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 $F_{3\text{-}6}$ 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 $F_{3\text{-}6}$.

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, $F_{3\text{-}6}$, SSB and recruitment are plotted in Figure 7.7. $F_{3\text{-}6}$ in 2022 is estimated by XSA (Shepherd, 1999) to have been at 0.26. $F_{3\text{-}6}$ 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, $F_{3\text{-}6}$ 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	$B_{lim} = B_{pa} / \exp(\sigma \times 1.645)$; $\sigma = 0.20$; 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 $F_{3\text{-}6}$ 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 $GM_{2019\text{-}2021}$ 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

AGLIA, 2009. Etude d'impact à court terme d'une augmentation du maillage pour la flottille chalutière de la Côtinière.

Berthou Patrick, Leblond Emilie, Demaneche Sebastien (2010). Redressement des données 2009 - application SACROIS . Ministère de l'Agriculture, de l'Alimentation, de la Pêche, de la Ruralité et de l'Aménagement du territoire, DPMA, Paris 75 , Ref. 10-1862 , 3p., 1p., 3p. https://archimer.ifremer.fr/doc/00024/13497/

EU. 2002. Council Regulation (EC) No. 2431/2002 fixing for 2003 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required.

EU. 2006. Council Regulation (EC) No 388/2006 of 23 February 2006 establishing a multiannual plan for the sustainable exploitation of the stock of sole in the Bay of Biscay.

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, L 83: 1–17. http://data.europa.eu/eli/reg/2019/472/oj.

Demaneche Sebastien, Begot Eric, Gouello Antoine, Habasque Jeremie, Merrien Claude, Leblond Emilie, Berthou Patrick, Harscoat Valerie, Fritsch Manon, Leneveu Clement, Laurans Martial (2010). Projet SACROIS "IFREMER/DPMA" - Rapport final - Convention SACROIS 2008-2010.

Demaneche Sebastien, Begot Eric, Gouello Antoine, Merrien Claude, Weiss Jerome, Leblond Emilie, Vignot Celine, Rouyer Armelle (2021). Rapport d'activité Sacrois - Valid & Expertise sur les données d'activité de pêche. Convention Socle Halieutique DPMA-Ifremer 2020 . Article 3.3 Accompagnement de la maîtrise d'ouvrage de la DPMA, relatif à son expertise halieutique, dans le cadre des projets Sacrois et Valid.

Gerritsen, H. and Minto, C. 2019. Filling in missing EVHOE survey data for the Black anglerfish in 7,8abd using the vector autoregressive spatio-temporal (VAST) model, WD 01, 599-608. In ICES. 2019. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). 2–11 May 2019. Lisbon, Portugal. ICES Scientific Reports. 1: 31, 692 pp. http://doi.org/10.17895/ices.pub.5299

ICES. 2011. Report of the Benchmark Workshop on Flatfish (WKFLAT), 1–8 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:39. 257 pp.

ICES. 2013a. Report of the Planning Group on Commercial Catches, Discards and Bio-logical Sampling (PGCCDBS 2013), 18–22 February 2013, Belfast, Northern Ireland. ICES CM 2013/ACOM: 49. 128 pp.

CES. 2013b. Report of the Working Group on Beam Trawl Surveys (WGBEAM), 23–26 April 2013, Ancona, Italy. ICES CM 2013/SSGESST: 12, 260 pp.

ICES. 2013c. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM), 10–16 May 2013, ICES Headquarters, Copenhagen. ICES CM 2013/ACOM:11A. 11 pp.

ICES. 2016a. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.4.1. 13 pp. http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/Special_Requests/EU_FMSY_ranges_for_selected_Western_Waters_Stocks.pdf

ICES. 2016b. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM: 58. 187 pp.

ICES. 2016c. Report of the Working Group on Beam Trawl Surveys (WGBEAM), 14–17 April 2015, Leuven, Belgium. ICES CM 2015/SSGIEOM: 20, 148 pp.

ICES. 2020. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 2:49. 845 pp. http://doi.org/10.17895/ices.pub.6033

ICES. 2019. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). 2–11 May 2019. Lisbon, Portugal. ICES Scientific Reports. 1: 31, 692 pp. http://doi.org/10.17895/ices.pub.5299

ICES. 2021. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 3:48. 1101 pp. https://doi.org/10.17895/ices.pub.8212

ICES. 2022. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 4:52. http://doi.org/10.17895/ices.pub.20068988

ICES. 2023a. Advice on fishing opportunities. In Report of the ICES Advisory Committee. ICES Advice 2023. Section 1.1.1. https://doi.org/10.17895/ices.advice.22240624.

ICES. 2023b. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. X:XX

ICES. 2023c. Working Group on Beam Trawl Surveys (WGBEAM). ICES Scientific Reports. 5:48. 84 pp. https://doi.org/10.17895/ices.pub.22726112

Ifremer. 2015. Évaluation de mesures de gestion pour le stock de sole (*Solea solea*) du Golfe de Gascogne. Saisine DPMA n°15–8690.

Kell, L. 2020. "Flr/Flxsa: EXtended Survivor Analysis for Flr." Flr. URL: http://flr-project.org/FLXSA

Lecomte, J.-B. 2023a. 2022 ORHAGO survey in the Bay of Biscay (B1706). WD XX , xx.-xx. In ICES. 2023. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). Hybrid meeting - ICES Headquarters and online, 3–12 May 2023. ICES Scientific Reports. X:XX.

Lecomte, J.-B. 2023b. Sole in the Bay of Biscay (B1706; ICES area 8)-2022 ORHAGO survey, Annex 7.1, 51-53. In ICES. 2023. Working Group on Beam Trawl Surveys (WGBEAM). ICES Scientific Reports. 5:48. 84 pp. https://doi.org/10.17895/ices.pub.22726112

Merzéreaud, M., Biais, G., Lisardy, M., Bertignac, M., and Biseau, A. 2013. Evaluation of proposed harvest control rules for Bay of Biscay sole, September 2013. ICES CM 2013/ACOM:75. 18 pp.

Mohn, R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES Journal of Marine Science, 56: 473–488.

OBSMER. 2003. OBServations à la MER à bord des navires de pêche professionnels sur les côtes françaises de métropole. URL: https://sextant.ifremer.fr/record/24538369-ea5a-48d7-a89b-0c9530247ed2/

R Core Team, 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/

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, 56: 584–591.

SIH Harmonie. 2003. ObsMer (Observations à la Mer à bord des navires de pêche professionnelle sur les côtes françaises de métropole). https://sextant.ifremer.fr/record/24538369-ea5a-48d7-a89b-0c9530247ed2/

Tellier C., Lecomte, J.B., Vermard, Y. 2022. Updating commercial LPUE for stock assessment of sole stock in 8.a.b: a preliminary approach. WD 02, 673-690 p. In ICES. 2022. Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 4: 52. http://doi.org/10.17895/ices.pub.20068988.

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 landings	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 landings	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).

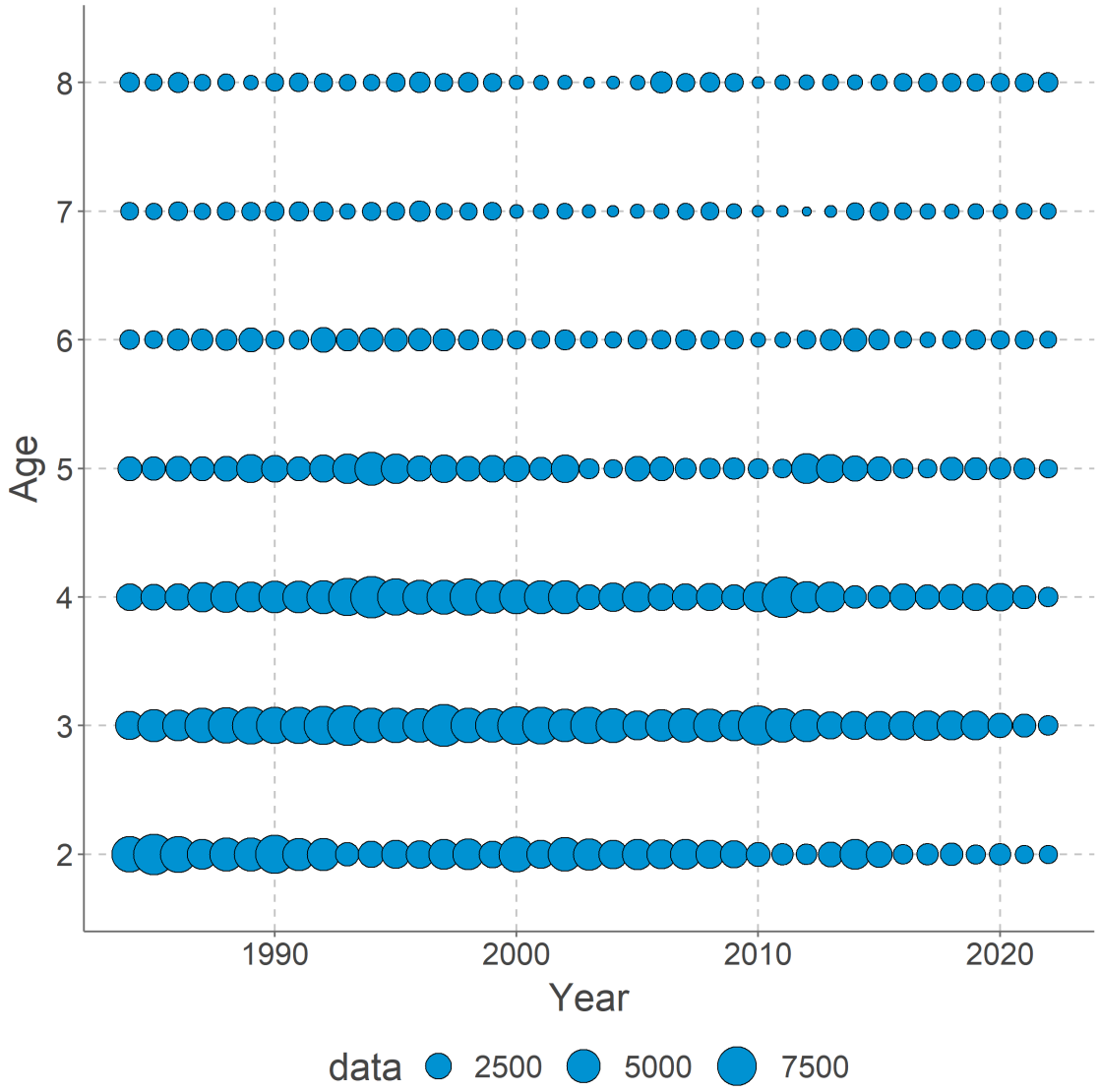

Figure 7.1. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Landings-at-age distributions.

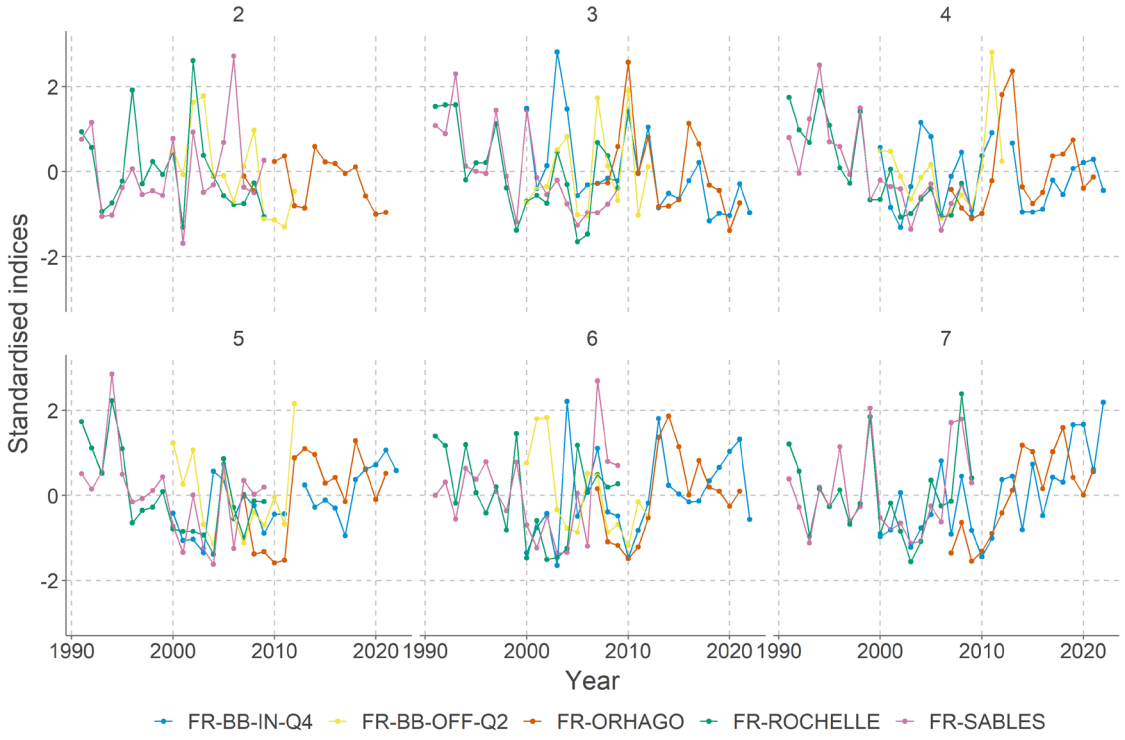

Figure 7.2. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Time-series of standardized indices per age class. Colours represent tuning fleets.

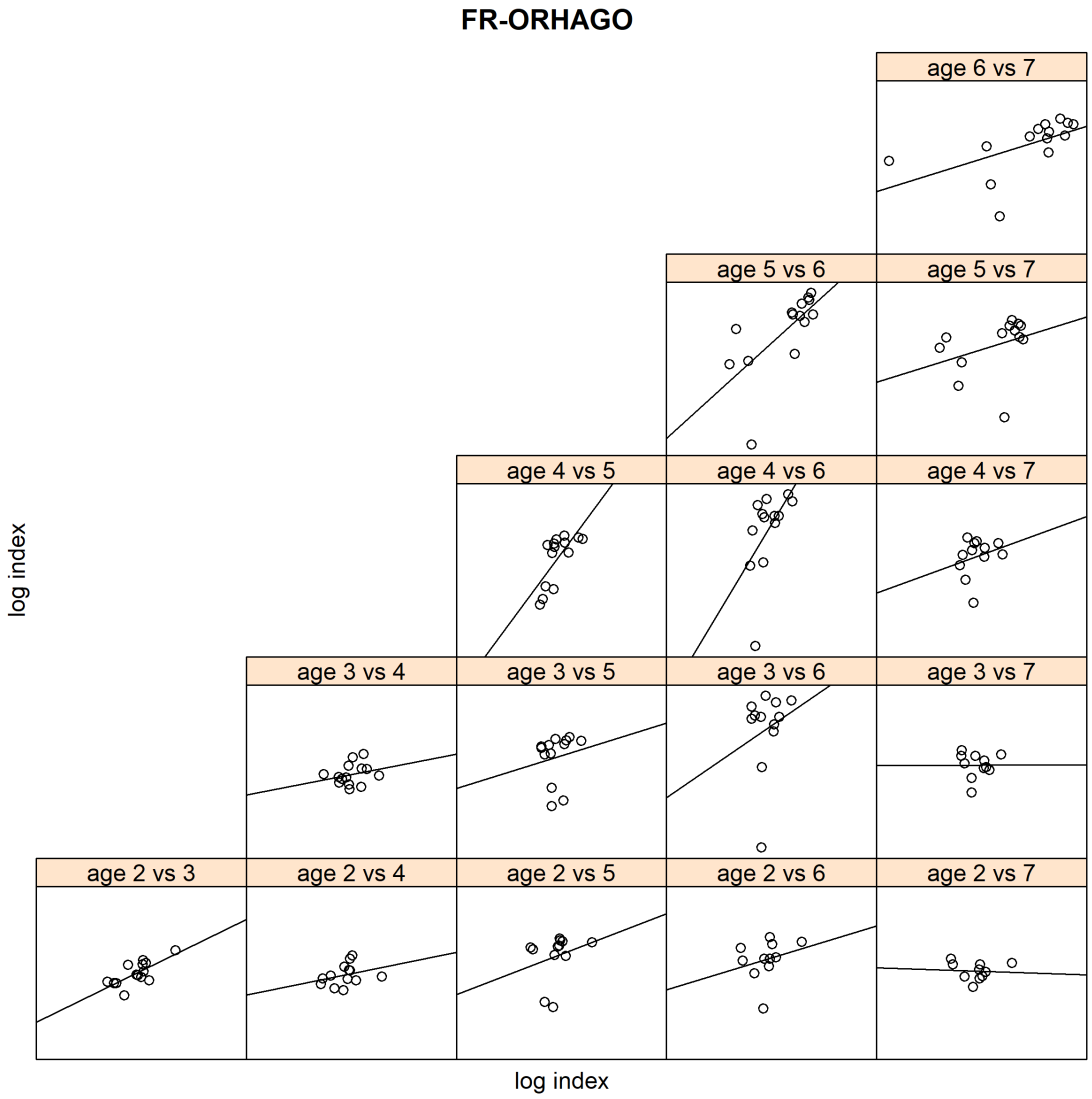

Figure 7.3. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b.Internal consistency of the ORHAGO (B1706) survey indices.

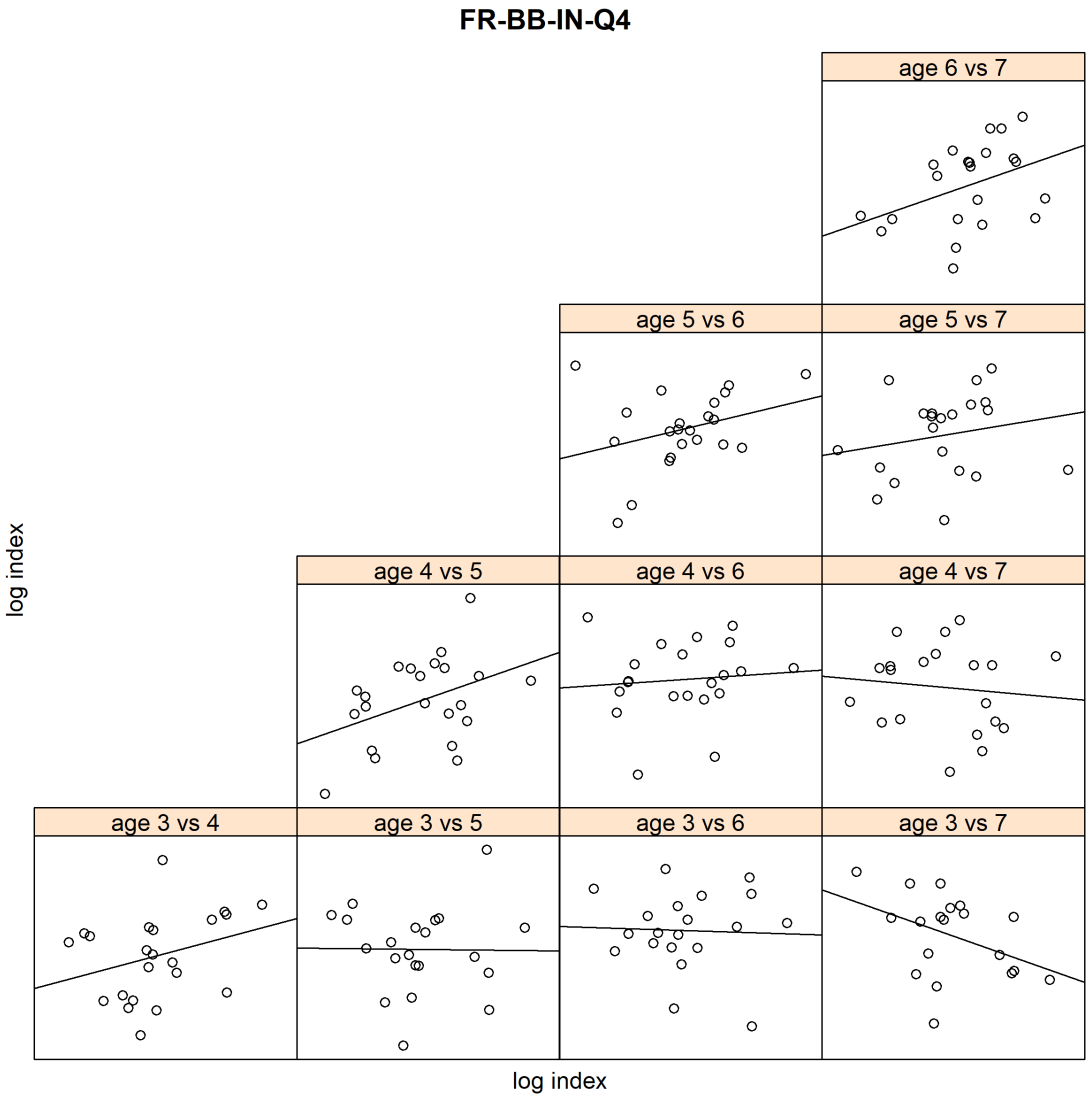

Figure 7.4. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Internal consistency of the Bay of Biscay inshore (FR-BB-IN-Q4) commercial tuning fleet.

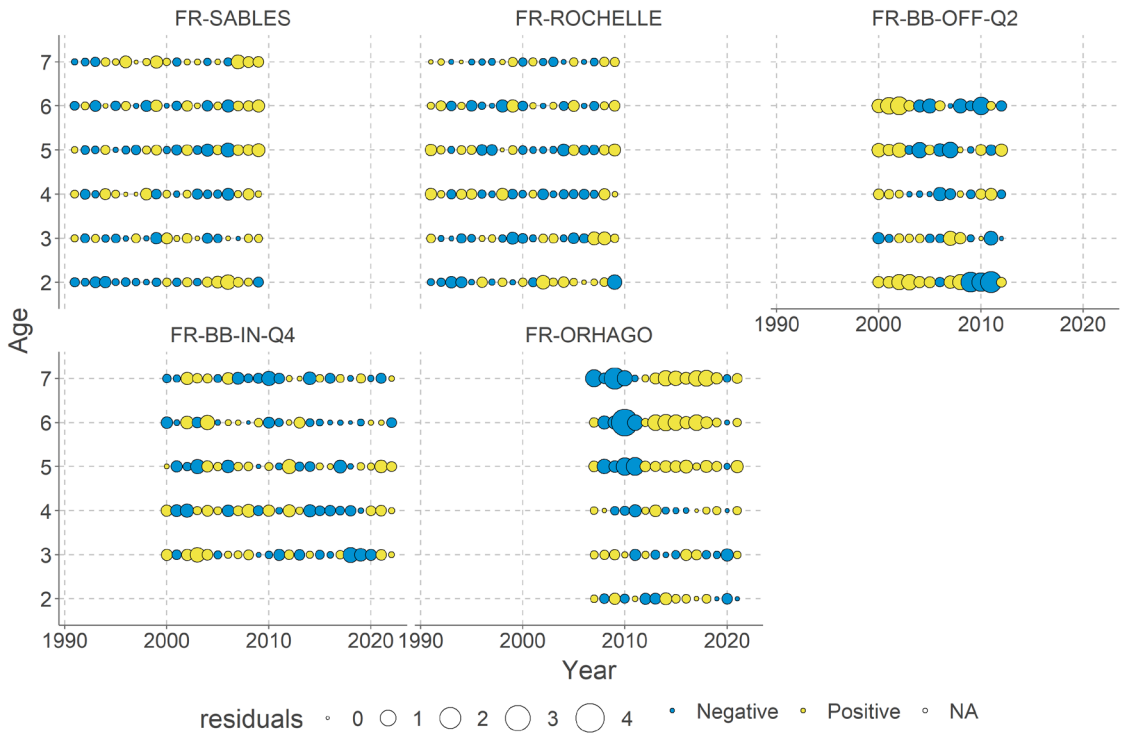

Figure 7.5. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. XSA assessment residuals (No Taper, mean q, s.e. shrink = 2.5, s.e. min = 2).

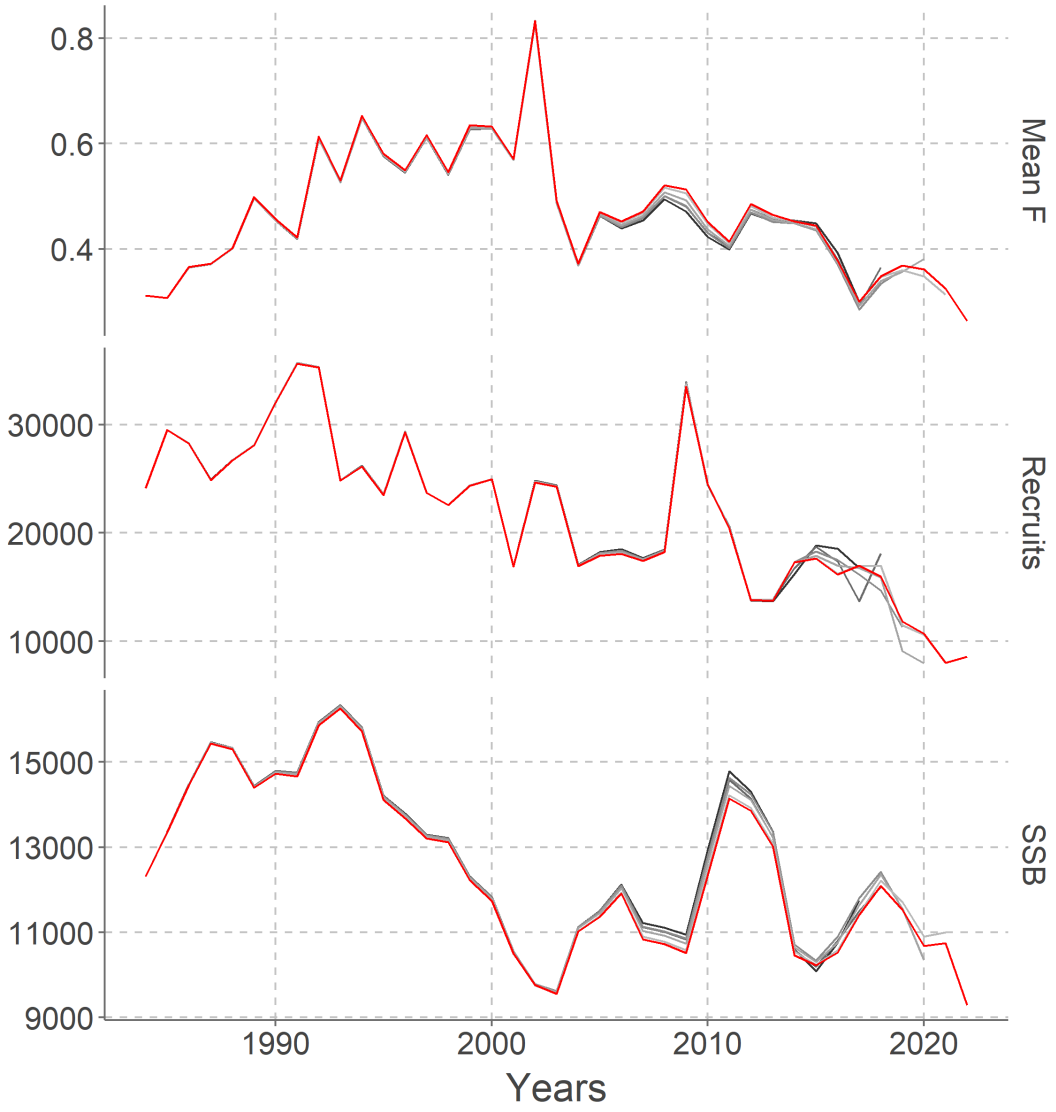

Figure 7.6. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Retrospective patterns (No taper, q indep. stock size all ages, q indep. of age > = 6, shr. = 1.5).

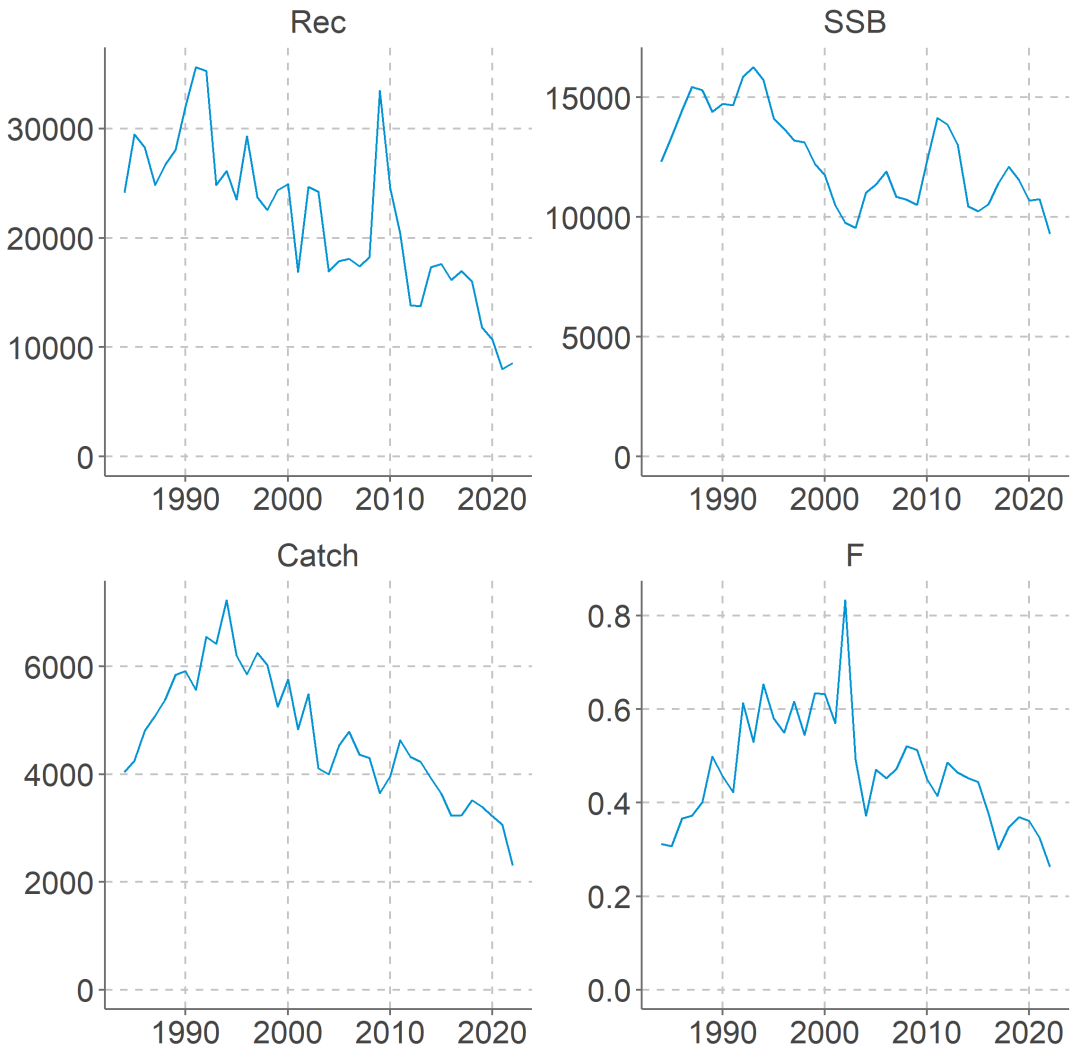

Figure 7.7. Bay of Biscay sole (*S. solea*) in divisions 8.a and 8.b. Trends for $F_{3\text{-}6}$, recruitment$_{age\ 2}$, SSB and total catch data. Recruitment$_{age\ 2}$ is in thousands while SSB and total catch are in tonnes.

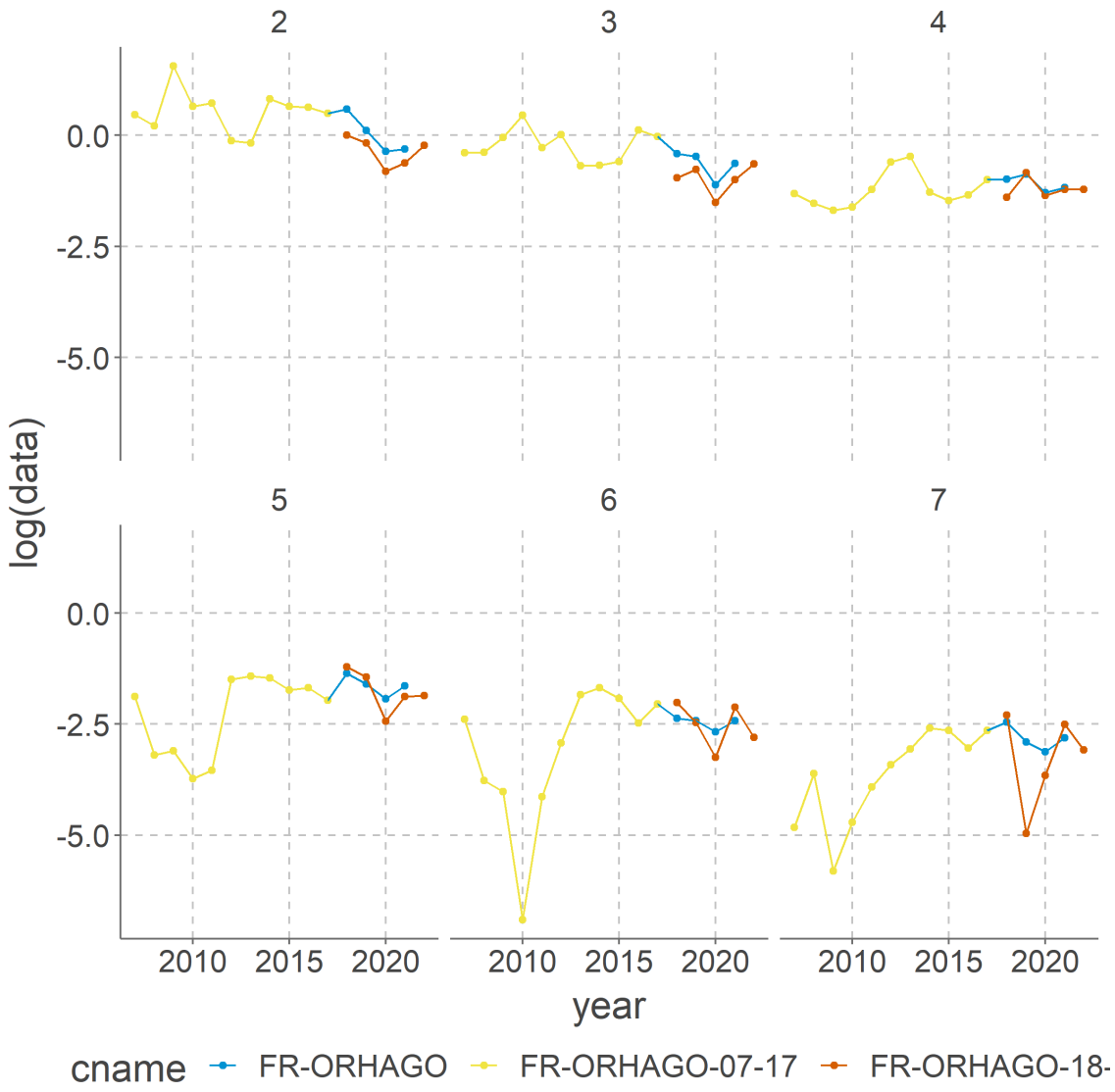

Figure 7.8. Time series comparisons of the standardized ORHAGO (B1706) survey index per age classes. Colours represent the different index. Blue ORHAGO index from 2007 to 2021 without 2022 data, Yellow ORHAGO index computed from 2007 to 2017 with all hauls sampled, Orange index computed from 2018 to 2022 using hauls only sampled in 2022. Before 2017, the blue and yellow lines have the same values.

Contents