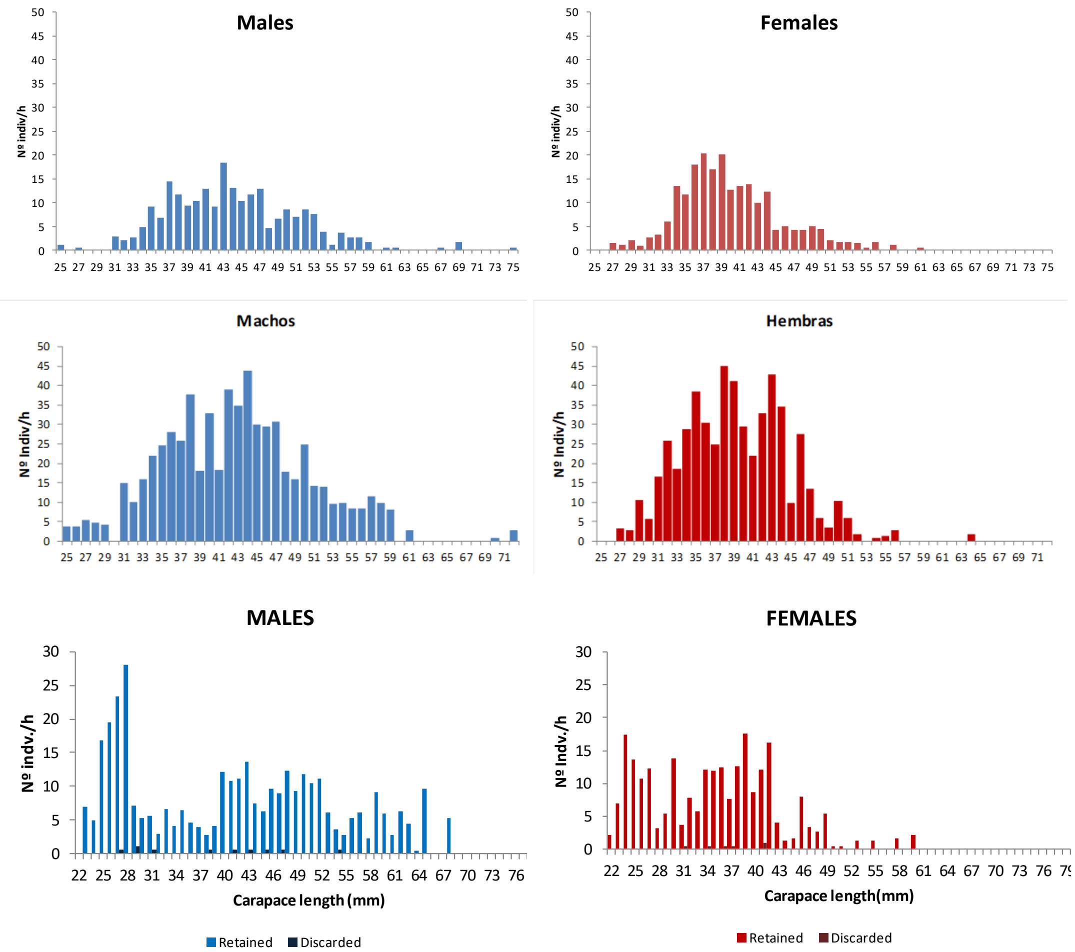

Figure 13.1.8. ***Nephrops*** **in FUs 26–27. Length–frequency distribution by sex from GALNEP-26 survey for the years 2019 (top panel), 2020 (middle panel) and 2021 (bottom panel).**

13.2 *Nephrops* in Functional Units (FUs) 28–29 (SW and S Portugal)

13.2.1 General

13.2.1.1 Ecosystem aspects

See Stock Annex.

13.2.1.2 Fishery description

See Stock Annex

13.2.1.3 ICES Advice for 2023 and management applicable for 2022 and 2023

ICES Advice for 2022

The advice for this stock is biennial and valid for 2022 and 2023. Based on the ICES approach for data-limited stocks (DLSs), ICES advises that catches in FUs 28 and 29 should be no more than 266 t in each of the years 2022 and 2023.

To ensure that the stock in FUs 28 and 29 is exploited sustainably, ICES advises that management should be implemented at the FU level.

Management applicable for 2022 and 2023

A recovery plan for southern hake and Iberian *Nephrops* stocks was enforced since the end of January 2006. The recovery plan aimed to rebuild the stocks within ten years, with a reduction of 10% in F relative to the previous year and the TAC set accordingly (Council Regulation (EC) No 2166/2005, 2005). ICES did not evaluate the recovery plan for *Nephrops* in relation to the precautionary approach. This plan was based on precautionary reference points for southern hake. A new Management Plan for Western Waters (Regulation (EU) 2019/472, 2019a) was established in 2019 for demersal species including *Nephrops* in these FUs and the former recovery plan was repealed. In the current Management Plan for Western Waters, applied from 2020 onwards, no effort limitations were established.

To further reduce the fishing pressure on *Nephrops* stocks in Division 9.a, seasonal restrictions were introduced in the trawl and creel fishery in two boxes (geographic areas) located in FUs 26 and 28, during the peak of the *Nephrops* fishing season. These restrictions are applied to *Nephrops* fleets fishing in these boxes in June–August and May–August, respectively, and were amended to the existing regulation on technical measures (Council Regulation (EC) No 850/98, 1998) by the Council Regulation (EC) No 2166/2005 (2005). A more recent regulation on technical measures (Regulation (EU) 2019/1241, 2019b) replaced the previous CR (EC) No 850/98 and kept the two boxes allowing fishing *Nephrops* only as bycatch.

The TAC set for the whole Division 9.a was 355 t for 2022, of which no more than 50 t may be taken in FU 30 (Council Regulation (EU) 2021/92). For 2023, the TAC for the Division 9.a was set as 298 t, with a maximum of 32 t for FU 30 (Council Regulation (EU) 2022/109). No catches are allowed to be taken in FUs 26 and 27.

13.2.2 Data

13.2.2.1 Commercial catches and discards

Table 13.2.1 and Figure 13.2.1-top left show the landings data series for these FUs. For the period 1984 to 1992, the recorded landings from FUs 28 and 29 have fluctuated between 420 and 530 t, with a long-term average of about 480 t, falling drastically down to 132 t in the period 1990–1996. From 1997 to 2005, landings increased to similar levels observed during the early 1990s then decreased until 2009. The landings values were approximately at the same level (≈ 150 t) for the years 2009–2011, presenting an increasing trend until 2018 and then a decreasing trend in the last period of the series. From 2013 onwards, the reduced TAC has limited the fishing activity, and the fishery has been closed for 1–2 months in the second semester, in some of the years.

Since 2011, landings include the Spanish official landings. Spanish vessels are licensed to fish for crustaceans in these FUs under a bilateral agreement since 2004. No data from these vessels' operations is available prior to 2011.

Spanish official landings are derived from logbooks. This source of information allows landings disaggregation by ICES statistical rectangles. In 2012 and 2013, *Nephrops* catches were recorded in statistical rectangles outside the FUs in Division 9.a and these were allocated to the closest rectangles in each FU. Since 2014, 100% of the caches were from FUs 28–29.

In terms of sex ratio, males are the dominant component in the catches of most of the years in the time-series. The years of 1991 and 1995 where the years when total female landings largely exceeded male landings (1:1.58 and 1:2.18 male:female ratio in numbers respectively for each year). In more recent years, from 2019 to 2021 females were also more abundant in landings (1:1.18, 1:1.05 and 1:1.33, respectively), while in 2022 males were slightly more dominant than females (1:0.95).

Information on discards and on the onboard sampling program was sent to WGBIE through the ICES Accessions. The frequency of *Nephrops* occurrence in discards samples is very low. Discards are negligible in this fishery mostly due to *Nephrops* quality and not related to the minimum landing size (MLS = 20 mm of carapace length). It was only in 2013 that the occurrence of *Nephrops* in discards samples was greater than 30% and a total amount of 3 t was estimated, with a high coefficient of variation (CV = 58%). In 2020 and 2021, the Portuguese on-board sampling programme was compromised by the COVID-19 pandemic situation and the sampling occurred only during the first quarter of the 2020, with no sampled trips in 2021. In 2022, there were limitations in the onboard sampling effort due to issues related with subcontracting services. Since discards were considered negligible for *Nephrops* during the whole sampling period 2004–2019, this was also assumed to be the case for the 2020 (ICES, 2021a), 2021 and 2022 assessments.

13.2.2.2 Biological sampling

Length distributions for both males and females for the Portuguese trawl landings are obtained from samples taken weekly at the main auction port, Vila Real de Santo António. Sampling frequency in 2022 was at the same level as in previous years and occurred in months when the Norway lobster fishing was open. The sampling data were raised to the total landings by market size category, vessel, and month.

The length compositions by sex of the landings are presented in Tables 13.2.2a-b and Figures 13.2.2a-b. The number of samples and measured individuals are presented in Table 1.4a.

In 2020, *Nephrops* sampling in Portuguese markets was affected by the COVID-19 pandemic and no sampling was conducted during the months of April, May, July, and August. Raising of the length compositions for the missing months was based on the mean length composition of the previous three years (2017–2019) in each of those months (ICES, 2021b). In 2021, the same procedure was used for August and September, due to deficient sampling. In 2022, no sampling was conducted in October and the raising of the length composition was based on the mean length of the two adjacent months (September and November) of the same year.

13.2.2.3 Biomass indices from surveys

Trawl surveys

Since 1997, groundfish (PtGFS-WIBTS-Q4; G8899) and crustacean trawl surveys (NepS (FU 28–29), G2913) were carried out every year, covering FUs 28 and 29. Table 13.2.3 and Figure 13.2.1-bottom-left show the average *Nephrops* CPUEs (kg/h trawling) from the crustacean trawl surveys, which can be used as an overall biomass index. As the surveys were performed with a smaller mesh size than the commercial fishery, this information provides a better estimation of the abundance for small-sized individuals. There was an increase in the overall biomass index in the period 2003–2005, as well as of small individuals at a particular juvenile concentration area in 2005, which could be an indicative of higher recruitment.

The R/V "Noruega" had some technical problems in 2010 and could not trawl in areas deeper than 600 m. The survey plan had to be adapted accordingly. The CPUE value estimated for 2010, the highest value for the whole series, was probably affected by this change. In 2011, due to an engine failure, the survey did not cover the whole area of *Nephrops* distribution. No CPUE index was presented for that year. The following year, budgetary constraints of national scope led to the unfeasibility of the R/V "Noruega" to be repaired as well as the chartering of a replacement research vessel and, therefore, no survey was conducted in 2012.

The biomass index estimated from the 2013 survey is only comparable to the value of 2009, which covered the same area. Comparing the fraction of the area covered in 2011 and the same area in 2013, the biomass of *Nephrops* increased in the area of Alentejo (FU 28). The survey in 2011 did not cover the main area of concentration in Algarve (FU 29).

Taking into account the information from the fishing grounds obtained from the VMS data, the survey area was adapted in 2014. Figure 13.2.3 shows the spatial distribution of the survey biomass index in the last five years.

In 2019, the survey was not conducted due to issues external to IPMA. In 2020, the survey was also not conducted due to legal constraints at the national level that made it unfeasible for hiring fishing and vessel crews on time to undertake the survey. This was not due to the COVID-19 pandemic disruptions (ICES, 2021b).

In 2021, the survey started to be conducted with a new vessel (R/V "Mário Ruivo"). Although the gear used is the same, the trawling speed and the doors characteristics may affect the net geometry and the performance of the fishing operation. This survey was considered a trial, with gear and equipment operational issues to be fixed. FU 28 was not completely covered (36% of the planned stations) due to engine problems during the third week of the survey. FU 29 was fully covered. In 2022, the survey was carried out with less operational issues than in 2021 and the whole stock area was covered.

UWTV experiments

In 2005 and 2007, some experiments to collect UWTV images from the *Nephrops* fishing grounds were made with a camera hanging from the trawl headline. In 2008, the images collected from nine stations in FU 28 with the same procedure showed very promising results. During the 2009 survey, a two-beam laser pointer was attached to the camera and UWTV images were recorded from 58 of the 65 sampled stations. The trawling speed and the water turbidity were the main problems affecting image clarity and the high variation of the camera height to the ground. Both factors contributed to significant variations in the field of view. It was not possible to guarantee that this method can be used for abundance estimation, mainly due to these uncertainties (information presented to SGNEPS 2012–Study Group of *Nephrops* Surveys (ICES, 2012a).

13.2.2.4 Mean sizes

Mean carapace length (CL) data for males and females in the landings and surveys are presented for the period 1994-2022 (Table 13.2.4). Figure 13.2.1-bottom right shows the mean CL trends since 1984. The mean sizes of males and females have fluctuated along the period with no apparent trend. The mean length of males and females in landings in 2021 was reviewed and updated; the new values are within the range of the time series.

13.2.2.5 Commercial catch-effort data

The effort in 2003–2004 corresponds to only eleven months of fleet operations for each year as the crustacean fishery was experimentally closed in January 2003 and 30 days for *Nephrops* fishery in September–October 2004.

A Portuguese national regulation (Portaria no. 1142/2004, 2004) closed the crustacean fishery in January-February 2005 and enforced a ban in *Nephrops* fishing for 30 days in September – October 2005. As a result, the effort in 2005 corresponds only to nine months.

The recovery plan for southern hake and Iberian *Nephrops* stocks was approved in December 2005 and entered into force at the end of January 2006. This recovery plan includes a reduction of 10% in F relative to the previous year (Council Regulation (EC) No 2166/2005, 2005). As a result, the number of fishing days per vessel was progressively reduced. Additional days were allocated in 2010 to Spanish and Portuguese vessels within divisions 8.c and 9.a excluding the Gulf of Cádiz, on the basis of the permanent cessation of vessels from each country (Commission Decision No 2010/370/EU, 2010a; Commission Decision No 2010/415/EU, 2010 b).

Besides this effort reduction, the Council Regulation (EC) No 850/98 (1998) was amended by the Council Regulation (EC) No 2166/2005 (2005), with the introduction of two boxes in Division 9.a, with one of them located in FU 28. In the period of higher catches (May-August), this box is closed for *Nephrops* fishing. By way of derogation, fishing with bottom-trawls in these areas and periods is authorized provided that the bycatch of Norway lobster does not exceed 2% of the total weight of the catch. The same applies to creels that do not catch *Nephrops*.

The effort reduction measures were combined with a national regulation closing the crustacean fishery every year in January (Portaria no. 43/2006, 2006). In 2016, this period was extended until February. Besides the closed season in 2013–2016, the Portuguese vessels had to stop fishing for 1.5 to 2 months, in October-November, due to quota limitations. With regards to the Spanish fleet, the number of fishing days was reduced due to sanctions imposed by EC related to the catches exceeding the quota in 2012. The operation of this fleet was also affected in the Portuguese fishing grounds for the period 2013–2015.

Crustacean vessels target two main species, rose shrimp and Norway lobster, which have different market values. Depending on their abundance and availability, the effort is mostly directed at one species or the other (Figure 13.2.4). A standardized CPUE series for *Nephrops* (Figure 13.2.5) based on Portuguese crustacean trawlers' logbooks and VMS records, is used to estimate the fishing effort in standard hours. The model used to standardize CPUE is described in the Stock Annex. In 2020, a new approach for the standardization of the CPUE series to incorporate both positive and null catches of *Nephrops* was presented and accepted during the WKMSYSPiCT (ICES, 2021a). Other improvements made to the model, include i) the incorporation of a variable to account for the spatial dimension of the *Nephrops* distribution (fishing ground), ii) the replacement of the variables used to mimic the target fishing in the previous model, that was not truly independent from the response variable, by a cluster-based variable estimated from the catch composition of the main crustacean species caught by the fishery; iii) the inclusion of the 'vessel' variable as a random effect, and iv) the estimation of the mean standardized annual CPUE considering all the factor levels and not only for a reference set of levels like in the previous model. The variability explained by the model increased from 51% to 60%, although both the previous and the new model produced similar trends. The model was updated with the 2022 data with a deviance explained of 61.9%. A decreasing trend is observed after 2018 (Figure 13.2.5).

Standardized effort in trawling hours is estimated based on the latest modelled series, dividing the total catch by the standardized CPUE. The series shows a consistent declining trend since 2005 reaching an historic low in 2009–2010. During the last decade the standardized fishing effort has fluctuated at a low level due to a quota reduction resulting from the application of the former recovery plan rules. It slightly increased up to almost 124 thousand hours in 2017 and has been decreasing since then ((Figure 13.2.1-top right and Table 13.2.5).

13.2.3 Assessment

The advice for this stock is biennial. The stock data were updated with the new information for 2022. The advice is based on the standardized commercial CPUE trend and the relative F obtained from Mean Length-Z (MLZ) model (ICES, 2015). According to the ICES data-limited approach, this stock is classified as category 3.2.0 (ICES, 2012b).

In February 2021, a Benchmark workshop (WKMSYSPiCT) on the application of SPiCT to produce MSY advice for selected stocks, including *Nephrops* in FUs 28–29, was conducted (ICES, 2021a). Given the input data available for the stock, different model configurations produced contradictory results and it was not possible to distinguish between two alternative stock statuses. For this reason, the SPiCT model was not accepted to provide assessment and advice for this stock. Thus, the stock remained as category 3.

In 2023, given the most recent ICES guidelines to provide advice for data limited stocks (ICES 2023), this stock should have been assessed using the ICES rfb rule (Method 2.1, ICES, 2021c). However, since the fishing pressure indicator from the MLZ, accepted in the last benchmark, is based on more complete information than the one in the Method 2.1, the new rule was not applied, following the ACOM recommendation.

WKLIFE XII, to occur in late 2023, has as one of its terms of reference to explore methods for *Nephrops* after which new guidelines will be available for the next advice in 2025.

13.2.3.1 Length-based indicators (LBIs)

Length-based indicators (LBIs), defined at WKLIFE V (ICES, 2015), were used to assess the status of the stock conservation, considering males and females separately (Table 13.2.6 and Figure 13.2.6). The ratios L_c/L_{mat} and $L_{25\%}/L_{mat}$ indicate that immature individuals are preserved. However, P_{mega} < 30% indicates a truncated length distribution of the female catch which may be explained by their reproductive behaviour of not leaving the burrows during the egg-bearing period. The F_{MSY} proxy ($L_{mean}/L_{F=M}$), suggests that the stock is exploited at sustainable levels, with values above or very close to 1 for both sexes.

13.2.3.2 Mean length-based mortality estimators (MLZ)

Assuming a constant M of 0.3 for males and 0.2 for females, F was estimated using the mean length-based mortality estimators (MLZ) as defined in WKLIFE-V (ICES, 2015) and WKProxy (ICES, 2016). The input data and the output of Gedamke and Hoenig (G&H; Gedamke and Hoenig, 2006) and Then, Hoenig and Gedamke (THoG; Then, 2014) models are summarized in Table 13.2.7. Figures 13.2.7 and 13.2.8 show the model diagnostics for G&H model and the F series estimated by the THoG model.

G&H model with two periods gives a better fit and a lower AIC. For the last period, fishing mortality was estimated at 0.17 for males and 0.10 for females. The results indicate that the stock is exploited at a level below the F_{MSY} proxy, either with the Gedamke & Hoenig or the THoG model, although the latter gives much lower F values. The M value estimated by the THoG model is also greater than the fixed M, historically assumed for *Nephrops* stocks. The results of the models were accepted using fixed values for M (0.3 for males and 0.2 for females) which give higher F values, while still below F_{MSY}.

13.2.3.3 Summary

The standardized commercial CPUE (Figure 13.2.5), used as an index of biomass shows a decreasing trend since 2018 (Figure 13.2.3). The fishing pressure indicator, corresponding to the relative F obtained from the MLZ model, is well below the MSY reference point for over a decade and remains at a low level (Figure 13.2.8), suggesting that the stock is exploited at sustainable levels.

13.2.4 Biological reference points

Proxies of MSY reference points were reviewed in WGBIE 2017 (ICES, 2017) using the methods developed in WKLIFE V and WKProxy (ICES, 2015, 2016, respectively). From length-based analysis of the period 1984–2016, the values of $F_{0.1}$ were updated at 0.23 for males and 0.24 for females, as proxies of F_{MSY}. No proxy for B_{MSY} was identified (ICES, 2017).

In November 2019, a workshop on methodologies for *Nephrops* reference points was held in Lisbon to evaluate reference point estimation methods for stocks with UWTV surveys, and to evaluate the utility of other modelling frameworks to assess and provide reference points for *Nephrops* stocks (ICES, 2020). Besides the LBIs and MLZ models (WKLIFE V, ICES, 2015) which are already used in the assessment of this stock, other approaches as Separable Cohort Analysis (*SCA* R package, version 1.2.0; Bell, 2019), Separable Length Cohort Analysis (SLCA – *nepref* R package, version 0.2.2; Dobby, 2019), Length-based Stock Potential Ratio (LBSPR, Hordyk *et al.*, 2015) and Surplus Production in Continuous Time (SPiCT, Pedersen and Berg, 2017) were tested.

13.2.5 Management considerations

Nephrops is caught by a multispecies and mixed bottom-trawl fishery.

A recovery plan for southern hake and Iberian *Nephrops* stocks was approved in December 2005 and in action since the end of January 2006 (Council Regulation (EC) No 2166/2005, 2005). This recovery plan includes a reduction of 10% in the hake F relative to the previous year and TAC set accordingly, within the limits of ± 15% of the previous year TAC. Although no clear targets were defined for Norway lobster stocks in the plan, the same 10% reduction has been applied to these stocks' TAC. The number of allowed fishing days is set in each year by EU regulation fixing the fishing opportunities for fish stocks, applicable in Union waters. The recovery plan target and rules have not been changed since it was implemented. In March 2019, a new multiannual plan (MAP) for stocks fished in the Western Waters (including the *Nephrops* stocks in these FUs) and adjacent waters was established, repealing the previous recovery plan (Regulation (EU) 2019/1241, 2019b).

Besides the recovery plan, the Council Regulation (EC) No 850/98 (1998) was amended with the introduction of two boxes in Division 9.a, one of them located in FU 28 (Council Regulation (EC) No 2166/2005, 2005). In the period of higher catches (May-August), this box is closed for *Nephrops* fishing. By derogation, fishing with bottom-trawls in these areas and periods are authorized provided that the bycatch of Norway lobster does not exceed 2% of the total weight of the catch. The same applies to creels that do not catch *Nephrops*. Recently, a new Regulation (Regulation (EU) 2019/1241, 2019b) repealed the one implemented in 1998 but kept the two boxes allowing fishing *Nephrops* only as bycatch.

With the aim of reducing effort on crustacean stocks, a Portuguese national regulation (Portaria no. 1142/2004, 2004) closed the crustacean fishery in January-February 2005 and enforced a ban in *Nephrops* fishing for 30 days in September–October 2005 in FUs 28–29. This regulation was revoked in January 2006, after the entry in force of the recovery plan and the amendment to the 1998' management plan, keeping only one month of closure of the crustacean fishery in January (Portaria no. 43/2006, 2006). This one-month closure period was extended for another month, until 29 February in 2016 (Portaria no. 8-A/2016, 2016). The national regulations are only applicable to the Portuguese fleet.

Portugal and Spain have bilateral agreements for fishing in each other's waters. The agreement for the period 2004–2013 was reviewed and extended. Under this agreement, a number of Spanish trawlers are licensed to fish crustaceans in Portuguese waters. No information from landings of these vessels is available for the years prior to 2011. A new bilateral agreement was signed in 2021 for 5 years since January 2022 (Dec. 23/2021). The number of Spanish trawlers allowed to fish crustaceans in Portuguese waters was set at five.

Unwanted catches from *Nephrops* are regulated by the discard plan for demersal fisheries in South-Western waters for the period 2019–2023 (Commission Delegated Regulations (EU) 2018/2033, replaced by 2019/2237 and later by 2020/2015), under which they are exempted from the landing obligation based on the species high survival rates as provided for in Article 5(4b) of Regulation (EU) No 1380/2013 (2013). This exemption applies to all catches of Norway lobster from ICES subareas 8 and 9 with bottom-trawls, and where all *Nephrops* discards shall be released immediately, and in the area where they were caught (Commission Delegated Regulation (EU) 2020/2015).

13.2.6 References

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13.2.7 Tables and figures

Table 13.2.1. *Nephrops* in FUs 28–29. Total landings (tonnes) per country.

Year	FU 28+29 SW+S Portugal					
	Spain		Portugal			Total
	28*	29	28+29			
	Trawl	Trawl	Artisanal	Trawl	Total	
1975	137	1510		34	34	1681
1976	132	1752		30	30	1914
1977	95	1764		15	15	1874
1978	120	1979		45	45	2144
1979	96	1532		102	102	1730
1980	193	1300		147	147	1640
1981	270	1033		128	128	1431
1982	130	1177		86	86	1393
1983				244	244	244
1984				461	461	461
1985				509	509	509
1986				465	465	465
1987			11	498	509	509
1988			15	405	420	420
1989			6	463	469	469
1990			4	520	524	524
1991			5	473	478	478
1992			1	469	470	470
1993			1	376	377	377
1994				237	237	237
1995			1	272	273	273
1996			4	128	132	132
1997			2	134	136	136
1998			2	159	161	161
1999			5	206	211	**211**
2000			4	197	201	**201**
2001			2	269	271	**271**
2002			1	358	359	**359**
2003			35	335	370	**370**
2004			31	345	375	**375**
2005			31	360	391	**391**
2006			17	274	291	**291**
2007			18	274	291	**291**
2008			35	188	223	**223**
2009			17	133	151	**151**
2010			16	131	147	**147**
2011		17	16	117	133	**150**
2012	0	14	3	211	214	**229**
2013		10	1	198	199	**209**
2014		8	3	183	186	**193**
2015		12	4	231	235	**247**
2016		21	8	254	262	**283**
2017		26	9	241	249	**275**

Year	FU 28+29 SW+S Portugal					
	Spain		Portugal			Total
	28*	29	28+29			
	Trawl	Trawl	Artisanal	Trawl	Total	
2018		25	10	263	273	**299**
2019		31	8	245	253	**284**
2020		31	7	209	216	**247**
2021		34	9	163	173	**207**
2022**		17	7	124	131	**148**

* **Spanish landings from FU 28 are included in FU 29.**

** **Preliminary values.**

Table 13.2.2.a. *Nephrops* in FUs 28–29. Length composition of males from landings 1984–2022.

Landings (thousands)														
Year	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
17														
18														
19					4	21					0			
20			0	16	4			6	4					
21		17	9			84		16	37	9				
22	7	5	14	15		97	9	29	96	38	9			
23	24	7	7	8		143	5	19	55	34			8	4
24	14	40	121	209	51	272	27	53	202	42	18		17	9
25	109	83	115	81	97	229	116	69	181	149	34	3	23	6
26	250	170	137	446	128	205	182	111	263	72	68	0	36	43
27	282	326	170	718	208	269	149	94	185	95	77	0	54	95
28	374	500	289	871	399	280	337	139	506	272	157	0	56	78
29	439	559	341	727	456	283	415	159	462	382	95	28	38	88
30	412	742	328	584	442	317	695	239	725	548	187	11	68	104
31	277	670	389	742	457	230	813	325	755	548	231	24	92	172
32	373	784	680	806	446	367	866	260	670	674	383	108	151	283
33	339	531	213	236	428	265	702	133	345	365	149	83	70	90
34	389	635	609	721	656	328	785	239	451	655	270	215	159	251
35	478	525	590	245	664	291	755	171	296	475	224	169	147	169
36	378	463	519	342	572	295	449	138	399	639	221	147	78	154
37	528	346	322	406	424	356	465	77	351	391	107	262	172	149
38	496	383	606	355	571	302	479	120	378	344	179	134	113	58
39	353	309	361	240	326	332	611	126	348	306	95	151	62	46
40	447	337	323	156	366	316	829	200	248	174	144	232	83	82
41	247	230	316	335	164	314	797	141	243	158	93	247	78	37
42	371	246	507	264	215	360	628	174	246	170	168	293	85	33
43	199	156	198	62	102	364	335	121	242	107	127	65	31	21
44	194	233	422	215	128	481	553	125	371	179	150	88	42	28
45	165	144	233	206	93	339	324	90	220	150	87	27	22	21
46	148	178	189	170	72	231	228	128	167	55	79	58	21	33
47	129	161	140	74	76	191	202	122	191	96	68	31	38	20
48	176	212	149	79	85	193	121	62	178	102	78	25	15	9
49	89	138	104	58	43	73	92	78	111	47	47	16	20	4
50	91	142	50	34	53	94	58	67	69	30	50	12	9	3
51	66	120	63	27	34	114	59	44	50	38	29	4	6	7
52	64	135	66	44	38	77	33	40	35	15	46	11	16	7
53	45	99	32	37	23	40	19	16	29	18	22	5	6	6
54	73	101	35	45	22	35	27	29	50	23	18	5	8	16
55	20	67	25	31	22	37	30	26	29	19	9	3	4	10
56	20	35	14	20	16	20	30	19	5	5	11	2	4	3
57	10	33	5	15	12	22	7	10	6	5	11	3	7	16
58	13	14	8	14	11	17	14		11	4	6		5	3
59	7	10	3	9	4	16	5	2	9	3	10	0	5	2
60	3	6	3	4	3	13	2		10	8	1	1	1	4
61	3	1	4	4	1	5		1	3	2	1	0	1	9
62	3	1	2	1	2	3		1	7	5	1		2	7
63	1	1		1	1	4		5	0	1	0		2	3
64		2	0	2	1			1	3	1	2		0	4
65	0	0		2	2				3	1	1		0	4
66	0			0	1					1			0	4
67	0			0	0	0			6	5				6
68					0	2				0	1			0
69				0										0
70	0			1		0				2				0
71										0				
72				0		0				1				
73														0
74	0									1				
75														
76														
77														
78		0			0									
79														
80									0					
81														
82														
83														
84														
85														
Total	**8106**	**9897**	**8709**	**9679**	**7925**	**8329**	**12255**	**4023**	**9249**	**7463**	**3766**	**2466**	**1854**	**2200**
Landings (t)	**292**	**353**	**315**	**277**	**249**	**318**	**351**	**345**	**304**	**232**	**139**	**98**	**65**	**74**

Table 13.2.2.a. *Nephrops* in FUs 28–29. Length composition of males from landings 1984–2022 (continued).

Landings Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
17														
18														
19						0				2	0			
20		4				0		4		3	1	0	0	
21		3	3	0	2	0	0	33		5	0	0	0	
22	2	0	16	1	2	13	4	51	10	20	8	2		0
23		5	8	3	1	3	15	32	22	31	10	4		1
24	8	9	20	5	2	11	20	107	53	53	26	29	8	0
25	16	39	13	6	3	40	45	120	46	65	28	30	10	1
26	32	33	58	8	11	56	126	153	75	121	32	38	8	3
27	81	49	85	24	24	87	187	206	94	111	52	63	22	6
28	65	68	44	24	48	62	205	286	144	141	60	89	14	4
29	65	109	148	53	60	147	246	330	220	189	62	83	33	5
30	160	133	87	74	139	248	300	533	290	297	60	129	44	5
31	129	272	111	92	123	188	277	573	270	256	93	116	75	22
32	289	88	161	274	233	325	475	757	378	295	129	135	116	32
33	95	182	92	139	281	248	352	437	247	246	108	80	78	21
34	269	152	160	224	257	264	352	574	311	327	150	94	104	52
35	118	175	100	173	274	275	347	333	194	252	121	76	83	31
36	166	143	158	163	265	195	224	263	168	256	83	59	77	34
37	167	128	162	167	247	234	167	293	172	224	109	57	78	64
38	85	75	106	99	254	197	147	226	164	265	73	58	125	69
39	47	180	81	109	229	174	93	175	100	173	75	61	71	39
40	83	83	96	159	254	215	165	152	100	188	77	63	84	44
41	53	184	102	130	163	163	108	129	125	163	102	53	55	49
42	167	58	91	195	163	168	177	152	190	198	128	105	75	68
43	43	102	47	181	167	172	113	118	95	82	76	38	51	45
44	69	63	86	173	122	121	122	176	144	90	61	51	65	43
45	34	111	61	140	113	103	131	140	96	83	60	25	39	19
46	38	67	85	144	106	76	103	117	118	71	38	25	26	15
47	34	59	88	120	111	75	97	113	61	60	48	25	43	18
48	24	40	55	80	104	83	90	66	54	65	48	23	35	12
49	13	50	37	79	86	59	58	52	41	38	34	24	23	12
50	33	32	65	93	103	94	82	69	28	42	36	20	25	11
51	14	32	34	71	72	65	41	40	30	37	27	17	20	15
52	31	8	53	88	94	73	65	45	37	48	29	32	30	24
53	11	13	18	41	69	58	31	22	22	21	24	13	16	9
54	19	15	31	54	53	57	50	24	33	27	23	19	21	24
55	8	9	19	34	28	46	26	12	15	10	20	12	14	15
56	6	13	19	29	43	29	57	14	11	8	15	13	8	25
57	8	8	19	37	37	25	16	9	6	6	17	11	9	25
58	5	4	13	23	26	21	12	9	7	7	20	7	11	45
59	3	4	10	15	16	13	15	8	9	5	11	4	6	19
60	1	1	8	15	25	16	24	12	6	3	9	7	5	13
61	1	2	14	9	11	8	11	8	8	4	8	4	5	7
62	1	3	6	10	11	15	16	8	8	3	15	8	6	22
63	0	2	1	4	11	11	7	7	7	1	8	4	6	7
64	0	1	1	9	11	8	10	10	7	1	10	6	5	17
65		0	4	6	5	4	3	10	7	1	9	2	3	9
66	0		1	5	8	3	7	3	4	2	11	1	3	5
67	0			4	3	5	2	2	6	1	6	1	3	3
68	0			1	6	6	2	3	4	0	8	0	4	3
69	0		0	3	3	2	2	2	4	1	4	1	0	2
70	0		0	6	2	4	3	4	5	0	4	1	0	1
71	0			2	2	4	1	1	3	1	2	0	0	0
72	0			2	2	4	1	3	4	0	3	1	0	1
73			0	0	1	1	1	2	2		1	0	0	1
74				0	1	1	1	3	1		1	1	0	1
75				0	1	0	0	1	1		1	1	2	0
76				0	0	0	0	0	1		1	0		0
77					0	0	0	0	1		1	0	0	0
78							0	1			0			0
79					0		0	1	0		0	0		
80								0			0			0
81									0		0	0		
82					0				0		0	0		
83											0			
84														
85														
Total	**2491**	**2811**	**2680**	**3602**	**4486**	**4575**	**5233**	**7036**	**4259**	**4598**	**2280**	**1822**	**1649**	**1018**
Landings (t)	**88**	**116**	**117**	**190**	**222**	**205**	**205**	**231**	**162**	**159**	**114**	**73**	**79**	**72**

Table 13.2.2.a. *Nephrops* in FUs 28–29. Length composition of males from landings 1984–2022 (continued).

Landings Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
17											
18											
19				1							
20											
21			0				1			0	
22	3		1				1			0	
23	0	3	1	0		8	20		0	1	0
24	8		1	1		4	28		11	1	3
25	27	8	6	5		8	180	22	16	26	7
26	37	6	7	3		23	89	19	10	12	8
27	47	27	15	8		68	162	70	30	14	10
28	37	25	12	10		109	201	34	30	16	14
29	143	55	35	27	10	149	241	86	80	36	25
30	158	84	36	71	27	324	321	163	149	92	36
31	248	82	49	112	51	293	382	188	131	50	50
32	573	217	120	138	36	345	433	189	169	81	61
33	329	109	47	96	75	207	281	124	163	44	27
34	436	276	119	162	166	277	334	222	195	71	66
35	356	155	144	263	128	295	387	325	290	191	145
36	248	191	119	202	173	138	146	115	101	84	63
37	211	145	108	191	155	145	191	158	112	77	47
38	206	216	144	179	240	82	89	136	82	76	41
39	126	95	129	125	300	71	116	106	59	66	34
40	112	162	160	139	247	114	128	174	88	102	64
41	114	113	90	117	179	86	69	119	66	57	35
42	140	171	129	142	185	101	112	138	76	56	53
43	79	64	58	85	182	64	45	89	43	50	48
44	87	89	104	127	222	94	82	105	70	39	54
45	52	42	59	92	187	108	64	111	57	57	81
46	46	81	59	62	211	75	23	59	64	37	68
47	47	89	83	61	129	53	42	49	66	44	76
48	30	67	26	28	157	18	26	26	21	34	50
49	32	53	36	48	92	32	33	25	30	33	43
50	19	59	25	58	69	41	53	48	43	31	44
51	17	37	32	56	58	27	47	28	34	23	33
52	33	47	64	70	26	46	57	33	37	24	29
53	22	18	25	45	34	38	34	26	29	20	19
54	32	36	44	48	52	46	54	37	46	28	19
55	15	16	24	60	41	38	45	36	47	21	19
56	24	20	20	43	51	30	30	29	38	17	11
57	20	15	20	27	36	22	33	32	34	14	8
58	7	12	10	14	45	5	19	12	10	9	6
59	7	8	9	16	38	12	18	15	19	10	6
60	4	10	7	10	30	10	15	9	11	13	5
61	9	7	4	4	21	4	10	5	5	6	2
62	3	1	12	4	10	5	8	2	2	6	2
63	2	4	3	3	14	2	3	1	1	7	2
64	2	3	8	3	10	2	4	4	1	8	4
65	1	1	2	1	9	2	9	5	4	6	5
66	3	2	3	2	6	3	5	5	2	5	3
67	3	1	2	1	4	2	5	4	3	4	2
68	3	1	1	0	4	1	2	3	11	1	1
69	1		1	0	8	1	3	4	9	3	1
70	3	1	1	0	3	1	4	3	8	3	3
71	1		1	0	3	1	0	1	3	2	0
72	3	0	1		2	0	2	1	0	0	1
73	1		1		0	0	0	2	3	1	0
74	1		1		0	0	0	2	0	1	0
75	1		0		0	0	3	2	0	2	1
76	0			0			0	0	2	1	
77	0				0		0	0	0	1	
78					0	0	0		1	1	
79	0				0		0		1	0	0
80							0		0		0
81											
82											
83											
84											
85								0	0		
Total	**4170**	**2928**	**2217**	**2959**	**3725**	**3632**	**4693**	**3204**	**2615**	**1713**	**1434**
Landings (t)	**149**	**132**	**114**	**147**	**166**	**139**	**169.424**	**142**	**126**	**88**	**78**

Table 13.2.2.b. *Nephrops* in FUs 28–29. Length composition of females from landings 1984–2022.

Landings (thousands)															
Year	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
17															
18					4										
19		0				35					0				
20	3	1	7		8	21				18					
21	1	1	22	3	21	102		21	9	49					
22	8	21	30	78		88	19	11	102	63			0	13	2
23	66	21	7	31	28	135	15	69	38	21	2		0	0	4
24	79	102	118	270	153	258	38	173	164	41	22	2	11	20	15
25	228	205	104	357	163	197	138	198	203	191	73		13	20	25
26	272	284	186	684	220	282	140	436	361	111	92	1	35	102	74
27	345	491	359	902	429	326	247	418	448	235	134	0	37	77	91
28	431	523	322	1421	471	231	345	598	597	413	170	6	36	152	148
29	443	672	419	1253	516	285	491	590	514	523	269	31	45	178	114
30	422	588	381	928	499	317	575	771	599	775	326	104	50	199	199
31	487	593	418	948	482	501	639	414	736	752	427	182	95	394	168
32	485	653	700	946	766	306	859	807	617	824	558	322	198	502	376
33	613	415	406	227	527	314	596	375	430	449	283	251	53	163	116
34	618	467	654	774	813	511	734	310	369	359	353	641	209	278	298
35	562	563	447	447	460	435	519	284	287	194	246	674	184	150	112
36	469	329	316	386	489	274	243	130	267	203	237	811	142	135	166
37	505	353	400	223	206	318	189	108	333	154	147	692	267	129	171
38	383	284	330	269	265	285	207	135	251	100	128	348	151	39	48
39	274	142	211	146	288	148	216	74	176	150	66	194	67	35	59
40	171	119	80	119	132	131	230	131	147	110	114	344	120	21	89
41	58	106	55	65	128	149	73	39	68	108	77	361	63	31	64
42	50	36	133	54	43	127	210	62	69	95	73	165	111	18	84
43	30	27	21	40	28	109	58	82	26	43	23	64	29	2	34
44	17	13	47	147	27	91	77	6	46	42	43	88	90	18	71
45	14	11	27	84	19	27	41	21	40	34	13	54	36	8	22
46	7	6	5	40	14	38	31	45	25	37	11	13	15	4	28
47	5	3	3	26	9	24	16	7	12	29	7	18	23	3	23
48	4	1		71	11	29	7	15	18	15	4	15	8	2	6
49	1	0	3	17	4	9	1	17	17	23	4	1	6	7	6
50	1	0		2	6	3	1	2	32	8	17	1	2	1	6
51	0	0	3	4	3	7	2	4	4	5	0			1	2
52	1			5	5	8	1		5	6	1	1	0	1	1
53	2			2	3	1			9	6	0			0	0
54				4	1	1			1	1			1	0	1
55				0	1	1			6	2					
56				3	0	2		5	14	5					0
57				0	0	1			4	1			0		0
58				0		0			4	1					
59				1	0	0									
60					0				1	0					
61						1									
62															
63									4	1					
64															
65															
66															
67															
68									4	1					
69															
70															
71															
72															
73															
74															
75															
76															
77															
78															
79															
80															
81															
82															
83															
Total	**7052**	**7032**	**6218**	**10978**	**7243**	**6126**	**6962**	**6358**	**7059**	**6198**	**3920**	**5385**	**2095**	**2702**	**2621**
Landings (t)	**169**	**156**	**150**	**232**	**171**	**151**	**174**	**134**	**165**	**145**	**97**	**174**	**67**	**62**	**72**

Table 13.2.2.b. *Nephrops* in FUs 28–29. Length composition of females from landings 1984–2022 (continued).

Landings Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
17					0								
18						0				0			
19					1				2	0			
20			0		0	0	8		4	1			
21		3	1	0	3	12	48	3	15	2	1		
22	5	18	0		3	10	88	14	26	12	1	0	
23	4	6	7	0	9	43	54	37	34	11	4	1	1
24	25	49	7	10	19	62	135	44	53	25	22	10	1
25	27	24	15	11	36	101	129	55	130	23	23	11	1
26	94	81	24	15	67	211	272	113	227	38	80	12	3
27	76	139	34	34	67	266	294	152	298	73	138	20	7
28	100	64	44	107	98	336	242	179	355	81	170	26	7
29	121	171	90	127	173	395	420	392	458	123	149	51	4
30	236	152	131	237	241	406	654	321	365	145	205	67	7
31	263	131	167	195	152	334	565	305	317	129	132	99	26
32	485	283	316	296	360	530	857	510	409	252	209	145	45
33	187	153	184	467	270	433	448	272	253	182	110	91	51
34	346	235	252	429	314	400	462	341	386	177	122	140	96
35	287	193	158	470	255	324	254	249	351	187	103	120	56
36	317	225	174	351	194	222	203	162	213	103	83	144	60
37	201	213	144	302	203	178	182	142	240	121	90	119	73
38	184	85	108	300	206	151	178	152	247	134	83	106	151
39	151	92	112	213	160	113	89	173	138	123	86	95	113
40	111	79	133	186	284	136	84	114	109	125	62	80	68
41	81	66	79	110	170	82	73	129	73	95	83	65	65
42	73	67	91	80	192	122	116	112	56	75	94	52	80
43	38	41	55	87	132	70	70	44	16	30	25	28	80
44	34	49	56	57	75	66	61	46	21	24	43	40	41
45	18	23	29	51	68	66	50	35	18	28	17	25	21
46	18	38	33	40	37	51	39	54	19	14	22	19	11
47	7	52	26	25	25	44	35	23	9	26	16	18	15
48	9	25	12	24	28	37	18	11	8	20	7	12	9
49	4	21	15	19	18	24	24	7	7	13	6	7	7
50	5	10	15	26	24	20	23	7	3	13	8	7	2
51	2	10	9	22	14	13	17	11	5	11	3	6	5
52	3	16	6	19	21	13	17	7	3	7	3	4	4
53		6	6	10	13	8	10	2	1	8	3	2	3
54		5	2	2	14	7	6	9	1	8	1	2	5
55		1	2	3	10	4	5	1	1	3	4	0	5
56		3	1	3	7	6	2	1	0	3	0	0	2
57		1	0	2	4	2	3	1		1	0	0	1
58			1	1	1	2	0	1	0	1	1	0	4
59		0	1	0	0	1	1	1			0	0	2
60			0		0		2			1		0	2
61		3	1		0	1					0	0	1
62				0	0	0	1	0				0	0
63			0	0			0				0	0	2
64						1	0		0	0	0		
65						0	0						0
66		0	0				0						
67													0
68													
69													
70						0					0		
71													
72													
73													
74													
75													
76													
77													
78													
79													
80													
81													
82													
83													
Total	**3509**	**2829**	**2540**	**4332**	**3969**	**5304**	**6240**	**4229**	**4871**	**2449**	**2211**	**1628**	**1138**
Landings (t)	**95**	**84**	**79**	**135**	**130**	**140**	**151**	**112**	**114**	**74**	**60**	**52**	**45**

Table 13.2.2.b. *Nephrops* in FUs 28–29. Length composition of females from landings 1984–2022 (continued).

Landings Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
17											
18											
19				0							
20											
21	7				4						
22		3	1		4		19		0	5	2
23		7	1	0	1		4	10	1	0	4
24	5	7	3		2	13	66	14	5	8	0
25	8	18	10	5	19	91	150	32	25	27	14
26	17	7	10	7	19	23	87	47	13	9	25
27	40	36	17	13	46	100	110	145	55	16	11
28	51	33	23	23	44	134	125	76	49	30	15
29	130	59	60	39	57	169	203	86	124	46	29
30	164	119	80	85	219	464	351	336	246	217	103
31	330	129	99	143	149	290	260	310	146	86	68
32	397	290	203	208	307	462	327	560	306	142	97
33	195	194	105	146	214	290	247	251	167	92	78
34	297	278	202	167	325	353	235	435	215	93	78
35	165	232	188	303	362	365	381	316	430	384	192
36	138	166	153	203	193	196	138	199	172	174	94
37	98	199	151	162	203	142	149	202	127	115	76
38	76	206	148	171	125	81	78	140	110	129	61
39	46	61	121	136	112	105	75	146	79	117	32
40	46	67	145	134	130	108	89	131	89	133	63
41	37	41	66	104	82	56	51	70	34	90	26
42	35	65	90	87	112	72	94	75	48	107	53
43	33	9	27	54	59	55	33	55	49	62	40
44	27	13	40	58	48	53	35	50	52	48	47
45	10	9	17	56	25	45	38	34	42	47	46
46	10	11	17	36	28	36	15	24	30	35	36
47	11	13	18	16	14	21	22	15	67	19	17
48	5	7	5	8	3	14	9	4	8	11	14
49	6	5	7	8	5	7	14	3	23	8	11
50	6	5	4	8	14	7	16	6	6	8	11
51	6	1	3	7	4	7	12	3	10	6	5
52	9	5	4	9	8	6	13	2	8	2	5
53	5	1	3	6	0	5	7	1	4	3	2
54	5	3	8	12	2	4	6	3	5	6	1
55	2	1	3	12	2	3	4	1	3	2	2
56	1	1	6	10	1	1	6	2	2	2	1
57	3	2	2	4	0	1	5	0	1	2	0
58	2	0		1	0	0	5	0	1	0	0
59	0	1	1	3	0	0	2		0	0	1
60	0		2	3	1	1	3	0	1	0	0
61	0					0	1		0		0
62	0	0	0	0			0		0		0
63	0						0		0		
64	0			0			2		0		
65				0		0			0	0	
66				0		0	0		0		0
67				0						1	
68							0		0		
69				0							
70				0							
71										0	
72											
73											
74											
75											
76											
77											
78											
79											
80											
81											
82											
83											
Total	**2424**	**2306**	**2044**	**2446**	**2946**	**3782**	**3487**	**3783**	**2755**	**2283**	**1361**
Landings (t)	**65**	**66**	**66**	**85**	**88**	**102**	**94**	**103**	**83**	**75**	**46**

Table 13.2.3. *Nephrops* in FUs 28–29. CPUEs (kg/h) estimated from demersal (PtGFS-WIBTS-Q4, G8899) and crustacean (Nep S (FU 28-29), G2913) research trawl surveys from 1994–2022.

Year	Demersal surveys			Crustacean surveys	
	CPUE (kg/hour)			Month and year of survey	CPUE (kg/hour)
	Summer	Autumn	Winter		
1994	ns	0.40	ns	May-94	2.3
1995	1.3	0.26	ns	No surveys 1995-96	
1996	ns	0.03	ns		
1997	0.7	0.06	ns	Jun-97	2.7
1998	0.7	0.02	ns	Jun-98	1.4
1999	0.3	0.02	ns	Jun-99	2.5
2000	1.0	0.92	ns	Jun-00	1.6
2001	0.6	0.35	ns	Jun-01	0.8
2002	ns	0.02	ns	Jun-02	2.8
2003	ns	0.19	ns	Jun-03	2.9
2004	ns	0.51	ns	Jun-04	nr
2005	ns	0.09	0.16	Jun-05	5.3
2006	ns	0.19	0.06	Jun-06	2.8
2007	ns	0.04	0.73	Jun-07	2.9
2008	ns	0.13	0.25	Jun-08	5.4
2009	ns	0.13	ns	Jun-09	2.8
2010	ns	0.34	ns	Jun-10	8.1
2011	ns	0.11	ns	Jun-11	nc
2012	ns	ns	ns	ns	ns
2013	ns	0.64	ns	Jun-13	2.5
2014	ns	0.06	ns	Jul-14	1.0
2015	ns	0.21	ns	Jul-15	3.2
2016	ns	0.69	ns	Jun-16	4.9
2017	ns	1.21	ns	Jul-17	5.0
2018	ns	0.46	ns	Aug-18	5.0
2019	ns	ns	ns	ns	ns
2020	ns	ns	ns	ns	ns
2021	ns	0.34	ns	Jun-21	3.1 (nc)
2022	ns	0.74	ns	Jun-22	3.5
ns = no survey nr = not reliable nc = whole area not covered					

Note: Since 2021, survey performed with a new vessel. In 2021 survey not covering the whole area.

Table 13.2.4. *Nephrops* in FUs 28–29. Mean sizes (mm CL) of male and females in Portuguese landings and the (PtGFS-WIBTS-Q4, G8899) and Nep S (FU 28-29), G2913) surveys from 1994–2022.

Year	Landings		Demersal surveys						Crustacean surveys	
			Summer		Autumn		Winter			
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
1994	37.4	33.6	ns	ns	39.0	33.6	ns	ns	ns	ns
1995	39.3	37.0	42.1	35.6	42.0	34.9	ns	ns	ns	ns
1996	36.9	36.6	ns	ns	38.6	32.2	ns	ns	ns	ns
1997	35.9	32.8	40.4	36.9	39.1	31.7	ns	ns	43.7	41.9
1998	36.8	34.5	36.0	33.9	40.6	35.9	ns	ns	39.5	36.7
1999	38.7	34.6	45.1	40.4	43.8	32.8	ns	ns	39.7	37.5
2000	38.9	35.2	40.8	37.1	39.0	35.1	ns	ns	41.7	40.2
2001	41.6	36.1	40.5	34.5	47.2	41.6	ns	ns	44.5	39.9
2002	40.7	36.2	na	na	35.0	39.0	ns	ns	44.8	40.7
2003	39.1	36.4	ns	ns	37.5	32.3	ns	ns	39.7	36.7
2004	37.3	33.8	ns	ns	36.7	31.3	ns	ns	39.0	37.0
2005	35.6	33.0	ns	ns	40.6	39.1	40.6	40.9	37.3	35.7
2006	37.2	34.1	ns	ns	36.1	32.8	31.7	35.0	37.7	35.2
2007	36.5	32.8	ns	ns	42.0	38.5	39.0	36.2	38.3	35.0
2008	40.1	35.5	ns	ns	43.2	41.4	46.7	40.6	40.1	36.7
2009	37.4	34.2	ns	ns	45.3	39.8	ns	ns	41.4	36.6
2010	40.1	36.5	ns	ns	39.7	33.7	ns	ns	37.7	36.6
2011	45.0	39.2	ns	ns	43.1	40.0	ns	ns	nc	nc
2012	36.9	34.4	ns	ns	ns	ns	ns	ns	ns	ns
2013	39.7	35.3	ns	ns	42.6	37.3	ns	ns	39.1	39.5
2014	41.3	36.7	ns	ns	46.5	39.2	ns	ns	37.8	35.2
2015	40.9	37.4	ns	ns	42.4	35.2	ns	ns	39.2	37.3
2016	39.5	35.8	ns	ns	43.7	41.6	ns	ns	38.7	36.1
2017	37.4	34.3	ns	ns	45.2	45.3	ns	ns	40.6	34.5
2018	36.2	33.8	ns	ns	43.5	37.9	ns	ns	37.7	34.0
2019	39.1	34.6	ns	ns	ns	ns	ns	ns	ns	ns
2020	39.7	35.6	ns	ns	ns	ns	ns	ns	ns	ns
2021	40.7	36.7	ns	ns	41.0	36.5	ns	ns	37.5	35.2
2022	41.9	36.9	ns	ns	36.3	35.7	ns	ns	35.8	32.9

ns = no survey nr = not reliable nc = whole area not covered

Note: Since 2021, survey performed with a new vessel. In 2021 survey not covering the whole area.

Table 13.2.5. ***Nephrops*** **in FUs 28–29. Effort and CPUE (kg/h) of Portuguese trawlers from 1994–2022.**

Year	No. of trawlers	CPUE (t/boat)	Estimated hours	CPUE** (kg/hour)
1994	31	7.6		
1995	30	9.1		
1996	25	5.3		
1997	25	5.5		
1998	25	6.4	412 135	0.4
1999	26	8.1	304 167	0.7
2000	27	7.4	524 884	0.4
2001	33	8.2	407 179	0.7
2002	31	11.5	195 227	1.8
2003	32	10.5	136 960	2.7
2004	23	15.0	250 134	1.5
2005	25	15.3	231 930	1.7
2006	25	11.0	134 807	2.2
2007	26	10.5	153 587	1.9
2008	27	7.0	99 950	2.2
2009	27	4.9	63 010	2.4
2010	25	5.2	72 969	2.0
2011	26	4.5	76 477	2.0
2012	21	10.2	79 477	2.9
2013	24	8.2	101 377	2.1
2014	24	7.5	99 505	1.9
2015	22	10.5	120 985	2.0
2016	22	11.5	107 933	2.6
2017	22	11.0	123 713	2.2
2018	22	12.0	102 788	2.9
2019	23	10.7	107 705	2.6
2020	24	8.7	89 496	2.4
2021	26	6.3	81 018	2.1
2022*	25	5.2	70 511	1.9

* provisional; ** standardized CPUE

Table 13.2.6. ***Nephrops*** **in FUs 28–29. Length-based indicators for males and females.**

Sex	Year	Conservation				Optimizing Yield	MSY
		L_c/L_{mat}	$L_{25\%}/L_{mat}$	$L_{max5\%}/L_{inf}$	P_{mega}	L_{mean}/L_{opt}	$L_{mean}/L_{F=M}$
		>1	>1	>0.8	>30%	~1 (>0.9)	≥1
Males	2020	1.02	1.18	0.90	0.14	0.86	1.02
	2021	1.02	1.21	0.92	0.14	0.89	1.05
	2022	1.16	1.18	0.87	0.13	0.94	1.04
Females	2020	0.97	1.08	0.76	0.03	0.83	0.95
	2021	0.97	1.08	0.76	0.02	0.86	0.98
	2022	0.97	1.08	0.77	0.04	0.86	0.99

Table 13.2.7. *Nephrops* in FUs 28–29. Results from the application of the Mean Length Z approach.

		Males	Females
	Input:		
	LFD period	1984-2022	1984-2022
	Effort series	1998-2022	1998-2022
	Growth		
	Linf =	70	65
	K =	0.2	0.065
	t0 =	-0.15	-0.15
	W~L relationship		
	a =	0.00028	0.00056
	b =	3.2229	3.0288
	External M	0.3	0.2
Method	**Results**		
Gedamke & Hoenig	Z =	0.47	0.30
	F* =	0.17	0.10
THoG	q estimate =	0.0015	0.0006
	q estimate* =	0.007	0.003
	M estimate =	0.43	0.26
	F_{2022} estimate =	0.010	0.004
	F_{2022} estimate* =	0.05	0.02
Y/R	F_{MSY} proxy: $F_{0.1}$ =	0.23	0.24

* indicates estimates with external fixed M

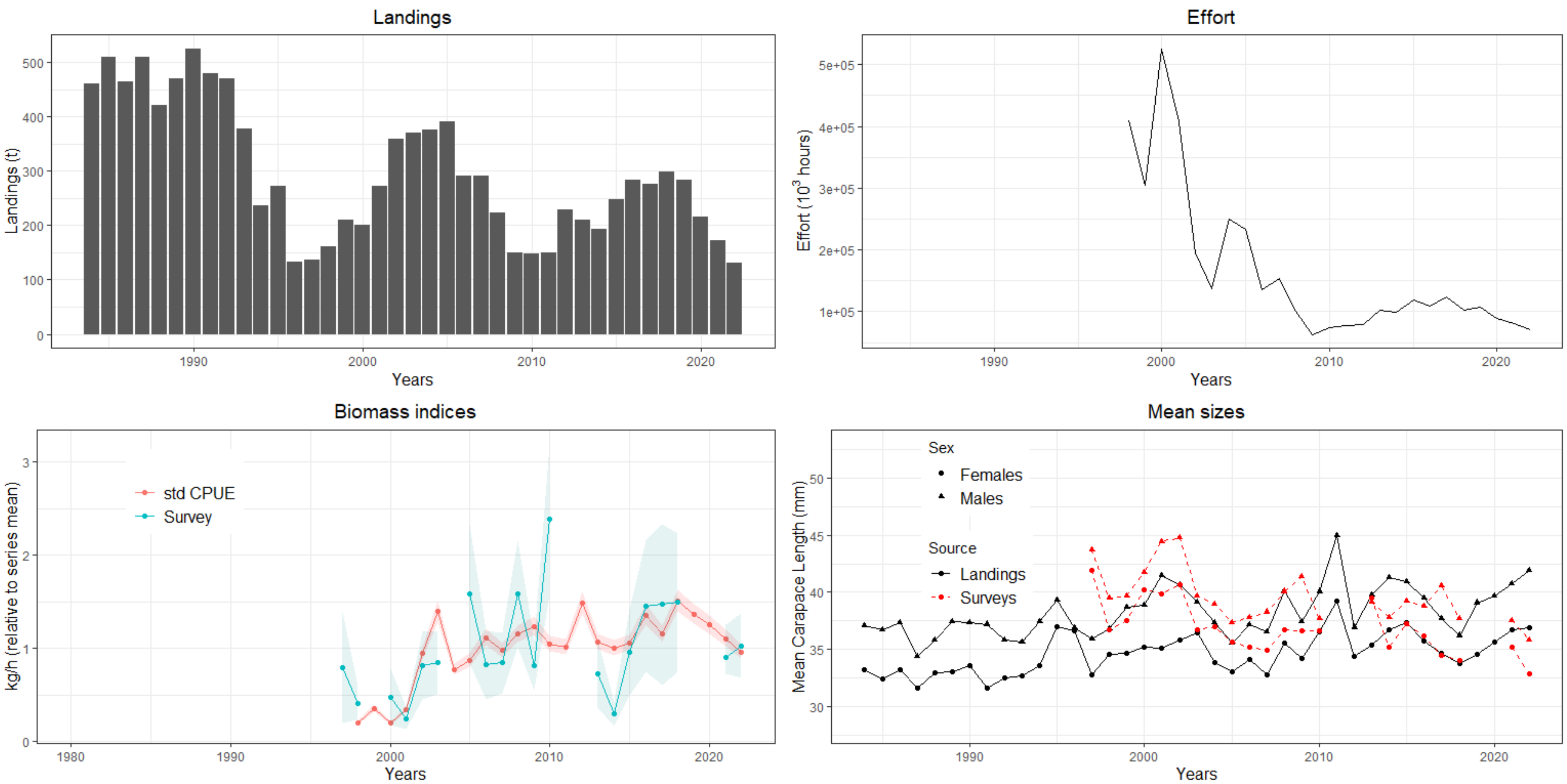

Figure 13.2.1. ***Nephrops*** **in FUs 28–29. Annual landings (top left), effort (top right), biomass indices (bottom left) and mean sizes in Portuguese landings and surveys (bottom right).**

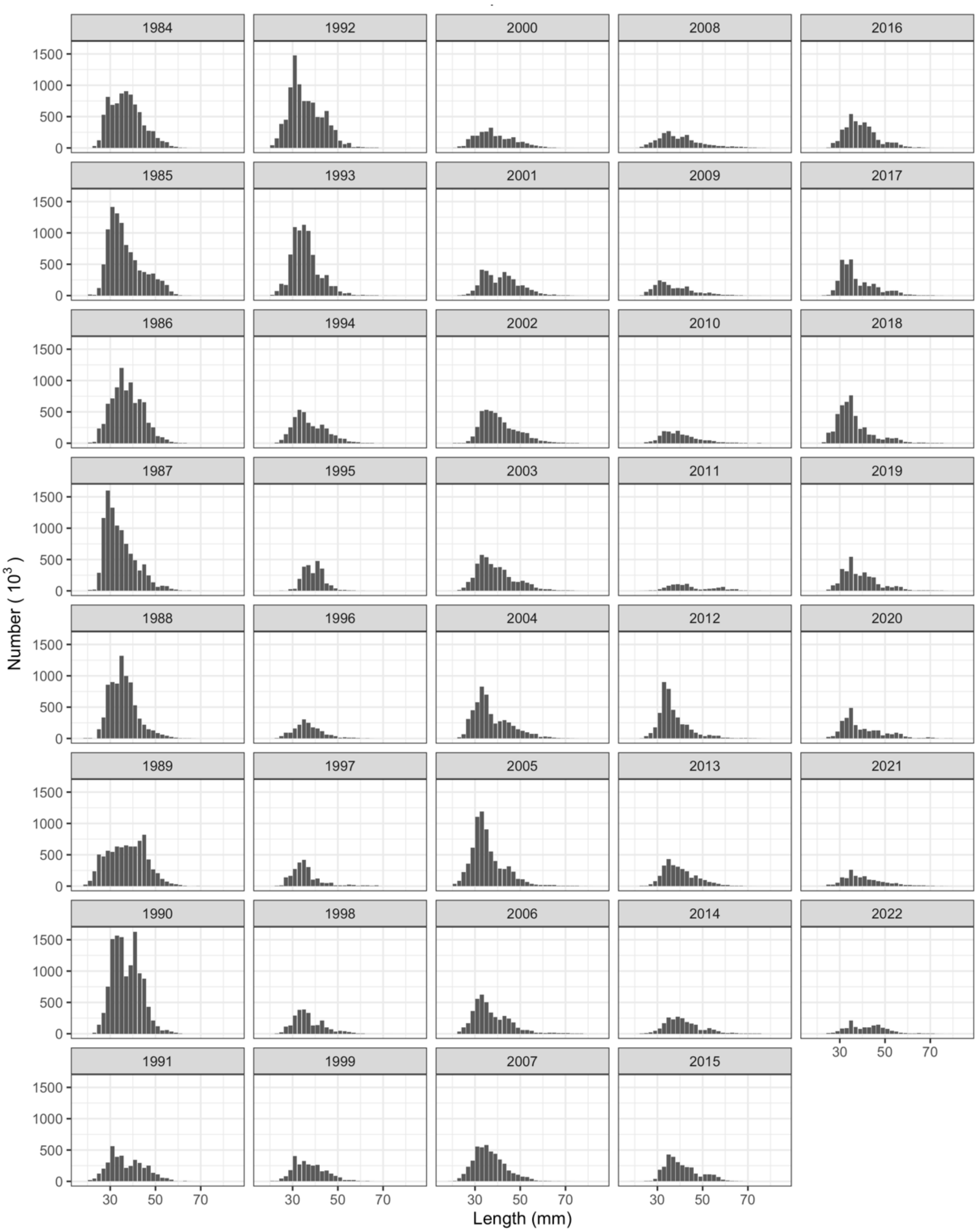

Figure 13.2.2.a. Nephrops in FUs 28–29. Males' length distributions for the period 1984–2022.

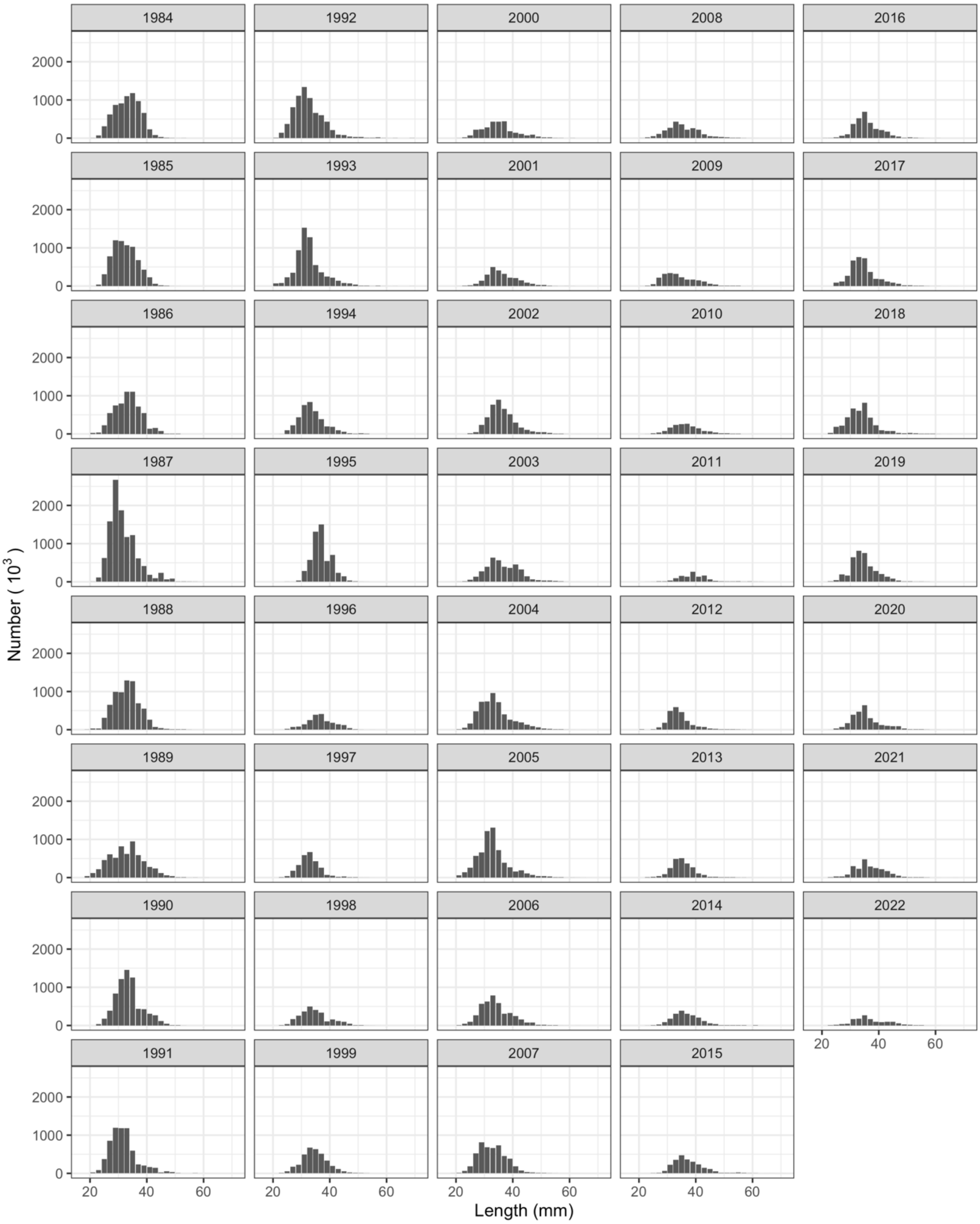

Figure 13.2.2.b. *Nephrops* in FUs 28–29. Females' length distributions for the period 1984–2022.

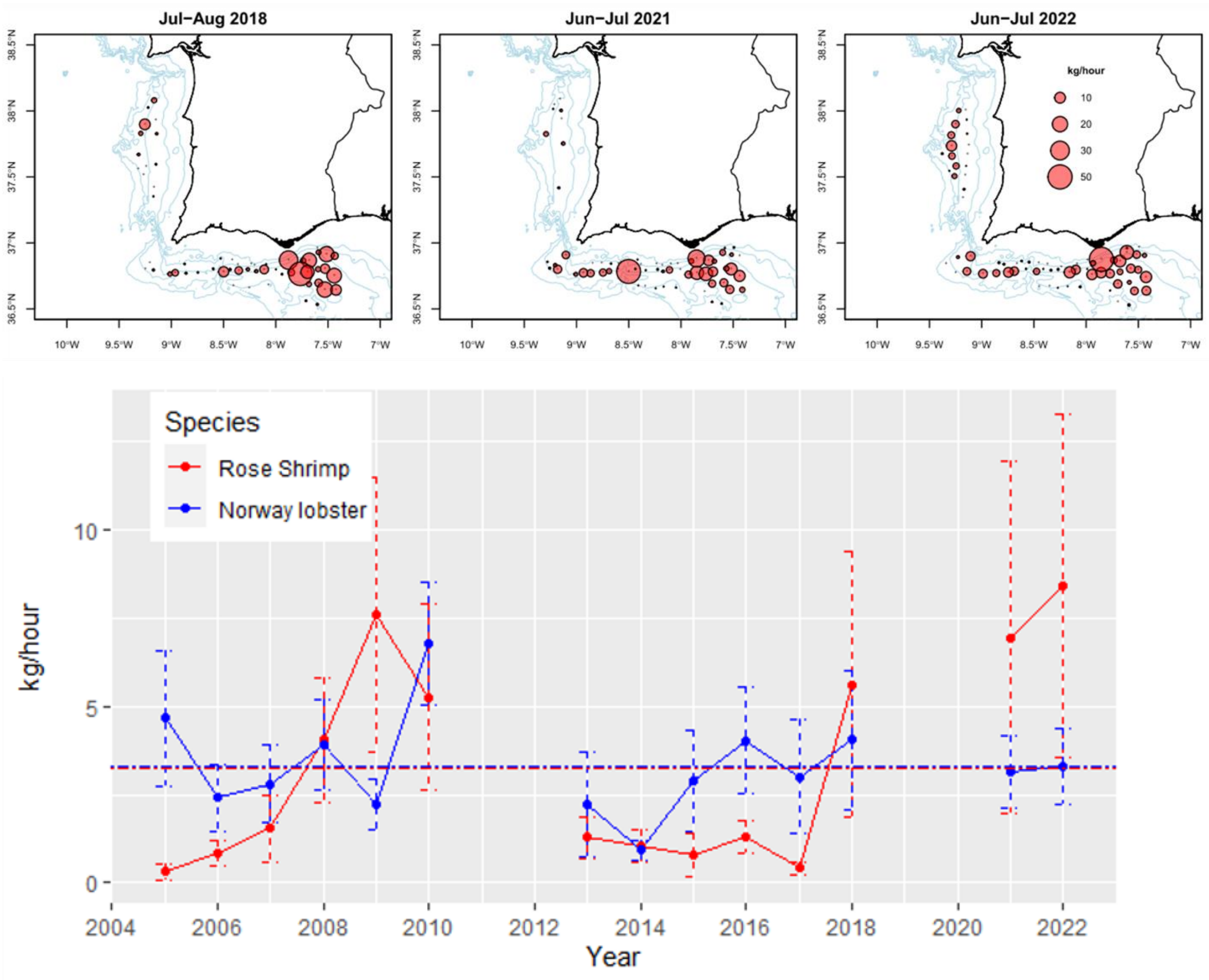

Figure 13.2.3. ***Nephrops*** **in FUs 28–29. Spatial distribution of Norway lobster's biomass survey index in 2018 and the period 2021–2022 (upper panel). Stratified mean biomass time-series (lower panel) with 95% confidence interval of Norway lobster (blue) and deep-water rose shrimp (red). Notes: (1) the 2021 survey did not cover the whole area; (2) horizontal lines represent the long-term average biomass indices.**

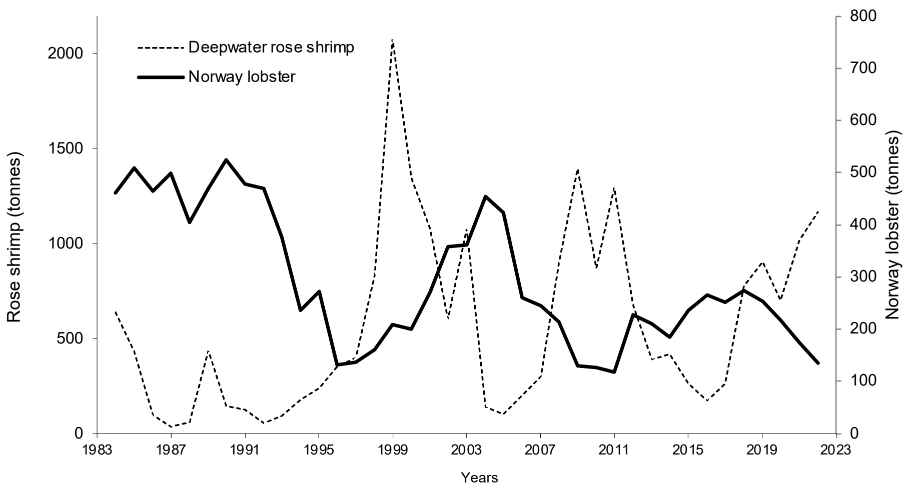

Figure 13.2.4 *Nephrops* in FUs 28–29. Landings (tonnes) of the two main target species of the crustacean fisheries in the period 1984–2022.

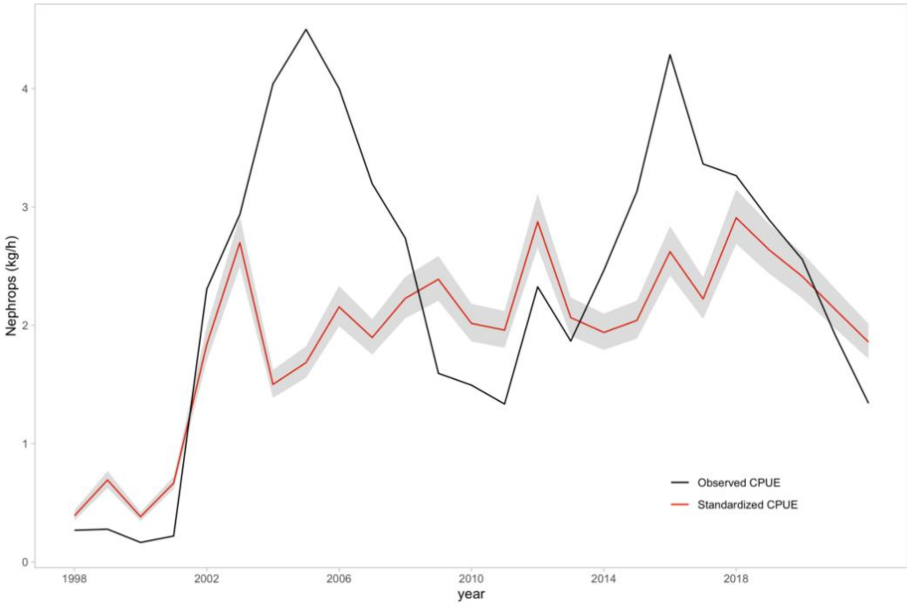

Figure 13.2.5. *Nephrops* in FUs 28–29. Comparison of the observed and standardized *Nephrops* CPUE trends using the standardization model. The shaded area represents the 95% confidence intervals.

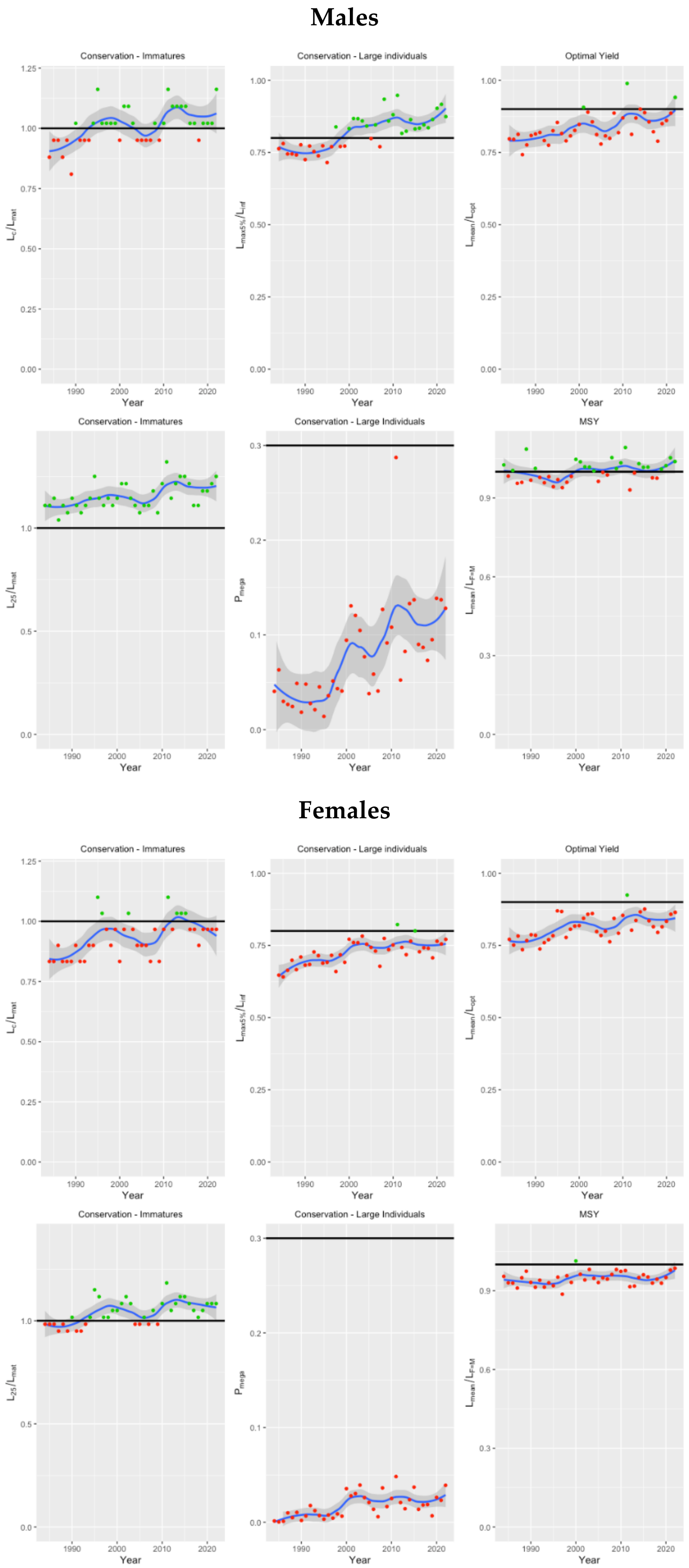

Figure 13.2.6. *Nephrops* in FUs 28–29. Length-based indicator ratios for males (above) and females (below).

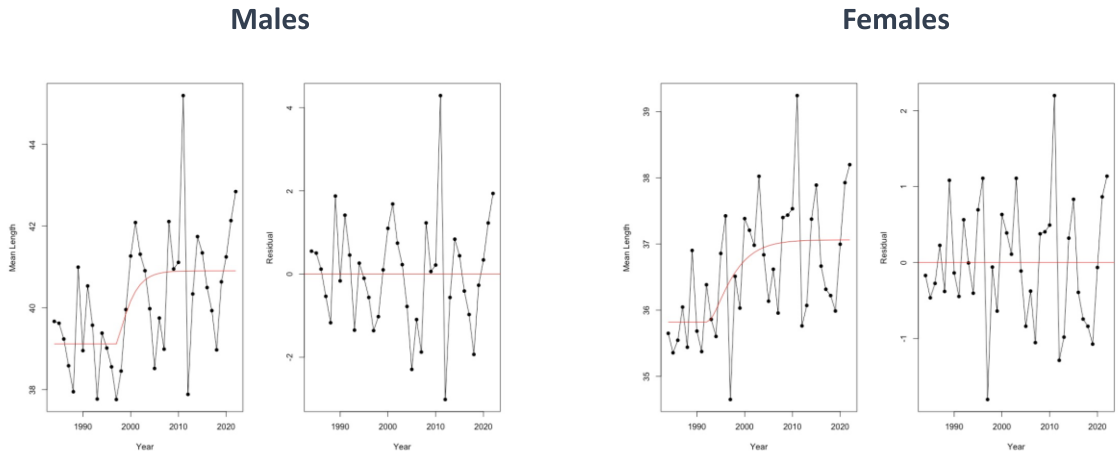

Figure 13.2.7. ***Nephrops*** **in FUs 28–29. Gedamke & Hoenig Mean Length-Z model diagnostics for males (2 graphs on the left side) and females (2 graphs on the right side).**

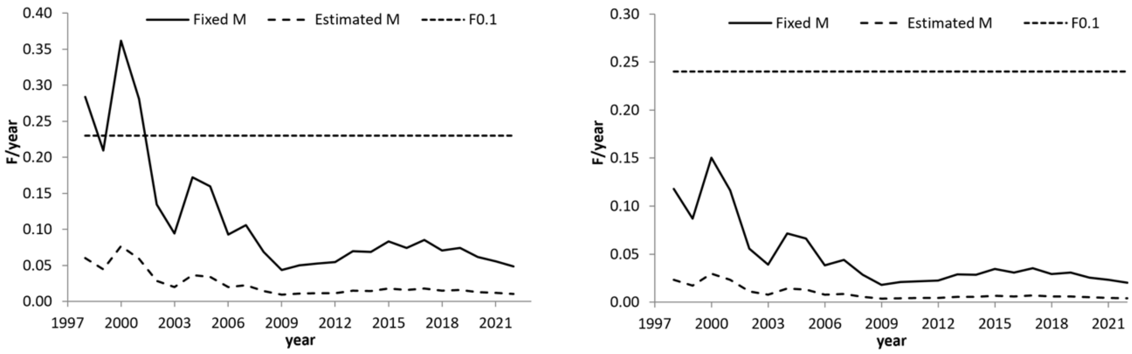

Figure 13.2.8. ***Nephrops*** **in FUs 28–29. Fishing mortality from the THoG model using an external fixed M or an M estimated by the model. Left panel: males,;right panel: females.**

13.3 *Nephrops* in Gulf of Cádiz (FU 30)

Nephrops FU 30 was benchmarked by WKNEP in 2016 (ICES, 2017a). A UWTV survey-based approach was considered appropriate to provide scientific advice on the stock abundance in this FU. However, a stock-specific MSY harvest rate could not be derived. The basis of advice for this stock followed a category 3 assessment using the 2-over-3 rule since 2019 (ICES, 2023b). When the stock-specific MSY reference points can be estimated, *Nephrops* FU 30 will meet the requirements for category 1 assessment (ICES, 2023a; b).

13.3.1 General

13.3.1.1 Ecosystem aspects

See Stock Annex.

13.3.1.2 Fishery description

See Stock Annex.

13.3.1.3 ICES advice for 2023 and management applicable for 2022 and 2023

ICES Advice for 2023

ICES advises that when the precautionary approach is applied, catches in 2023 should be no more than 32 t.

To ensure that the stock in FU 30 is exploited sustainably, ICES advises that management should be implemented at the FU level (ICES, 2023a; b).

Management applicable for 2022 and 2023

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019a). This plan applies to demersal stocks including *Nephrops* in FU 30.

An increase of mesh size to 55 mm was established since September 2009 (Orden ARM/2515/2009) for the bottom trawl fleet.

The TAC for the whole Division 9.a was set at 355 and 298 t for 2022 and 2023, respectively, of which no catch is allowed in FUs 26 and 27. In FU 30, no more than 50 and 32 t can be taken in 2022 and 2023, respectively.

A modification of the Fishing Plan for the Gulf of Cádiz was established in 2014 (AAA/1710/2014). This regulation established an assignment of *Nephrops* quotas by vessel. A closed season in autumn for the bottom trawl fleet of the Gulf of Cádiz is implemented since 2004. Since 2018, this closed season is from 16 September to 31 October (APM/453/2018) annually.

13.3.2 Data

13.3.2.1 Commercial catch and discard

Landings in this FU are reported by Spain, and in minor quantities, by Portugal. Spanish landings are based on sales notes which are compiled and standardized by IEO-CISC. Since 2013, trips from sales notes are also combined with their respective logbooks, which allow georeferencing the catches.

The total landings have been estimated by this WG since 2016 when the concurrent sampling was satisfactorily implemented. The Spanish concurrent sampling is used to raise the FU 30 observed landings to total effort by *métier*. When the estimated landings exceed the official landings, the difference is provided to InterCatch as non-reported landings.

Since the WGHMM meeting in 2010 (ICES, 2010), *Nephrops* landings in Ayamonte port were incorporated in the Gulf of Cádiz landings time-series as well as directed effort and LPUE from 2002 (Table 13.3.1 and Table 13.3.5). *Nephrops* total landings in FU 30 decreased from 108 t in 1994 to 49 t in 1996. After that, there has been an increasing trend, reaching 307 t in 2003 but sharply declined to 147 t in 2004, which is more than a 50% drop. After a new increase in 2005 (246 t), landings declined up to 120 t in 2008. In 2008–2012, landings remained relatively stable at around 100 t. Landings declined again in 2013–2015 up to a mean value of 22 t. Since the quota in 2012 was exceeded, the European Commission applied a sanction to be paid within 3 years, 2013–2015 (Figure 13.3.1). The TAC advice was reduced, limiting the fishery, during this 3-year period. Moreover, the *Nephrops* fishery was closed in 2013 and vessels could only go *Nephrops* fishing for only a few days during summer and winter (ICES, 2017a). Total estimated landings increased in 2016 and 2017 (124 and 140 t, respectively), representing almost six times the landings observed in 2013–2015. Landings estimation was 75 t in 2018, representing 46% less than the previous year (Figure 13.3.1). Landings show a declining trend since that year. In 2022, landings were 44 t, representing 68% less than in 2017 when landings recorded were higher than 100 t. Total landings estimates since 2016 are considered the best information available.

A modification of the regulation implemented for the Spanish Administration for the Gulf of Cádiz grounds in 2014 (Orden AAA/1710/2014) established the assignment of *Nephrops* quotas by vessel. This regulation may have caused unreported *Nephrops* landings in the period 2016–2018. The highest value of non-reported landings was recorded in 2017. In 2019, the non-reported landings were lower than 10% of the official landings and were considered zero. Non-reported landings were not recorded since 2019.

Information on discards is submitted to the WG through InterCatch. The discard rate of *Nephrops* in this fishery fluctuates annually but is always very low, if not zero. Thus, discards are considered negligible (Table 13.3.2). The discard sampling program in 2020 was suspended partially as a result of the COVID-19 disruptions and administrative issues. Therefore, no information on *Nephrops* discards was obtained for that year. In 2022, the percentage of discards remains low but it was 3.3% higher in weight and 27.2% higher in number. The number of individuals, mainly of very small-sized ones, discarded increased significantly. The mean size of the discarded fraction was 15.6 mm CL, the lowest value recorded in the whole time series (Table 13.3.2 and Figure 13.3.2). The highest mean carapace length of the discarded fraction was observed in 2017 (24.2 mm CL). Discards in 2022 were estimated at 0.82 t. Figure 13.3.2 shows the estimated length–frequency distributions (LFDs) of the discarded and retained *Nephrops* per trip for the annual discarding programme (2005–2022).

13.3.2.2 Biological sampling

The species sampling level is given in Table 1.4. Figure 13.3.3 shows the annual landings length distribution for males, females and both sexes combined during the period 2001–2022. The length composition of landings was considered biased from 2001 to 2005 since the landings sampling was not stratified by commercial categories (Silva *et al.*, 2006). A new sampling scheme was applied from 2006 to 2008, making information more reliable (Stock Annex) . The mean sizes for both sexes remained relatively stable after the sampling scheme was changed, around 29 mm CL for both sexes combined.

Since 2009, onboard concurrent sampling is carried out as required by the Data Collection Framework (DCF; EU, 2007). Outside the *Nephrops* fishing season, a larger proportion of observer trips are likely not sufficient to cover *Nephrops* catches, whereas, when the directed *Nephrops* sampling was carried out in harbours during the past, the LFDs of landings were covered for all months. This insufficiency of *Nephrops* catches coverage could reduce the consistency of the catch-at-length distribution data. The number of samples between 2013 and 2015 was influenced by the EU sanction in this period coupled with the closure of *Nephrops* fishery in 2013 (ICES, 2017a). The sampling effort has been increasing since summer of 2016 as a result of the additional *Nephrops*-directed sampling to improve the quality of the commercial LFDs. In 2019, the sampling level decreased in the third quarter and was zero during the fourth quarter. This fact could had some impact on the annual estimation of the sex ratio, the mean length and the mean weight in landings. Summer is the main *Nephrops* fishing season, when females are out from their burrows for reproduction thus, making them more accessible to the fishery. Therefore, sex ratio and mean weight might be affected by the sampling effort distribution along the year.

Onboard sampling was partially conducted in 2020 because of the COVID-19 disruptions and administrative issues. Only one *Nephrops* sampling survey was carried out in the third quarter of 2020, but it was not considered representative of the stock size composition. In order to estimate the landings size composition in 2020, the average LFDs of the last three years (2017–2019) was used to raise and estimate the total landings for 2020. The estimated 2020 total annual landings in number was used to estimate the harvest rate (%) for that year and, consequently, could have certain impacts on the stock assessment in 2021 (ICES, 2021a). During the WGBIE in 2023, a revision of the 2020 landings size composition was estimated using the information available in the years 2018, 2019 and 2021. Results obtained are more realistic as the 2017 size compositions that were previously used differ significantly from the recent years' values used. The sampling levels in 2021 and 2022 were slightly lower compared from previous values mainly due to the COVID-19 disruptions in 2020. However, the main issue remains regarding the incomplete coverage of all the quarters samplings such that the second quarter in 2021 was not sampled while the fourth one is missing in 2022.

Mean sizes of males and females (mm CL) in the *Nephrops* landings time series (2001–2022) are shown in Figure 13.3.1. The mean sizes show a slightly increasing trend from 2006 to 2013 (35.3 and 31.9 mm CL for males and females, respectively). In 2014 and 2015, the mean size in females was higher than for males, the opposite of what should be expected and as was observed in previous years. It could be as a result of sampling problems. This fact was investigated in collaboration with the observers. The number of samples and the number of individuals sampled were low in both years. This sample paucity could distort the sex ratio and the mean size in both sexes. The LFDs in both sexes improved since 2016 when additional *Nephrops*-directed samplings were implemented. However, in the last two years, these *Nephrops*-directed samplings decreased. The mean sizes for both sexes (32.0 and 30 mm CL for males and females, respectively) remained relatively stable for the period 2016-2018. The LFD shows an increase of small-sized individuals in 2017 and 2018 (see Figure 13.3.3). The mean sizes for both sexes fluctuated from 2019 onwards despite a slightly increasing trend. In 2022, mean sizes decreased for both sexes compared to the previous year but especially for males, 34.4 mm CL, while is at 33.0 mm CL for females.

The proportion of males in the sex ratio of the landings is shown in Figure 13.3.4. The proportion of males remained stable, around 50% since 2009, despite an increase observed in 2017 and 2019 (representing 60% and 65% of the landings, respectively). Nevertheless, the increases observed during these two years might be influenced by the low sampling level during the third quarter. Females, on the other hand, are more accessible to the fishing gear in summer (the main *Nephrops* fishing season) when they are out of their burrows for reproduction. In 2020, the sex ratio was estimated from the average LFDs from the years 2018, 2019 and 2021 because the sampling was not conducted due to the COVID-19 disruptions and administrative issues. In 2022, the proportion of males in the landings decreased to about 10%.

13.3.2.3 Mean weight in landings

The mean weights in landings are shown, for the whole time-series, in Figure 13.3.5. Since 2009, an increasing trend of the mean weight was observed. In 2013, it declined but remained stable at about 31 g until 2015 (period affected by the 2013 sanction and rebatement in TAC limitation for 3 years). In 2016, a decline in the landings' mean weight was observed again then remained stable in 2017 and 2018, reaching a mean value of 23.4 g during these last three years. The mean weight increased up to 32.4 g in 2019. The low level of sampling when females are more accessible to the *Nephrops* fishery could have caused an increment in the mean weight of the annual landings as males tend to be larger and heavier than females. Mean weight in 2020 (29.2 g) has been estimated from the average LFD from the years 2018, 2019 and 2021 as a consequence of the pandemic and administrative problems explained before. The mean weight in landings was 39.2 g in 2021 while in 2022, a decrease was observed and it was estimated at 30.7 g.

13.3.2.4 Abundance indices from surveys

Trawl surveys

The biomass and the abundance indices time-series (1993–2022) of *Nephrops* by depth strata, estimated from the Spanish Gulf of Cádiz IBTS-Q1 (G7511) are shown in Table 13.3.3. No survey was conducted in 2021 due to some administrative and technical issues with the vessel encountered that year.

The overall abundance index trend decreased from 1993 to 1998 and remained stable from 1999 to 2009 despite the occurrence of strong fluctuations in some years. In 2003, the survey was not conducted due administrative issues. The lowest values in the time-series were recorded in 2004 and 2012. In 2010, the deeper strata (500–700 m) were not sampled as a result of a reduction in the number of days at sea as a consequence of adverse weather conditions. Therefore, only the abundance index for the 200–500 m strata is available for 2010 and its value is similar to the corresponding strata in previous years. The abundance index increased significantly in 2013 and 2014 (Table.13.3.3). The survey index has fluctuated since 2015 then declined in 2017 and 2018. Results in 2019 and 2020, showed an increasing trend reaching the highest value recorded in 2020 for the whole time series (Figure 13.3.6). In 2022, survey index dropped at the same level as that of 2011. It should be noted that this survey is not specifically directed to *Nephrops* and is not carried out during the main *Nephrops* fishing season. In addition, *Nephrops* spatial distribution and density are strongly related to the substratum such that the stock's abundance index might differ depending on the allocation of the hauls within the strata.

The length distributions of *Nephrops* obtained in the Spanish Gulf of Cádiz IBTS-Q1 (G7511) during the period 2001–2022 are presented in Figure 13.3.7. As previously indicated, no survey was conducted in 2021. An increase of smaller individuals was observed in 2015 and 2016. The mean size for both sexes increased in 2017 while remaining relatively stable in 2018 and 2019 (~36 mm CL in males and ~30 mm CL in females). In 2020, the mean size decreased to 33.9 mm CL in males while remained stable at around 30 mm CL in females. However, the mean size in males increased but declined in females in the last year (38.1 and 27.5 mm CL for males and females, respectively). This is the lowest mean size recorded for females in the time series. The time-series for the *Nephrops*' mean sizes by sex that were obtained from this survey is shown in Figure 13.3.8. No apparent trends are observed. The mean size ranged between 27.5 and 32.7 mm CL for females while 31.9 and 42.9 mm CL for males.

UWTV surveys

An exploratory *Nephrops* UWTV survey on the Gulf of Cádiz fishing grounds, also known as the ISUNEPCA UWTV (U9111) survey, was carried out within a project framework supported by Biodiversity Foundation (Spanish Ministry of Agriculture, Food and Environment) and

European Fisheries Fund (EFF) in 2014 (Vila *et al*., 2014). This survey was initially considered exploratory in 2014 and, currently, data from seven UWTV surveys are available (2015 to 2022). UWTV survey was not conducted in 2020 as a result of the COVID-19 disruptions.

The ISUNEPCA UWTV (U9111) surveys are based on a randomized isometric grid design with stations spaced by 4 nm. The methods used during the surveys are according to WKNEPHTV (ICES, 2007), WKNEPHBID (ICES, 2008), and SGNEPS (ICES, 2012) and WGNEPS (ICES, 2020b, 2021b). A description of the ISUNEPCA UWTV (U9111) surveys carried out in FU 30 since 2014 is documented in the Stock Annex.

Results from the ISUNEPCA UWTV (U9111) surveys were evaluated during the WKNEP benchmark workshop on *Nephrops* stocks in 2016 (ICES, 2017a). During this workshop, it was concluded that this survey in FU 30 is appropriate for providing scientific advice on stock abundance.

Data compiled during ISUNEPCA UWTV (U9111) survey series (2015-2021) suggested that the previously sampled survey area was probably not adequate as surface size than what should be considered for the evaluation of this stock. Therefore, it was concluded that a review and revision of the survey area should be carried out because it could directly affect the *Nephrops* abundance estimate and, as a consequence, the scientific advice. According to SGNEPS, the boundary definition of the survey area should also be assessed on a regular basis (ICES, 2012). In this sense, a new area for the ISUNEPCA UWTV (U9111) survey was proposed last year since nowadays new and more accurate information is available. A working document explaining details about the re-definition of the survey area was presented in advance to WGBIE in 2022 (Vila and Burgos, 2022) for the WG to recommend a review by external experts to evaluate the validity of the revised sampling area for the ISUNEPCA UWTV (U9111) survey in 2022, following the WGNEPS recommendation in 2021 (ICES, 2022c).

The *Nephrops* fishing activity was analysed using the Andalusia Regional Government vessel monitoring system, called SLSEPA (*"Sistema de Localización y Seguimiento de embarcaciones Pesqueras Andaluzas*") and sales notes in 2019. SLSEPA is a special vessel monitoring system on vessels using GPRS/GSM, a cellular network technology that sends the vessel exact position and speed data every three minutes instead of the usual two-hour transmitted data obtained from a traditional VMS. Additionally, information obtained from the bottom trawl surveys (SpSGFS-cspr-WIBTS-Q1 (G7511) and SpGFS-caut-WIBTS-Q4 (G4309)) indices time-series for the period 1994–2020 and the beam trawl and sediment samples from the ISUNEPCA UWTV survey (U9111) from 2017 to 2019 which are coupled with a more detailed and recent information on seabed morphology and the sediment-habitat relationships in the Gulf of Cádiz (Lozano *et al.*, 2019; Lozano *et al.*, 2020; Urra *et al.*, 2021) were also used to redefine the survey area in FU 30 (ICES, 2022b; c).

The new surface area coverage considered after the WGNEPS (ICES, 2022c) in 2021 is 2 332.13 Km^2, representing approximately 20% less than the previous survey area. The kriged density estimates for the ISUNEPCA UWTV (U9111) survey and the geostatistical abundance of burrows were updated for the whole of the time series based on the new defined area before October 2022, when the advice for this stock was released. ns Not survey
**** Strata not sampled**

Na abundance and biomassa not availabe

Table 13.3.4 shows the results of the updated geostatistical analysis based on the redefined survey area. In 2022, the number of stations considered for the estimation of a new geostatistical abundance is lower due to the reduction of the surveyed area. A sampling grid with a 3.5 nm stations-spacing was agreed and was first implemented in the ISUNEPCA UWTV (U9111) survey in 2022 and will now be used annually instead of the 4 nm spacing previously used in the time-series to estimate the abundance (ICES, 2021a). The revision of the distance between stations was made in order to increase the number of stations for the geostatistical analysis.

The highest mean burrow density (adjusted to the cumulative bias) was obtained in 2017. This value slightly decreased in 2018 and has declined considerably from 2019 to 2021. Mean burrow density in 2022 decreased slightly compared to the previous year, reaching the lowest value of the time-series (ns Not survey
**** Strata not sampled**

Na abundance and biomassa not availabe

Table 13.3.4).

Abundance estimates obtained after the survey area re-definition in 2015 and 2016 were lower than before the surface area revision (17% and 10% less, respectively) but were higher in 2017 and 2018 (3% and 13% more, respectively) (ns Not survey
**** Strata not sampled**

Na abundance and biomassa not availabe

Table 13.3.4). The new abundance estimates in 2019 and 2021 were 3% and 9% lower, respectively, than those estimated before the survey area. Nevertheless, despite the change in abundance values due to the surface area revision, the general trend observed is similar to that of the previous time series (ICES, 2022b). The updated model of density surfaces for the all the time-series (2020 unavailable) using the revised survey area is shown as heat maps and bubble plots in **Error! Reference source not found.**9.

The updated abundance estimate derived from the kriged burrow surface (and adjusted for the cumulative bias) increased from 249 in 2015 to 383 million burrows in 2017 but with a lower value recorded in 2016 (209 million burrows). In 2018, the new geostatistical abundance estimate (370 million burrows) was slightly lower than the previous year. However, the heat map of the abundance estimates in the main patch within the *Nephrops* distribution area where the commercial bottom-trawl fishery operates, shows an increase value compared to 2017. The geostatistical abundance estimate shows a decreasing trend since 2019 (110 million burrows) which was 50% less than in 2021 (66 million burrows). The abundance in 2022 was estimated at 53 million burrows. The ISUNEPCA UWTV (U9111) survey in 2020 could not be conducted as a result of the COVID-19 pandemic.

The coefficient of variation of the updated time-series was in general higher than the previous series (ICES, 2022b). Values ranged between 6.7% in 2018 and 12.1% in 2016 (ns Not survey
**** Strata not sampled**

Na abundance and biomassa not availabe

Table 13.3.4), although always below of the 20% threshold established by the WGNEPS (ICES, 2012).

13.3.2.5 Commercial catch and effort data

Figure 13.3.1 and Table 13.3.5 show directed *Nephrops* effort estimates and LPUE series revised after the incorporation of data from Ayamonte port since 2002. Directed effort is estimated from trips that land at least 10% of *Nephrops*. The directed fishing effort trend is clearly increasing from 1994 to 2005, where the highest value of the time-series was recorded (4 336 fishing days). After that, the effort declined up to 2008 (73%) remaining relatively stable during the 2009–2012 period. As a consequence of the sanction in 2012 (referred in section 13.3.2.1), the effort dropped (mean value 283 fishing days) in 2013–2015. Fishing effort increased from 2016 (443 fishing days) to 2019 (675 fishing days), remaining relatively stable at around 600 fishing days in 2020 and 2021. In 2022, *Nephrops* directed effort decreased by 63% in relation to the previous year (Figure 13.3.1).

The commercial LPUE obtained from the directed effort shows a gradual decrease from 1994 to 1998 followed by a slight increase from 1999 until 2003. This dropped again in 2004 to a low value of 44.3 Kg/fishing day. In general, the commercial LPUE has fluctuated during the time-series (Figure 13.3.1). During the last period, the commercial abundance index has declined since 2019 reaching the estimated value of 48.7 Kg/fishing day in 2021. However, directed LPUE slightly increased to 54.4 Kg/fishing day in 2022.

It should be noted that the commercial LPUE for the period 2013–2015 must be taken with caution as during this period a penalty for exceeding the quota in 2012 was applied, which increases the uncertainty associated with the LPUE index. Moreover, the assignment of *Nephrops* quotas by vessel implemented in 2014 might have caused unreported landings and contributed to increasing the uncertainties around the commercial LPUE index estimated since then. On the other hand, the commercial LPUE index was estimated using the official (reported) and not the total landings estimated by the WG since 2016. This factor might contribute to an increase of the commercial LPUE abundance index uncertainty.

13.3.3 Assessment

This *Nephrops* stock was benchmarked in October 2016 (ICES, 2017a). The assessment is based on the ISUNEPCA UWTV (U9111) survey trends according to a category 3 stocks (ICES, 2022a; 2023b).

13.3.4 Catch options

The prediction of landings for the FU 30, using the procedure agreed upon at WKNEP in 2016 (ICES, 2017a) and outlined in the Stock Annex, is usually made on the basis of the ISUNEPCA UWTV (U9111) survey estimated abundance obtained in the advice year and is presented in October for the provision of advice (ICES, 2023a). The 2023 ISUNEPCA UWTV (U9111) survey is scheduled from 31 May to 12 June. The input table for the catch options to provide advice for 2023 is given below and Figure 13.3.6.:

Variable	Value	Source	Notes
Stock abundance	available in October	ICES (2023a)	UWTV survey 2023
Mean weight in landings	33.1 g	ICES (2023a)	Average 2020-2022
Mean weight in discards	-	ICES (2023a)	Not relevant
Discard proportion	0%	ICES (2023a)	Negligible
Discard survival rate	-	ICES (2023a)	Not relevant
Dead discard rate	0%	ICES (2023a)	Negligible

13.3.5 Biological reference points

F_{MSY} proxy ($F_{0.1}$) derived from the Separable Cohort Analysis (SCA; Pope and Shepherd, 1982) model during the WKNEP in 2016 (ICES, 2017a), corresponds to a harvest rate (HR) of 9.5% but this resulted in a much higher catch advice than the historical values observed. WKNEP 2016 decided to derive the HR from historical catches of this stock and the exploitation in similar stocks as an interim solution until a more consolidated basis for generating an advice from ISUNEPCA UWTV (U9111) survey abundance estimates can be developed (ICES, 2017a). Taking into account the history of the fishery in *Nephrops* FU 30, HR was estimated to range between 1.5% in 2010–2012 and 4% in 2003 when landings reached the highest value for the whole time series. The TACs for the period 2013–2015 were not considered since these limited the fishery as a consequence of the penalty applied for exceeding the TAC in 2012. Thus, in 2016 the WKNEP recommended setting an initial F_{MSY} proxy to 4% and moving gradually towards this level despite the absence of a current transition scheme definition. As the ISUNEPCA UWTV (U9111) survey was just recently implemented in the FU 30 during WKNEP 2016, caution was recommended in the definition of the transition scheme towards F_{MSY} proxy (ICES, 2017a).

WKNEP (ICES, 2017a) in 2016 also recommended a new EG that will examine the estimation methodology for all *Nephrops* reference points with focus on natural mortality (M) and growth.

The ADGNEP agreed in October 2017 that in the absence of a stock-specific MSY HR, normally used for calculating the F_{MSY} for category 1 *Nephrops* stocks (ICES, 2023a; b), *Nephrops* in FU 30 should follow the category 4 approach as the basis of advice for this stock (ICES, 2023a) due to the poor fits in length–frequency model analyses. ADGNEP recommended that once the stock-specific MSY reference points can be estimated, *Nephrops* in FU 30 will meet the requirements for a category 1 stock assessment.

The WGBIE in 2017 supported the proposal of a specific intersessional workshop before the 2018 WGBIE meeting (ICES, 2017b). Unfortunately, the WK*Nephrops* was only finally held in November 2019 (ICES, 2020c). Different assessment models were applied and explored for this stock during the WK*Nephrops* workshop. Some of them are methods developed for data-limited stocks (DLS) such as the Length-Based Indicators (LBIs) or Mean Length-Z (MLZ) based on the WKLIFE V (ICES, 2015) workshop were implemented while the Separable Cohort Analysis (*SCA* R package version 1.2.0; Bell, 2019) and Separable Length Cohort Analysis (Leocádio *et al.*, 2018; SLCA–*nepref* R package version 0.2.2; Dobby, 2019;) were used for calculating MSY Reference Points for Category 1 *Nephrops* stocks. The SCA model gave estimates for the *Nephrops* in FU 30 stock far below those estimated based on the ISUNEPCA UWTV (U9111) survey. Factors as the uncertainties around M and growth parameters can affect the shape of the catch-at-length distribution and can produce different magnitudes of stock abundance. On the other hand, the abundance from the ISUNEPCA UWTV (U9111) input value in the model for FU 30 seems to be very sensitive, where lower survey inputs resulted in a model with a better fit. Some exploratory runs were carried out using SLCA but the resulting HRs were also very high (ICES, 2020c).

To conclude, the MSY reference point could not be properly derived for FU 30 during the WK*Nephrops* in 2019 (ICES, 2020c). Other methods need to be explored in order to obtain specific FU 30 MSY reference points and upgrade this *Nephrops* stock to category 1. Nevertheless, methods as SCA or SLCA should be tested again since the UWTV survey area and the geo-statistical abundance of *Nephrops* burrows was updated last year.

Estimates from LBIs and MLZ methods as defined in WKLIFE-V (ICES, 2015) and WKProxy (ICES, 2016) are used for category 3 stocks. These estimates were updated during this WGBIE for *Nephrops* in FU 30.

From length-based analysis of the period 2009–2022, LBI results indicate that the fishing mortality (F) is above the MSY indicator in males while below in females (Table 13.3.7). The MLZ model results show the values of $F_{0.1}$ as proxies of F_{MSY} are 0.23 for males and 0.24 for females. According to these models, the stock is being fished in different ways for males and females in relation to the reference point (Figure 13.3.11). Males are fished above the F_{MSY} and females below the F_{MSY}. No proxy for B_{MSY} was identified.However, reference points resulting from the application of these methods are only indicative. In stocks assessed using the ISUNEPCA UWTV (U9111) surveys, the F reference point is expressed as a HR (in percentage).

13.3.6 Management considerations

Nephrops fishery is taken in mixed bottom-trawl fisheries. Therefore, the harvest control rules (HCRs) applied to other species will affect this stock.

During the WGBIE meeting this year, the WG was informed about the new guidelines for estimating HCRs for categories 2 and 3 stocks (ICES, 2022a). As a category 3 stock, the HCR for this stock…

In 2013 and 2014, the *Nephrops* fishery was closed for most of the year because the quota in 2012 was exceeded and the European Commission applied a sanction to be paid in 3 years (2013-2015).

A Recovery Plan for the Iberian stocks of hake and *Nephrops* was approved in December 2005 (EU, 2005). This recovery plan was based on a precautionary reference point for southern hake. By derogation, a different method for effort management was applied to the Gulf of Cádiz. A multiannual management plan (MAP) for the Western Waters was published by the European Parliament and the Council (EU, 2019a) and repealed the former recovery plan. This multiannual management plan applies to demersal stocks including *Nephrops* in FU 30 in ICES Division 9.a.

Different Fishing Plans for the Gulf of Cádiz have been established by the Spanish Administration since 2004 in order to reduce the fishing effort of the bottom trawl fleet (ORDENES APA/3423/2004, APA/2858/2005, APA/2883/2006, APA/2801/2007, ARM/2515/2009, ARM/58/2010, ARM/2457/2010; AAA/627/2013). These plans established a closed fishing season of 45 days, between September and November, plus an additional 5 days to be selected by the shipowner during the duration of this Plan. The potential effect of the closed seasons on the *Nephrops* population has not been evaluated. Additionally, an increase of the mesh size to 55 mm or more was implemented at the end of 2009 in order to reduce discards of individuals below the minimum landing size (MLS). In 2014, a modification of the last Fishing Plan for the Gulf of Cádiz was established (AAA/1710/2014, modified by AAA/1406/2016). This new regulation established the assignment of *Nephrops* quotas by fishing vessel. The Fishing Plan for the Gulf of Cádiz (APM/453/2018) changes the closed season for the bottom trawl fleet to the period from 16 September to 31 October.

Several regulations were established by the Regional Administration with the aim of distributing the fishing effort throughout the year (Resolutions: 13 February 2008, BOJA nº 40; 16 February 2009, BOJA nº 36; 23 November 2009, BOJA nº 235; 15 October 2010, BOJA nº 209). These regional regulations control the days and time when the Gulf of Cádiz bottom trawl fleet can enter or leave the fishing ports. Although the regulations varied among them, they generally allowed a large flexibility during late spring and summer (e.g. the 2010 Regulation established a continuous period from Monday 3 am to Thursday 9 pm during May–August, that was implemented in 2011) which is the main *Nephrops* fishing season and a more restricted implementation of the regulation during other months. This fishing flexibility during summer might have induced fleets from the ports closer to the *Nephrops* grounds, such as Ayamonte or Isla Cristina, to direct their fishing effort to this species between 2008 and 2011. Currently, this regulation is no longer implemented.

Unwanted catches from *Nephrops* are regulated by the discard plan for the demersal fisheries in southwestern waters for the period 2019–2023 (EU, 2018 replaced by EU, 2019b and later by EU, 2020), under which the *Nephrops* stocks are exempted from the landing obligations if the species has a high survival rates. This exemption applies to all bottom trawl catches of Norway lobster from ICES subareas 8 and 9, with the immediate release of all discards in the area where they were caught.

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13.3.8 Tables and figures

Table 13.3.1. *Nephrops* in FU 30. Gulf of Cádiz: Landings (in tonnes) by country and discards.

Year	Spain*	Portugal	Non-reported	Discards	Total
1994	108				108
1995	131				131
1996	49				49
1997	97				97
1998	85				85
1999	120				120
2000	129				129
2001	178				178
2002	262				262
2003	303	4			307
2004	143	4			147
2005	243	3			246
2006	242	4			246
2007	211	4			215
2008	117	3			120
2009	117	2			119
2010	106	1			107
2011	93	3			96
2012	115	1			116
2013	26	< 1			27
2014	14	< 1			15
2015	25	< 1			25
2016	35	< 1	89		124
2017	38	< 1	101		140
2018	49	< 1	27		75
2019	65	0	0		65

Year	Spain*	Portugal	Non-reported	Discards	Total
2020	55	8	0		63
2021	43	6	0		49
2022	44	0	0	<1	45

*** Ayamonte landings are included since 2002.**

Table 13.3.2. *Nephrops* in FU 30. Gulf of Cádiz. Mean carapace length (in mm) of the discarded and retained fraction and percentage of discard in weight and number (2005–2022) for the annual discarding program.

Year	Mean carapace length (mm)		% Discarded	
	Discarded fraction	Retained fraction	Weight	Number
2005	23.4	33.5	5.2	15.2
2006	20.5	29.4	4.6	11.8
2007	23.2	33.7	0.5	1.4
2008	20.8	35.2	2.5	7.7
2009	21.2	30.2	2.7	4.0
2010	21.9	31.7	1.3	4.5
2011	-	32.7	0.0	0.0
2012	-	32.6	0.0	0.0
2013	23.9	32.7	3.7	10.9
2014	-	34.5	0.0	0.0
2015	21.2	33.6	2.0	5.4
2016	20.5	31.0	0.0	0.1
2017	24.2	29.8	2.5	3.0
2018	23.5	32.0	2.9	7.6
2019	21.4	35.6	1.6	7.2
2020*	n/a	n/a	n/a	n/a
2021	22.6	34.6	0.6	7.2
2022	15.9	35.9	3.3	27.2

*** Discard sampling was only partially conducted as a result of the COVID-19 pandemic and administrative problems in IEO.**

Table 13.3.3. ***Nephrops*** **in FU 30. Gulf of Cádiz. Abundance index from Spanish Gulf of Cádiz International Bottom Trawl Surveys Q1 (G7511).**

Year	200–500 meters		500–700 meters		200–700 meters	
	Kg/60'	Nb/60'	Kg/60'	Nb/60'	Kg/60'	Nb/60'
1993	0.77	19	1.16	34	0.95	26
1994	1.23	31	0.60	8	0.94	21
1995	0.55	8	**	**	na	na
1996	0.56	10	1.33	29	0.93	19
1997	0.08	2	0.70	23	0.38	12
1998	0.40	16	0.23	7	0.30	11
1999	0.50	15	0.28	7	0.41	12
2000	0.22	7	0.57	15	0.37	10
2001	0.32	8	0.61	14	0.44	11
2002	0.49	17	0.45	11	0.47	14
2003	ns	ns	ns	ns	ns	ns
2004	0.15	5	0.15	4	0.15	5
2005	0.54	18	0.76	25	0.64	21
2006	0.24	6	0.66	20	0.42	12
2007	0.44	16	0.23	9	0.35	13
2008	0.88	26	0.81	14	0.85	20
2009	0.64	18	0.30	4	0.37	9
2010	0.63	20	**	**	na	na
2011	0.35	11	0.08	2	0.23	7
2012	0.15	4	0.22	4	0.18	4
2013	0.36	13	1.39	51	0.79	29
2014	2.97	84	0.50	9	1.92	52
2015	1.04	45	1.58	52	1.27	48
2016	4.38	194	0.5	15	2.73	118
2017	2.27	79	0.86	20	1.67	54
2018	0.49	15	0.23	5	0.38	11
2019	1.49	46	1.14	27	1.34	38

Year	200–500 meters		500–700 meters		200–700 meters	
	Kg/60'	Nb/60'	Kg/60'	Nb/60'	Kg/60'	Nb/60'
2020	7.07	262	4.93	405	6.16	323
2021	ns	ns	ns	ns	ns	ns
2022	0.33	12	0.14	3	0.25	8

ns Not survey
**** Strata not sampled**
Na abundance and biomassa not availabe

Table 13.3.4. *Nephrops* in FU 30. Gulf of Cádiz. Summary table of results from the geostatistical analysis for ISUNEPCA UWTV (U9111) survey.

Year*	Nº stations***	Mean density adjusted	Domined Area	Geoestatistical Abundance estimate adjusted	CV on burrow estimate
		Burrow/m2	Km2	Millions burrows	%
2015	48	0.1043	2332.13	249	7.7
2016	48	0.087	2332.13	209	12.1
2017	46	0.1659	2332.13	383	10.3
2018	47	0.1506	2332.13	370	6.7
2019	48	0.0499	2332.13	110	11.3
2020**	NA	NA	NA	NA	NA
2021	46	0.0272	2332.13	66	12.0
2022	67	0.0215	2332.13	53	10.8

* Updated in 2023 using the new survey area established during wgbie2022.

**UWTV Survey in 2020 was not carried out due the COVID-19 disruption.

*** Sampling grid with stations spacing 4 nm from 2015 to 2021 and 3.5 nm in 2022.

Table 13.3.5. *Nephrops* in FU 30. Gulf of Cádiz. Total landings and landings, LPUE and effort of the bottom-trawl fleet fishing trips with at least 10% of *Nephrops* catches.

Year	Total landings (t)*	Landings (t)**	LPUE (Kg/day) **	Effort (Fishing days) **
1994	108	90	98.6	915
1995	131	107	99.4	1079
1996	49	40	88.2	458
1997	97	75	79.2	943
1998	85	51	62.3	811
1999	120	83	66.2	1259
2000	129	90	60.6	1484
2001	178	130	67.7	1924
2002	262	196	69.4	2827

Year	Total landings (t)*	Landings (t)**	LPUE (Kg/day) **	Effort (Fishing days) **
2003	307	214	75.4	2840
2004	147	98	44.3	2206
2005	246	228	52.7	4336
2006	246	227	64.0	3555
2007	215	198	63.7	3105
2008	120	84	72.9	1150
2009	119	83	50.0	1653
2010	107	73	45.5	1603
2011	97	62	54.6	1135
2012	116	80	58.0	1380
2013	27	24	92.1	262
2014	15	12	40.1	293
2015	25	17	58.8	294
2016***	124	29	64.6	443
2017	140	24	45.5	535
2018	76	31	47.1	658
2019	65	50	73.7	675
2020	63	37	59.0	625
2021	49	30	48.7	611
2022	45	21	54.4	386

***Ayamonte landings are included since 2002.**
****Landings, LPUE and fishing effort from fishing trips with at least 10% of *Nephrops* catches.**

Table 13.3.6. *Nephrops* in FU 30. Gulf of Cádiz. Summary for the assessment which will be updated after the 2022 ISUNEPCA UWTV (U9111) survey.

Year	Landing in number	Total discards in number*	Removals in number	UWTV Abundance estimates	95% conf. intervals	Harvest Rate	Mean weight in landings	Mean weight in discards	Discard rate	Dead discard rate
	millions	millions	millions	millions	millions	%	g	g	%	%
2014**	0.48	0	0.48	282		0.2	31.2	0	0	0
2015	0.80	0	0.80	249	38	0.3	30.8	0	0	0
2016	5.35	0	5.35	209	50	2.6	23.2	0	0	0
2017	5.95	0	5.95	383	77	1.6	23.3	0	0	0
2018	3.21	0	3.21	370	48	0.9	23.4	0	0	0
2019	1.99	0	1.99	110	24	1.8	32.5	0	0	0
2020***	2.55	0	2.55	NA	NA	-	29.2	0	0	0
2021	1.25	0	1.25	66	16	1.9	39.3	0	0	0
2022	1.45	0	1.45	53	11	2.7	31.5	0	0	0

*** Discards are considered negligible and not included in the assessment.**
**** UWTV survey in 2014 considered only exploratory. Abundance estimate not adjusted by cumulative bias.**
***** UWTV survey in 2020 not carried out as a result of the COVID-19 disruptions. Sampling for landings length distribution in 2020 not carried out as a result of pandemic disruption and administrative issues. Landings in number in 2020 estimated as the average of the LFDs for the years 2018, 2019 and 2021 raised to the 2020 total landings.**

Table 13.3.7. *Nephrops* in FU 30. Gulf of Cádiz . Length Based Indicator (LBI) results for both sexes.

MALES

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%} / L_{mat}$	$L_{max\ 5} / L_{inf}$	P_{mega}	L_{mean} / L_{opt}	$L_{mean} / L_{F=M}$
2020	1.02	1.09	0.74	0.02	0.79	0.94
2021	1.09	1.16	0.79	0.04	0.86	0.99
2022	0.95	1.02	0.75	0.02	0.76	0.94

FEMALES

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%} / L_{mat}$	$L_{max\ 5} / L_{inf}$	P_{mega}	L_{mean} / L_{opt}	$L_{mean} / L_{F=M}$
2020	1.02	1.09	0.67	0.15	1.01	1.01
2021	1.02	1.09	0.73	0.37	1.09	1.08
2022	0.94	1.09	0.69	0.33	1.05	1.10

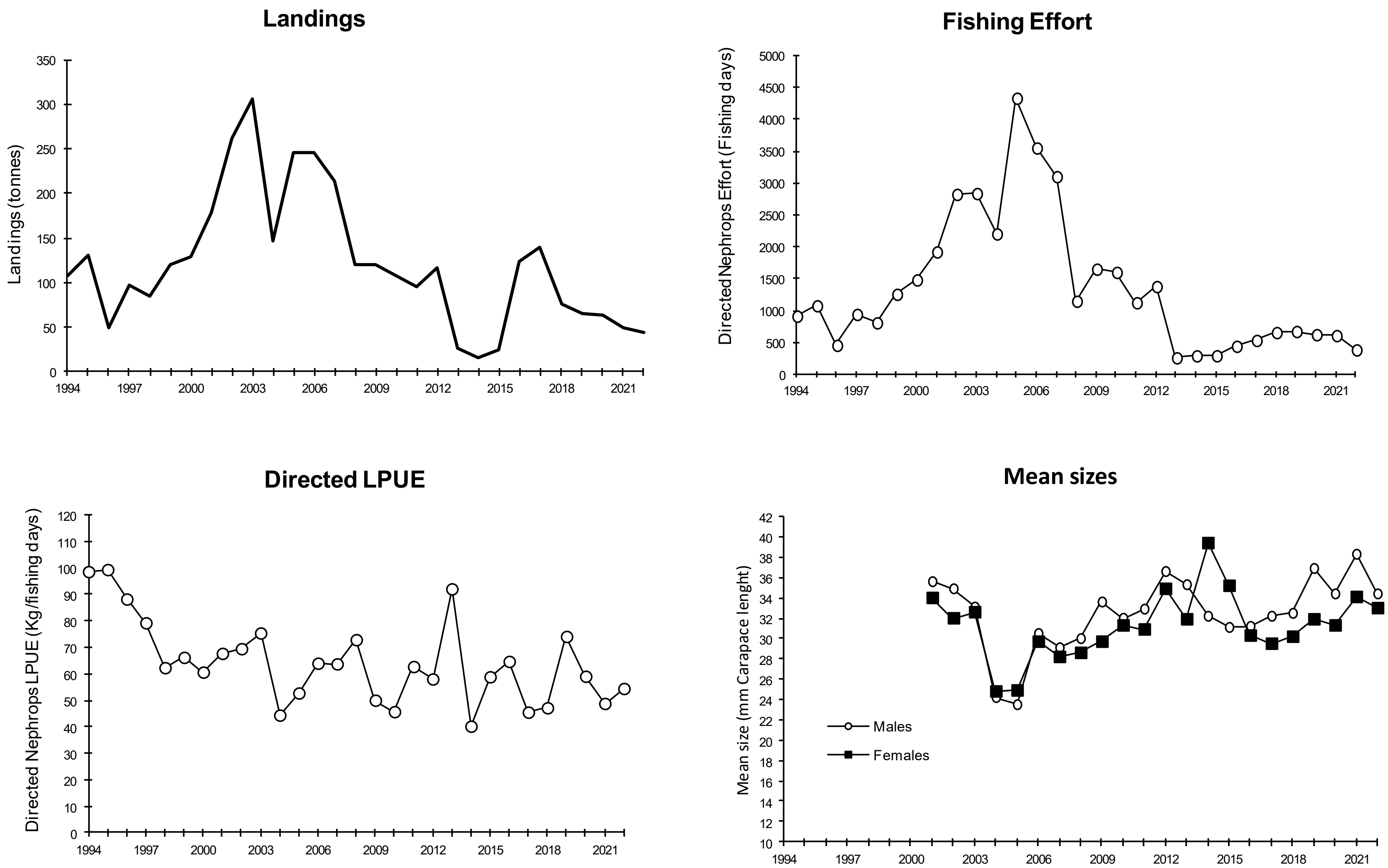


Figure 13.3.1. *Nephrops* in FU 30. Gulf of Cádiz. Long-term trends in the landings, *Nephrops*-directed effort and LPUE and mean sizes.

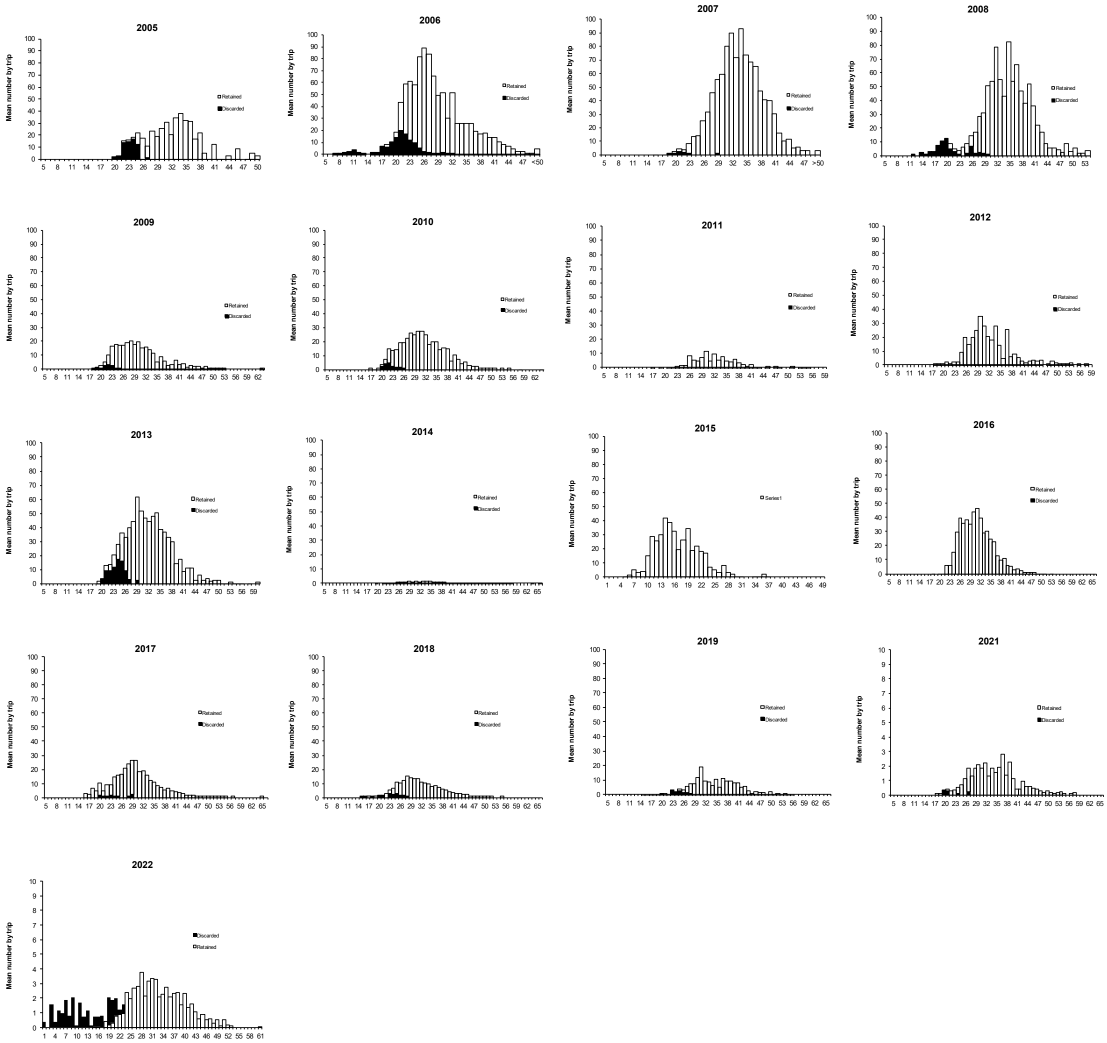


Figure 13.3.2. *Nephrops* in FU 30. Gulf of Cádiz. Length–frequency distribution of *Nephrops* retained and discarded fractions from the discards program (2005–2022). Discard sampling was partially carried out as a result of COVID-19 pandemic and administrative problems in 2020. No data are available in 2020.

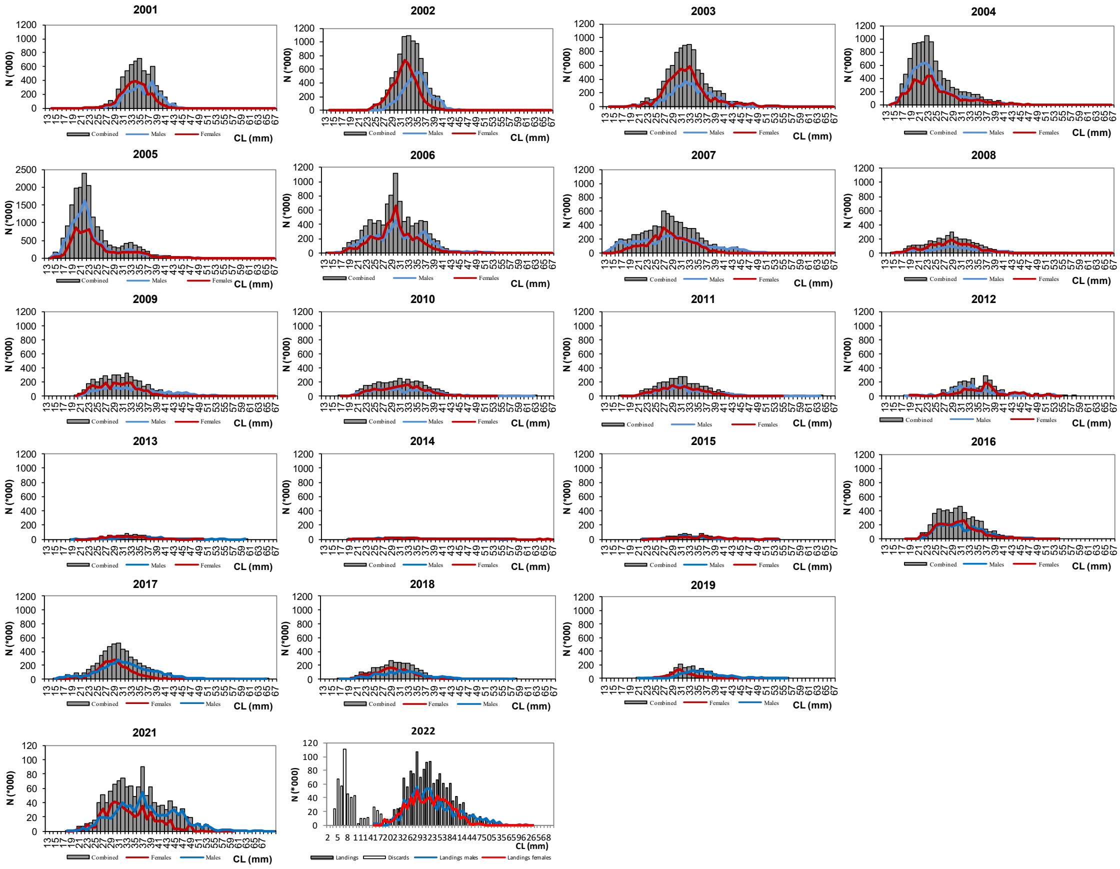


Figure 13.3.3. ***Nephrops*** **in FU 30. Gulf of Cádiz. Length distributions of landings for the period 2001–2022. Landings size composition in 2020 has been estimated as the average length-frequency distribution from 2018, 2019 and 2021 years and raised to the total landings in 2020. Y-axis has been modified to provide more clarity in 2021 and 2022.**

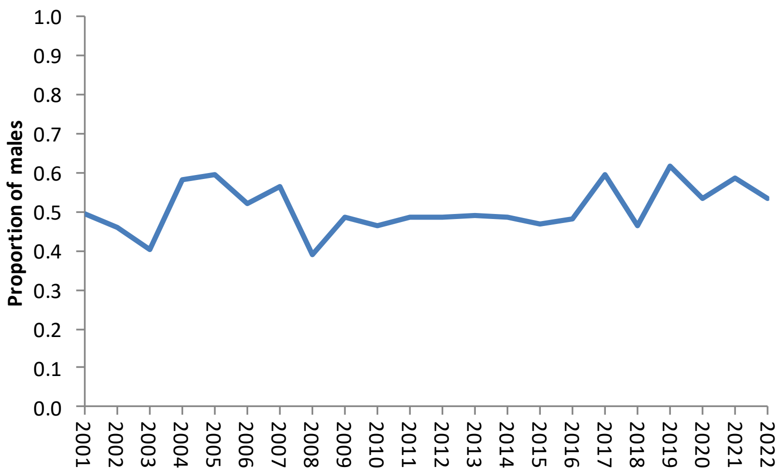


Figure 13.3.4. ***Nephrops*** **in FU 30. Gulf of Cádiz. Proportion of males in landings for the time-series. Sex-ratio in 2020 has been estimated from the average length–frequency distribution for the years 2018, 2019 and 2021.**

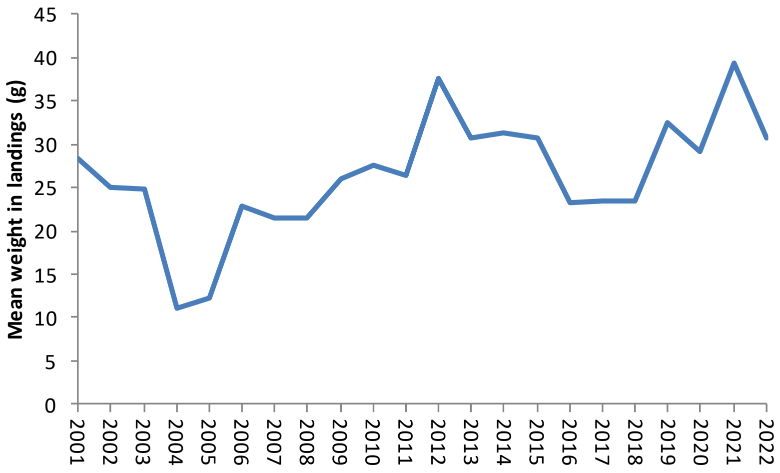
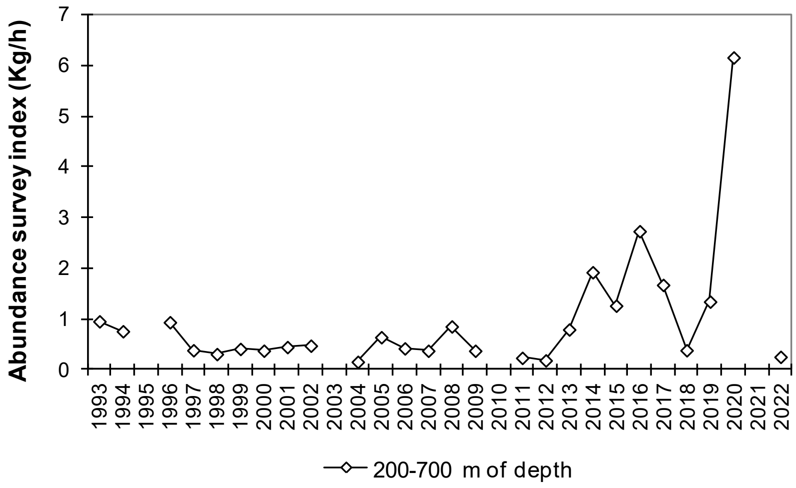


Figure 13.3.5. *Nephrops* in FU 30. Gulf of Cádiz. Time-series of the mean weight trend in commercial landings. Data in 2020 has been estimated from the average length–frequency distribution for the years 2018, 2019 and 2021.



* 1995 and 2010: strata 500-700 m no sampled

** 2003 and 2021: no survey

Figure 13.3.6. *Nephrops* in FU 30. Gulf of Cádiz, Abundance index from Spanish International Gulf of Cádiz Bottom Trawl Surveys Q1 (G7511). No survey was conducted in 2021 as a result of technical and administrative issues.

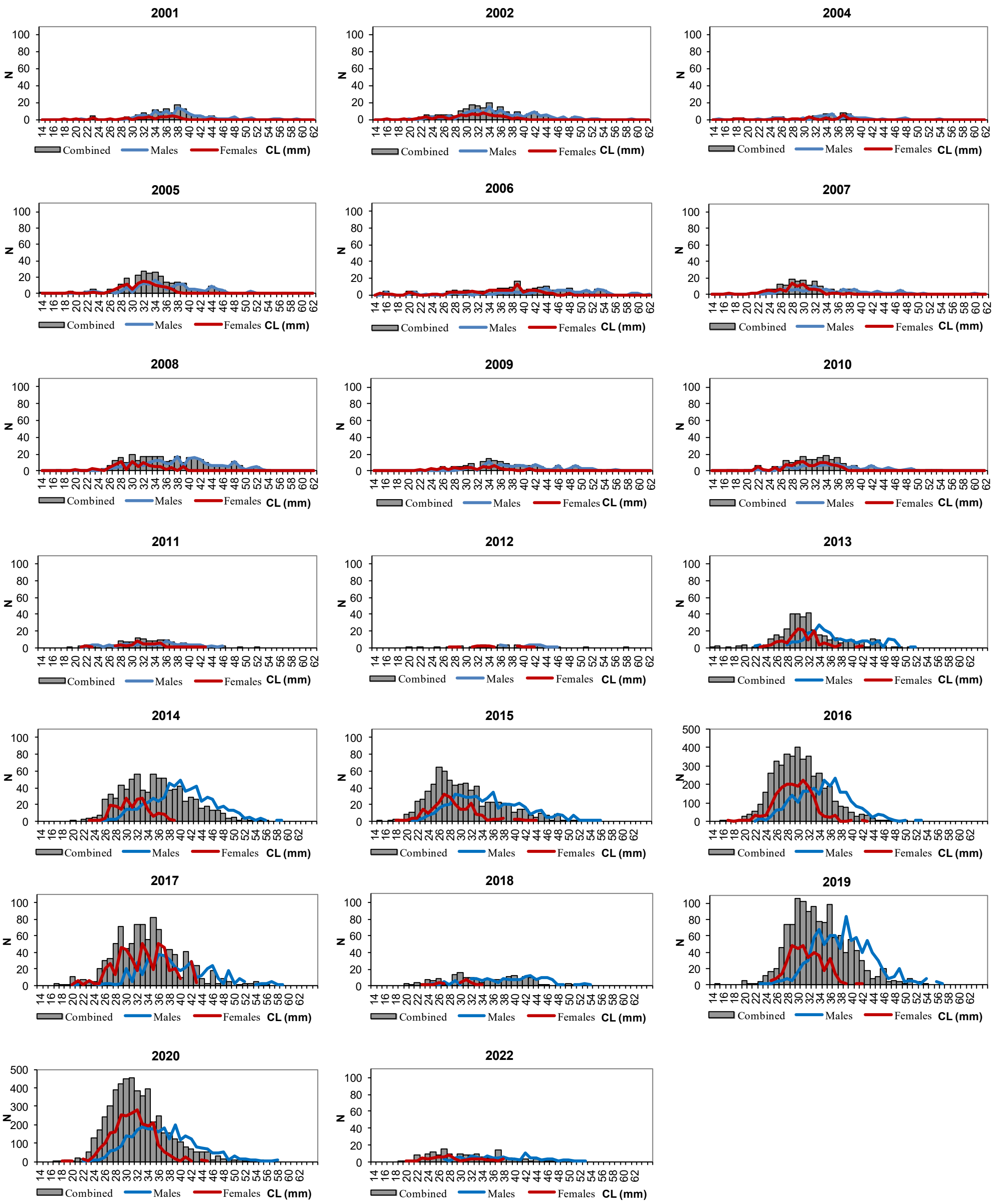


Figure 13.1.7. *Nephrops* in FU 30. Gulf of Cádiz. Length–frequency distributions from Spanish International Gulf of Cádiz Bottom Trawl Surveys Q1 (G7511) for the period 2001–2022. No survey was conducted in 2021 as a result of technical and administrative issues.

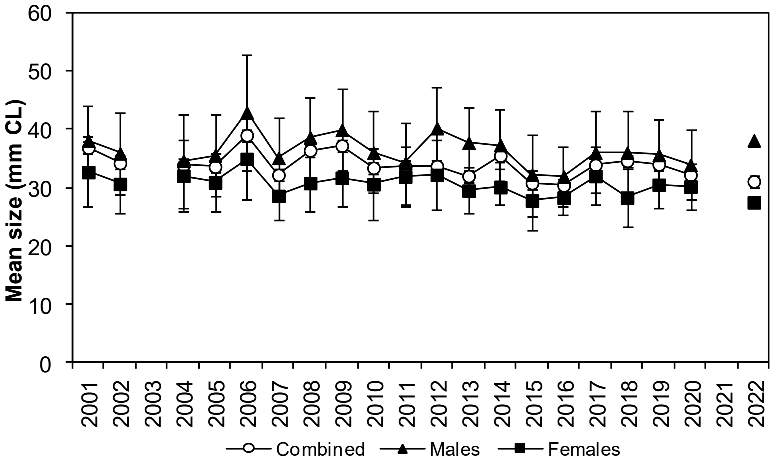


Figure 13.3.8. ***Nephrops*** **in FU 30, Gulf of Cádiz. Mean size in Spanish International Gulf of Cádiz Bottom Trawl Surveys Q1 (G7511) for the period 2001–2022. No survey was conducted in 2021 as a result of technical and administrative issues.**

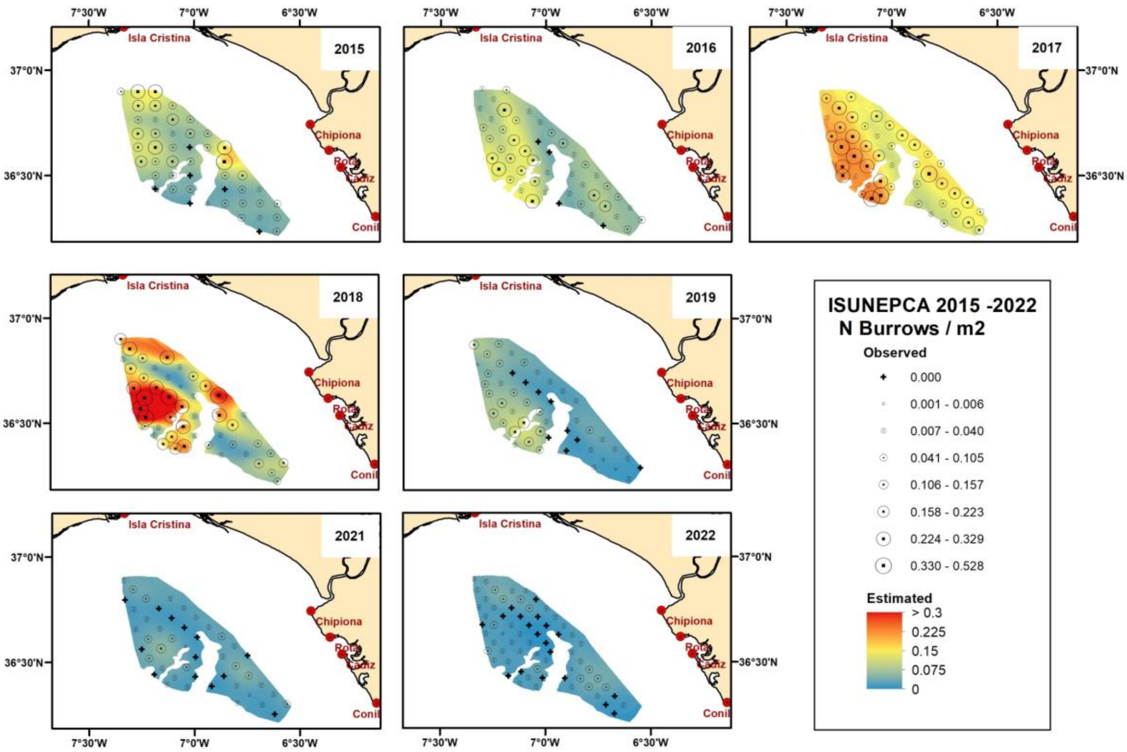


Figure 13.1.9. ***Nephrops*** **in FU 30. Gulf of Cádiz. Contour plots of the kriged density estimates for the ISUNEPCA UWTV (U9111) surveys for the period 2015–2022 that were updated after the re-definition of the survey area. No UWTV survey was conducted in 2020 as a result of the COVID-19 disruptions.**

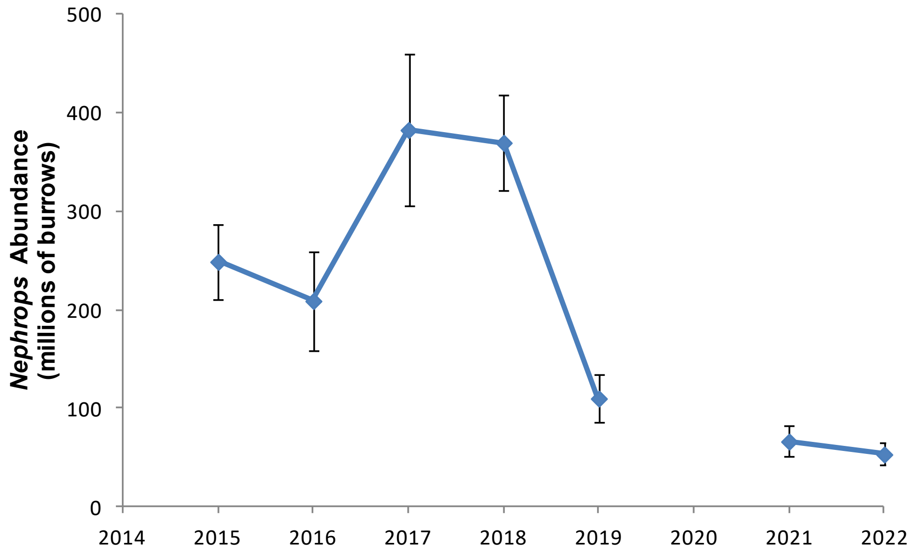


Figure 13.3.10. ***Nephrops*** **in FU 30. Gulf of Cádiz. Geostatistical abundance estimate. Data time-series was updated after the re-definition of the survey area. Error bars correspond to the 95% confidence interval.**

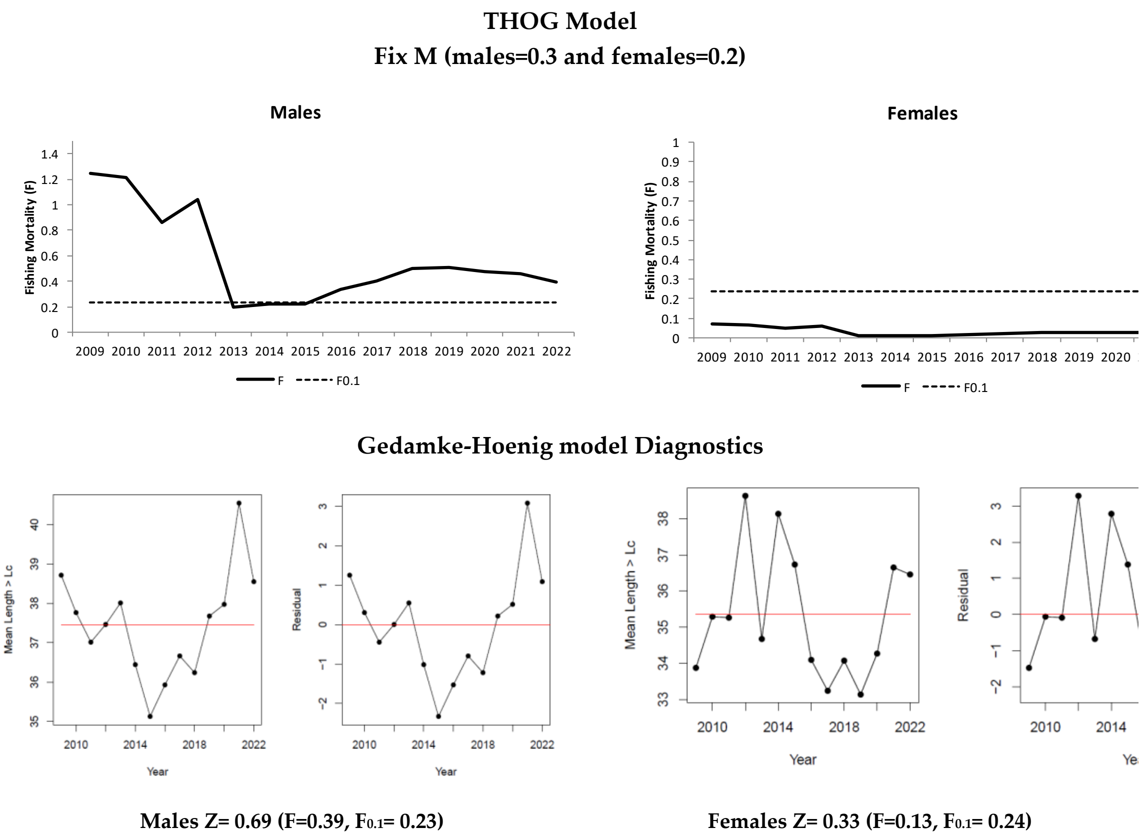


Figure 13.1.11. ***Nephrops*** **in FU 30. Gulf of Cádiz. Mean Length-Z model results. THOG Model with fixed natural mortality (M) (above). Gedamke-Hoenings (2006) model diagnostics (below).**

14 Sea bass in northern and central Bay of Biscay

bss.27.8ab – *Dicentrarchus labrax in divisions 8.a-b*

14.1 General

Type of assessment: age-at-length stock synthesis (SS, Methot and Wetzel, 2013) runs/update for a category 1 stock. Stock was last benchmarked during WKBASS 2018 (ICES, 2018a) and IBPBASS in 2018 (ICES, 2018b). There were no data revisions for this update assessment.

14.1.1 Stock definition and ecosystem aspects

A better understanding of the stock identity was reported during the first step of the benchmark (ICES, 2023), and this would be integrated, if possible, in the new assessment model during the next steps of the benchmark.

14.1.2 Fishery description

Sea bass in the Bay of Biscay is targeted mainly by France with more than 98.3% of international landings in 2022 (Table 14.1). Spain is responsible for about 1.7% of the catches in 2022. A more detailed description of the fishery can be found in the Stock Annex.

Table 14.1. Summary of official and ICES commercial landings data (in tonnes). The UK includes England, Wales, Northern Ireland, and Scotland.

Year	Belgium	France	NL	Spain	UK	Total Official	Total ICES
1985	0	2477	0	0	0	2477	3420
1986	0	2606	0	0	0	2606	3549
1987	0	2474	0	0	5	2479	3417
1988	0	2274	0	0	15	2289	3217
1989	0	2201	0	0	0	2201	3144
1990	0	1678	0	0	0	1678	2621
1991	0	1774	0	17	0	1791	2734
1992	0	1752	0	14	0	1766	2709
1993	0	1595	0	14	0	1609	2552
1994	0	1708	0	17	0	1725	2668
1995	0	1549	0	0	0	1549	2492
1996	0	1459	0	0	0	1459	2402
1997	0	1415	0	0	0	1415	2358

Year	Belgium	France	NL	Spain	UK	Total Official	Total ICES
1998	0	1261	0	27	0	1288	2231
1999	0	NA	0	11	0	11	2091
2000	0	2080	0	67	0	2147	2362
2001	0	2020	3	68	0	2091	2306
2002	0	1937	0	176	0	2113	2392
2003	0	2812	0	119	0	2931	2616
2004	0	2561	0	96	0	2657	2380
2005	0	3184	0	74	0	3258	2796
2006	0	3318	0	167	2	3487	2875
2007	1	2984	0	74	1	3060	2751
2008	0	1508	0	145	0	1653	2745
2009	1	2339	0	194	0	2534	2278
2010	0	2322	0	165	2	2489	2229
2011	1	2536	0	311	0	2848	2575
2012	1	2325	0	204	5	2535	2549
2013	0	2504	0	156	0	2660	2685
2014	0	2926	0	89	0	3015	2991
2015	0	2216	0	71	0	2287	2264
2016	0	2121	0	85	0	2206	2252
2017	0	2146	0	65	0	2211	2295
2018	0	2204	0	84	0	2288	2316
2019	0	2116	0	97	0	2213	2227
2020	0	2032	0	24	0	2056	2090
2021	0	1956	0	41	0	1997	2032
2022	0	1861	0	33	0	1894	1906

For France, line fisheries (handlines and longlines) take place all year-round (especially during quarters 3 and 4), while nets, pelagic and bottom-trawl fisheries take place from November to April, the period when prespawning and spawning sea bass aggregate to reproduce. In 2022, nets represent 35.5% of the landings of the area, lines 38.9%, bottom trawl 18.4%, pelagic trawl 2.9%, and other gears 4.3%.

In 2022, total landings decreased slightly compared to 2021. Landings were observed stable for liners and other gears while a decrease for both pelagic, bottom trawlers and netters (Figure 14.1). Note that netters are very dependent on weather conditions (2014 was an exceptional year).

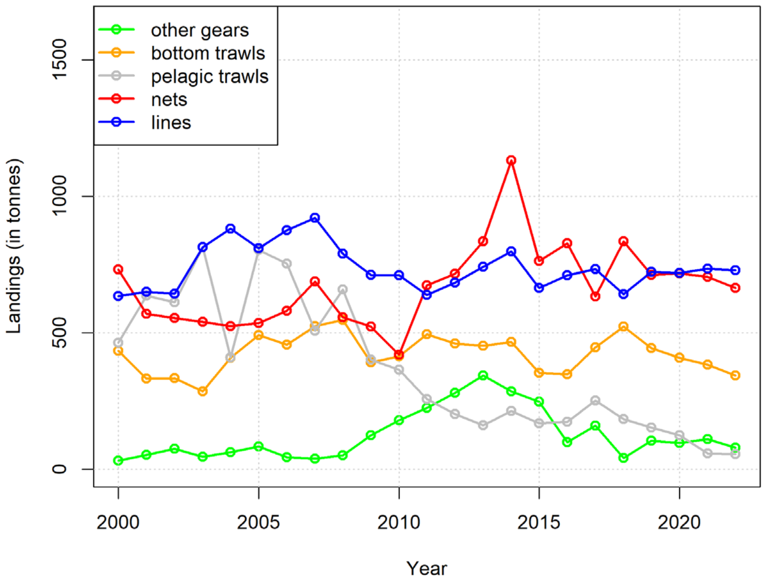


Figure 14.1. French landings per gear.

14.2 ICES advice for 2023

ICES advises that when the EU multiannual plan for Western waters and adjacent waters is applied (MAP; EU, 2019), total removals in 2023 that correspond to the F ranges in the plan are between 2897 tonnes and 3398 tonnes.

14.3 Management

14.3.1 Commercial fishery

Sea bass in the Bay of Biscay is not subject to EU TACs and quotas. However, sea bass is ruled by an EU multiannual plan since 2019 (EU, 2019). It aims to ensure that particular sea bass stocks are exploited sustainably and that the decisions on fishing opportunities are based on the most up-to-date scientific information. It allows certain flexibility in setting fishing opportunities by defining the target F as a range of values, which would result in a long-term F_{MSY} and would be based on the best available scientific advice. The plan does not include quantified reference points for F or biomass levels, which are instead provided by the latest scientific advice available, and used by the Council when fixing fishing opportunities. In addition to the F_{MSY} ranges, the plan introduces safeguard measures based on biomass levels, in order to restore the stocks when they fall below the safe biological limits. Where recreational F has a significant impact on a stock managed on the basis of MSY (which is the case of sea bass stocks), the Council should be able to set non-discriminatory limits for recreational fishers. The Council should use transparent and objective criteria when setting such limits. Where appropriate, Member States should make the necessary and proportionate arrangements for monitoring the stocks and data collection in order to make a reliable estimate of effective levels of recreational catches.

14.3.2 Commercial fishery at national level

Since 2012, a national professional quota system for sea bass fishing licences, defined and implemented by the Committees for Maritime Fisheries and Fish Farming (CNPMEM, 2020), has regulated French professional catches of the species both for the Bay of Biscay (divisions 8.a, 8.b, and 8.d) and the Northern stocks (divisions 4.b, 4.c, 7.a, 7.d–7.h).

Since 2017, a Minimum Landing Size (MLS) of 38 cm has been implemented in the Bay of Biscay (ICES divisions 8.a, 8.b, and 8.d). This MLS was revised to 40 cm in 2019 and applied in 2020. Moreover, all French professional fishing activities in the area have been subjected to an annual overall catch limit. It has been implemented since 2017. To manage the overall catch limit, annual and periodic individual limitations of fishing opportunities were implemented.

14.3.3 Recreational fishery

A series of management measures have been implemented for the French recreational fishery:

- A minimum conservation size of 42 cm was implemented in 2013.
- A 5-fish bag limit was implemented in 2017.
- A 3-fish bag limit was implemented in 2018-2019.
- A 2-fish bag limit was implemented in 2020-onwards.

14.4 Data

14.4.1 Commercial landings and discards

A detailed description of the commercial landings can be found in the Stock Annex. Landings time-series were reconstructed using the three main sources available (Figure 14.2):

1. Official statistics recorded in the FishStat database (FAO, 2020) since around the mid-1980s (total landings).
2. French landings for 2000-2022 from a separate analysis of logbook and auction data by Ifremer (SACROIS methodology; Demaneche *et al.*, 2010), which is used to answer the ICES annual InterCatch data call. Landings are available by *métier*.
3. Spanish landings for 2007–2011 from sale notes and for 2012–2018 from InterCatch statistics.

The 2022 French data have been used for the assessment. There was no data revision for this stock (Figure 14.2).

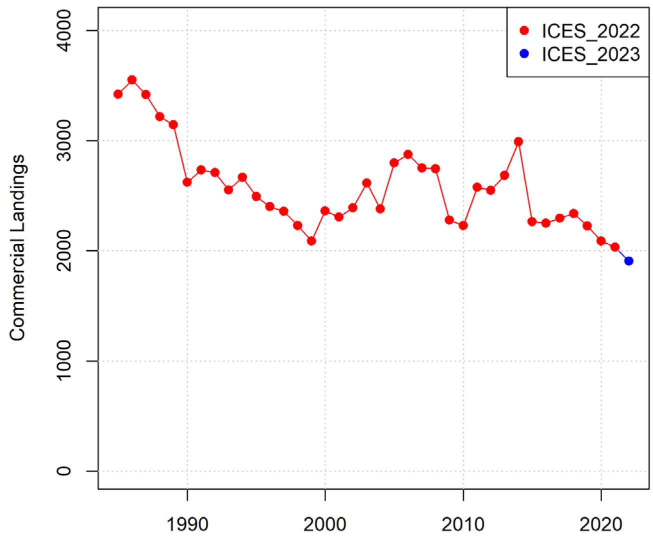


Figure 14.2. Commercial landings used in the 2021 and 2022 assessments. Weights are in tonnes.

Discarding of sea bass by commercial fisheries can occur when fishing takes place in areas where caught individuals are smaller than the MLS. For France, discards rates are low (Table 14.2). In 2022, the total discards percentage was estimated at 7.74% of the total French commercial catches, corresponding to an amount of 160 t. For Spain, observer data from Spanish vessels fishing in Area 8, have shown that no sea bass was discarded since 2003. No information in 2022 was available on discards for this year's WG.

In agreement with the Stock Annex that considered discards as negligible, they were not included in the stock assessment, despite the availability of this information and their increasing trend. However, when providing catch options, discards prediction was computed for 2024, and added to both the projected commercial landings and recreational removals as follows:

- r = average discards rate (2015-2022)
- r = mean(commercial discards/commercial landings)
- r = 5.73 %
- Commercial discards (2024) = commercial landings (2024) x (r/(1-r))
- Total catches (2024) = commercial landings (2024) + commercial discards (2024) + recreational removals (2024)

Table 14.2: Estimated sea bass discards of French vessels in the Bay of Biscay. Weights are in tonnes.

Year	Commercial discards	Commercial landings	Total commercial catches	% commercial discards
2015	68	2264	2332	2.92
2016	65	2252	2317	2.81
2017	196	2295	2491	7.87
2018	155	2338	2493	6.22
2019	183	2227	2410	7.59
2020	41	2090	2131	1.92
2021	196	2032	2228	8.80
2022	160	1906	2066	7.74

14.4.2 Length and age sampling

The full description of the biological sampling is available in the Stock Annex.

14.4.2.1 French commercial fishery

The French sampling programme for sea bass landings length compositions covers at-sea and onshore samplings. Data are available from 2000 onwards. French length compositions for 8.a–b across time and all gears combined are presented in Figure 14.3. It is worth noting that the sampling effort has increased since 2021 for commercial length composition.

The French sampling programme for sea bass age compositions is based on age-length keys (ALKs) with fixed allocation. For the 8.a–b area, the information is available only from 2008. This year, as for the years 2018–2021, it was observed that the 2022 ALK showed a pattern inconsistent with the historical data. The observed bias was related to a change in age readers over the years (Table 14.3). WGBIE decided again this year not to include these age-at-length data.

Table 14.2. Proportion of scales read by each age reader over years 2008–2022.

Year	Age readers				
	JH	KS	RE	SM	AD
2008			100		
2009			100		
2010		71	29		
2011		100			
2012		100			
2013		100			
2014	13	78	9		
2015		31	69		
2016		89	5	6	
2017		88	12		
2018			100		
2019			100		
2020			100		
2021			73		27
2022					100

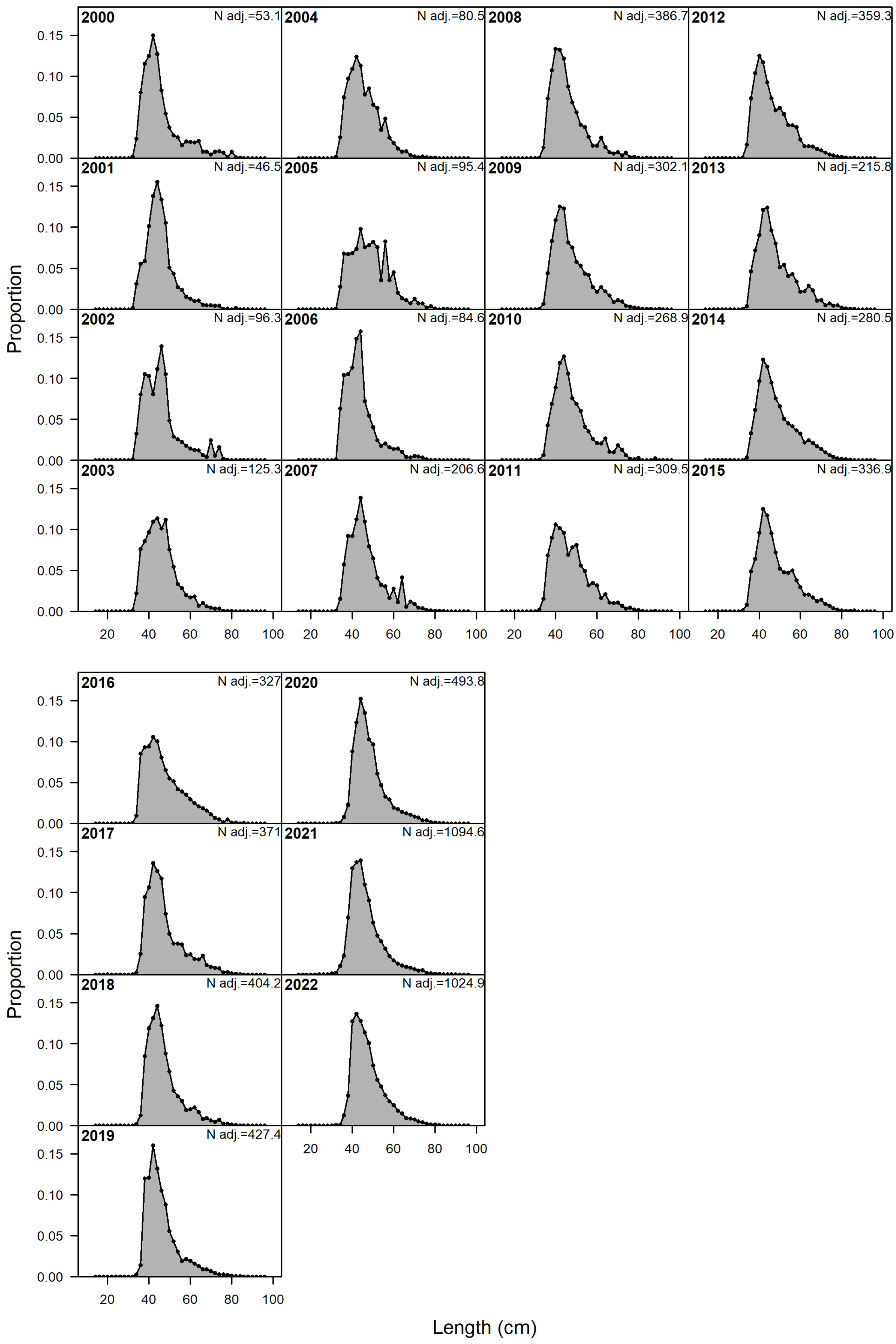


Figure 14.3. Length compositions of all French fleets combined from 2000 onwards.

14.4.2.2 Recreational fishery

The full description of the recreational catches is presented in the Stock Annex.

Recreational fishery catches reconstructed for the whole time-series

In a previous report (ICES, 2016b), partitioning French recreational data between the Biscay and Northern stock was only possible for the 2009–2011 study (Rocklin *et al*., 2014). There are no historical estimates of the recreational catch over the entire time-series. IBPBASS (ICES, 2014) considered it more plausible to treat recreational fishing as having more stable participation and effort over time than commercial fishery. A decision was made during WKBASS 2018 benchmark meeting (ICES, 2018a) to apply a constant recreational F over time considering the same approach used for the Northern stock. Total retained recreational catches were iteratively adjusted to obtain a constant recreational F over all years in the time-series, which was derived using the catch value of 1430 t estimated in 2010. The implementation of new management measures should have led to a reduction in F as more and larger fish are released (Hyder *et al*., 2018). This means that it is not appropriate to assume constant recreational F in the last years and, thus, it is necessary to re-estimate the recreational removals. This has been done using the estimated reductions generated from the assessment of the effect of different bag limit levels and Minimum Conservation Reference Size (MCRS) (Armstrong *et al*., 2014) in order to derive changes in recreational F. Also, the application of different management measures gave a recreational F multiplier for 2010–2012 of 1 and 0.684 for 2013–2016 (related to an increase in MCRS to 42 cm). In 2017, with a 5-fish bag limit implementation, the multiplier was estimated to be unchanged. However, for 2018 with a 3-fish bag limit implementation, it was estimated to be 0.647. In 2020–2022, a 2-fish bag limit was decided and the new multiplier used was estimated to be 0.584. Table 14.4 and Figure 14.4 compiled figures used in the assessment for the recreational fishery.

Table 14.3. Time-series used in the SS model as commercial landings and recreational removals (in tonnes).

Year	Estimated recreational removals	Observed recreational removals
1985	1593	
1986	1541	
1987	1501	
1988	1482	
1989	1474	
1990	1485	
1991	1501	
1992	1499	
1993	1481	
1994	1435	
1995	1367	
1996	1287	
1997	1215	
1998	1179	

Year	Estimated recreational removals	Observed recreational removals
1999	1219	
2000	1298	
2001	1371	
2002	1422	
2003	1448	
2004	1455	
2005	1451	
2006	1444	
2007	1452	
2008	1460	
2009	1453	
2010		1430
2011	1391	
2012	1335	
2013	868	
2014	804	
2015	754	
2016	754	
2017	772	
2018	748	
2019	748	
2020	659	
2021	681	
2022	691	

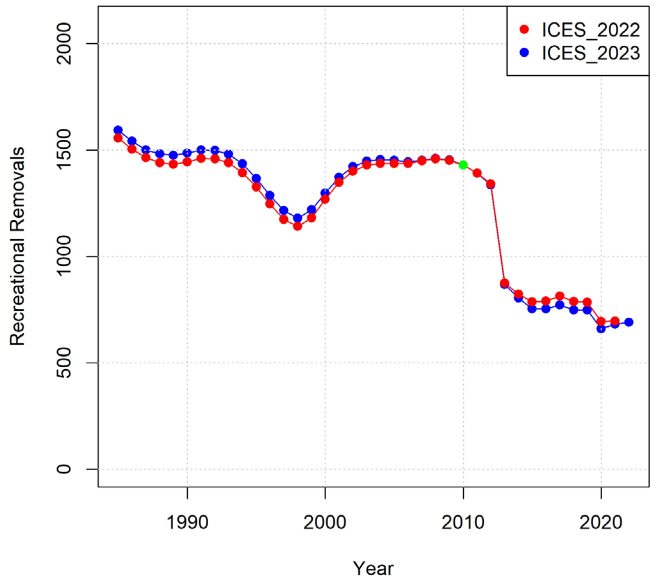


Figure 14.4. Recreational removals used in the 2021 and 2022 assessments. Weights are in tonnes.

After the benchmark in 2018 (ICES, 2018a), an additional survey has been conducted in France by FranceAgriMer that provided estimates of the sea bass recreational removals in the Bay of Biscay. However, this survey has different associated uncertainty and bias than the ones encountered in 2010. It is not straightforward how well these data can be combined for use in the assessment and also ensure no significant departure or changes from the current approach. Hence, this should be done as part of the next benchmark and then peer-reviewed to ensure the robustness of the process. As a result, the current approach will be used until the next benchmark and the review of recreational removals and their inclusion in the assessment will be included on the issue list.

Recreational post-released mortality (PRM)

Based on the information provided by Hyder *et al.* (2018), WKBASS 2018 agreed on a figure of 5% for PRM in recreational fisheries for the Northern and the Bay of Biscay sea bass stocks (ICES, 2018a). This estimate was based on a published study (Lewin *et al.*, 2018).

Recreational length compositions

The estimate of removals was recalculated for the 2010 reference year as the sum of the retained and released fish with a PRM of 5%. A length composition for recreational removals for the 2010 reference year was estimated as described in a WD from Hyder *et al.* (2018) and illustrated in Figure 14.5.

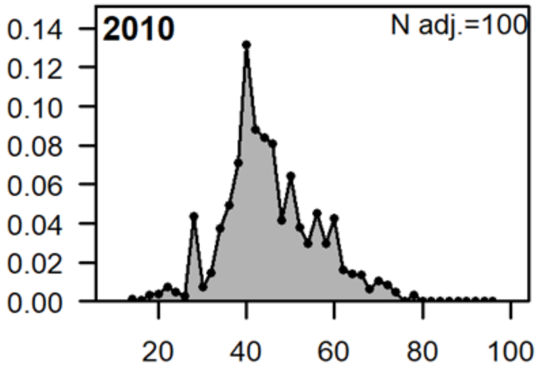


Figure 14.5. Length composition for the recreational fishery. Data available only for 2010.

14.4.3 Abundance indices from surveys

Currently, there is no survey providing relative indices of adult or juvenile sea bass abundance over time. A French study has been undertaken since 2013 to explore the possibility of creating recruitment indices in estuarine waters. Good results were obtained from this study but financial support is needed to be routinely carried out (Le Goff *et al.*, 2017). Abundance indices have been calculated for years 2016–2022 in the Loire estuary and for years 2019–2022 for the Gironde estuary. These series of indices collection are planned to be continued. The ultimate objective would be to fund them in a sustainable manner through the Data Collection Framework (DCF).

14.4.4 Commercial landing-effort data

A full description of the LPUE and its estimation methods are presented in the Stock Annex and in a WD by Laurec and Drogou (2017). The absence of a relative index of abundance covering adult sea bass has been identified as a major issue for the assessment of the Bay of Biscay stock. There are no scientific surveys providing sufficient data on adult sea bass to develop an abundance index for the area. Hence, Ifremer investigated the potential of deriving an index from commercial fishery landings and effort data available since 2000. This allowed the possibility to derive from French logbooks data (vessels with length > or < 10 m) an LPUE index at the resolution of ICES rectangle and gear strata. A new LPUE index was presented at WKBASS 2018 (ICES, 2018a). This index was obtained by modelling the zero and non-zero values using a delta-GLM approach (Stefánsson, 1996). A review of the study has been done by an external expert (M.C. Christman, MCC Statistical Consulting, Gainesville, Florida, USA) before WKBASS 2018 (ICES, 2018a). The reviewer recommended the use of the new LPUE index in the assessment of the Bay of Biscay sea bass stock. The new LPUE index has been incorporated in the Northern and the Bay of Biscay stocks assessment models. Results updated with 2022 data are presented in Figure 14.6.

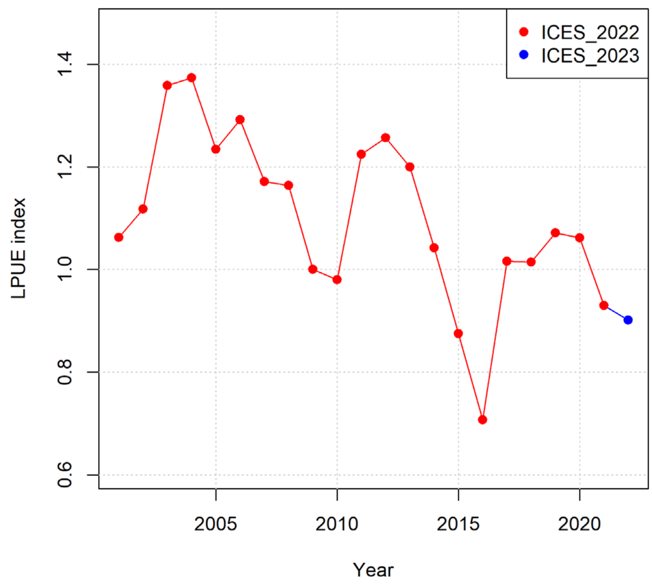


Figure 14.6. Comparison of the LPUE index used in the 2022 and 2023 assessments.

14.4.5 Biological parameters

The full description of the biological parameters is presented in the Stock Annex.

14.4.5.1 Growth

In the Bay of Biscay, studies on sea bass growth exist and have been published by Dorel (1986) and Bertignac (1987). To update these studies, sea bass was sampled by Ifremer during the years 2014–2015 along the coasts of France in areas 8.a and 8.b (Drogou *et al.*, 2018). The von Bertalanffy model parameters were estimated using an absolute error model minimizing $\sum(obs - exp)^2$ the lengths-at-age data used. L_{inf} was fixed to 80.4 cm (Bertignac, 1987). The standard deviation could be described by a linear model: SD = 0.1861 * age + 2.6955 (samples used from age 0 to age 15). The standard deviation of length-at-age increased with length as expected. K was estimated (see Stock Annex), but this value is not used as K is re-estimated by the assessment model.

14.4.5.2 Maturity

Sea bass maturity has been studied with samples collected by Ifremer in the Bay of Biscay. Samples were derived from French fisheries around the Bay of Biscay coast. The size at which 50% of the females are mature is 42.14 cm (with a lower limit of 41.31 cm and an upper limit of 43.08 cm). The Pearson test (p-value = 0.597) identifies a good fit of the model to the data (Figure 14.7).

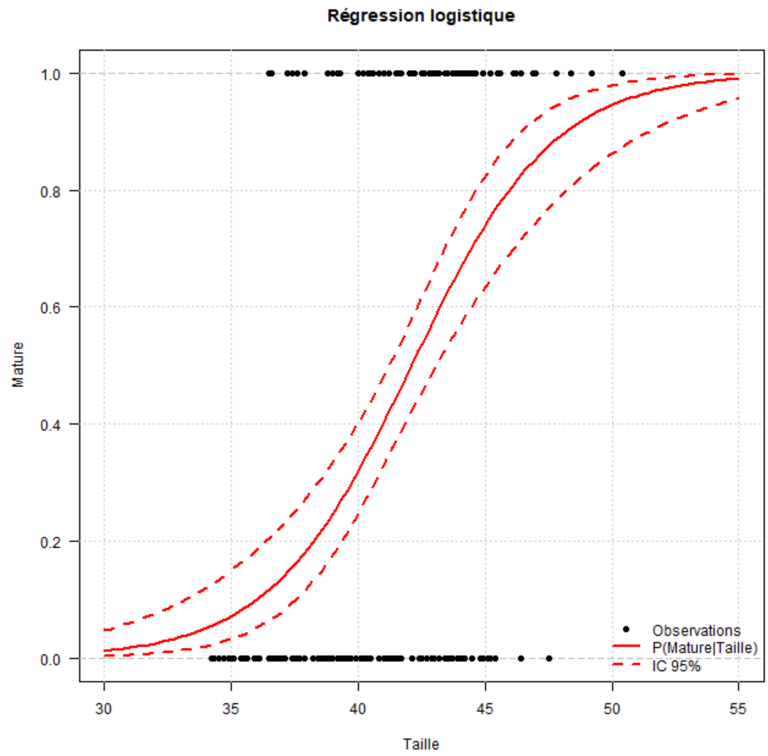


Figure 14.7. Maturity ogive for the Bay of Biscay sea bass stock.

14.4.5.3 Natural mortality

WKBASS 2017/2018 (ICES, 2018a) proposed to use the same value for both the northern and the Bay of Biscay sea bass stocks and set the natural mortality (M) to 0.24, the value predicted by Then *et al*. (2015) based on a t_{max} method which is considered more robust than inferences from any single study.

14.5 Assessment

This is an update assessment including the new data available for the year 2022 from the WKBASS assessment.

14.5.1 Input data

Input data are described in the Stock Annex (see under section “Input data for Stock Synthesis”).

14.5.2 Data revisions

There were no data revisions for this update assessment.

14.5.3 Model

The SS assessment model (Methot and Wetzel, 2013) was selected for use in this assessment. Model description and settings are presented in the Stock Annex (under “Current assessment” for model description and “SS settings (input data and control files)” for model settings).

14.5.4 Assessment results

The assessment model includes estimation of size-based selectivity functions (selection pattern-at-length) for commercial and recreational fleets and LPUE abundance index. Figure 14.8 presents selectivity functions by fleet estimated by the model. The inclusion of 2022 data did not change the general shape of the selectivity pattern.

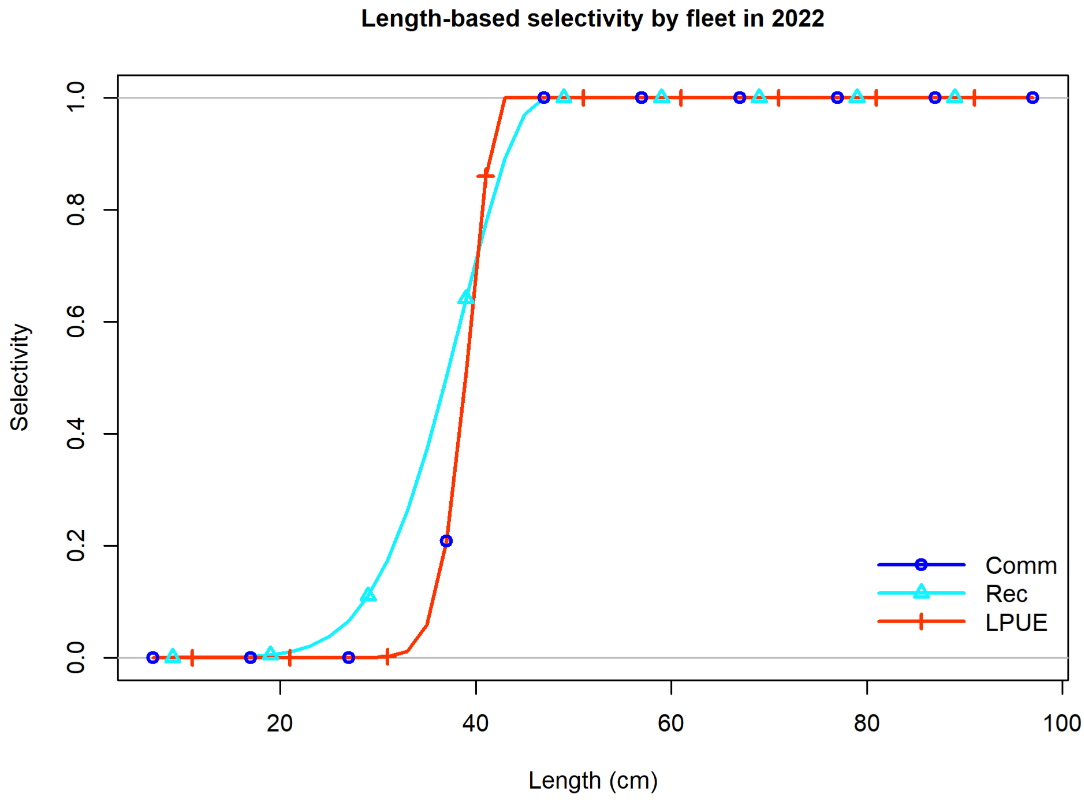


Figure 14.8. Selection patterns at length by commercial and recreational fleets estimated by the SS model. Selection pattern for the LPUE abundance index was assumed to follow the one from the commercial fleets.

The selection curve is assumed constant over the whole period for all the fleets. The selection curve for the LPUE abundance index was assumed identical to that of the commercial fleets. The assessment currently assumes that commercial fleets do not discard fish (at the time of the last benchmark, discards were negligible, i.e. less than 5% of the total landings).

Model fit for the LPUE abundance index was good (Figure 14.9). The index was useful for the model to get the correct trend over time.

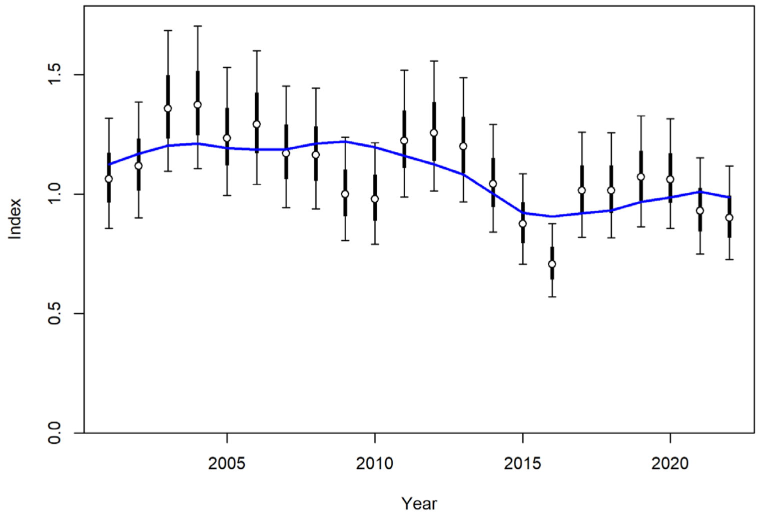
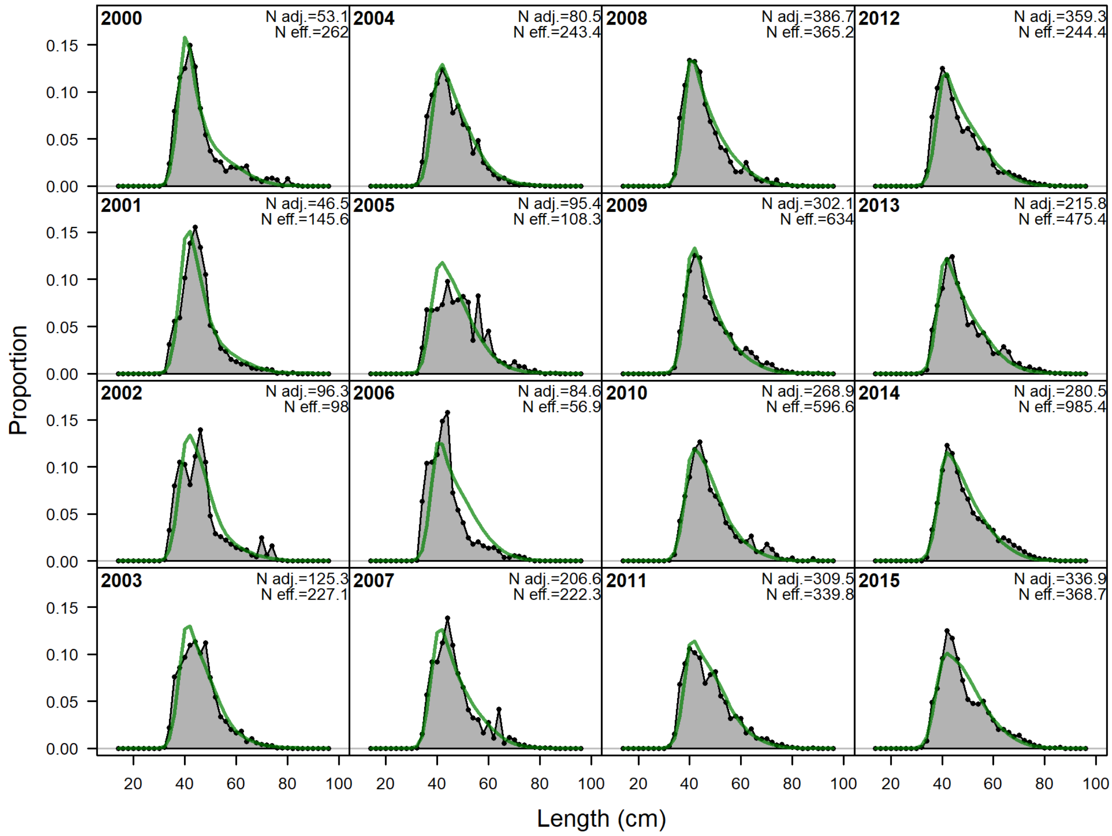


Figure 14.9. Fit to the LPUE abundance index.

Model fit for the commercial and recreational length composition data was good (Figures 14.10 and 14.11).



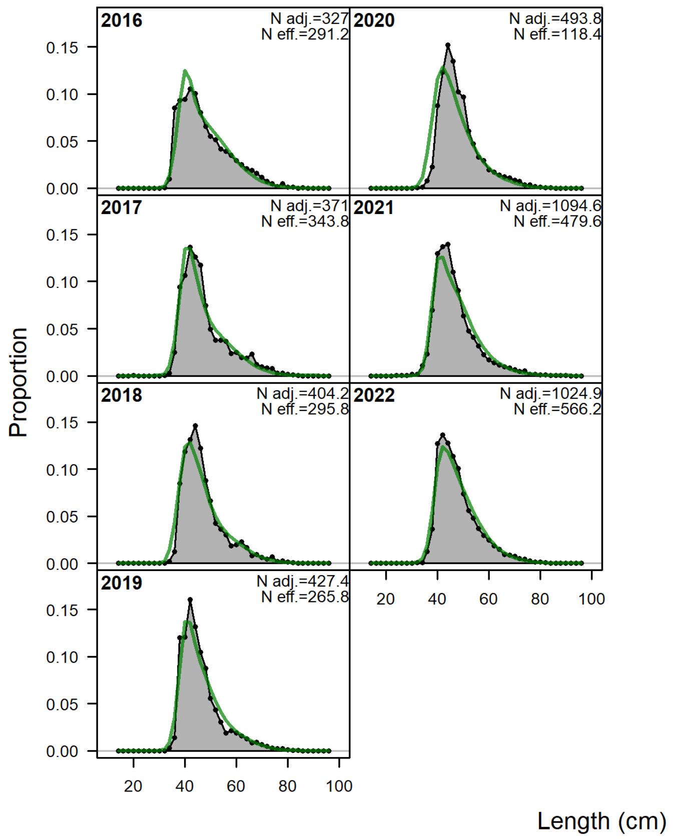


Figure 14.10. Fit to the commercial fishery length composition data.

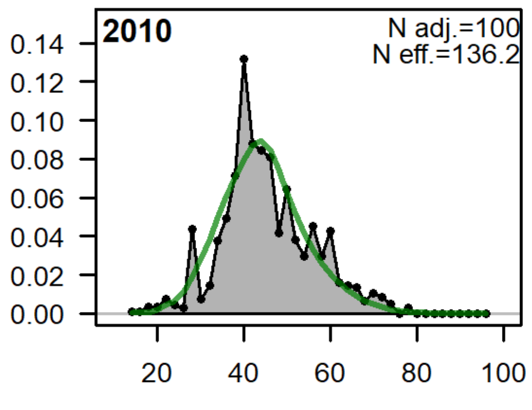
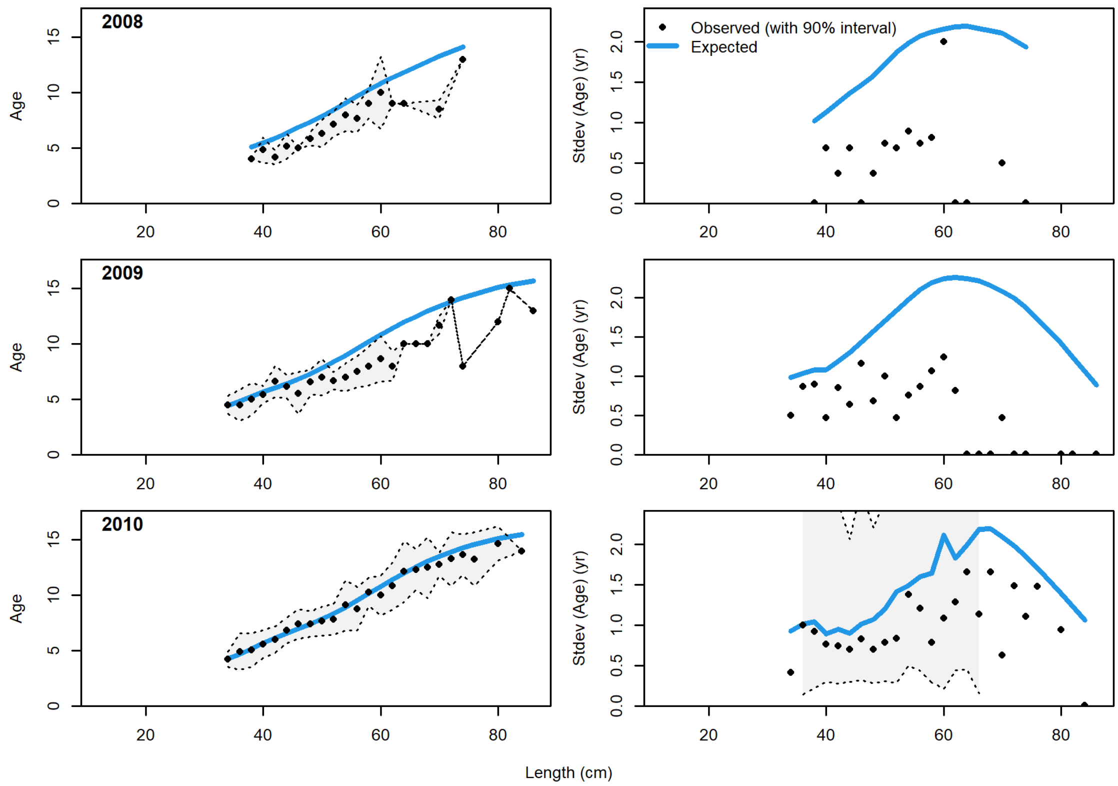
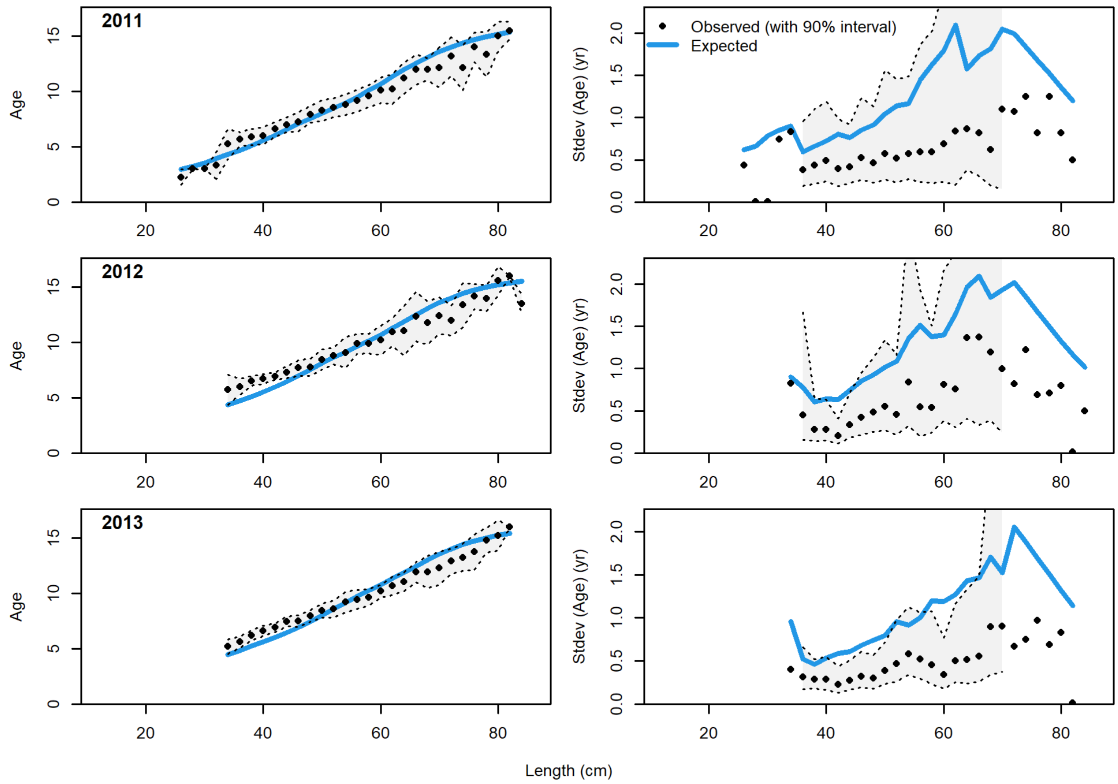


Figure 14.11. Fit to the recreational fishery length composition data.

Model fit for the aggregated fishery age-at-length composition data was good on average, but poor in standard deviation (Figure 14.12). 2018, 2019, 2020, 2021 and 2022 age-at-length data were not included in the assessment as they showed a pattern incoherent with the historical data.

The fit was poor for the first 2 ALKs for years 2008 and 2009 as the sampling size during these two years was considered low.


2008
2009
2010
Age
Stdev (Age) (yr)
Observed (with 90% interval)
Expected
Length (cm)


2011
2012
2013
Age
Stdev (Age) (yr)
Observed (with 90% interval)
Expected
Length (cm)

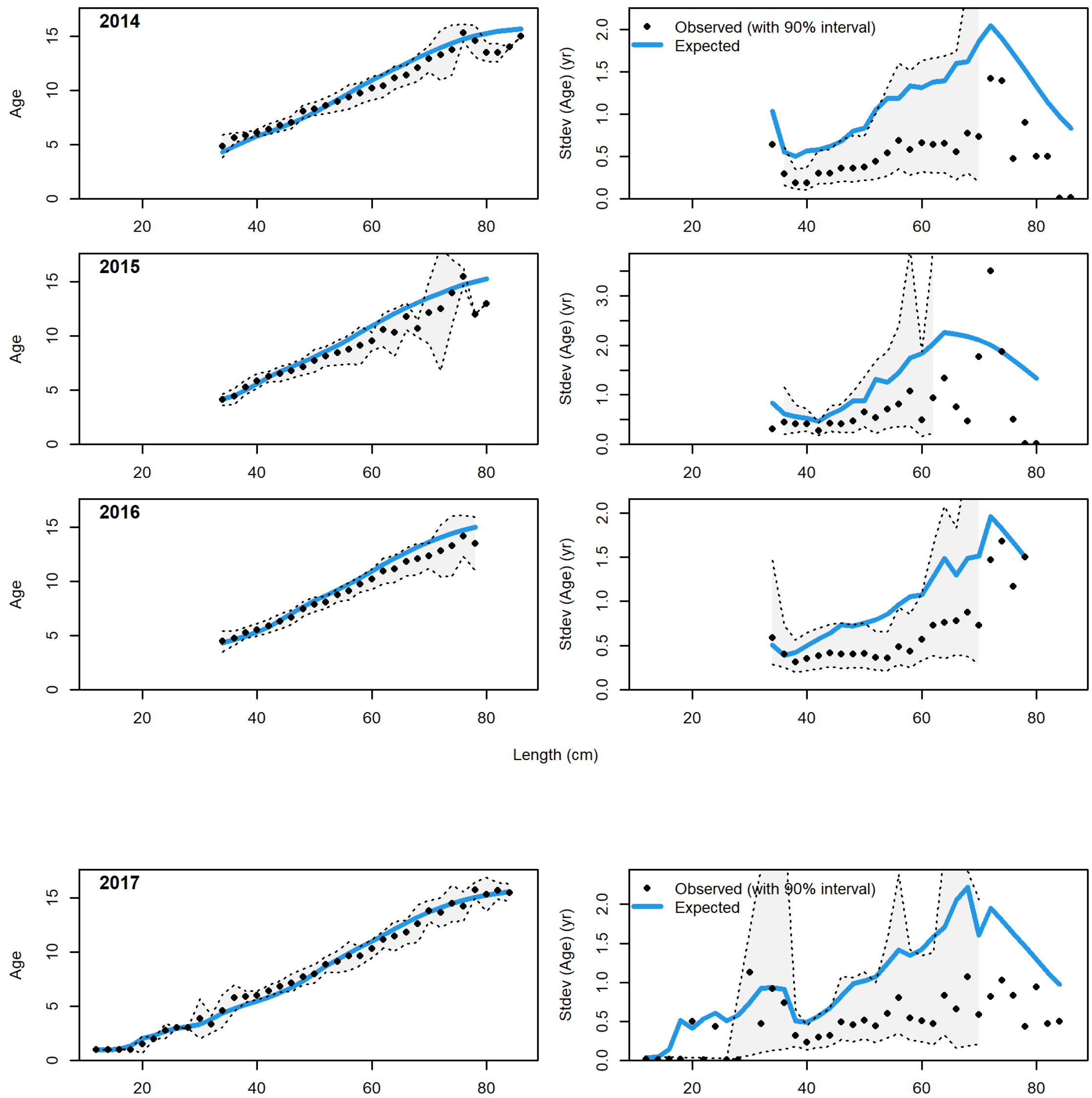


Figure 14.12. Fit to conditional age-at-length for commercial fishery.

Age composition data were included in the base model as “ghost,” meaning that they were not used for estimating the model likelihood. The purpose was to illustrate what the model estimated in terms of age composition data (Figure 14.13). Model and observations compared well despite the evident discrepancies for some years. For instance, in the years 2011–2014, the model overestimated the proportion of age ≤ 5 individuals compared to observations, or *vice versa*. Uncertainty in age reading or sampling bias may be considered as a potential explanation. Model underestimate age 4 and 5 in 2022.

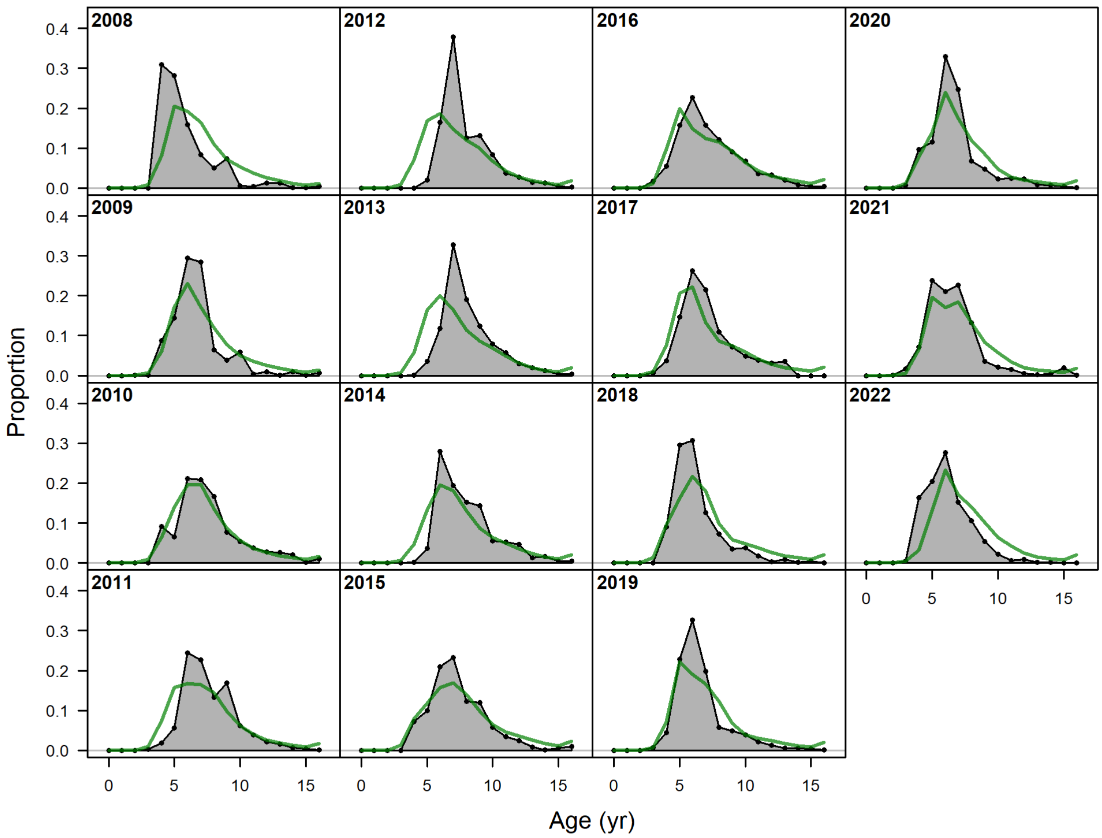


Figure 14.13. Observations and model predictions for age composition.

Figure 14.14 shows a comparison between the 2022 and 2023 assessments for the sea bass in the Bay of Biscay area. The recruitment series show great changes, with three low values estimated for 2015, 2017-2018, the latter value being revised to lower value compare to 2022 assessment. The SSB increases slightly during the recent years. The F continues to decrease.

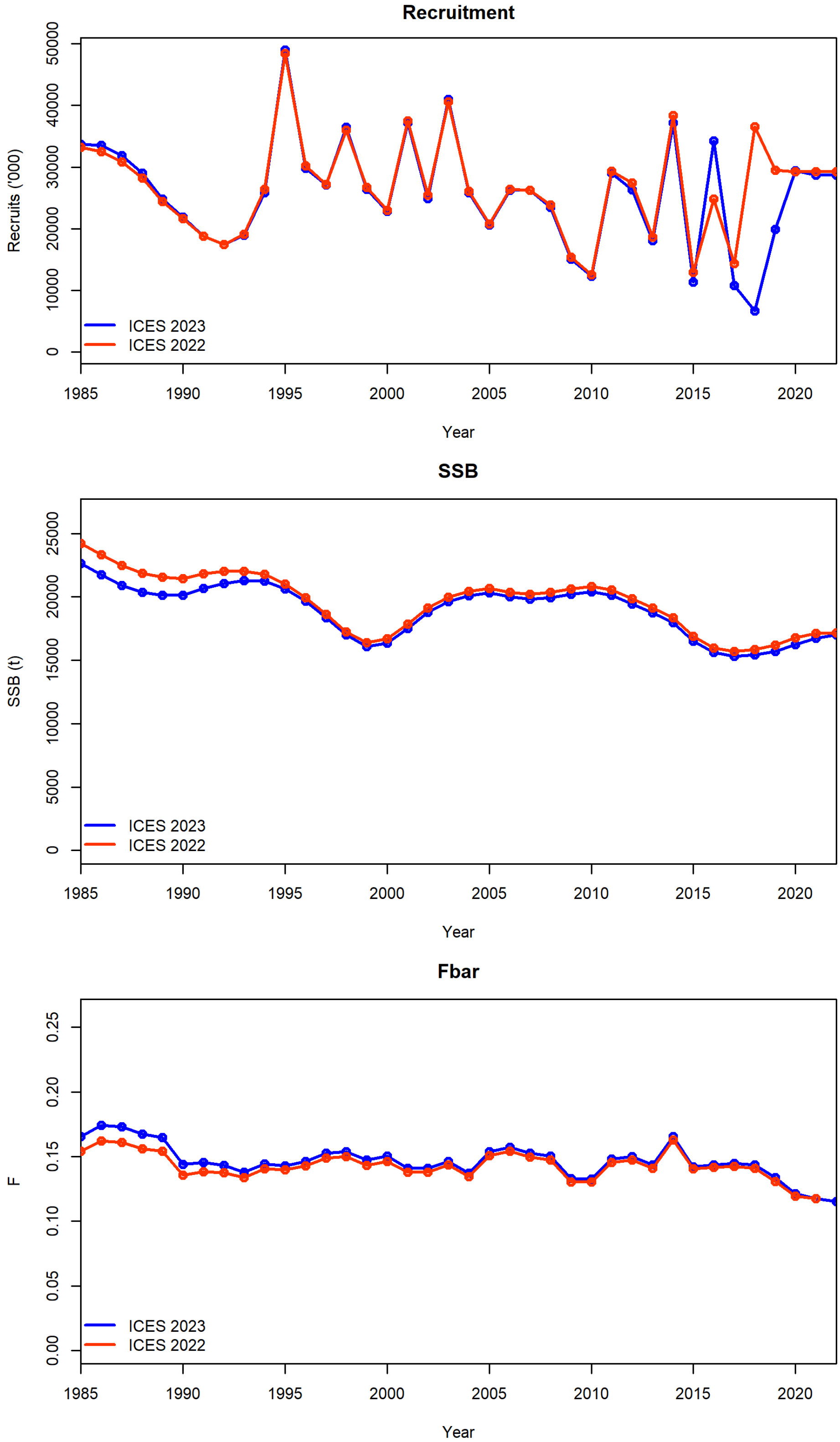


Figure 14.14. Comparison of the 2021 and 2022 assessment outputs (Recruitment, SSB, Fbar).

A retrospective analysis was performed (Figure 14.15). Recruitment, SSB and F series showed a pattern. The assessment tends to overestimate stock size and underestimate fishing pressure. This change was particularly large last year. The pattern is lower this year. The SSB is stable at around 20 000 t, while the F is below 0.15 with a decreasing trend. Recruitment was poorly estimated in recent years and showed high variability during the last decade.

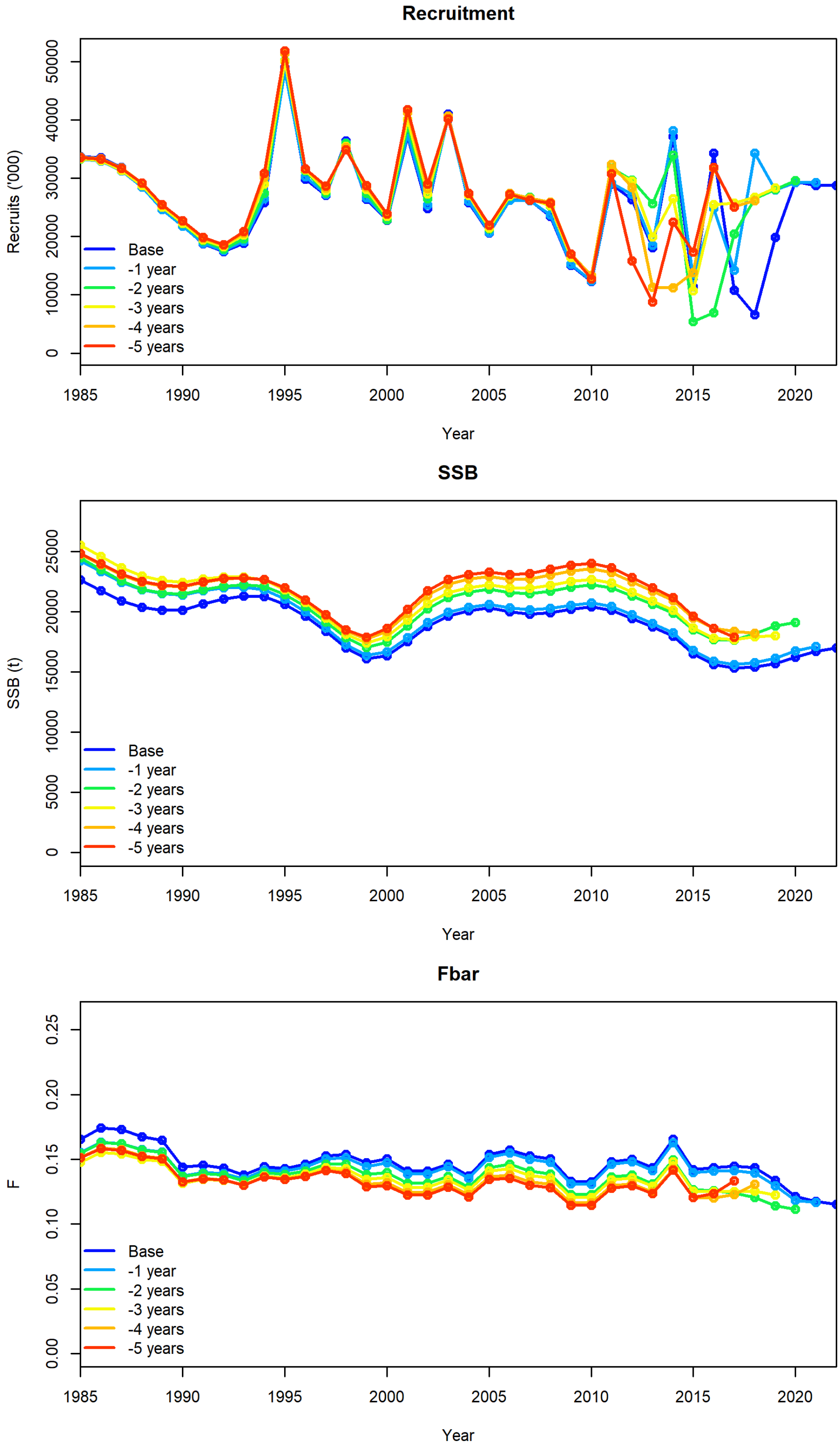


Figure 14.15. Retrospective analysis of SSB, F, and recruitment

Inconsistencies between the time-series of the retrospective analysis were quantified by Mohn's rho values (see Table 14.5; Mohn, 1999). The 2023 assessment shows a high Mohn's rho value for the recruitment series, which is highly variable and uncertain. Data that help quantifying recruitment only comes from length distributions of the commercial fisheries at age 5, revising every year recruitment series estimated by SS, the latter recruitment values only depending of recruitment parameters (R0, steepness, etc) before age 5.

Table 14.4. Mohn's rho values for the retrospective analysis.

2023 assessment		
SSB	Rec	Fbar
0.139	0.948	-0.068

An in-depth analysis of the assessment model parameters shows that the selectivity pattern is slightly increasing over time (see Figure 14.16), thus affecting SSB and F level estimates of the 2022 assessment. This trend in the selectivity pattern is in agreement with the management measures implemented on the MLS. This change should be accounted for in the next benchmark.

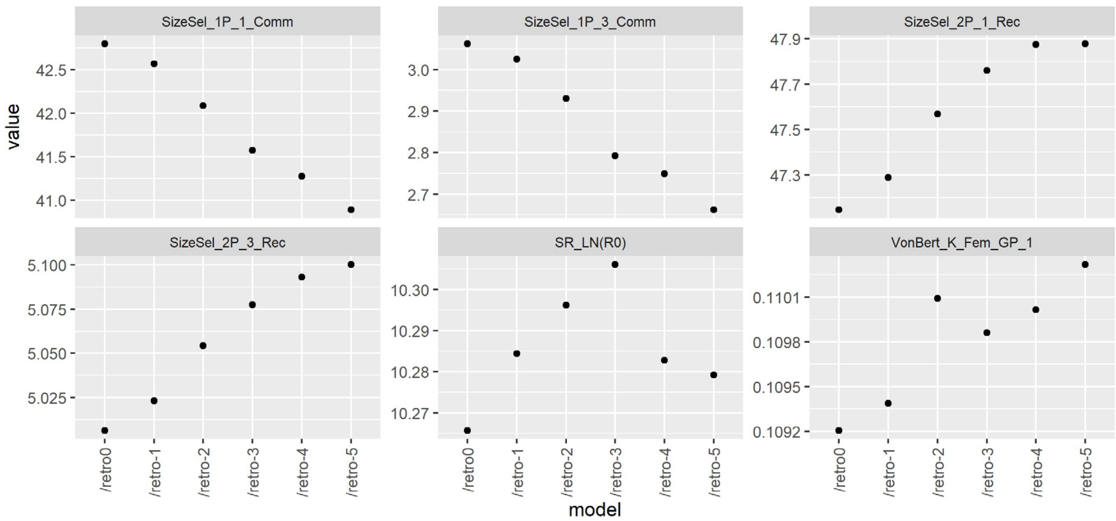


Figure 14.16. Retrospective plot for assessment model parameters that are not annual and that vary more than 1%.

14.6 Historic trends in biomass, fishing mortality, and recruitment

In 2022, fishing pressure on the stock is below F_{MSY} and spawning-stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim} (Figure 14.17).

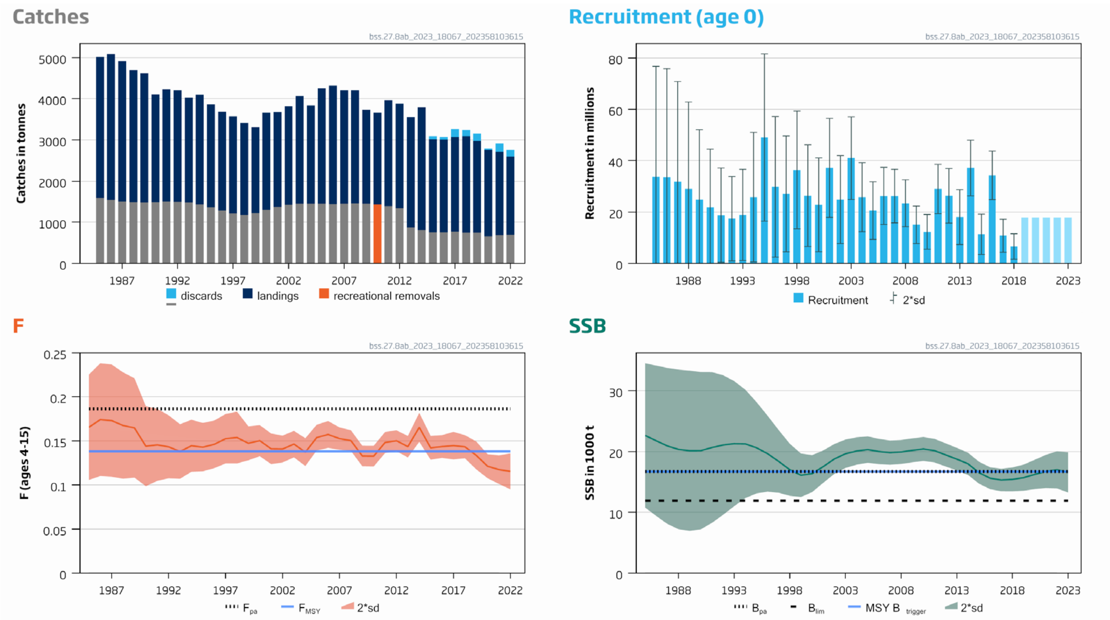


Figure 14.17. Summary of the stock assessment (weights in thousand tonnes). Commercial landings (with discards only included in 2015-2022), and recreational removals (only presented for 2010, where the data are available), including 5% mortality of released fish. Fishing mortality is shown for the combined commercial and recreational fisheries. The assumed recruitment value for 2019–2023 is shaded in a lighter colour. Recruitment, F and SSB are shown with 95% confidence intervals.

The stock is at full reproductive capacity, but incoming low recruitment causes the intermediate year's SSB to fall below MSY Btrigger (Table 14.6).

Table 14.5. State of the stock and fishery relative to reference points.

	Fishing pressure					Stock size				
		2020	2021	2022			2021	2022	2023	
Maximum sustainable yield	F_{MSY}	✔	✔	✔	Appropriate	MSY $B_{trigger}$	✔	✔	✖	Below trigger
Precautionary approach	F_{pa}, F_{lim}	✔	✔	✔	Undefined	B_{pa}, B_{lim}	✔	✔	o	Increased risk
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	–	Not applicable

Uncertainties around recruitment remain high throughout the time-series (Figure 14.18). Uncertainties around other ages reduced with age (Figure 14.19). The selectivity pattern is slightly increasing over time, thus affecting SSB and F level estimates (Figure 14.18).

The quality of the assessment is expected to improve when recruitment information from scientific surveys will be included in the next benchmark (Figure 14–18). Annual surveys have been conducted by France in the Bay of Biscay (Baie de Douarnenez, Loire and Gironde estuaries) since 2016.

Note that, this year, to smooth out the recruitment variability in the forecast, the last 5 years of numbers at age 0 are now replaced by its long term geometric mean.

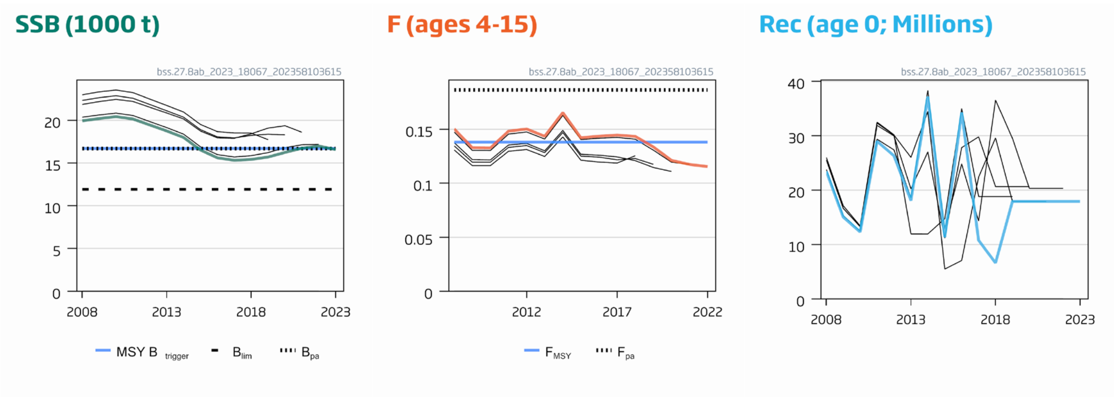


Figure 14.18. Historical assessment results (3 final-year recruitment assumption included for each line, except for 2022 for which 5 final-year recruitment assumption was made).

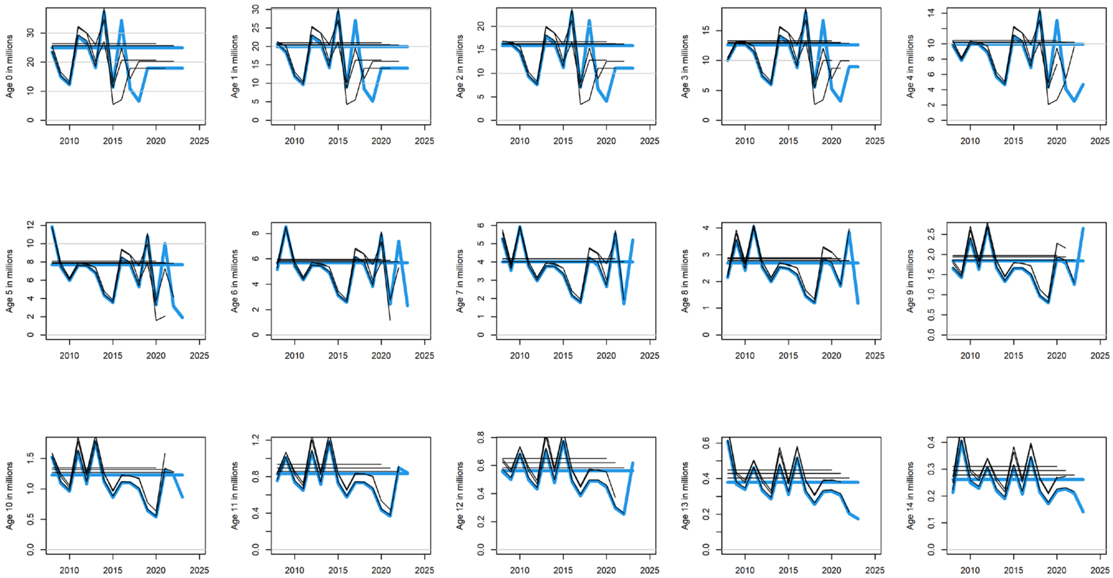


Figure 14.19. Historical assessment results for numbers-at-age (from age 0 to 14). 3 final-year recruitment assumptions are included for each line when appropriate. Horizontal lines represent averages over the series.

Table 14.6. Compilation of the assessment summary provided by the SS model. These assessment outputs were used to produce the standard graph of the advice (Figure 14.17).

Year	Recruitment			SSB			F			simulated recreational removals	recreational removals	comm. landings	comm. discards
	Low	Mid-point	High	Low	Mid-point	High	Low	Mid-point	High				
	thousands			tonnes						t	t	t	t
1985	0	33684	76721	10773	22651	34528	0.106	0.166	0.23	1593		3420	

Year	Recruitment			SSB			F			simulated recreational removals	recreational removals	comm. landings	comm. discards
	Low	Mid-point	High	Low	Mid-point	High	Low	Mid-point	High				
	thousands			tonnes						t	t	t	t
1986	0	33554	75845	9395	21770	34145	0.110	0.174	0.24	1541		3549	
1987	0	31874	70833	8084	20921	33758	0.109	0.173	0.24	1501		3417	
1988	0	28986	62799	7224	20353	33482	0.107	0.168	0.23	1482		3217	
1989	0	24829	52016	6952	20133	33314	0.108	0.165	0.22	1474		3144	
1990	0	21842	44469	7201	20145	33088	0.099	0.144	0.189	1485		2621	
1991	398	18794	37189	8261	20663	33065	0.105	0.146	0.187	1501		2734	
1992	974	17398	33823	9579	21075	32570	0.108	0.143	0.179	1499		2709	
1993	1129	18895	36660	11008	21300	31592	0.107	0.138	0.169	1481		2552	
1994	598	25807	51015	12337	21260	30183	0.115	0.145	0.174	1435		2668	
1995	16470	49020	81569	13102	20630	28157	0.116	0.143	0.170	1367		2492	
1996	2497	29839	57180	13404	19651	25897	0.119	0.146	0.173	1287		2402	
1997	4534	27079	49625	13210	18371	23532	0.124	0.153	0.181	1215		2358	
1998	13512	36429	59346	12717	17000	21282	0.124	0.154	0.183	1179		2231	
1999	6579	26370	46161	12520	16101	19682	0.128	0.147	0.167	1219		2091	
2000	4554	22805	41056	13318	16362	19407	0.133	0.150	0.168	1298		2362	
2001	17916	37189	56462	14849	17519	20189	0.124	0.141	0.158	1371		2306	
2002	7733	24854	41974	16322	18783	21244	0.126	0.141	0.156	1422		2392	
2003	24861	40974	57087	17295	19638	21982	0.131	0.146	0.161	1448		2616	
2004	12364	25797	39231	17836	20089	22343	0.121	0.137	0.153	1455		2380	
2005	9359	20596	31833	18151	20323	22496	0.139	0.154	0.168	1451		2796	
2006	15125	26260	37394	17928	20009	22090	0.142	0.157	0.173	1444		2875	

Year	Recruitment			SSB			F			simulated recreational removals	recreational removals	comm. landings	comm. discards
	Low	Mid-point	High	Low	Mid-point	High	Low	Mid-point	High				
	thousands			tonnes						t	t	t	t
2007	15788	26216	36644	17822	19823	21824	0.140	0.153	0.165	1452		2751	
2008	14347	23448	32549	17958	19934	21910	0.139	0.150	0.162	1460		2745	
2009	7750	15041	22332	18221	20197	22173	0.121	0.133	0.145	1453		2278	
2010	5536	12299	19062	18454	20420	22387	0.121	0.133	0.145		1430	2229	
2011	19351	28982	38613	18205	20149	22092	0.136	0.148	0.160	1391		2575	
2012	15670	26313	36957	17536	19446	21355	0.138	0.150	0.162	1335		2549	
2013	7392	18081	28771	16883	18749	20615	0.131	0.144	0.156	868		2685	
2014	26334	37176	48017	16158	17989	19819	0.149	0.165	0.182	804		2991	
2015	3502	11346	19191	14705	16513	18321	0.129	0.142	0.156	754		2264	68
2016	24795	34280	43766	13803	15608	17413	0.131	0.144	0.157	754		2252	65
2017	4321	10775	17229	13460	15314	17168	0.129	0.145	0.160	772		2295	196
2018	1653	6601	11549	13450	15418	17386	0.130	0.143	0.157	748		2338	155
2019		17928**		13552	15701	17851	0.118	0.134	0.149	748		2227	183
2020		17928**		13819	16233	18647	0.108	0.121	0.135	659		2090	41
2021		17928**		13998	16727	19456	0.101	0.117	0.134	681		2032	196
2022		17928**		13932	16993	20053	0.095	0.115	0.136	691		1906	160
2023		17928**		13257	16571	19885							

*** Recreational removals are estimates derived from the 2010 observed data.**

**** Geometric mean 2008–2018.**

14.7 Biological reference points

IBPBASS (ICES, 2018b) set the biological reference points to be used for this stock. Table 14.8 compiles the biological reference points computed under type 6 stock–recruitment relationship as also agreed during the IBPBASS. In 2021, ICES ACOM asked WGBIE to revise the computation basis for F_{pa}, to ensure that the F leads to SSB ≥ B_{lim} with 95% probability (i.e. $F_{p0.5}$). F_{pa} was higher than the current F_{lim}. Consequently, F_{lim} was revised as "undefined". Consistent with the decision regarding $F_{pa} = F_{p05}$, F_{MSY} and MAP F_{MSY} were changed to the uncapped value from the IBPBASS 2018 (ICES, 2018b). F_{MSY} value is now set to 0.138.

Table 14.7. Biological reference points accepted during the IBPBASS (ICES, 2018b) for use in the ICES advice. All weights are in tonnes.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	16 688	B_{pa}
	F_{MSY}	0.138	The F that maximizes median long-term yield in stochastic simulations under constant F exploitation; constrained by the requirement that $F_{MSY} \leq F_{pa}$
Precautionary approach	B_{lim}	11 920	B_{pa} / exp (CV × 1.645)
	B_{pa}	16 688	Lowest observed SSB
	F_{lim}	Undefined	F_{lim} (0.172) is no longer considered appropriate given the estimate of F_{pa}
	F_{pa}	0.186	$F_{p.05}$ with AR: The F that provides a 95% probability for SSB to be above B_{lim}
Management plan	MAP MSY $B_{trigger}$	16 688	MSY $B_{trigger}$
	MAP B_{lim}	11 920	B_{lim}
	MAP F_{MSY}	0.138	F_{MSY}
	MAP range F_{lower}	0.117	Consistent with ranges provided by ICES (2018b), resulting in no more than 5% reduction in long-term yield compared with MSY.
	MAP range F_{upper}	0.151	Consistent with ranges provided by ICES (2018b), resulting in no more than 5% reduction in long-term yield compared with MSY.

14.8 Short-term forecast and catch options

Forecast inputs used for the projections are compiled in Table 14.9. The recruitment used for the projection is the geometric mean (GM) calculated from 2008 to 2018. For the short-term projection, F-at-age averaged over the last three years (2020-2022) and scaled to 2022 value was used for both the commercial and recreational fleets (Table 14.9).

Table 14.8. Forecast inputs table.

Ages	N@age	Weight@age	Prop.mature@age	Commerical F	Commerical mean weight	Recreational F	Recreational mean weight	Natural mortality
0	17928	0.004	0.000	0.000	0.009	0.000	0.009	0.24
1	14103	0.020	0.000	0.000	0.044	0.000	0.051	0.24

2	11093	0.077	0.000	0.000	0.262	0.001	0.150	0.24
3	8720	0.179	0.000	0.000	0.440	0.004	0.297	0.24
4	6831	0.325	0.039	0.011	0.597	0.011	0.478	0.24
5	1935	0.508	0.200	0.047	0.741	0.021	0.678	0.24
6	2321	0.721	0.489	0.079	0.907	0.028	0.887	0.24
7	5205	0.957	0.738	0.093	1.112	0.032	1.111	0.24
8	1188	1.207	0.880	0.097	1.348	0.034	1.351	0.24
9	2647	1.465	0.946	0.098	1.600	0.034	1.602	0.24
10	866	1.725	0.975	0.098	1.856	0.035	1.858	0.24
11	842	1.982	0.988	0.098	2.110	0.035	2.111	0.24
12	619	2.234	0.994	0.099	2.357	0.035	2.357	0.24
13	175	2.476	0.997	0.099	2.594	0.035	2.594	0.24
14	141	2.708	0.998	0.099	2.820	0.035	2.820	0.24
15	144	2.928	0.999	0.099	3.033	0.035	3.033	0.24
16	325	3.510	0.999	0.099	3.593	0.035	3.593	0.24

Age 0,1,2,3,4 over-written as follows: 2023 yc -> 2023 age 0 replaced by 2008–2018 LTGM (17 928 thousand); 2022 yc -> 2023 age 1 from SS survivor estimate at-age 1, 2023 * LTGM / SS estimate of age 0 in 2021; 2021 yc -> 2023 age 2 from SS survivor estimate at age 2, 2023 * LTGM / SS estimate of age 0 in 2020; 2020 yc -> 2023 age 3 from SS survivor estimate at age 2, 2023 * LTGM / SS estimate of age 0 in 2019; 2019 yc -> 2023 age 4 from SS survivor estimate at age 4, 2023 * LTGM / SS estimate of age 0 in 2018.

Total landings forecasted for 2023 are 2414 t, with 1765 t for the commercial landings and 649 t for recreational fishery. SSB for 2024 is forecasted to be at 15569 thousands, i.e. just below MSY $B_{trigger}$ (Table 14.10).

Table 14.9. The basis for the catch scenarios.

Variable	Value	Notes
$F_{ages\ 4–15}$ (2023)	0.115	Total F: average $F_{2020–2022}$ scaled to F_{2022} (0.085) for the commercial fishery plus F_{rec} = 0.031 for the recreational fishery (bag limit of 2 fish/day).
SSB (2024)	15569	Short-term forecast (STF); in tonnes.
$R_{age\ 0}$ (2019–2023)	17928	Geometric mean of recruitment (GM, 2008–2018); in thousands.
Total catch (2023)	2414	STF; in tonnes.
Projected commercial landings (2023)	1765	STF; in tonnes.
Commercial discard rate (2023)	5.73	Average discard rate, 5.73% (2015–2022) relative to commercial landings; in tonnes.

Projected recreational removals (2023)	649	STF; in tonnes.

Following the ICES advice rules, in the case where SSB < MSY $B_{trigger}$ and a reduced F value is used for the forecast instead of F_{MSY}, total catch (commercial landings, commercial discards and recreational removals) in 2024 should be no more than 2642 tonnes (Table 14.11).

Table 14.10. Catch options table.

Basis	Total removals (2024) #	$F_{ages\ 4–15}$ Total (2024)	SSB (2025)	% SSB change ##	% advice change ^^
ICES advice basis					
EU MAP^ : $F_{MSY} \times SSB_{2024}/MSY\ B_{trigger}$	2642	0.129	14509	-6.8%	-22%
F = MAP^ : $F_{MSY\ lower} \times SSB_{2024}/MSY\ B_{trigger}$	2249	0.109	14816	-4.8%	-22%
Other scenarios					
MSY approach : F_{MSY}	2820	0.138	14370	-7.7%	-17%
F = 0	0	0	16593	6.6%	-100%
$F = F_{pa}$	3722	0.186	13669	-12.2%	9.5%
$SSB_{2025} = B_{lim}$	5994	0.32	11920	-23%	76%
$SSB_{2025} = B_{pa}$	-136	-0.005	16688	7.2%	-104%
SSB_{2025} = MSY $B_{trigger}$	-136	-0.005	16688	7.2%	-104%
$SSB_{2025} = SSB_{2024}$	1287	0.061	15569	0%	-62%
$F = F_{2022} = F_{sq}$	2379	0.115	14714	-5.5%	-25%

Includes commercial landings, recreational removals, and commercial discards computed assuming an average ratio of 5.73%.

SSB 2025 relative to SSB 2024 (15569 tonnes).

^ EU multiannual plan (MAP) (EU, 2019).

^^ Advice values for 2024 are relative to the corresponding 2023 values (MAP advice of $F_{MSY} \times SSB_{2023}/MSY\ B_{trigger}$ = 3398 and $F_{MSY\ lower} \times SSB_{2023}/MSY\ B_{trigger}$ = 2897, respectively; all other values are relative to F_{MSY}).

14.8.1 Advice change

The advice has been reduced by 22% due to the downward revision of the recruitment in years 2017-2021 (Figure 14.20). Consequently, the intermediate year's SSB falls below MSY Btrigger, and a reduced FMSY is applied for the 2024 catch advice.

Figure 14.20: Advice change for commercial landings, SSB, recruitment and total F.

Advice change is mostly affected by numbers and biomass at ages 5 and 6 (Figure 14.21).

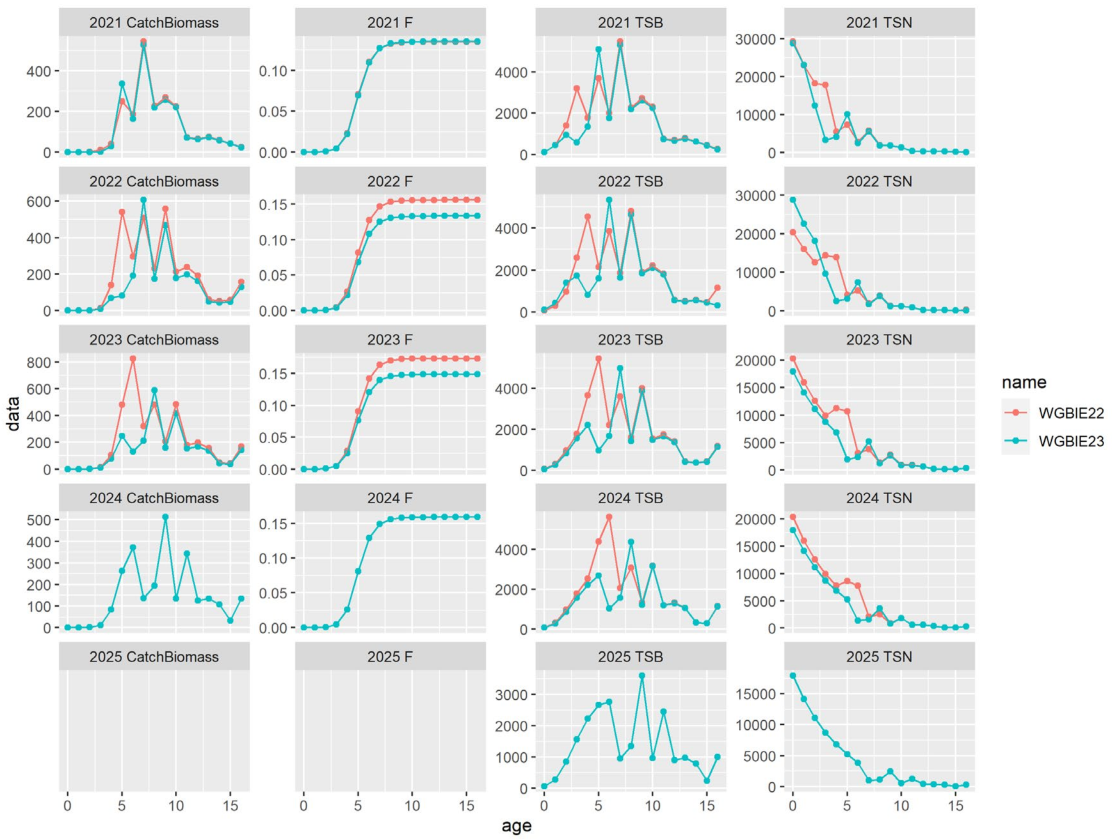


Figure 14.21: Advice change in catches-at-age, F-at-age, total stock biomass-at-age, total stock numbers-at-age.

14.9 Comments on the assessment

The assessment for the Bay of Biscay sea bass stock shows that since 2000, the spawning-stock biomass (SSB) fluctuated around 20 000 t. A low SSB was observed just before the 2000s, and a high SSB was observed around the year 2010. SSB is currently above MSY $B_{trigger}$ in the assessment. F showed a decreasing trend over the recent years and is currently below F_{MSY}. Recruitment is variable over time, and it was below average for the years 2009-2010 and 2015, 2017-2018. Total catches are slightly decreasing over time.

14.10 Considerations for a benchmark

This assessment relies on short time-series data: length composition time-series started only in 2000; age-at-length time-series started only in 2008 (with a proper sampling after 2010); recreational data were surveyed for only one year, in 2010. In addition, there is no scientific survey for adult sea bass to scale the model to an appropriate level of abundance. There is also no survey for recruits. All these elements make this assessment uncertain. In order to improve future assessments and advice for this stock, several important data limitations and deficiencies for the Bay of Biscay sea bass stock should be considered and addressed.

1. Recruitment indices are needed for the Bay of Biscay area. Estimation of recruitment is only based on commercial landings which may be smoothed by ageing errors (Laurec and Drogou, 2012). A French study has been undertaken in 2013–2018 to explore the possibility of creating recruitment indices in estuarine waters. The survey delivered good results but it needs stable economic support to be carried out routinely (Le Goff *et al.*, 2017). Abundance indices have been calculated for years 2016-2022 in the Loire estuary, and for years 2019-2022 in the Gironde estuary and additional surveys are planned for both estuaries for the year 2023. The final objective is to make these surveys sustainable through DCF funding from 2024, implement and test these estimated abundance indices in future assessments then discuss the results and their pertinence during a benchmark.
2. Robust relative fishery-independent abundance indices are needed for adult sea bass in the Bay of Biscay. The establishment of dedicated surveys on the spawning grounds could provide valuable information on abundance trends and the adult sea bass population structure. These can also provide information on the stock structure and linkages between spawning and recruitment grounds can be identified using a drift model.
3. Further research is needed to better understand the stock spatial dynamics (mixing between stock areas; effects of site fidelity on fishery catch rates; spawning site–recruitment ground linkages; environmental influences on recruitment).
4. The present assessment model should be revised through the integration of the undergoing tagging and genetic program results.
5. Studies are needed to investigate the accuracy and bias in ageing as well as identify errors due to historically aged sampling schemes.
6. Continued estimations of recreational removals and size compositions are needed across the stock range. Information to evaluate historical trends in recreational effort and removals would be beneficial for interpreting changes in age–length compositions over time.

7. Historical catches data (1985–2000) need to be revised following the methodology used for the recent years (2000 onwards) and disaggregated into several fishing fleets (e.g. midwater trawls, bottom trawls, nets, lines) to obtain longer time-series data.
8. Discard rates are considered negligible in the current assessment. Nonetheless, a time-series of discards-at-length and/or -age may be needed for all fleets if the impact of technical measures to improve selectivity is to be evaluated as part of any future sea bass management.
9. The absence of length composition data for French fisheries prior to 2000 is a serious deficiency in the assessment modelling as this prevents any evaluation of selectivity changes that may have occurred due to changes in the proportion of different gear types and especially with the significant decrease in pairtrawlers after 1995.

14.11 Management considerations

Sea bass is characterized by slow growth, late maturity, and low M in adults, which imply the need for comparatively low rates of F to avoid depletion of the spawning potential in each year class. The northern stock (4.b–c, 7.a,d–h) whose productivity is well-known, is affected by extended periods of enhanced or reduced recruitment which appear to be related to changes in sea temperature (ICES, 2016a). Warm conditions facilitate northward penetration of sea bass in the Northeast Atlantic and enhance the growth and survival of young fish in estuaries and other coastal nursery habitats. In the Bay of Biscay, there is no reason to observe a difference in dynamics. In terms of the numbers of recruits, the Bay of Biscay area looks more productive than in the North. If no efficient management plan is put in place, and if a combination of increasing F and environmental conditions cause relative successive poor recruitments, it could lead to a long-term and significant decline of biomass which is occurring in the Northern part.

The life-history behaviour of sea bass forming predictable aggregations for spawning in winter and moving inshore to feed at other times of the year increases their vulnerability to exploitation by offshore and inshore fisheries. The effects of targeting offshore spawning aggregations of sea bass are poorly understood considering the strong site fidelity of sea bass, particularly on how the fishing effort is distributed in relation to the mixing of fish from different nursery grounds or summer feeding grounds. Fisheries targeting offshore aggregation are mainly netters and, to a lesser extent, pelagic trawlers operating from December to March. Note that a high increase in the French landings of the nets fishery is observed since 2011. Indeed, as sea bass is currently a non-TAC species, there is a potential for a fishing effort displacement from other species with limiting quotas to this stock as observed with the netters in the Bay of Biscay that shifted their catches from sole to sea bass. The risk of a shift towards sea bass targeted fisheries occurring is high with no effective control on the fishery to limit the increase of the landings as observed in 2014. Many small-scale artisanal fisheries, especially line fishing, have developed a high seasonal catch dependence on sea bass. There is also a significant recreational F in inshore waters. The importance of sea bass to recreational, artisanal and other inshore commercial and large-scale offshore fisheries in different regions means that resource sharing is an important management consideration.

14.12 Information from stakeholders

Since 2017, the French commercial fishing activities in the Bay of Biscay (ICES divisions 8.a, 8.b, and 8.d) have been subjected to national management measures. These are aimed at limiting both sea bass fishing effort and fishing capacity, at levels compatible with the ICES recommendations.

These especially concern annual and periodic limitations of sea bass fishing opportunities, at the levels of both the whole fishery and individual vessels (CNPMEM, 2020).

15 Sea bass in southern Bay of Biscay and Atlantic Iberian waters

bss.27.8c9a – *Dicentrarchus labrax* in divisions 8.c and 9.a

15.1 General

Type of assessment: No analytical assessment. Sea bass (*Dicentrarchus labrax)* stock in divisions 8.c and 9.a is considered a data-limited stock (DLS) and it is classified as a category 5.2 stock (ICES, 2012a). Advice basis: Precautionary approach. The advice for this stock is biennial (ICES, 2023a).

15.1.1 Stock identity and sub-stock structure

Sea bass is a widely distributed species in Northeast Atlantic shelf waters with a range from southern Norway, through the North Sea, the Irish Sea, the Bay of Biscay, the Mediterranean and the Black Sea to Northwest Africa. The species is at the northern limits of its range around the British Isles and southern Scandinavia. Further studies are needed on sea bass stock identity using conventional and electronic tagging, genetics and other individual and population markers (e.g. otolith microchemistry and shape), together with data on spawning distribution, larval transport and VMS data for vessels tracking migrating sea bass shoals, to confirm and quantify the exchange rate of sea bass between areas that could form management units for this stock (ICES, 2012a; 2012b; 2012c).

In 2022, a workshop sea bass stock identification (WKSEABASSID; ICES, 2023b) met to review evidence and propose plausible stock structure scenarios that can be integrated on the upcoming sea bass assessment model benchmark, potentially in 2024, with the other seabass stocks in the other ICES ecoregions. The conclusion mentioned in the workshop's report states that "*although this meeting exclusively examined the northern and southern sea bass stock units, future studies must extend this effort to investigate evidence of boundaries and/or connectivity with other areas. ICES advice is currently provided for divisions 8.ab (northern and central Bay of Biscay), 4.b-c, 7.a and 7.d-h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel and Celtic Sea (de Pontual et al., 2019). Additionally, two stocks are recognised but no advice is provided by ICES: divisions 8.c-9.a (Iberian) and 6.a, 7.b, 7.j (West of Scotland and Ireland) (de Pontual et al., 2019). Due to the high degree of connectivity revealed by this report, it is highly unlikely that the Iberian and West of Scotland/Ireland sea bass are isolated components. Therefore, additional genomics, tagging, pelagic connectivity and microchemistry will need to be undertaken to reveal how sea bass within these regions link to existing stock units.* "

15.1.2 Biological reference points

No biological reference points are defined for this stock.

15.2 ICES advice on fishing opportunities

ICES advises that when the precautionary approach is applied, commercial catches in each of the years 2024 and 2025 should be no more than 382 t. All commercial catches are assumed to be landed. Recreational removals cannot be quantified. Therefore total catches cannot be calculated.

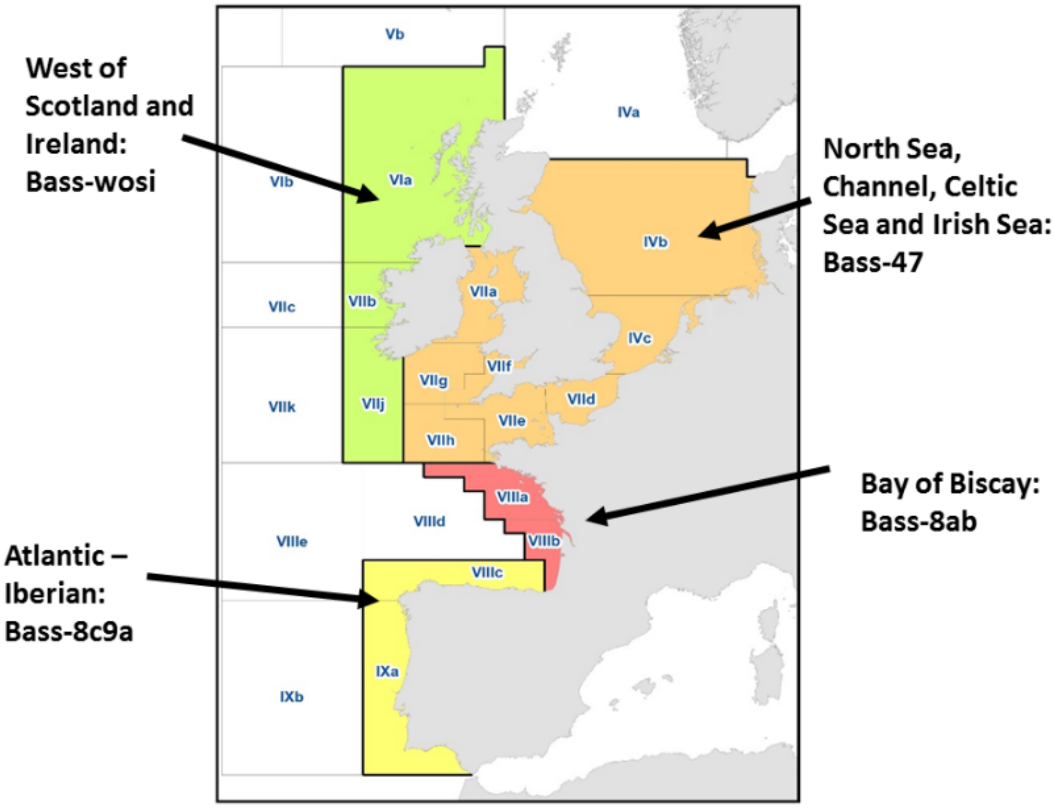


Figure 15.1. Sea bass (*Dicentrarchus labrax*) in divisions 8.c and 9.a. Current stock structure definitions for the sea bass.

15.3 Management

15.3.1 Management applicable to 2017

Sea bass is not subjected to EU TACs and quotas. Under the EU regulation, the minimum landing size (MLS) for commercial fisheries of sea bass in the Northeast Atlantic is 36 cm in total length. A variety of national restrictions on commercial sea bass fishing are also implemented.

The measures affecting recreational fisheries in Portugal include gear restrictions, an MLS equal to the commercial fishery (36 cm), the total catch of fish and cephalopods by each fisher must be less than 10 kg per day or 15 kg per day for spear fishing, excluding, in both cases, the largest fish, and the sale of catch is prohibited.

15.3.2 Management applicable to 2018

No management measures were known in 8.c, 9.a for the year 2018.

15.3.3 Management applicable to 2019–2023

A multiannual management plan (MAP) has been published for the Western Waters (EU, 2019). This plan applies to demersal stocks including sea bass in ICES divisions 8.c and 9.a.

15.4 Fisheries data

15.4.1 Commercial landings data

Landings series are given in Figure 15.1 and are derived from:

i. Official statistics recorded in the FishStat database (FAO, 2020) since around the mid-1970s;
ii. Spanish landings for 2007–2011 from sales notes;
iii. Portuguese estimated landings from 1986 to 2011 including the distinction between *Dicentrarchus labrax* and *D. punctatus*;
iv. Official landings from recent years (reviewed from 2012 onwards);
v. InterCatch.

Spanish and Portuguese vessels represent almost all of the total annual landings in areas 8.c and 9.a. Commercial landings represent 816 t in 2022 (source: InterCatch/ICES Accessions). Artisanal fisheries are mainly observed in this area (Table 15.2). Landings from Portugal are only from Division 9.a, while the Spanish landings are distributed between divisions 8.c and 9.a (214 and 242 t in 2022, respectively). Landings per country are given in Figure 15.2 while landings (split by country, gear and area) are given in Table 15.2.

It should be noted that according to the Portuguese administration, official landings from 2018 are probably overestimated due to a duplication in the calculations. Official landings were extracted from the ICES Official Statistics webpage for *D. labrax* (BSS) and divisions 8.c and 9.a. The difference between ICES and official statistics is primarily that prior to 2006, most of the sea bass catches in the Portuguese statistics was registered under the species code BSE which represents all *Dicentrarchus* spp. combined. After the implementation of the Data Collection Framework (DCF), there was a progressive increase in the correct identification of *D. labrax* in the official statistics (the number of BSS increased while BSE decreased) that consider all *Dicentrarchus* spp. landings. *D. labrax* comprises almost all of the landings while 2.3% is deducted from total removals and is considered as *D. punctatus*. This proportion is estimated based on the DCF market and onboard samplings between 2008 and 2012.

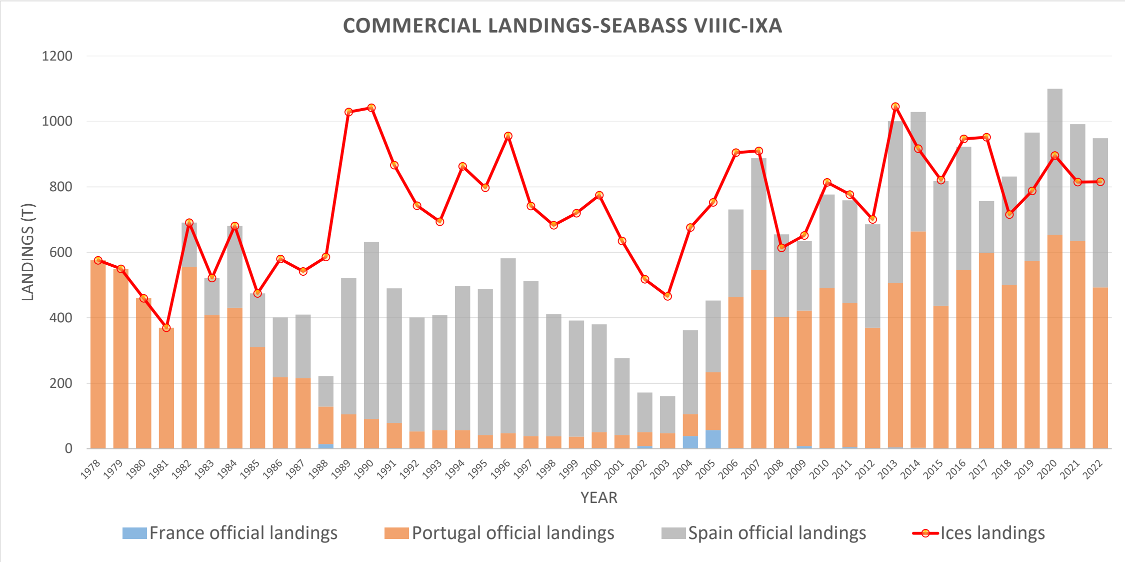


Figure 15.2. Sea bass (*Dicentrarchus labrax*) in divisions 8.c and 9.a. Commercial landings per country in divisions 27.7.8.c and 27.7.9.a (source: official landings and InterCatch/ICES accessions).

15.4.2 Commercial length composition data

Quarterly length composition is available in Division 9.a (source: InterCatch) for the both the commercial Portuguese (MIS_MIS_0_0_0) for the period 2016–2022 (Figure 15.3) and Spanish fleets from 2017 to 2022 (Figure 15.4).

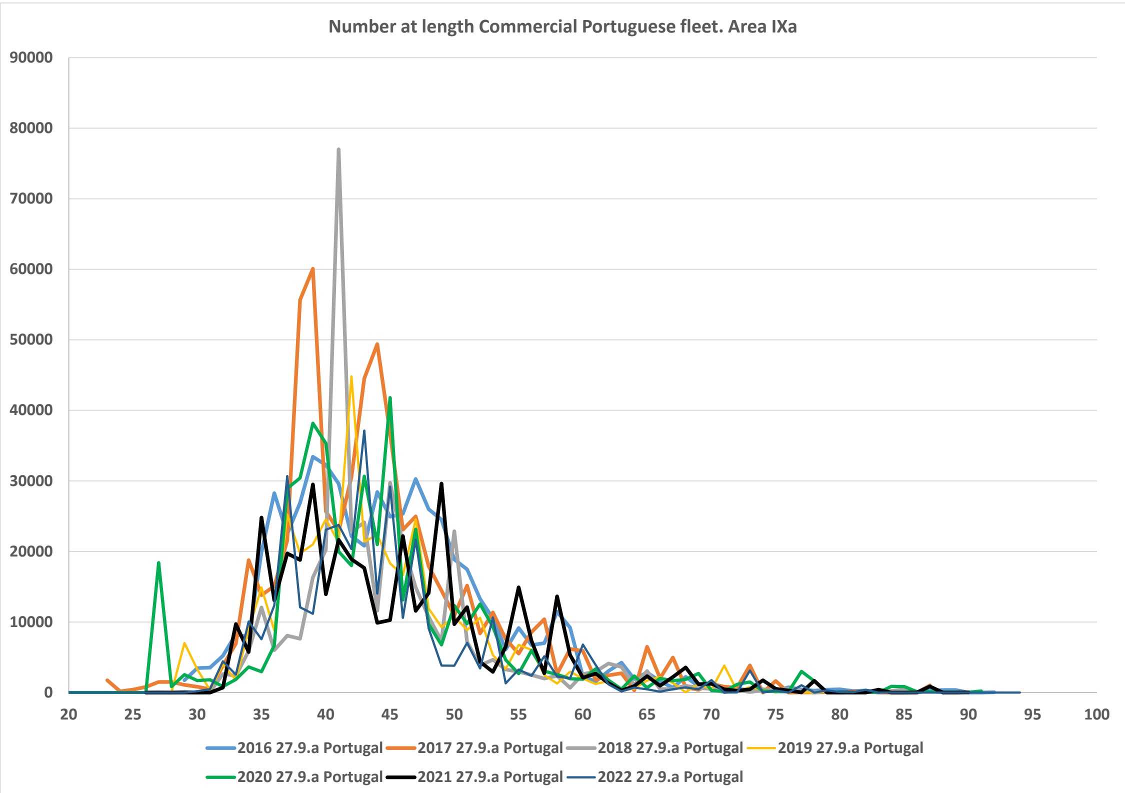


Figure 15.3. Sea bass (*Dicentrarchus labrax*) in divisions 8.c and 9.a. Commercial length composition in 2016–2022 for Portuguese fleet landings (source: InterCatch/ICES accessions).

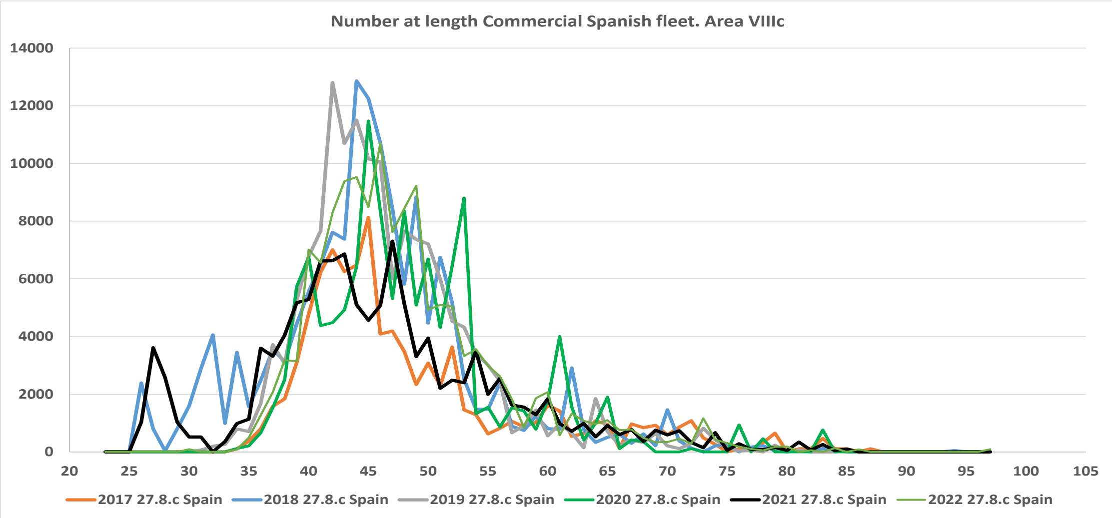


Figure 15.4. Sea bass (*Dicentrarchus labrax*) in divisions 8.c and 9.a. Commercial length composition of the Spanish commercial fleet landings from 2017 to 2022 (source: InterCatch).

15.4.3 Commercial discards

Portugal: Discards are recorded by the DCF onboard sampling program and are reported only for the trawl fisheries. There is no occurrence of sea bass discards during the sampling period 2004–2022. No discards are expected for the other *métiers* due to the high commercial value of the stock.

Spain: No sea bass discards was reported from 2003 to 2022.

15.4.4 Effort

Some effort data were available (source: InterCatch) for the Spanish commercial fleet from 2016. On the other hand, effort data collection from the Portuguese commercial began in 2015 which was followed by slight but consecutive annual decreases from 2016 onwards (Figure 15.5).

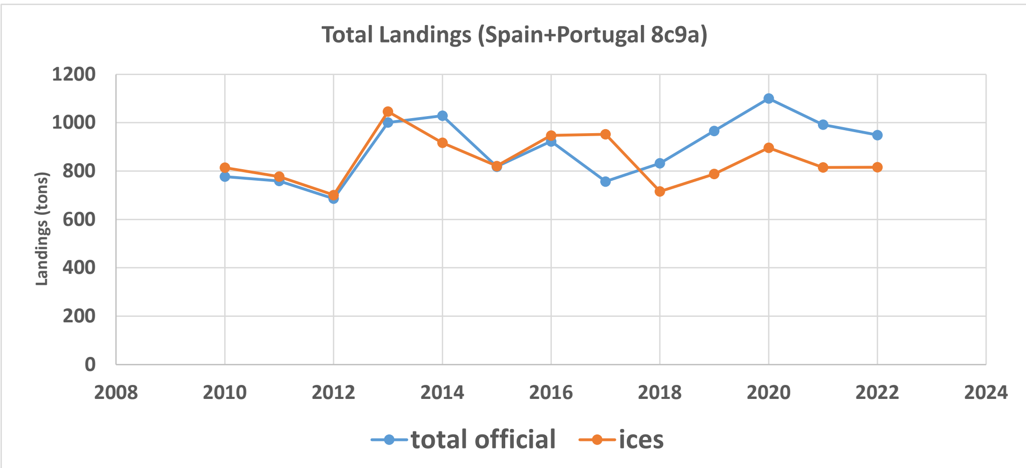


Figure 15.5. Sea bass (*Dicentrarchus labrax*) in divisions 8.c and 9.a. Effort (in KWD) for Spanish and Portuguese commercial fleets in divisions 8.c and 9.a (source: InterCatch).

Recreational removals

Recreational removals of sea bass in divisions 8.c and 9.a are currently unquantified but are considered to be substantial. Several studies exist that supports this:

In Portugal, the ongoing Pescardata project aims to study the DCF recreational removals in mainland Portugal in order to characterize several aspects of this fishery, describe the catches and define robust catch estimates for the stock (ICES, 2023c). Collected data still need to be reviewed. Further details can be found on https://pescardata.pt/.
Another study intends to characterize, assess and monitor recreational removals in marine protected areas (MPA), coastal areas and other sensitive marine areas on the Portuguese mainland coast. Surveys took place between April 2021 and November 2022 (ICES, 2023c). The study considered 7 MPAs (Ria Formosa, Natural Park of Southwest's Alentejo and Vicentina Coast, Arrábida Natural Park, Sintra-Cascais Natural Park, Berlengas Natural Reserve, Aveiro's Ria Natural Park, North Litoral – Esposende Natural Park), 2 urban areas (Greater Lisboa and Greater Porto) and 3 other areas (Algarve's Leeward, Algarve's Windward and Peniche). Data analysis showed that the estimated total annual catch reached around 8.650 t. Among the captured species, the white seabream was the most dominant (2.345 t) followed by the sea bass (1.579 tons) then the cephalopods (1.265 tons) and finally the gilthead seabream (1.150 tons). Thus, recreational removals can have a high impact on the total catches of the species. Details can be found at https://www.dgrm.mm.gov.pt/web/guest/dados-estatisticos
In Spain, a survey is currently in place to generate annual estimates of participation, effort, and catches of recreational fishers in the Autonomous Region of Andalusia (ICES, 2023c). A routine monitoring programme is running since 2015 in the Basque country to estimate catch and effort for all DCF mandatory species (Zarauz et al., 2015; ICES, 2017b; Bachiller et al, 2022). In addition, multispecies surveys are currently being carried out to estimate effort, catch estimates for main target species and human dimensions of the activity since 2020 (ICES, 2023c).

15.5 Assessment model, diagnostics, and retrospectives[1]

15.5.1 History of previous assessments

In 2018, a precautionary approach (PA) has been adopted as the basis for advice of this stock in 2013 based on the average of the 2009–2011 catches (ICES, 2018). A new precautionary buffer of 20% less was applied to the 2018 advice which did not make sense to WGBIE due to the previous period considered for the calculations, the relative stability in landings over time, the presence of very large individuals (up to 92 cm) in length composition of commercial landings and since sea bass is not a targeted species in this area compared to the northern stock. The application of the precautionary buffer (20% less) on the mean catches for the period 2014–2016 would have probably been more appropriate as this resulted in a catch advice of 716 t.

***Advice for 2022 and 2023*:** A new advice was issued in 2021 for the years 2022 and 2023. ICES advises that when the precautionary approach is applied, commercial catches in each of the years 2022 and 2023 should be no more than 382 t. All commercial catches are assumed to be landed. Recreational removals cannot be quantified and, therefore, total catches cannot be calculated. The stock status relative to a candidate reference points was unknown; therefore, the precautionary buffer was applied in the advice (ICES, 2022). The precautionary buffer was also earlier applied in 2017 (ICES, 2017).

[1] Assessment is only based on commercial landings. Recreational removals are not included.

15.5.2 Current assessment

ICES advises that when the precautionary approach is applied, commercial catches in each of the years 2024 and 2025 should be no more than 382 t. All commercial catches are assumed to be landed. Recreational removals cannot be quantified and, therefore, total catches cannot be calculated.
The ICES framework for category 5 stocks (ICES, 2012a) was applied. For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was last applied in 2021 (ICES, 2021) and was therefore not considered this year.

15.6 Recommendations for the next benchmark assessment

In 2019, WGBIE encouraged to document the sea bass data quality for the Iberian waters, and proposed studies to better understand the stock dynamics and movements between the current stock areas (ICES, 2019). Sea bass in Iberian waters is still considered a category 5.2 (ICES, 2023a). The ICES framework for category 5 stocks is applied (ICES, 2012a) for catch advice. Currently, no information is available to provide the status of this stock. Note that divisions 8.c and 9.a are mainly caught by artisanal fleets (vessel < 10 m) which do not fill the logbooks. Nevertheless, sale notes are reported in InterCatch.

WGBIE is aware of ongoing projects on these species in Portugal and Spain. WGBIE is trying to contact with these researchers to look for a collaborative approach that can help to improve the available information for this stock.

15.7 Management plan

The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters (EU, 2019). The MAP stipulates that when the F_{MSY} ranges are not available, fishing opportunities should be based on the best available scientific advice. This plan applies to demersal stocks including sea bass in ICES divisions 8.c and 9.a.

15.8 References

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Diário da República, 1.ª série — N.º 16 — 23 de janeiro de 2014; Portaria n.º 14/2014, of the 23rd January, article 12, n.º 1 ("O peso total das capturas diárias na pesca lúdica não pode, no seu conjunto, exceder 10 kg por praticante, não sendo contabilizado para o efeito o exemplar de maior peso, sendo que para a pesca submarina este limite é de 15 kg, não sendo igualmente contabilizado o maior exemplar.")

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16 Plaice in Bay of Biscay and Atlantic Iberian waters

ple.27.89a – *Pleuronectes platessa* in Subarea 8 and Division 9.a

16.1 General

Type of assessment: no analytical assessment. The Bay of Biscay and Atlantic Iberian waters plaice (*Pleuronectes platessa*) is considered a data-limited stock (DLS) and classified as a category 5.2 stock (ICES, 2012; ICES, 2023a).

Advice basis: Precautionary approach. The advice for this stock is biennial[1].

16.1.1 Stock identity

The stock unit definition of plaice (*P. platessa*) in this area is not clear. WGNEW (ICES, 2014) concluded that in the absence of specific information on stock structure, the ICES ecoregions (North Sea including 7.d, Celtic Seas, and southern European Atlantic) are to be used as minimum level of disaggregation for the definition of stock units (ICES, 2012). This is an interim solution until more information is available on the stock.

16.1.2 Biological reference points

No biological reference points are defined for this stock.

16.1.3 Fishery description

Plaice is caught as bycatch by various fleets and gear types covering small-scale artisanal and trawl fisheries. Portugal and France are the major actors in this fishery.

16.1.4 Summary of ICES advice and management

16.1.4.1 ICES advice for 2024 and 2025

ICES advises that when the precautionary approach is applied, landings in each of the years 2024 and 2025 should be no more than124 t. ICES cannot quantify the corresponding total catches.

16.1.4.2 Management plan

The EU multiannual plan (MAP) for stocks fished in Western Waters (EU, 2019) takes bycatch of this species into account.

[1] Note on data revisions: landings for years 1994 to 2000 were included with information available in the ICES historical database. Catches from 2014 to 2000 were extracted from InterCatch.

16.2 Fisheries data

16.2.1 Commercial landings

Plaice (*P. platessa*) is caught as a bycatch by various fleets and gear types covering both small-scale artisanal and trawl fisheries. Portugal and France are the main countries exploiting the stock with Spain playing a minor role. Landings may contain misidentified flounder (*Platichthys flesus*) as they are often confounded at market auctions in Portugal. The official landings are given in Table 16.1 while the catches submitted to WGBIE are given in Table 16.2. The quantity of discarding is uncertain. It is likely that discards are relatively minor but WGBIE cannot currently conclude that discarding is less than 5% of the catch.

No commercial index is currently available. However, the advice might benefit from commercial LPUE data if these were made available to WGBIE.

Biological information needs to be compiled. Issues concerning the quality of landing statistics in addition to the lack of survey or commercial abundance indices need to be resolved before an assessment can be made. As this species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula (Figure 16.1), perhaps merging the northern and southern stocks would provide a better opportunity to improve the assessment of the stock.

This stock is under the EU landing obligation since 2016 (EU, 2016).

16.3 Assessment model, diagnostics, and retrospectives

16.3.1 Previous assessment

16.3.1.1 ICES 2020 and 2021 Advice (Published 28 June 2019)

The ICES framework for category 5 stocks was applied (ICES, 2012). ICES advises that when the precautionary approach is applied, wanted catches in each of the years 2020 and 2021 should be no more than 155 t. ICES cannot quantify the corresponding total catches. The stock status relative to reference points remains unknown. The precautionary buffer was not applied in 2017 for the 2018 and 2019 advice and is therefore applied in 2020.

16.3.1.2 ICES 2022 and 2023 Advice (Published 30 June 2021)

ICES advises that when the precautionary approach is applied, landings in each of the years 2022 and 2023 should be no more than 155 t, similar to the last advice provided for this stock. ICES cannot still quantify the corresponding total catches to date.

The ICES framework for category 5 stocks (ICES, 2012) was again applied. For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The stock status relative to reference points remains unknown. The precautionary buffer was applied in 2019 (for the 2020 and 2021 advice) and is, therefore, not applied this year (ICES, 2023b).

16.3.1.3 Note on Benchmark workshop 2 on the development of MSY advice using SPiCT (ICES 2023)

The WKBMSYSPiCT2 workshop (ICES, 2023c) held in late 2022, evaluated the appropriateness of data and the use of the Surplus Production in Continuous Time (SPiCT; Pedersen and Berg, 2017) model to provide MSY advice for selected stocks and for which this stock was considered.

The conclusion of WKBMSYSPiCT2 benchmark (ICES, 2023c) with regards to this stock was as follows: "It was not possible for the group to recommend or approve a SPiCT assessment model for this stock. The reasons for this included (a) some doubts on whether a LPUE index such as the value derived in the WKBMSYSPiCT2 would appropriately reflect the biomass of a stock essentially caught as a bycatch in mixed fisheries directed on common sole or cephalopods (squids and cuttlefish). Doubts linked to the back-transformation of the LPUE index to the natural scale as well as the severe constraints that needed to be applied to reach convergence and avoid the stock to fluctuate at two different states depending on the initial values. The 'one-way trip' trajectories of landings and biomass indices considerably made the estimation of parameters complicated and contributed to a high level of uncertainty associated with estimated parameters. Alternatively, the use of integrated models could be explored in the future to account for the scarce amount of size and age information available for this stock and identify the spatial differences of the stock's distribution over the area."

16.3.2 Current assessment

The ICES framework for category 5 stocks (ICES, 2012; ICES, 2023a) was applied. For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock (ICES, 2023b). The stock status relative to reference points remains unknown. The precautionary buffer was last applied in 2019 to provide advice for each of the years 2020 and 2021, wasn't applied during WGBIE 2021 for catch advice 2022 and 2023 and therefore has been used this year.

16.4 References

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16.5 Tables and figures

Table 16.1. Plaice (*P. platessa*) in Subarea 8 and Division 9a. Official landings by country in tonnes.

Year	Belgium	France	Portugal	Spain	Total
1994		365	33	1	399
1995		319		12	331
1996		248		14	262
1997		255		3	258
1998		219		6	225
1999	1			3	4
2000	15	193		22	230
2001		201		22	223
2002	1	167		11	179
2003	1	217	1	4	223
2004		229	163	7	399
2005	4	186	1	33	224
2006	2	248	1	5	256
2007	5	214	41	4	263
2008	2	98	89	4	193
2009	2	133	101	8	244
2010	2	200	112	12	325
2011	2	208	65	9	283
2012	3	183	63	4	252
2013	0	147	45	5	197
2014	1	164	51	6	222
2015	2	142	45	5	194
2016	1	121	49	4	175
2017	1	98	33	2	134
2018	0	90	39	3	133
2019	0	94	36	3	133
2020	0	76	46	4	126

Year	Belgium	France	Portugal	Spain	Total
2021	0	65	27	4	96
2022	0	48	12	2	62

Table 16.2. Plaice (*P. platessa*) in Subarea 8 and Division 9a. Catches (in tonnes) submitted to InterCatch.

Catch category	Country	Gear	2014	2015	2016	2017	2018	2019	2020	2021	2022
Discards	France	Nets	-	10.0	3.0	4.0	2.0	2.0	2.0	4.3	0.2
		Other	-	2.0	0	0	0	0	-	0	0
		Trawl	-	4.0	0	1.0	1.0	0	-	0	0
	Spain	Nets	0	-	-	-	0	-	-	0	0
		Trawl	0	-	-	-	0	-	-	0	0
	Portugal	Trawl	X	0*	0*	0*	0	-	-	0	0
Discards Total			**0**	**15.0**	**3.0**	**5.0**	**3.0**	**2.0**	**2.0**	**4.3**	**0.2**
Landings	Belgium	Other	1.0	2.0	1.0	1.0	-	0.4	0.3	0.1	0
	France	Nets	42.0	46.0	48.0	42.0	41.0	38.0	37.0	32.4	25.4
		Other	38.0	21.0	12.0	24.0	6.0	7.0	4.0	3.2	2.3
		Trawl	82.0	74.0	62.0	33.0	44.0	49.0	36.0	29.6	20.3
	Portugal	Other	47.0	44.0	47.0	33.0	39.0	36.0	46.0	27.1	12.0
	Spain	Nets	4.0	3.0	3.0	1.0	2.0	2.0	2.2	2.1	1.8
		Other	1.0	1.0	1.0	0	0	0.2	0.6	0.2	0.1
		Trawl	1.0	1.0	1.0	1.0	1.0	0.06	0.63	1.2	0.4
Total landings			**217.0**	**193.0**	**174.0**	**135.0**	**133.0**	**133.0**	**126.0**	**96.3**	**62.3**
Total catches			**217.0**	**208.0**	**177.0**	**140.0**	**136.0**	**135.0**	**128.0**	**100.6**	**62.5**
Official Landings**			**220.0**	**193.0**	**173.0**	**134.0**	**133.0**	**133.0**	**126.0**	**96.0**	**62.0**

*** Not available in InterCatch but submitted to (AC).**

**** Official provisional statistics from ICES website: http://data.ices.dk/rec12/downloadData.aspx**

17 Pollack in Bay of Biscay and Atlantic Iberian waters

pol.27.89a – *Pollachius pollachius* in Subarea 8 and Division 9.a

17.1 General

Type of assessment: the Bay of Biscay and Atlantic Iberian waters pollack is classified as a category 3 stock (this report). LBI (Length Based Indicators) method is used to assess this stock. The advice for this stock is biennial and advice basis the MSY approach.

Until this working group this stock was classified by ICES as a category 5 stock and the latest advice was provided in 2021 (ICES, 2021a) following a precautionary approach. This stock was benchmarked in 2023 (ICES, 2023a),

17.1.1 Stock identity and fishery description

See Stock Annex.

17.1.2 Summary of ICES advice for 2022 and 2023 and management for 2021 and 2022

17.1.2.1 ICES advice for 2022 and 2023

In 2021, ICES advised that when the precautionary approach is applied, commercial catches should be no more than 905 t in each of the years 2022 and 2023.

17.1.2.2 Management applicable for 2022 and 2023

Pollack is managed under a TAC that was set at 1851 t for both 2022 and 2023. The 2023 TAC for pol.27.89.a is set separately for ICES divisions 8.a, 8.b, 8.d, 8.e, Division 8.c, and subareas 9 and 10 (and Union waters of CECAF 34.1.1) and is shown in Table 17.1. The reported landings of pol.27.89.a in 2022 were 65% of the established TAC.

17.2 Fisheries data

17.2.1 Commercial landings

Pollack, *Pollachius pollachius*, is mainly exploited by France and Spain, with minor contribution of landings from Portugal. For the last 10 years, France was responsible for 77% of stock's commercial landings while Spain for 18%. The commercial landing statistics are given in Table 17.2. A more detailed description of the fisheries and biology of the species is provided in the Stock Annex.

The landings by gear submitted to WGBIE are given in Table 17.3. Note that these are not the landings values used in the advice issued in 2015 and 2017 due to numerous data gaps. A new French landings series by *métier* from 2000 to 2014 was available from the ROMELIGO project (Léauté *et al.*, 2018a - WD 05 in ICES, 2018a), and these data were used to update the pollack landings for these years. The ROMELIGO data (N. Caill-Milly, Ifremer, pers. comm.) have been used to complete the official information available for this stock.

Annual commercial landings have fluctuated between 1199 and 2313 t since 2000, without a clear trend. Pollack landings decreased from 1535 t in 2020 to 1199 t in 2022, which is an 22% decline. The TAC for 2022 was set at 1851 t, which means that commercial landings have not exceeded this value.

Recreational catches may be considerable (Radford *et al.*, 2018) but have not been quantified.

17.2.2 Commercial discards

Discard estimates are available since 2003 for the French fleets, and since 2015 for all relevant fleets (Table 17.4). Discard information from 2003 to 2014 was compiled from data provided by the ROMELIGO project (N. Caill-Milly, Ifremer, pers. comm.) to WGBIE. Most fleets did not report pollack in discards and for Spanish netters discards are considered negligible (less than 0.5% of catch). French netters and liners discarded the 2% and 0.1% of their catches in 2022, respectively.

17.2.3 Length composition

There is a time-series of commercial landings-at-length data for 2010–2022 (Figure 17.2). Length composition sampled were compiled from InterCatch (years > 2015) and the ROMELIGO project (Leauté *et al.*, 2018a; 2018b). From 2010 to 2015, the length composition information is only available for the French métiers. From 2015 onwards, Spain provides length information for its *métiers* through InterCatch and Portugal also recently started uploading *métier*-related length information since 2019. The raising procedure used to obtain an aggregated-weighted length composition of landings follows the following strata: country, area, gear type, and year. The average percentage of volume of sampled catches was 35%, with the highest values in 2020 (58%) and 2022 (77%) (Table 17.5).

17.2.4 Commercial abundance indices

17.2.4.1 Commercial LPUE FR-GNS>90mm-8a-2s

A commercial abundance index for pollack is available for the French gillnet fleet in Division 8.a. The index includes information for fishing sequences performed with gillnets of mesh size > 90 mm and acting during the second semester of the year (FR-GNS>90mm-8a-2s). This index value was estimated and provided by Léauté *et al*. (2018a; 2018b) from the ROMELIGO project. A new methodology, based on a conditional decision tree, has been developed to select the information from the FR-GNS>90mm-8a-2s fleet based on logbook records (Caill-Milly *et al*., 2020 - WD11 in ICES, 2020). This methodology has been used to update the abundance index last year (ICES, 2021b). In 2022, the updated time-series of landings, effort and LPUEs have been provided to WGBIE (Caill-Milly, N., Ifremer, pers. comm.) and is summarized in Table 17.6. The FR-GNS>90mm-8a-2s fleet index is available from 2005 to 2021 and represents an average of 7.5% of the total landings of the stock. Landings of this fleet have fluctuated between 52 and 172 t, each recorded in 2006 and 2014, respectively (Figure 17.3). Since 2014, there is a decreasing trend in landings that reached a value of 110 t in 2018 followed by a slight increase since 2019. In 2020, pollack landings were 158 t. The effort unit is the fishing sequence, a combination of vessel, gear, statistical rectangle, and day. After an increasing period between 2011 and 2016, effort of the FR-GNS>90mm-8a-2s fleet has decreased in 2017 and 2018 then increased again in 2019 and 2020. The LPUE showed a decreasing trend from 2012 to 2018, declining from 200 kg/Fs in 2012 to 101 kg/Fs in 2018.

Because this commercial LPUE is not standardized, the WKMSYSPICT1 did not recommend its use for the assessment of the stock (ICES, 2021c).

17.2.4.2 Standardized LPUE France Gillnets

During the last benchmark a new standardized commercial LPUE was presented and it was approved to be used in the assessment of pol.27.89a (ICES 2023a; Sampedro *et al.*, WD2 in this report). A commercial abundance index was provided using the French bottom-sets gillnetters (GNS) fleet, which represents 47% of the French landings for pollack. The vessels included in the fleet were selected applying two filters, vessels with a minimum of 5 years of positive pollack catches and have been catching a minimum of 500 kg of pollack per year. The French database changed in 2009, which led to a change in the repositories of the effort. All declarative variables were impacted by this change in the database. Therefore, the data were split into two series: from 2000 to 2009 and from 2010 to 2021.

Catches were normalized into relative proportions by weight and square-root transformed (Winker, 2013). Principal component scores derived from a Principal Component Analysis (PCA) of the catch data were used as predictor variable in the Generalized Additive Model (GAM) framework. PCs that had an eigenvalue higher than 1, in this case they were four PCs (RS1, RS2, RS3 and RS4), were selected

The model fitting LPUE records was a GAM with a Tweedie distribution, which takes into account high frequencies of zeros in the data. A cyclic-cubic regression spline was chosen to smooth the month predictor, while smoothing of other continuous variables was realized by thin plate regression spline functions. There is a random effect on vessels. Characteristics of vessels (in terms of vessel length) are also included in the model. Effort was estimated using vessel time at sea and is used as an offset in the model.

The final GAM model equation was as follows:

$$pollack\_weight \sim offset\ (\log(time_{sea})) + as.factor(year) + s(month, bs = \text{cc}, k = 12) + s(carre.lon, carre.lat, k = 20) + s(vessel_{id}, bs = \text{"re"}) + s(rs1) + s(rs2) + s(rs3) + s(rs4) + as.factor(vessel_{length})$$

Where s() is spline smoothing; pollack_weight are the landings of pollack; time_sea is the effort in days; year is the year time; month is the month time; lon, lat are the coordinates of ICES rectangle; vessel_id is the vessel identificator; vessel length is the length of the vessel and rs1-4 are the PC scores.

In order to compare the influence of adding the covariates on the predictions the next five models were tested:

1. base: $pollack_{weight} \sim offset\ (\log(time_{sea})) + as.factor(year) + s(vessel_{id}, bs = \text{"re"})$

2. mois:

   $pollack_{weight} \sim offset\ (\log(time_{sea})) + as.factor(year) + s(month, bs = \text{"cc"}, \text{k=12}) + s(vessel_{id}, bs = \text{"re"})$

3. space: $pollack_{weight} \sim offset\ (\log(time_{sea})) + as.factor(year) + s(month, bs = \text{"cc"}, \text{k=12}) + s(vessel_{id}, bs = \text{"re"})$ + s(carre.lon, carre.lat, k=20)

4. carac:

$$pollack_{weight} \sim offset\ (\log(time_{sea})) + as.factor(year) + s(month, bs = \text{"cc"}, \text{k} = 12) + s(vessel_{id}, bs = \text{"re"}) + s(carre.lon, carre.lat, k = 20) + as.factor(vessel\_length)$$

5. tot:

$$pollack_{weight} \sim offset\ (\log(time_{sea})) + \ as.factor(year) + s(month, bs = \text{"cc"}, \text{k} = 12) + \ s(vessel_{id}, bs = \text{"re"}) + s(carre.lon, carre.lat, k = 20) + s(rs1) + \ s(rs2) + s(rs3) + s(rs4) + \ as.factor(vessel\_length)$$

Predictions were made for the five GAM models and with the two periods of the series: 2000-09 and 2010-21 (Figure 17.4). For visualizing, all LPUEs are standardized by its mean.

For this WG, the LPUE was updated to include a new year of data (Vermand, Y., Ifremer, pers. comm.) and the normalised predicted biomass index is shown in Figure 17.5. The predicted values of the index indicated that the abundance has been steadily decreasing since 2013, reaching a minimum of the series in 2021, and with a slight recovery in 2022.

17.3 Scientific surveys

Pollack abundance indices resulted negligible or zero in the groundfish surveys carried out in the distribution area: FR-EVHOE, SP-NSGFS and PT-IBTS. The bottoms preferred for this species (wrecks and rocky bottoms) makes that trawl surveys are not well suited for monitoring this species.

17.4 Life history parameters

Life history parameters for pollack were compiled from literature and working documents. The information was selected considering the quality and extension of the scientific work and the representativeness for pol.27.89a stock. The summary of the life history information is shown in Table 17.7. Von Bertalanffy growth parameters $Linf$ and K are estimated at 98.3 cm and 0.18 year^{-1}, respectively, from a study using samples from ICES subareas 6 and 7. Related to maturity, the $Lmat$ for both sexes together, is at 42.3 cm, corresponding to the estimates from the microscopic study carried out in division 9a (Alonso-Fernández *et al*., 2013), other maturity studies in Subarea 8 confirmed this value (Léauté *et al*., 2018a). The natural mortality is set at 0.34, that corresponds with the results of a metanalysis carried out with different empirical methods to estimate M (ICES, 2023a).

Values of $Linf, Lmat, K$ and M are used as input information for the performance of the assessment and advice.

17.5 Stock assessment

17.5.1 Length based indicators assessment

The assessment of this stock is provided using the Length-based indicators (LBIs), defined at WKLIFE V and VI (ICES, 2015; 2017), as the proposal accepted by this working group (Sampedro *et al*., WD2 –this report).

The LBIs can classify the stocks according to conservation, optimal yield and length distribution relative to expectations under maximum sustainable yield (MSY), providing a perception of the relative stock status (ICES, 2018b).

Length-based indicators are calculated from length-frequency distributions obtained from landings and compared to the reference levels derived from life-history parameters. For the LBI analysis, the further life-history parameters were considered:

- $Linf = 98.3\ cm$ (estimated for pollack in Subarea 6 and 7 (Alemany, 2017)).
- $Lmat = 42.3\ cm$ (for both sexes, microscopic maturity determination (Alonso-Fernández *et al.*, 2013)).
- $M/K = 1.868$, derived from $M = 0.34$ (metanalysis with different empirical methods for pollack (ICES, 2023a)) and $K = 0.182$ estimated for pollack in Subarea 6 and 7 (Alemany, 2017).
- Length–weight relationship parameters a = $1.09e^{-5}$ and b = 3.044 (Leauté *et al.*, 2018a).

The LBI makes two main assumptions: the population is in equilibrium with total mortality and recruitment have been constant for a period as long as the lifetime of the time-series, and the selectivity follows a logistic curve. For our data, the assumption of a unimodal length distribution that would reflect near-equilibrium conditions was achieved by aggregating the length frequencies distributions in 5 cm length bins (Figure 17.6).

The ratios $Lc/Lmat$ and $L25\%/Lmat$ indicate that immature individuals are not being protected (Figure 17.7 and Figure 17.8). The Lc has varied between 77 and 124% of $Lmat$ in the time series. The $Lmax5\%$ < 0.8 *Linf and the Pmega < 0.3 suggest that larger individuals are not being caught. The low values of larger individuals could be explained by the dome-shaped selectivity of some of the fleets targeting pollack. Since 2017 $Lmean$ is equal or above $LF = M$ suggesting that the stock is exploited at or below F_{MSY} level.

The conclusion of the LBI analysis is that the stock in 2022 is exploited below F_{MSY}.

Sensitivity Analysis

The assumed values of life-history parameters in LBI analysis are based on sound scientific studies of the species and their sources are well identified. Nevertheless, the LBI results could be sensitive to assumed values of $Linf$, $Lmat$, and M/K. In order to assess the impact of the values assumed a sensitivity analysis on these parameters was carried out overestimating and underestimating them by 5 and 10%.

The results indicated that LBI ratios for conservation of larger individuals, optimizing yield and MSY are sensitive to the input value for $Linf$ (Figure 17.9). An overestimation of $Linf$ leads to a worst perception of the stock for all the ratios impacted and for the underestimation the opposite is right. However, for the whole range of the simulated $Linf$ values (88-108 cm) the stock would be exploited below the F_{MSY} in 2022.

Although the perception of the conservation of immature gets worst with the increase of the value of $Lmat$, the conclusions are similar to those obtained for the base LBI analysis (Figure 17.10).

The overestimation of M/K produces slight increases in the proportion of mega-spawners (Pmega), the optimizing yield and MSY indicators that would not change the perception of the stock in recent years (Figure 17.11).

Length Based Spawning Potential Ratio (LBSPR)

The overall perception of the stock status provided by LBI was tested using the method Length Based Spawning Potential Ratio (LBSPR). The LBSPR method is focused on the effect of fishing on the spawning biomass per recruit (SBPR) of the stock, considering that without fishing, the population can reach 100% of its spawning potential ratio (SPR). The LBSPR analysis uses maximum likelihood to estimate the size at which individuals in a stock become vulnerable to capture and the relative fishing mortality (F/M), which are used to calculate the SPR (Hordyk *et al*., 2015a; 2015b).

The values of the life-history parameters derived from a literature review are the following ones:

– M = 0.34 and K = 0.182 (Table 17.7) and, therefore, M/K = 1.868.
– L_∞ = 98.2 cm (Table 17.7).
– L_{50} = 42.3 cm (Table 17.7).
– L_{95} = 59 cm (calculated from Alonso-Fernandez *et al*. (2013)).

The LFDs are the same used for the LBI method.

The SPR assessment shows that the relative fishing pressure (F/M) is decreasing since 2018, and in 2022 was estimated at 0.83 (Figure 17.12). The SPR shows an overall increasing trend, being in 2022 above 30% for the first time. As in the case of LBI analysis, LBSPR method could be slightly underestimating the SPR for populations caught with gillnets which present a dome-shaped selectivity curve.

17.6 Application of advice rule

The latest advice was provided in 2021 following the framework for category 5 stocks (ICES, 2021a). ICES advised that commercial landings should be no more than 905 t in each of the years 2022 and 2023.

This year, the framework for category 3 stocks (ICES, 2022) was followed to provide the advice for 2024 and 2025. The method 2.1, *rfb* rule, was applied for this stock as the needed information (biomass index, length composition of data and life-history parameters) was available and the growth parameter *K* is below 0.2.

The input data for applying the *rfb* rule are shown in Table 17.8. The time series of commercial landings as calculated by ICES, the indicators derived LBI analysis and the biomass index corresponding to the standardized LPUE FRANCE_GNS.

The estimated components and results of the *rfb* rule are presented in Table 17.9. Because there was a high difference between the recent catches and the previous advice provided as Category 5 stock (905 t), the referenced catch (Ay) was estimated as the average of commercial landings of the last three years (2020-2022) and it is equal to 1369 t. The $I_{trigger}$, was defined as I_{loss} (year 2021 = 0.73) multiply by 1.4, $I_{trigger}$ = 1.0157. The stability clause was not applied as the biomass safeguard (I_{2022} / $I_{trigger}$) is below 1.

The proposal advice resulted from applying the *rfb* rule on the previous advice (1369 t), was 872 t for each of the years 2024 and 2025. The reduction in advice is due to the decreasing trend in the biomass index (0.78), the application of the biomass safeguard (0.79) and the precautionary multiplier (0.95).

17.7 Biological reference points

Based on the current LBI assessment and the biomass index used in the application of the advice rule, the further reference points in the MSY approach framework were defined for pol.27.89a (ICES, 2018b):

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$ proxy	1.02	Biomass index trigger value (Itrigger), defined as Itrigger = Iloss × 1.4, where Iloss is the lowest observed historical biomass index value (year 2021=0.73)
	F_{MSY} proxy	$\frac{L_{mean}}{L_{F=M}} = 1$	Relative value from LBI analysis, assuming M/K = 1.868. $L_{F=M}$ is based on L_c (Length at 50% of modal abundance) which varies each year.

17.8 Management plans

No management plan is known for pollack in the area.

17.9 References

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17.10 Tables and figures

Table 17.1. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. TAC for pollack for the two ICES divisions (8.a, 8.b, 8.d, 8.e and 8.c) and two subareas (9 and 10) in 2023.

TAC	155		

Species:	Pollack *Pollachius pollachius*	Zone:	8a, 8b, 8d and 8e (POL/8ABDE.)
Spain	252	Precautionary TAC	
France	1 230		
Union	1 482		
TAC	1 482		

Species:	Pollack *Pollachius pollachius*	Zone:	8c (POL/08C.)
Spain	149	Precautionary TAC	
France	17		
Union	166		
TAC	166		

Species:	Pollack *Pollachius pollachius*		Zone:	9 and 10; Union waters of CECAF 34.1.1 (POL/9/3411)
Spain	196	(1)	Precautionary TAC	
Portugal	7	(1)(2)		
Union	203	(1)		
TAC	203	(2)		

(1) Special condition: of which up to 5% may be fished in 8c (POL/*08C.).

(2) In addition to this TAC, Portugal may fish quantities of pollack not exceeding 98 tonnes (POL/93411P).

Table 17.2. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Commercial landings (in tonnes) by country as estimated by WGBIE. Shaded values come from ICES historical database, FAO FishStat (FAO, 2020), and ROMELIGO project (Léauté *et al.*, 2018a; b). Figures from 2015 to 2022 were derived from the InterCatch database.

	Bay of Biscay (Subarea 8)				Atlantic Iberian waters (Division 9.a)				
Year	Belgium	Spain	France	UK	Spain	Portugal	Total	Unallocated	ICES estimates
1979	0	1021	2221	0	0	0	3242	0	3242
1980	1	1576	2158	0	0	0	3735	0	3735
1981	1	902	2326	0	0	0	3229	0	3229
1982	2	85	2185	2	32	0	2306	0	2306
1983	0	581	2652	0	203	0	3436	0	3436
1984	0	1606	2351	1	642	0	4600	0	4600
1985	0	2304	2769	23	636	0	5732	0	5732
1986	0	437	2127	5	237	0	2806	0	2806
1987	0	584	2022	1	308	3	2918	0	2918
1988	3	476	1761	6	329	7	2582	0	2582
1989	13	214	1682	4	57	3	1973	0	1973
1990	14	194	1662	2	27	1	1900	0	1900
1991	1	221	1867	1	76	2	2168	0	2168
1992	2	154	1735	0	65	2	1958	0	1958
1993	3	135	1327	0	47	1	1513	0	1513
1994	3	157	1764	0	28	3	1955	0	1955
1995	6	153	1457	2	59	2	1679	0	1679
1996	8	137	1164	0	43	2	1354	0	1354
1997	2	152	1167	1	54	2	1378	0	1378
1998	1	152	956	0	55	1	1165	0	1165
1999	0	120	n/a	0	36	1	157	0	157
2000	0	121	1294	0	49	15	1479	0	1479
2001	0	346	1278	0	81	41	1746	0	1746
2002	0	170	1722	0	35	45	1972	0	1972
2003	0	142	1450	1	39	31	1663	0	1663
2004	0	211	1343	0	90	12	1656	70	1726
2005	0	306	1552	0	132	0	1990	-4	1986
2006	0	251	1596	171	102	0	2120	6	2126
2007	0	198	1375	62	103	5	1743	104	1847
2008	0	265	1732	64	128	31	2220	93	2313
2009	0	218	1371	41	68	3	1701	111	1812
2010	0	265	1170	44	91	2	1572	110	1682
2011	0	322	1475	27	104	2	1930	102	2032
2012	0	159	1131	2	139	2	1433	87	1520
2013	0	251	1346	8	110	3	1718	93	1811
2014	0	185	1612	19	93	1	1910	49	1959
2015	0	195	1244	37	78	18	1573	37	1610
2016	0	186	1292	25	111	28	1642	19	1661
2017	0	128	1219	0	95	38	1480	1	1481
2018	0	135	1220	0	124	33	1513	0	1513
2019	0	174	1189	0	143	57	1562	0	1562
2020	0	171	1174	0	136	54	1535	0	1535
2021	0	166	987	0	165	54	1372	0	1372
2022	0	189	805	0	157	48	1199	0	1199

Table 17.3. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Commercial landings (in tonnes) from France, Spain and Portugal by country and gear as submitted to WGBIE. Shaded values come from ICES historical database, FAO FishStat (FAO, 2020), and ROMELIGO project (Léauté *et al.*, 2018a) ; b). Non-shaded figures, from 2015 to 2022, were derived from the InterCatch database.

	France				Spain			Portugal	
Year	Nets	Trawl	Lines	Others	Lines	Nets	Others	Others	Trawl
2000	671	353	176	94	-	-	-	-	-
2001	794	271	133	80	31	53	169	-	-
2002	1151	321	170	79	26	28	134	-	-
2003	990	215	182	64	31	35	146	-	-
2004	679	298	292	73	47	36	222	16.5	0.1
2005	801	364	326	62	90	36	161	7.8	0.6
2006	882	395	245	74	48	29	243	6.7	0.3
2007	797	301	228	49	72	51	210	4.5	0.4
2008	1055	267	351	59	147	95	163	33.3	0
2009	829	185	328	30	101	76	97	2.4	0.5
2010	719	128	249	74	167	162	93	1.7	0.1
2011	850	180	357	88	207	199	20	1.2	0.3
2012	631	148	305	46	123	122	53	-	-
2013	756	210	327	52	-	-	-	-	-
2014	925	288	345	55	110	147	103	1	0
2015	766	178	258	42	145	114	14	18	0.2
2016	735	128	399	30	185	87	26	28	0
2017	596	100	486	37	123	91	9	38	0
2018	684	78	405	54	134	120	6	32	0.8
2019	683	76	387	43	152	162	3	55	1.8
2020	670	71	409	24	168	133	7	49	5
2021	510	51	397	29	148	175	8	49	5
2022	455	25	294	30	167	173	6	47	1

Table 17.4. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Discards estimates (in tonnes) from France, Spain and Portugal by country and gear as submitted to WGBIE. Shaded values come from ROMELIGO project (Léauté *et al.*, 2018a; b). Non-shaded figures, from 2015 to 2022, were derived from the InterCatch database.

	France			Spain			Portugal
Year	Nets	Trawl	Lines	Lines	Nets	Trawl	Trawl
2003	0	0	-	-	-	-	-
2004	0	0.2	-	-	-	-	-
2005	11	0	-	-	-	-	-
2006	1.4	13.9	-	-	-	-	-
2007	5.7	0	-	-	-	-	-
2008	35.5	0	0	-	-	-	-
2009	3.2	0	1.5	-	-	-	-
2010	9	0	0	-	-	-	-
2011	2.9	0	6.2	-	-	-	-
2012	13	0	1.2	-	-	-	-
2013	19.4	0.3	6.8	-	-	-	-
2014	63.6	0	1.1	-	-	-	-
2015	28.1	0	0	0	3.5	0	0
2016	83.1	5.4	4.3	0	0.4	0	0
2017	18.6	0	0	0	0	0	0
2018	38.7	0	0	0	0	2.8	0
2019	8.2	0	6.1	0	0	0	0
2020	8.5	0.0	0.6	0.0	0.0	0.0	0.0
2021	12.9	0	3.2	0	0.35	0	0
2022	11.2	0	0.4	0	0	0	0

Table 17.5. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Volume of catches sampled to estimate annual length composition.

Year	%Vol Sampled
2010	35
2011	19.6
2012	23.9
2013	27.7
2014	38.5
2015	19.2
2016	32.8
2017	34.2
2018	15.1
2019	41.1
2020	57.9
2021	66.7
2022	76.7

Table 17.6. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Data for the commercial FR-GNS>90mm-8a-2s fleet index as submitted to WGBIE in 2022 (ICES, 2022). The representativeness of the index related to the total annual stock landings (in kg) is indicated in the last column.

Year	Landings (kg)	Effort (fishing sequence)	LPUE (kg/fs)	% Stock
2005	97484	829	117.6	4.9
2006	51794	669	77.4	2.4
2007	120701	895	134.9	6.5
2008	139003	1036	134.2	6.0
2009	104658	810	129.2	5.8
2010	81178	721	112.6	4.8
2011	142528	654	217.9	7.0
2012	149691	746	200.7	9.8
2013	148872	876	169.9	8.2
2014	171901	1045	164.5	8.8
2015	168819	1051	160.6	10.5
2016	149391	1335	111.9	9.0
2017	133548	1204	110.9	9.0
2018	110553	1095	101.0	7.3
2019	155317	1163	133.5	9.9
2020	157757	1328	118.8	10.0
2021	97339	891	109.2	7.1

Table 17.7. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Life history parameters values selected to be used in the stock assessment of pol.27.89a. Source of the data and areas of study are indicated in the last two columns.

Life history parameter		Value	Sex	ICES Subarea/Division	Source
L_{inf} (cm)	Asymptotic length	98.3	Both	6.7	Alemany (2017)
K (year^{-1})	Von Bertalanffy parameter	0.182	Both	6.7	Alemany (2017)
L_{mat} (cm)	Length-at-maturity	42.3	Both	9a	Alonso-Fernández *et al*. (2013)
a	Length-weight relationship parameter	1.09E-05	Both	8	Léauté *et al*. (2018a)
b	Length-weight relationship parameter	3.044	Both	8	Léauté *et al*. (2018a)
M	Natural mortality	0.34	Both		Metanalysis different empirical methods (ICES, 2023a)
M/K		1.868	Both		

Table 17.8. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Input information used for the application of the *rfb* rule.

Year	Landings	Lc	Lmean	LF=M	Biomass Index
2010	1682	32.5	42.03	46.37	0.82
2011	2032	52.5	58.59	62.15	1.04
2012	1520	47.5	58.67	58.21	1.15
2013	1811	47.5	56.62	58.21	1.25
2014	1959	32.5	52.78	46.37	1.18
2015	1610	27.5	43.10	42.43	1.08
2016	1661	37.5	46.38	50.32	1.04
2017	1481	32.5	49.06	46.37	0.97
2018	1513	32.5	53.37	46.37	1.05
2019	1562	32.5	46.21	46.37	0.98
2020	1535	37.5	50.21	50.32	0.91
2021	1372	32.5	47.09	46.37	0.73
2022	1199	32.5	50.58	46.37	0.80

Table 17.9. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Estimated components and result of the *rfb* rule.

Component	Value
Ay: Mean catch Cy (2020, 2021, 2022)	1369 tonnes
Stock biomass trend	
Index A (2021,2022)	0.76
Index B (2018,2019,2020)	0.98
r: Stock biomass trend (index ratio A/B)	0.78
Fishing pressure	
f: Fishing pressure proxy relative to MSY proxy (Lmean_2022/LF=M_2022)	1.09
Biomass safeguard	
Last index value (I2022)	0.8
Index trigger value (Itrigger = Iloss x 1.4)	1.02
b: index relative to trigger value	0.79
Precautionary multiplier to maintain biomass above Blim with 95% probability	
m: multiplier (K< 0.2)	0.95
RFB calculation (Ay*r*f*b*m)	872
Stability clause (+20%/-30% compared to Ay and b=1)	Not applied
% advice change	-36%

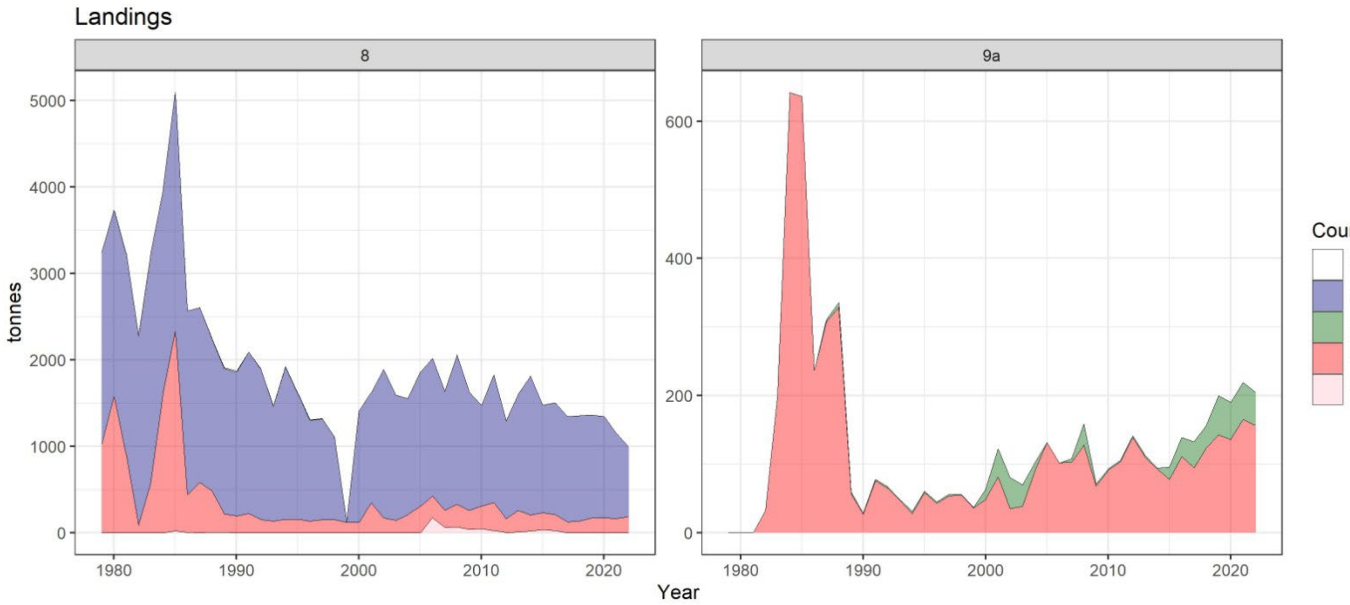

Figure 17.1. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Commercial landings (in tonnes) by country in Subarea 8 (left) and Division 9.a (right). French data are missing for 1999.

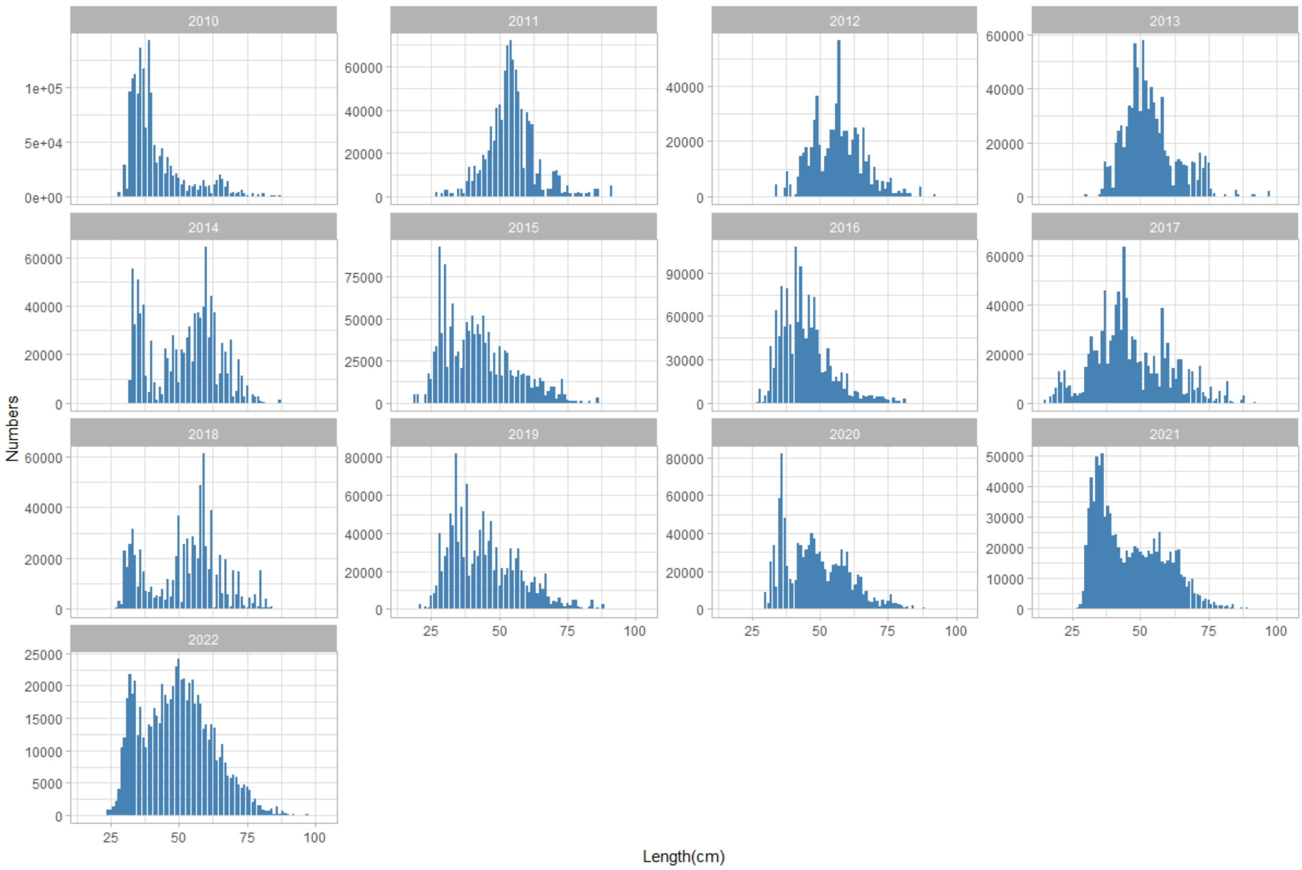

Figure 17.2. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Length composition of landings for the period 2010–2022.

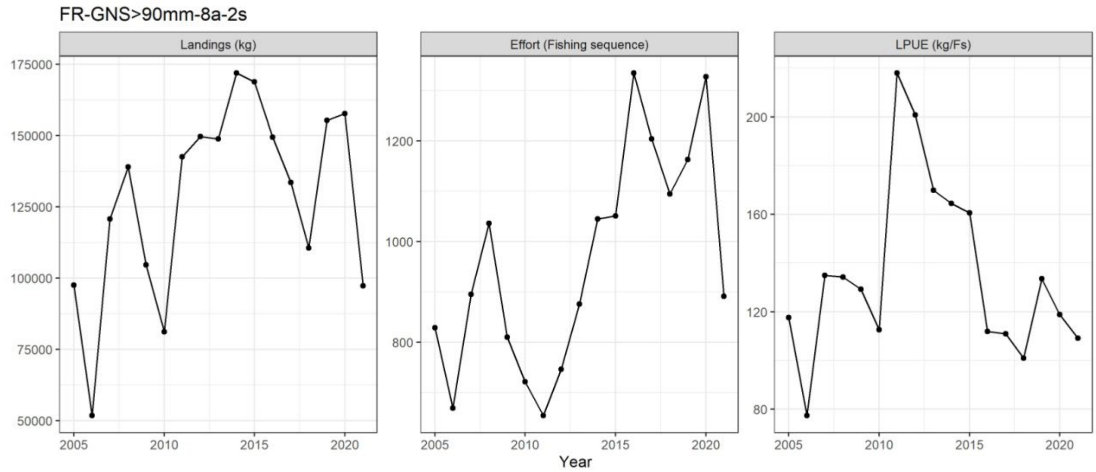

Figure 17.3. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Landings, effort and LPUEs for the FR-GNS>90mm-8a-2s commercial fleet.

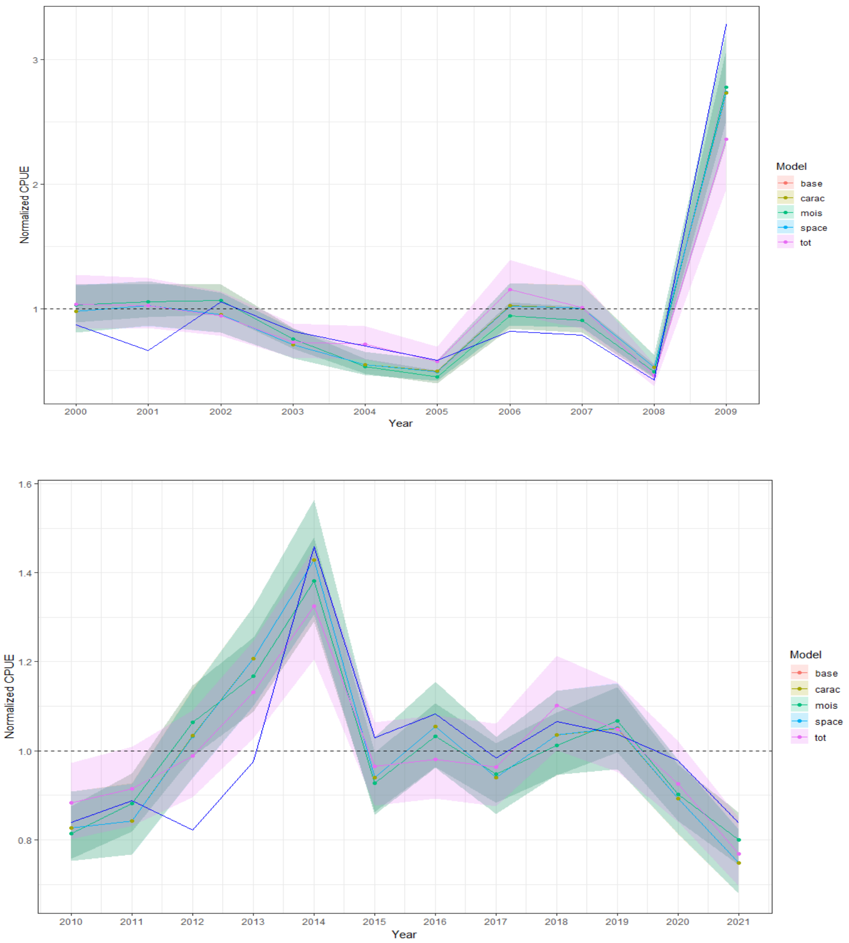

Figure 17.4. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Normalized LPUEs estimated from the 5 GAM models tested and nominal LPUE (blue line) from FRANCE_GNS. The two periods of the abundance index are separately represented: 2000-09 (up) and 2010-21 (bottom).

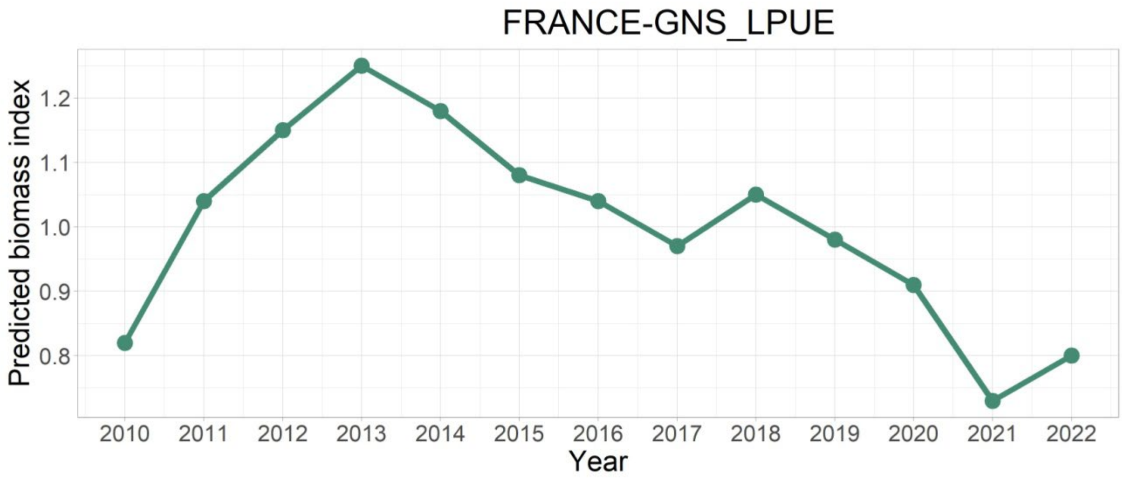

Figure 17.5. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Predicted biomass index from standardized FRANCE_GNS LPUE normalized by its mean for the period 2010-2022.

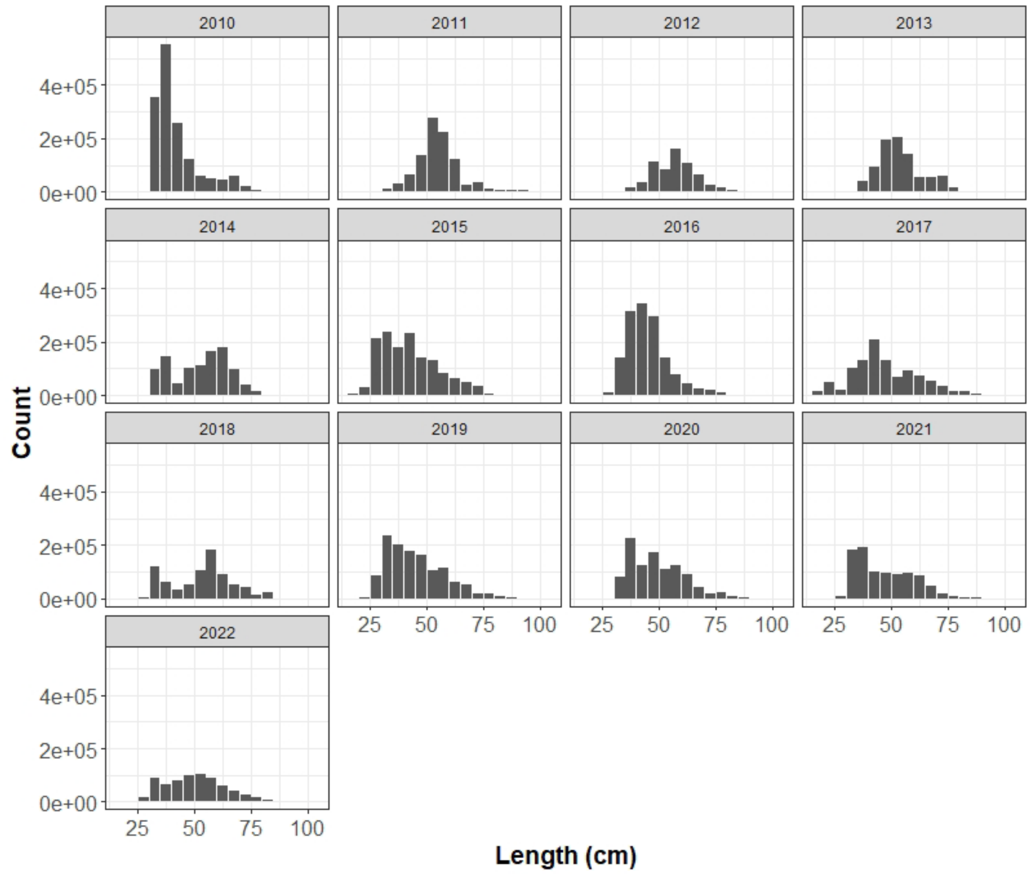

Figure 17.6. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Aggregated (5 cm length bin) length distributions for pollack landings in the period 2010-2022.

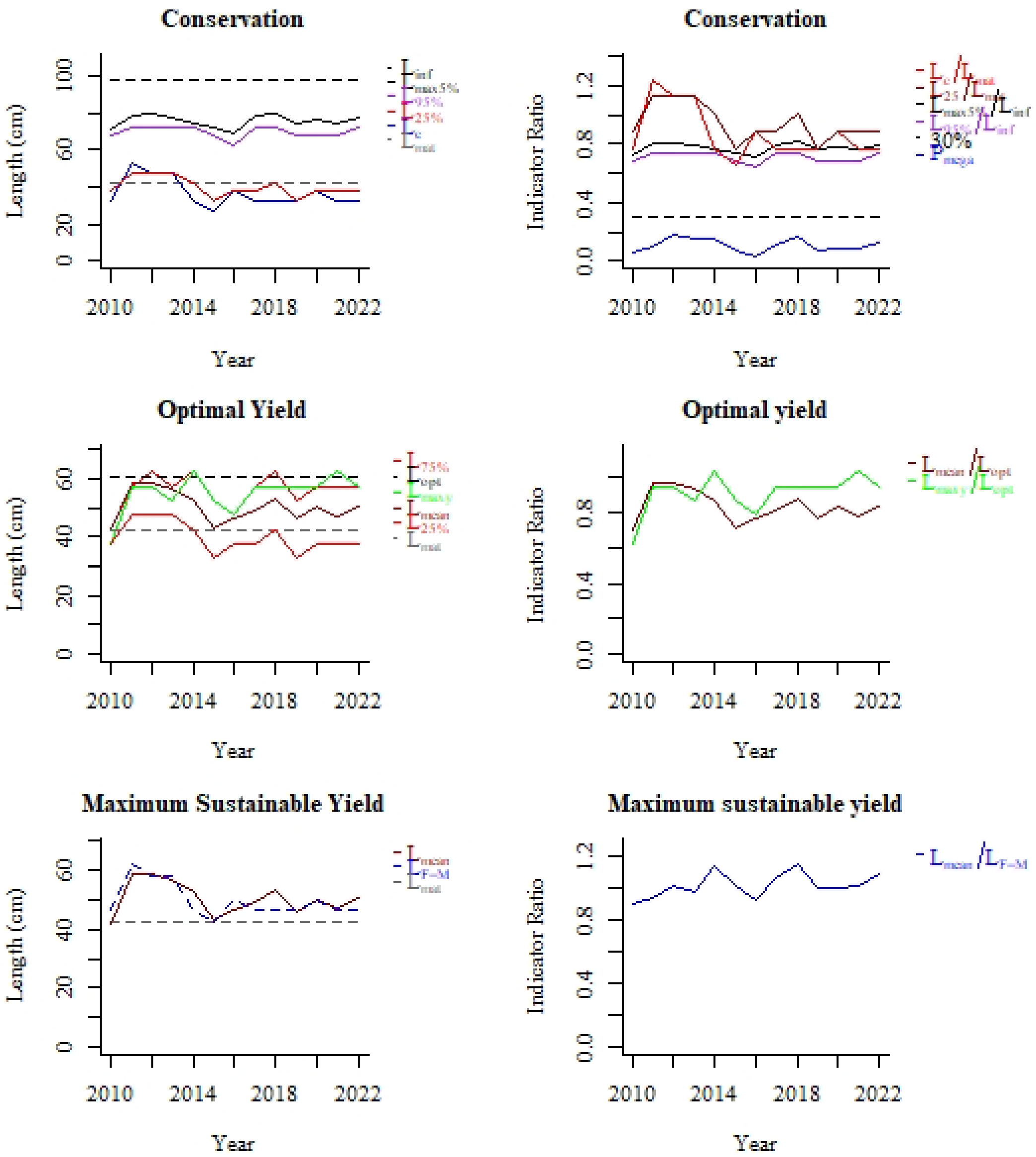

Figure 17.7. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Time series of LBI indicators and ratios.

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%} / L_{mat}$	$L_{max\ 5} / L_{inf}$	P_{mega}	L_{mean} / L_{opt}	$L_{mean} / L_{F=M}$
2010	0.77	0.89	0.72	0.06	0.69	0.91
2011	1.24	1.12	0.80	0.10	0.97	0.94
2012	1.12	1.12	0.81	0.19	0.97	1.01
2013	1.12	1.12	0.79	0.16	0.94	0.97
2014	0.77	1.00	0.76	0.15	0.87	1.14
2015	0.65	0.77	0.73	0.07	0.71	1.02
2016	0.89	0.89	0.71	0.04	0.77	0.92
2017	0.77	0.89	0.80	0.12	0.81	1.06
2018	0.77	1.00	0.82	0.17	0.88	1.15
2019	0.77	0.77	0.76	0.08	0.76	1.00
2020	0.89	0.89	0.78	0.09	0.83	1.00
2021	0.77	0.89	0.76	0.09	0.78	1.02
2022	0.77	0.89	0.79	0.13	0.84	1.09

Figure 17.8. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Traffic light table for LBI ratios for years 2010-2022. Conservation of juveniles: Lc/Lmat (Length at 50% of modal abundance/Length of maturity) and L25%/Lmat (25th percentile of length distribution/Length of maturity); Conservation of larger individuals: Lmax 5/ Linf (Mean length of largest 5% / Linf) and Pmega (Proportion of individuals above Lopt + 10%); Optimizing yield: Lmean/Lopt (Mean length

of individuals > Lc / Lopt = 2/3 Linf); MSY: Lmean/LF=M (Mean length of individuals > Lc / LF=M: (1-a)*Lc + a*Linf), being a=1/(2*(M/K)+1)).

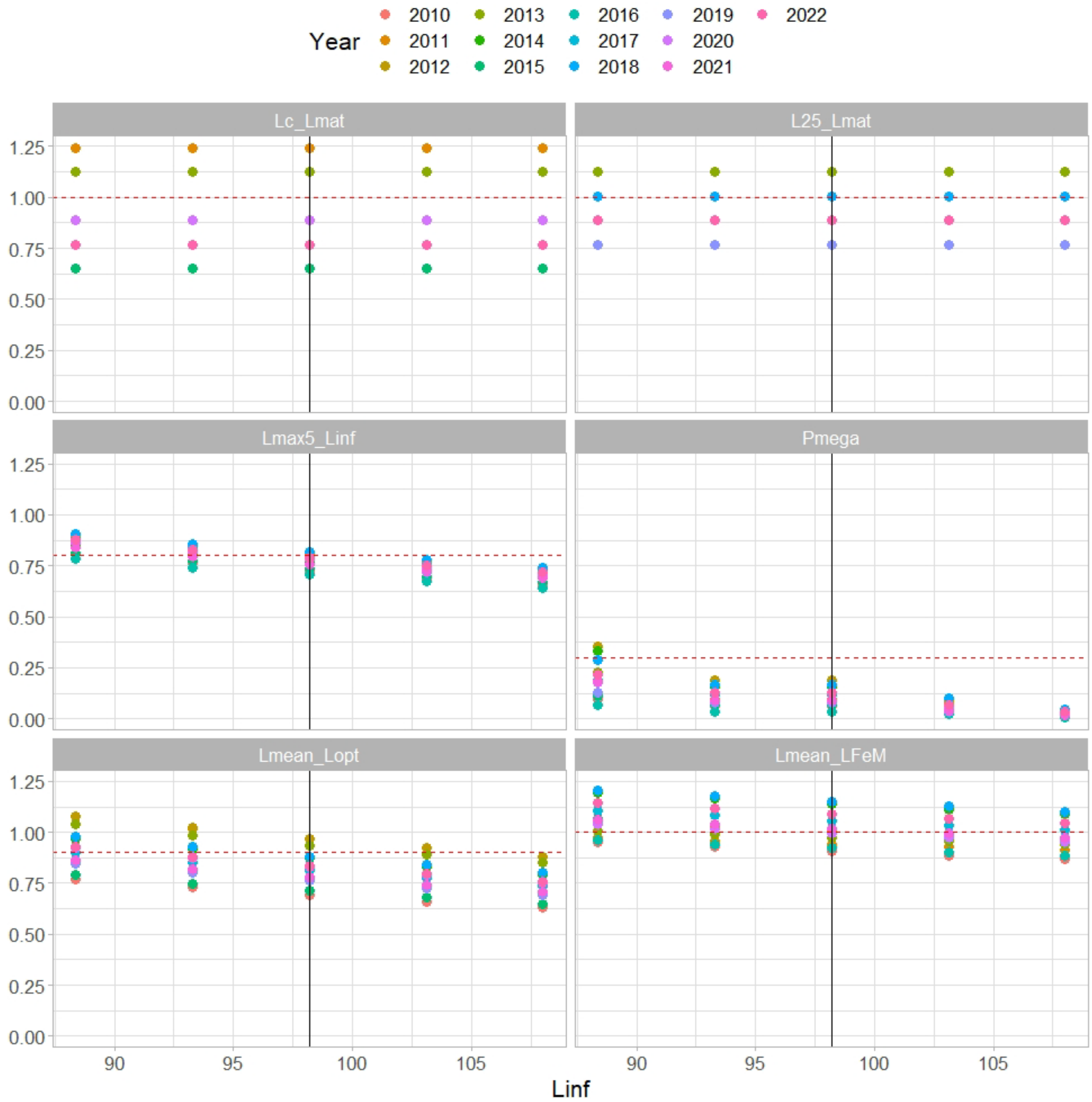

Figure 17.9. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Results from the sensitivity analysis for *Linf*

value in LBI ratios. Vertical line shows the value assumed for the LBI-analysis. The horizontal dashed line indicates the reference value for each ratio.

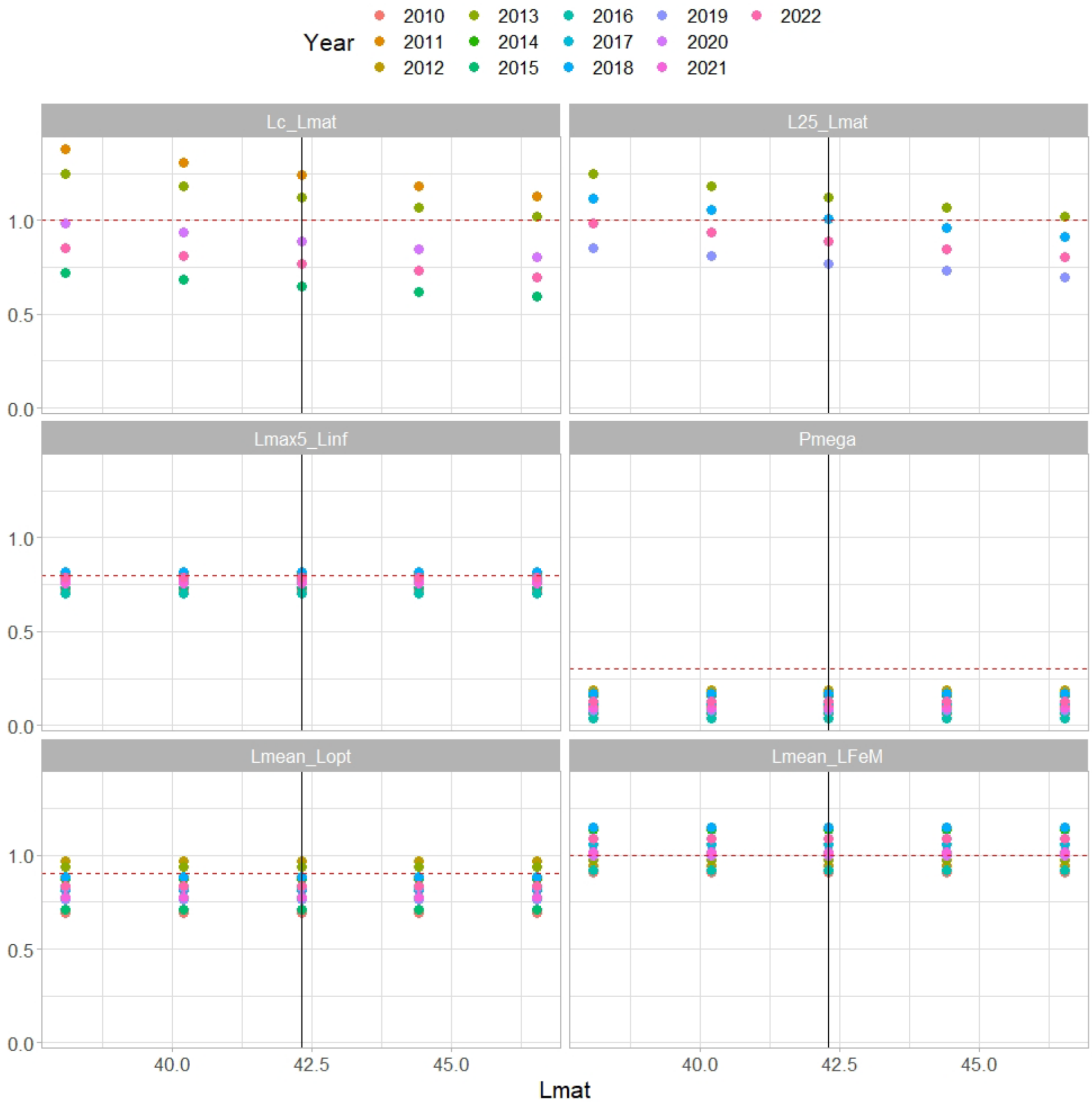

Figure 17.10. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Results from the sensitivity analysis for *Lmat* value in LBI ratios. Vertical line shows the value assumed for the LBI-analysis. The horizontal dashed line indicates the reference value for each ratio.

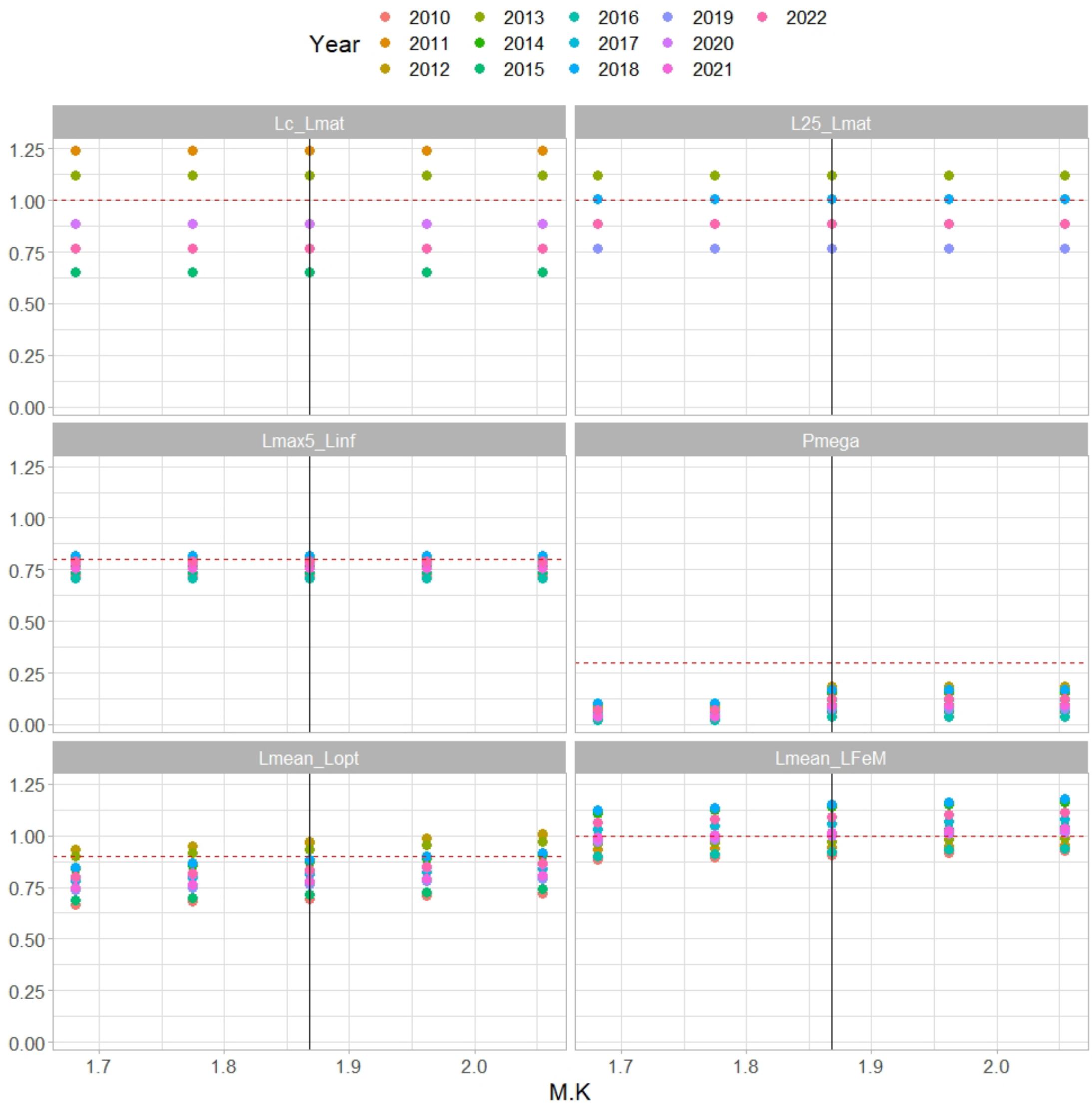

Figure 17.11. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Results from the sensitivity analysis for *M/K* value in LBI ratios. Vertical line shows the value assumed for the LBI-analysis. The horizontal dashed line indicates the reference value for each ratio.

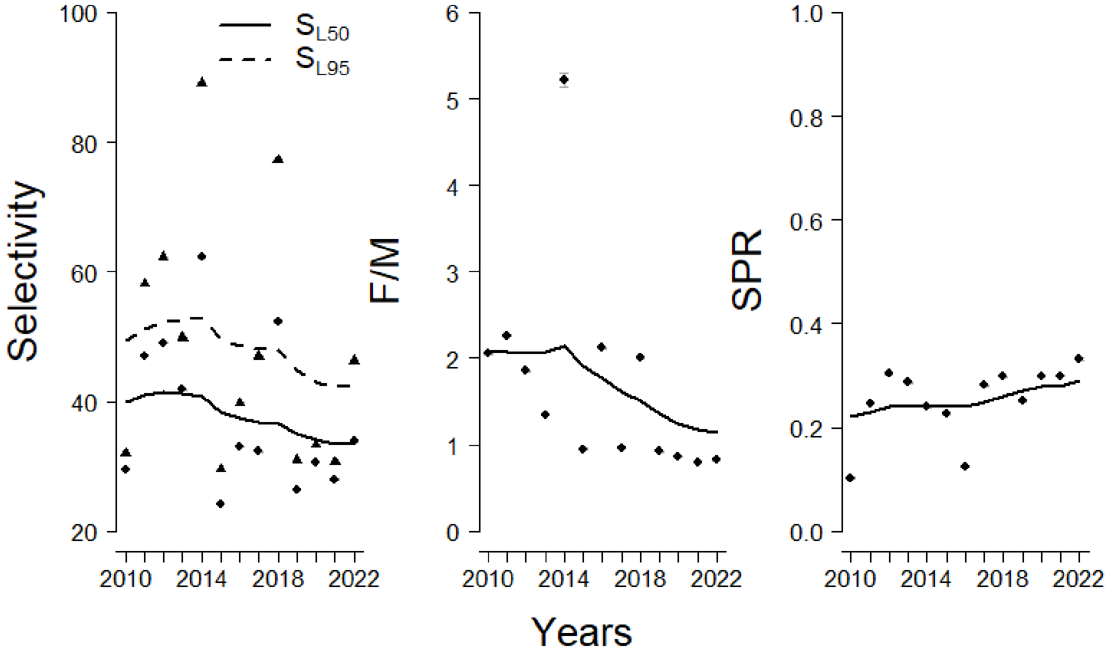

Figure 17.12. Pollack (*Pollachius pollachius*) in Subarea 8 and Division 9.a. Main results of the LBSPR method.

18 Whiting in Bay of Biscay and Atlantic Iberian waters

whg.27.89a – *Merlangius merlangus* in Subarea 8 and Division 9.a

18.1 General

of assessment in 2023:

Category 3 Length-based indicator method (LBI; ICES, 2017a) as fishing pressure indicator

Changes in the assessment: This stock was upgraded this year from a category 5 to 3 stock using the commercial LPUE and catch length structures.

Data revision in 2023: InterCatch data were compiled for 2022. French bottom trawl LPUE was updated for 2022.

18.1.1 Summary of ICES advice for 2022 and 2023

ICES advises that when the precautionary approach is applied, catches should be no more than 1 347 t in each of the years 2023 and 2024.

The rationale for the catch option was the following:

The ICES framework for category 5 stocks (ICES, 2012) was previously applied. For stocks with no information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was last applied in 2019 and, thus, was again applied this year.

18.2 Data

18.2.1 Commercial catches and discards

Whiting (*Merlangius merlangus*) is caught in mixed demersal fisheries primarily by France and Spain (Table 18.1 and Figure 18.1). There are concerns about the reliability of the French data from 2008–2009 which appear to be incomplete. There is some whiting misidentification in the Portuguese markets with pollack due to the common names used for both stocks. This resulted in most pollack landings being recorded as whiting during the period 2004-2012. Based on this information, pollack landings were deducted from the whiting landings during this period and were then considered as unallocated (Table 18.1). Sampling data since 2012 indicate that Portuguese landings of whiting and pollack from division 9.a consisted of 2% whiting and 98% pollack (EC, 2015) as whiting landed by Portuguese vessels makes up an insignificant proportion of the total whiting landings in this area.

18.2.1.1 Commercial catches and discards

For 2023, the 2022 InterCatch data were processed to compute landings and discards estimates.

The standard procedure to estimate discards is to use the discard data provided for the different combinations of countries/gears/seasons/areas (“strata”), and to raise the available discard data to the total landings for the strata with limited available data.

In 2022, estimated discard rate is slightly below the average of the whole time-series (see Table 18.3) [DR_{2022} = 0.230, $average_{2016–2022}$ = 0.277, $max_{2016–2021}$ = 0.331].

18.2.1.2 Length structure of commercial catches

About 63, 44, 46, 41, 51, 78, 85% of the landings (in volume) had a length structure associated in 2016, 2017, 2018, 2019, 2020, 2021 and 2022, respectively.

For discards, the percentage of the total discards (after raising) with a length distribution provided are 60, 43, 44, 30, 17, 29 and 29% in 2016, 2017, 2018, 2019, 2020, 2021 and 2022, respectively. See Tables 18.4–10 for details.

Length distribution of landings and discards before and after raising are shown in Figures 18.2–8. Final distributions (pink dots) are similar to the sampled (provided) distribution, showing the limited effect of the raising procedures on length compositions.

The length distributions of the landings are truncated below 27 cm due to the minimum conservation reference size (MCRS) set at 27 cm in this area (EU, 2019b).

18.2.2 Survey data and commercial CPUEs

This species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula (Figure 18.8). It is not clear whether this is a separate stock from a biological point of view.

18.2.2.1 Survey data

Whiting is caught in the Bay of Biscay during the French EVHOE-WIBTS-Q4 (G9527) survey. In 2017, WGBIE investigated if this survey could provide an index of recruitment and/or biomass (ICES, 2017b). The survey regularly catches whiting on inshore stations but the catch rates are highly variable, resulting in very wide confidence limits. Thus, WGBIE does not propose to use these indices as a basis for the advice.

18.2.2.2 Commercial CPUEs

Commercial LPUEs were provided during the WKBMSYSPiCT2 (ICES, 2023b) workshop in order to explore the possibility of implementing the SPiCT (Pedersen and Berg, 2017) assessment approach for that stock. Even if the results were not conclusive in terms of assessment, estimated LPUEs could be used to provide a category 3 advice (ICES, 2023a) for the stock together with the life-history parameters and catch length structures.

LPUE standardisation was described in detail in the WKBMSYSPiCT2 report (ICES, 2023b) but the details of the main steps of the process are also provided below.

French logbooks were used to extract whiting landings from bottom trawls which represents around 1/3 of the total French landings. In order to reduce the number of vessels in the analysis, only vessels that have landed at least one tonne of whiting in 5 years over the period 2010-2022 where kept in the analysis.

All fishing operation using a bottom trawl of the selected vessel where used to compute the standardised LPUE. The standardisation was made by GAM using a Tweedie distribution (high frequencies of zeros in the data).

In order to take into account the targeting behaviour in the standardisation, only the 10 major species that are caught with whiting are selected. Catches were normalized into relative proportions by weight and the square root transformed (Winker et al., 2013). To construct data input for the GAM models, the direct principal component analysis (PCA) was conducted. It uses directly the PC's scores of the PCA as predictor variable in the model. We retained PCs that showed an eigenvalue superior to 1. Here, four PCs are considered. A cyclic cubic regression spline was chosen to smooth the month predictor, while smoothing of other continuous variables was realized by thin plate regression spline functions. A random effect on vessels is applied. Characteristics of vessels (in term of size) is also included in the model. Efforts were estimated using the vessel fishing time and used as an offset in the model. The PC's scores of a PCA runs are represented by the covariates RS1, RS2, RS3 and RS4.

The final model is:

formula = "WHG_weight ~ offset(log(fishing_time)) + (YEAR) + s(MONTH, bs='cc', k=12) + s(carre.lon,carre.lat, k=20) + s(NAVS_COD, bs = 're') + s(RS1) + s(RS2) + s(RS3) + s(RS4) + (size_NAVS)"

LPUEs from French bottom trawl were updated in 2022 and standardised values are presented in table 18.12 and figure 18.10. LPUEs show a decreasing trend between 2015 and 2018 followed by fluctuating levels since 2019. The lowest value was observed in 2020 while the 2022 value is lower than the MSY $B_{trigger}$ proxy set at 1.4*lowest observed value.

18.2.3 Indicators

18.2.3.1 Length-based indicators

Whiting length samples (sex-combined) from commercial catches were provided in InterCatch format for the years 2016–2022. Length structures of the catches were estimated from these samples and were used for the analyses of MSY proxies applying the length-based indicator (LBI) method as defined in WKLIFE VI (ICES, 2017a). The length distributions were binned to 40 mm length classes (Figure 19.11).

The method also requires growth and maturity parameters which were estimated from sampling data. Data from area 27.8 were limited and did not allow the adjusting of the von Bertalanffy curves. Data from area 27.7 were added to the analyses. Fits are shown in figure 18.12. Estimated L_{inf} is 488 mm and the k = 0.3. These values were compared with the FishBase (Fröese and Pauly, 2023) values for this species where L_{inf} is estimated at 413 mm while k is set at 0.2.

L_{mat} was also estimated based on the available sampling data and the estimated maturity ogive and is shown in figure 18.13. L_{50} for this stock was estimated at 203 mm. As a comparison, the estimated L_{50} in the North Sea is 202 mm (ICES, 1996) and 280 mm in the Celtic Sea (Hehir, 2003).

The results of the LBI method (ICES, 2017b) showed that all indicators are above the reference points (Figure 18.13).

However, given the uncertainty around the biological values, some sensitivity analyses were performed where the LBI on fishing pressure is computed using a range of L_{inf} (ref = 488 mm), varying from 440 to 540mm and a varying M/K ratio from 1 to 2 (ref = 1.5).

The results of the sensitivity analysis on the input parameter used for the computation of the $L_{mean}/L_{F=M}$ indicator is presented in figure 18.14. This analysis shows that the stock is considered exploited in 2022 above the F_{MSY} proxy due to the combination of a high L_{inf} (> 500 mm) and a low M/K (< 1.2) values.

From these results, it was concluded that even if the life-history parameters are not well estimated, whiting is currently exploited below F_{MSY} as $L_{mean}/L_{F=M}$ is above 1 from 2016 onwards.

18.2.3.2 LBSPR

Based on the life-history parameters and catch length structures, the LBSPR methods were also applied as indicator of stock development.

As for LBIs, given the uncertainty around life-history parameters, a sensitivity analysis was performed to assess the impact of the L_{50} and M/K ratio on the LBSPR results.

Two runs were made. The first run considered an L_{50} of 203 mm combined with an M/K ratio of 1.5 and was compared with a second run where L_{50} is set to 290 mm with an M/K ratio of 1.

Both results are presented in figure 18.14. Comparing the two runs, the second run (L_{50} = 290 mm and M/K = 1) more pessimistic in term of life history parameter, resultis in SPR values observed between 0.2 and 0.6, where 0.4 being considered as a population fished at MSY.

18.2.4 Assessment

The new ICES framework for category 3 stocks was applied (ICES, 2023a). Here, the new '*rfb*' rule (Method 2.1 in ICES, 2022) that replaced the previously applied 2-over-3 rule (ICES, 2012; 2018; 2019) for category 3 stocks was used to provide an MSY advice for the stock. A stock biomass index using the standardized commercial French bottom trawl LPUEs, estimated during the last WKBMSYSPiCT2 (ICES, 2023b) benchmark, was considered as the index of stock development.

This year, the advice is based on the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B) multiplied by the recent catch advice, a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard and a precautionary multiplier.

Inputs used for the analyses are presented in table 18.13. The results of the advice are presented in table 18.14. The catch advice is 41% lower than the previous advice. The length structure and LPUE data were revised during the recent benchmark (ICES, 2023b) and the advice is now based on a category 3 stock assessment using the ICES framework for data-limited stocks (DLS). Due to the difference between recent catches and recent advice, and given that this is the first implementation of the '*rfb*' rule (Method 2.1; ICES, 2022), the most recent years (2020–2022) of catch were used in the calculation instead of recent advice. In addition, the biomass index has declined below the biomass safeguard.

Both the stock biomass trend and fishing pressure proxy are above 1. The precautionary multiplier used is 0.9 which corresponds to a stock with k values between 0.20 and 0.32.

The biomass safeguard (b) is below 1. Since the last value of the index is below $I_{trigger}$ and the b is below 1, the stability clause should not be applied.

18.3 Biological reference points

The reference points proxies can be derived from the LBI analysis and the biomass index value (French bottom trawl LPUEs).

The proxies for the reference points are presented in table 18.15.

18.4 Management plans

The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters applies to this stock (EU, 2019a). The MAP stipulates that when the F_{MSY} ranges are not available, fishing opportunities should be based on the best available scientific advice.

18.5 Issue list

Issues	Problems/Aims	Work needed / possible resolutions for consideration	Required data to resolve this. Are these available/ where should these come from?	Benchmark external expertise needed Type of expertise & proposed names
Data needed and/or to be quantified[1]	Time-series of catch data	7 years of data have been consolidated in InterCatch. A longer time-series needs to be consolidated.	France, Spain and Portugal need to consolidate their InterCatch data to get a longer time-series	
	Time-series of length structures. Samplings may not be sufficient in all areas	Assess the representativeness of the samplings in subarea 8 and evaluate the possibilities for use to raise data in division 9 where very few samples are available.	Raw sampling data	
	Time-series of age structures. Samplings may not be sufficient in all areas	Assess the representativeness of the sampling in subarea 8 and evaluate the possibilities for use to raise data in division 9 where very few samples are available.	Raw sampling data Estimate an age-length key (ALK)	
Discards	Time-series of discards has to be consolidated	7 years of data have been raised in InterCatch. A longer time-series needs to be consolidated	France, Spain and Portugal need to consolidate their InterCatch data to get a longer time-series	
Stock ID	This species is at the southern extent of its range in the Bay of Biscay and Iberian Peninsula. It is not clear whether this is a separate stock from a biological point of view	Review of literature		
Biological Parameters	Maturity	Little information about maturity is currently available for assessment but some information should have been collected during the scientific surveys and DCF collections in France, Spain and Portugal.	France, Spain and Portugal should provide all individual biological data to assess if some maturity ogive can be derived for this stock.	

Issues	Problems/Aims	Work needed / possible resolutions for consideration	Required data to resolve this. Are these available/ where should these come from?	Benchmark external expertise needed Type of expertise & proposed names
Assessment method	Some ongoing works exist which aim to provide length/age data. Once the data are consolidated, an a4a (Millar and Jardim, 1999) model can be envisaged and explored			a4a experts
Biological reference points	Fishing level values of catch, F and biomass	Little information is known about the SSB and recruitment while a significant uncertainty in F is known	Collect more information from literature	

- No discard information is provided for the Subarea 8.c and Division 9.a.
- Very little information is available about the stock distribution.
- Existing surveys should be further investigated to check for potential data availability.

18.6 Recommendations for a benchmark

This stock was benchmarked in 2023 during WKMSYSPiCT2 (ICES, 2023b) workshop. It was not possible to fit a SPiCT model for the stock due to the time constraints and the limited information provided by the catch time-series.

A significant amount of data needs to be collected and intersessional works should be done before this stock can proceed to another benchmark. Currently, only a short time-series of landings data is available with information on discards and limited data on abundance and/or biomass, stock distribution and biological parameters. This significant input data gap, identified in the issues list above, should be resolved prior to the next benchmark.

Once these data are collected, a simple linear model such as the Assessment for All (a4a; Millar and Jardim, 1999) or other integrated models can be explored and implemented.

18.7 References

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18.8 Tables and figures

Table 18.1. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Official landings (in tonnes). ICES estimates are based on a correction of mixed species (whiting and pollack) landings recorded in the Portuguese landings in Division 9a.

Year	Belgium	France	Portugal	Spain	Total	Unallocated *	ICES estimates
1994		3 496	15	136	3 647	0	3 647
1995		2 645	2	1	2 648	0	2 648
1996		1 544	4	13	1 561	0	1 561
1997		1 895	3	47	1 945	0	1 945
1998		1 750	3	105	1 858	0	1 858
1999			1	211	212	0	212
2000	2	1 106	2	338	1 448	0	1 448
2001	3	1 989	1	288	2 281	0	2 281
2002	3	1 970	1	230	2 204	0	2 204
2003	1	2 275	4	171	2 451	0	2 451
2004		1 965	77	249	2 291	-70	2 221
2005	3	1 662	2	416	2 083	-2	2 081
2006	2	1 420	7	433	1 862	-6	1 856
2007	4	1 617	107	296	2 024	-104	1 920
2008	1	772	98	187	1 058	-93	965
2009	2	1 303	114	54	1 473	-111	1 362
2010	3	2 234	114	101	2 452	-110	2 342
2011	1	2 029	105	108	2 243	-102	2 141
2012	3	1 791	90	110	1 994	-87	1 907
2013	1	1 943	95	55	2 094	-93	2 001
2014	1	1 579	65	55	1 700	-49	1 651
2015	2	2 138	38	56	2 234	-35	2 199
2016	1	2 441	20	40	2 502	23	2 525
2017	0	1 871	18	20	1 909	16	1 925
2018	2	1 524	15	26	1 565	0	1 565
2019	1	1 348		13	1 362	34	1 396
2020	1	1 094		1	1 096	25	1 121
2021	1	1 229		15	1 245	26	1 271
2022†	1	1 167			1 168	29	1 197

*Unallocated are mostly coming from landings subtracted from pollock in subarea 8 and division 9a.
†Provisional

Table 18.2. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Landings with associated discards (in percent) in the same strata* that were submitted to InterCatch.

Year	Landings with associated discards*
2016	88%
2017	72%
2018	70%
2019	49%
2020	33%
2021	47 %
2022	53 %

*Similar combinations of countries/gears/seasons/areas.

Table 18.3. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Landings and discards (in tonnes) after raising procedures.

Year	Landings (Imported)	Discards (Imported)	Discards (raised)	Total discards	Overall discard rate
2016	2 525.00	828.40	98.38	926.78	0.268
2017	1 925.00	617.60	320.20	937.80	0.328
2018	1 565.00	376.00	279.50	655.50	0.295
2019	1 396.00	243.90	291.20	535.10	0.280
2020	1 122.00	92.50	206.20	298.70	0.210
2021	1 271.00	267.20	362.30	629.50	0.331
2022	1 198.00	262.20	108.20	370.40	0.230

Table 18.4. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Summary of the structures provided in 2020 (Imported_Data refers to data imported to InterCatch, Raised_Discards refers to discard raised based on observed data for other strata, Sampled_Distribution refers to landings or discards with length structures provided, Estimated_Distribution refers to length distribution estimated from the provided strata).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Logbook Registered Discard	Imported_Data	Estimated_Distribution	0	NA
Landings	Imported_Data	Sampled_Distribution	1022	85
Landings	Imported_Data	Estimated_Distribution	175.6	15
Discards	Imported_Data	Sampled_Distribution	231.5	62
Discards	Raised_Discards	Estimated_Distribution	108.2	29
Discards	Imported_Data	Estimated_Distribution	30.71	8

Table 18.5. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Summary of the structures provided in 2021 (Imported_Data refers to data imported to InterCatch, Raised_Discards refers to discard raised based on observed data for other strata, Sampled_Distribution refers to landings or discards with length structures provided, Estimated_Distribution refers to length distribution estimated from the provided strata).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	997.6	78
Landings	Imported_Data	Estimated_Distribution	273.7	22
Discards	Raised_Discards	Estimated_Distribution	362.3	58
Discards	Imported_Data	Sampled_Distribution	184.1	29
Discards	Imported_Data	Estimated_Distribution	83.08	13

Table 18.6. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Summary of the structures provided in 2020 (Imported_Data refers to data imported to InterCatch, Raised_Discards refers to discard raised based on observed data for other strata, Sampled_Distribution refers to landings or discards with length structures provided, Estimated_Distribution refers to length distribution estimated from the provided strata).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Estimated_Distribution	577.3	51
Landings	Imported_Data	Sampled_Distribution	544.2	49
Discards	Raised_Discards	Estimated_Distribution	206.2	69
Discards	Imported_Data	Sampled_Distribution	50.84	17
Discards	Imported_Data	Estimated_Distribution	41.66	14

Table 18.7. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Summary of the structures provided in 2019 (Imported_Data refers to data imported to InterCatch, Raised_Discards refers to discard raised based on observed data for other strata, Sampled_Distribution refers to landings or discards with length structures provided, Estimated_Distribution refers to length distribution estimated from the provided strata).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Estimated_Distribution	826	59
Landings	Imported_Data	Sampled_Distribution	570.1	41
Discards	Raised_Discards	Estimated_Distribution	291.2	54
Discards	Imported_Data	Sampled_Distribution	163.2	30
Discards	Imported_Data	Estimated_Distribution	80.77	15

Table 18.8. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Summary of the structures provided in 2018 (Imported_Data refers to data imported to InterCatch, Raised_Discards refers to discard raised based on observed data for other strata, Sampled_Distribution refers to landings or discards with length structures provided, Estimated_Distribution refers to length distribution estimated from the provided strata).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Estimated_Distribution	846.2	54
Landings	Imported_Data	Sampled_Distribution	718.6	46
Discards	Imported_Data	Sampled_Distribution	290.5	44
Discards	Raised_Discards	Estimated_Distribution	279.5	43
Discards	Imported_Data	Estimated_Distribution	85.51	13

Table 18.9. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Summary of the structures provided in 2017 (Imported_Data refers to data imported to InterCatch, Raised_Discards refers to discard raised based on observed data for other strata, Sampled_Distribution refers to landings or discards with length structures provided, Estimated_Distribution refers to length distribution estimated from the provided strata).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Estimated_Distribution	1080	56
Landings	Imported_Data	Sampled_Distribution	844.4	44
Discards	Imported_Data	Sampled_Distribution	404.7	43
Discards	Raised_Discards	Estimated_Distribution	320.2	34
Discards	Imported_Data	Estimated_Distribution	212.9	23

Table 18.10. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Summary of the structures provided in 2016 (Imported_Data refers to data imported to InterCatch, Raised_Discards refers to discard raised based on observed data for other strata, Sampled_Distribution refers to landings or discards with length structures provided, Estimated_Distribution refers to length distribution estimated from the provided strata).

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	1585	63
Landings	Imported_Data	Estimated_Distribution	939.9	37
Discards	Imported_Data	Sampled_Distribution	553.1	60
Discards	Imported_Data	Estimated_Distribution	275.2	30
Discards	Raised_Discards	Estimated_Distribution	98.38	11

Table 18.11. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Parameters used as input for the LBI method.

Data Type	Value/Year	Source
Length at maturit	261 261 261	https://www.fishbase.in/Reproduction/MaturityList.php?ID=29
von Bertalanffy growth parameter	443 443 443	https://www.fishbase.in/Reproduction/MaturityList.php?ID=29
Catch at length by year	2014 2020	Length data from IC
Length-weight relationship parameters for landings and discards	2014 2020	Mean weight at length from IC

Table 18.12. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Standardised LPUE from the French otter trawl.

Year	Standardised LPUE
2010	1.001
2011	1.346
2012	1.320
2013	1.269
2014	1.020
2015	1.288
2016	1.177
2017	0.895
2018	0.775
2019	0.767
2020	0.615
2021	0.830
2022	0.699

Table 18.13. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Assessment summary. All weights are in tonnes.

Year	Biomass index * (ratio)	Landings	Discards	Inverse f
2010	1.001	2 342		
2011	1.346	2 141		
2012	1.320	1 907		
2013	1.269	2 001		
2014	1.020	1 651		
2015	1.288	2 199		

Year	Biomass index * (ratio)	Landings	Discards	Inverse f
2016	1.177	2 525	927	0.929
2017	0.895	1 925	938	0.913
2018	0.775	1 565	656	0.96
2019	0.767	1 396	535	0.872
2020	0.615	1 121	299	0.908
2021	0.830	1 271	629	0.955
2022	0.699	1 197	370	0.941

* Standardized biomass index commercial French otter trawl LPUEs.

Table 18.14. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. The basis for the catch scenarios*

Previous catch advice Ay (2023)		1 630 tonnes
Stock biomass trend		
Index A (2021, 2022)		0.76
Index B (2018, 2019, 2020)		0.72
r: Index ratio (A/B)		1.06
Fishing pressure proxy		
Mean catch length ($L_{mean} = L_{2022}$)		340 mm
MSY proxy length ($L_{F=M}$)		320 mm
f: multiplier for relative mean length in catches ($L_{mean}/L_{F=M\ 2022}$)		1.06
Biomass safeguard		
Last index value (I_{2022})		0.70
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		0.86
b: multiplier for index relative to trigger min{$I_{2022}/I_{trigger}$, 1}		0.81
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.90
rfb calculation $C_{y+1} = C_y \times r \times f \times b \times m$		1 3470 tonnes
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not applied	
Discard rate		0.28
Catch advice for 2024 and 2025 (A_y × stability clause)		1 347 tonnes
Projected landings corresponding to advice**		970 tonnes
% advice change^		-41%

* The figures in the table are rounded. Calculations were done with unrounded inputs and computed values may not match exactly when calculated using the rounded figures in the table.
** [Advised catch for 2024 and 2025] × [1 – discard rate].
^Advice value for each of the years 2024 and 2025 relative to the advice value for each of the years 2022 and 2023 (2 276 tonnes).

Table 18.15. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$ proxy	0.86	Biomass index trigger value ($I_{trigger}$), defined as $I_{trigger} = I_{loss} \times 1.4$, where I_{loss} is the lowest observed historical biomass index value.	(ICES, 2023b)
	F_{MSY} proxy	$\frac{L_{mean}}{L_{F=M}} = 1*$	Relative value from LBI analysis, assuming the natural mortality rate (M) relative to somatic growth rate (M / K) = 1.5. $L_{F=M}$ is based on L_c (length at 50% of modal abundance) which varies each year.	(ICES, 2023b)

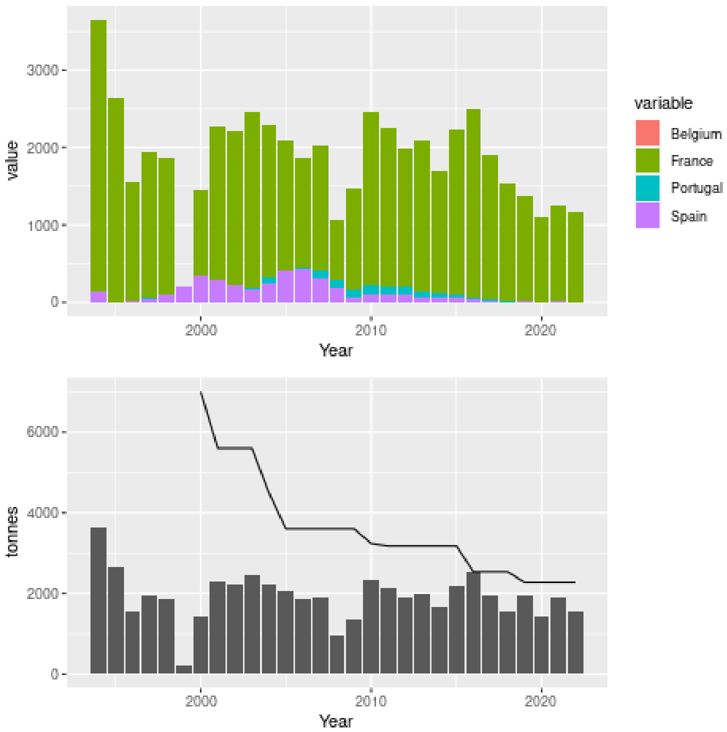

Figure 18.1. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Landings (in tonnes) per country (upper panel), landings (in tonnes) prior to 2019 (lower panel) and catches (in tonnes) after 2019 compared to TAC (solid line).

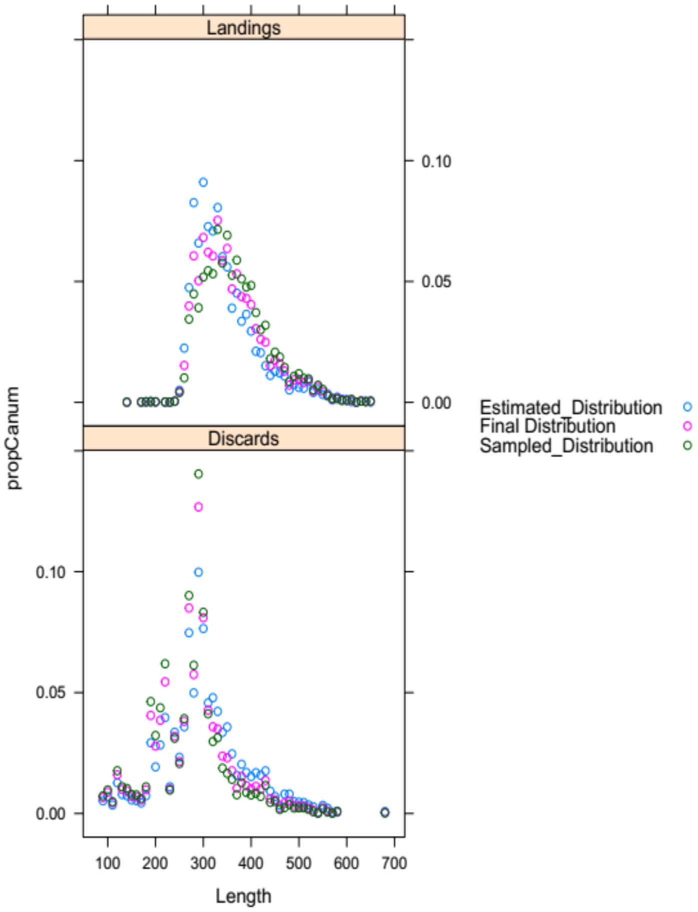

Figure 18.2. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Length distribution of landings (top) and discards (bottom) for 2016.

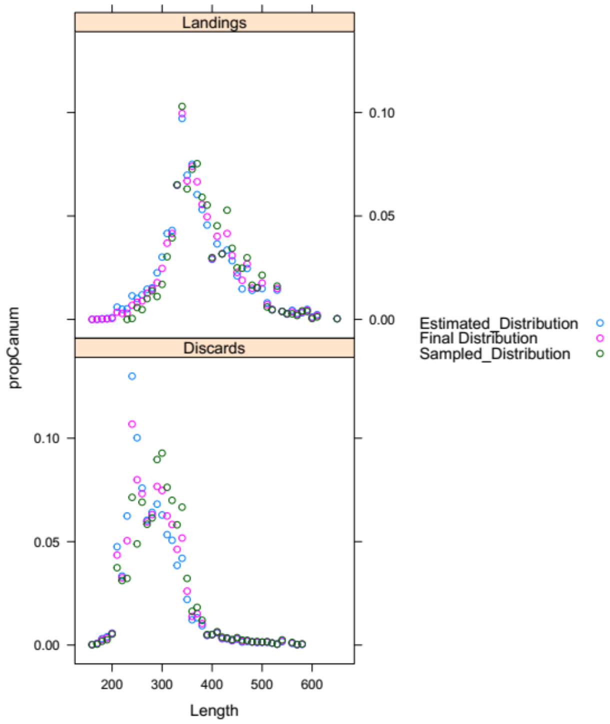

Figure 18.3. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Length distribution of landings (top) and discards (bottom) for 2017.

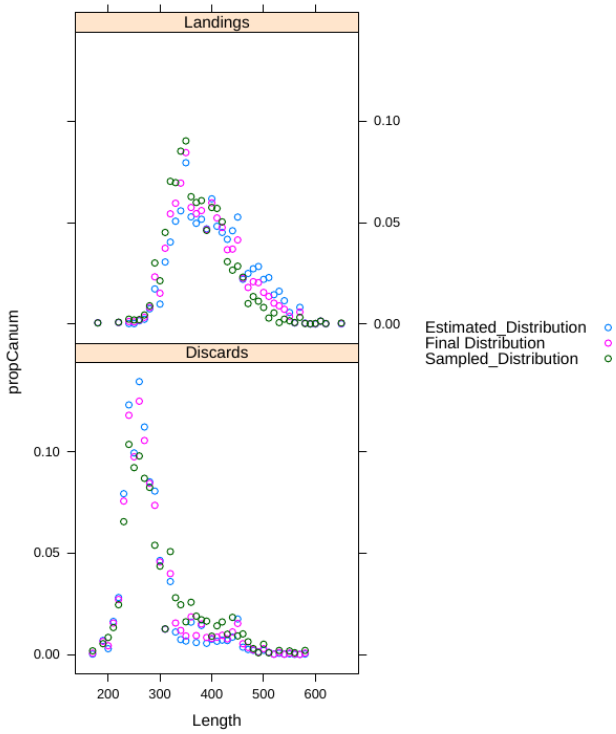

Figure 18.4. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Length distribution of landings (top) and discards (bottom) for 2018.

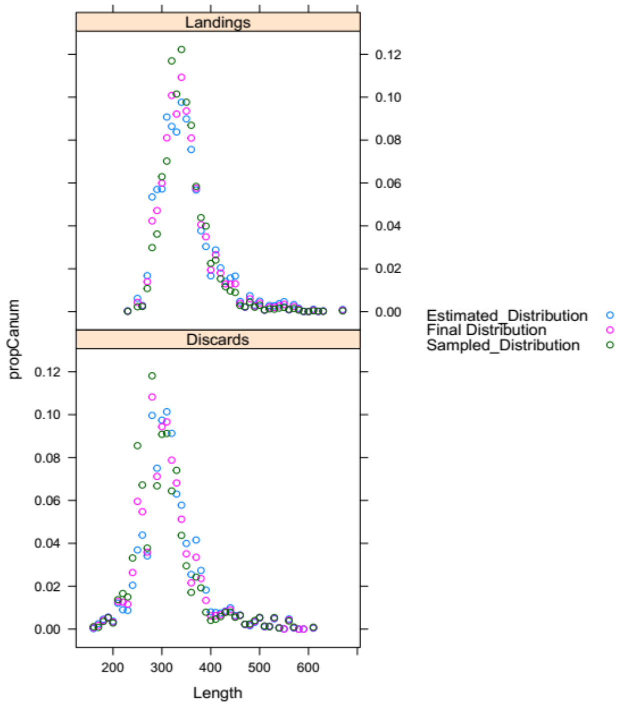

Figure 18.5. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Length distribution of landings (top) and discards (bottom) for 2019.

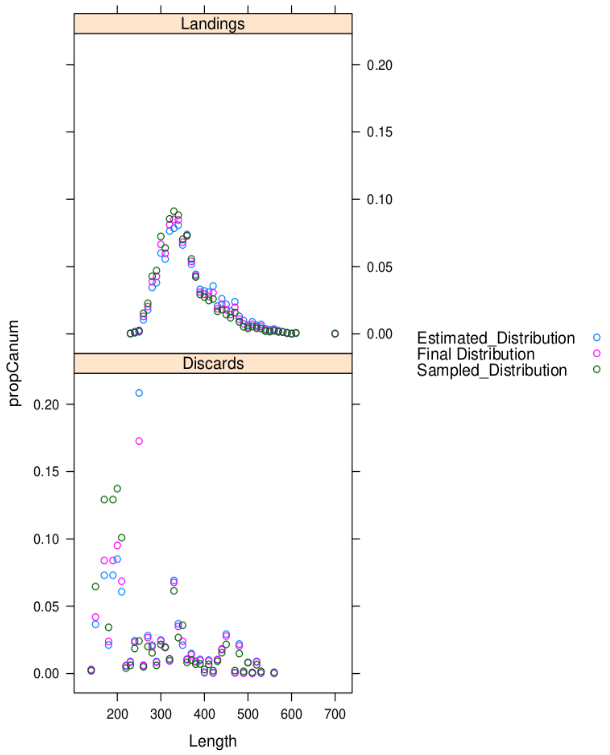

Figure 18.6. Whiting (Merlangius merlangus) in Subarea 8 and Division 9a. Length distribution of landings (top) and discards (bottom) for 2020.

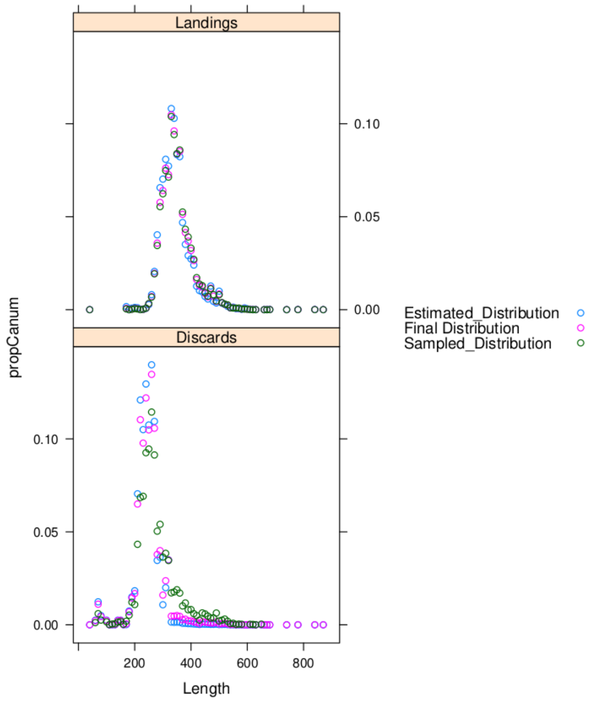

Figure 18.7. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Length distribution of landings (top) and discards (bottom) for 2021.

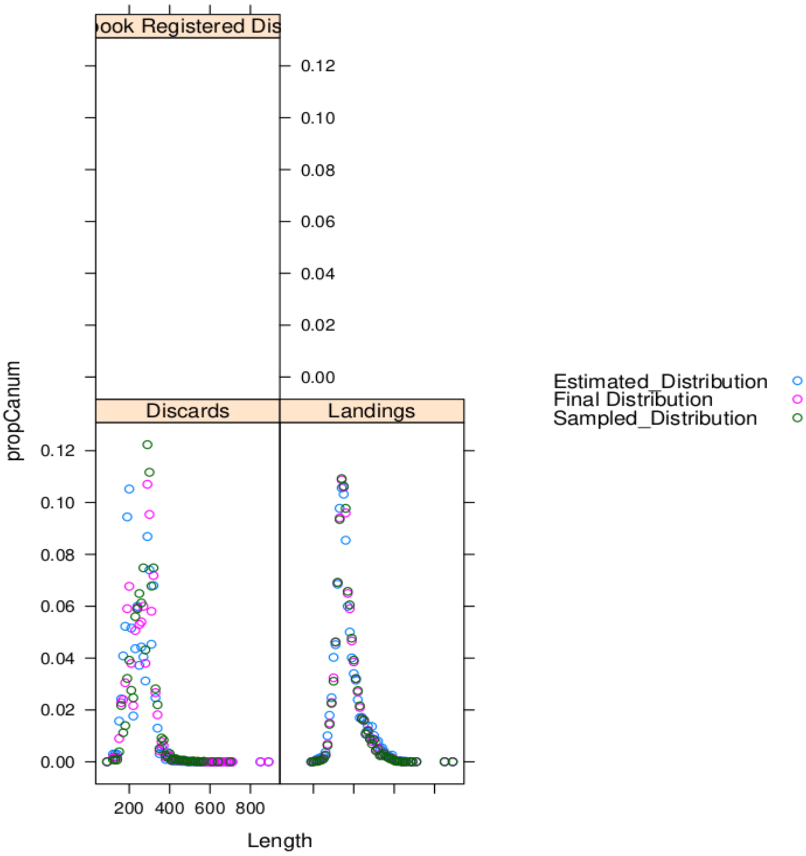

Figure 18.8. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Length distribution of Log book registered discards (no values on top) and landings and discards (bottom) for 2022.

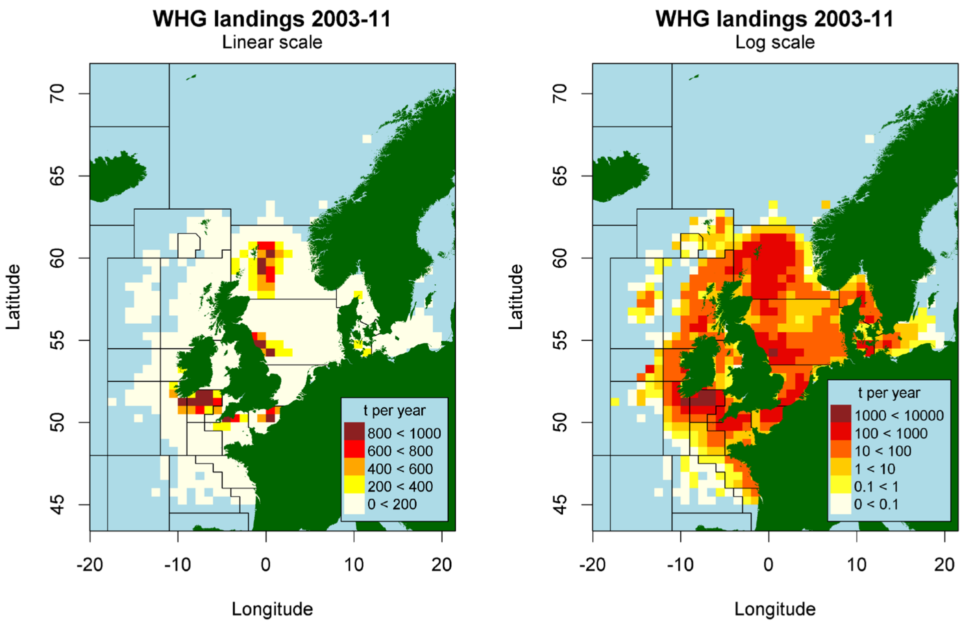

Figure 18.9. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Spatial distribution of whiting landings.

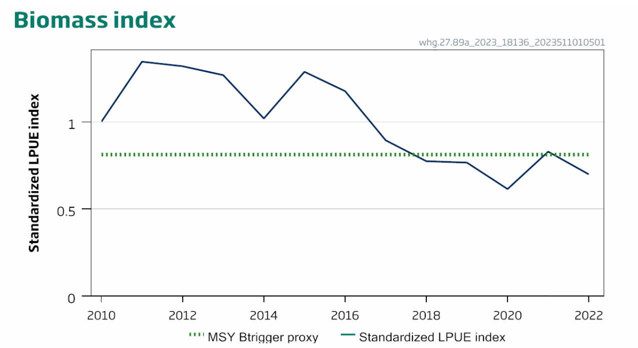

Figure 18.10. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Time series of standardised whiting LPUE for otter trawl fleets fishing in Divisions 8abd.

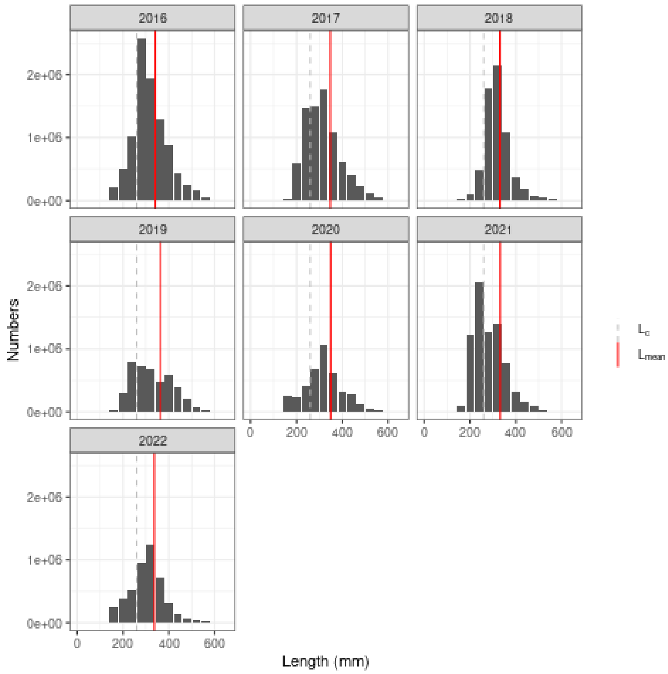

Figure 18.11. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Length composition of whiting catches binned at 40 mm.

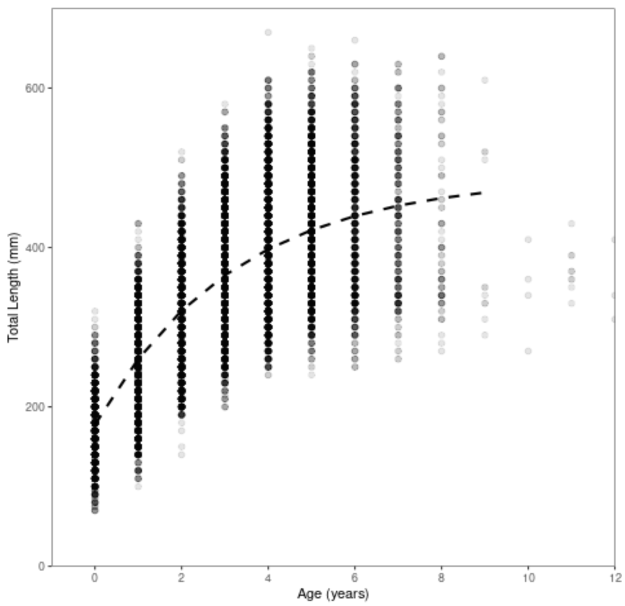

Figure 18.12. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. The von Bertalanffy curve adjusted on sampling data from areas 27.8 and 27.7.

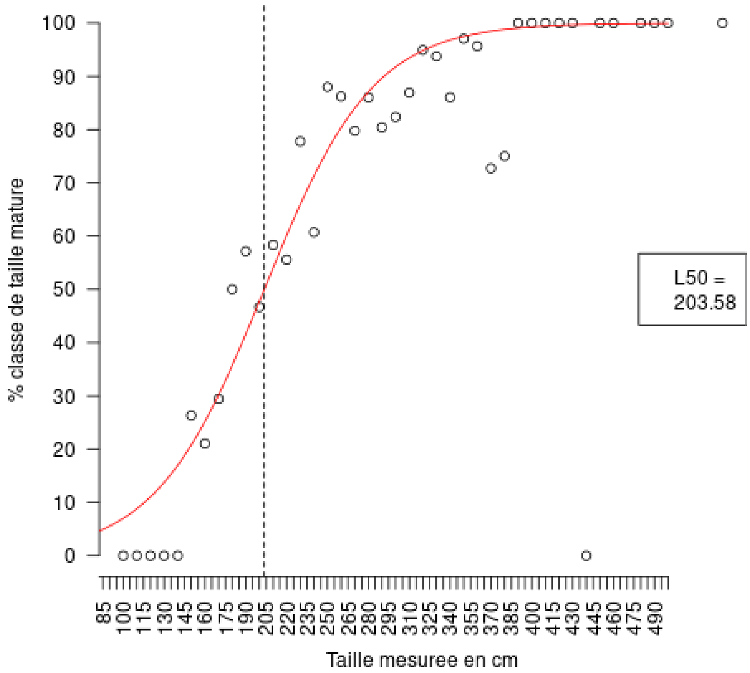

Figure 18.12. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Maturity ogive adjusted on sampling data from areas 27.8 and 27.7. The y-axis is the proportion of mature size class and x-axis is the measured length (in cm).

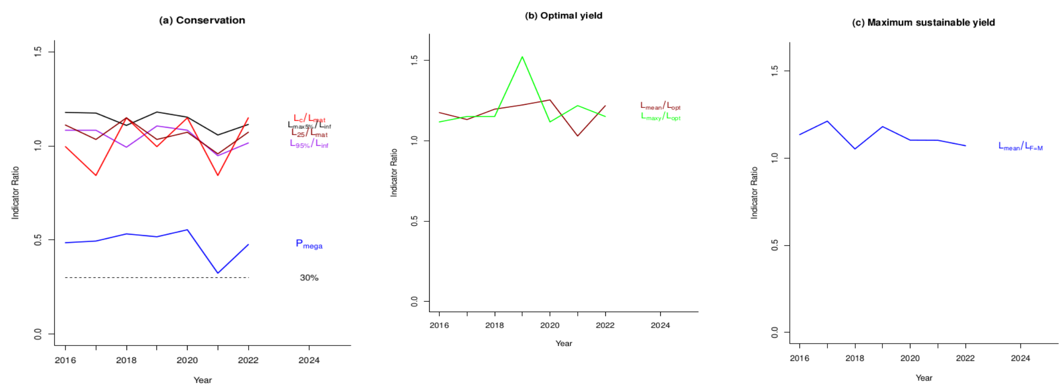

Figure 18.13. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. LBI analyses results.

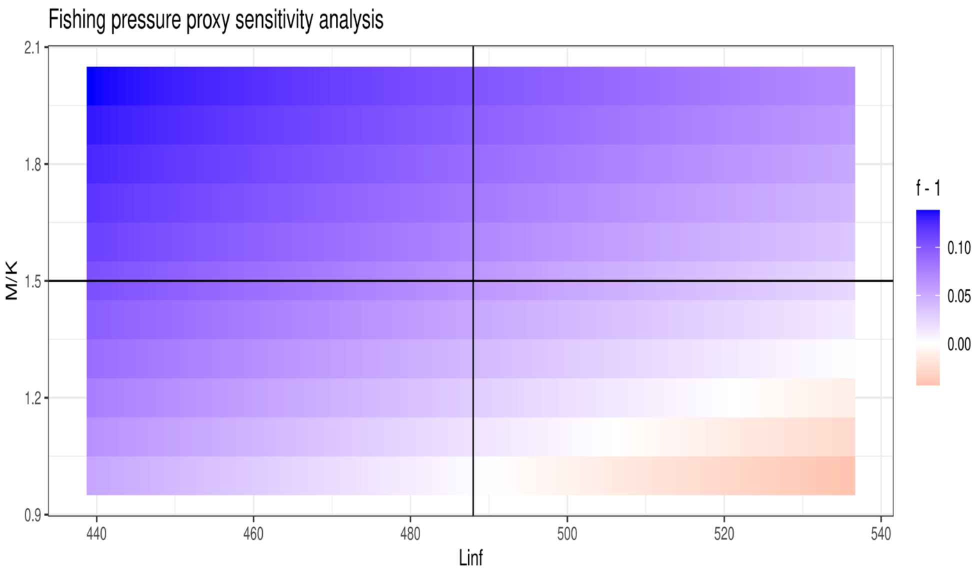

Figure 18.14. Whiting (*Merlangius merlangus*) in Subarea 8 and Division 9a. Fishing pressure proxy sensitivity analysis. Colours represent the difference between the indicator $L_{mean}/L_{F=M}$ Blue values mean that the indicator is above 1 and that the stock is fished under F_{MSY} proxy.

Annex 1: List of participants

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Annex 2: Resolutions

WGBIE– Working Group for the Bay of Biscay and Iberian Waters Ecoregion

2022/2/FRSG08 The **Working Group for the Bay of Biscay and Iberian Waters Ecoregion** (WGBIE), chaired by Ching Villanueva, France and Santiago Cerviño, Spain, will meet at ICES Headquarters in Copenhagen, Denmark, 03–11 May 2023 to:

a) Address generic ToRs for Regional and Species Working Groups;

b) Review results and recommendations from benchmark and other interim relevant workshops held in 2022 and early 2023;

c) Update on Stock ID studies.

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting.

Material and data relevant to the meeting must be available to the group on the dates specified in the 2023 ICES data call.

WGBIE will report by May 19 2023 for the attention of the Advisory Committee.

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

Generic ToRs for Regional and Species Working Groups

The following ToRs apply to: AFWG, HAWG, NWWG, NIPAG, WGWIDE, WGBAST, WGBFAS, WGNSSK, WGCSE, WGDEEP, WGBIE, WGEEL, WGEF, WGHANSA and WGNAS.

The working group should focus on:

a) Consider and comment on Ecosystem and Fisheries Overviews with a focus on:

   i) identifying and correcting mistakes and errors (both in the text, tables, and figures);

   ii) proposing concrete evidence-based input that is considered essential to the advice but is currently underdeveloped or missing (with references and Data Profiling Tool entries, as appropriate).

   The input will feed into the annual updates of the overviews. Delivery of contributions other than those outlined above is also welcomed but will be utilized during the revision process (around every 5 years).

b) Conduct an assessment on the stock(s) to be addressed in 2023 using the method (assessment, forecast or trends indicators) as described in the stock annex; complete and document an audit of the calculations and results; and produce a **brief** report of the work carried out regarding the stock, providing summaries of the following where relevant:

   i) Input data and examination of data quality; in the event of missing or inconsistent survey or catch information refer to the ACOM document for dealing with missing data and the linked template that formulates how deviations from the stock annex are to be reported;

   ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

   iii) For relevant stocks (i.e. all stocks with catches in the NEAFC Regulatory Area), estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in 2022;

   iv) For category 3 and 4 stocks requiring new advice in 2023, implement the methods recommended by WKLIFE X (e.g. SPiCT, rfb, chr, rb rules) to replace the former 2 over 3 advice rule (2 over 5 for elasmobranchs). MSY reference points or proxies for the category 3 and 4 stocks (ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3);

   v) Evaluate spawning-stock biomass, total-stock biomass, fishing mortality, and catches (projected landings and discards) using the method described in the stock annex:

      1) For category 1 and 2 stocks, in addition to the other relevant model diagnostics, the recommendations and decision tree formulated by WKFORBIAS (see Annex 2) should be considered as guidance to determine whether an assessment remains sufficiently robust for providing advice.

      2) If the assessment is deemed no longer suitable as basis for advice, provide advice using an appropriate Category 2–5 approach as described in ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3 or ICES.

      3) If the assessment has been moved to a Category 2–5 approach in the past year consider what is necessary to move back to a Category 1 and develop proposal for the appropriate benchmark process.

   vi) Catch scenarios for the year(s) beyond the terminal year of the data for the stocks for which ICES has been requested to provide advice on fishing opportunities;

   vii) Historical and analytical performance of the assessment and catch options with a succinct description of associated quality issues. For the analytical performance of category 1 and 2 age-structured assessments, report the mean Mohn's rho (assessment retrospective bias analysis) values for time-series of recruitment, spawning-stock biomass, and fishing mortality rate. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

c) Produce a first draft of the advice on the stocks under consideration according to ACOM guidelines.

d) Review progress on benchmark issues and processes of relevance to the Expert Group:

   i) update the benchmark issues lists for the individual stocks in SID;

   ii) review progress on benchmark issues and identify potential benchmarks to be initiated in 2024 for conclusion in 2025;

   iii) determine the prioritization score for benchmarks proposed for 2024–2025;

   iv) as necessary, document generic issues to be addressed by the Benchmark Oversight Group (BOG).

e) Prepare the data calls for the next year's update assessment and for planned data evaluation workshops.

f) Identify research needs of relevance to the work of the Expert Group.

g) Review and update information regarding operational issues and research priorities on the Fisheries Resources Steering Group SharePoint site.

h) If not completed previously, complete the audit spreadsheet 'Monitor and alert for changes in ecosystem/fisheries productivity' for the new assessments and data used for the stocks. Also note in the benchmark report how productivity, species interactions, habitat and distributional changes, including those related to climate change, could be considered in the advice.

i) Deliver conservation status advice in accordance with the Technical guidelines on conservation status advice. The advice is only to be given when conservation aspects were identified and where clear, demonstrable management action can be recommended for any non-catch anthropogenic pressure. It can also be used to highlight clear demonstrable sensitivity to climate change. The qualification required to show clear, demonstratable management action is high. Avoid generic statements that are of no specific application to management.

j) Update SAG and SID with final assessment input and output.

Information on the stocks to be considered by each Expert Group is available here.

Annex 3: Working documents

The following six working documents (WDs) were presented at WGBIE 2023.

No.	Title	Authors
1	2022 ORHAGO (B1706) survey in the Bay of Biscay	Lecomte, J.-B.
2	Pollack in ICES subarea 8 and division 9a: Results from the WKBMSYPICT2 benchmark and proposal of length-based assessment and HCR Category 3 for providing advice in 2023	Sampedro, P., Vermard, Y., Ouzoulias, F.
3	Results of most relevant commercial species on the 2022 Northern Spanish Shelf groundfish survey	Blanco, M., Ruiz-Pico, S., Fernández-Zapico, O., Punzón, A., González-Irusta, J.M., Velasco, F.
4	European hake connectivity	Rodríguez-Ezpeleta, N., Manuzzi, A., Pereda-Agirre, I., Díaz-Arce, N., García, D., Sánchez, S.
5	White (*Lophius piscatorius*) and black-bellied anglerfish (*Lophius budegassa*): species ID and hybridization	Rodríguez-Ezpeleta, N., Pereda-Agirre, I., Manuzzi, A.
6	Close-kin Mark-recapture for spawning stock biomass estimation of Northeast Atlantic demersal species	Rodríguez-Ezpeleta, N., Pereda-Agirre, I., Manuzzi, A., Díaz-Arce, N., García, D., Ibaibarriaga, L., Urtizberea, A., Iriondo, A., Sánchez, S.

WD 1. 2022 ORHAGO (B1706) survey in the Bay of Biscay

This is a WD that describes the resolutions implemented on the Bay of Biscay sole 2023 stock assessment and advice. Due to terrible weather conditions which occurred during the 2022 ORHAGO (B1706) survey that had considerably impacted the common sole sampling as only less than 50% of the defined stations was sampled during a span of 6 (~20%) instead of 27 days sample collection period. The impact of using the 2022 survey data as abundance index for the 2023 stock assessment was explored and quantified. The document provides quantified impact scenarios that served as strong scientific basis for the non-consideration of the 2022 ORHAGO (B1706) survey decision that WGBIE took for the 2023 Bay of Biscay sole stock assessment which was consequently used as the basis for the 2023 advice.

WD 2. Pollack in ICES subarea 8 and division 9a: Results from the WKBMSYPICT2 benchmark and proposal of length-based assessment and HCR Category 3 for providing advice in 2023

This WD provides a summary of results for the pollack during the WKBMYSPiCT2 workshop held last January 2023. It also provides a description of the implementation of the LBI approach for the assessment of the stock to support its upgrade from a category 5 to 3 stock. The document also includes the results obtained and some discussions to support the adequacy of applying the new HCR guidelines (implementation of the new '*rfb*' that replaces the previously used 2-over-3 rule) and the provision of a category 3 advice for pollack.

WD 3. Results of most relevant commercial species on the 2022 Northern Spanish Shelf groundfish survey

This WD provides a summary of the 2022 northern Spanish Shelf groundfish (SPGFS; G4309) survey results which showed an increase of total catches as reflected on the biomass of the most relevant commercial species. Among the fish species that showed elevated abundance levels in the survey catch includes the southern hake, megrims and Norway lobsters where the abundance level of the latter species reached the highest value of its whole time-series. Increase in the recruitments of hake, black anglerfish and especially megrims were also observed while a that of the white anglerfish continues to decline.

WD 4. European hake connectivity

An update of the genetic studies on European hake was provided in this WD. Recent analyses tested an increase number of samples and these additional or complementary results showed that there is a clear mismatch between this species' stocks and population which can affect the stocks' assessments in the different ICES ecoregions and that the Close Kin Mark-recapture (CKMR) analyses showed promising results in terms of understanding the hake migrations.

WD 5. White (*Lophius piscatorius*) and black-bellied anglerfish (*Lophius budegassa*): species ID and hybridization

An update of the genetic and stock identification studies on the black and white anglerfish stocks is described in this WD. The document shows and discusses complementary results from additional anglerfish species samples collected recently that confirm the preliminary conclusions indicated in a previous published literature (see Aguirre-Sarabia *et al*., 2021[1]). The study confirms that there is a significant misidentification between the black and white anglerfish stocks. The genetic analyses showed that the color of the species' peritoneum is no longer a viable refence parameter for distinguishing or differentiating one species from another. This consequently increase species identification and stock grouping or distribution uncertainties. This study also underpinned the hybridization process between both species and finally no white anglerfish in the northeast Atlantic shows a panmictic population.

WD 6. Close-kin Mark-recapture (CKMR) for spawning stock biomass estimation of Northeast Atlantic demersal species

This WD discusses the potential use of CKMR can provide additional information on commercially exploited stocks' total mortality (Z) and spatial dynamics aside from being used as a fishery-independent abundance estimator. The document describes a framework development for applying the CKMR on hake and anglerfish. Preliminary result showed that the CKMR approach can be a powerful tool to accurately estimate SSBs of these two stocks. Further analyses should be undertaken and the paper provides relevant arguments on why a good sampling program and the joint collaboration of survey coordinators, geneticists and modelers are necessary for the full implementation of the CKMR approach.

[1] Aguirre-Sarabia I., Díaz-Acre N., Pereda-Agirre I., Mendibil I., Urtizberea A., Gerritsen H., Burns F., Holmes I., Landa J., Coscia I., Quincoces I., Santurtún M., Zanzi A., Martinsohn J.T., Rodríguez-Ezpeleta N. 2021. Evidence of connectivity, hybridization, and misidentification in whte anglerfish supports the need of a genetic-informed fisheries management framework. Evolutionary applications: https://onlinelibrary.wiley.com/doi/full/10.1111/eva.13278

2022 ORHAGO survey in the Bay of Biscay (B1706)

Jean-Baptiste Lecomte
March 2023

ABSTRACT

The French ORHAGO survey in the Bay of Biscay (B1706) was strongly impacted by the bad weather conditions in November 2022. The number of working days at sea was 6 out of the 27 days of the ship mobilization. As a result, 23 stations were fished out of the 49 planned. First, an analysis describing the impact of the hauls missing in 2022 on the computation of the age-based sole index is provided. The hauls sampled in 2022 do not allow for continuing the age-based sole index in 2022. Secondly, an analysis aiming at providing alternative scenario to perform the 2023 sole stock assessment in 8.ab is provided. Two alternative scenarios are tested: (1) perform the stock assessment without the 2022 French survey data and (2) perform the stock assessment with two age-based index using the French survey. One index using years from 2007 to 2017 using all sampled hauls during this period, and one index using 2018 to 2022 using only hauls sampled in 2022. The two approaches are compared in terms of model estimates and advice using short-term forecasts.

1 CONTEXT

The French ORHAGO survey in the Bay of Biscay (B1706) was strongly impacted by the bad weather conditions in November 2022. The number of working days at sea was 6 out of the 27 days of the ship mobilization. As a result, 23 stations were fished out of the 49 planned (Figure 1).

2 EFFECT OF MISSING HAULS ON SOLE INDEX OF ABUNDANCE

Given the number of stations withdrawn, the impact of the cancellation of these stations on the abundance index deserves to be examined. For this purpose, the index (2015 to 2021) was recalculated without the stations cancelled in 2022 and this series was compared to the series comprising all the reference stations which were carried out each year.

Figure 2 represents the index computed with all sampled stations and stations sampled in 2022 only. Figure 3 shows the percentage of change between the index computed with all the available data and without the stations unsampled in 2022.

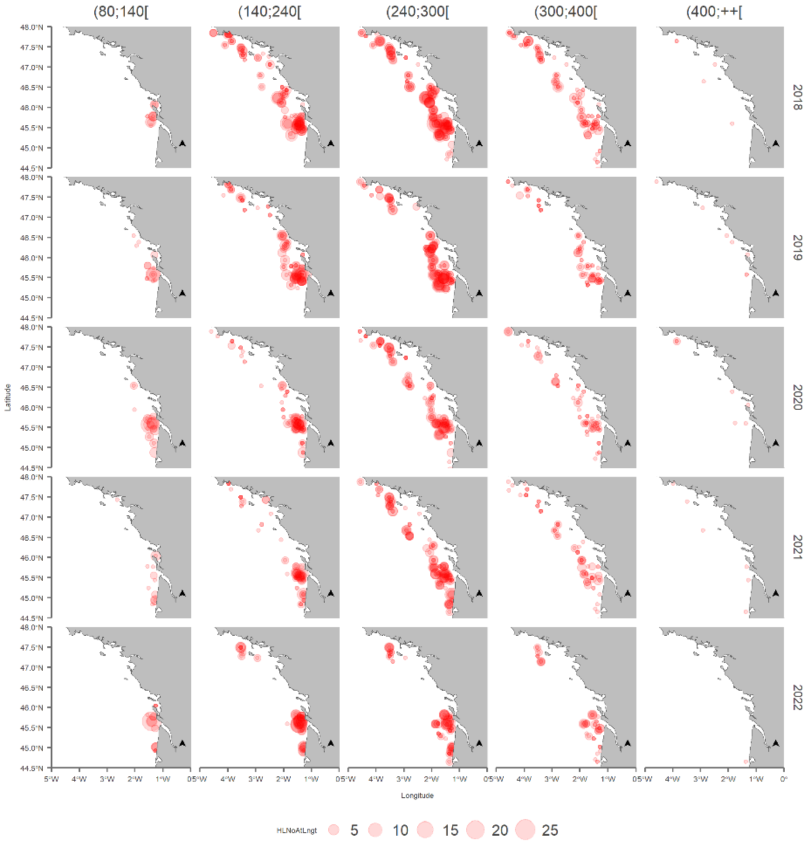

Figure 1: Map of the number of sole per length class caught by the French Orhago Survey since 2018

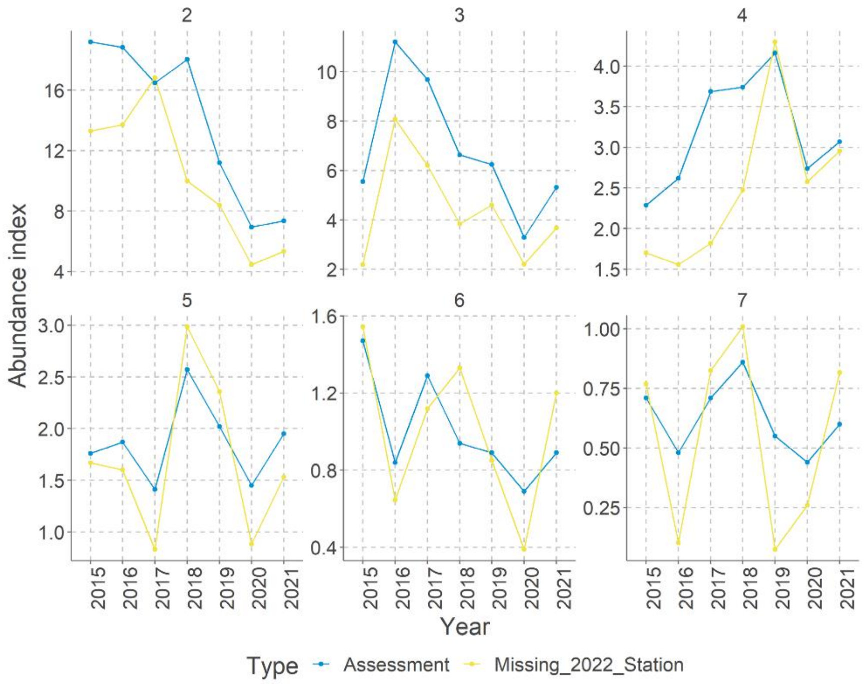

Figure 2: Comparison of the abundance index calculated without the stations cancelled in 2022 and with all the reference stations

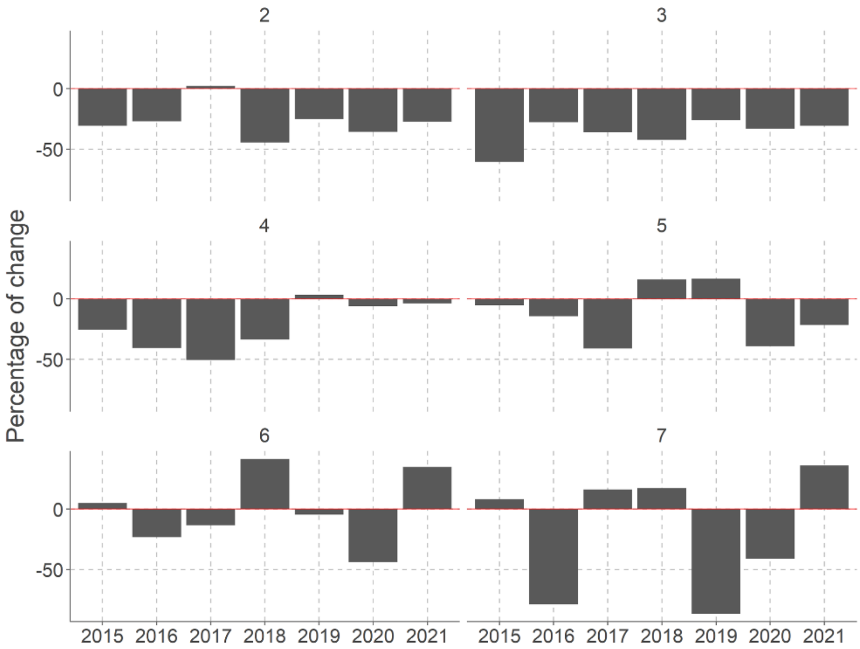

Figure 3: Percentage of change of the abundance index calculated without the stations cancelled in 2022 and with all the reference stations

This comparison shows that the general trend of the index is strongly affected by the stations withdrawn in 2022 at each age (Figure 2). The index calculated without the stations cancelled in 2022 is generally lower than the index including all the stations (Figure 2). The percentage of change between the index computed without 2022 missing stations is 25% to 50% lower for ages 2 and 3 and this change can be negative or positive for ages 4 to 7 (Figure 3). The trend is similar for ages 2 to 4 with and without 2022 missing stations (Figure 2). However, ages 5 to 7 show discrepancies between the two time series (Figure 2). This can be explained by the fact that soles older than age 5 are less targeted and caught than sole under age 5, leading to higher spatial and annual variability.

3 QUANTIFYING THE IMPACT OF A BTS-VIII SURVEY MISSING YEAR ON STOCK ASSESSMENT

Figure 4 provides the contribution of each age-based index for the year 2021. It highlights the importance of the BTS-VIII survey for the early ages (2 to 4).

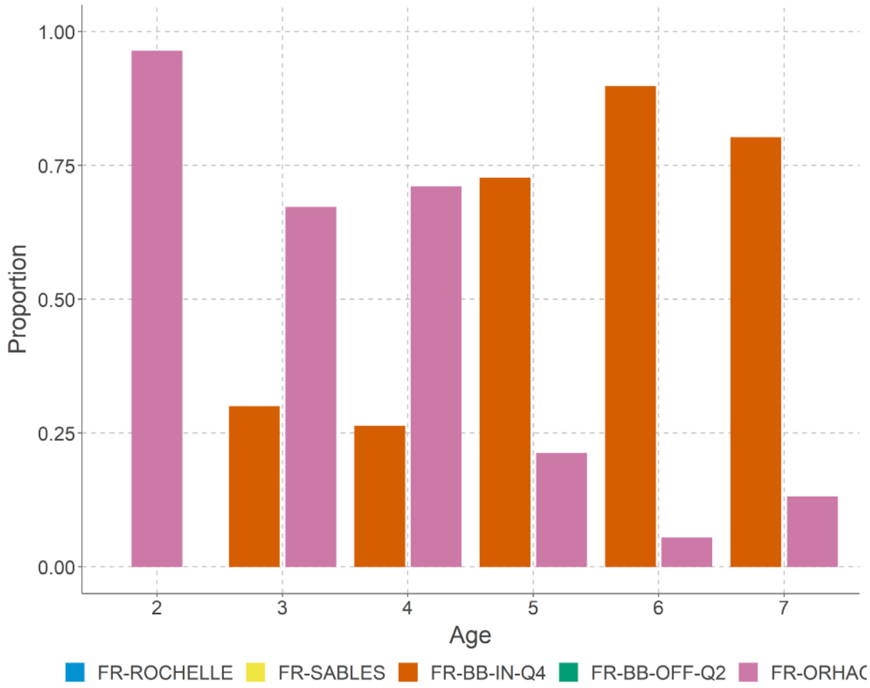

Figure 4: Contribution of each age-based indices to the model stock assessment for the year 2021.

In order to quantify the impact of a missing year of the BTS-VIII survey on the sole stock assessment in 27.8.ab, two stock assessments are conducted: (1) the 2022 stock assessment is performed without the 2021 BTS-VIII survey and (2) the 2021 stock assessment is performed without the 2020 BTS-VIII survey. The results obtained without the terminal year of BTS-VIII survey are compared to their respective stock assessment which used the terminal year of the BTS-VIII survey.

3.1 Results

3.1.1 2022 assessment with and without 2021 survey

3.1.1.1 XSA outputs

Figure 5 shows the results of the XSA model used with and without 2021 BTS-VIII survey. As expected, the overall series (Catch, F_bar, Recruitment and SSB) are not impacted by the missing 2021 BTS-VIII survey and differences are only observed in recent years. Figure 6 focuses on recent years and highlights that the recruitment computed without the 2021 BTS-VIII survey is lower than the recruitment computed with the 2021 BTS-VIII survey. The same pattern is observed for the SSB with a lower SSB estimated without the 2021 BTS-VIII survey than with the 2021 BTS-VIII survey. Finally, the F_bar estimated without the 2021 BTS-VIII survey is greater than the one estimated with the 2021 BTS-VIII survey. The observed difference between the estimates of the two models is relatively low (Table 1).

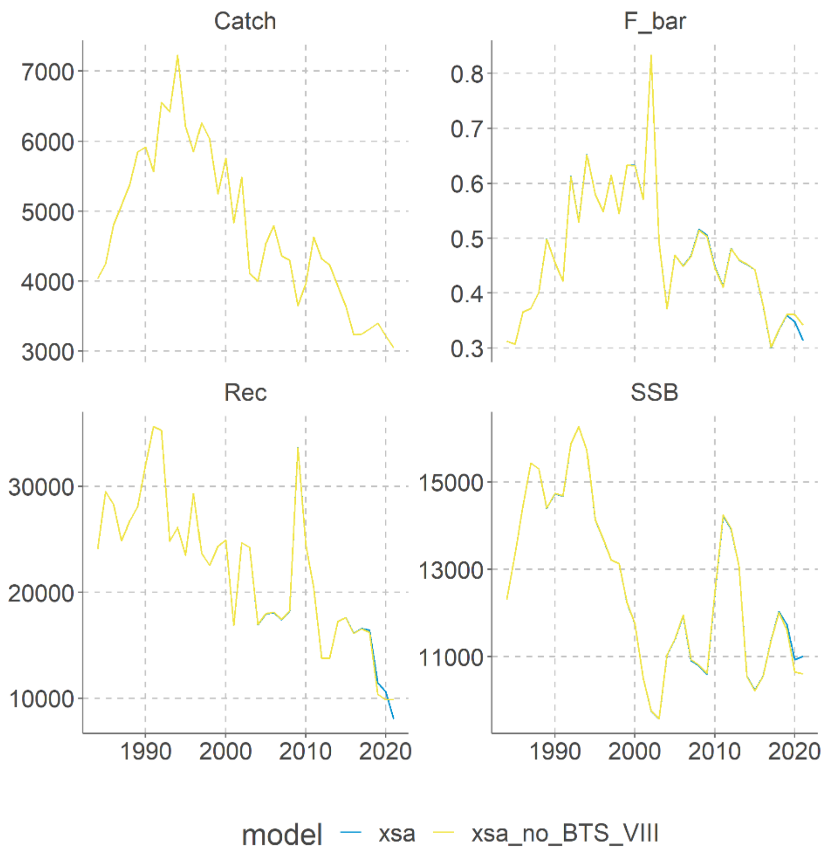

Figure 5: Comparisons of models using 2021 BTS-VIII survey (xsa) and without 2021 BTS-VIII survey (xsa_noBTS_VIII). Trends for F, recruitment, SSB and total catch data. Recruitment is in thousands while SSB and total catch are in tonnes.

Figure 6: Comparisons of models using 2021 BTS-VIII survey (xsa) and without 2021 BTS-VIII survey (xsa_noBTS_VIII) from 2015 to 2021. Trends for F, recruitment, SSB and total catch data. Recruitment is in thousands while SSB and total catch are in tonnes.

Table 1: *Percentage of difference between outputs using 2021 BTS-VIII survey (xsa) and without 2021 BTS-VIII survey (xsa_noBTS_VIII) for the terminal year (2020).*

year	Variable	xsa	xsa_no_BTS_VIII	percentage
2,021	SSB	11,008.00	10,606.00	-3.8
2,021	Rec	8,041.00	9,873.00	18.6
2,021	Catch	3,049.00	3,049.00	0.0
2,021	F_bar	0.31	0.34	8.8

3.1.1.2 Short-term forecast

The short-term forecast was performed using the same assumptions as the stock assessment conducted in 2022 (TAC constraints because of a substantial reduction of the TAC in 2022). Table 2 and Table 3 provide respectively the parameters used for the short-term forecast for the model using 2021 BTS-VIII survey and without 2021 BTS-VIII survey. Table 4 and Table 5 provide the advice scenarios with and without 2021 BTS-VIII survey respectively. Figure 7 shows the comparisons of short-term forecast outputs for the EU MAP basis.

Table 2: *Short-term forecasts input parameters using 2021 BTS-VIII survey.*

Variables	Values	Notes
Fage 3–6 (2022)	0.27	TAC constraints because of the reduction of the TAC in ,2022 leading of an F lower than the F Statu-quo (F2021 = 0.31).
SSB (2023)	9,859.00	Assessment forecast; in tonnes.
R_{age2} (2022–2023)	12,757.00	Geometric mean (2016–2021); in thousands.
Projected landings (2022)	2,233.00	Short-term forecast; average landing rate of 2015–2021; in tonnes.
Projected discards (2022)	51.00	Computed using the average discard ratio (2.3%) over 2015–2021 but not used in the assessment; in tonnes.

Table 3: *Short-term forecasts input parameters without 2021 BTS-VIII survey.*

Variables	Values	Notes
Fage 3–6 (2022)	0.28	TAC constraints because of the reduction of the TAC in ,2022 leading of an F lower than the F Statu-quo (F2021 = 0.31).
SSB (2023)	9,775.00	Assessment forecast; in tonnes.
R_{age2} (2022–2023)	12,793.00	Geometric mean (2016–2021); in thousands.
Projected landings (2022)	2,233.00	Short-term forecast; average landing rate of 2015–2021; in tonnes.
Projected discards (2022)	51.00	Computed using the average discard ratio (2.3%) over 2015–2021 but not used in the assessment; in tonnes.

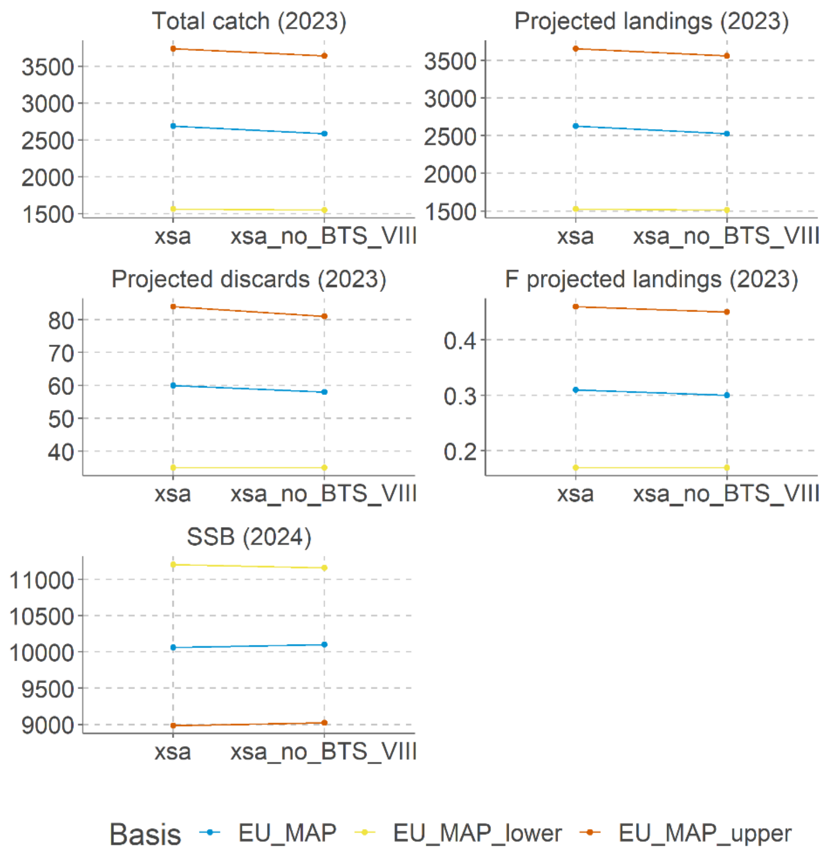

Figure 7: Comparison of short-term forecast outputs for EU MAP basis for models using 2021 BTS-VIII survey (xsa) and without 2021 BTS-VIII survey (xsa_noBTS_VIII).

***Table 4:** 2022 advice table*

Basis	Total catch (2023)	Projected landings (2023)	Projected discards (2023)	F projected landings (2023)	SSB (2024)	% SSB change ***	% TAC change	% Advice change ^^
EU_MAP	2,685	2,625	60	0.31	10,062	2.1	20.2	20.2
EU_MAP_lower	1,563	1,528	35	0.17	11,206	13.7	-30	23.6
EU_MAP_upper	3,742	3,659	84	0.46	8,986	-8.9	67.6	20.8

***Table 5:** 2022 advice table without 2021 BTS-VIII survey*

Basis	Total catch (2023)	Projected landings (2023)	Projected discards (2023)	F projected landings (2023)	SSB (2024)	% SSB change ***	% TAC change	% Advice change ^^
EU_MAP	2,584	2,526	58	0.3	10,101	3.3	15.7	15.7
EU_MAP_lower	1,549	1,514	35	0.17	11,160	14.2	-30.6	22.4
EU_MAP_upper	3,640	3,559	81	0.45	9,025	-7.7	63	17.5

3.1.1.3 Comparison

In 2022, ICES advised that when the EU multiannual plan (MAP) for the Western waters and adjacent waters is applied, catches in 2023 that correspond to the F ranges in the plan are between 1563 (EU MAP lower) tonnes and 2685 tonnes (EU MAP upper). This advice was provided using the 2021 BTS-VIII survey.

Providing the 2022 advice without the 2021 BTS-VIII survey results in 2023 catches between 1549 (EU MAP lower) tonnes and 2584 tonnes (EU MAP upper). The percentage of change between the total catch provided with and without BTS-VIII survey is 3.7% lower for the EU MAP upper basis and 0.9% lower for the EU MAP lower basis.

3.1.2 2021 assessment with and without 2020 survey

3.1.2.1 XSA outputs

Figure 8 shows the results of the XSA model used with and without 2020 BTS-VIII survey. As expected, the overall series (Catch, F_bar, Recruitment and SSB) are not impacted by the missing 2020 BTS-VIII survey and differences are only observed in the last years. Figure 9 focuses on recent years and highlights that the recruitment computed without the 2020 BTS-VIII survey is lower than the recruitment computed with the 2020 BTS-VIII survey. The same pattern is observed for the SSB with a lower SSB estimated without the 2020 BTS-VIII survey than using the 2020 BTS-VIII survey (Table 6). Finally, the F_bar estimated without the 2020 BTS-VIII survey is greater than the ones estimated with the 2021 BTS-VIII survey. The observed difference between the estimates of two the models are relatively low.

Figure 8: Comparisons of models using 2021 BTS-VIII survey (xsa) and without 2021 BTS-VIII survey (xsa_noBTS_VIII). Trends for F, recruitment, SSB and total catch data. Recruitment is in thousands while SSB and total catch are in tonnes.

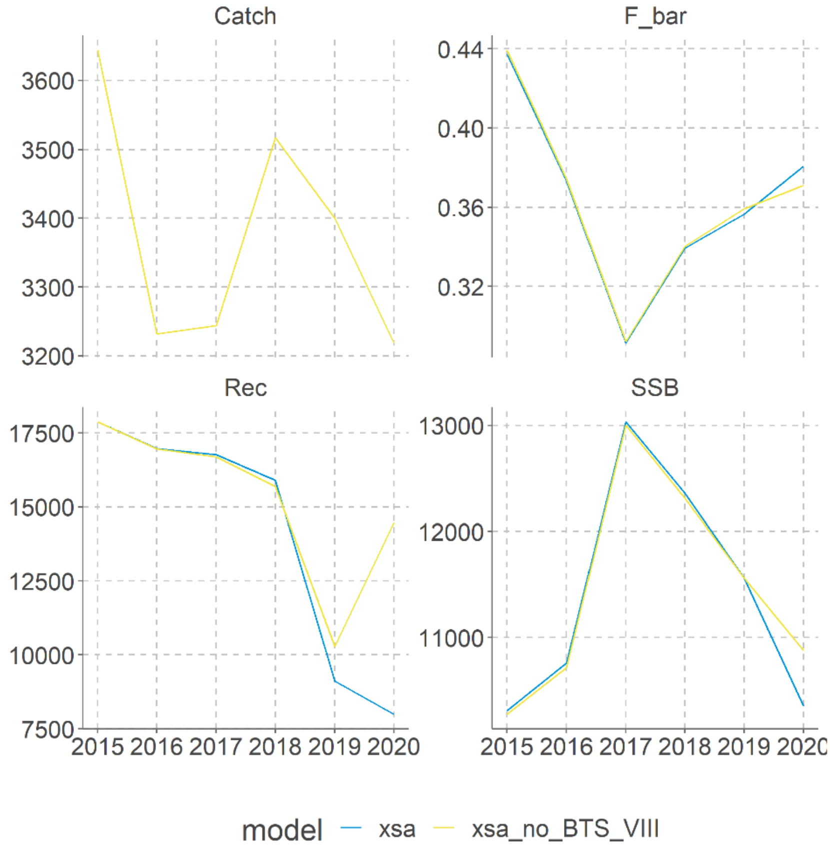

Figure 9: Comparisons of models using 2021 BTS-VIII survey (xsa) and without 2021 BTS-VIII survey (xsa_noBTS_VIII) from 2015 to 2021. Trends for F, recruitment, SSB and total catch data. Recruitment is in thousands while SSB and total catch are in tonnes.

Table 6: *Percentage of difference between outputs using 2021 BTS-VIII survey (xsa) and without 2021 BTS-VIII survey (xsa_noBTS_VIII) for the terminal year (2020).*

year	Variable	xsa	xsa_no_BTS_VIII	percentage
2020	SSB	10,355.00	10,879.00	4.8
2020	Rec	7,986.00	14,468.00	44.8
2020	Catch	3,219.00	3,219.00	0.0
2020	F_bar	0.38	0.37	-2.7

3.1.2.2 Short-term forecast

The short-term forecast was performed using the same assumptions as the stock assessment conducted in 2021 (F status quo). Table 7 and Table 8 provide respectively the parameters used for the short-term forecast for the model using 2020 BTS-VIII survey and without 2020 BTS-VIII survey. Table 9 and Table 10 provide the advice scenarios with and without 2020 BTS-VIII survey respectively. Figure 10 shows the comparison of short-term forecast outputs for EU MAP basis.

Table 7: *Short-term forecasts input parameters using 2021 BTS-VIII survey.*

Variables	Values	Notes
Fage 3–6 (2021)	0.38	TAC constraints because of the reduction of the TAC in ,2021 leading of an F lower than the F Statu-quo (F2021 = 0.31).
SSB (2022)	8,934.00	Assessment forecast; in tonnes.
R_{age2} (2021–2022)	12,688.41	Geometric mean (2016–2020); in thousands.
Projected landings (2021)	2,955.00	Short-term forecast; average landing rate of 2015–2020; in tonnes.
Projected discards (2021)	71.00	Computed using the average discard ratio (2.4%) over 2015–2020 but not used in the assessment; in tonnes.

Table 8: *Short-term forecasts input parameters without 2021 BTS-VIII survey.*

Variables	Values	Notes
Fage 3–6 (2021)	0.37	TAC constraints because of the reduction of the TAC in ,2021 leading of an F lower than the F Statu-quo (F2021 = 0.31).
SSB (2022)	10,733.00	Assessment forecast; in tonnes.
R_{age2} (2021–2022)	14,587.18	Geometric mean (2016–2020); in thousands.
Projected landings (2021)	3,328.00	Short-term forecast; average landing rate of 2015–2020; in tonnes.
Projected discards (2021)	80.00	Computed using the average discard ratio (2.4%) over 2015–2020 but not used in the assessment; in tonnes.

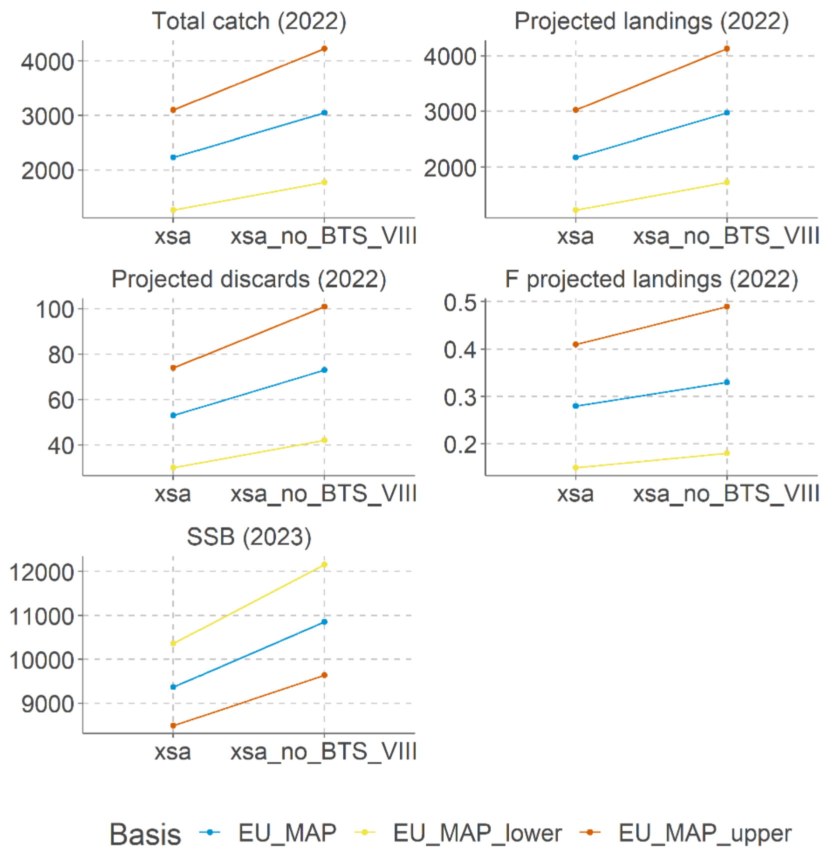

Figure 10: Comparison of short-term forecast outputs for EU MAP basis for models using 2021 BTS-VIII survey (xsa) and without 2021 BTS-VIII survey (xsa_noBTS_VIII).

Table 9: *2022 advice table*

Basis	Total catch (2022)	Projected landings (2022)	Projected discards (2022)	F projected landings (2022)	SSB (2023)	% SSB change ***	% TAC change	% Advice change ^^
EU_MAP	2,233	2,180	53	0.28	9,372	4.9	-35.9	-35.9
EU_MAP_lower	1,265	1,234	30	0.15	10,359	15.9	-63.7	-37.9
EU_MAP_upper	3,097	3,023	74	0.41	8,493	-4.9	-11.1	-35.7

Table 10: *2022 advice table without 2021 BTS-VIII survey*

Basis	Total catch (2022)	Projected landings (2022)	Projected discards (2022)	F projected landings (2022)	SSB (2023)	% SSB change ***	% TAC change	% Advice change ^^
EU_MAP	3,048	2,976	73	0.33	10,853	1.1	-12.5	-12.5
EU_MAP_lower	1,775	1,733	42	0.18	12,163	13.3	-49	-12.8
EU_MAP_upper	4,230	4,129	101	0.49	9,641	-10.2	21.5	-12.1

3.1.2.3 Comparison

In 2021, ICES advised that when the EU multiannual plan (MAP) for the Western waters and adjacent waters is applied, catches in 2022 that correspond to the F ranges in the plan are between 1265 tonnes and 3097 tonnes. This advice was provided using the 2020 BTS-VIII survey.

Providing the 2021 advice without the 2020 BTS-VIII survey results in 2021 catches between 1775 (EU MAP lower) tonnes and 4230 tonnes (EU MAP upper) with 3048 tonnes for the EU MAP. The percentage of change between the total catch provided with and without BTS-VIII survey is 73% higher for the EU MAP Basis and 71% higher for the EU MAP lower.

3.2 Discussion

The effect of a missing year of the BTS-VIII survey on the sole stock assessment and its advice is not negligible as highlighted by the 2021 stock assessment comparison. One proposition to avoid this lack of data will be to compute a sole abundance index using stations only sampled in 2022. The index computed with all stations available and stations only sampled in 2022 follow similar trends from 2015 to 2021 except for age 2 in 2017 (Figure 2).

4 2023 STOCK ASSESSMENTS

4.1 Dealing with uncomplete French ORHAGO survey

Two approaches are proposed do deal with the uncomplete French ORHAGO survey in 2022.

(1) Do not include data sampled in 2022 by the French ORHAGO survey. The index of abundance is used from 2007 to 2021 (Figure 11 and Figure 12). This scenario is named “no_BTS_VIII” in following sections.

(2) Make use of the sampled stations in 2020 by the French ORHAGO survey with (a) computing a new series from 2018 to 2022 using only stations sampled in 2022 (b) using the historical index series from 2007 to 2017 (Figure 13 and Figure 14). This scenario is named “split_BTS_VIII” in following sections.

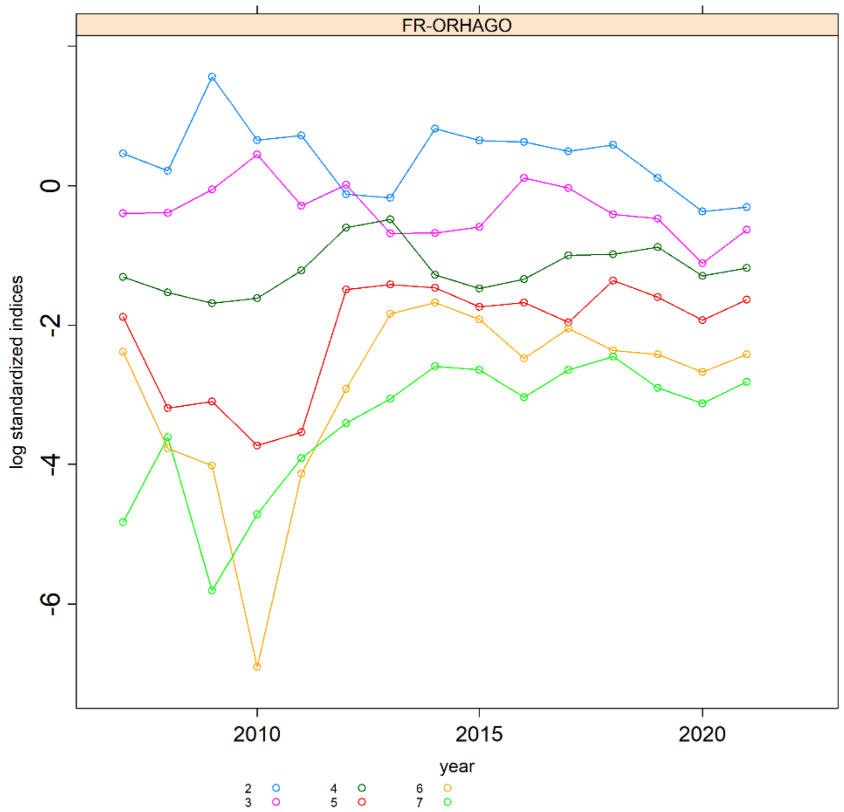

Figure 11: Time series of standardized ORHAGO index per age classes. Colours represent ages

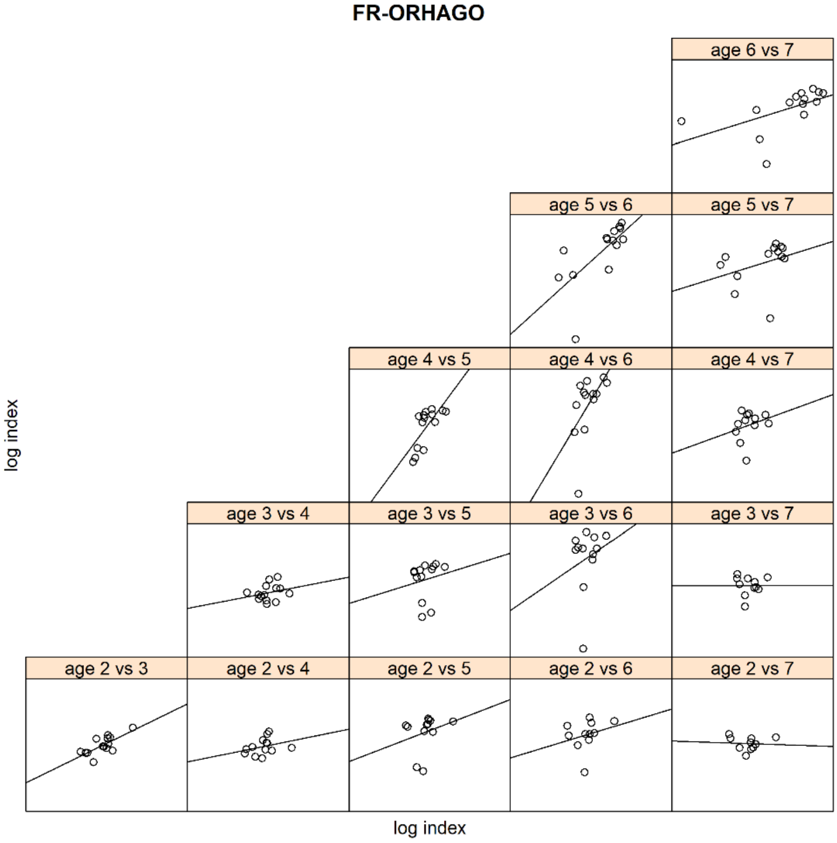

Figure 12: Internal consistency of the survey index ORHAGO (B1706).

Figure 13: Time series of standardized ORHAGO index per age classes. Right panel is the index computed from 2007 to 2017 and right panel is the index computed from 2018 to 2022 with stations sampled in 2022 only. Colours represent ages."

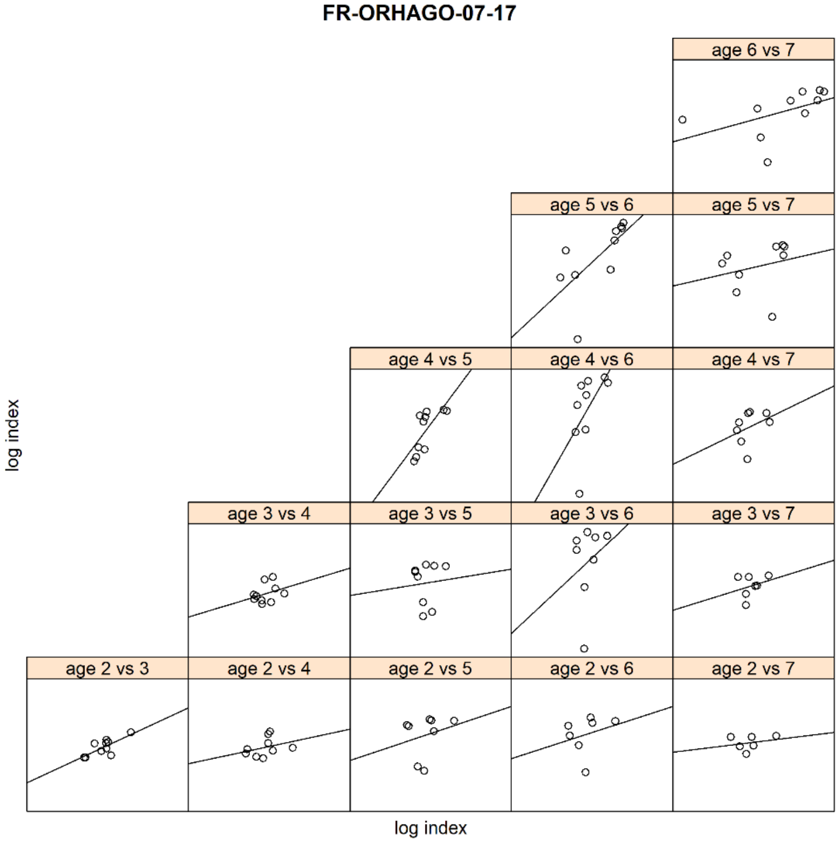

Figure 14: Internal consistency of the survey index ORHAGO (B1706) when split in two indexes.

Figure 15 shows the 3 index with a small increase observed in 2022 for the index using the stations sampled in 2022.

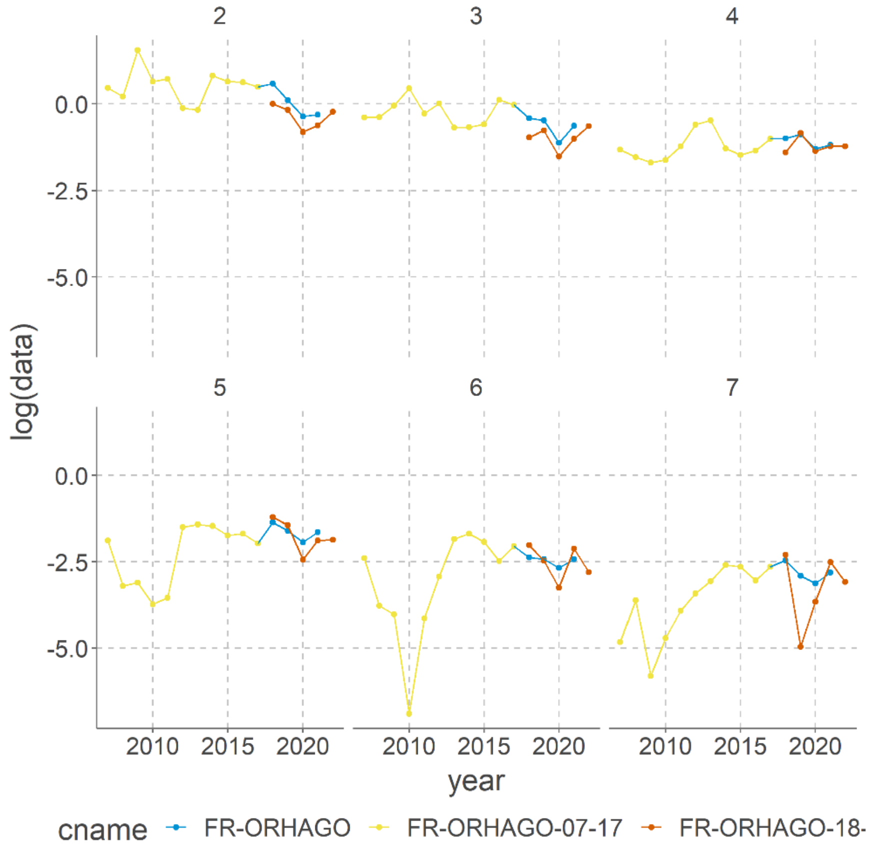

Figure 15: Comparisons of time series of standardized ORHAGO index per age classes. Colours represent the different index.

4.1.1 Model fits and residuals

Model fits for both models are very similar until year 2018 (Figure 16 and Figure 17). For the period 2019 to 2022, trends for F or SSB are the same, but the estimated SSB for the model using split BTS-VIII index is larger than the model without 2022 BTS-VIII survey. A difference is also observed for the recruitment estimates : when using split BTS-VIII survey, the estimated recruitment is estimated higher than the estimated recruitment for the model without 2022 BTS-VIII index. Residuals of model fits are consistent among both models. The residuals of index FR-ORHAGO (used from 2007 to 2021) and FR-ORHAGO-18-22 (2018 to 2022) share the same trends for shared years (2018 to 2022). Figure 19 and Figure 20 show the retrospective analysis for each model fits. The retrospective analysis for the model using split BTS-VIII survey indicates more uncertainty than the retrospective obtain with the model without a 2022 BTS-VIII index.

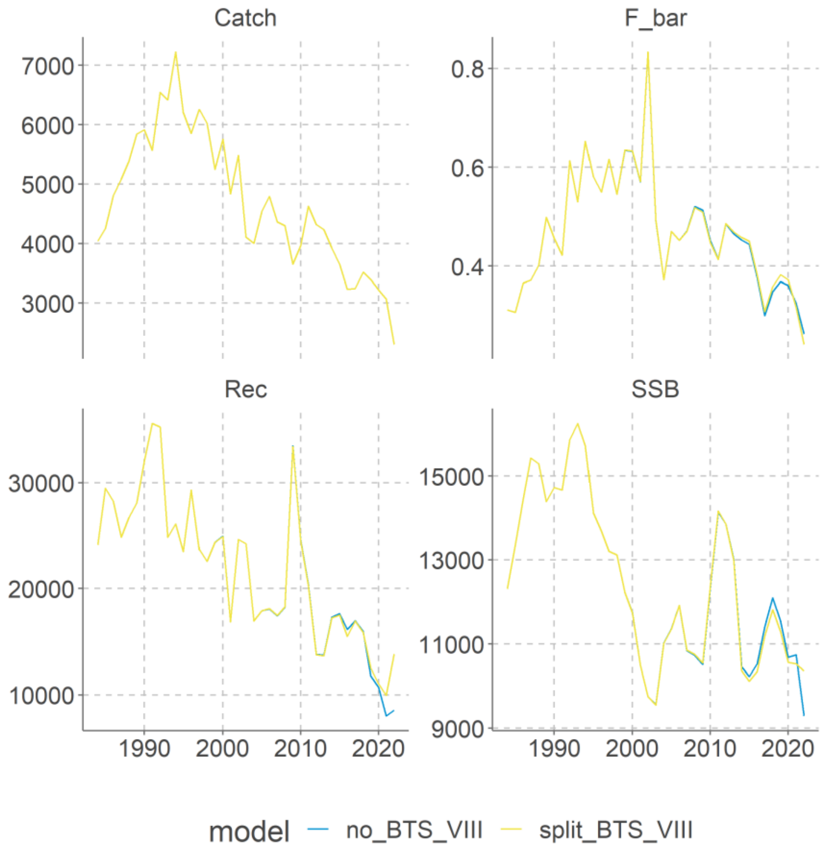

Figure 16: Comparisons of models without 2022 BTS-VIII survey (no_BTS_VIII) and with two BTS-VIII survey index (split_BTS_VIII). Trends for F, recruitment, SSB and total catch data. Recruitment is in thousands while SSB and total catch are in tonnes.

Figure 17: Comparisons of models without 2022 BTS-VIII survey (no_BTS_VIII) and with two BTS-VIII survey index (split_BTS_VIII) from 2015 to 2021. Trends for F, recruitment, SSB and total catch data. Recruitment is in thousands while SSB and total catch are in tonnes.

Figure 18: Bay of Biscay sole (Division 8a,b), assessment residuals XSA (No Taper, mean q, s.e. shrink = 2.5, s.e. min = .2) for each model fit. Top panel is model without 2022 BTS-VIII survey, two bottom panels are model with split BTS-VIII survey.

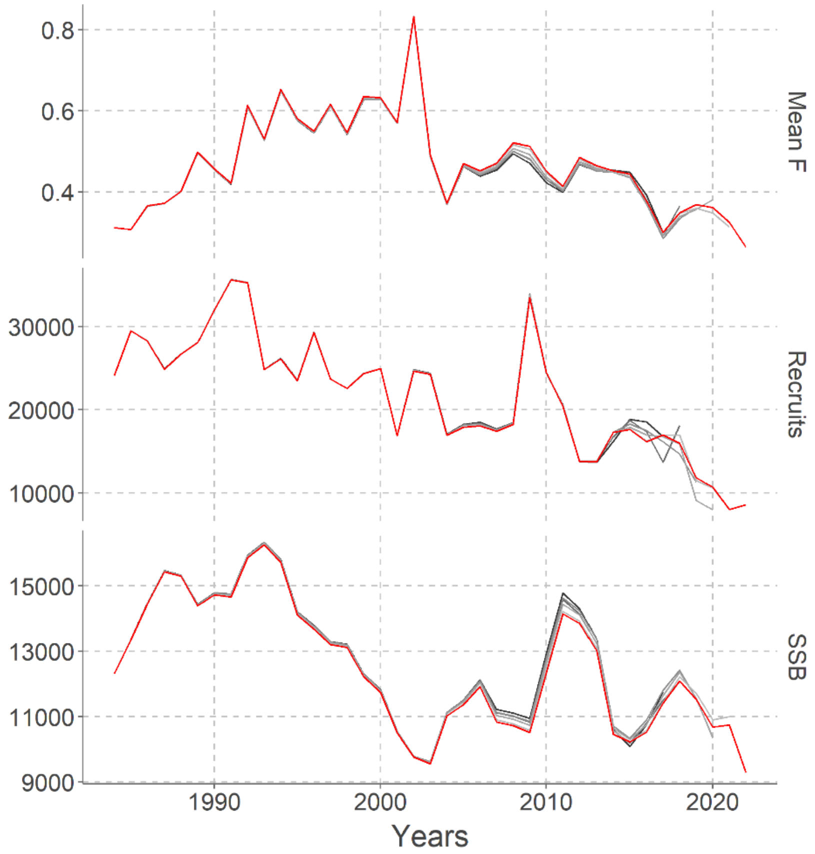

Figure 19: Retrospective results (No taper, q indep. stock size all ages, q indep. of age>=6, shr.=1.5) for the model without 2022 BTS-VIII survey.

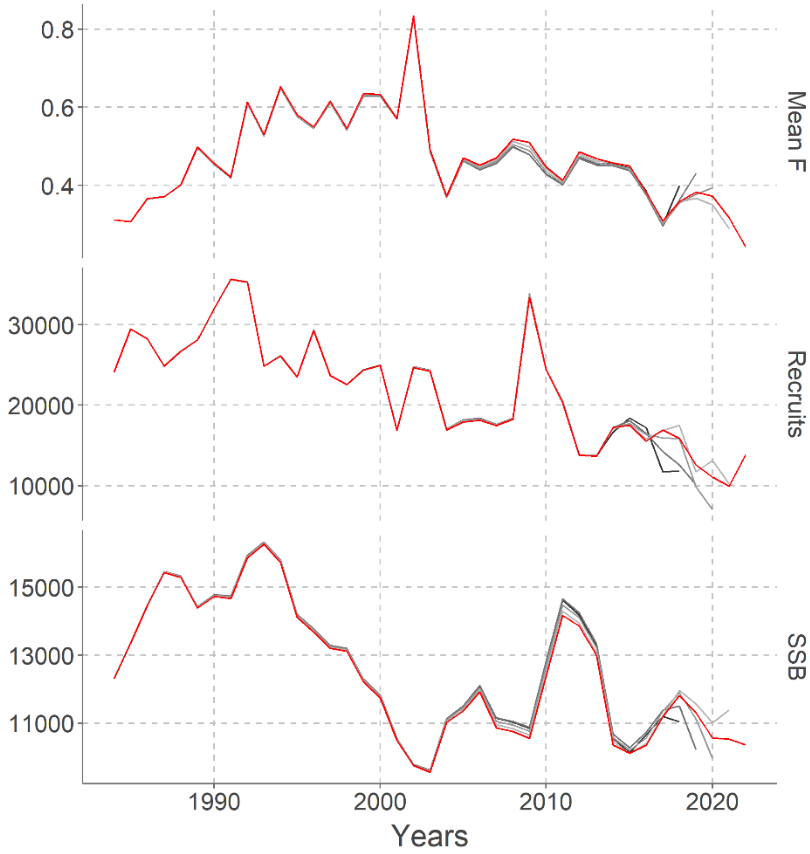

Figure 20: Retrospective results (No taper, q indep. stock size all ages, q indep. of age>=6, shr.=1.5) for the model with split BTS-VIII surveys.

4.1.2 Short term forecast and advice

The short-term forecast was performed using the same assumptions for each model (Table 11 and Table 12). Values used in both short-term forecasts are not the same because SSB and recruitment of each model fits are different (Figure 17). Figure 21 shows the comparison of short-term forecast outputs for EU MAP basis for both models. Using the model using split BTS-VIII survey lead to better projection in terms of SSB and catch. The main reasons are the difference in SSB and recruitment estimated in both models : the model using split BTS-VIII survey estimates larger SSB and recruitment value than the model without 2022 BTS-VIII survey.

***Table 11:** 2023 advice table without 2022 BTS-VIII survey.*

Variables	Values	Notes
Fage 3–6 (2023)	0.26	Average selection pattern from 2020 to 2022 scaled to the F of 2022.
SSB (2024)	9,405.00	Short-term forecast (STF); in tonnes.
R_{age2} (2023–2024)	10,038.00	Geometric mean (2019–2021); in thousands.
Projected landings (2023)	2,190.00	Short-term forecast; average landing rate of 2020–2022; in tonnes.
Projected discards (2023)	48.00	Computed using the average discard ratio (2.2%) over 2015–2022 but not used in the assessment; in tonnes.

***Table 12:** 2023 advice table with split BTS-VIII survey.*

Variables	Values	Notes
Fage 3–6 (2023)	0.24	TAC constraints because of the reduction of the TAC in ,2023 leading of an F lower than the F Statu-quo (F2021 = 0.31).
SSB (2024)	10,645.00	Assessment forecast; in tonnes.
R_{age2} (2023–2024)	11,138.00	Geometric mean (2016–2022); in thousands.
Projected landings (2023)	2,285.00	Short-term forecast; average landing rate of 2015–2022; in tonnes.
Projected discards (2023)	50.00	Computed using the average discard ratio (2.2%) over 2015–2022 but not used in the assessment; in tonnes.

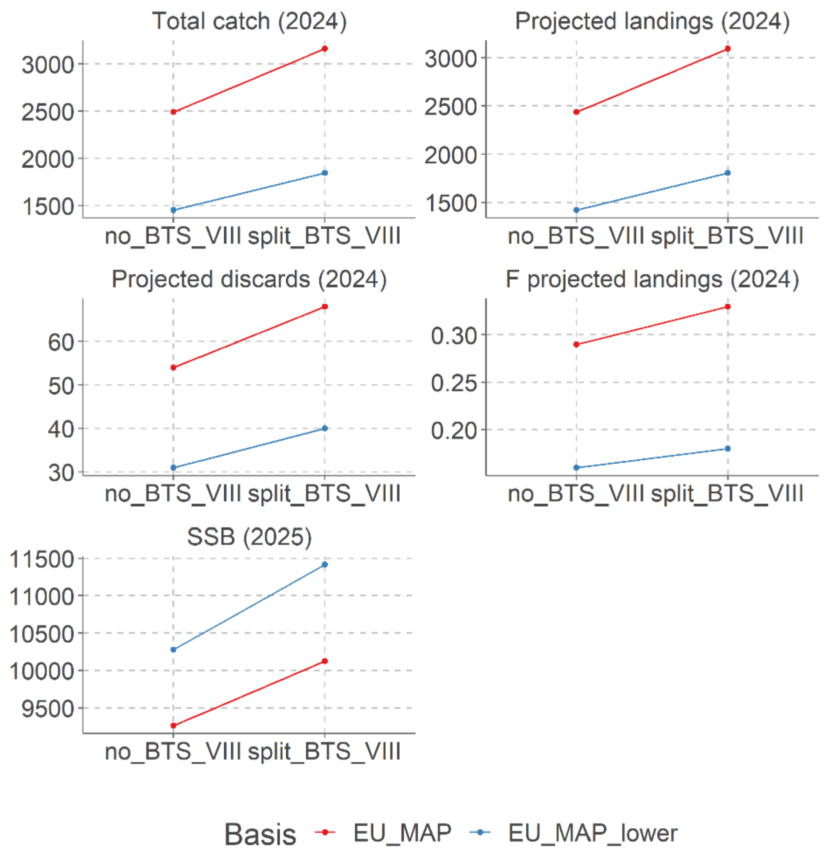

Figure 21: Comparison of short-term forecast outputs for EU MAP basis for models using 2022 BTS-VIII survey (no_BTS_VIII) and with two BTS-VIII survey index (split_BTS_VIII).

Working Document presented to the Working Group the Bay of Biscay and the Iberian Waters Ecoregion
ICES WGBIE, Copenhagen, Denmark, 3rd - 11th May 2023

Pollack in ICES subarea 8 and division 9a: results from the WKBMSYSPICT-2 benchmark and proposal of length-based assessment and HCR Category 3 for providing advice in 2023

Paz Sampedro[1], Youen Vermard[2], Fanny Ouzoulias[2]

ABSTRACT

The pollack stock pol.27.89a was benchmarked in January 2023 at the WKBMSYSPICT-2. New information was compiled and evaluated during the benchmark in order to fit a SPiCT model assessment. Despite the multiple SPiCT exploratory runs performed, using different priors and input data, the conclusion was that the model had not enough information from the input data to fit a robust model. The lack of contrast in the catch time series and the short abundance index available avoid a good fit of the SPiCT models. The benchmark made available a standardized commercial abundance index (FRANCE_GNS) for the stock, a times series of length composition of landings and life history parameters. Following the ICES guidelines for assessment and HCR for stock category 2 and 3, a length based assessment and HCR method *rfb* can be applied to provide advice for pol.89a in 2023.

1. Introduction

The Bay of Biscay and Atlantic Iberian Waters pollack stock is considered as data-limited stock (DLS) and is classified as category 5.2 stock (ICES, 2012). This stock was benchmarked in 2021 (WKBMSYSPiCT; ICES, 2021). Due to the short time-series of the abundance index and to the gap of contrast in the input data, it was not possible to fit an acceptable assessment model with the SPiCT framework (Pederson and Berg, 2017). Hence, the stock remains in ICES category 5 (ICES, 2022). The WGBIE2022 proposed and supports that the stock goes through a benchmark in 2023 to evaluate recent available data and information, which may be sufficient to allow an assessment of the stock.

For the WKBMSYSPICT2 (ICES, 2023) the following information was made available: the time series of landings (1979-2021), an standardized commercial abundance index FRANCE_GNS (2000-09; 2010-2021), life history parameters and length composition of landings (2010-21). This information was evaluated in order to apply a stochastic production model in continuous time (SPiCT) (Pedersen and Berg, 2007). The exploratory SPiCT runs indicated that the available time series of commercial landings is lack of contrast, especially in the last 20 years, making very complicate to achieve a good fit of a SPiCT model. Besides, the unavailability of a fishery-independent abundance index increases the difficulty of fitting a SPiCT model.

With the available information of the stock (length composition of landings, an abundance index and life history parameters) is possible to apply length based assessment methods for pol.89a. Therefore, the ICES technical guidelines for harvest control rules and stock assessment in categories 2 and 3 (ICES, 2022a) indicates that the method 2.1. the *rfb* rule is appropriate for this stock.

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2. Results from benchmark WKBMSYSPICT2

2.1 Compiled information

The available data of commercial landings, as estimated by the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (ICES, 2022b), extends from 1979 to 2021. There is a missing value in the series for France in 1999. In order to complete the series and used it as input for the assessment, a value for total landings was calculated as the average of the previous and next year of total landings, resulting in 1322 t. Also, because of the high uncertainty regarding to the Spanish landings in 1985, a higher uncertainty on the catch series (six times higher) was set in 1985 in the SPiCT assessment. Historical data base, FAO, EUROSTAT and ICES database, were explored trying to extend back the time series of commercial landings. The results show that before 1950 the reported landings were anecdotal and discontinuous and they cannot be used for SPiCT assessment.

Although it is known that the recreational catches may be considerable, they have not been quantified (Radford et al. 2018). For this reason, it was decided to only consider commercial landings to perform the assessment.

Pollack abundance indices resulted negligible or zero in the groundfish surveys carried out in the distribution area: EVHOE, SP-NSGFS and PT-IBTS. The bottoms preferred for this species (wrecks and rocky bottoms) makes that trawl surveys are not well suited for monitoring this species.

Standardized commercial abundance index

Because of the very low or null number of individuals of pollack observed in the fishery-independent surveys in the distribution area of the stock (EVHOE, SGFS, PTGFS), it can provide a reliable biomass index for pol.27.89a. Therefore, fishery-dependent data had to be used to provide an index of exploitable biomass for this stock.

A commercial abundance index was provided using the French bottom-sets gillnetters (GNS) fleet, which represents 47% of the French landings for pollack. The vessels included in the fleet were selected applying two filters, vessels with a minimum of 5 years of positive pollack catches that the vessels and have been catching a minimum of 500 kg of pollack per year. The French database changed in 2009, which led to a change in the repositories of the effort. All declarative variables were impacted by this change in the database. Therefore, the data were cut in two series: from 2000 to 2009 and from 2010 to 2021.

Catches were normalized into relative proportions by weight and square-root transformed (Winker, 2013). Principal component scores derived from a Principal Component Analysis (PCA) of the catch data where used as predictor variable in the Generalized Additive Model (GAM) framework. PCs that had an eigenvalue higher than 1, in our case they were four PCs (RS1, RS2, RS3 and RS4).

The models fitting CPUE records was a GAM with a Tweedie distribution, which takes into account high frequencies of zeros in the data. A cyclic-cubic regression spline was chosen to smooth the month predictor, while smoothing of other continuous variables was realized by thin plate regression spline functions. There is a random effect on vessels. Characteristics of vessels (in term of vessel length) is also included in the model. Effort was estimated using vessel time at sea and is used as an offset in the model.

The final GAM model equation was as follows:

$$pollack\_weight \sim offset\ (\log(time_{sea})) + \ as.factor(year) + s(month, bs = \text{cc}, k = 12) + s(carre.lon, carre.lat, k = 20) + \ s(vessel_{id}, bs = \text{"re"} + s(rs1) + s(rs2) + s(rs3) + s(rs4) + as.factor(vessel_{length})$$

Where s() is spline smoothing; pollack_weight are the landings of pollack; time_sea is the effort in days; year is the year time; month is the month time; lon, lat are the coordinates; vessel_id is the vessel identificator; vessel length is the length of the vessel and rs1-4 are the PC scores.

In order to compare the influence of adding the covariates on the predictions the next five models were tested:

1. **base**: $pollack_{weight} \sim offset\ (\log(time_{sea})) + \ as.factor(year) + s(vessel_{id}, bs = \text{"re"})$
2. **mois**:

   $pollack_{weight} \sim offset\ (\log(time_{sea})) + \ as.factor(year) + s(month, bs = \text{"cc", k=12}) + \ s(vessel_{id}, bs = \text{"re"})$
3. **space**: $pollack_{weight} \sim offset\ (\log(time_{sea})) + \ as.factor(year) + s(month, bs = \text{"cc", k=12}) + \ s(vessel_{id}, bs = \text{"re"})$ + s(carre.lon, carre.lat, k=20)
4. **carac**:

   $$pollack_{weight} \sim offset\ (\log(time_{sea})) + \ as.factor(year) + s(month, bs = \text{"cc"}, \text{k} = 12) + \ s(vessel_{id}, bs = \text{"re"}) + s(carre.lon, carre.lat, k = 20) + as.factor(vessel\_length)$$
5. **tot**:

   $$pollack_{weight} \sim offset\ (\log(time_{sea})) + \ as.factor(year) + s(month, bs = \text{"cc"}, \text{k} = 12) + \ s(vessel_{id}, bs = \text{"re"}) + s(carre.lon, carre.lat, k = 20) + s(rs1) + \ s(rs2) + s(rs3) + s(rs4) + \ as.factor(vessel\_length)$$

Predictions were made for the five GAM models and with the two periods of the series: 2000-09 and 2010-21 (Figure 1). For visualizing all CPUEs are standardized by its mean.

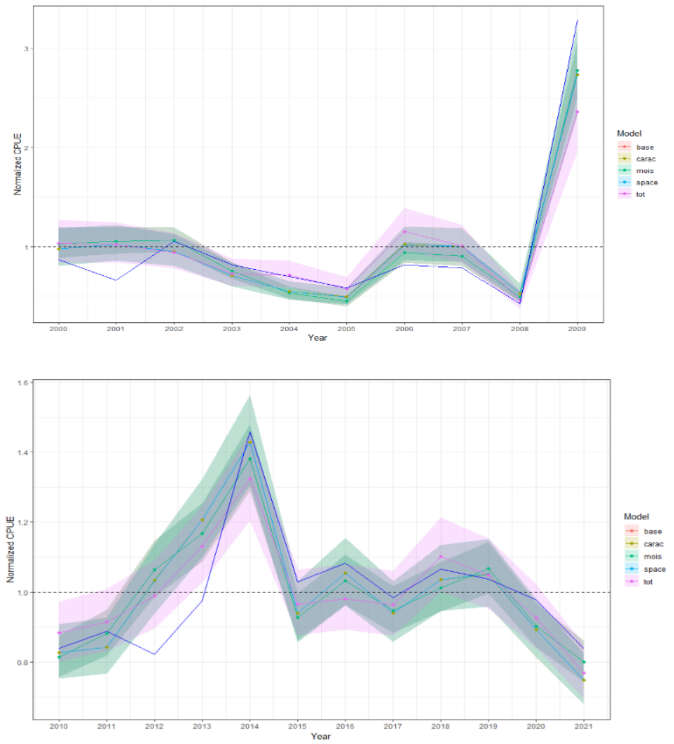

Figure 1. Normalized CPUEs estimated from the 5 GAM models tested and nominal CPUE (blue line). The two periods of the abundance index are separately represented: 2000-09 (up) and 2010-21 (bottom).

The final standardized CPUEs used in the SPiCT model are presented in Table 1.

Table 1. Normalized predictions of the GAM model used in the SPiCT assessment of pol.27.89a.

Year	Prediction	Year	Prediction
2000	1.03	2011	0.92
2001	1.02	2012	0.99
2002	0.94	2013	1.13
2003	0.73	2014	1.32
2004	0.71	2015	0.97
2005	0.57	2016	0.98
2006	1.15	2017	0.96
2007	1.00	2018	1.10
2008	0.46	2019	1.05
2009	2.36	2020	0.93
2010	0.88	2021	0.77

Length composition of landings

Length distribution of landings is available for some métiers and quarters for France (2010–2021), Spain (2015-2021) and Portugal (2019). The métiers and quarter coverage of the length sampling has changed from year to year, and the sampling level has been extremely low for some years. These issues reduce the representativeness and the quality of the length composition of landings, although in recent years the level of sampling has improved and the quality of the length composition of landings are good. A set of length compositions of commercial landings, annual and gear-combined, for the period 2010–2021 were raised to total landings using information from ROMELIGO project (2010–2014) (ICES, 2019) and from InterCatch (2015–2021) (Figure 2).

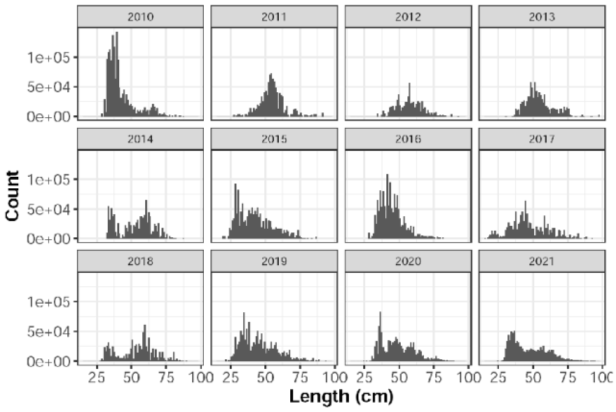

Figure 2. Annual length composition of commercial landings of pol.27.89a.

Due to time issues the quality of the length composition was not evaluated in the WKBMSYSPICT2, and the chairs recommended to be explored in the WGBIE and/or an InterBenchmark before applying a length based assessment.

Life history parameters

The available data on the biology of pollack are sparse and their availability vary among stocks and ICES subareas. Life history parameters are needed to conduct a reliable assessment, not only to incorporate the parameters in the model, but also to evaluate the plausibility of the estimated production function in production models.

The available life history information for pollack, from literature and working documents, was reviewed. The information was selected considering the quality and extension of the scientific work and the representativeness for pol.27.89a. The summary of the life history information is shown in Table 2. The von Bertalanffy growth parameters are available from a Bayesian analysis for Subarea 8 and from frequentist analysis for Subareas 6 and 7. The value of $Linf$ is estimated at 102.1 cm and 98.3 cm depending of the study. Related to maturity, the Lm both sexes together, is at 42.3 cm, corresponding to the estimates from the microscopic study carried out in division 9a (Alonso-Fernández et al. 2013), other maturity studies in Subarea 8 confirmed this value (Léauté et al. 2018). Lc and $Lmax$ were estimated in this work using the available size composition of landings for pol.27.89a. Lc was estimated at 32.5 cm, well below the Lm (43.2 cm), and $Lmax$ was equal to 97.5 cm.

Table 2. Summary of life history parameters selected to be used in the stock assessment of pol.27.89a. Source of the data and areas of study are indicated in the last two columns.

Life history parameter	Value (units)	Source	ICES Subarea/Division

L_{inf}	Asymptotic length	102.143 (cm)	Alemany (2017). Bayesian analysis.	8
		98.3 (cm)	Alemany (2017)	6.7
K	Von Bertalanffy parameter	0.193	Alemany (2017). Bayesian analysis.	8
		0.182	Alemany (2017)	6.7
t_0	Von Bertalanffy parameter	-0.682	Alemany (2017). Bayesian analysis.	8
		-0.935	Alemany (2017)	6.7
L_m	Length-at-maturity	42.3 (cm)	Alonso-Fernández et al (2013)	9a
t_m	Age-at-maturity	3.5 (year)	Léauté et al (2018)	8
L_{max}	Maximum observed length in the stock	97.5 (cm)	Estimated from length composition (2010-2021)	89a
t_{max}	Maximum age	15 (year)	Alemany (2017)	67
a	Length-weight relationship parameter	1.09e-5	Léauté et al (2018)	8
b	Length-weight relationship parameter	3.044	Léauté et al (2018)	8
Lc	Length-at-50%-capture	32.5 (cm)	Estimated from length composition (2010-2021)	8.9a

2.1 SPiCT exploratory assessment

The input data for the model were the time-series of commercial landings for years 1979–2021 and two commercial abundance indices FR-GNS for years 2000-2009 and 2010–2021 (Figure 3).

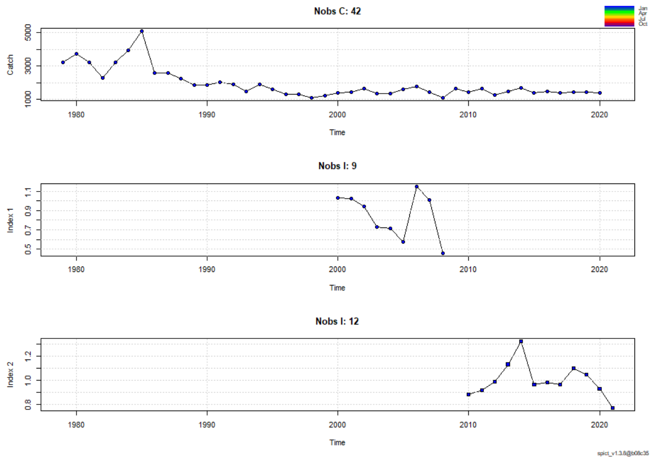

Figure 3. Input data for SPiCT.

Multiple runs were built with different priors and input data. For each of the runs, convergence, as well as diagnostic figures and retrospective plots were examined. The main problem that we encountered was the high uncertainty of the fishing mortality and the catch in the results plots. Even if diagnostics were fine in some trials, the high uncertainty could not allow estimating correctly the parameters. The results of these exploratory SPiCT assessments suggested that the model does not have enough information to estimate all parameters of the model. This is likely a result of the short length of the abundance indices used (10 + 12 years) and the lack of contrast in catch series in the overlapping period catch-CPUE.

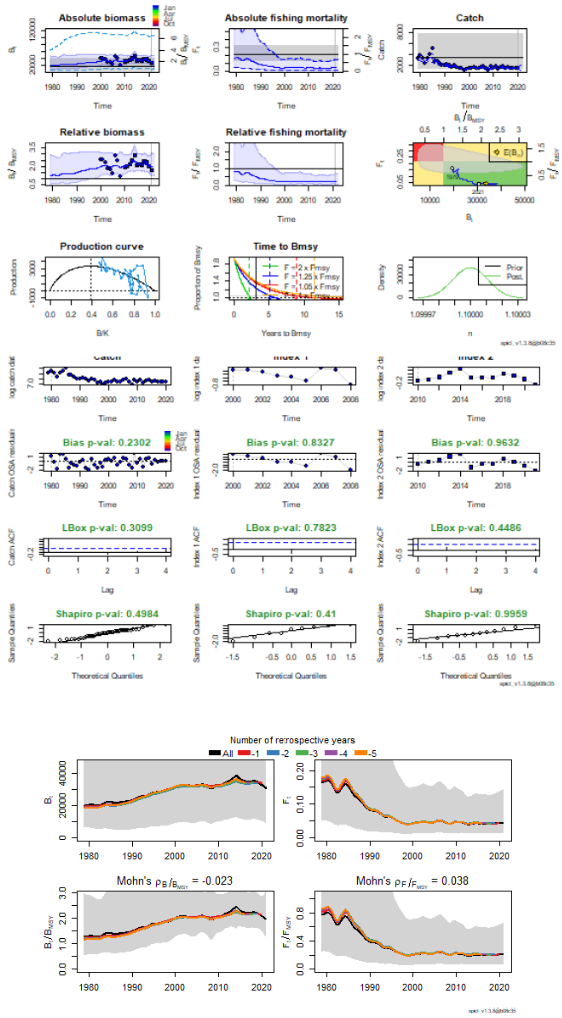

Figure 4. Main results, diagnostics and retrospective analysis for one of the exploratory Run for pol.89a in WKBMSYSPICT2.

3 Proposal of Category 3 stock: advice rules for length based approaches

As any of the proposed SPiCT models was accepted during the WKBMSYSPICT2, it was suggested to evaluate the suitability of relevant information compiled for the benchmark (length composition of landings, life history parameters and abundance index) to perform length based assessment methods (ICES, 2022a).

Following the ICES guidelines the most appropriate method based on the available information and the biology of the species (k < 0.2) is Method 2.1 *rfb* rule with the multiplier m=0.95:

The decision tree flow diagram in Figure 2 shows how to choose the appropriate method for a stock.

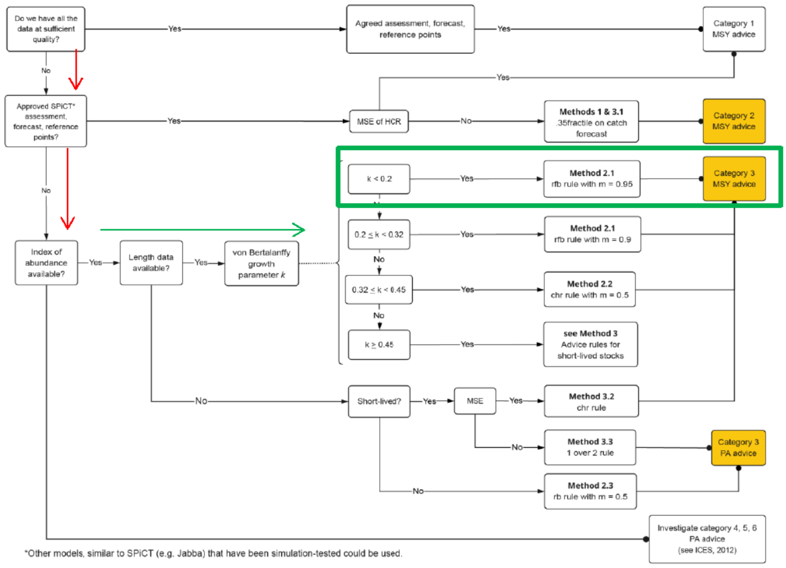

Figure 5. Decision tree flow diagram for choosing the appropriate method for pol.89a (ICES, 2022a).

Length frequency information

Length compositions of landings are available for some *metiers* from 2010 to 2022 and they were compiled from Romeligo project (2010-2014) and InterCatch (2015-22). This stock is explored by many different metiers and gears. The catchability of the main fleets (nets and longliners) are different causing a bimodal length composition of total landings in many years. The size range of gillnets catches is wider starting at 20 cm and until 90 cm. The volume of catches sampled to estimate the annual length composition has increased in recent years to be 77 % in 2022 (Table 3). Years 2015 and 2018 showed very low sampling levels and important assumptions were made to obtain the length composition of total landings of the stock.

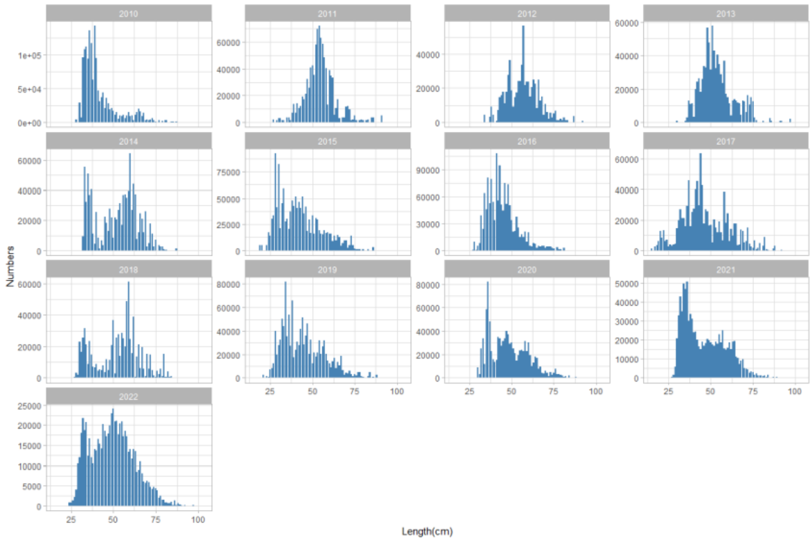

Figure 6. Annual length frequency distribution of landings of pol89a for the period 2010–2022.

Table 3. Percentage of the catch sampled for length composition.

Year	%Vol Sampled
2010	35
2011	19.6
2012	23.9
2013	27.7
2014	38.5
2015	19.2
2016	32.8
2017	34.2
2018	15.1
2019	41.1
2020	57.9
2021	66.7
2022	76.7

Lc was estimated using the available size composition of landings for pol.89a for the period 2010-22. Lc was estimated at 32.5 cm, well below the Lm (42.3 cm). The length of first capture Lc, the length at which 50% of fish is retained, was derived by fitting the length-based estimator to the available size data. Since 2017, the Lc was estimated at 32.5 cm except in year 2020.

Table 4. Length of first capture and other length based indicators for pol.89a.

Year	Lc	Linf	Lmat	Lmean
2010	32.5	98.2	42.3	42.0
2011	52.5	98.2	42.3	58.6
2012	47.5	98.2	42.3	58.7
2013	47.5	98.2	42.3	56.6
2014	32.5	98.2	42.3	52.8
2015	27.5	98.2	42.3	43.1
2016	37.5	98.2	42.3	46.4
2017	32.5	98.2	42.3	49.1
2018	32.5	98.2	42.3	53.4
2019	32.5	98.2	42.3	46.2
2020	37.5	98.2	42.3	50.2
2021	32.5	98.2	42.3	47.1
2022	32.5	98.2	42.3	50.6

Abundance Index - Standardized FRANCE_GNS LPUE series

The standardized abundance index FRANCE_GNS approved in the WKBMSYSPICT2 was updated to include the data for year 2022. The predicted values of the index indicated that the abundance has been steadily decreasing since 2013, reaching a minimum of the series in 2021, and with a slight recovery in 2022.

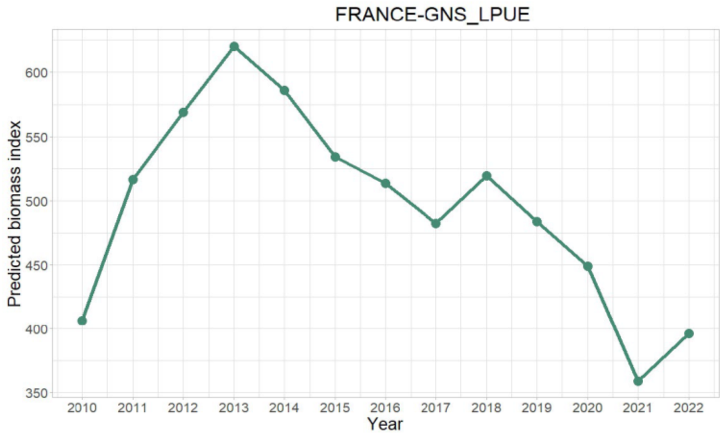

Figure 7. Standardized commercial LPUE of the French gillnet fleet in ICES area 8 for pol.89a (2010–2022).

The standardized abundance index FRANCE_GNS, estimated and approved during the WKBMSYSPICT-2, the available life history parameters and good quality of the length composition of landings in recent years constitute the information needed to perform a length based assessment and to apply the HCR Method 2.1 *rfb* defined for Category 3 stocks.

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Working Document presented to the Working Group the Bay of Biscay and the Iberian Waters Ecoregion

ICES WGBIE, Copenhagen, Denmark, 3rd - 11th May 2023

Results of most relevant commercial species on the 2022 Northern Spanish Shelf groundfish survey

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Abstract

This working document presents the results of the most relevant commercial species caught on the 2022 Spanish Groundfish Survey on Northern Spanish shelf. Biomass, geographical and length distributions are analyzed for European hake (*Merluccius merluccius*), four-spot megrim (*Lepidorhombus boscii*), megrim (*L. whiffiagonis*), black-bellied anglerfish (*Lophius budegassa*), white anglerfish (*L. piscatorius*), sole (*Solea solea*) and Norway lobster (*Nephrops norvegicus*). Information on the scarce species i.e. seabass (*Dicentrarchus labrax*), pollack (*Pollachius pollachius*) and whiting (*Merlangius merlangus*) requested in ICES DCF Data Call is also presented. The increase of the total catches this last survey is reflected in the biomass of most commercial species, except for black anglerfish, that decreased slightly. Hake and both megrims abundance reached the highest values of the time series, Anglerfishes stayed steady whereas Norway lobster reached the highest value of the last twenty years. Sole increased slightly in standard hauls. An increase of hake, black anglerfish and specially megrim recruits was found while for the white anglerfish, recruits have declined.

Introduction

The bottom trawl survey on the Northern Spanish Shelf has been carried out every autumn since 1983, except in 1987, aiming to provide data and information relevant for the assessment of the commercial fish species and the ecosystems on the Galician and Cantabrian shelf (ICES Divisions 8c and 9a North) (ICES, 2017).

The aim of this working document is to update the results (abundance indices, length frequency and geographic distribution) of the most relevant exploited species on the bottom trawl survey on the Northern Spanish Shelf, after the results presented previously (Blanco *et al*. 2021). The species analyzed in this working document are European hake (*Merluccius merluccius*), four-spot megrim (*Lepidorhombus boscii*), megrim (*Lepidorhombus whiffiagonis*), black-bellied anglerfish (*Lophius budegassa*), white anglerfish (*Lophius piscatorius*), sole (*Solea solea*), Norway lobster (*Nephrops norvegicus*), and some other scarcer species as seabass (*Dicentrarchus labrax*), pollack (*Pollachius pollachius*) and whiting (*Merlangius merlangus*).

Material and methods

The Northern Spanish Shelf groundfish survey on the Cantabrian Sea and Off Galicia (Divisions 8c and Northern part of 9a; SPNGFS) has been carried out annually since 1983 except in 1987. The area covered extends from longitude 1° W to 10° W and from latitude 42° N to 44.5° N, following the standard IBTS methodology for the western and southern areas (ICES, 2017). The sampling design is random stratified with five geographical sectors (MF. Miño-Finisterre, FE. Finisterre-Estaca de Bares, EP. Estaca de Bares- cape Peñas, PA. Peñas- cape Ajo, AB. Ajo-Bidasoa) (Figure 1, ICES, 2017). Depth stratification was changed in 1997 from 30-100 m, 101-200 m, 200-500 m to 70-120 m, 121-200 m and 201-500 to overcome the shortage of grounds shallower than 70 m that hindered the coverage of this stratum.

Nevertheless, some extra hauls are carried out every year, if possible, to cover shallower (<70 m) and deeper (>500 m) grounds. These additional hauls are plotted in the distribution maps, although they are not included in the calculations of the stratified abundance indices, since the coverage of these grounds (shallower and deeper) is not considered representative of the area. Nevertheless, the information from these depths is considered relevant due to the changes in the depth distribution of fishing activities in the area (Punzón et al. 2011), and these hauls are also used to define the depth range of the different species.

Results

This last survey 129 valid hauls were carried out, 114 of the total were standard hauls and 15 additional hauls (2 of them shallower than 70 m and 13 of them between 500 m and 930 m) (Figure 1).

Figure 2 shows the strong increase of total stratified fish catch in biomass per haul in 2022, Fish represented about 85 % of the total stratified catch, while the species considered in this Working Document represented about 7 % of the total fish catch with the following percentages per species considering only those hereby discussed: hake (40%), anglerfishes (9%), megrims (51%) and sole (less than 1%). These percentages are in line with those obtained in other years.

In 2022, the increase of the total catch was reflected in the biomass of most commercial species, which followed the upward trend, except for black anglerfish, that decreased slightly. Norway lobster reached the highest value since 2001. Sole, have increased in standard hauls and has stayed steady in additional hauls shallower than 70 m. A sharp increase of megrim recruits was found, while for hake, black anglerfish and four-spot megrim shows a modest increase and for black anglerfish recruitment has declined.

Merluccius merluccius (hake)

Biomass (9.53 ± 0.75 kg./haul) of hake increased greatly in the last survey after the downward trend of the six previous years reaching the peak of 2015. Abundance (246.30 ± 28.06 ind./haul) shows a slighter increase. Recruits (< 20cm) abundance increased significantly in 2022 (Figure 3 and 4).

Some of main biomass spots from last year for this species remained, in the easternmost part of the Cantabrian Sea, but a significant increase is noted in the whole study area and speciallyin the area located on Galician waters. Regarding recruits the main spots occurred in northern Galicia as usual, and were also present on the Rias Baixas and on the Basque grounds, as happened before 2020 (Figure 5).

The length distribution shows the usual peak of recruits, specimens from 6 to 20 cm with a clear mode in 13 cm (Figure 6). The maximum size was 94 cm this last survey, slightly smaller than the previous year.

Lepidorhombus boscii (four-spot megrim)

In 2022, the catch in biomass of *L. boscii* (6.48 ± 0.57 kg./haul) grew reaching a value similar to 2017, and staying within the higher values of the time series. Regarding abundance, it increased moderately (97.13 ± 7.89 ind./haul), it kept also being among the highest values in the time series (Figure 7).

In the survey four-spot megrim was distributed along all the study area, but the maximum biomass and abundance was found in the Finisterre-Estaca sector, as usual. An increase in recruits can be observed, especially in the central Cantabrian Sea and in the small spots of abundance of age 1 on the easternmost sector, whereas recruitment has decreased around Finisterre and the southern area of Galician waters (Figure 8).

The abundance of recruits age 0 (around 5-7 cm) and age 1 (~7-17 cm) has slightly increased this last survey, adults kept an abundance similar to that of the previous year (Figure 9, Figure 10 and Figure 11).

Lepidorhombus whiffiagonis (megrim)

L. whiffiagonis biomass (5.78 ± 0.72 kg./haul) and abundance (89.19 ± 10.78 ind./haul) has ballooned in 2022, rising to the highest values of the time series (Figure 12).

In 2022, *L. whiffiagonis* was, as usual, found mainly in the Cantabrian Sea. Age 1 recruits increased specially in the easternmost areas of the Cantabrian Sea (Figure 13),

The length distribution of *L. whiffiagonis* shows very few individuals between 6 and 9 cm, and a mode between 15 and 18 cm of recruits (age 1: ~12-23 cm) with a very high abundance, and the adults also had a higher abundance than those of the previous years (Figure 14, Figure 15). Recruitment has reached the highest values of the time series (Figure 16).

Lophius budegassa (black-bellied anglerfish)

Biomass (0.46 ± 0.08 kg./haul) of black monkfish stayed steady whereas the abundance (0.71 ± 0.11 ind./haul) increased in 2022, following the increasing trend from the last two years and surpassing the mean values from the last seven years in abundance terms (Figure 17).

Most of the specimens dwelled on the eastern part of the Cantabrian Sea, as in previous years, but some spots of biomass west of Cape Peñas and south of Finisterre appeared in 2022 (Figure 18 and Figure 19).

After the small peak of recruitment, found in 2020 compared to those in 2017-2019 mainly at the easternmost area of the Cantabrian Sea, a shy recruitment signal is still present in the area (Figure 20), a few spots of *L. budegassa* juveniles appear in this easternmost region, as it did in previous year, and some south of Finisterre.

It is remarkable the presence of individuals smaller than 13 cm, after being absent the previous year and the increase of specimens from 30 to 40 cm. The size of the largest individuals is smaller (maximum size of 75 cm) (Figure 21).

Lophius piscatorius (white anglerfish)

The biomass and abundance of *L. piscatorius* continued the raising trend from 2020 after the low values of the last seven years, showing in 2022 a peak (the highest point since 2014) in biomass (1.58 ± 0.33 kg./haul) and also observed in its abundance (0.88 ± 0.09 ind./ haul) (Figure 22).

The specimens of *L. piscatorius* were scattered throughout the study area, as usual, with bigger spots of biomass in 2022 in the central and western area of the Cantabrian sea (Figure 23 and 24)) and being absent south of Finisterre as last year. Recruits were found from northern Galicia to Cape Ajo, as usual in the time series. However, a remarkable increase, compared to previous years, is noted from Finisterre to west of Estaca de Bares (Figure 25).

Figure 26 shows a decrease of individuals between 15 and 20 cm compared to 2021, with a clear mode in 18 cm and an increase of individuals from 30 to 40 cm that could be the signal of last year recruitment, the maximum size was 109 cm.

Solea solea (sole)

The biomass and abundance of *S. solea* grew moderately in 2022 in standard hauls in contrast to the shallowest depth strata (Figure 27). This year the traditional biggest spot of biomass found in a special shallow haul west of Cape Peñas (Figures 28, 29 and 30) was smaller. Abundance of all specimens has increased in comparison with the previous year but is remarkable the presence of individuals smaller than 30 cm, the maximum size was 46 cm this last survey (Figure 31) in standard hauls.

Nephrops norvegicus (Norway lobster)

The biomass and abundance of this scarce commercial crustacean rose up in 2022 from the extremely low abundances observed in the last two decades (Figure 32). Observing the evolution in biomass and abundance by Functional Units (FU) a complete absence in FU -26 (geographical sector Miño-Finisterre) is appreciated, while both FU -25 (geographical sector Finisterre-Estaca) and FU -31 (geographical sectors Peñas-Ajo and Ajo- Bidasoa) show a sharp increase (Figure 33 and Figure 34).

The biggest spot of biomass was found in the westernmost part of the Cantabrian Sea (Figure 35) in a 433 m deep haul with 214 specimens from 22 to 56 mm, followed by a haul in Central part with 38 bigger specimens from 28 to 73 mm. In addition, *N. norvegicus* was found in deeper hauls (>500 m), where the biomass and abundance were also low in the last eighteen years. In 2022, *N. norvegicus* was found in 3 hauls deeper than 500 m of a total of 12 hauls. Length distribution shows an increase of individuals of all sizes with a clear mode in 28 mm, and a length range between 16 and 73 mm. (Figure 36 and Figure 37).

Other scarce commercial species: *Dicentrarchus labrax* (seabass), *Pollachius pollachius* (pollack) and *Merlangius merlangus* (whiting)

These three species are uncommon in the study area, or at least on the grounds surveyed, since seabass could be found in shallower and rocky grounds not well covered in the survey. Only one specimen of *D. labrax* was found in a haul at 40 m depth in 2022. *P. pollachius* has not been found since 2010 and *M. merlangus* was only found in 1990. Most of the biomass of *D. labrax* has been usually found in additional shallower hauls in the Cantabrian Sea (Figure 38), while biomass of *P. pollachius* was not (Figure 39).

Acknowledgements

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Figures

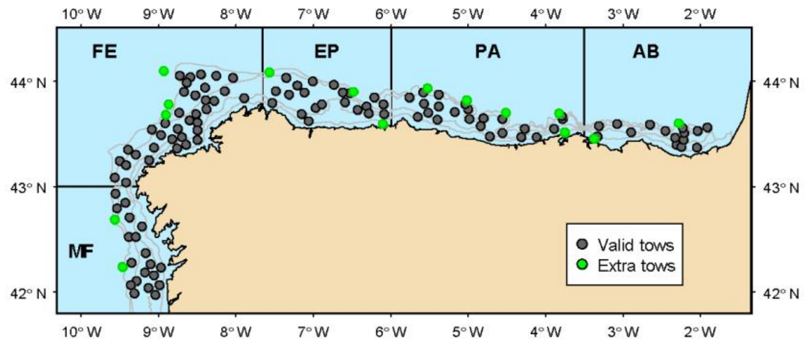

Figure 1 Stratification design and hauls carried out on the Northern Spanish shelf groundfish survey in 2022; Depth strata are: A) 70-120 m, B) 121 – 200 m and C) 200 – 500 m. Geographic sectors are MF: Miño-Finisterre, FE: Finisterre-Estaca, EP: Estaca-cape Peñas, PA: Peñas-cape Ajo, and AB: Ajo-Bidasoa. Green dots are hauls out of the standard stratification.

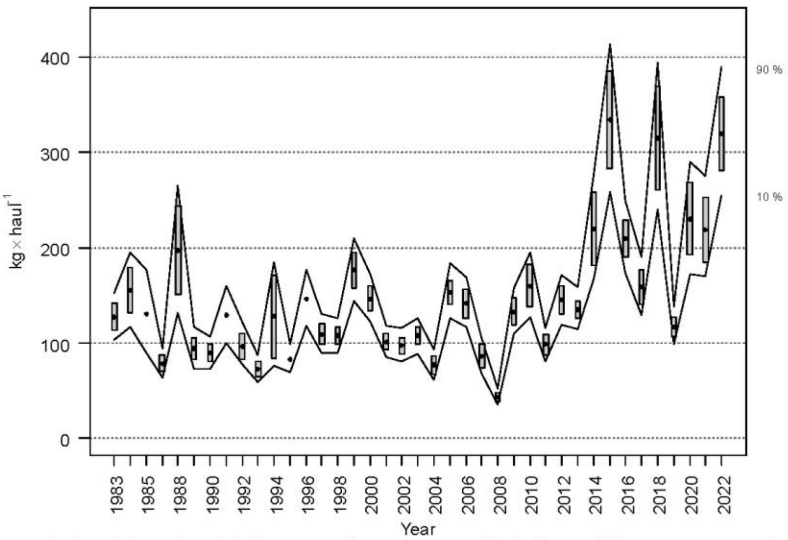

Figure 2 Evolution of the total catch in biomass on the Northern Spanish shelf groundfish survey. only standard hauls (>70 m & <500 m considered within the standard sampling stratified to the area.

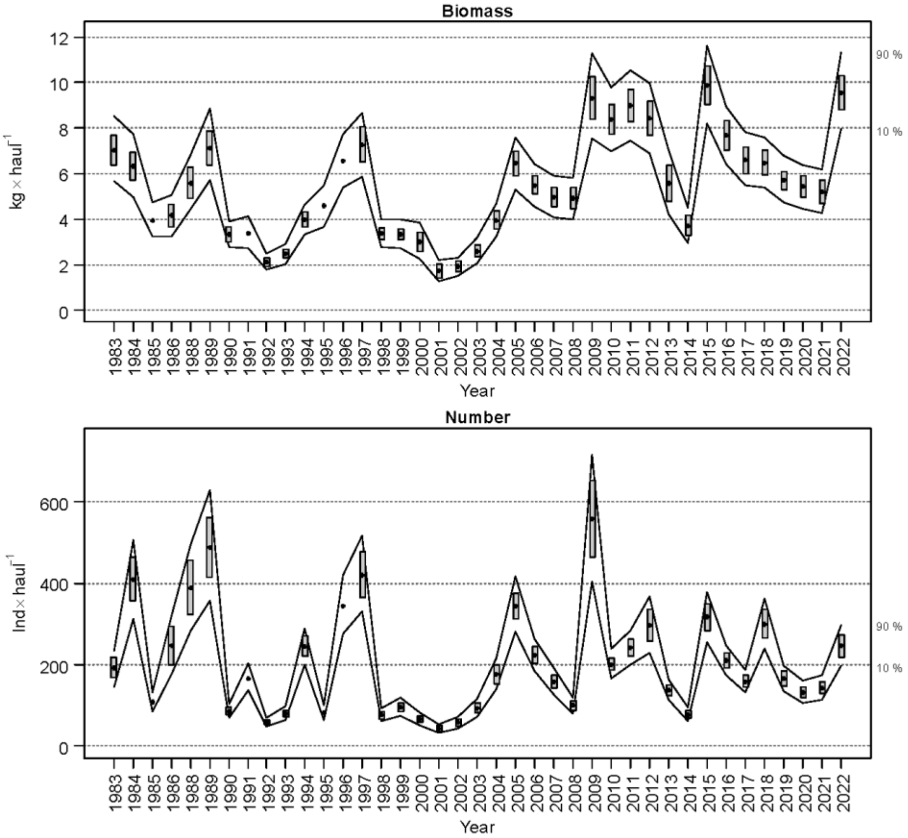

Figure 3 Evolution of *Merluccius merluccius* biomass and abundance indices on the North Spanish shelf bottom trawl survey time series (1983-2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

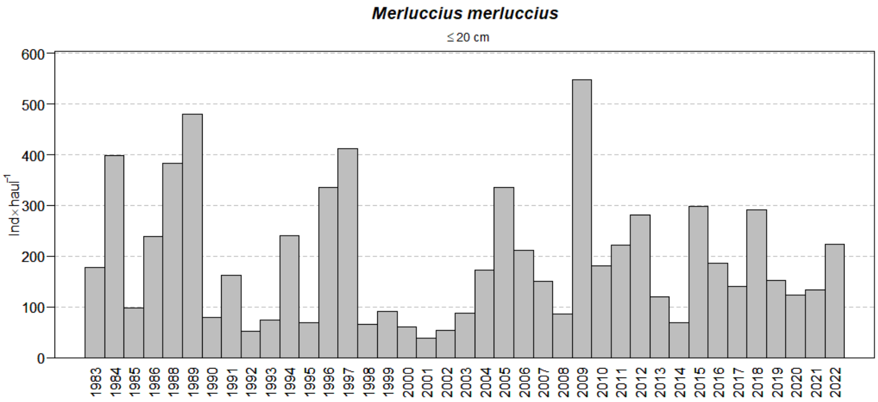

Figure 4 Mean stratified abundance of *Merluccius merluccius* recruits (0-20 cm) in North Spanish shelf bottom trawl survey (1983-2022)

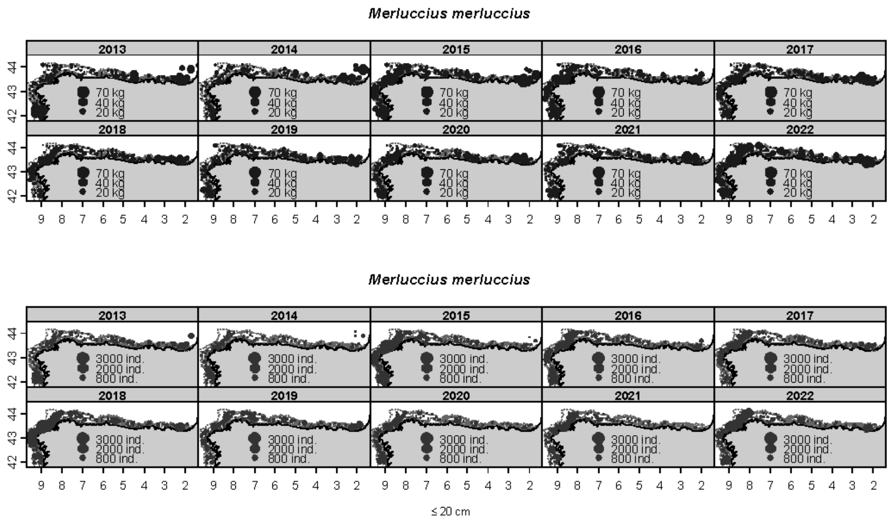

Figure 5 Geographic distribution of *Merluccius merluccius* catches (kg×30 min haul-1) and recruits (0-20 cm) in numbers on the Northern Spanish Shelf groundfish survey (2013-2022)

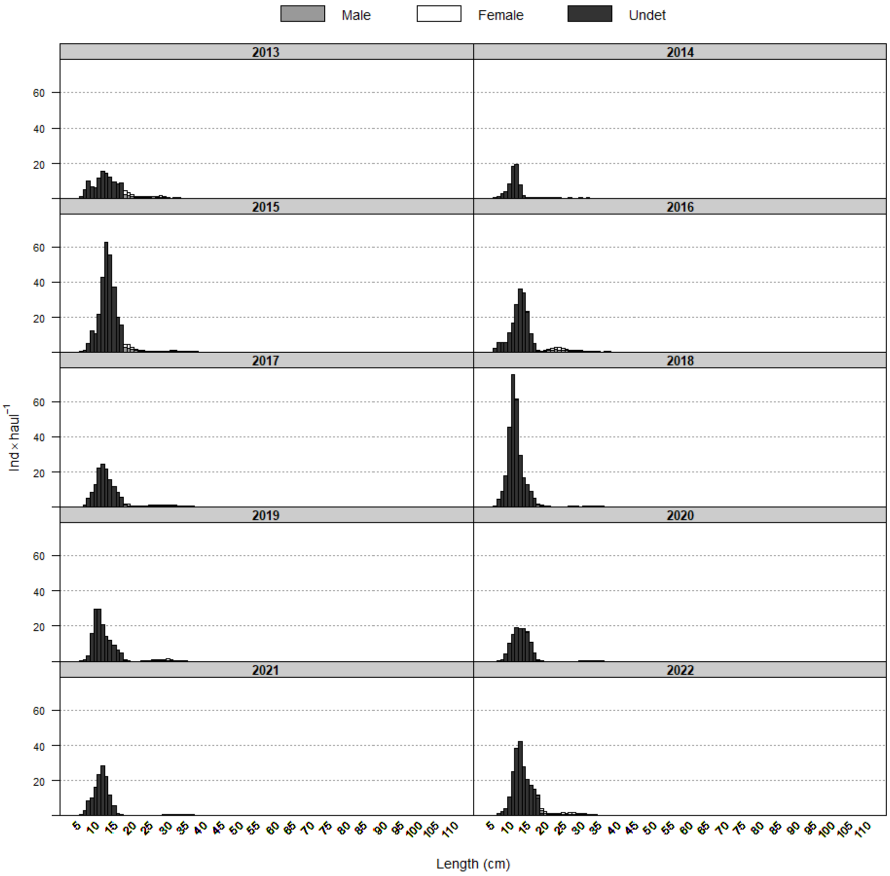

Figure 6 Mean stratified length distributions of *Merluccius merluccius* on the Northern Spanish Shelf Groundfish Survey (2013-2022)

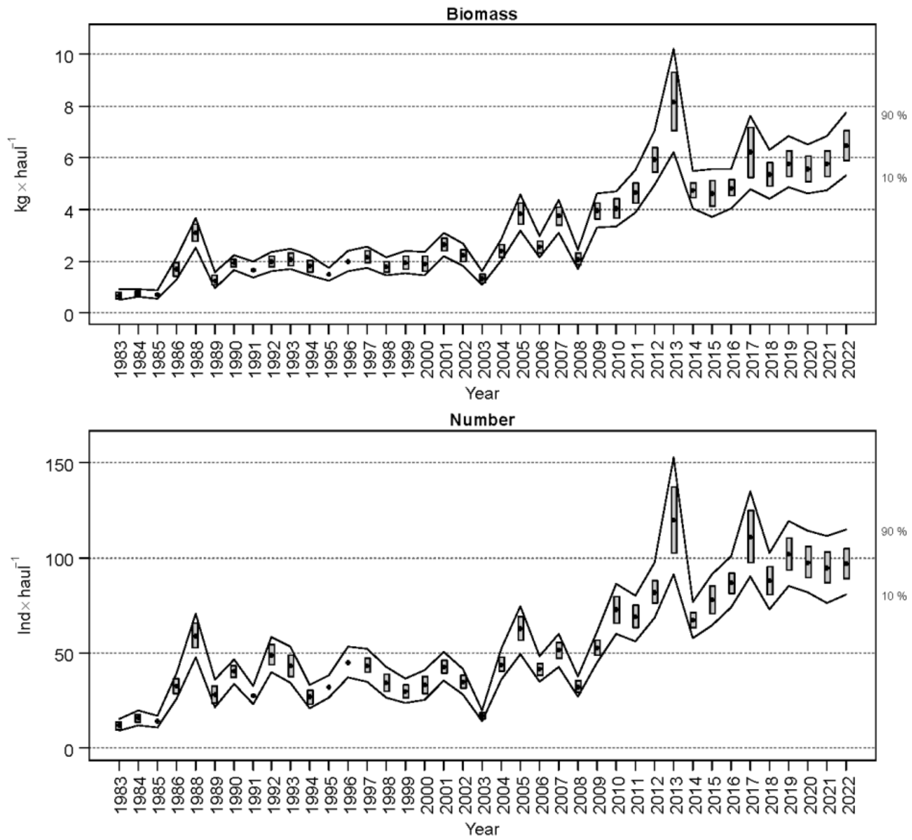

Figure 7 Evolution of *Lepidorhombus boscii* biomass and abundance indices in the North Spanish shelf bottom trawl survey time series (1983-2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

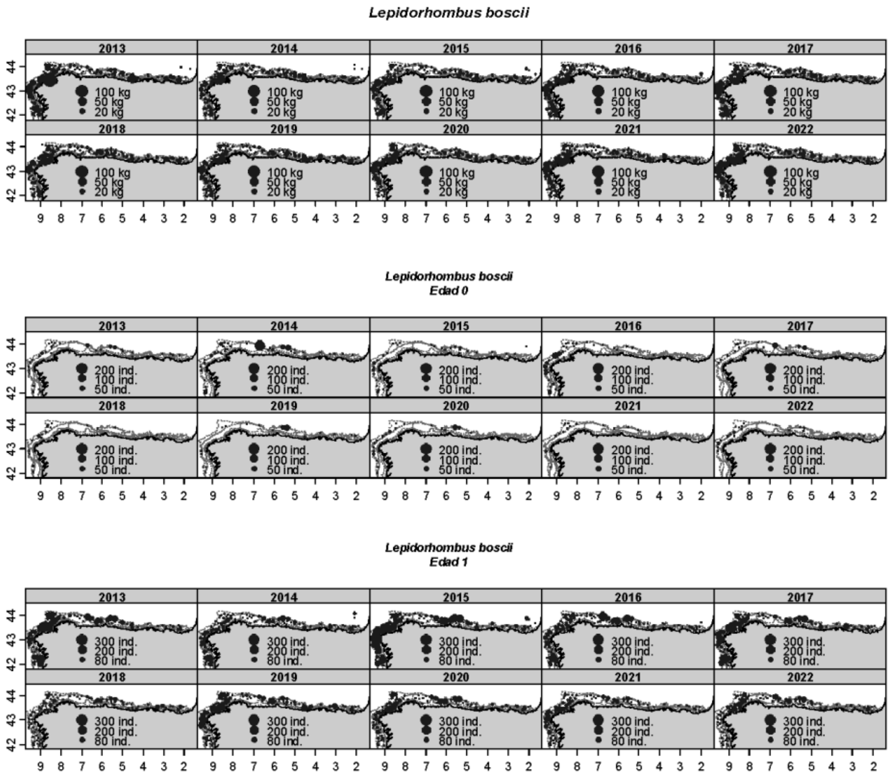

Figure 8 Geographic distribution of *Lepidorhombus boscii* biomass (kg×30 min haul-1) and recruits in number (ages 0 and 1) in the Northern Spanish Shelf groundfish survey (2013-2022)

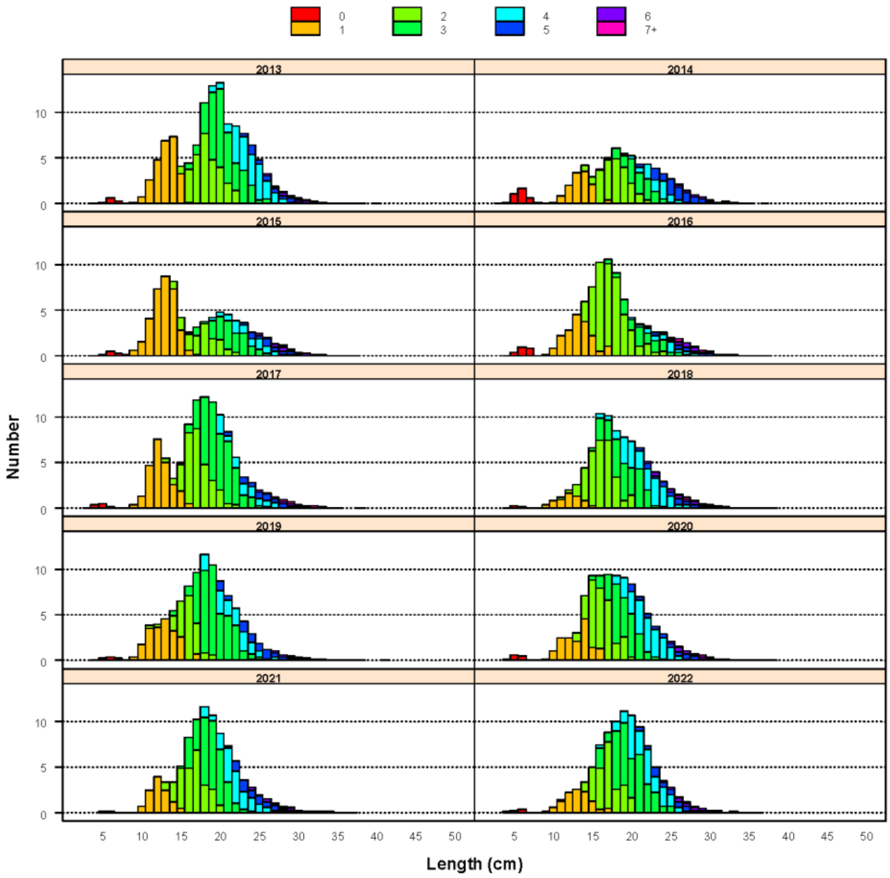

Figure 9 Mean stratified length distributions of *Lepidorhombus boscii* with the age classes in the Northern Spanish Shelf groundfish survey during last decade (2013-2022)

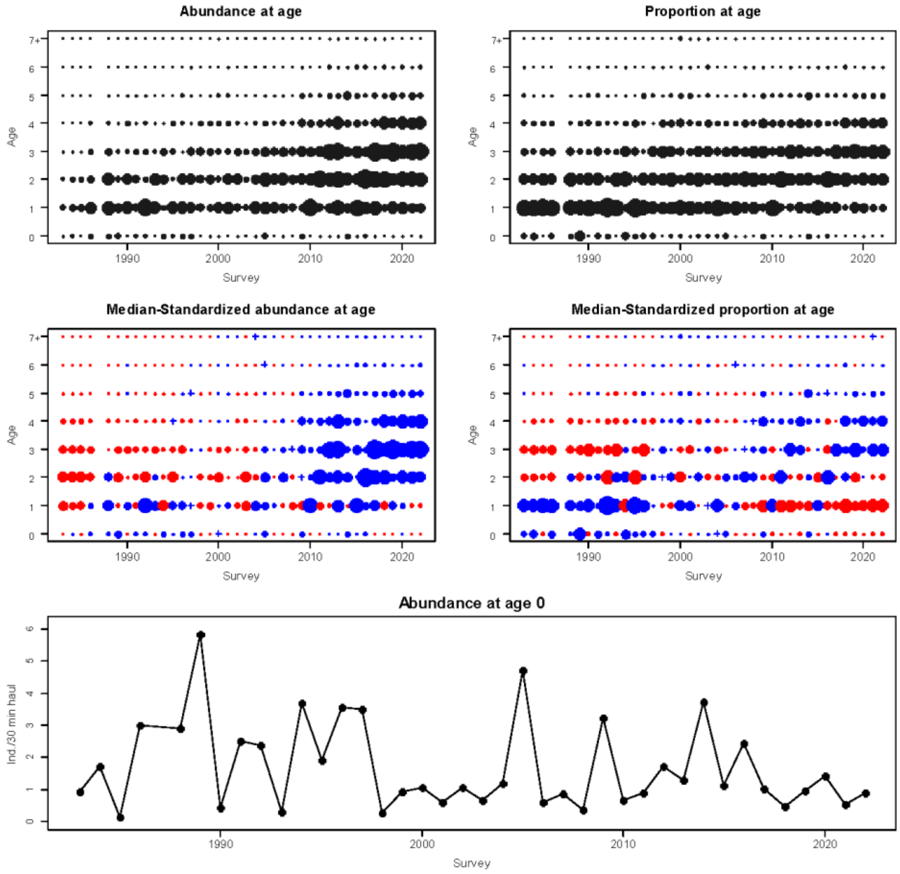

Figure 10 Bubble plot of *Lepidorhombus boscii* abundances at age, proportion at age and standardized abundances at age 0 ((year-mean years)/dev years) and proportion at age.

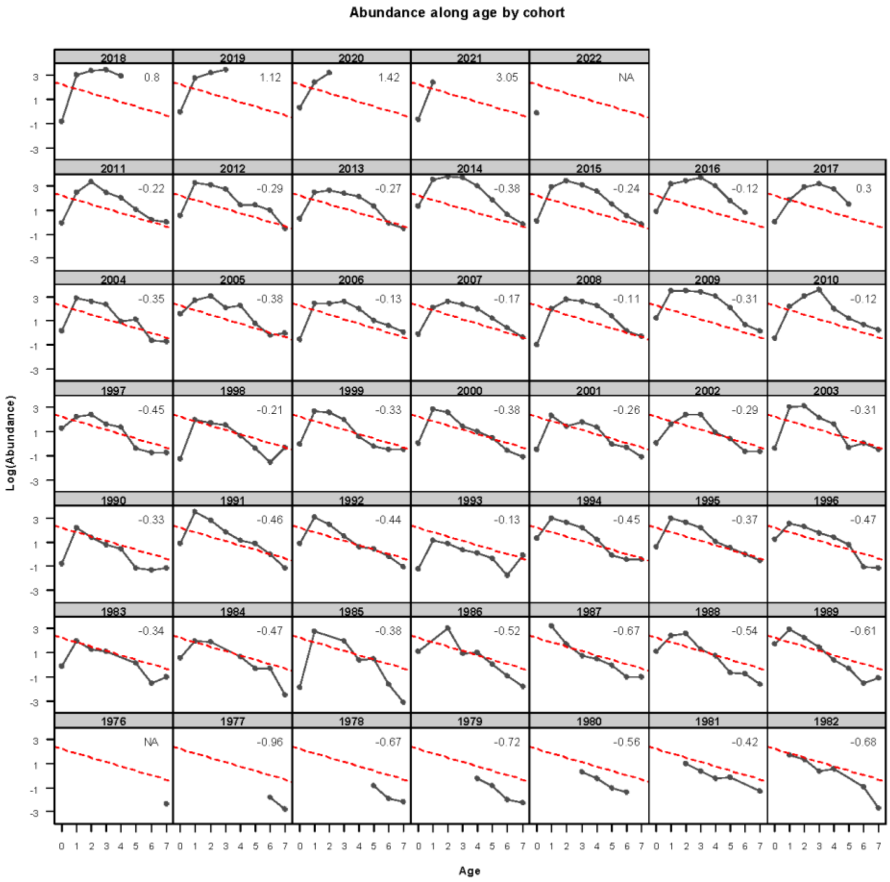

Figure 11 *Lepidorhombus boscii* abundance (No./30 min haul) evolution in logarithmic scale along each cohort sampled in North Spanish Shelf surveys time series. Solid lines mark the linear regression fitted by cohort to the log(abundance)~age; the figure in the lower right corner of each panel corresponds to the slope. Dashed line marks the linear regression fitted to the overall time series.

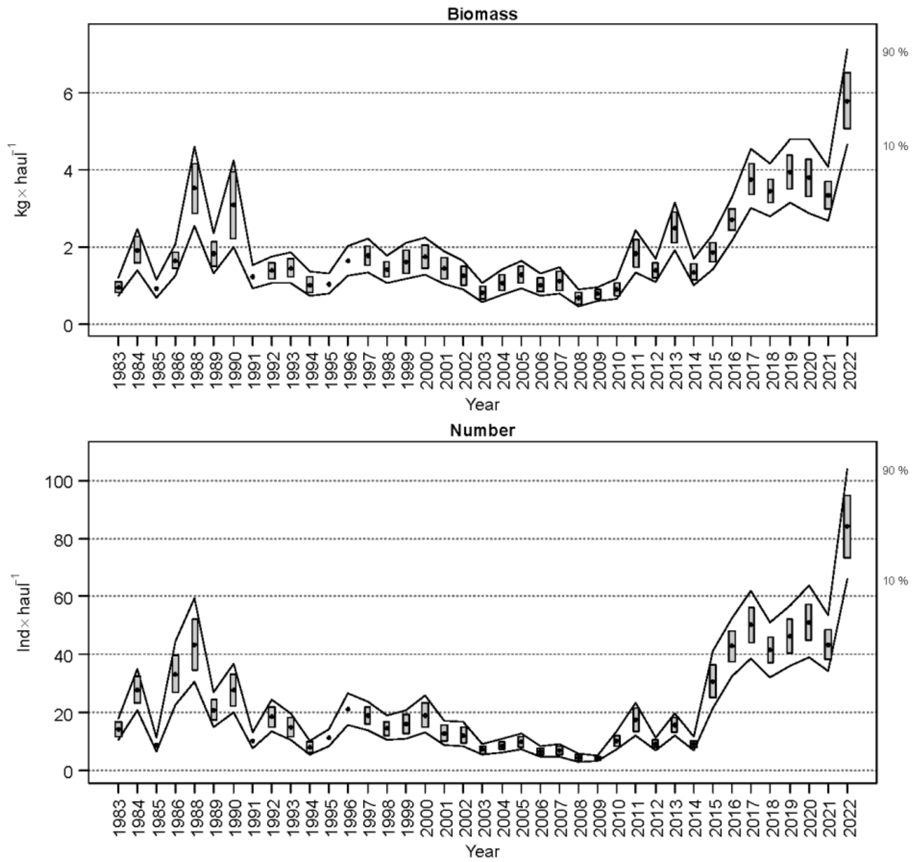

Figure 12 Evolution of *Lepidorhombus whiffiagonis* biomass and abundance indices in the North Spanish shelf bottom trawl survey time series (1983-2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

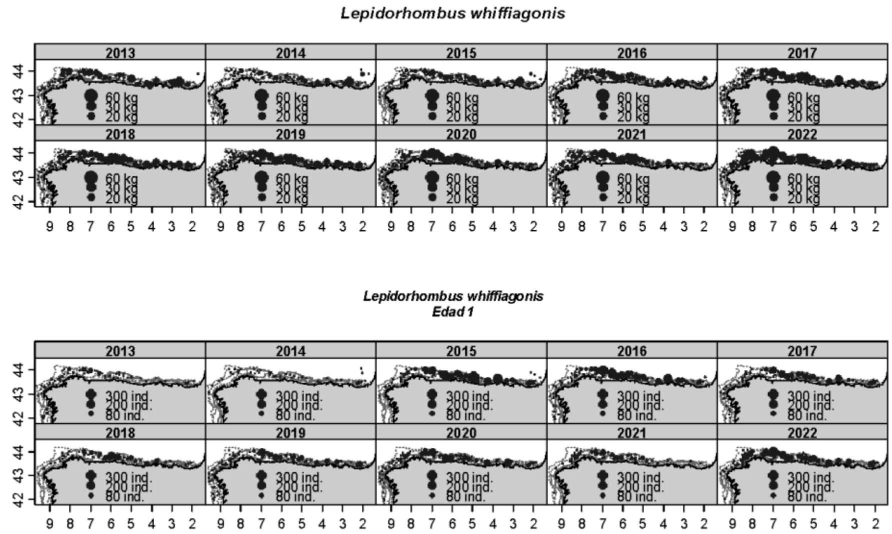

Figure 13 Geographic distribution of *Lepidorhombus whiffiagonis* biomasss (kg×30 min haul-1) and number of recruits (age 1) in the Northern Spanish Shelf groundfish survey (2013-2022)

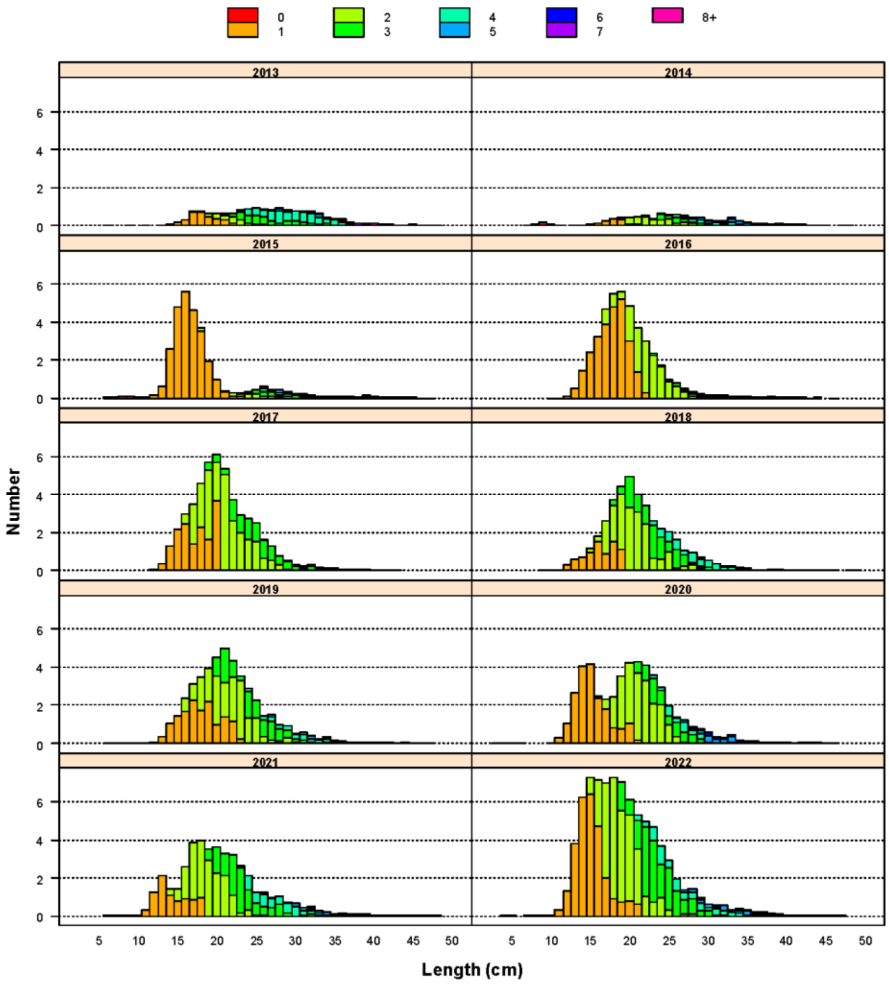

Figure 14 Mean stratified length distributions of *Lepidorhombus whiffiagonis* with the age classes in the Northern Spanish Shelf groundfish Survey (2013-2022)

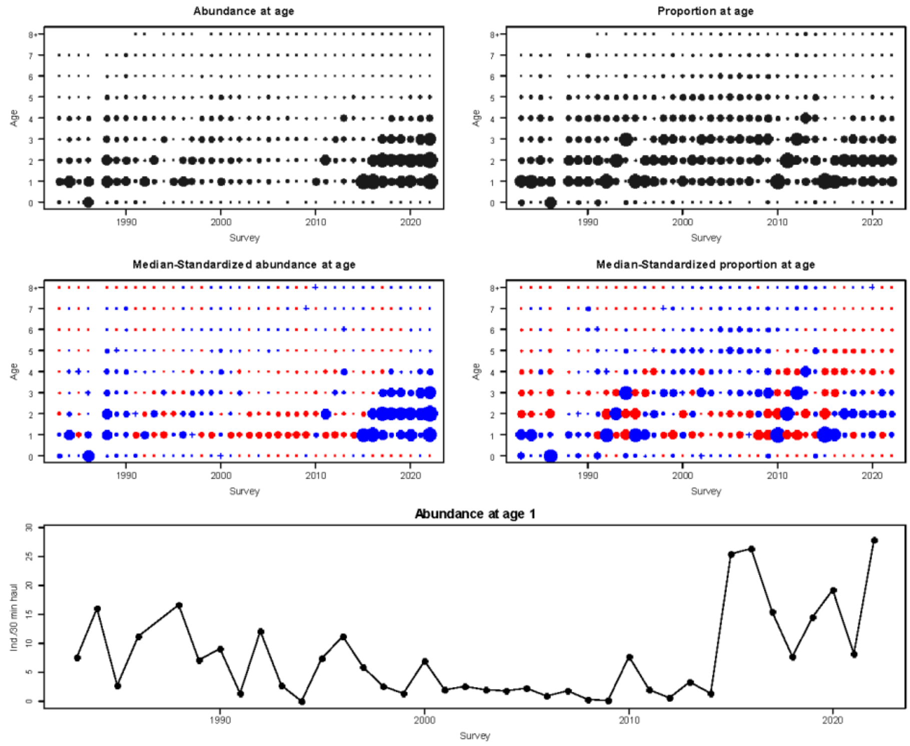

Figure 15 Bubble plot of *Lepidorhombus whiffiagonis* abundances at age, proportion at age and standardized abundances at age 1((year-mean years)/dev years) proportion at age and evolution of recruitment (age 1).

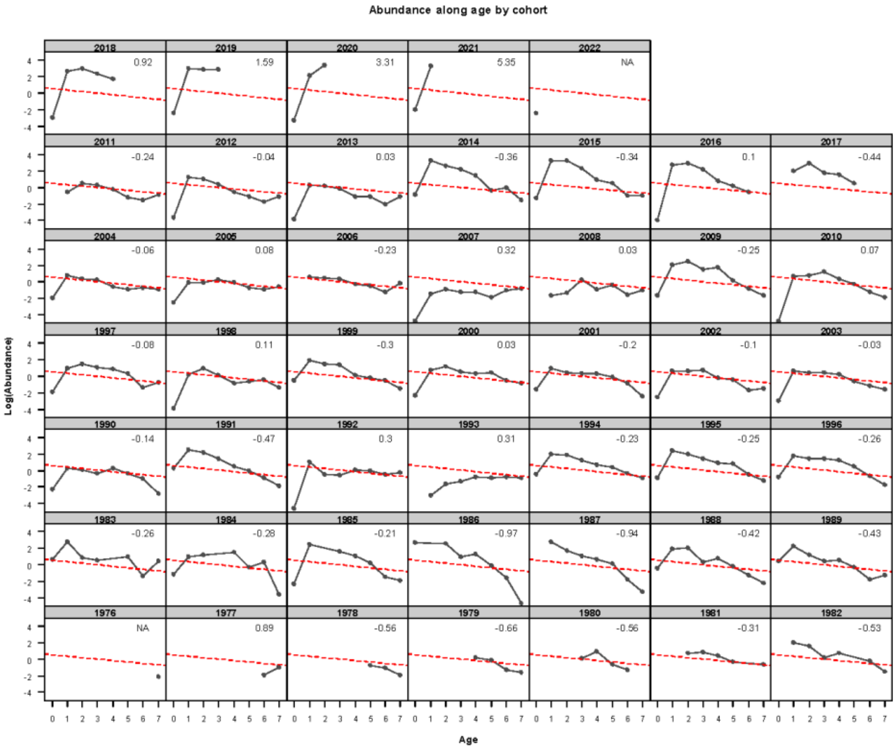

Figure 16 *Lepidorhombus whiffiagonis* abundance (No./30 min haul) evolution in logarithmic scale along each cohort sampled in North Spanish Shelf surveys time series. Solid lines mark the linear regression fitted by cohort to the log(abundance)~age; the figure in the lower right corner of each panel corresponds to the slope. Dashed line marks the linear regression fitted to the overall time series.

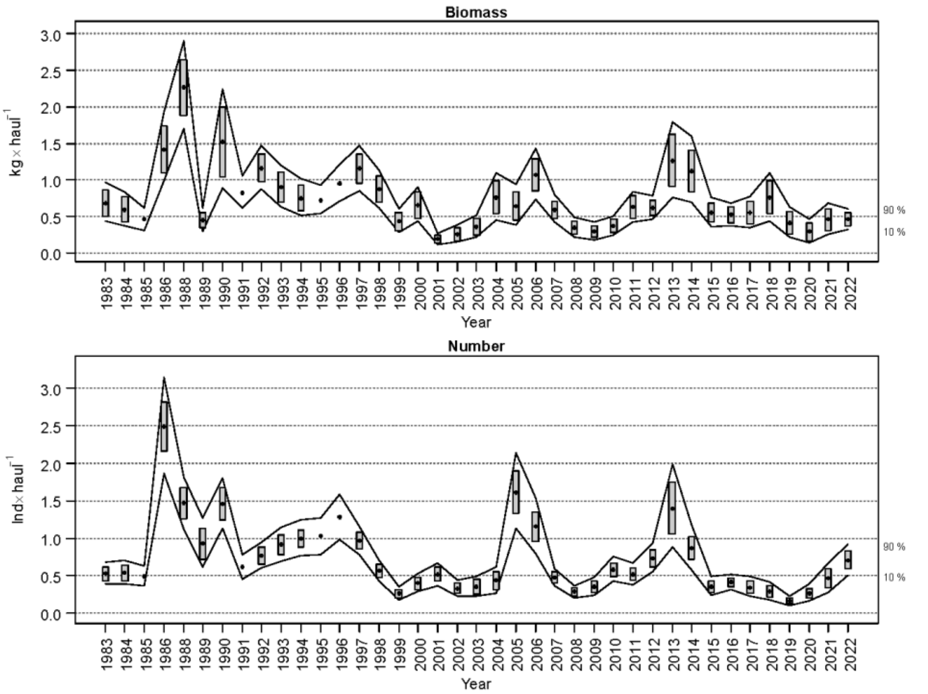

Figure 17 Evolution of black-bellied anglerfish (*Lophius budegassa*) biomass and abundance indices in the North Spanish shelf bottom trawl survey time series (1983-2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

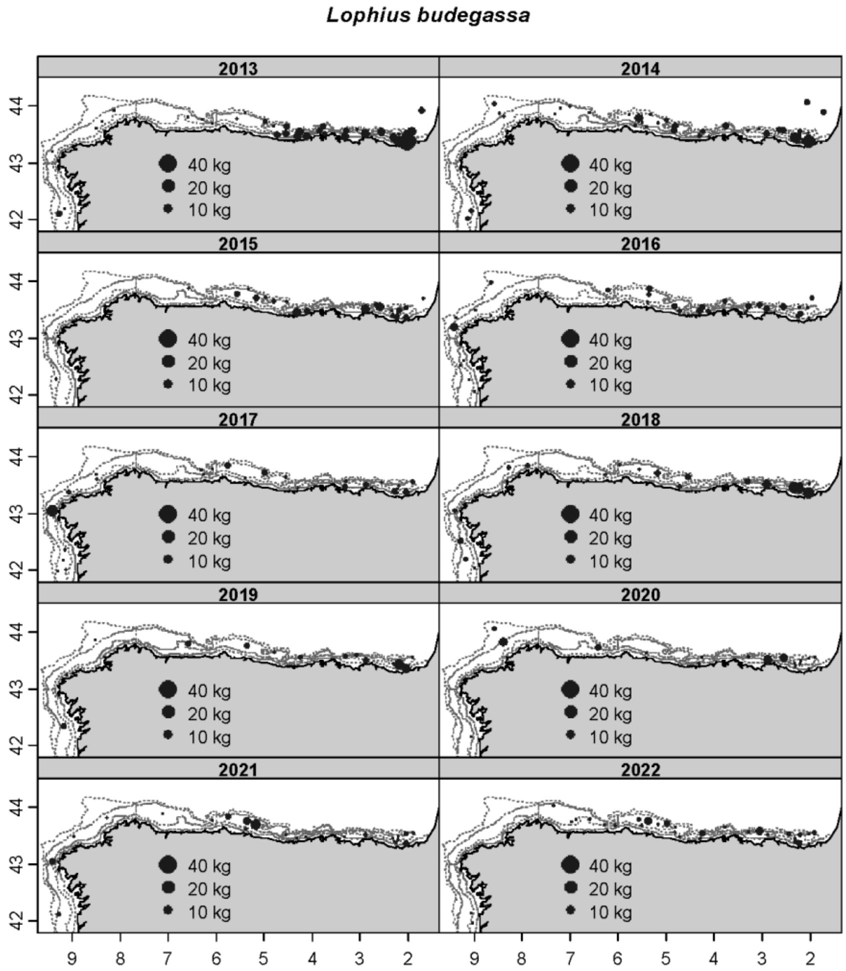

Figure 18 Geographic distribution of *Lophius budegassa* catches (kg×30 min·haul^{-1}) in the Northern Spanish Shelf groundfish Survey (2013-2022)

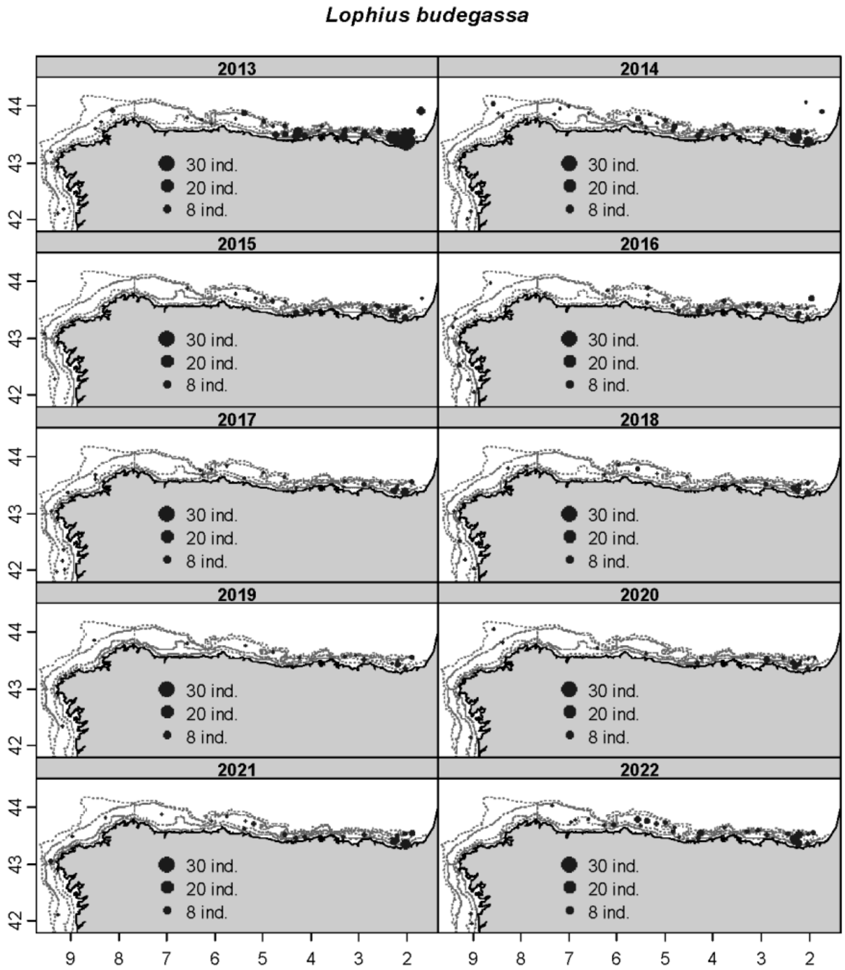

Figure 19 Geographic distribution of *Lophius budegassa* catches in numbers in the Northern Spanish Shelf groundfish Survey (2013-2022)

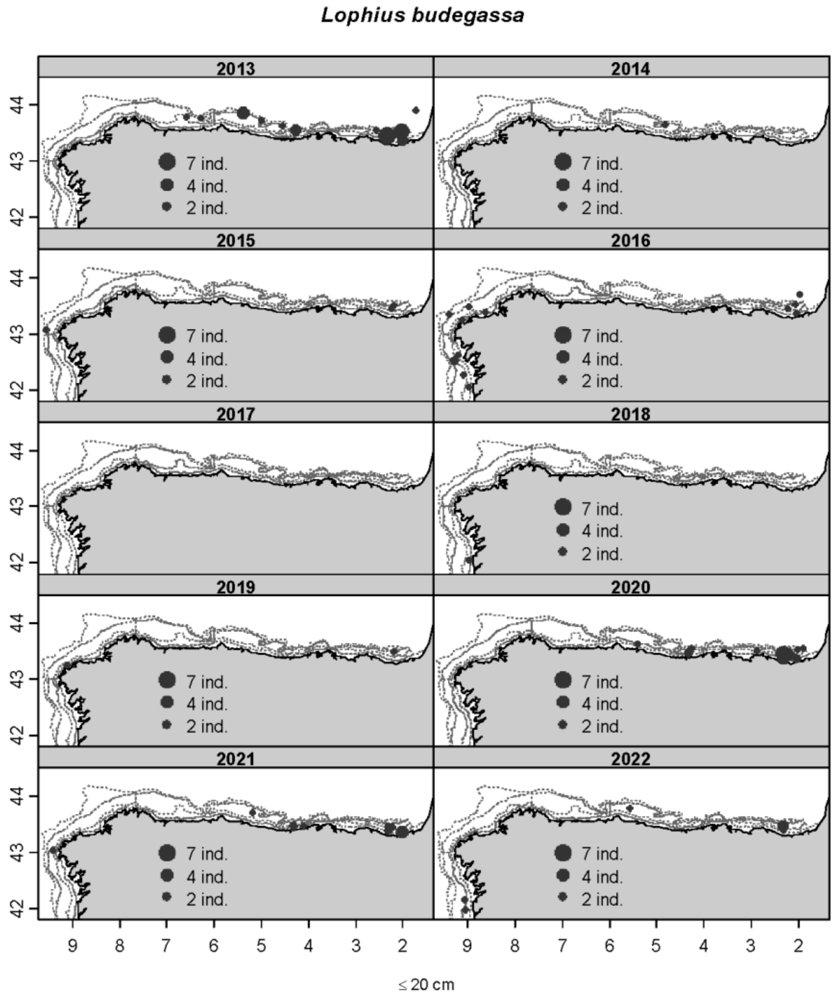

Figure 20 Geographic distribution of *Lophius budegassa* juveniles (≤20 cm) in the Northern Spanish Shelf groundfish Survey (2013-2022)

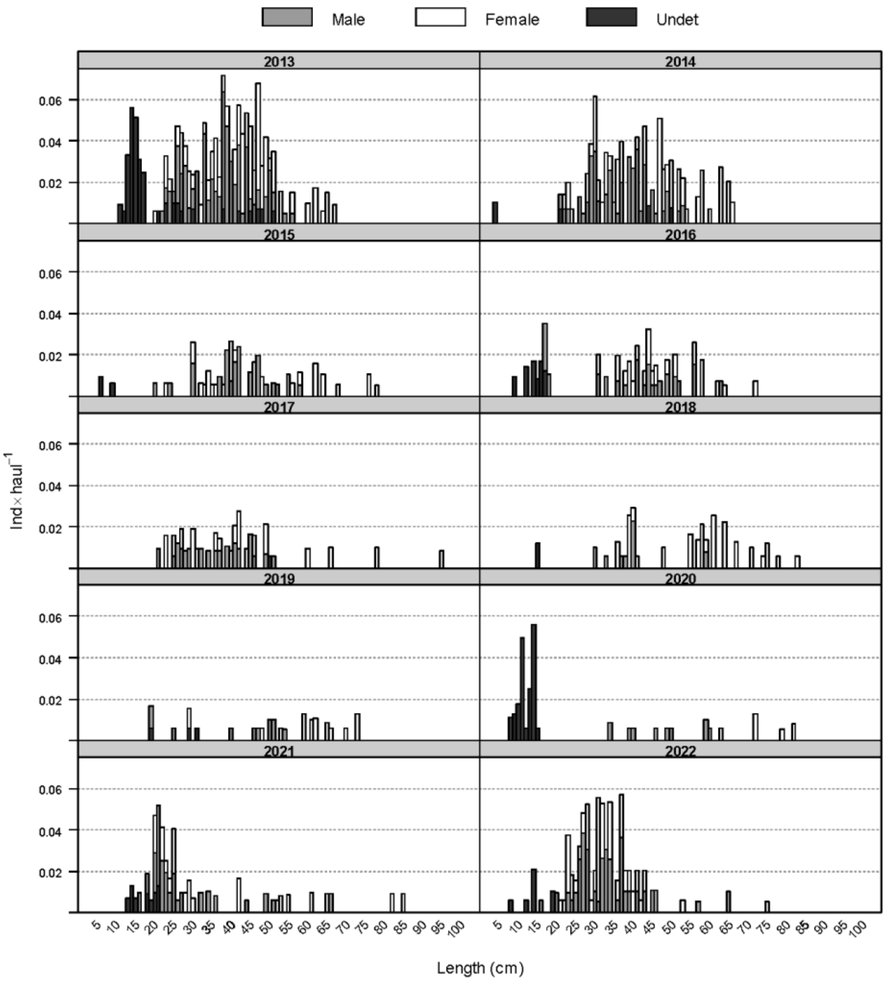

Figure 21 Mean stratified length distributions of *Lophius budegassa* in the Northern Spanish Shelf groundfish Survey (2013-2022)

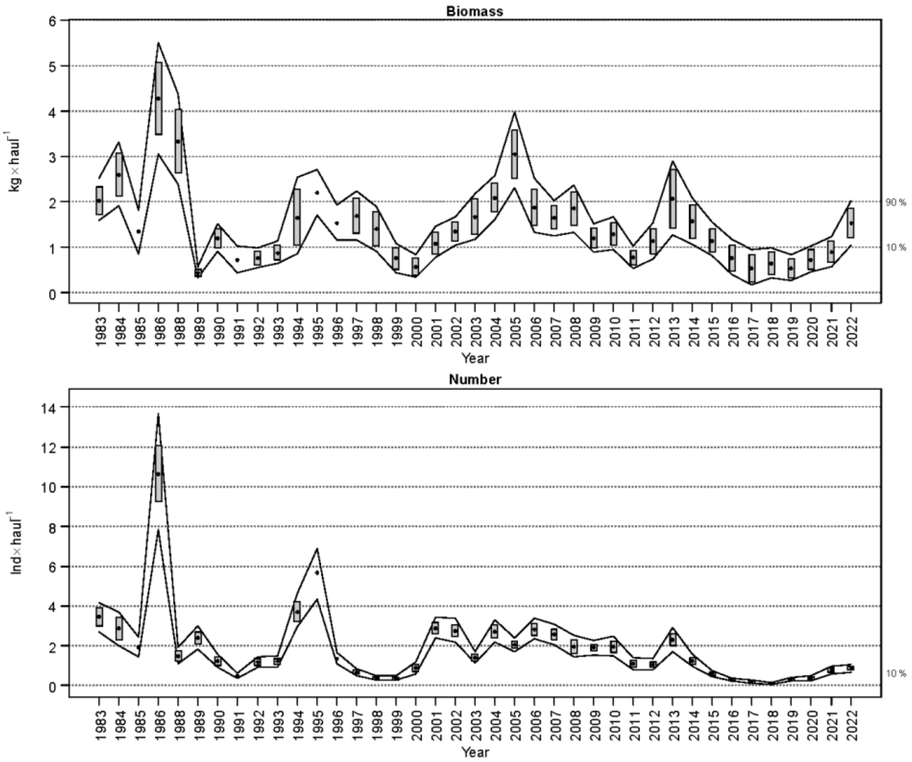

Figure 22 Evolution of white anglerfish (*Lophius piscatorius*) biomass and abundance indices biomass and abundance indices in the North Spanish shelf bottom trawl survey time series (1983-2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

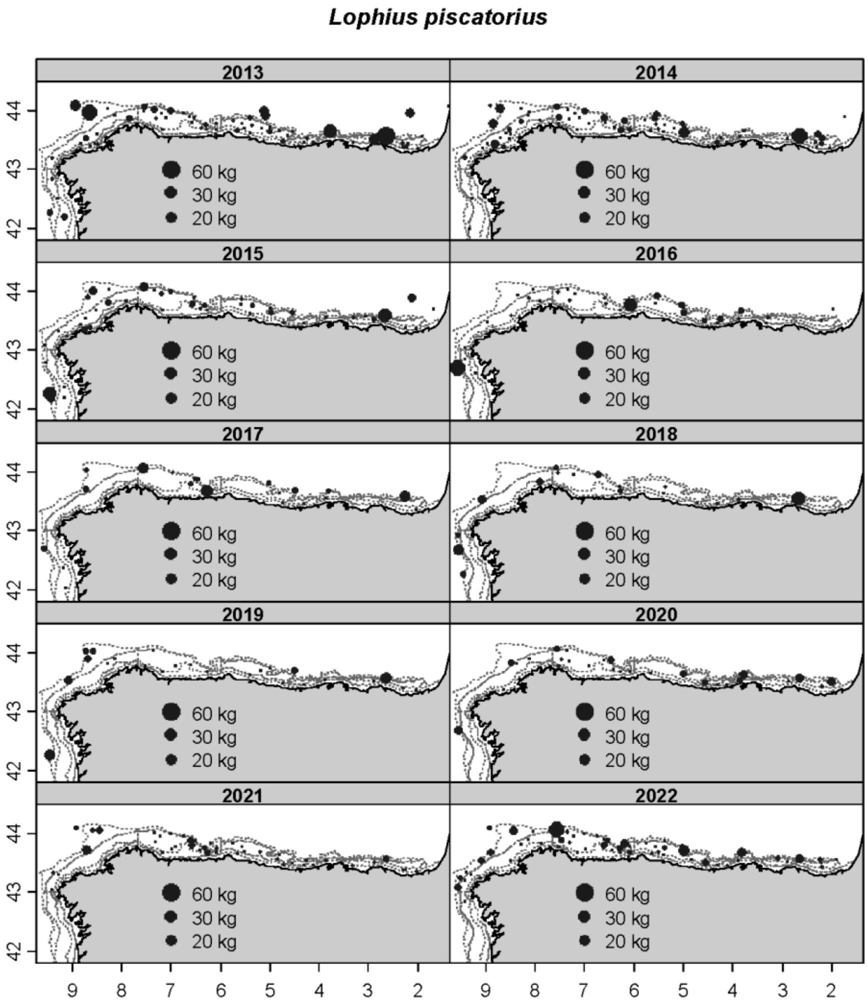

Figure 23 Geographic distribution of *Lophius piscatorius* catches (kg×30 min haul-1) in the Northern Spanish Shelf groundfish survey (2013-2022)

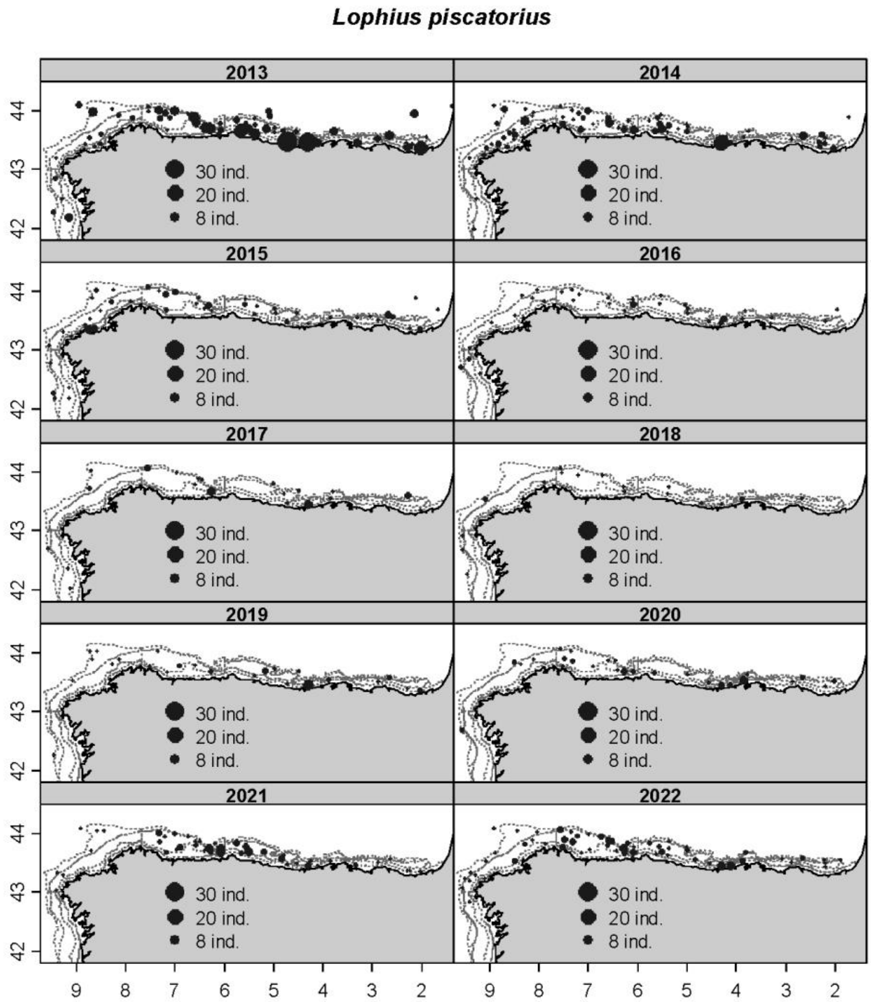

Figure 24 Geographic distribution of *Lophius piscatorius* catches in number in the Northern Spanish Shelf groundfish survey (2013-2022)

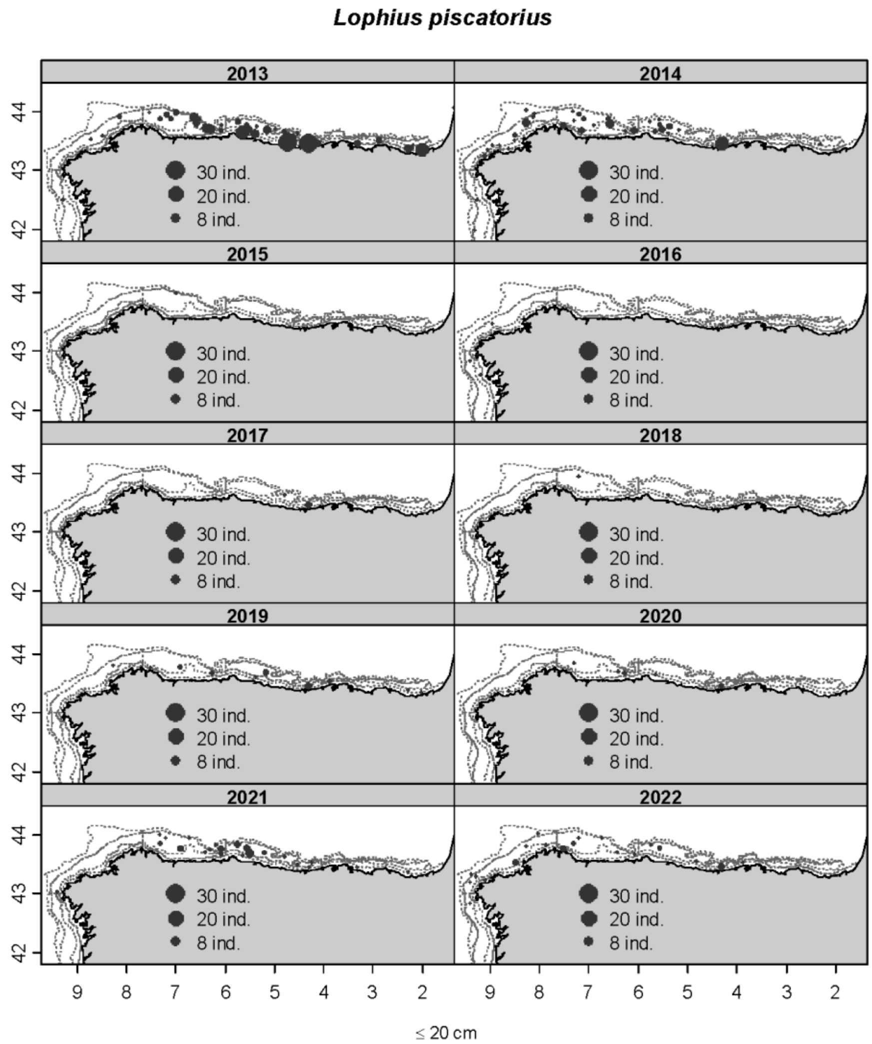

Figure 25 Geographic distribution of *Lophius piscatorius* juveniles (1-20 cm) in the Northern Spanish Shelf groundfish survey (2013-20212)

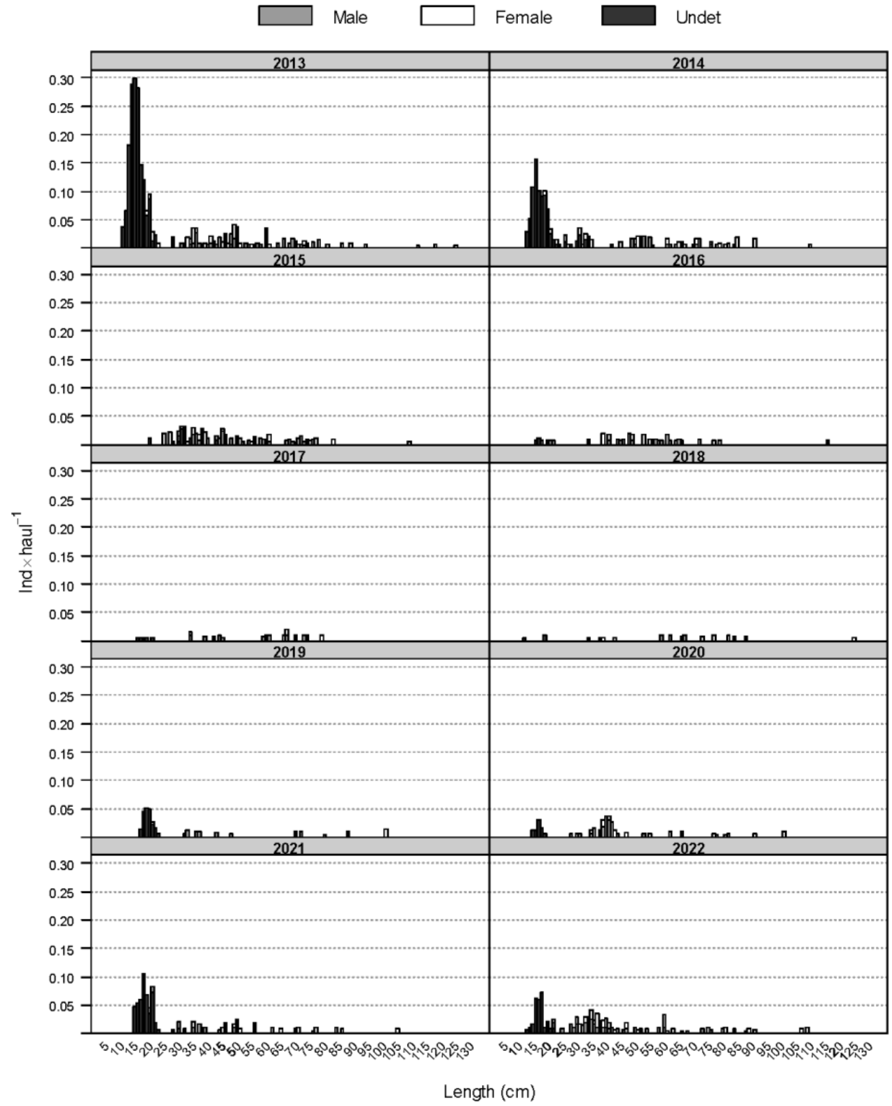

Figure 26 Mean stratified length distribution of *Lophius piscatorius* in the Northern Spanish Shelf groundfish survey (2013-2022)

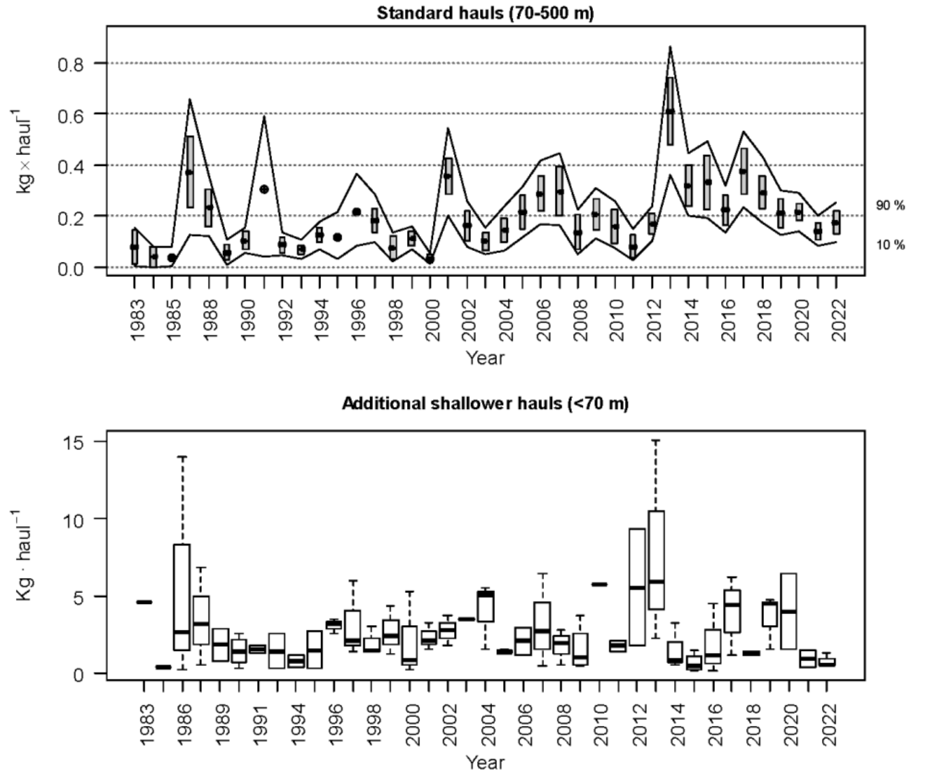

Figure 27 Evolution of sole (*Solea solea*) biomass index in standard (upper graph) and additional hauls (lower graph) in the North Spanish shelf bottom trawl survey time series (1983-2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

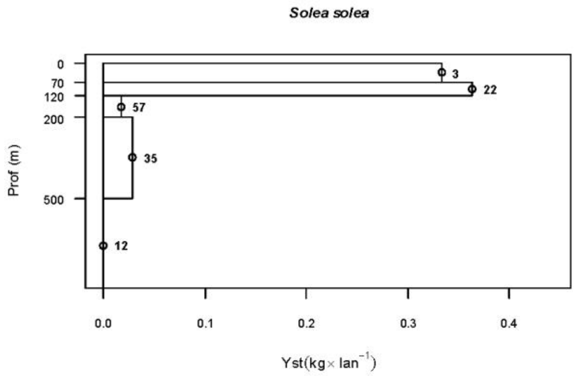

Figure 28 Depth distribution of *Solea solea* in the Northern Spanish Shelf groundfish survey 2022. Numbers mark the total number of hauls done in that depth range.

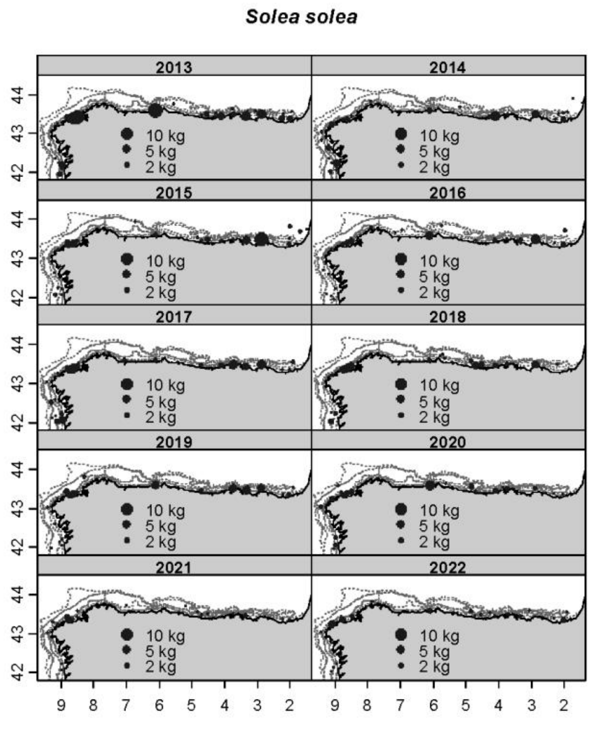

Figure 29 Geographical distribution of sole (*Solea solea*) in the Northern Spanish Shelf groundfish survey (2013-2022)

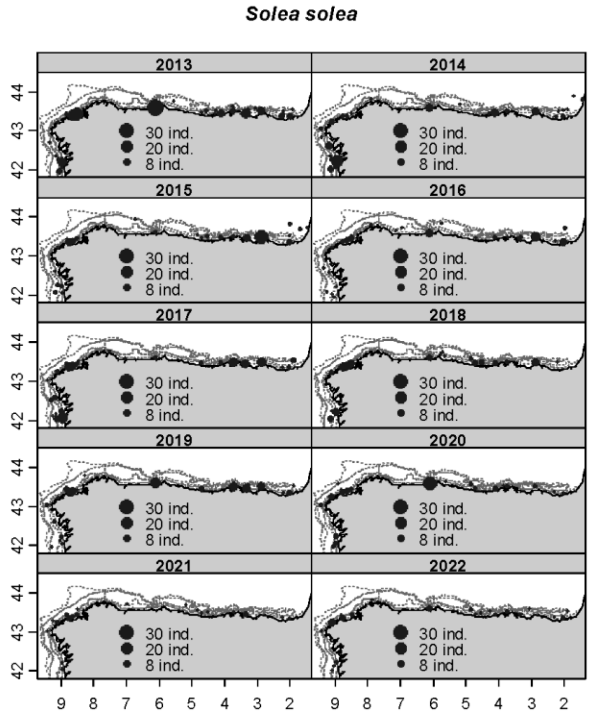

Figure 30 Geographic distribution of *Solea solea* catches in numbers in the Northern Spanish Shelf groundfish survey (2013-2022).

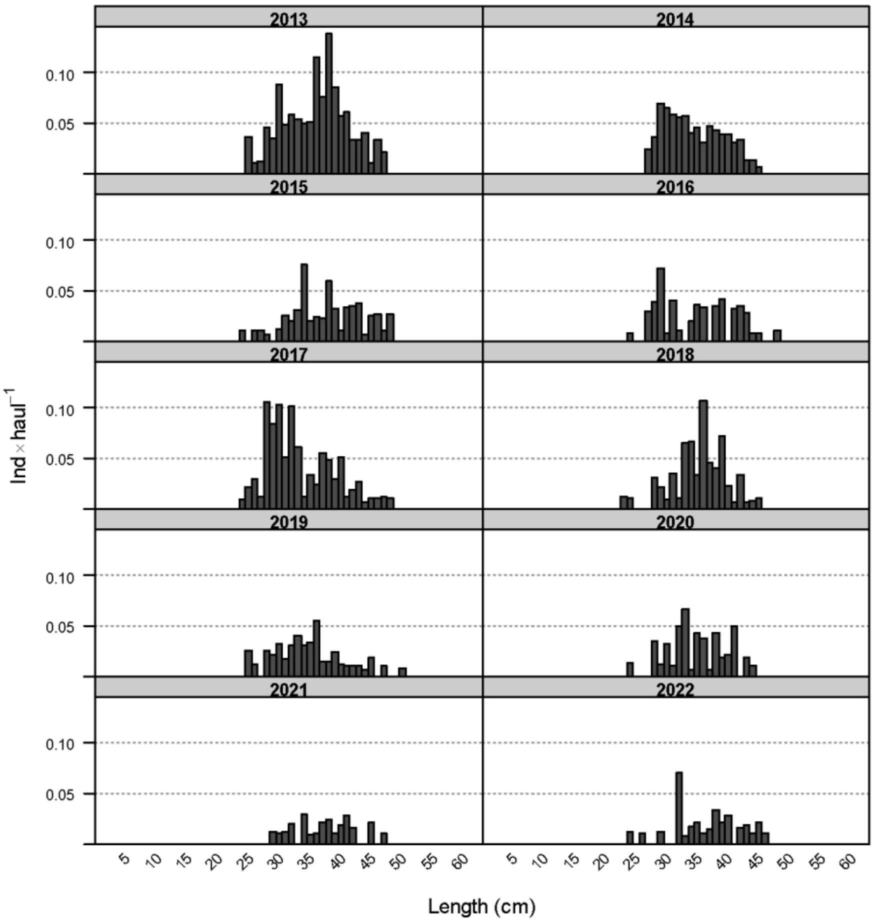

Figure 31 Mean stratified length distribution of sole (*Solea solea*) in the Northern Spanish shelf groundfish survey (2013-2022)

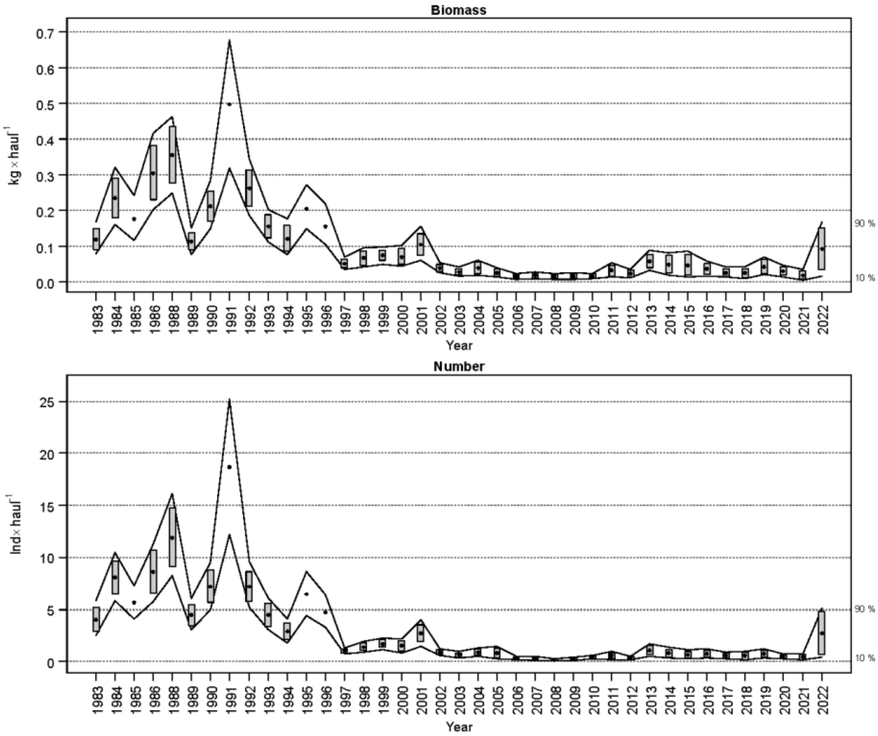

Figure 32 Evolution of *Nephrops norvegicus* biomass and abundance indices in the North Spanish shelf bottom trawl survey time series (1983-2022). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

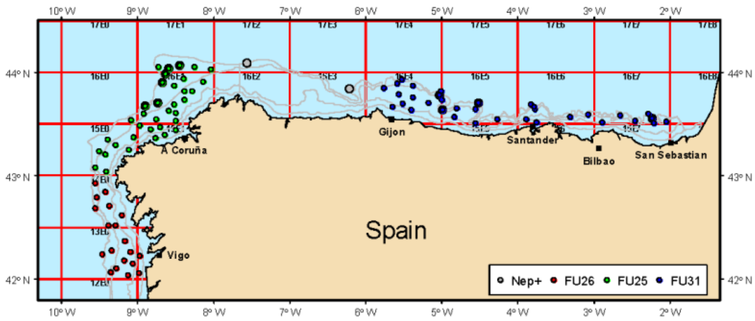

Figure 33 Geographic distribution of *Nephrops norvegicus* catches (kg×30 min haul-1) in the 2022 Northern Spanish Shelf groundfish survey by Funtional Units.

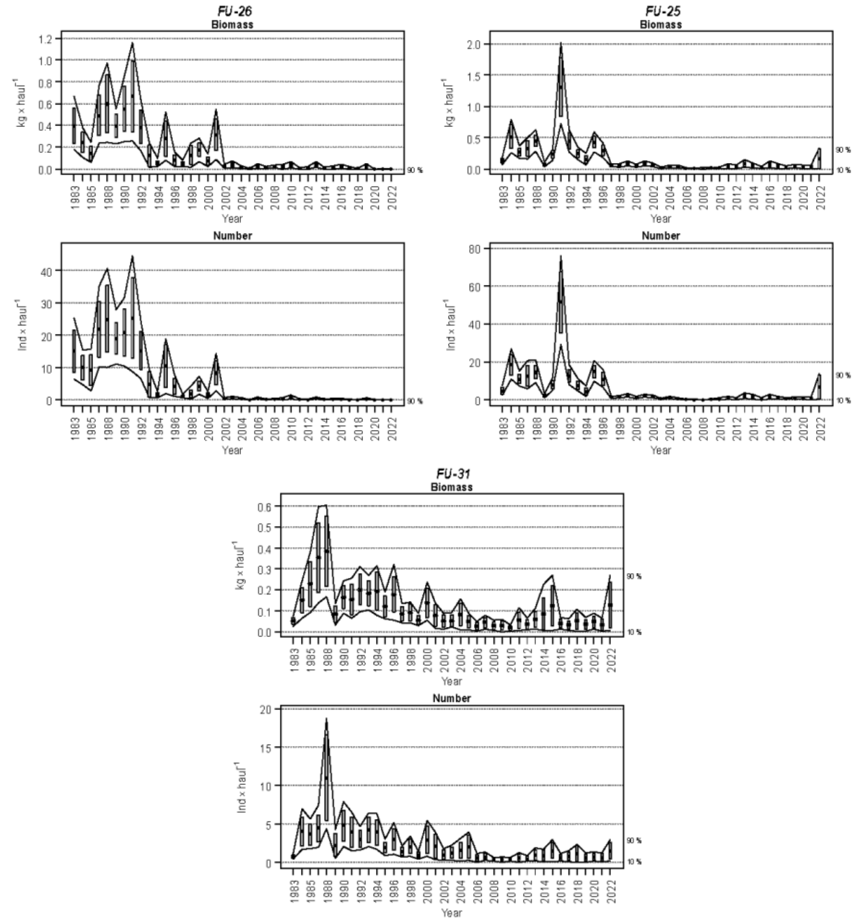

Figure 34 Evolution of *Nephrops norvegicus* mean stratified abundance in Northern Spanish Shelf surveys time series (1983- 2022) approximation to Functional Units (see Figure 33 for details):

FU – 26: geographical sector Miño-Finisterre.

FU – 25: geographical sector Finisterre-Estaca.

FU – 31: geographical sectors Peñas-Ajo and Ajo – Bidasoa.

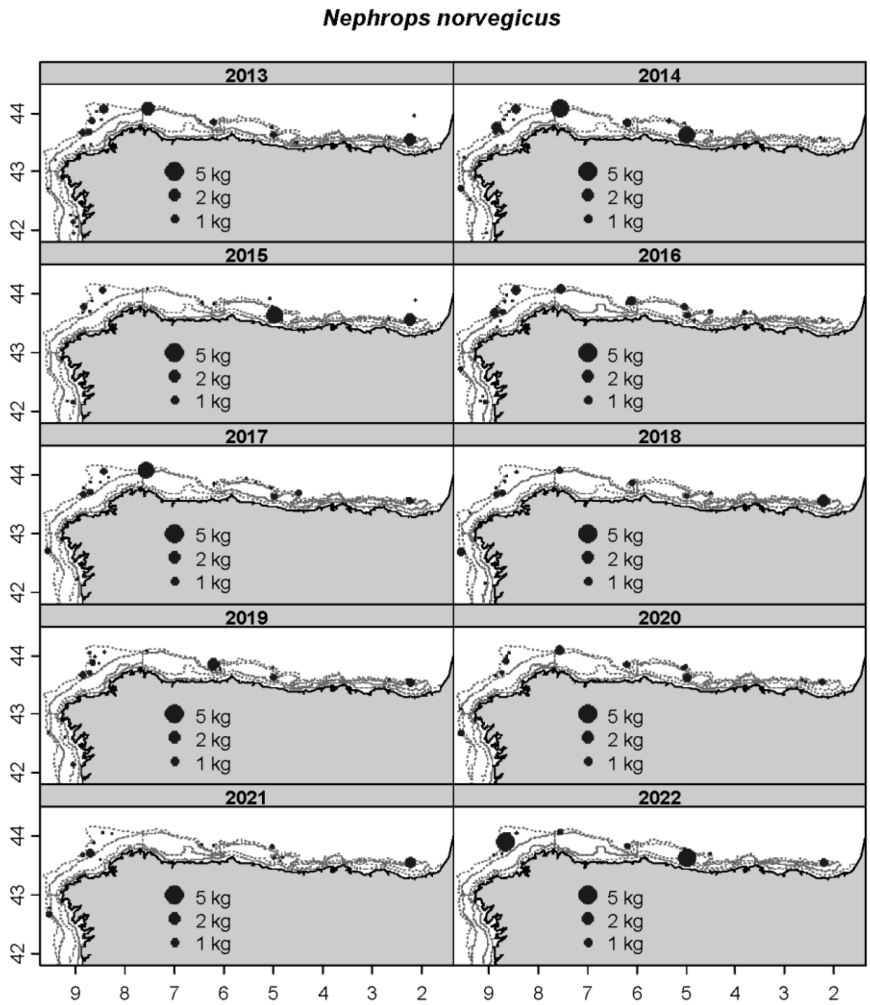

Figure 35 Geographic distribution of *Nephrops norvegicus* catches (kg×30 min haul-1) in the Northern Spanish Shelf groundfish survey (2013-2022)

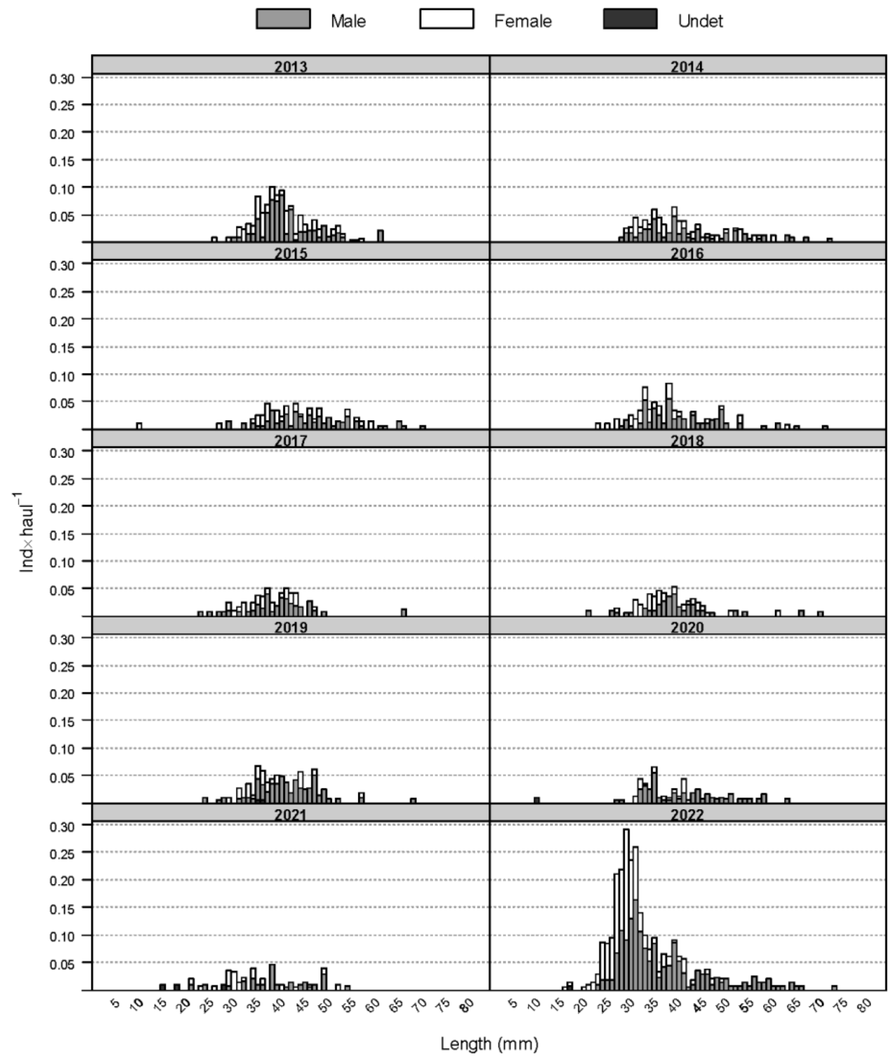

Figure 36 Mean stratified length distribution of *Nephrops norvegicus* in the Northern Spanish shelf groundfish survey (2013-2022)

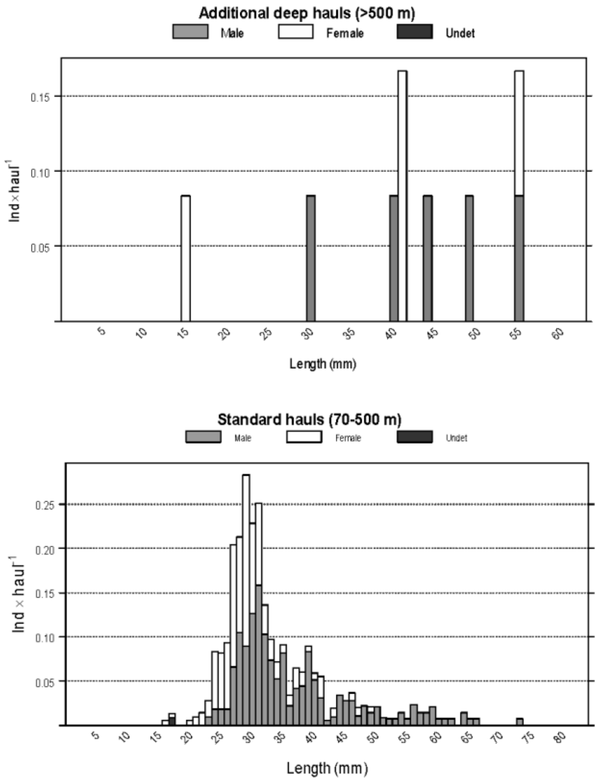

Figure 37 Mean stratified length distribution of *Nephrops norvegicus* in additional and standard hauls in the Northern Spanish Shelf groundfish survey 2022

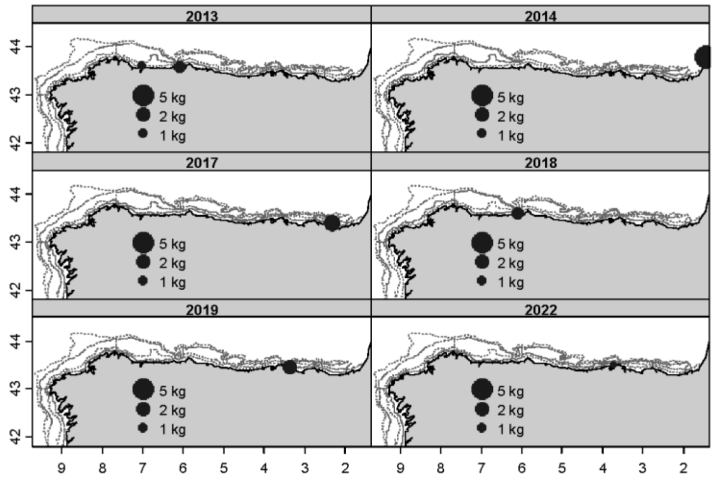

Figure 38 Geographical distribution of *Dicentrarchus labrax* in the Northern Spanish Shelf groundfish survey (2013-2022 only years with catches are shown)

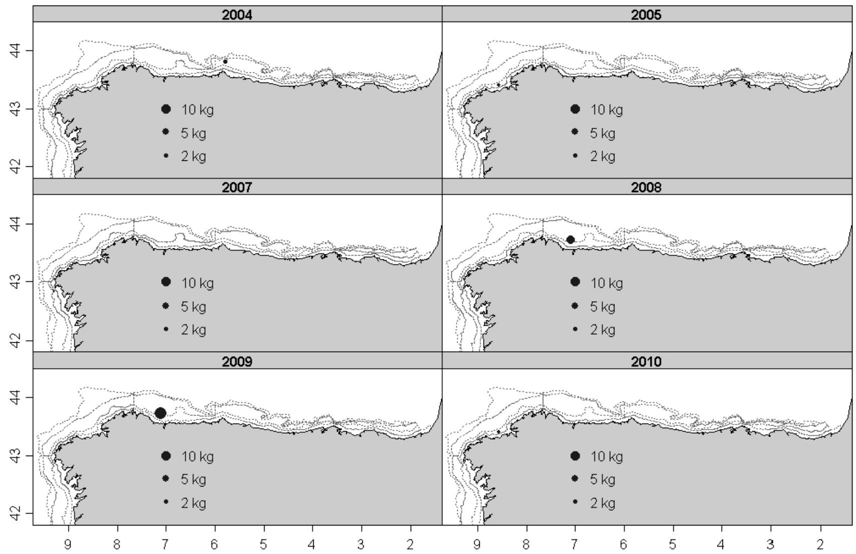

Figure 39 Geographical distribution of *Pollachius pollachius* in the Northern Spanish Shelf groundfish survey (2000-2022 only years with catches are shown)

Working Document for WGBIE 2023

European hake connectivity

Naiara Rodríguez-Ezpeleta, Alice Manuzzi, Iker Pereda-Agirre, , Natalia Díaz-Arce, Dorleta García, Sonia Sánchez

AZTI Basque Research and Technology Alliance

Does population structure coincide with assessment units in European hake?

Previous studies (Leone et al. 2019; IJMS) revealed a mismatch between stocks and populations but did not allow detecting the population boundaries because it lacked enough samples. An analysis based on additional samples covering the whole distribution of the species, show that the hake follows an isolation by distance population structure pattern with the Norwegian sea and the Mediterranean sea in the extremes connected with the central locations through the North sea and Alboran sea respectively (Figure 1).

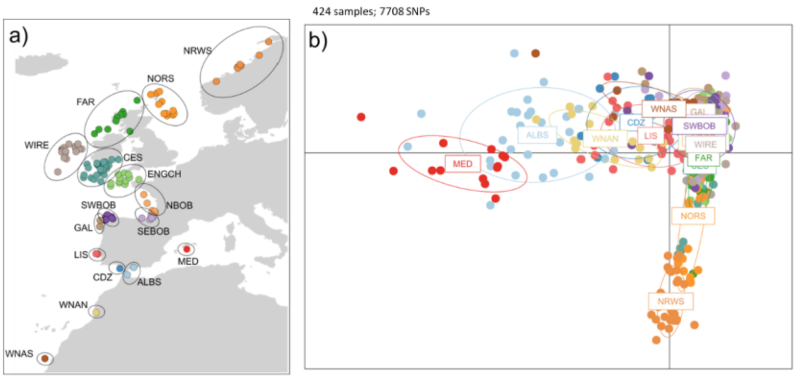

Figure 1: Population structure of European hake

This implies that the current assessment is considering jointly the locations that are least connected (e.g. Northern bay of Biscay + North Sea and Southern Bay of Biscay and Cadiz) it whereas separates the locations that are the most connected (e.g. Southern Bay of Biscay and Celtic Sea + Western Ireland + English Chanel). Additional analyses are in progress, but the main message will not change. CKMR analyses could provide additional insights into the movement patterns of European hake.

CONCLUSIONS:

- There is a mismatch between stocks and populations in European hake
- The consequences of that mismatch in the assessment should be evaluated for which a Stock ID workshop could be stablished.
- CKMR studies could provide additional insights into hake movements.

Working Document for WGBIE 2023

White (*Lophius piscatorius*) and black-bellied anglerfish (*Lophius budegassa*): species ID and hybridization

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AZTI Basque Research and Technology Alliance

Genetic studies revealed unknowns relevant for white anglerfish assessment

A previous study (Aguirre-Sarabia et al. 2019; Evol. Appl.) revealed three assessment-relevant results in white anglerfish: 1) there is misidentification between species, that is, some anglerfish with white peritoneum are in reality black anglerfish; 2) there is hybridization between both species, resulting in hybrids that can reproduce with pure individuals but not beyond; 3) within the white anglerfish, no population structure is found in the northeast Atlantic, which represent a panmictic population (Figure 1)

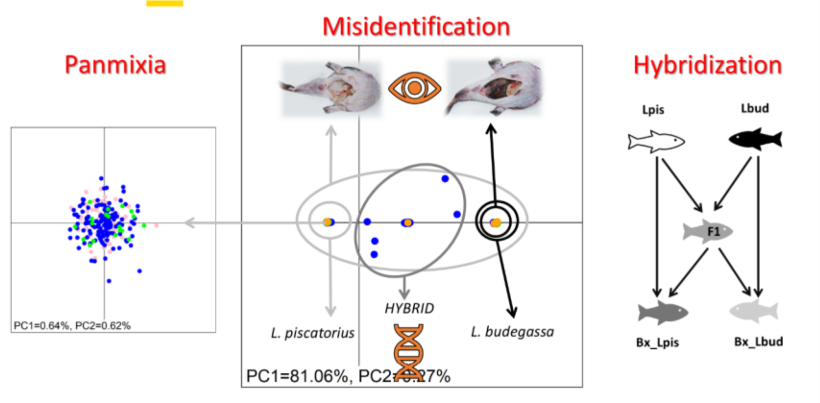

Figure 1: Summary of results by Aguirre-Sarabia et a. 2019

Additional analyses including more samples (Manuzzi et al. in preparation) have confirmed these results, including the absence of second-generation hybrids. This means that hybrids can only reproduce with pure individuals most likely due to a genomic barrier for further reproduction. The nature of these barriers and potential future scenarios are being explored with the help of the newly generated white anglerfish genome. Yet, for assessment purposes, hybrid individuals can be considered as not contributing to the spawning stock biomass.

Distribution of hybrids and misidentified individuals

The analysis of 1255 white and 588 white and black anglerfish reveal different proportions of hybrid and misidentified individuals depending on the area. The southern stock is mostly affected by misidentifications whereas the northern stock is mostly affected by hybrids. The northern platform stock is the least affected (Figure 2).

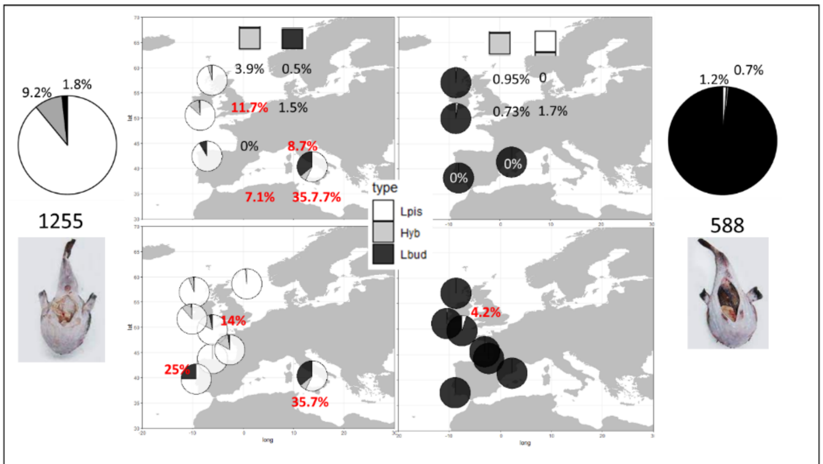

Figure 2: Proportion of hybrid and misidentified individuals per stock (above) and per smaller area (below) for the white (left) and black (right) peritoneum samples.

Additional analyses are ongoing to determine temporal stability of hybrids, for which a quick cand cost-effective assay has been developed. Yet, hybrid monitoring requires the analyses of a large number of samples for a long period of time.

CONCLUSIONS:

- The proportion of hybrid and misidentified individuals in some areas is so that it should be accounted for in the assessment
- A continuous monitoring of misidentification and hybrids is required so that temporal and spatial distribution and stability can be more accurately defined.
- A regular monitoring network should be established so that a large number of anglerfish for genetic studies are collected per year

Working Document for WGBIE 2023

Close-kin Mark-recapture for spawning stock biomass estimation of Northeast Atlantic demersal species.

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AZTI Basque Research and Technology Alliance

Can close-kin mark-recapture be applied to Northeast Atlantic commercially exploited fish species?

Close-Kin Mark-Recapture (CKMR) is a fishery-independent abundance estimation method that can also provide information on stocks' total mortality and spatial dynamics. CKMR is based on the principle that the larger a population, the smaller the probability that kins are found in a random subsample of the population, but also involves (and can estimate) other demographic parameters such as mortality. Evaluating the viability of CKMR for a given species requires assessing existing qualitative knowledge on species specific characteristics such as fecundity, mortality, and stock connectivity but also depends on availability of biological data, and access to a large enough number of samples. We have evaluated the viability of CKMR for several Northeast Atlantic commercially exploited fish species (anchovy, sardine, horse mackerel, mackerel, megrim, hake, white anglerfish, yellowfin tuna and bigeye tuna) by gathering the biological knowledge available for each of them and calculating the number of samples likely required to find enough kin pairs (Pereda-Aguirre et al. in preparation). See Figure 1 for numbers related to hake and anglerfish.

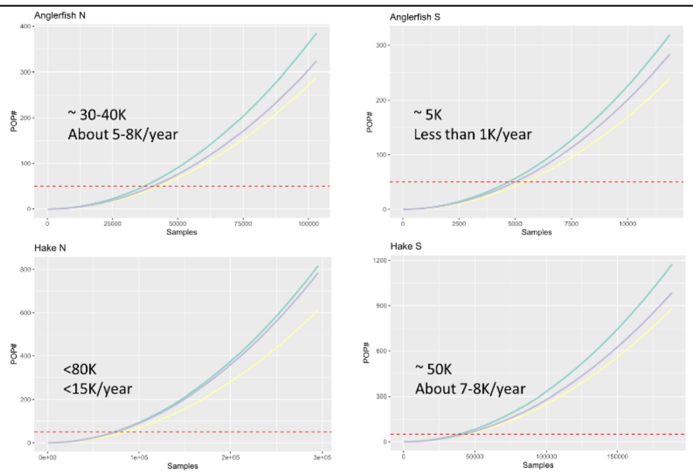

Figure 1: Number of parent offspring pairs (POPs) found as function of number of samples collected considering a sampling proportion of juveniles vs adults of 1:1 (blue), 3:1 (yellow) or the actual proportion (purple)

Development of a framework for applying CKMR in hake and anglerfish

For application of CKMR in European hake and white anglerfish, we have

i) established a sampling collection network using existing scientific surveys; this has been done using the goodwill of survey coordinators and collaborators, but a regular sampling network provided with funding (through DCF) should be implemented.

ii) developed a SNP array that allows to cost-effectively genotype hundreds of samples for geographic origin assignment and kin finding; this array is also valid for monitoring anglerfish and hake populations (including hybrids and misidentification in the former)

iii) developed a CKMR model considering the characteristics of each species, including ages estimation uncertainties.

Applied to thousands of samples genotyped with the SNP array, our model will be used to estimate the abundance of the European hake and white anglerfish to inform stock assessment.

CONCLUSIONS:

- CKMR could be a powerful approach for accurate SSB estimations in hake and anglerfish
- A full implementation of CKMR requires a joint effort from survey coordinators, geneticists and modelers
- A full implementation of CKMR requires a good sampling program in place so that the required number of genetic samples can be collected.

Annex 4: Letter from the French National Committee (Comité National des Pêches; CNPMEM) in 2023

This is a recent letter of the French CNPMEM to WGBIE and ICES that new management measures that are implemented specifically on the French Bay of Biscay sole fishery since 2022.

Paris, 28th April 2023

In view of the WGBIE 2023, the CNPMEM wishes to inform the working group members of the main additional management measures that were applied to the French sole fishery in the Bay of Biscay in 2022. It also wishes to reiterate its requests relating to the organisation of a benchmark and on the production beforehand of an ICES advice on the influence of environmental factors on the recruitment and natural mortality of this stock.

1. Implementation of additional management measures for the French sole fishery in the Bay of Biscay in 2022

By decision of the Council of European Ministers of December 12 and 13, 2021, the 2022 TAC for Bay of Biscay sole (SOL/8AB) has been reduced by 37%, in line with ICES recommendation.

In order to compensate for the socio-economic consequences of this drastic reduction, a **mechanism of temporary cessation of fishing activities** has been set up for the benefit of the French fleet of gillnetters and bottom trawlers, which contributes more than 90% total landings of this stock [2].

The benefit of this instrument was open to shipowners holding a national fishing authorization for the common sole stock in the Bay of Biscay (NFA SBB)[3] as well as shipowners whose vessel(s) were dependent on the sole stock equivalent to 10% or more of the total value of the vessel's catch during the reference year 2019 or 2020.

The mechanism was implemented under the following conditions:

- Open from January 1 to December 31, 2022;
- Minimum duration of stoppage of the vessel of 45 days and maximum duration of 90 days;
- Stoppage of activity that can be split into incompressible periods of 5 working days;
- Obligation de file at least 15 days of stoppage over the period from January 1 to March 31, 2022 inclusive;

[2] Arrêté du 30 décembre 2021 relatif à la mise en œuvre d'un arrêt temporaire aidé des activités de pêche pour les navires pêchant le stock de sole commune du golfe de Gascogne (https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000044807119), modifié par l'arrêté du 28 février 2022 (https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000045332535).

[3] In 2022, 337 NFA SBB were issued.

- Suspension in 2022 of the biological fishing stop applicable to gillnetters holding the NFA SBB[4].

The first assessment of the mechanism shows that 261 eligible files were submitted, for as many vessels exploiting the sole of the Bay of Biscay by bottom trawl or net. For a majority of them, the cessation of activity lasted more than 75 days.
In addition, and in order to promote stock recovery, the **minimum landing size for common sole from the Bay of Biscay applicable to French vessels was increased from 24 to 25 cm in the second half of 2022[5].** This measure concerned the period during which young soles, which contribute to the increase in spawning biomass, experience higher fishing mortality.

Beyond the socio-economic and biological objectives, the CNPMEM wishes to warn of the potential impact of these measures on the data (fishing effort) used for stock assessment in 2023.

2. Impact of environmental factors on stock dynamics, particularly on recruitment

Each year since 2018, the last year for which the good state of the stock has been confirmed by ICES, the scientific recommendations on the setting of fishing opportunities for the stock are followed in application of the MSY approach or the Western Waters Multiannual Management Plan. However, despite the respect of the TAC level each year by the profession and the existence in France of a strict and restrictive regulatory framework for the fishery, the downward trend in recruitment continues, reaching in 2021 the lowest value in the data set.

In this context, the French profession considers that environmental factors (water quality, global change, etc.) could play a significant or even preponderant role on changes in stock dynamics and on recruitment in particular (impact of environmental conditions on the quality and functionality of the species' essential habitats and/or on the juveniles themselves). Since 2021, the French profession has been trying to identify additional management measures likely to reverse this downward trend in recruitment.

The exercise is proving to be particularly difficult, in particular because certain biological and modelling parameters (maturity ogive, reference points, etc.) used for stock assessment seem to be out of step with the reality which is reported by scientific studies in which the profession participates. Similarly, the effects of the improvement in the exploitation diagram implemented since 2017 for trawlers (mesh size of 80mm) must be appraised and taken into account in the assessment of this stock.

In accordance with the statement by the European Commission on scientific advice for sole in divisions 8a and 8b expressed during the Council of European Ministers of December 12 and 13, 2022, the CNPMEM calls for **a benchmark to be engaged on this stock as soon as possible. The French committee would also like the ICES to be able**

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[4] Arrêté du 28 février 2022 modifiant l'arrêté du 12 février 2015 créant un régime national de gestion pour la pêcherie de la sole commune ((*Solea solea*) dans le golfe de Gascogne (divisions CIEM VIII a et b) (https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000045294551)

[5] Arrêté du 1er juillet 2022 déterminant une taille minimale de débarquement pour la sole commune (*Solea solea*) dans les zones CIEM VIIIa et VIIIb (https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000046005132)

to carry out beforehand an analysis of the influence of environmental factors on the recruitment and natural mortality of this stock.

Annex 5: Audit reports

Audit Nephrops in Divisions 8a,b - FU 23-24

Review of ICES Scientific Report WGBIE 2023 - Nephrops in Divisions 8a,b - FU 23-24

Review date: 17/05/2023

Reviewers: Hans Gerritsen

Expert group Chair: Santiago Cerviño and Ching Villanueva

Secretariat representative: Anne Cooper

Audience to write for: advice drafting group, ACOM, and next year's expert group

General

- Autumn advice – for now this audit only concerns the WGBIE 2023 report section
- I made some language edits and comments in the report section
- The report supports the information needed for the advice
- No inconsistencies identified

For single-stock summary sheet advice – to be updated in autum

Stock: - Nephrops in Divisions 8a,b - FU 23-24

Short description of the assessment as follows (examples in grey text):

1) Assessment type: benchmark/update
2) Assessment: accepted/rejected/not presented
3) Forecast: accepted/rejected/not presented
4) Assessment model: XSA + VPA Bayesian assess – proposed by expert group, accepted by review group – tuning by three comm + two surveys
5) Consistency: last year's assessment rejected – this year's accepted; the view of the review group was that last year's assessment should have been accepted.
6) Stock status: $B < B_{lim}$ for a while; $F_{lim} < F < F_{pa}$; R uncertain, seems to be high in recent years
7) Management plan: agreed in 2006: SSB to be above 35 000 t within ten years and fishing mortality to be reduced to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is not evaluated by ICES.

General comments

Technical comments

Conclusions
(Single tables or figures can be added in the text, longer texts should be added as annexes.)

Review of ICES Scientific Report, WGBIE 2023 (03–11 May 2023)

Reviewers: *Isabel González Herraiz*

Expert group Chair: *Ching Villanueva and Santiago Cerviño*

Secretariat representative: *Anne Cooper*

General

For the 2023 WGBIE there was a minor revision of the data and some issues were corrected. The stock annex was updated.

hke.27.8c9a

Short description of the assessment as follows:

1) Assessment type: From the 2022 WKANGHAKE benchmark.

2) Assessment: accepted.

3) Forecast: accepted.

4) Assessment model: Stock Synthesis (SS) model – tuning by three surveys + two commercial indices.

5) Consistency: SSB and F trends from 2021 and 2022 are very similar. Total landings, total discards and length distributions by fleet are well estimated by the model. There are not patterns in the surveys data residuals. Consistent recruitment projection.

6) Stock status: F is below Flim, Fpa and Fmsy. SSB is above Bpa and Blim.

7) Management plan: Multiannual plan (MAP) for the Western Waters and adjacent waters. For this stock the MAP requires MSY Btrigger, MAP Blim, MAP Fmsy, MAP range Flower and MAP range Fupper.

General comments

- Two countries (Spain and Portugal) and several fleets (trawlers, gillnets+longliners, artisanal and Cádiz trawl) are involved in this stock. Landings, discards and length distributions of catch are input data of the model. Other input data are SpGFS-WIBTS-Q4 (G2784) and SPGFS-caut-WIBTS-Q4 (G4309), ptGFS-WIBTS-Q4 (G8899)Pt-PGFS, SP-NSGFS and SP-GCGFS survey indices and length distributions and commercial indices from the Spanish trawl and gillnets+longliners fleets.
- Decrease of observed landings and discards in 2022.
- SSB is increasing.

Technical comments

- Discard proportions estimated by the retention model.
- Exploitation pattern: average last 3 years.
- Recruitment in the intermediate and forecast years predicted from Stock Synthesis stock-recruit relationship.
- F (2023) is the average F (2020-2022).
- The model was set in the 2022 WKANGHAKE benchmark. Converge is a main issue for this stock and the final model was chosen among those performed in the jitters and replicated the best one of 50 models.

Conclusions

The assessment meets quality standard. The catch advice is 9.5% bigger than the previous one (EU MAP F=Fmsy upper 17445 t for 2024, 15925 t for 2023).

Review of ICES Scientific Report, WGBIE 2023 (03–11 May 2023)

Reviewers: Spyros Fifas

Expert group Chair: Ching Villanueva and Santiago Cerviño

Secretariat representative: Anne Cooper

General

- Category 1 stock. This stock was last benchmarked in 2022 using the a4a statistical catch-at-age model.
- This stock was assessed and projections were performed.
- The assessment is carried out by taking into account abundance indices provided by surveys: Western IBTS Q4 Porcupine Survey (Spain) and Western IBTS Q4 EVHOE and IGFS surveys (France/Ireland) combined.
- Catches include landings and discards for 6^{th} consecutive year.

For single-stock summary sheet advice

Megrim (*Lepidorhombus whiffiagonis*) in west and south-west of Ireland and in the Bay of Biscay: meg.27.7b-k8abd

Short description of the assessment as follows:

1) Assessment type: Updated

2) Assessment: Analytical assessment. Accepted

3) Forecast: Accepted

4) Assessment model: a4a statistical catch-at-age model.

5) Consistency: Assessment was performed on the basis of combined Irish and French bottom trawl surveys as the combination provided more consistent results than tuning separately series.

6) Stock status: New biomass reference points are fairly similar to the old ones, therefore F_{MSY} is slightly higher: the stock status remains unchanged relative to these results ($F<F_{MSY}$, B>>MSY $B_{trigger}$).

7) Management plan: precautionary management plan (ICES, 2021).

General comments

The report was correctly written and properly documented. All tables and figures are well referenced.

Technical comments

- The Mohn's rho values are slightly out of the defined bounds in WKFORBIAS although after the revision of the diagram $F < F_{MSY}$, B >> MSY $B_{trigger}$, thus it was decided to give advice for this stock.
- The median recruitment fluctuated in a range 1 to 1.5 in the whole series, with a decreasing trend in the last period. Projections were performed by using GM throughout the full time-series excluding the last two years.
- The SSB shows an overall decreasing trend from the start of the series in 1984-2005 followed by a significant increasing trend in recent years up to 2022. Uncertainty in the SSB remains low for the overall time-series.
- The F showed three marked data periods with a global decreasing trend, reaching the lowest value of the series in 2022 with low uncertainty.

Conclusions

The assessment has been performed correctly.

Review of ICES Scientific Report, WGBIE 2023 (03–11 May 2023)

Reviewers: Mickael Drogou

Expert group Chair: Ching Villanueva and Santiago Cerviño

Secretariat representative: Anne Cooper

General

- Benchmarked in 2022 during WKMEGRIM. Assessment a4a (assessment for all) is used. This year is an update of the category 1 assessment.
- The advice is based on discards and landed numbers-at-age were incorporated resulting in catch numbers-at-age as input data from 1986 to 2022 and the year 2022 was added to the Spanish SpGFS-WIBTS-Q4 (G2784) survey index.
- The advice for 2024 is 31% higher than the advice for 2023. They main reason for this is the increase in numbers at age [ages 1-4 in year 2022] estimated in current assessment

For single-stock summary sheet advice

Megrim (Lepidorhombus whiffiagonis) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)

Short description of the assessment as follows:

1) Assessment type: update. Category 1.

2) Assessment: accepted

3) Forecast: accepted

4) Assessment model: Age-based assessment (a4a; ICES, 2022a, 2023) that uses catches in the model and in the forecast and one survey index, the Spanish North Coast Bottom Trawl Survey (SP-NSGFS-Q4 [G2784]).

5) Consistency: Last year's assessment (ICES, 2022) was updated on the basis of the benchmark WKMEGRIM (Ices 2022)

6) Stock status: B>Blim and F<Fmsy

7) Management plan: The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters applies to this stock. The plan specifies conditions for setting fishing opportunities depending on stock status and making use of the FMSY range for the stock. ICES consider that the FMSY range for this stock used in the MAP is precautionary.

General comments: Assessment was well presented to WGBIE and report section for this stock is clearly written. No issues found with the advice. During the WKMegrim benchmark (ICES, 2022), it was not possible to find a4a experts to participate during the meeting who may have provided guidelines or advice to resolve some issues. Due to this outstanding modelling problem, WGBIE still supports the organization of an interbenchmark as soon as possible, with an objective of soliciting the participation of a4a experts in order to explore, improve and validate other model configurations and obtain better and robust retrospective pattern fits.

Technical comments: Assessment and advice were carried out following ICES procedures

Conclusions: The assessment has been performed correctly.

Review of ICES Scientific Report for stock mon.27.78abd (WGBIE 2023 3-11th May 2023)

Reviewers: Paz Sampedro

Expert group Chair: Santiago Cerviño and Ching-María Villanueva

Secretariat representative: Anne Cooper

General

- *Category 1 stock. Update assessment. Last benchmarked in 2022.*
- *Length-based age-structured Stock Synthesis model (SS) that uses catches in the model and forecast.*
- *Commercial landings and discards and three surveys: IE-IGFS (G7212) and EVHOE (G9527) combined into a single index with the acronym FR_IE_IBTS; the Irish Anglerfish and Megrim survey IAMS (G3098); and SpGFS-WIBTS-Q4 (G5768).*
- *Assessment and projections were carried out using 2022 data according to the stock annex.*

For single-stock summary sheet advice

Stock **mon.27.78abd**

Short description of the assessment as follows (examples in grey text):

1) Assessment type: *update*
2) Assessment: *accepted*
3) Forecast: *accepted*
4) Assessment model: *Length-based age-structured Stock Synthesis model (SS) accepted in the last Benchmark (2022)*
5) Consistency: *The perception of the stock has not changed compared to last year assessment. The stock was benchmarked in 2022, the estimated fishing mortality and recruitment have changed considerably due to the new methodology. Recruitment is poorly estimated for final year*
6) Stock status: *$F < F_{MSY}$ and SSB > MSY Btrigger, Bpa, and Blim.*
7) Management plan: *A multiannual management plan (EU MAP) was adopted by the EU for this stock (EU, 2019). There is no agreed shared management plan with UK for this stock, and the advice is provided according to MSY approach.*

General comments

Report is well written and properly documented. Tables and figures have been correctly updated for 2022 data.

Technical comments

The assessment and forecast are done according to the stock annex. Recruitment in the last data year (2022) is replaced by the predicted one from stock-recruit relationship.

Conclusions

The assessment has been carried out correctly. The assessment and forecast model were performed as specified in the Stock Annex.

Review of ICES Scientific Report, WGBIE 2023 (03–11 May 2023)

Reviewer: Marta Gonçalves, IPMA, Portugal

Expert group Chair: Ching Villanueva and Santiago Cerviño

Secretariat representative: Anne Cooper

General

- The stock is currently classified as category 3 and assessed with UWTV survey abundance trends.
- The advice for this stock is annual and applies the 2/3 rule. The last assessment was conducted in the autumn of 2022.
- In 2022 the stock abundance decreased and, since the precautionary buffer was applied, the advised catch for 2023 decreased by 36%.
- Next advice will be provided in autumn 2023, based on the 2023 UWTV survey results.
- It was proposed that the stock could be upgraded to category 1 given that it can meet the requirements for this category, namely the estimation of MSY reference points. To do so, it was agreed to estimate Harvest Rates from the Separable Length Cohort (SCA) method, given the new survey area redefined in 2022, as well as the most recent length distributions, using all data up to 2022 but excluding 2023. The results will be discussed within the group to decide whether it should be benchmarked.

For single-stock summary sheet advice

Norway lobster (*Nephrops norvegicus*) in Division 9.a, Functional Unit 30

nep.fu.30

1) Assessment type: update of fishery-dependent data from 2022

2) Assessment: ICES framework for category 3 stocks

3) Forecast: not presented – it will be provided in autumn 2023

4) Assessment model: UWTV survey approach

5) Consistency: consistency can be evaluated upon the next assessment and advice, in autumn 2023

6) Stock status: The stock abundance decreased from 2021 to 2022. This stock has no specific reference points, so it is not possible to assess the status of the stock.

7) Management plan: ICES is aware of the EU multiannual plan (MAP) that has been agreed for this stock (Council Regulation (EU) 2019/472) and considers it to be precautionary when implemented at the FU level. There is no agreement with the UK regarding this plan, and it is not used as the basis for the advice for this stock. The MAP stipulates that when the FMSY ranges are not available, fishing opportunities should be based on the best available scientific advice.

General comments

The report is well structured and clear and in agreement with the Stock Annex.

Technical comments

Edits were added directly to the report where necessary using track changes.

Conclusions

The global information currently available, before the next autumn stock assessment, was correctly presented.

Audit of *nephrops* Functional Unit 31 (nep.fu.31), WGBIE 2023 3RD- 11TH of May

Reviewers: **David Murray**

Expert group Chair: **Ching Villanueva and Santiago Cerviño**

Secretariat representative: **Anne Cooper**

General

This is a category 2 stock with an assessment/forecast that is accepted for trends only. In 2021 the SPiCT model for nep.fu.31 was accepted at WKMSYSPiCT.

- SPiCT diagnostics and retrospective plots did not show any major problems.
- B_t/B_{MSY} and F_t/F_{MSY} Mohn's rho values are inside the range -2 to 2.
- Stock biomass (B) is below both $B_{trigger}$ and B_{lim}.
- Fishing mortality (F) is below F_{MSY}.

For advice other than single-stock summary fisheries advice

NA, this is a single-stock advice only.

For single-stock summary sheet advice

Stock: nep.fu.31

Short description of the assessment as follows (examples in grey text):

1) Assessment type: Category 2 stock.
2) Assessment: Analytical assessment for trends only
3) Forecast: Short term projections consider the fishing pressure in 2024 to be above MSY
4) Assessment model: A SPiCT model is used for this stock and input data comes from commercial fisheries catches (1983-2022) and SpGFS-WIBTS-Q4 (G2784) survey index (1983-2022).
5) Consistency: The assessment and short-term forecast follows the stock annex and SPiCT model generated during WKMSYSPiCT in 2021.
6) Stock status: Stock biomass (B) has been below $B_{trigger}$ since 2007, and below B_{lim} since 2012. Fishing mortality has been below B_{MSY} since 2009.
7) Management plan: This stock is not included in the multiannual plan for stocks fished in Western Waters. A fishing plan for the northwest Cantabrian ground was established in 2011 (ARM/3158/2011, BOE, 2011). This established an Individual Transferable Quota System (ITQs) which includes *nephrops*.

General comments: This assessment follows the stock annex which was updated after WKMSYSPiCT 2021 and an additional piece of coding (inp$stdevfacC=c(rep(1,34),4,4,4,4)) was added to increase uncertainty to catches in years where the TAC is zero.

There are several concerns for this stock moving forward with SPiCT. Firstly, as this stock is in such poor condition and TAC is once again zero it seems that uncertainty will need to be artificially inflated for the foreseeable future. Secondly, as SPiCT cannot cope with zero catch data, 2017 was removed from the assessment. With the Sentinel Fishery finishing in 2021 there is a chance that future catch data will also be zero which will impact the robustness of the assessment in the future. The stock coordinator cannot do anything about this, but it should be kept in mind by WGIE while the TAC is set to zero.

Technical comments: None

Conclusions: The advice is correct and was thoroughly assessed during WGBIE. The Stock Annex has been updated appropriately and the stock coordinator did a great job communicating their working and logic behind their assessment.

Template for audit of assessments made by EG members

Audit of Norway lobster (*Nephrops norvegicus*) in Division 9.a, functional units 26–27 (Western Galicia and northern Portugal)

Date: 11/05/2023
Auditor: Anxo Paz

Review of ICES Scientific Report, WGBIE 2023 (3/05-11/05)
Reviewers: Anxo Paz
Expert group Chair: Santiago Cerviño, Ching Villanueva
Secretariat representative: Anne Cooper

General

- The stock was benchmarked in 2021 (WKMSYSPiCT), where the Surplus Production in Continuous Time model (SPiCT) was accepted to provide advice, and the stock was upgraded to category 2.
- Zero catch advice was given in 2022 for three years (2023, 2024 and 2025).
- Stock data was updated with the 2022 information, indicating that the stock is depleted, so there are no changes in the stock status since last year advice.

For single stock summary sheet advice:
There is no advice this year, so there is no summary sheet available.

General comments
The report is well detailed, properly documented and clearly explained. Since there is no advice, no model has been applied.

Technical comments
There are no remarkable technical comments on this stock audit.

Conclusions
The assessment has not been performed this year. Next advice presumably in 2025.

Template for audit of assessments made by EG members

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

Template for audit of assessments made by EG members

Audit of Norway lobster (*Nephrops norvegicus*) in Division 9.a, functional units 28–29 (Atlantic Iberian waters East and southwestern and southern Portugal)

Date: 11/05/2023
Auditor: Anxo Paz

Review of ICES Scientific Report, WGBIE 2023 (3/05-11/05)
Reviewers: Anxo Paz
Expert group Chair: Santiago Cerviño, Ching Villanueva
Secretariat representative: Anne Cooper

General

- Category 3 stock with biennial assessment. Last advice in 2021. Last benchmark in 2021 (WKMSYSPiCT), where SPiCT was not accepted to provide assessment for this stock.
- Given the 2021 ICES guidelines to provide advice for data limited stocks, this stock should have been assessed using the ICES *rfb* rule. However, the length-based mortality estimators' model (MLZ), accepted in the 2021 benchmark, provides quite different results. Since the fishing pressure indicator from MLZ is based on more complete information, the WGBIE decision has been that the new rule will not be applied, following the ACOM recommendation.
- The standardized CPUE shows a decreasing pattern since 2018. The relative fishing mortality (the used fishing pressure indicator) obtained from the MLZ model, is well below FMSY for over a decade, which suggests that the stock is exploited in sustainable levels. Discards are considered negligible and an uncertainty cap is applied, reducing catches by 20% in relation to the last advice (from 266 tonnes in 2022 and 2023 to 213 tonnes for 2024 and 2025).
- Later in 2023, WKLIFE XII has as one of its terms of reference to explore methods for *Nephrops* after which new guidelines will be available for the next advice.

For single stock summary sheet advice:

1) **Assessment type:** Updated.
2) **Assessment**: Trends from standardized commercial CPUE and relative F obtained from MLZ.
3) **Forecast**: Not presented.
4) **Assessment model**: Model length-based mortality estimators (MLZ) based on commercial catches from Portugal (1984-2020) and Spain (2011-2022), one commercial CPUE index from the Portuguese crustacean trawl fleet (1998-2022), and the length composition from Portuguese commercial catches.
5) **Consistency**: The relative natural mortality obtained by MLZ as in the 2021 advice will continue to be used as an indicator of fishing pressure this year, instead of the ICES rfb rule, proposed in the 2021 ICES guidelines to provide advice for data limited stocks.
6) **Stock status**: The standardized commercial CPUE used as a biomass index shows a decreasing trend since 2018. Fishing pressure on the stock is below the FMSY proxy.
7) **Management Plan**: The stock is included in the EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters.

Template for audit of assessments made by EG members

General comments

The assessment follows the stock annex. The report is well detailed, properly documented and clearly explained. The advice was accepted.

Technical comments

MLZ model, is well below FMSY for over a decade, which suggests that the stock is exploited in sustainable levels, but an uncertainty cap is applied, reducing catches by 20% in relation to the last advice due to a decreasing pattern in the standardized CPUE since 2018. The relative fishing mortality obtained from MLZ (accepted in the 2021 benchmark) was applied in this stock despite the ICES rfb rule gived in the 2021 ICES guidelines to provide advice for data limited stock, since MLZ is based on more complete information. Later in 2023, WKLIFE XII has as one of its terms of reference to explore methods for *Nephrops* after which new guidelines will be available for the next advice.

Input and output data were revised and it is verified that they are correct

Conclusions

The assessment has been performed correctly.

Template for audit of assessments made by EG members

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

Audit of ple.27.89a, WGBIE 2023 3[RD]- 11[TH] of May

Reviewers: **David Murray**

Expert group Chair: **Ching Villanueva and Santiago Cerviño**

Secretariat representative: **Anne Cooper**

General

Plaice in Bay of Biscay and Atlantic Iberian waters is a category 5 stock with no biological reference points. Advice for this stock is biennial and the advice for 2024 and 2025 is that landings should be no more than 124 tonnes.

For advice other than single-stock summary fisheries advice

Section: **NA**

This is single-stock advice only.

For single-stock summary sheet advice

Stock: **ple.27.89a**

Short description of the assessment as follows (examples in grey text):

1) Assessment type: **category 5 stock.**
2) Assessment: **Non-analytical, assessment is based on trends.**
3) Forecast: **NA**
4) Assessment model: **NA**
5) Consistency: **The language in the use of the precautionary buffer needs to be checked on the draft report and advice sheet.**
6) Stock status: **Reference points are undefined.**
7) Management plan: **The EU Multiannual Plan for the Western Waters (MAP; EU, 2019) takes bycatch of this species into account**.

General comments:

I'm slightly confused regarding the use of the precautionary buffer. The presentation (slide 2) states that the precautionary buffer was applied in 2019 (for the 2020 and 2021 advice). According to the current advice draft advice sheet on the SharePoint, under 'Catch Scenarios', the precautionary buffer was also applied in 2021 (for the 2022 and 2023 advice) and has been applied again for the 2024 and 2025 advice. However, when I look at the report (16.3.1.2) it states that the precautionary buffer was applied in 2019 (for the 2020 and 2021 advice) and is therefore not applied this year (2022 and 2023).

Check to make sure the report and advice sheet reflect when the precautionary buffer was applied, if it was applied during 2020, 2021, 2022 and 2023, does this mean it shouldn't be applied this advice cycle (2024 and 2025)? I was under the impression that to avoid repeated advice for catch reduction, the precautionary buffer is applied at intervals. This may just be a typo which is easily fixed.

Commented [MDIBP01]: BuBuffer was applied during wgbie 2019 for wanted catch advice 2020 and 2021. During wgbie 2021, it hasn't been applied for wanted catch advice 2022 and 2023. So during wgbie 2023 it has been applied. Actually, a there was a mistake in the sentence of the report section "current assessment. This has been corrected.

Technical comments:

Stock was put forward f FOR éàéàor SPiCT assessment, however no survey was able to provide reliable biomass indices.

Conclusions:

Information on the use of the precautionary buffers needs to be checked on the advice draft sheet and report, otherwise the assessment has been undertaken correctly.

Review of ICES Scientific Report, WGBIE 2023 (03–11 May 2023)

Reviewers: Yolanda Vila

Expert group Chair: Ching Villanueva and Santiago Cerviño

Secretariat representative: Anne Cooper

General

- Category 1 stock.
- This stock was assessed and projections were performed with some issues.
- The abundance index ORHAGO use in the assessment according to the stock annex could not be derived because the half of hauls was missing by bad weather conditions during the survey. Different options to conduct the assessment were presented to the WGBIE, which are included in a working document (WD 01).
- The assessment has been performed but there was a deviation of the stock annex related to the survey index.

For single-stock summary sheet advice

Sole (*Solea solea*) in divisions 8.a–b (northern and central Bay of Biscay) sol.27.8ab

Short description of the assessment as follows:

1) Assessment type: Updated

2) Assessment: Analytical assessment. Accepted

3) Forecast: Accepted

4) Assessment model: Age-structured Extended Survivors Analysis (XSA; Shepherd, 1999) model. The assessment was carried out using R FLXSA package (Kell, 2020) in R (R Core Team, 2020): Landings and tunning by 1 survey and 4 commercial LPUEs. Discards are not used in the assessment, but used for projected discards.

5) Consistency: The abundance index ORHAGO was not used in the assessment this year. This year's assessment has resulted in a downward revision of recruitment in recent years.

6) Stock status: Stock biomass is below MSY $B_{trigger}$ and between B_{pa} and B_{lim}; Fishing pressure decreased and is below F_{MSY}.

7) Management plan: The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters applies to this stock. The plan specifies conditions for setting fishing opportunities depending on stock status and making use of the FMSY range for the stock.

General comments

The report was well structured, written, properly documented and easy to follow.

Technical comments

- Recruitment has been well estimated by the model since 2013 and decline since 2015 with the lowest values recorded in 2019, 2020 and 2021.
- Recruitment in 2022 was assume as the geometric mean for the 2019-2021 period for short-term projections because the survey index ORHAGO was not used in the assessment. That period was considered more realistic of the recruitment in recent years than the historical geometric mean specified in the stock annex (GM2016-2021).

- SSB has been decreasing in recent years but a slight increase of SBB is predicted in the short-term forecast in 2024. SSB continue below MSY $B_{trigger}$ and B_{pa}.
- Fishing mortality (F) has decreased in the last years and is below F_{MSY}.

<u>Conclusions</u>

The assessment has been performed correctly.

Review of ICES Scientific Report, WGBIE 2023 (03–11 May 2023)

Reviewers: Jean-Baptiste Lecomte

Expert group Chair: Ching Villanueva and Santiago Cerviño

Secretariat representative: Anne Cooper

General

- Benchmarked in January 2023 during the WKMSYSPiCT2. Assessment using the SPiCT model were not conclusive, but a commercial LPUE has been accepted by the benchmark. Cath data were revised during the benchmark.
- : This stock was moved from category 5 to category 3 using commercial LPUE and catch length structures.
- The advice is based on the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), multiplied by the recent catch advice, a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard and a precautionary multiplier.
- The 2023 advice decreased of 17% compared to the 2022 advice. This decrease can be explained by a decrease in the biomass index, the low biomass safeguard and the precautionary multiplier.

For single-stock summary sheet advice

[Whiting (Merlangius merlangus) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters) - whg.27.89a]

Short description of the assessment as follows:

1) Assessment type: Category 3 Length Based Indicator method (LBI) as fishing pressure indicator.

2) Assessment: accepted

3) Forecast: not presented, no forecast with .Cat 3 stock using LBI approach.

4) Assessment model: No model used. Cat 3 stock using LBI approach.

5) Consistency: last year's assessment Cat 5, now Cat 3 if accepted by the review group in May.

6) Stock status: Landings are decreasing since 2010, but are stable since 2020. Biomass index is also decreasing since 2010, with an important decrease observed between 2016 and 2017.The biomass index ratio is stable since 2017 with some variation between 0.6 and 0.8.

7) Management plan: The EU multiannual plan (MAP; EU, 2019) for stocks in the Western Waters and adjacent waters applies to this stock. The MAP stipulates that when the FMSY ranges are not available, fishing opportunities should be based on the best available scientific advice.General comments

Technical comments

The ICES framework for category 3 stocks was applied (rfb-rule to provide MSY advice, Method 2.1, ICES, 2021b).

Conclusions

The report and the advice sheet present the advice given for whiting using a Cat3 advice. The WGBIE was in favour of using a Cat3 advice instead of a Cat5 after the presentation of the improvement made during the WKMSYSPiCT2 benchmark even if the results obtained with the SPicT model were not conclusive.

The report is well written and the assessment as been done correctly.

Review of ICES Scientific Report, WGBIE *2023* (*03-11 May 2023*)

Reviewer: João Pereira (IPMA, Portugal)

Expert group Chair: Santiago Cerviño

Secretariat representative: Anne Cooper

General
The current stock annex and report for this stock are outdated in that there are additional data available from research on recreational fisheries in Portugal (two projects – one for general recreational fisheries and another for recreational fisheries conducted in MPAs) that has not been taken into consideration and contains relevant information. A review of this work should be undertaken in time for the 2024 WGBIE.

Section: A.2. Fishery

Fishery management regulations

Short description
This section attempts to describe the regulatory framework, but incorrectly describes the daily limits for recreational catches in Portugal.

Comments
Where it is said that: "the total catch of fish and cephalopods by each fisher must be less than 10 kg per day"

It should be said that: "the total catch of fish and cephalopods by each fisher must be less than 10 kg per day or 15kg per day for spear fishing, excluding, in both cases, the largest fish"

Reference
Diário da República, 1.ª série — N.º 16 — 23 de janeiro de 2014; Portaria n.º 14/2014, of the 23rd January, article 12, n.º 1 ("*O peso total das capturas diárias na pesca lúdica não pode, no seu conjunto, exceder 10 kg por praticante, não sendo contabilizado para o efeito o exemplar de maior peso, sendo que para a pesca submarina este limite é de 15 kg, não sendo igualmente contabilizado o maior exemplar.*")

Section: 15.4.5 Recreational removals

Short description
This section presents the available information on the recreational removals (catch) of fish from the stock

Comments
Where it is said that: "Recreational removals of sea bass in divisions 8.c and 9.a are unquantified but are considered not negligible ."

I argue that the sentence is inadvertedly conferring a lower importance to the recreational removals than the most recent research is showing. In order to better set the stage for a forthcoming reassessment of the importance of these removals, I propose the tone to be slightly upped: "Recreational removals of sea bass in divisions 8.c and 9.a are currently unquantified but are considered to be substancial."

General comments
The report is solid in that it follows the guidelines and presents the findings in adequate, clear and concise language. The format, results and conclusions are state-of-the-art in respect of the available information which is logged in the appropriate

repositories. The auditor is aware of new results form two research projects on recreational fisheries in Portugal, one on general recreational removals in the country

Technical comments
No specific comments.

Conclusions
The current report follows the appropriate structure and is correctly developed around the available information, considering the official submission of data through the established channels.

The auditor of the review is aware of new results from two research projects on recreational fisheries conducted recently in Portugal, that are especially relevant to the results of the assessment for this stock.

1) The first was conducted during the pandemic and is currently initiating a second phase. The first report may be accessed but is not currently available online. The website for this project is: https://pescardata.pt/
2) The second was conducted with a view to assess the impact of this type of fisheries in the coastal MPAs in Portugal, and covers a significant part of the recreational fisheries, since the attraction of these areas to these activities is significant. The results of this project can be accessed through the following link: https://www.dgrm.mm.gov.pt/web/guest/dados-estatisticos

In future WGBIE, an effort should be made to include results and conclusions of these projects in the advice.

Audit of Anglerfish (*Lophius budegassa*) in Divisions 8c and 9a.

Working group: WGBIE
Date: 11/05/2023
Reviewer: Agurtzane Urtizberea
Expert group Chair: Santiago Cerviño and Chin Villanueva
Secretariat representative: Anne Cooper

Audience to write for: advice drafting group, ACOM, and next year's expert group

General

- The stock is managed under a combined species TAC with Lophius piscatorius.
- The last benchmarked conducted was in 2021 and a stochastic production model in continuous-time (SPiCT) was accepted.
- Mohn's rho for B/BMSY and F/FMSY values are within the accepted range for long live species and does not indicate strong retrospective pattern.
- B is estimated to be above MSY Btrigger proxy the all time series.
- Fishing pressure(F) is below FMSY proxy.

For single-stock summary sheet advice

Stock: Black-bellied anglerfish (Lophius budegassa) in divisions 8.c and 9.a (Cantabrian Sea, Atlantic Iberian waters)

Short description of the assessment as follows (examples in grey text):

1) Assessment type: update
2) Assessment: analytical assessment
3) Forecast: Short-term projections consider the fishing pressure in the intermediate year as the estimated F at the time-step of the last observation and the estimated seasonal F process. All the scenarios considered for fishing pressure are expected to keep the stock above BMSY in 2023.
4) Assessment model: The assessment is dependent on commercial catches and on one commercial index. The model robustness was checked to different initial parameter values, results point to the existence of two local optima in the likelihood function. However, most of the runs agree in the final value, which corresponds to the best fit (the objective functions of both models were compared). The model will be consistent in the results as SPiCT always uses the same initial parameters. Model diagnostics are good.
5) Consistency: The assessment and the short-term forecast follows the stock annex.
6) Stock status: Stock biomass was above MSY Btrigger proxy (0.5×BMSY proxy) over the whole time series; F has been below FMSY proxy for the last 20 years.
7) Management plan: Although the stock is included in the multiannual plan for stocks fished in the Western Waters and adjacent waters, FMSY ranges were not yet defined.

General comments: The assessment follows stock annex, which has been updated. The report is well written, the advice is correct and the communication with the stock coordinator has been very good.

Technical comments: The conclusion of the last benchmark was that the model is good enough to give advice. However, the main issues are the standardization of the CPUE indices, an index covering the all area is missing and more knowledge on the historical catches. In addition, the advice is increasing to much higher catches than what they catch while the effort is decreasing.

Conclusions: All the technical issues mentioned above could be explored in a benchmark.

Template for audit of assessments made by EG members

Text in italics is explanatory – to be deleted from final report

Audit of (ank.27.78abd)

Date: 09/05/2023

Auditor: Marta Cousido Rocha

General

- Report and advice sheet were reviewed and comments were added to documents using track changes and communicated to stock coordinator via email.

For single stock summary sheet advice:

1) **Assessment type:** The Stock Synthesis model accepted in the WKAngHake 2022.
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: Stock Synthesis. Input data: combined French and Irish survey index which is referred to by the ICES acronym FR_IE_IBTS, the Irish Anglerfish and Megrim survey IAMS (G3098) and landings and discards data from two commercial fleets (trawls and gillnets). Discard trend and length frequency distributions, and landings trend and length frequency distributions started at 2003, 2003, 1950 and 1986, respectively. FR_IE_IBTS and IAMS length frequency distributions are considered by sex.
5) **Data issues:** UK submitted revised landings data in October 2022 resulting in an increase of 1,319 tonnes of landings for 2021.

   The discard rates of the French OTB_CRU and OTB_DEF fleets appeared to be unrealistically high and were replaced with the average discard rates of other OTB_CRU and OTB_DEF fleets from 2017-2022.
6) **Consistency**: Second year of assessment using Stock Synthesis model accepted in the WKAngHake 2022. Model details are correct specified in the stock annex.
7) **Stock status**: Fishing pressure on the stock is below FMSY and total biomass is above BMSY, Btrigger and Blim.
8) **Management Plan**: Multiannual plan for the North Western Waters and adjacent waters (Commission Delegated Regulation (EU) 2019/472) for anglerfish.

General comments

Detailed and clearly explained information.

Technical comments

The report does not present any issues. The assessment is carried out according the stock annex, the Stock Synthesis model accepted in the WKAngHake 2022.

Short-term prediction is done using FLR instead of SS; however, Section D in the stock annex does not mention that. If the use of FLR for predictions was agreed in the Benchmark, a comment about it should be included in the stock annex.

Conclusions

The assessment has been performed correctly.

Template for audit of assessments made by EG members

Text in italics is explanatory – to be deleted from final report

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? Yes
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

Review of ICES Scientific Report, WGBIE 2023 (03–11 May 2023)

Reviewers: Bárbara Serra Pereira

Expert group Chair: Ching Villanueva and Santiago Cerviño

Secretariat representative: Anne Cooper

General

- Category 1 stock.
- Benchmarked in 2022, with change of assessment model, Age-based assessment 'Assessment for all' (a4a; ICES, 2022), and review of the input data (ICES. 2022. Benchmark workshop for selected megrim stocks (WKMEGRIM). ICES Scientific Reports. 4:53. http://doi.org/10.17895/ices.pub.20069000.)
- No data revisions performed in 2023
- The stock assessment and projections were performed without any particular issues, and according to the stock annexe (updated in 2022).
- The two species of megrim - megrim (*Lepidorhombus whiffiagonis*) and four-spot megrim (*Lepidorhombus boscii*) - are subject to a common TAC

For single-stock summary sheet advice

Four-spot megrim (*Lepidorhombus boscii*) in divisions 8.c and 9.a (southern Bay of Biscay and Atlantic Iberian waters East), ldb.27.8c9a

Short description of the assessment as follows:

1) Assessment type: update

2) Assessment: accepted (analytical assessment)

3) Forecast: presented and following the ICES rules for category 1 stocks.

4) Assessment model: Age-based assessment a4a + 2 surveys (G2784 and G2913)

5) Consistency: The 2023 assessment is consistent with the 2022 assessment and the methods described in the stock annex. Results are consistent and the assessment and forecast were accepted.

6) Stock status: SSB is above MSY $B_{trigger}$, B_{pa}, and B_{lim}. F is below F_{MSY}.

7) Management plan: The EU multiannual plan (MAP) for demersal stocks and their fisheries in the Western Waters and adjacent waters applies to this stock (EU Parliament and Council Regulation no. 2019/472, of 19 March 2019). The plan specifies conditions for setting fishing opportunities depending on stock status and defines the target fishing mortality within the range of F_{MSY}.

General comments

The section is well structured, properly documented and it is easy to follow. No inconsistencies in the text or in tables or figures were detected. The data, assessment and forecast were used/realized according to the Stock Annexe. The advice for 2024 is 3% higher than the advice for 2023 due to an upward revision of SSB.

Technical comments

- Assessment years are 1986–2022 and ages 0–7+.
- Catches in recent years are the lowest of the time series.
- Portuguese survey considered until 2018, as revision of the most recent values in the data series is still needed due to new vessel being used.
- Discards of age-0 with trend in the residuals - and removed from the model (benchmark decision).

- The residuals show a slight trend in catch, with higher values in the last 4 years.
- No relevant issues in the retrospective pattern

- Recruitment for 2022 replaced by the historical geometrical mean (GM1990-2020) for short-term projections.
- SSB is above MSY $B_{trigger}$, B_{pa}, and B_{lim} and with an increasing trend in the most recent years. Since 2015 the values are the highest of the time-series, with a maximum in 2022.
- The fishing mortality (F) is below F_{MSY} since 2017, and the lowest in the time-series. The F time-series shows an overall decreasing trend since the early 90s.
- The recruitment (age 0) has been decreasing since 2014, with a small increase in the last two years (2022-2023).

- ***Stock annex:*** Updated in 2022

- ***Report:*** Minor edits were added directly to the report where necessary using track changes.

- ***Advice sheet*** Minor corrections added directly using track changes.

Conclusions

The assessment has been performed correctly and according to stock annex.

Template for audit of assessments made by EG members

Text in italics is explanatory – to be deleted from final report

Audit of nep.fu.25

Date: 18/05/2023

Auditor: Esther Abad

General

- Stock with TAC=0.

For single stock summary sheet advice:

1) **Assessment type:** As it was decided in 2022 to set the TAC=0 for the next 3 years, no assessment was performed during this WG and no new advice was given.
2) **Assessment**:
3) **Forecast**:
4) **Assessment model**:
5) **Data issues:**
6) **Consistency**:
7) **Stock status**: Fishing pressure on the stock is below FMSY and total biomass is below BMSY, Btrigger and Blim.
8) **Management Plan**: ICES is not aware of any agreed precautionary management plan for Norway lobster in this area.

General comments

Th report is well documented. Some minor issues were reported to the author.

Technical comments

Conclusions

Template for audit of assessments made by EG members

Text in italics is explanatory – to be deleted from final report

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? No assessment this year
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
- Have the data been used as specified in the stock annex?
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any major reason to deviate from the standard procedure for this stock?
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

Review of ICES Scientific Report, WGBIE 2023 (03–11 May 2023)

Reviewers:	Sonia Sánchez-Maroño (AZTI, Spain)
Expert group Chair:	Santiago Cerviño and Ching Villanueva
Secretariat representative:	Anne Cooper

General

This is a Category 5 stock, and no quantitative assessment is carried out. There is no request to give advice in 2023, as last year the advice was provided for the period 2023-2025. The precautionary buffer was not applied, so the previous advice was maintained.

For single-stock summary sheet advice

Four-spot megrim in divisions 7.b-k, 8.a-b, and 8.d (ldb.27.7b-k8abd).

1) Assessment type: no assessment (ICES category 5).
2) Assessment: not presented.
3) Forecast: not presented.
4) Assessment model: no model used (only exploratory data analysis).
5) Consistency: consistent with previous year exploratory analysis.
6) Stock status: uncertain, not enough data to estimate reference points.
7) Management plan: The EU multiannual plan (MAP) for stocks in Western Waters and adjacent waters (EU, 2019) takes into account bycatch of this species. There is no agreed shared management plan with UK for this stock, and ICES provides advice according to ICES Precautionary approach. A combined species TAC is set for four-spot megrim (*Lepidorhombus boscii*) and megrim (*Lepidorhombus whiffiagonis*)

General comments

The report is well written and data were correctly updated.

Technical comments

Assessment has been carried out following the ICES procedure for Category 5 stocks.
Some suggested minor edits have been added to the report and Stock Annex for consideration of the stock coordinator.

Conclusions

The assessment has been carried out adequately. No advice has been provided this year.

Review of ICES Scientific Report for stock mon.27.8c9a (WGBIE 2023 3-11th May 2023)

Reviewers: Eoghan Kelly (Marine Institute, Ireland)

Expert group Chair: Ching-Maria Villanueva and Santiago Cerviño López

Secretariat representative: Anne Cooper

General

- Category 1 stock (Stock Synthesis)
- Update assessment and projections were carried out using 2022 data according to the stock annex

For single-stock summary sheet advice

Stock: White anglerfish (*Lophius piscatorius*) in divisions 8.c and 9.a

Short description of the assessment as follows (examples in grey text):

1) **Assessment type:** update
2) **Assessment:** accepted
3) **Forecast:** accepted
4) **Assessment model:** SS3 update assessment in relation to the model assessment adopted in the 2018 WKANGLER benchmark.
5) **Consistency:** Last year's assessment (ICES, 2022) was updated with the inclusion of the 2022 data.
6) **Stock status:** SSB2023 > Bpa; F2022 < FMSY < Fpa; R seems to have moderately increased in recent years
7) **Management plan:** The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters applies to this stock. The plan specifies conditions for setting fishing opportunities depending on stock status and making use of the FMSY range for the stock.

General comments

Report is well written, properly documented and tables and figures have all been correctly updated for 2022 data.

Technical comments

- Impact of inclusion of unallocated landings from 2011-2019 in assessment is unclear.
- Since 2012 there has been no commercial abundance indicator which may affect SSB and F estimation for larger individuals.

Conclusions

The assessment has been performed correctly and documented accurately in the EG report.

Annex 6: Stock annex edits

ank.27.78abd

Stock Annex: Black-bellied anglerfish (*Lophius budegassa*) in Subarea 7 and divisions 8.a–b and 8.d (Celtic Seas, Bay of Biscay). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.21623154

ank.27.8c9a

Stock annex: Black-bellied anglerfish (*Lophius budegassa*) in divisions 8.c and 9.a (Cantabrian Sea, Atlantic Iberian waters). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23606046

hke.27.3a46-8abd

Stock Annex: 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). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.21623226

hke.27.8c9a

Stock Annex: Hake (*Merluccius merluccius*) in divisions 8.c and 9.a, Southern stock (Cantabrian Sea and Atlantic Iberian waters). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.21623340

ldb.27.7b-k8abd

Stock annex: Four-spot megrim (Lepidorhombus boscii) in divisions 7.b-k, 8.a-b, and 8.d (west and southwest of Ireland, Bay of Biscay). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23608032

ldb.27.8c9a

Stock Annex: Four-spot megrim (*Lepidorhombus boscii*) in divisions 8.c and 9.a (southern Bay of Biscay and Atlantic Iberian waters East). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23261030

meg.27.7b-k8abd

Stock Annex: Megrim (*Lepidorhombus whiffiagonis*) in divisions 7.b-k, 8.a-b, and 8.d (west and southwest of Ireland, Bay of Biscay. ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23261078

meg.27.8c9a

Stock Annex: Megrim (*Lepidorhombus whiffiagonis*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23261081

mon.27.78abd

Stock Annex: White anglerfish (*Lophius piscatorius*) in Subarea 7 and divisions 8.a–b and 8.d (Celtic Seas, Bay of Biscay). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.21623349

nep.fu.2324

Stock annex: Norway lobster (*Nephrops norvegicus*) in divisions 8.a and 8.b, Functional Units 23-24 (northern and central Bay of Biscay). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23607954

nep.fu.2829

Stock annex: Norway lobster (*Nephrops norvegicus*) in Division 9.a, Functional Units 28-29 (Atlantic Iberian waters East and southwestern and southern Portugal). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23607939

sol.27.8ab

Stock annex: Sole (*Solea solea*) in divisions 8.a-b (northern and central Bay of Biscay). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23607891

sol.27.8c9a

Stock annex: Sole (*Solea solea*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters). ICES Stock Annexes. https://doi.org/10.17895/ices.pub.23607981