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6 Cod in divisions 7.e–k (eastern English Channel and southern Celtic Seas)

Full analytical assessment

This stock has been benchmarked at WKCELTIC 2020. XSA was replaced by SAM as the assessment model. Time-series of data were updated since 2004 as well as the tuning series. The first ten years of data (1970–1979) were removed from the assessment time-series of catches, because of inconsistency in cohort tracking information. Data, assessment and forecast procedure are detailed in the stock annex.

Latest ICES advices in 2020 and 2021

2020 – “For Cod in divisions 7.e–k, ICES advises that when the MSY approach is applied, there should be zero catch in 2021.”

2021 – “For Cod in divisions 7.e–k, ICES advises that when the MSY approach and precautionary considerations are applied, there should be zero catch in 2022.”

6.1 General

6.2 Stock description and management units

The TAC is set for ICES areas 7.b–c, 7.e–k, 8, 10, and CECAF 34.1.1(1), excluding 7.d. This is representative of the stock area as the cod population in 7.d is more relevant to the North Sea population. However, landings from 7.bc are not included in the assessment area.

Management applicable in 2021 and 2022

TAC 2021 (Council regulation 2021/1239)

Species:	Cod <i>Gadus morhua</i>	Zone:	7b, 7c, 7e-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	18 ⁽¹⁾	Analytical TAC	
France	290 ⁽¹⁾	Article 9 of this Regulation applies	
Ireland	422 ⁽¹⁾	Article 3 of Regulation (EC) No 847/96 shall not apply	
The Netherlands	0 ⁽¹⁾	Article 4 of Regulation (EC) No 847/96 shall not apply	
Union	730 ⁽¹⁾		
United Kingdom	75 ⁽¹⁾		
TAC	805 ⁽¹⁾		
⁽¹⁾ Exclusively for by-catches of cod in fisheries for other species. No directed fisheries for cod are permitted under this quota.			

Preliminary TAC 2022 (Council regulation 2022/109)

Species:	Cod	Zone:	7b, 7c, 7e-k, 8, 9 and 10; Union waters of CECAF 34.1.1
	<i>Gadus morhua</i>		(COD/7XAD34)
Belgium	28 ⁽¹⁾	Analytical TAC	
France	463 ⁽¹⁾	Article 9 of this Regulation applies	
Ireland	92 ⁽¹⁾	Article 3 of Regulation (EC) No 847/96 shall not apply	
Netherlands	0 ⁽¹⁾	Article 4 of Regulation (EC) No 847/96 shall not apply	
Union	583 ⁽¹⁾		
United Kingdom	61 ⁽¹⁾		
TAC	644 ⁽¹⁾		
⁽¹⁾ Exclusively for by-catches of cod in fisheries for other species. No directed fisheries for cod are permitted under this quota.			

Since 2005, ICES rectangles 30E4, 31E4, and 32E3 have been closed during the first quarter (Council Regulations 27/2005, 51/2006, and 41/2007, 40/2008, and 43/2009).

Technical measures applied to this stock are a minimum mesh size (MMS) for beam and otter trawlers in Subarea 7 and a minimum landing size (MLS) of 35 cm.

Fishery

Landings data used by the WG are summarised in Table 6.1 and the Figure 6.1 provides historical landings by countries. In 2021, the catches are 1360 t.

TAC was overtaken in 2021. An overtaking of the agreed TAC was observed for France, while Belgium, Ireland and UK were closed to the TAC. Cod is no longer a target species but a bycatch in haddock and whiting dedicated fisheries.

Given the rapid growth of cod in this area, discards are mostly composed of one and two year-old fish. Since 2011, quotas were not restricted and the discard rate has been stable around 10–15%. However, following the recent TAC reductions, TAC is now restrictive for most of the countries. Discards estimate for 2021 is 733 t. It corresponds to a discards rate of 54%, which is significantly greater than the average discards rate of recent years (around 20%). This discards rate increase may be the result of high grading, because of restrictive TACs and delay in total TAC attribution. This delay was mainly due to long discussions in Brexit fisheries negotiations.

Cod is mainly caught in area 27.7.g, followed by areas 27.7.h, 27.7.e and 27.7.j respectively. No landings are reported in 27.7.k and few in 27.7.j2 (Figure 6.2). France is fishing in all areas but most of its landings are taking in 27.7.h. Ireland is mainly fishing in 27.7.g and Belgium in 27.7.f and UK in 27.7.e. For each country, landings distribution in the Celtic Sea is similar to previous years.

In Celtic Sea, cod is mainly caught by OTB_DEF_100-119_0_0_all métiers (37% of the landings and 75% of the catches), followed by OTB_DEF_70-99_0_0_all, OTB_CRU_100-119_0_0_all and seine SCC_DEF_100-119_0_0_all. Beamers (i.e. TBB_DEF_70-99_0_0_all) also contribute to cod landings (Figure 6.3).

Discards rate in weight varies among métiers depending on gear, mesh size range and targeted species (Figure 6.4).

The group advises to follow métier definition specified in the Appendix 2 of the ICES data call to reduce the number of métier upload in InterCatch. Métier which contribute to less than 1% of the landings should be included in the MIS_MIS_0_0_0_HC métier.

Information from the industry

In recent years, yields have been very low and cod is no longer targeted by French vessels and catches represent a very low number of individuals per tow.

The recent regulatory changes in the Celtic Sea since 2019 (Reg UE 2034/2018 which introduces many new selective devices since 01/07/2019 and article 13 Reg UE 123/2020) significantly modifies (1) the size structure of species catches by improving selectivity and the (2) vessel strategy in order to respect different catch composition thresholds.

6.3 Data

InterCatch procedure

Since 2013, international landings and discards data are uploaded in InterCatch. An updated data tile series, from 2004 to 2019, was provided as part of the WKCELTIC 2020. Discards are raised for unreported strata to estimate total discards in weight. During WKCELTIC efforts were made to streamline data compilation procedures for fishery-dependent data of the three main gadoids species (cod, haddock and whiting).

Unsampled strata of landings and discards (number-at-age) are filled in using an allocation procedure. Information on national and international assumptions made by data providers and submitters at the national level and allocation grouping used in IC are available on SharePoint (R script). To ensure the consistency of data processing at international level, the same rules are applied each year for the allocation procedure: fill unsampled strata using as much as possible the same métier and quarter, regardless of area and country. Unsampled BMS landings and Log-book Registered Discards are filled in using discards data employing as much as possible the same métier and quarter, regardless of area and country.

The impact of the Covid-19 pandemic on the fishery cannot be quantitatively determined but may be assumed to have reduced fishing effort in quarter 2 of 2020.

The percentage of sampled versus raised data as well as the distribution of sampled data over the quarters were considered satisfactory (Figure 6.5).

Season	Source	%
1	Imported	23
2	Imported	45
3	Imported	11
4	Imported	19

Catches

Age distribution of 2021 catches (i.e. landings and discards) is illustrated in the Figure 6.10 and Table 6.2. It is noticeable that this stock has always been composed of few age classes, even though Celtic Sea cod can live up to ten years. While the catch was mainly composed of age 2 over the period 2005–2008, the strong 2009 year class has contributed strongly to the catch at older ages in recent years: 63% in number in 2012 at age 3, 36% at age 4 in 2013 (Table 8.2.a and 8.2.b). In 2014, high recruitment has been observed resulting in an increasing proportion of age 1 fish in the landings (53%), age 2 accounts for 22% of the landings. In 2015, landings are dominated by fish of age 2, in 2016 landings are dominated by fish of age 3 and in 2017 landings was mostly composed by cod of age 2. In 2018, 20% of the landings was fish of age 1, 35% of fish of age 2 and 31% of fish of age 3. In 2019, more than 50% of the catches are age 1 fish, and less than 30% of the catches are made of age superior to 2. In 2020, 36% of the catches are age 1 fish, and 58% of the catches (in number) are made of age 2. In 2021, age 1 and age2 represent each 40 % of the catches (in number).

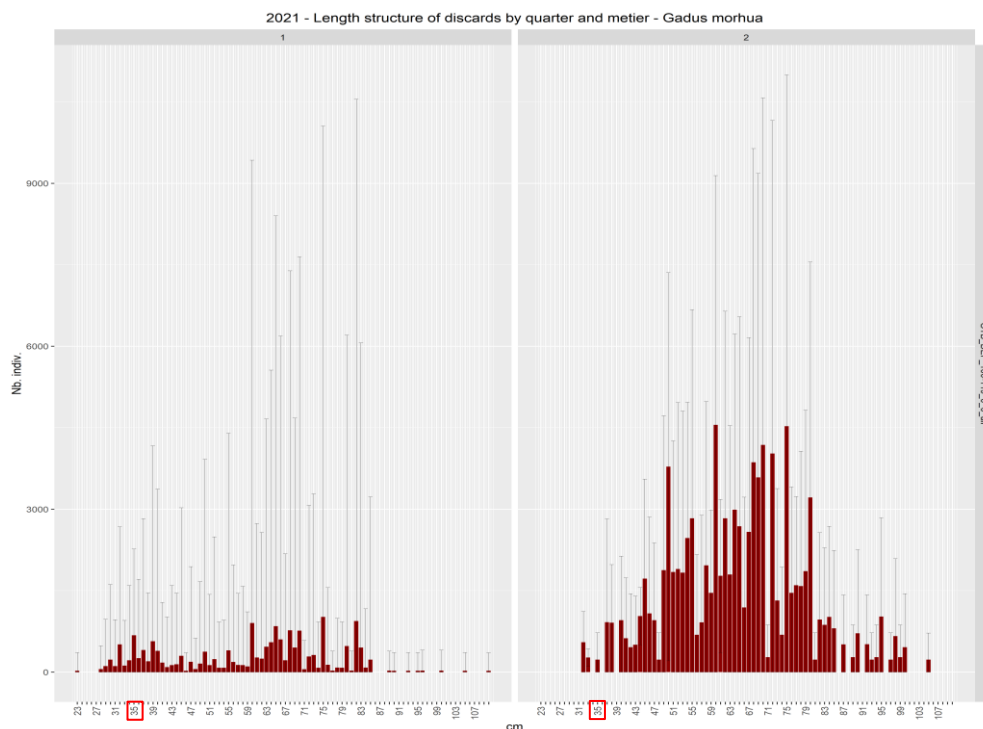
Discards

The landings/discards pattern is known to be strongly variable between fleets and years due to métier, recruitment intensity, TACs constraints and mixed fisheries concerns.

In 2009, age 1 individuals (30–45 cm, Mahé *et al.*, 2016) were mainly discarded. In 2010, most of them were landed. In 2011, ages 1 and 2 represents respectively 51% and 46% of the total discards in numbers for all fleets. Due to the low TAC relative to the high magnitude of recruitment in 2009 and 2010, all countries had unusually high discard rates in 2011, generally 70% by weight was made up of fish above the minimum landing size (MLS, i.e. 35 cm for Celtic Sea cod). The high-graded fish from the French fishery have been added to the landings in 2003–2011. In 2014, total amount of discards was 740 t (639 t imported + 101 t raised), giving a discard rate of 19%. This discards rate was higher than the average 10% and mostly consisted of undersized fish from the strong 2013 year class (fish of age 1 in 2014). In 2015, the total amount of discard was 565 t (250 t sampled and uploaded in InterCatch and 309 t resulting from the raising procedures), giving a discard rate by weight of 12%, which is considered the usual discard rate for this species in the mixed fisheries. High grading in 2015 (discards of fish above Minimum conservation size) was low. In 2016, the total amount of discards was 220 t (154 t sampled and uploaded in InterCatch and 52 t resulting from the raising procedures), giving a discard rate by weight of 6.3%. In 2017, the total amount of discards was 117 t (47 t sampled and uploaded in InterCatch and 62 t resulting from the raising procedures), giving a discard rate by weight of 5%, which is considered lower than average. They are mainly composed of age 1 fish (Figure 6.10).

In recent years, due to quota constraints at vessels levels, length distribution of discards for the UK fleet have shown high-grading pattern (cod being a non-target species). However, this fleet has little contribution to both, landings and discards quantities and this was no more reported in 2017. In 2019, discards are mostly composed of fish of 1 year, as in 2018 (Figure 6.10).

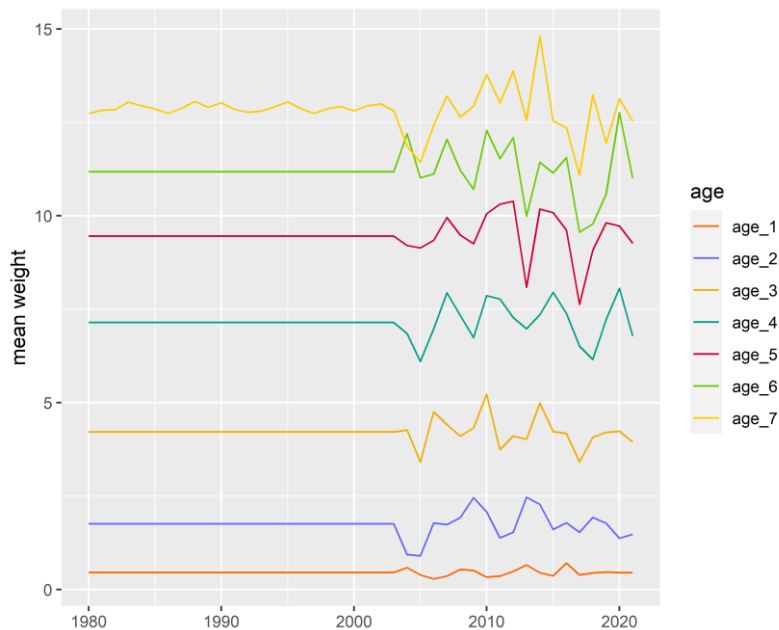
In 2021, French fleet have recorded high-grading pattern for its discards, maybe due to restrictive TACs and delay in total TAC attribution. Individual TAC allocations were attributed in three times and the entire individual TAC was allocated in June. The two preliminary individual TAC, allocated for the period between January and March and between March and July, were reached before the end of their corresponding periods which have led to discard high grading in Q1 and 2.



Biological

Catch numbers-at-age, catch weights-at-age and stock weights-at-age are given respectively in Tables 6.2, 6.3 and 6.4.

Temporal trends in stock and catch were scrutinized at WGCSE 2021, to ensure that reduce sampling due to Covid-19 pandemic did not impact catch weight. No important issues were reported.



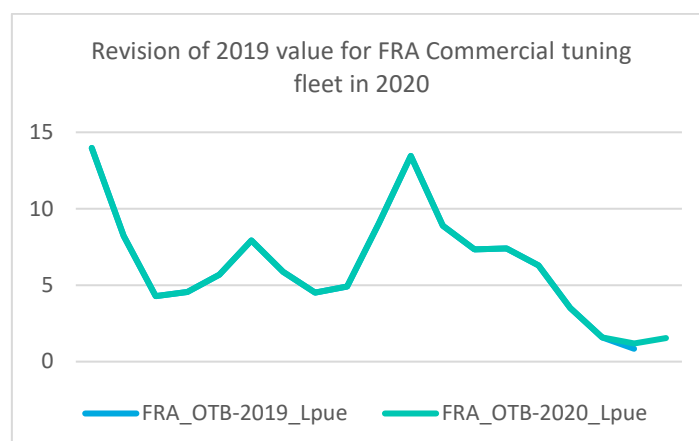
Biological parameters are described in the stock annex which has been updated at WKCELTIC 2020. Celtic Sea cod are very fast growing and early maturing compared with more northern cod stocks.

Commercial LPUE

Tables 6.5 a–c gather the values of landings, fishing effort and LPUE dataserries for the French (a), Irish (b) and UK fleets (c). Figures 6.6 a–c illustrate the trends of LPUE and effort by country.

A general decrease in the LPUE trend is observed in almost all series between 1990 and 2004, where the TAC began to be constraining. From that point, the LPUE seemed to stabilize, or even to increase if high grading is taken into account. The strong 2009 year class resulted in an increase of LPUE for all fleets between 2010 and 2012. Different features are observed in the effort time-series. The métiers showing the highest levels of cod directed effort have decreased significantly in the last 5–10 years until 2010. Since then, effort has gone up again until 2013 following the increased of TAC possibilities.

Since 2013, French fishing effort and LPUE have decreased (Figure 6.6a). Effort of Irish fleet targeting gadoids (i.e. Otter trawl 27.7.g) remains at a high level as a consequence of mixed-fisheries interaction with increased whiting and haddock fisheries opportunities (Figure 6.6b). In the meantime, the Spawning–Stock Biomass (SSB) is low, as such LPUE is decreasing since 2013. In 2018, Otter trawl Irish 27.7.g LPUE has increased. Effort of the UK trawl fleet in 27.7.e–k shows a decreasing trend (down to zero in 2016) and increases since then, while beam trawl effort in 27.7.e–k relatively stable in recent years (Figure 6.6c). Minor revision of FRA commercial fleet from 0.84 to 1.18 in 2019 was made, which is believed to have very little impact on assessment results.



The impact of the Covid-19 pandemic on the fishery cannot be quantitatively determined, but a slight reduction of fishing effort of the main fleets in 2020 was observed for all country. As, a result in 2020, LPUE of Irish otter trawls in 7g and UK trawls in 7ek are decreasing, while French otter trawl LPUE remain stable.

Remark: The UK English and Welsh effort data are only reliable for vessels over 12 metres registered length, and therefore has always been provided to working groups for vessels greater than 12 metres. The fleet of vessels over 12 meter has been declining gradually over the years, until in 2016 no effort recorded from this fleet. The zero figures provided for 2016 have been checked and are correct (Figure 6.6c).

Surveys and commercial tuning fleet

Two ongoing surveys, both part of the DCF, IBTS Q4 (EVHOE-WIBTS-Q4; IGFS-WIBTS-Q4) are combined and modelled to produce a single index using VAST modelling (see details in the stock annex and WKCELTIC 2020 report).

In 2017 and 2018, the French EVHOE survey was not conducted due to technical difficulties at the beginning of the survey. The Irish survey covered additional stations normally undertaken by the EVHOE survey.

Commercial tuning index based on French OTB and OTT fleet is provided. The calculation of the commercial tuning series was updated at WKCELTIC 2020 to better account for changes in fleet behaviour along the years (see details in the stock annex and WKCELTIC 2020 report). LPUE is decreasing since 2012.

The historical time-series of commercial tuning index (OTDEF French fleet for quarters 2, 3 and 4), and the survey index are shown in Table 6.6.

Data issues

No important issues were reported this year. Owing to notable divergence of recent discards patterns, it was not possible to forecast separate landings and discards estimates for 2023.

Catch sampling of the fisheries has been reduced in 2020 due to Covid-19, which may have result in a higher uncertainty associated with discard estimates and age structure of the catch. However, this was considered to have had minimal impact on the perception of the stock status.

Remark: When for a métier/strata landings are upload annually, there are no information available in InterCatch to split the annual landings into quarterly landings and therefore the associated age composition and mean weight-at-age. As a result, when extracting quarter 1 versus

quarters 2, 3 and, 4 data to inform on mean weight of the stock and the catch for the assessment, these data are not used.

6.4 Stock assessment

Model used: SAM (stockassessment.org).

Final update assessment (SAM)

The final assessment was run with the same settings as established by WKCELTIC 2020 and described in the stock annex. Discards are included in the assessment. (sotcokassessment.org, Cod_7ek_WGCSE2020).

Residuals and diagnostics do not highlight any problem regarding the input data and model fit (Figure 6.7 and 6.8). Outputs from the assessment are reported in Tables 6.7–6.10 and in Figures 6.7–6.11.

The comparison of runs with and without tuning indices indicates is shown in Figure 6.12b. The information contains in both indices are consistent.

In 2022, the assessment shows a downward revision in F (Figure 6.12a). The estimate of fishing mortality is highly sensitive to the additional annual data, this is due to the low stock size.

Mohn's rho analysis (i.e. a measure of the relative difference between an estimate from an assessment with a truncated time-series and an estimate of the same quantity from an assessment using the full time-series) resulted in values of -12% for $F_{\text{bar}(2-5)}$, 23% for SSB and 40% for recruitment.

The retrospective bias in assessment when an additional year of data are incorporated may be due to the variability of cod recruitment over years, the strong dependency of the fishery to recruitment (not well estimated by the survey) and the unexpected disappearance of fish of older age.

Despite the high values of the Mohn's rho coefficient and the uncertainties in the estimates of the most recent year, the assessment has been validated (the stock is maintained in category 1), and the output are used to provide the short-term forecast. This decision follows the guidelines provide by WGBIAS (decision tree). Despite the uncertainties in the estimates of the most recent years, SSB and F are estimated well below biological references points.

The conclusions of the very recent benchmark was that given the recruitment driven dynamics of the stock and the low stock size reducing.

State of the stock

Tables 6.7 and 6.8 summarise the estimated fishing mortality-at-age and the stock numbers-at-age, respectively. The stock summary is reported in Table 6.9 and Figure 6.11.

Catches were around 5000 t between 2000 and 2016, with some higher catches following strong recruitments, and decreased around 1300 t since 2019 (Figure 6.11). Reliable discard estimates are available since 2004 and range between 134 and 3749 t depending on the interplay between recruitment dynamics and TAC constraints.

Recruitment has been highly variable over time with occasional very high recruitment followed by period of low recruitments. Since 2012, recruitment has been very weak with the exception of the 2014 year class, which is above average (Table 6.9 and Figure 6.11).

Spawning–stock biomass (SSB) has been fluctuating around B_{pa} since 2004, except from 2011 to 2013 (as the consequence of a very good recruitment year) and is below B_{lim} since 2017 (Table 6.9 and Figure 6.11, ICES, 2012).

Fishing mortality has been above F_{MSY} for the entire time-series, fluctuating between F_{lim} and F_{pa} . Fishing mortality increased up to above F_{lim} between 2017 and 2019 (Table 6.9 and Figure 6.11).

6.5 Short-term projections

Assumptions made for the short-term projections are described in Table 6.12 and followed the stock annex.

F status quo was used as an assumption of F in 2021 to reflect recent fishing pressure and was kept for 2022.

Recruitment values of 2022 and 2023 are similar in the stochastic forecast, because random resampling of a distribution may lead to identical median estimates. The recruitment age 1 fish values are 1305 thousands in 2022 and 2023.

SSB is predicted to be 992 t in 2023 which would still be below B_{lim} (4200 t) (Table 6.11).

ICES provides zero-catch advice for this stock in 2023, because the median SSB remains below B_{lim} by 2023 under all catch scenarios (Tables 6.12 and 6.13).

In the ICES advice framework, this would result in advised catches between 46 tonnes (at $F_{MSY} \times SSB_{2023}/MSY B_{trigger}$) and 77 tonnes (at $F_{MSY} \times SSB_{2023}/MSY B_{trigger}$), but the median SSB would remain below B_{lim} by 2024.

The assumed recruitment in 2022 and 2023 used in the forecast constitutes a significant part (70%) of the projected SSB in 2024 (45% and 25%, respectively; Figure 6.14 and Table 6.14).

6.6 Medium-term projection

No medium-term projections were carried out.

6.7 Biological reference points

The reference points have been estimated using the agreed ICES guidelines, see Table 6.11 (ICES, 2016). F_{pa} was set to $F_{p0.5}$; the F that leads to $SSB \geq B_{lim}$ with 95% probability at the last benchmark in 2020.

6.8 Management plans

The European Parliament and the Council have published a multiannual management plan (MAP) for the Western Waters (EU, 2019). This plan applies to demersal stocks including cod in ICES divisions 7.e–k.

6.9 Uncertainties and bias in assessment and forecast

The stock was benchmarked in 2020 (ICES, 2020a). The model was changed to a stochastic state–space assessment model (SAM). Maturity and natural mortality information was updated, discards were included in the assessment, catch (landings and discards) time-series were reviewed and updated from 2004 to 2018, commercial tuning series were reviewed and included as

biomass index, and survey indices were updated to a single modelled time-series using a vector-autoregressive spatio-temporal model (VAST). The F-pattern shows less variability across the time-series and higher estimates in most recent years than the previous assessment. Fishing mortality is observed to be sensitive to the addition of an extra year of data.

However, despite this uncertainty, it is quite clear that the cod stock is well below SBB limits and well above F target. Given that situation and the recommendations of WKBIAS, the last benchmark and WGCSE 2022 validated the proposed assessment model and its use for prediction.

6.10 Recommendations for future developments

There is room for development of a modelled commercial tuning fleet instead of the current method based on catch thresholds. Indeed, despite the work performed to improve the commercial tuning fleet, it is never easy to account for changes in fisheries targeting behaviours. Indeed, in recent years, cod is not targeted anymore by most of the fisheries.

Even if the survey index combined two surveys, it is based on few fish. Further work and sensitivity analysis on the VAST assumptions might also be performed and documented in the future to ensure that the model will converge for all ages and show low retrospective patterns.

6.11 Management considerations

The strong retrospective pattern implies that the current F estimates might be uncertain. Forecasts are sensitive to the assumption on recruitment as the landings are usually composed of a high proportion of age 2 fish (and age 1 for discards).

The recent technical measures introduced in the Celtic Sea, increase in the mesh size of the square mesh panels and raised lines are expected to reduce catches of Celtic Sea cod and improved the selection pattern. Impact of this measure should be monitored.

Additionally, mixed-fisheries issues could be responsible for maintaining F at high level, as other gadoids fishing opportunities are higher. In this context, cod is no longer a target species but can be considered as bycatch in the fleet targeting haddock, whiting and *Nephrops*.

Historical information on management consideration can be found in the stock annex.

6.12 References

- ICES. 2012. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE), 9–18 May 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:12.
- ICES. 2016. Report of the Workshop to consider FMSY 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.

Table 6.1. Cod in Division 7.e–k. History of official commercial landings presented by country and used by the Working Group. All weights are in tonnes.

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in rectangles 33E2 and 33E3 *
1971	NA	NA	NA	NA	NA	5782	NA	NA
1972	NA	NA	NA	NA	NA	4737	NA	NA
1973	NA	NA	NA	NA	NA	4015	NA	NA
1974	NA	NA	NA	NA	NA	2898	NA	NA
1975	NA	NA	NA	NA	NA	3993	NA	NA
1976	NA	NA	NA	NA	NA	4818	NA	NA
1977	NA	NA	NA	NA	NA	3059	NA	NA
1978	NA	NA	NA	NA	NA	3647	NA	NA
1979	NA	NA	NA	NA	NA	4650	NA	NA
1980	NA	NA	NA	NA	NA	7243	NA	NA
1981	NA	NA	NA	NA	NA	10597	NA	NA
1982	NA	NA	NA	NA	NA	8766	NA	NA
1983	NA	NA	NA	NA	NA	9641	NA	NA
1984	NA	NA	NA	NA	NA	6631	NA	NA
1985	NA	NA	NA	NA	NA	8317	NA	NA
1986	NA	NA	NA	NA	NA	10475	NA	NA

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in rectangles 33E2 and 33E3 *
1987	NA	NA	NA	NA	NA	10228	NA	NA
1988	554	13863	1480	1292	2	17191	NA	NA
1989	910	15801	1860	1223	15	19809	NA	NA
1990	621	9383	1241	1346	158	12749	NA	NA
1991	303	6260	1659	1094	20	9336	NA	NA
1992	195	7120	1212	1207	13	9747	NA	NA
1993	391	8317	766	945	6	10425	NA	NA
1994	398	7692	1616	906	8	10620	NA	NA
1995	400	8321	1946	1034	8	11709	NA	NA
1996	552	8981	1982	1166	0	12681	NA	NA
1997	694	8662	1513	1166	0	12035	NA	NA
1998	528	8096	1718	1089	0	11431	NA	NA
1999	326	5488	1883	897	0	8594	NA	NA
2000	208	4281	1302	744	0	6535	NA	NA
2001	347	6033	1091	838	0	8309	NA	NA
2002	555	7368	694	618	0	9235	NA	NA
2003	136	5222	517	346	0	6221	NA	NA

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in rectangles 33E2 and 33E3 *
2004	153	2934	657	281	1	4027	543	108
2005	186	2127	855	309	1	3478	1426	54
2006	101	2431	995	371	3	3902	2118	103
2007	107	3113	1208	411	3	4842	1248	527
2008	65	2994	1222	295	1	4577	306	558
2009	48	3020	847	267	5	4187	1229	193
2010	52	2449	1030	296	3	3831	3040	143
2011	123	4808	1010	427	7	6376	3749	147
2012	290	6900	1539	706	8	9443	2341	85
2013	202	5051	1470	548	3	7273	562	76
2014	141	2715	1189	466	0	4512	1569	24
2015	121	3373	1109	422	3	5028	483	39
2016	97	2579	881	365	1	3924	525	40
2017	82	1578	623	188	0	2471	134	19
2018	49	611	706 c	130	0	1496 c	316	20
2019	43	369	554 c	84	NA	1051 c	300	37
2020**	18	371	487	44	2	922	231	71

Year	Belgium	France	Ireland	UK	Others	Total	Discard estimates	Landings taken or reported in rectangles 33E2 and 33E3 *
2021**	11	261	309	46	0	627	733	52

*Included in Ireland landings estimates. Landings in the south of Division 7.a (33E2 and 33E3) are included in the assessment and are considered to be part of the stock.

** Preliminary official landings.

° Incomplete due to part of the data being unavailable under national GDPR clauses.

Table 6.2. Cod in Division 7e–k. Catch number-at-age (in thousands). Number-at-age 1 and 2 before 2004 are estimated by the assessment model.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	NA	NA	285	175	52	55	14
1981	NA	NA	811	153	41	20	12
1982	NA	NA	888	169	36	19	5
1983	NA	NA	540	424	77	21	11
1984	NA	NA	134	97	94	22	5
1985	NA	NA	465	61	40	47	15
1986	NA	NA	673	254	30	31	17
1987	NA	NA	448	250	62	20	15
1988	NA	NA	320	133	46	21	8
1989	NA	NA	2483	149	77	18	11
1990	NA	NA	1006	663	79	21	16
1991	NA	NA	229	330	203	48	14
1992	NA	NA	329	64	70	53	17
1993	NA	NA	928	79	24	19	16
1994	NA	NA	1199	258	27	10	17
1995	NA	NA	310	284	73	13	5
1996	NA	NA	1199	134	95	43	4
1997	NA	NA	951	297	48	22	6
1998	NA	NA	641	254	99	36	8
1999	NA	NA	756	158	59	36	14
2000	NA	NA	419	169	44	17	14
2001	NA	NA	136	98	70	19	19
2002	NA	NA	883	64	33	12	11
2003	NA	NA	827	217	15	9	7
2004	873	1077	229	189	65	5	6
2005	2875	2080	182	93	47	19	8
2006	7477	1052	295	17	25	13	9
2007	3556	1302	355	79	10	8	11

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2008	467	885	403	122	27	4	6
2009	2212	421	424	120	47	11	4
2010	9794	618	151	107	46	14	5
2011	2325	4905	423	49	34	13	4
2012	746	1860	1757	117	18	14	11
2013	388	383	581	516	55	16	7
2014	4708	415	83	132	149	8	2
2015	242	2272	137	26	47	37	7
2016	624	195	707	33	7	17	16
2017	159	561	57	166	24	5	15
2018	902	172	137	14	38	5	2
2019	944	247	29	26	4	11	2
2020	342	548	36	3	2	2	2
2021	329	321	140	16	4	2	1

Table 6.3. Cod in Division 7e–k. Catch weight-(in kg) at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	0.457	1.756	4.217	7.147	9.454	11.179	12.73800
1981	0.457	1.756	4.217	7.147	9.454	11.179	12.82433
1982	0.457	1.756	4.217	7.147	9.454	11.179	12.84160
1983	0.457	1.756	4.217	7.147	9.454	11.179	13.04373
1984	0.457	1.756	4.217	7.147	9.454	11.179	12.94520
1985	0.457	1.756	4.217	7.147	9.454	11.179	12.85860
1986	0.457	1.756	4.217	7.147	9.454	11.179	12.73800
1987	0.457	1.756	4.217	7.147	9.454	11.179	12.87613
1988	0.457	1.756	4.217	7.147	9.454	11.179	13.06075
1989	0.457	1.756	4.217	7.147	9.454	11.179	12.90245
1990	0.457	1.756	4.217	7.147	9.454	11.179	13.02887
1991	0.457	1.756	4.217	7.147	9.454	11.179	12.84900
1992	0.457	1.756	4.217	7.147	9.454	11.179	12.76847
1993	0.457	1.756	4.217	7.147	9.454	11.179	12.80275
1994	0.457	1.756	4.217	7.147	9.454	11.179	12.92082
1995	0.457	1.756	4.217	7.147	9.454	11.179	13.04880
1996	0.457	1.756	4.217	7.147	9.454	11.179	12.86750
1997	0.457	1.756	4.217	7.147	9.454	11.179	12.73800
1998	0.457	1.756	4.217	7.147	9.454	11.179	12.86750
1999	0.457	1.756	4.217	7.147	9.454	11.179	12.92300
2000	0.457	1.756	4.217	7.147	9.454	11.179	12.81200
2001	0.457	1.756	4.217	7.147	9.454	11.179	12.94226
2002	0.457	1.756	4.217	7.147	9.454	11.179	12.99664
2003	0.457	1.756	4.217	7.147	9.454	11.179	12.81200
2004	0.585	0.939	4.268	6.849	9.207	12.192	11.86933
2005	0.388	0.899	3.412	6.107	9.138	11.017	11.43300
2006	0.285	1.780	4.758	6.971	9.341	11.119	12.42300
2007	0.362	1.738	4.412	7.943	9.953	12.043	13.20200
2008	0.541	1.925	4.105	7.337	9.483	11.220	12.64783

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2009	0.510	2.457	4.324	6.740	9.252	10.707	12.93800
2010	0.330	2.078	5.223	7.863	10.056	12.290	13.78180
2011	0.358	1.381	3.740	7.774	10.314	11.531	13.02500
2012	0.488	1.532	4.108	7.276	10.386	12.096	13.87391
2013	0.655	2.471	4.019	6.976	8.088	9.991	12.55800
2014	0.448	2.281	4.988	7.353	10.180	11.432	14.80600
2015	0.367	1.608	4.230	7.952	10.087	11.147	12.53600
2016	0.706	1.787	4.175	7.386	9.619	11.556	12.35400
2017	0.393	1.532	3.414	6.517	7.630	9.563	11.09620
2018	0.444	1.927	4.076	6.160	9.081	9.780	13.23200
2019	0.465	1.774	4.203	7.223	9.815	10.576	11.95100
2020	0.455	1.369	4.233	8.058	9.731	12.757	13.13100
2021	0.450	1.477	3.946	6.784	9.264	11.004	12.535

Table 6.4. Cod in Division 7e–k. Stock weight at age =1st quarter values.

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	0.370	1.421	3.936	6.901	9.324	11.107	13.574000
1981	0.370	1.421	3.936	6.901	9.324	11.107	13.578000
1982	0.370	1.421	3.936	6.901	9.324	11.107	13.578800
1983	0.370	1.421	3.936	6.901	9.324	11.107	13.626820
1984	0.370	1.421	3.936	6.901	9.324	11.107	13.583600
1985	0.370	1.421	3.936	6.901	9.324	11.107	13.607930
1986	0.370	1.421	3.936	6.901	9.324	11.107	13.574000
1987	0.370	1.421	3.936	6.901	9.324	11.107	13.580400
1988	0.370	1.421	3.936	6.901	9.324	11.107	13.695250
1989	0.370	1.421	3.936	6.901	9.324	11.107	13.620270
1990	0.370	1.421	3.936	6.901	9.324	11.107	13.640620
1991	0.370	1.421	3.936	6.901	9.324	11.107	13.579140
1992	0.370	1.421	3.936	6.901	9.324	11.107	13.575410
1993	0.370	1.421	3.936	6.901	9.324	11.107	13.577000
1994	0.370	1.421	3.936	6.901	9.324	11.107	13.582470
1995	0.370	1.421	3.936	6.901	9.324	11.107	13.588400
1996	0.370	1.421	3.936	6.901	9.324	11.107	13.580000
1997	0.370	1.421	3.936	6.901	9.324	11.107	13.574000
1998	0.370	1.421	3.936	6.901	9.324	11.107	13.580000
1999	0.370	1.421	3.936	6.901	9.324	11.107	13.582570
2000	0.370	1.421	3.936	6.901	9.324	11.107	13.577430
2001	0.370	1.421	3.936	6.901	9.324	11.107	13.605840
2002	0.370	1.421	3.936	6.901	9.324	11.107	13.624640
2003	0.370	1.421	3.936	6.901	9.324	11.107	13.577430
2004	0.356	0.830	4.035	6.101	9.324	13.784	9.952167
2005	0.320	0.830	4.035	6.101	9.324	11.135	15.169000
2006	0.267	1.516	4.370	6.325	9.350	11.081	12.688000
2007	0.290	1.453	3.916	8.101	10.658	11.413	15.827000
2008	0.344	1.623	4.027	7.200	8.941	10.916	12.550670

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2009	0.399	1.914	3.880	6.404	8.898	10.507	13.964000
2010	0.286	1.597	4.874	7.466	9.852	11.254	13.545200
2011	0.324	1.030	3.478	8.051	10.251	11.355	15.493000
2012	0.410	1.289	3.641	6.979	9.704	12.111	15.844000
2013	0.440	1.774	3.746	6.854	7.334	9.330	12.844000
2014	0.363	1.762	4.109	6.762	10.082	11.634	15.360000
2015	0.428	1.202	4.326	8.210	10.337	11.508	14.311000
2016	0.618	1.542	3.622	7.110	10.048	11.707	13.416000
2017	0.335	1.337	3.313	6.189	7.249	9.651	10.962330
2018	0.376	1.617	3.675	5.655	8.508	9.223	12.240000
2019	0.366	1.509	3.821	7.254	9.725	10.795	11.486000
2020	0.420	1.200	3.705	8.174	10.286	13.407	13.634000
2021	0.401	1.154	3.272	6.038	8.786	11.148	15.225

Table 6.5a. Cod in Division 7e–k. LPUE for French OT-DEF fleets. Units: landings in tonnes, effort in 000s hours fished and LPUE in kg/hour fished. This series is used to tuned the assessment model.

Year	Effort	Landings
2002	264146	3692073
2003	240535	1978251
2004	214247	918840
2005	156961	714850
2006	125245	712566
2007	150288	1193033
2008	138626	814340
2009	143812	647808
2010	143730	705691
2011	258383	2332986
2012	252110	3393990
2013	190886	1696287
2014	151518	1113363
2015	185791	1374691
2016	178399	1122665
2017	137849	483571
2018	102586	163178
2019	114838	136473
2020	96907	149412
2021	97502	102964

Table 6.5b. Cod in Division 7e–k. Time-series of landings, effort and LPUE for the Irish fleets. Units: landings in tonnes live weight, effort in 000s hours fished and LPUE in kg/hour fished.

	Otter_trawl_27.7j			Beam_trawl_27.7j			Scottish_seiner_27.7j			Gillnet_27.7j		
	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	339,3	93,2	3,6	0,0	0,2	0,2	75,5	5,3	14,4	178,8	21,3	8,4
1996	326,4	70,2	4,6	8,7	1,4	6,3	124,5	8,2	15,3	65,0	5,2	12,4
1997	352,7	82,7	4,3	3,4	1,7	2,0	115,8	10,7	10,8	45,5	8,3	5,5
1998	262,7	89,1	2,9	19,1	5,2	3,7	103,4	6,6	15,6	59,1	16,0	3,7
1999	76,7	40,5	1,9	27,5	7,4	3,7	9,6	1,4	6,8	24,6	8,7	2,8
2000	95,5	63,9	1,5	21,2	6,9	3,1	24,4	3,5	7,0	13,8	7,0	2,0
2001	148,5	67,4	2,2	10,7	3,0	3,6	31,3	4,4	7,1	14,8	6,6	2,3
2002	150,0	90,4	1,7	5,4	3,1	1,7	24,6	8,9	2,8	12,3	8,1	1,5
2003	73,6	107,4	0,7	8,8	9,0	1,0	12,0	7,9	1,5	6,3	11,2	0,6
2004	36,1	88,3	0,4	2,5	2,2	1,2	10,3	8,1	1,3	4,2	6,1	0,7
2005	37,8	71,3	0,5	4,7	2,4	2,0	17,5	5,8	3,0	3,4	6,1	0,6
2006	39,6	64,5	0,6	2,0	1,5	1,3	15,6	5,3	2,9	7,2	7,3	1,0
2007	35,9	78,3	0,5	7,8	2,4	3,3	9,8	3,5	2,8	6,5	10,5	0,6
2008	33,1	66,7	0,5	2,6	1,1	2,3	9,5	2,8	3,3	6,5	7,9	0,8
2009	26,6	73,0	0,4	4,7	2,8	1,7	8,9	3,3	2,7	8,0	10,9	0,7
2010	52,5	85,7	0,6	1,7	1,0	1,7	17,0	4,4	3,9	8,4	9,4	0,9
2011	57,7	62,8	0,9	1,7	0,6	2,7	21,6	4,6	4,7	16,8	8,0	2,1
2012	62,8	65,6	1,0	0,4	0,3	1,5	29,8	5,4	5,6	25,2	8,3	3,0
2013	66,1	61,3	1,1	1,8	0,6	3,3	32,5	6,6	4,9	15,4	9,8	1,6
2014	51,6	53,9	1,0	1,2	0,6	1,9	52,6	7,4	7,1	9,7	12,2	0,8
2015	63,6	46,9	1,4	0,6	0,1	6,3	38,2	5,3	7,2	18,1	14,2	1,3
2016	48,5	50,7	1,0	0,3	0,2	1,5	25,2	5,3	4,7	15,8	17,1	0,9
2017	41,3	56,4	0,7	0,0	0,0	10,0	24,0	5,3	4,5	10,4	18,0	0,6
2018	42,3	52,1	0,8	0,2	0,1	2,4	28,5	6,4	4,5	5,9	16,8	0,4
2019	30,4	53,4	0,6	0,2	0,1	1,7	18,1	7,3	2,5	5,5	14,5	0,4
2020	26,72	44,11	0,61	0,07	0,02	2,92	17,16	5,53	3,10	13,80	13,52	1,02
2021	12,95	40,28	0,32	0,11	0,31	0,35	11,05	5,29	2,09	15,24	19,73	0,77

NA	Otter_trawl_27.7g			Beam_trawl_27.7g			Scottish_seiner_27.7g			Gillnet_27.7g		
	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	429,8	63,3	6,8	85,8	20,7	4,1	111,3	6,4	17,3	114,9	6,3	18,1
1996	569,2	60,0	9,5	112,5	26,7	4,2	164,9	9,7	16,9	338,9	6,2	54,8
1997	401,9	65,0	6,2	131,5	28,1	4,7	215,2	16,1	13,4	52,8	1,9	27,7
1998	450,5	72,3	6,2	166,8	35,2	4,7	264,1	14,9	17,7	87,3	3,4	25,4
1999	300,7	51,5	5,8	190,6	40,8	4,7	64,6	8,0	8,1	200,4	8,4	23,9
2000	279,4	60,6	4,6	180,6	36,8	4,9	106,0	9,9	10,8	151,7	10,1	15,0
2001	358,5	69,4	5,2	101,2	39,5	2,6	115,0	16,3	7,0	115,8	8,8	13,2
2002	212,9	77,2	2,8	57,9	31,5	1,8	71,0	20,9	3,4	31,0	6,4	4,8
2003	167,2	86,8	1,9	56,8	49,2	1,2	35,6	20,1	1,8	31,3	11,1	2,8
2004	190,2	97,1	2,0	74,3	54,9	1,4	54,4	18,4	3,0	62,0	13,5	4,6
2005	292,5	124,7	2,3	118,9	49,6	2,4	64,4	14,6	4,4	77,9	10,9	7,2
2006	379,4	118,0	3,2	128,6	60,5	2,1	91,0	14,8	6,2	63,7	7,8	8,1
2007	316,1	135,4	2,3	96,2	55,8	1,7	58,5	15,8	3,7	85,4	9,4	9,1
2008	344,9	125,4	2,7	85,4	37,2	2,3	55,6	11,6	4,8	88,0	14,1	6,2
2009	405,9	137,1	3,0	74,4	37,9	2,0	34,6	8,2	4,2	81,1	13,8	5,9
2010	524,8	140,8	3,7	94,7	40,2	2,4	54,3	9,7	5,6	76,0	14,0	5,4
2011	438,4	120,3	3,6	82,5	35,3	2,3	46,7	11,0	4,2	76,6	11,3	6,7
2012	780,7	127,7	6,1	161,9	40,3	4,0	111,5	14,1	7,9	129,1	15,4	8,4
2013	721,4	118,2	6,1	195,8	38,5	5,1	111,3	13,2	8,5	92,5	14,4	6,4
2014	600,1	127,3	4,7	142,9	37,8	3,8	110,5	12,5	8,9	59,2	14,1	4,2
2015	526,3	132,7	4,0	160,1	37,8	4,2	59,2	9,3	6,4	48,7	12,5	3,9
2016	418,1	148,2	2,8	106,8	39,6	2,7	51,1	10,4	4,9	47,1	13,6	3,5
2017	361,4	136,1	2,7	46,4	35,2	1,3	42,1	9,7	4,3	22,4	14,8	1,5
2018	387,6	108,2	3,6	72,6	37,4	1,9	61,1	9,7	6,3	16,7	14,0	1,2
2019	244,8	103,9	2,4	71,9	34,1	2,1	50,9	14,3	3,6	21,9	16,0	1,4
2020	184,36	89,91	2,05	55,00	29,14	1,89	51,51	13,59	3,79	20,08	15,02	1,34
2021	108,54	83,90	1,29	45,08	31,57	1,43	28,73	14,8	1,94	15,59	17,59	0,89

Table 6.5c. Cod in Division 7e–k. Time-series of landings, effort and LPUE for the UK fleets. Units: landings in tonnes, effort in days fished and LPUE in kg/day.

YEAR	Beam_trawl_27.7ek		Trawl_27.7ek		Trawl_27.7e	
	Lands..t.	Effort..Days.	Lands..t..1	Effort..Days..1	Lands..t..2	Effort..Days..2
1983	25.55	2853	40.93	2573	20.60	1871
1984	128.75	8427	235.68	8092	76.42	5618
1985	145.39	7706	250.67	7186	63.97	5411
1986	165.76	6651	232.19	6174	78.31	4425
1987	248.91	8060	210.36	5446	88.49	3701
1988	249.21	9487	262.68	5645	151.35	4265
1989	231.24	10071	177.12	5997	96.00	4607
1990	309.07	10477	305.78	6661	119.41	4423
1991	256.19	9017	242.33	5938	83.60	4004
1992	256.33	8183	231.85	6494	80.76	4108
1993	221.79	9511	183.05	5055	42.88	3761
1994	179.13	13925	78.23	4426	41.25	3423
1995	241.35	15076	115.05	4405	55.09	3294
1996	304.22	15748	120.46	4476	59.21	2589
1997	303.67	16373	150.01	5088	79.81	3011
1998	266.15	15574	119.56	4729	62.50	2699
1999	257.43	15614	90.68	6638	46.81	2486
2000	188.07	16456	110.79	7054	52.59	2681
2001	257.24	17335	109.75	5875	59.05	2732
2002	132.13	16503	82.70	5657	34.11	2448
2003	108.77	18285	58.80	5120	24.48	2273
2004	96.93	18250	44.06	5273	15.05	2334
2005	103.60	17157	41.13	5047	17.38	1762
2006	91.88	15412	55.43	5314	13.54	1699
2007	111.28	15085	49.65	5679	21.61	1917
2008	71.38	13734	49.34	4686	24.26	1750
2009	67.27	12170	27.56	4928	12.56	1847
2010	65.62	12150	31.13	5185	15.27	2213

YEAR	Beam_trawl_27.7ek		Trawl_27.7ek		Trawl_27.7e	
	Lands..t.	Effort..Days.	Lands..t..1	Effort..Days..1	Lands..t..2	Effort..Days..2
2011	99.03	13205	47.73	4354	26.00	1931
2012	165.63	13411	79.03	4312	30.95	2068
2013	114.49	12950	37.30	2014	22.94	1587
2014	87.55	12807	17.07	1606	14.06	1440
2015	89.39	12769	16.68	1061	14.40	978
2016	73.81	13913	0.00	0	0.00	0
2017	35.49	14283	19.37	3718	9.33	2398
2018	24.41	13065	17.51	3233	5.34	1987
2019	18.03	12649	11.76	2660	3.64	1548
2020	10.21	12332	2.55	1481	1.74	1093
2021	14.87	12593	2.53	1895	1.25	1353

Table 6.6. Cod in Division 7e–k. Time-series of survey indices scrutinized at WGCSE and used in the assessment.

Cod in Divisions 7e-k, tuning fleets, WGCSE2021			
102			
FR-OTDEF Q2+3+4 trawlers in 7e–k			
2002	2020		
1	1	0.25	1
-1	-1		
Year	Effort	Landings	
2002	264146	3692073	
2003	240535	1978251	
2004	214247	918840	
2005	156961	714850	
2006	125245	712566	
2007	150288	1193033	
2008	138626	814340	
2009	143812	647808	
2010	143730	705691	
2011	258383	2332986	
2012	252110	3393990	
2013	190886	1696287	
2014	151518	1113363	
2015	185791	1374691	
2016	178399	1122665	
2017	137849	483571	
2018	102586	163178	
2019	114838	136473	
2020	96907	149412	
2021	97502	102964	
next table			
IR-GFS FR-EVHOE Q4 combined indices - VAST Modelling			
2003	2020	NA	NA

1	1	0.79	0.92		
1	4	NA	NA		
Year	Effort	Age 1	Age 2	Age 3	Age 4
2003	1	24.431	39.006	49.727	17.447
2004	1	34.942	33.287	15.157	18.076
2005	1	112.156	33.891	12.266	0.000
2006	1	74.788	44.300	8.044	0.000
2007	1	95.111	69.869	33.235	12.524
2008	1	29.186	72.709	30.874	11.022
2009	1	58.069	20.743	27.982	11.823
2010	1	491.426	62.255	5.542	7.331
2011	1	241.122	364.573	24.152	4.165
2012	1	21.254	115.420	141.296	26.223
2013	1	25.047	8.148	23.572	33.161
2014	1	292.211	30.564	13.048	20.528
2015	1	13.884	154.490	9.121	0.000
2016	1	128.255	21.528	113.529	17.994
2017	1	21.796	65.972	26.003	38.008
2018	1	36.502	9.271	12.465	11.512
2019	1	145.144	36.138	2.239	6.908
2020	1	55.313	105.361	3.107	0.958
2021	1	23.014	28.033	37.635	1.668

Table 6.7. Cod in Division 7e—k. Final SAM fishing mortality-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+	$F_{\text{bar}}(\text{mean } 2-5)$
1980	0.494	0.976	0.912	0.891	0.880	1.107	1.107	0.915
1981	0.485	0.958	0.894	0.869	0.855	1.073	1.073	0.894
1982	0.461	0.909	0.845	0.818	0.802	1.002	1.002	0.843
1983	0.464	0.915	0.851	0.821	0.803	1.000	1.000	0.848
1984	0.426	0.836	0.775	0.743	0.727	0.902	0.902	0.770
1985	0.428	0.841	0.779	0.745	0.726	0.898	0.898	0.773
1986	0.450	0.887	0.824	0.786	0.763	0.936	0.936	0.815
1987	0.459	0.905	0.842	0.802	0.778	0.947	0.947	0.832
1988	0.442	0.869	0.808	0.764	0.741	0.897	0.897	0.796
1989	0.464	0.914	0.851	0.800	0.773	0.928	0.928	0.835
1990	0.500	0.990	0.924	0.867	0.835	0.995	0.995	0.904
1991	0.531	1.054	0.989	0.927	0.894	1.060	1.060	0.966
1992	0.531	1.055	0.990	0.925	0.893	1.056	1.056	0.966
1993	0.525	1.042	0.977	0.908	0.876	1.032	1.032	0.951
1994	0.538	1.068	1.002	0.929	0.896	1.053	1.053	0.974
1995	0.526	1.044	0.979	0.904	0.872	1.022	1.022	0.950
1996	0.533	1.057	0.992	0.909	0.874	1.017	1.017	0.958
1997	0.525	1.041	0.976	0.887	0.845	0.974	0.974	0.937
1998	0.538	1.068	1.003	0.906	0.859	0.980	0.980	0.959
1999	0.546	1.085	1.019	0.916	0.865	0.978	0.978	0.972
2000	0.541	1.075	1.010	0.903	0.851	0.955	0.955	0.960
2001	0.550	1.093	1.028	0.919	0.868	0.968	0.968	0.977
2002	0.562	1.117	1.052	0.934	0.879	0.975	0.975	0.995
2003	0.551	1.093	1.030	0.910	0.856	0.947	0.947	0.972
2004	0.539	1.069	1.008	0.889	0.838	0.928	0.928	0.951
2005	0.554	1.097	1.038	0.915	0.867	0.962	0.962	0.979
2006	0.519	1.023	0.969	0.855	0.818	0.914	0.914	0.916
2007	0.507	1.000	0.952	0.844	0.814	0.917	0.917	0.903
2008	0.486	0.959	0.920	0.822	0.801	0.909	0.909	0.875

2009	0.481	0.951	0.917	0.824	0.811	0.928	0.928	0.875
2010	0.465	0.921	0.891	0.804	0.798	0.921	0.921	0.853
2011	0.462	0.918	0.888	0.801	0.798	0.927	0.927	0.851
2012	0.489	0.977	0.947	0.855	0.856	1.001	1.001	0.908
2013	0.508	1.023	0.994	0.900	0.906	1.065	1.065	0.956
2014	0.483	0.973	0.942	0.852	0.858	1.011	1.011	0.906
2015	0.495	1.000	0.967	0.873	0.880	1.044	1.044	0.930
2016	0.518	1.052	1.017	0.916	0.924	1.101	1.101	0.977
2017	0.587	1.201	1.162	1.048	1.058	1.264	1.264	1.117
2018	0.612	1.254	1.212	1.087	1.094	1.307	1.307	1.162
2019	0.600	1.231	1.188	1.066	1.072	1.289	1.289	1.139
2020	0.541	1.105	1.062	0.950	0.961	1.162	1.162	1.020
2021	0.554	1.133	1.089	0.977	0.990	1.196	1.196	1.047

Table 6.8. Cod in Division 7e–k. Final SAM stock number-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1980	17720	4867	698	299	89	70	21
1981	8019	6664	1318	228	95	29	23
1982	3889	2988	1869	401	76	34	13
1983	8433	1440	864	636	141	28	15
1984	9296	3258	402	271	216	51	12
1985	8141	3697	1030	149	104	84	22
1986	9219	3198	1152	373	61	43	34
1987	27983	3487	942	378	130	25	25
1988	14070	11124	993	314	123	47	15
1989	4807	5524	3482	365	120	46	21
1990	6490	1779	1604	1106	145	44	23
1991	17005	2352	462	478	347	57	21
1992	19077	6167	581	132	139	106	23
1993	10876	6892	1571	163	42	44	35
1994	21331	3797	1773	457	53	14	23
1995	16618	7699	915	488	143	18	10
1996	12144	5958	1987	286	151	49	8
1997	12659	4287	1490	569	102	47	15
1998	7921	4586	1080	420	188	41	18
1999	4374	2809	1145	299	128	65	19
2000	16676	1474	684	311	94	43	26
2001	14810	6063	347	189	98	33	23
2002	5412	5275	1506	99	60	31	18
2003	3354	1850	1196	386	31	20	15
2004	4741	1211	443	309	119	11	11
2005	7966	1865	277	136	98	41	8
2006	8275	2736	469	64	44	32	16
2007	6203	2819	729	145	21	16	17
2008	2242	2181	719	214	50	8	11

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2009	5403	847	612	221	74	19	6
2010	24640	1998	250	188	79	25	8
2011	9323	9490	615	88	66	29	10
2012	1771	3552	2762	203	34	24	13
2013	2337	638	958	816	70	13	11
2014	11992	852	169	276	266	22	6
2015	1111	4661	244	50	93	87	9
2016	2320	407	1207	76	16	31	27
2017	666	821	110	302	26	6	16
2018	1472	222	173	27	74	7	5
2019	3502	459	44	36	8	19	3
2020	1305	1216	86	10	8	2	4
2021	923	455	270	23	4	3	2

Table 8.9. Cod in Divisions 7e–k. Final SAM summary table.

Year	R(age 1)	Low	High	SSB	Low	High	$F_{\text{bar}(2-5)}$	Low	High	TSB	Low	High
1980	17720	8502	36932	10247	7843	13387	0.915	0.749	1.119	20177	13640	29845
1981	8019	3988	16127	13034	9933	17105	0.894	0.750	1.066	20721	14781	29049
1982	3889	1949	7760	13167	10494	16521	0.843	0.712	0.999	17074	13373	21799
1983	8433	4312	16495	10489	8677	12681	0.848	0.716	1.003	14789	11776	18573
1984	9296	4767	18131	8588	6982	10565	0.770	0.630	0.942	14269	10651	19114
1985	8141	4205	15762	9830	7912	12213	0.773	0.640	0.932	15542	11741	20574
1986	9219	4695	18101	10758	8700	13301	0.815	0.693	0.958	16576	12729	21587
1987	27983	14496	54019	10551	8582	12972	0.832	0.707	0.978	23444	16386	33542
1988	14070	7264	27253	16219	12026	21873	0.796	0.659	0.960	28970	20206	41534
1989	4807	2454	9419	21417	16488	27820	0.835	0.705	0.988	27766	21184	36393
1990	6490	3257	12932	17023	13673	21193	0.904	0.773	1.058	21029	16842	26257
1991	17005	8528	33908	10934	9097	13143	0.966	0.811	1.150	18890	13951	25578
1992	19077	9725	37422	10555	8075	13797	0.966	0.824	1.132	21805	14990	31719
1993	10876	5449	21710	13519	10277	17783	0.951	0.818	1.106	22481	16162	31269
1994	21331	10979	41447	13521	10730	17038	0.974	0.834	1.137	24384	17768	33463
1995	16618	8616	32050	14295	11018	18546	0.950	0.818	1.102	25728	18429	35916
1996	12144	6327	23307	15874	12485	20184	0.958	0.825	1.114	24810	18594	33104
1997	12659	6588	24326	14352	11592	17770	0.937	0.805	1.091	22249	16992	29133
1998	7921	4120	15232	12818	10363	15855	0.959	0.826	1.114	19044	14555	24918
1999	4374	2287	8365	10582	8628	12978	0.972	0.835	1.130	14352	11320	18197
2000	16676	9099	30560	7486	6228	8999	0.960	0.826	1.115	14808	10932	20059
2001	14810	8194	26768	8824	6725	11577	0.977	0.844	1.132	18362	13296	25358
2002	5412	3108	9426	11384	9147	14167	0.995	0.857	1.156	17249	13446	22129
2003	3354	2123	5296	9163	7727	10867	0.972	0.847	1.116	11943	10025	14227
2004	4741	2937	7653	5463	4694	6358	0.951	0.838	1.080	7738	6566	9119
2005	7966	5530	11477	4190	3640	4823	0.979	0.849	1.129	7530	6393	8868
2006	8275	5536	12371	5522	4708	6477	0.916	0.809	1.037	9783	8177	11705
2007	6203	4238	9079	6708	5695	7900	0.903	0.796	1.023	10591	8897	12607
2008	2242	1541	3262	6814	5818	7981	0.875	0.769	0.996	9416	8013	11065

Year	R(age 1)	Low	High	SSB	Low	High	$F_{\text{bar}(2-5)}$	Low	High	TSB	Low	High
2009	5403	3739	7808	5438	4656	6350	0.875	0.771	0.994	8505	7273	9947
2010	24640	17401	34892	5431	4675	6310	0.853	0.742	0.981	14031	11440	17211
2011	9323	6505	13361	9140	7692	10861	0.851	0.739	0.980	16807	13986	20196
2012	1771	1229	2551	14076	11764	16842	0.908	0.806	1.024	17612	14870	20859
2013	2337	1599	3414	10315	8747	12165	0.956	0.831	1.100	12115	10433	14068
2014	11992	8271	17387	6343	5420	7423	0.906	0.791	1.038	11435	9560	13678
2015	1111	759	1627	6499	5510	7666	0.930	0.813	1.064	9626	7946	11660
2016	2320	1586	3394	5834	4832	7043	0.977	0.856	1.117	7862	6625	9331
2017	666	447	992	3224	2705	3843	1.117	0.972	1.285	3978	3364	4703
2018	1472	1000	2168	1689	1450	1966	1.162	1.004	1.345	2452	2113	2845
2019	3502	2423	5062	1097	940	1279	1.139	0.984	1.320	2709	2202	3333
2020	1305	856	1990	1346	1105	1640	1.020	0.811	1.282	2588	2106	3180
2021	923	464	1837	1334	1036	1716	1.047	0.812	1.350	2007	1531	2632

Table 6.10a. Cod in Division 7e–k. Table of model parameters.

Parameter name	par	sd(par)	exp(par)	Low	High
logFpar_0	-6.920	0.050	0.001	0.001	0.001
logFpar_1	-3.149	0.159	0.043	0.031	0.059
logFpar_2	-2.190	0.156	0.112	0.082	0.153
logFpar_3	-1.929	0.156	0.145	0.106	0.198
logSdLogFsta_0	-2.480	0.465	0.084	0.033	0.212
logSdLogN_0	-0.079	0.132	0.924	0.710	1.202
logSdLogN_1	-2.012	0.396	0.134	0.061	0.295
logSdLogObs_0	-0.707	0.214	0.493	0.322	0.756
logSdLogObs_1	-1.129	0.251	0.323	0.196	0.534
logSdLogObs_2	-1.235	0.110	0.291	0.233	0.362
logSdLogObs_3	-1.850	0.218	0.157	0.102	0.243
logSdLogObs_4	-0.449	0.139	0.638	0.483	0.843
transfIRARdist_0	-0.754	0.447	0.470	0.193	1.149
itrans_rho_0	1.849	0.706	6.356	1.548	26.092

Table 6.10b. Cod in Division 7e–k. Model fitting.

Model	log(L)	#par	AIC
Current	-221.51	14	471.01
base	-209.68	14	447.37

Table 6.11. Cod Division 7e–k. Short-term forecast assumption.

Variable	Value	Notes
F ages 2–5 (2022)	1.139	$F_{sq} = F_{average}$ (2019–2021)
SSB (2023)	992	Fishing at F_{sq} ; in tonnes.
Recruitment age 1 (2022–2023)	1305,1305	Median from resampled (2015–2021); in thousands
Total catch (2022)	1220	Fishing at F_{sq} , in tonnes.

Table 6.12. Cod in Division 7e–k. Reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	5800	B_{pa} ; in tonnes	ICES (2020a)
	F_{MSY}	0.29	Segmented regression with B_{lim} (EqSim)	ICES (2020a)
Precautionary approach	B_{lim}	4200	B_{loss} , lowest observed SSB from which there has been some recovery (2005) rounded value; in tonnes	ICES (2020a)
	B_{pa}	5800	$B_{lim} \times 1.4$; in tonnes	ICES (2020a)
	F_{lim}	1.13	Segmented regression with B_{lim} (EqSim)	ICES (2020a)
	F_{pa}	0.77	$F_{p0.5}$; the F that leads to $SSB \geq B_{lim}$ with 95% probability	ICES (2020a)
Management plan	MAP MSY $B_{trigger}$	5800	MSY $B_{trigger}$; in tonnes	EU (2019), ICES (2020a)
	MAP B_{lim}	4200	B_{lim} ; in tonnes	EU (2019), ICES (2020a)
	MAP F_{MSY}	0.29	F_{MSY}	EU (2019), ICES (2020a)
	MAP range F_{lower}	0.17	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY	EU (2019), ICES (2020a)
	MAP range F_{upper}	0.41	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY	EU (2019), ICES (2020a)

Table 6.13. Stochastic Short-term forecast.

F_{MSY}

Year	F _{bar} median	F _{bar} low	F _{bar} high	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.290	0.207	0.406	1305	666	3502	992	490	1909	406	247	759
2024	0.290	0.199	0.420	1305	666	3502	2042	1040	4137	740	429	1424

Basis for the advice F=0

Year	F _{bar} median	F _{bar} low	F _{bar} high	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.000	0.000	0.000	1305	666	3502	992	490	1909	0	0	0
2024	0.000	0.000	0.000	1305	666	3502	2649	1419	5309	0	0	0

Other scenarios**F status quo then F_{MSY} HCR**

Year	F _{bar} median	F _{bar} low	F _{bar} high	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.050	0.035	0.069	1305	666	3502	992	490	1909	77	47	146
2024	0.290	0.199	0.420	1305	666	3502	2531	1345	5088	890	513	1736

F status quo then F_{MSY} lower HCR

Year	F _{bar} median	F _{bar} low	F _{bar} high	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.029	0.021	0.041	1305	666	3502	992	490	1909	46	28	86
2024	0.290	0.199	0.420	1305	666	3502	2579	1375	5183	904	521	1766

F status quo then F_{MSY} upper HCR

Year	$F_{bar median}$	$F_{bar low}$	$F_{bar high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.070	0.050	0.098	1305	666	3502	992	490	1909	108	66	204
2024	0.290	0.199	0.420	1305	666	3502	2485	1316	4998	876	505	1706

Stable SSB

Year	$F_{bar median}$	$F_{bar low}$	$F_{bar high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	1.116	0.796	1.563	1305	666	3502	992	490	1909	1136	681	2078
2024	1.145	0.787	1.660	1305	666	3502	992	426	2173	1195	666	2228

 F_{2022}

Year	$F_{bar median}$	$F_{bar low}$	$F_{bar high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	1.139	0.813	1.596	1305	666	3502	992	490	1909	1151	689	2104
2024	1.139	0.783	1.652	1305	666	3502	972	416	2135	1175	654	2192

 F_{pa}

Year	$F_{bar median}$	$F_{bar low}$	$F_{bar high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	0.770	0.549	1.078	1305	666	3502	992	490	1909	890	538	1637
2024	0.770	0.530	1.116	1305	666	3502	1336	618	2813	1148	660	2138

F_{lim}

Year	$F_{bar median}$	$F_{bar low}$	$F_{bar high}$	Rec median	Rec low	Rec high	SSB median	SSB low	SSB high	Catch median	Catch low	Catch high
2021	1.047	0.816	1.344	925	471	1812	1346	1052	1724	1333	1065	1677
2022	1.139	0.847	1.535	1305	666	3502	1196	732	1879	1220	833	1805
2023	1.130	0.806	1.583	1305	666	3502	992	490	1909	1145	686	2094
2024	1.130	0.777	1.638	1305	666	3502	980	420	2151	1175	655	2193

B_{lim} - Not archivable.

B_{pa} , MSYBtrigger, not archivable.

Table 6.14. Catch option table.

Basis	Total catch (2023)	F_{total} (2023)	SSB (2024)	% SSB change *
ICES advice basis				
MSY and precautionary considerations: $F = 0$	0	0	2649	167
Other scenarios				
$F_{MSY} \times SSB_{2023} / MSY B_{trigger}$	77	0.050	2531	155
$F_{MSY lower} \times SSB_{2023} / MSY B_{trigger}$	46	0.029	2579	160
$F_{MSY upper} \times SSB_{2023} / MSY B_{trigger}$	108	0.070	2485	150
$F = F_{MSY}$	406	0.290	2042	106
$F = 0$	0	0	2649	167
$F = F_{lim}$	1145	1.130	980	-1.2
$F = F_{pa}$	890	0.770	1336	35
$SSB_{2024} = B_{lim}$				
$SSB_{2024} = B_{pa} = MSY B_{trigger}$				
$F = F_{2022}$	1151	1.139	972	-2
$SSB_{2024} = SSB_{2023}$	1136	1.116	992	0

Table 6.15.Cod in Division 7e–k. Forecast (a) yield in 2023 and (b) SSB in 2024.

recruitment	val	type	Prop	Age
2023	0,00024668	2023 Catch	17,194287	1
2022	0,0006068	2023 Catch	42,2951259	2
2021	0,00024928	2023 Catch	17,3752029	3
2020	0,00014912	2023 Catch	10,3938527	4
2019	0,00015426	2023 Catch	10,7518776	5
2018	2,24E-05	2023 Catch	1,55794101	6
2017	6,19E-06	2023 Catch	0,43171295	7
2024	0	2024 SSB	0	1
2023	651,38811	2024 SSB	25,0285744	2
2022	1188,47341	2024 SSB	45,6652411	3
2021	375,213077	2024 SSB	14,4169785	4
2020	186,541001	2024 SSB	7,16754763	5
2019	176,350869	2024 SSB	6,77600769	6
2018	24,6112966	2024 SSB	0,94565077	7

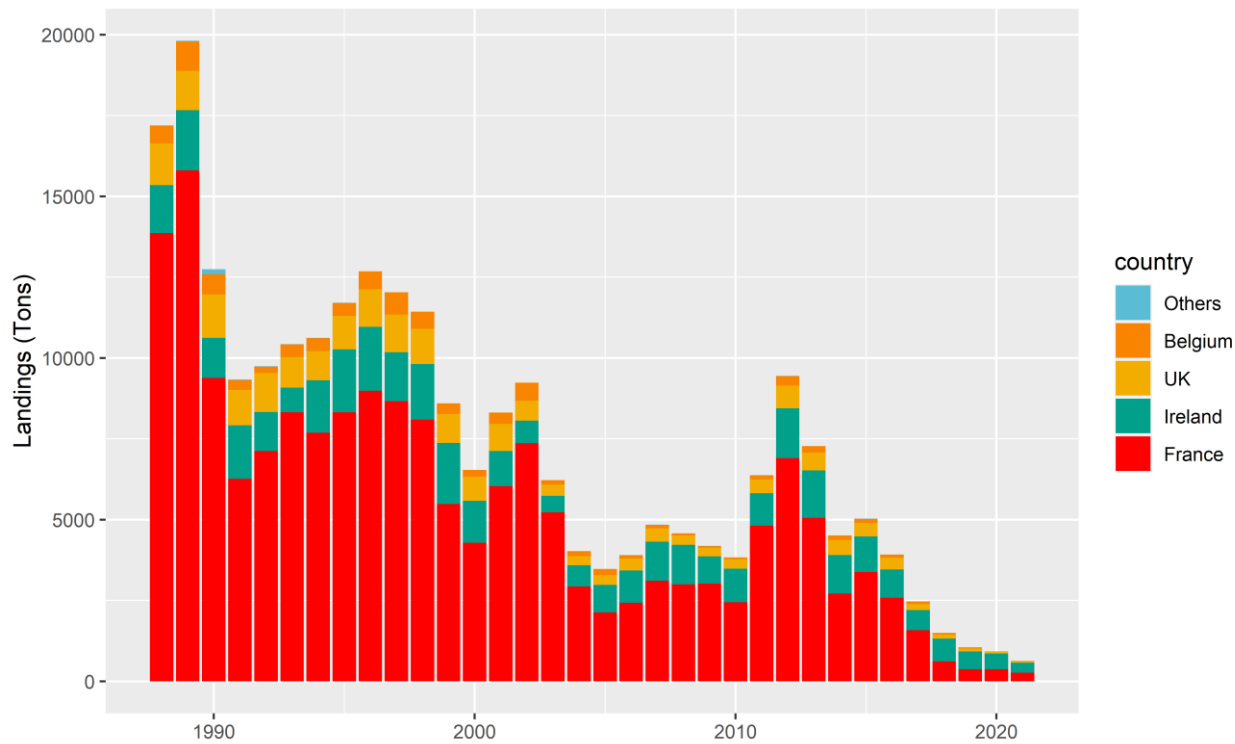


Figure 6.1. Cod in Division 7e-k. Historical landings (in tonnes) by country. Revised at WKCELTIC 2020.

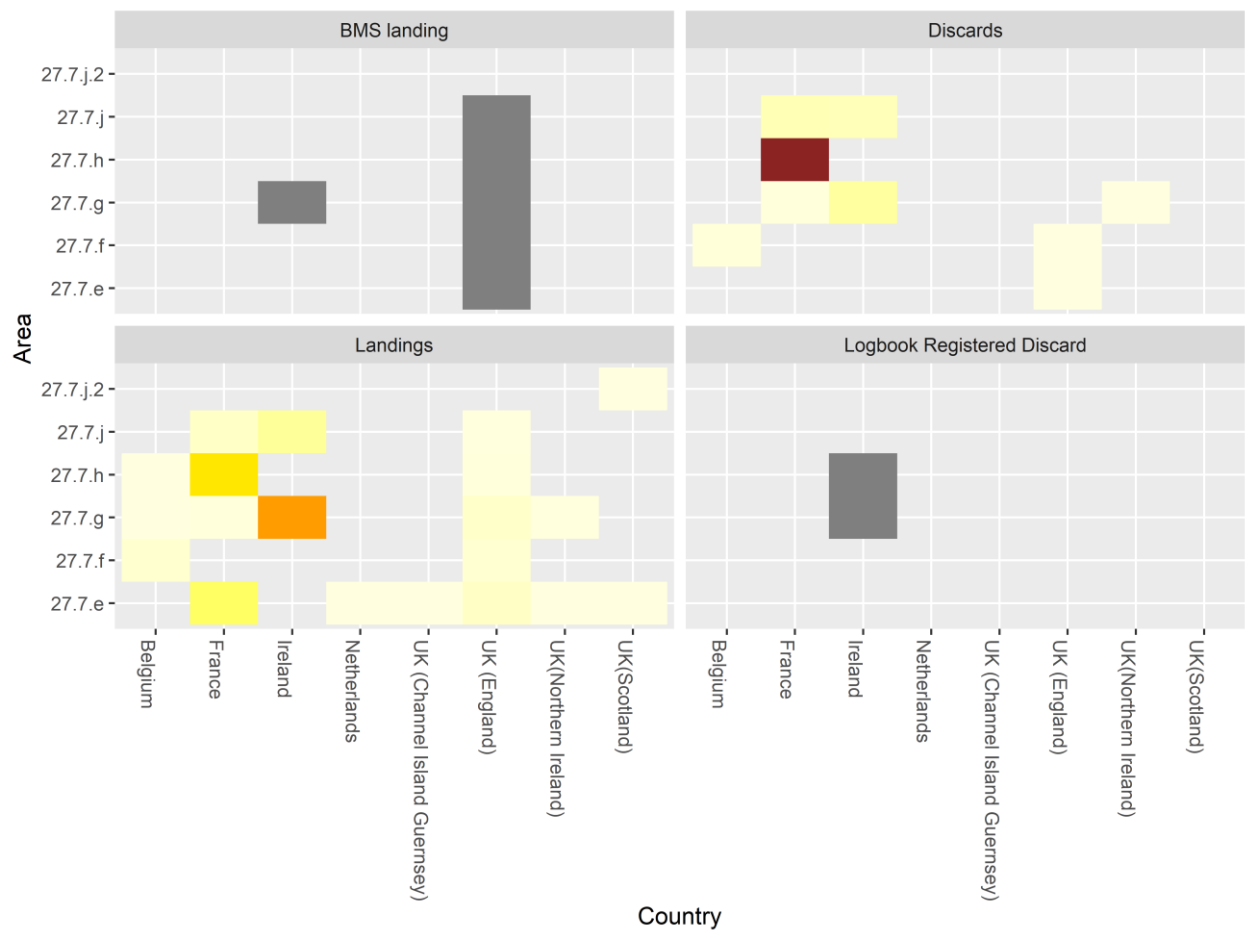


Figure 6.2. Cod in Division 7e–k. Catches volume in Tonnes (i.e.landings and discards) by area and country.

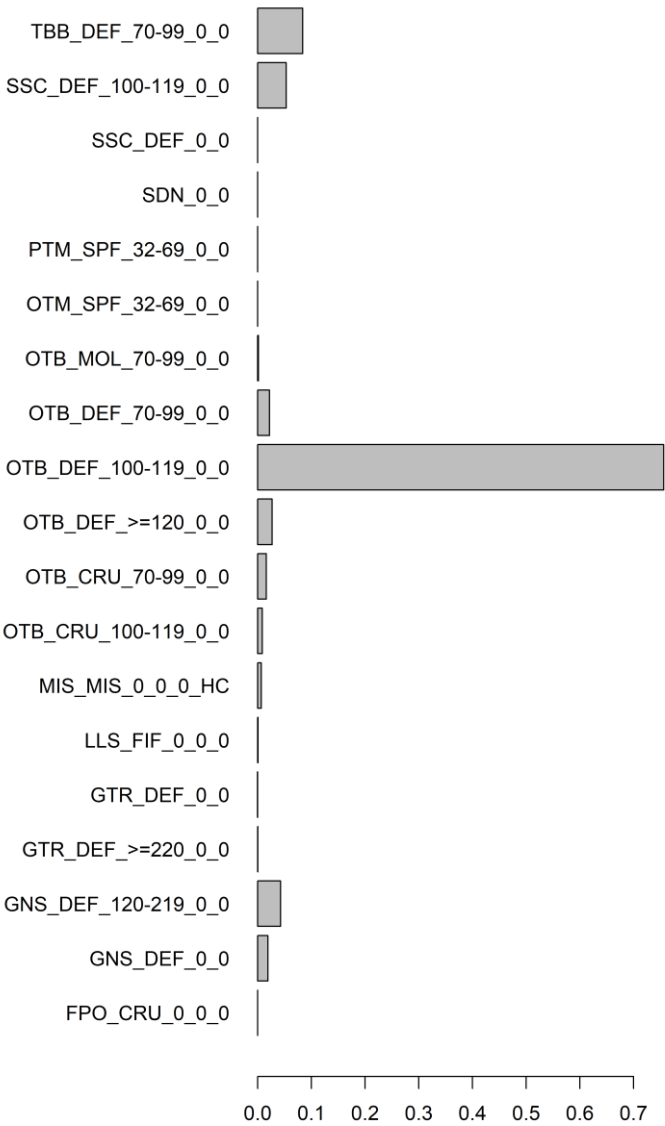


Figure 6.3. Cod in Division 7e-k. Proportion of the catches per métier (Level 6).

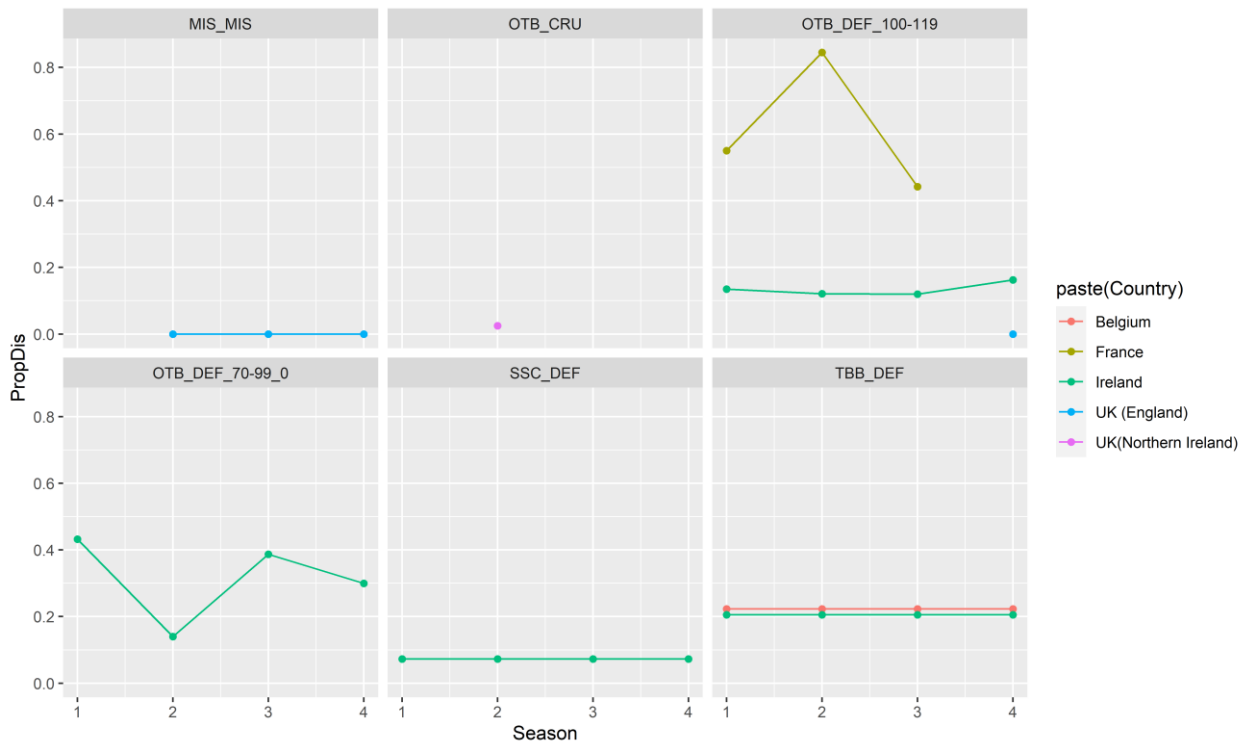


Figure 6.4. Cod in Division 7e-k. Discard proportion per métier and season.

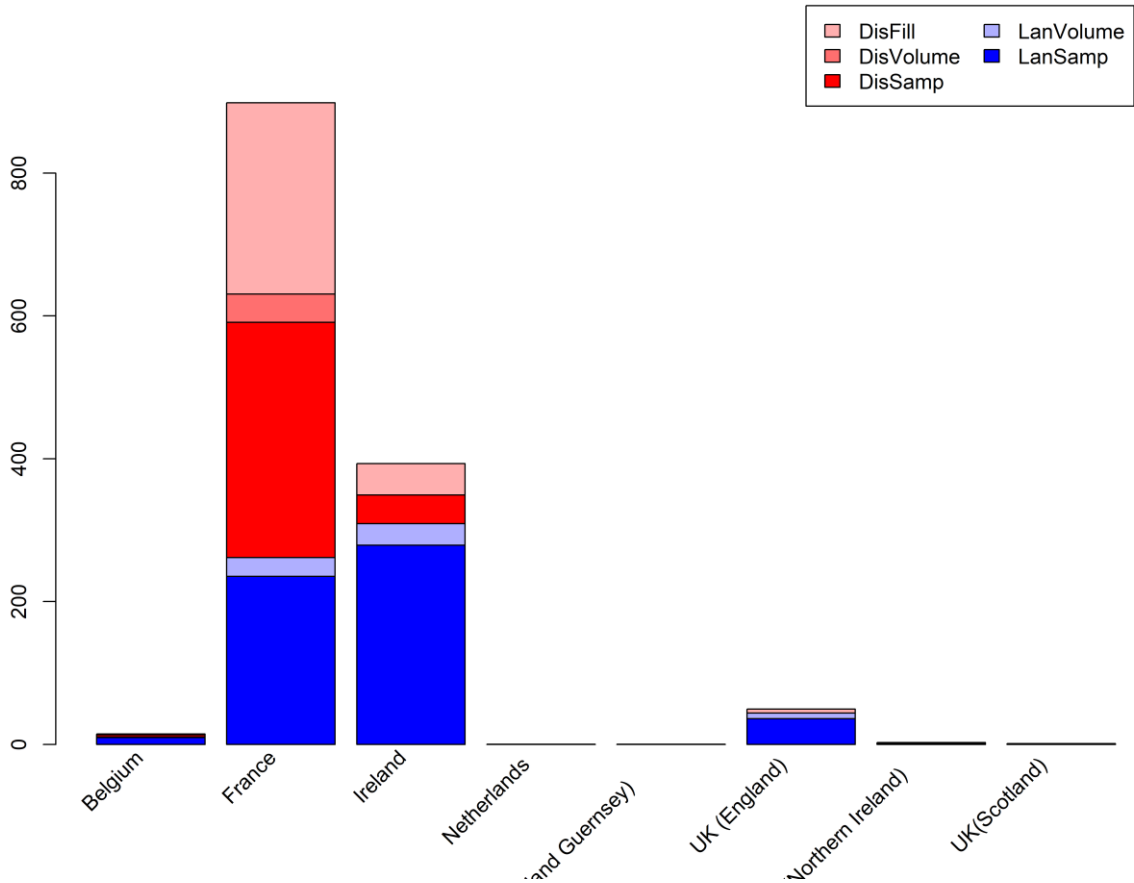


Figure 6.5. Cod in Division 7e-k. Allocation procedure.

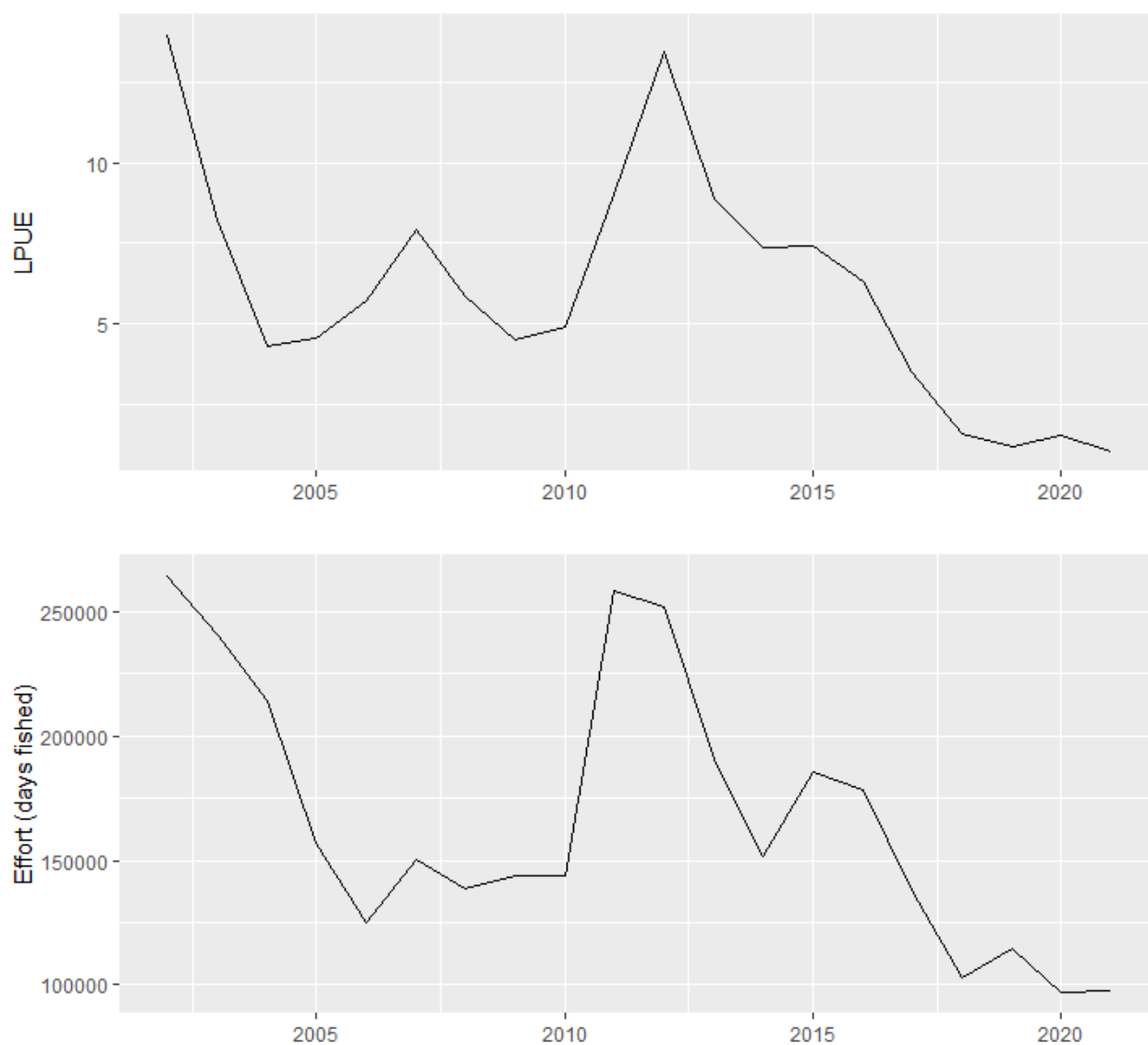


Figure 6.6a. Cod in Division 7e–k. Time-series of (a) LPUE and (b) fishing effort for the French fleets. Units: LPUE in kg/day and fishing effort in days fished.

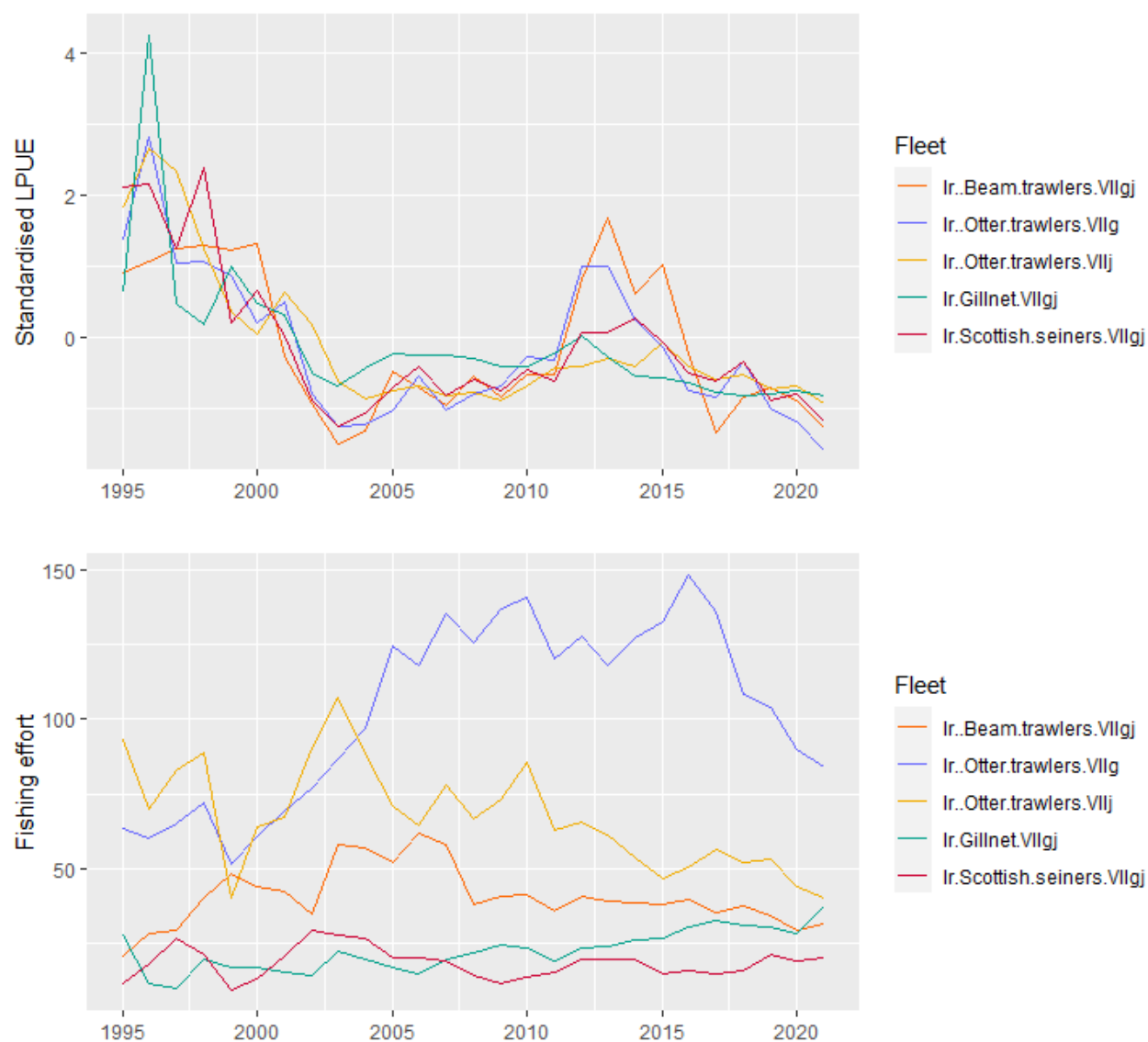


Figure 6.6b. Cod in Division 7e–k. Time-series of (a) LPUE and (b) fishing effort for the Irish fleets. Units: LPUE in kg/day fished and Effort in 000s hours fished.



Figure 6.6c. Cod in Division 7e–k. Time-series of LPUE and fishing effort for the UK fleets. Units: LPUE in kg/day and fishing effort in days fished.

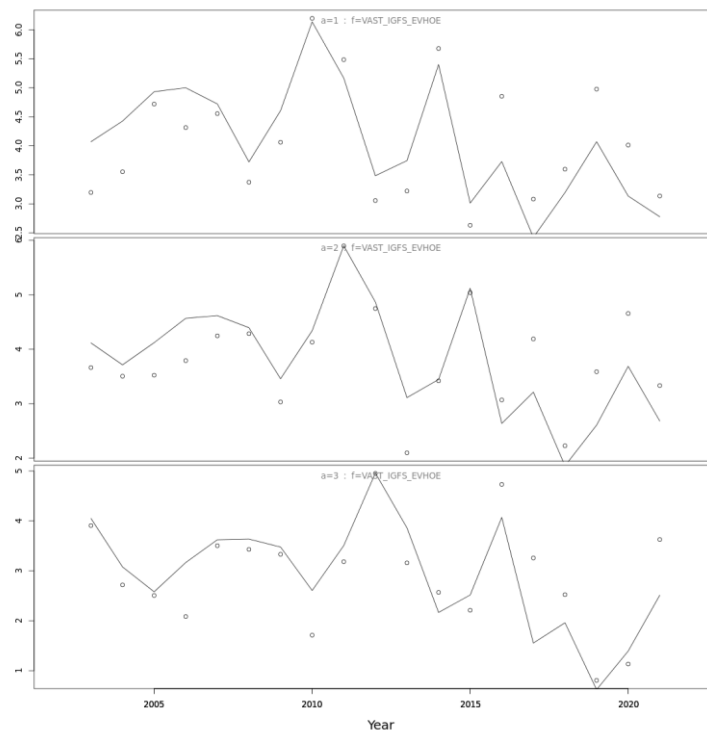
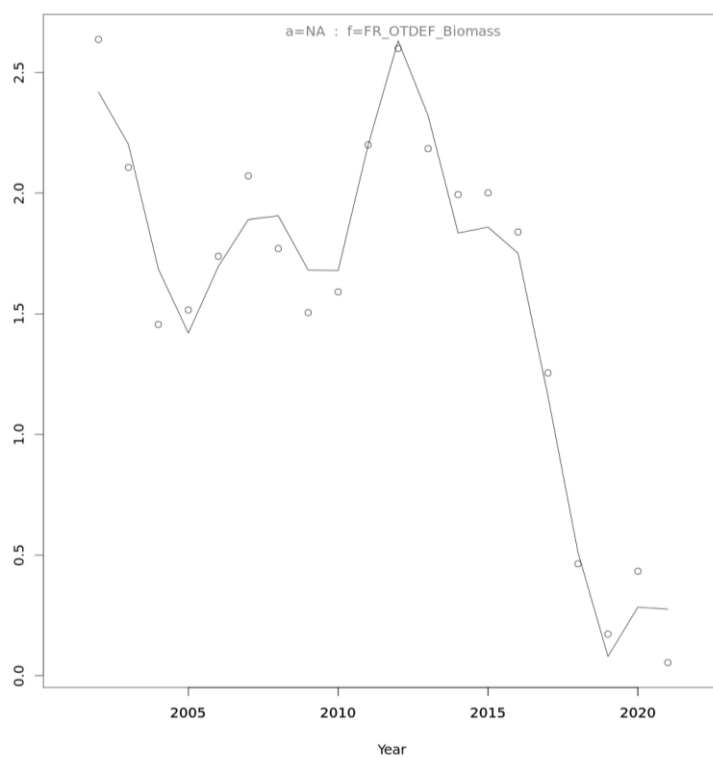


Figure 6.7. Cod in Division 7e-k. Fits of the tuning indices used in the assessment. Commercial tuning fleet corresponds to French OTDEF Q2+3+4 as biomass index. The survey index is a combined index based on both French IR-GFS and FR-Evhoe Q4 data where mean number-at-age are modelled using VAST.



Figure 6.8. Cod in Division 7e-k. Final assessment. Residuals.

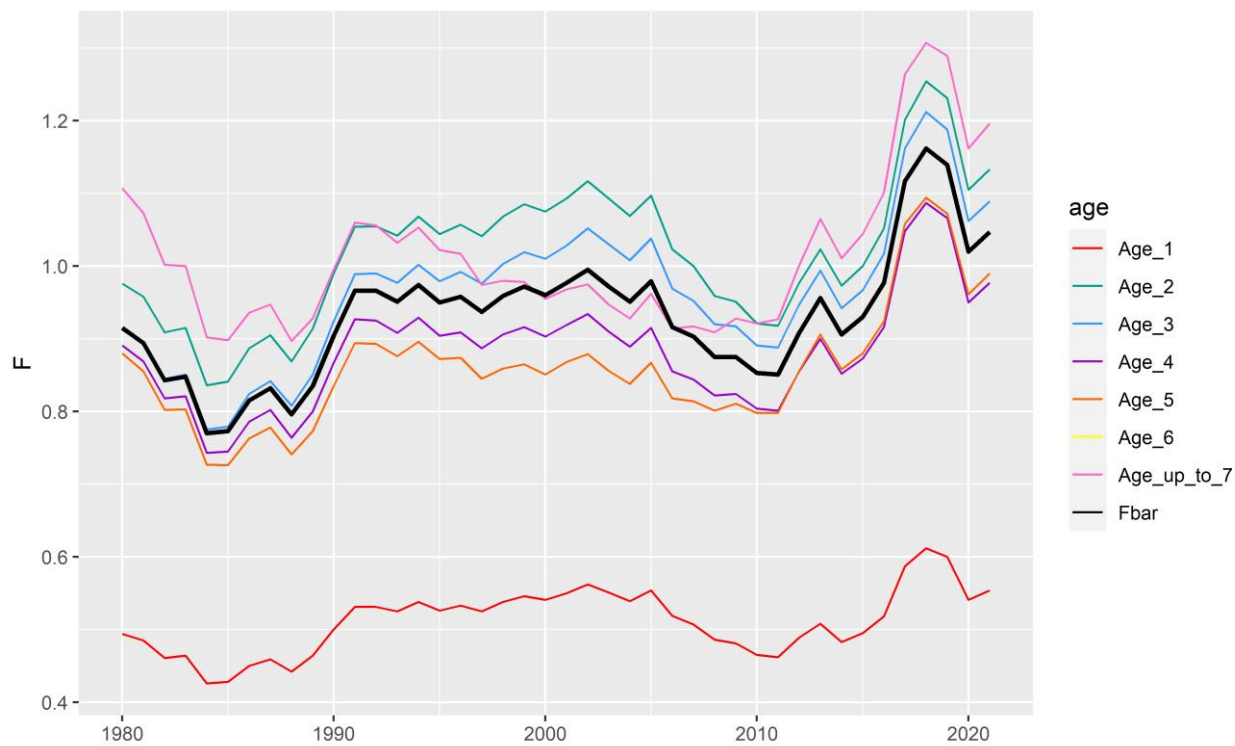
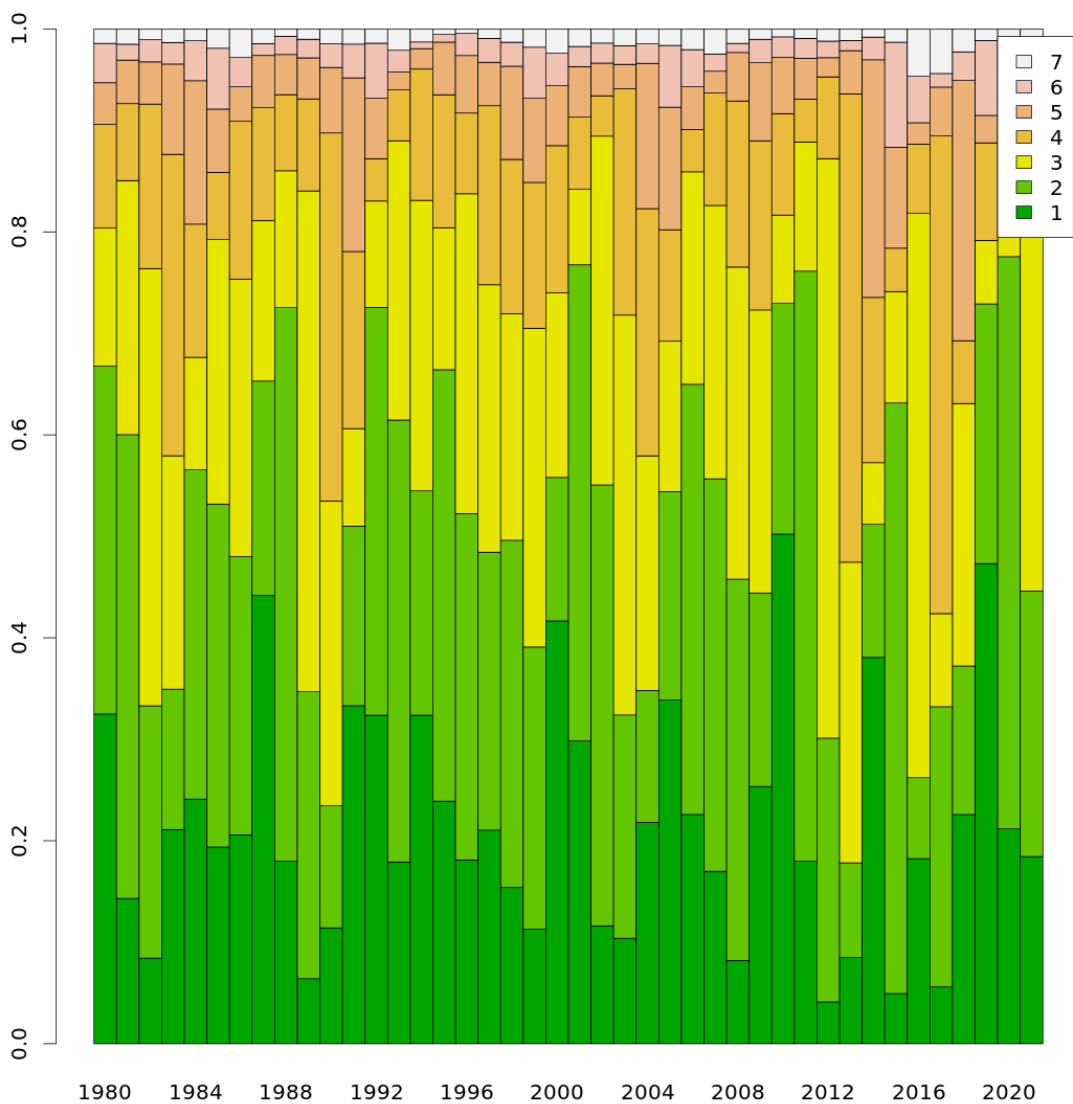
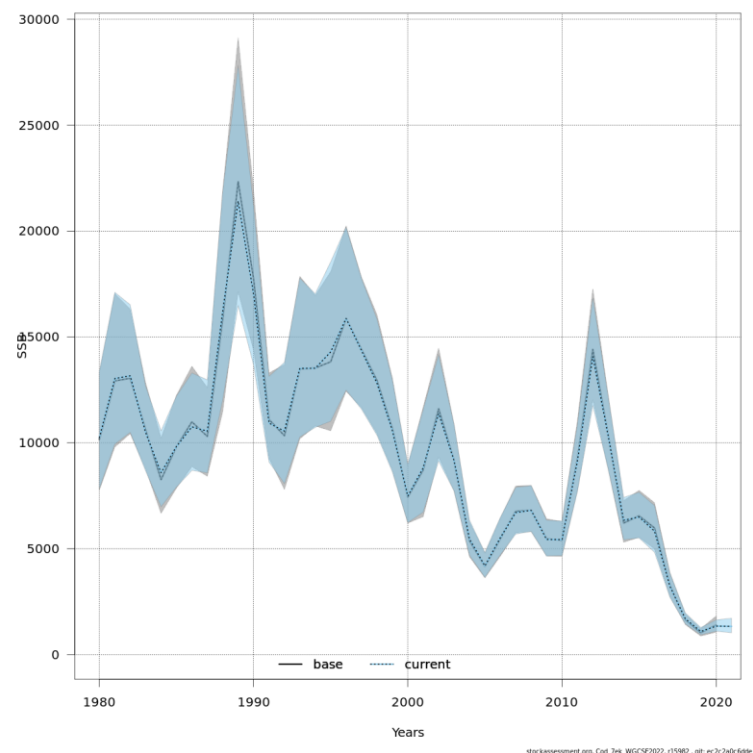
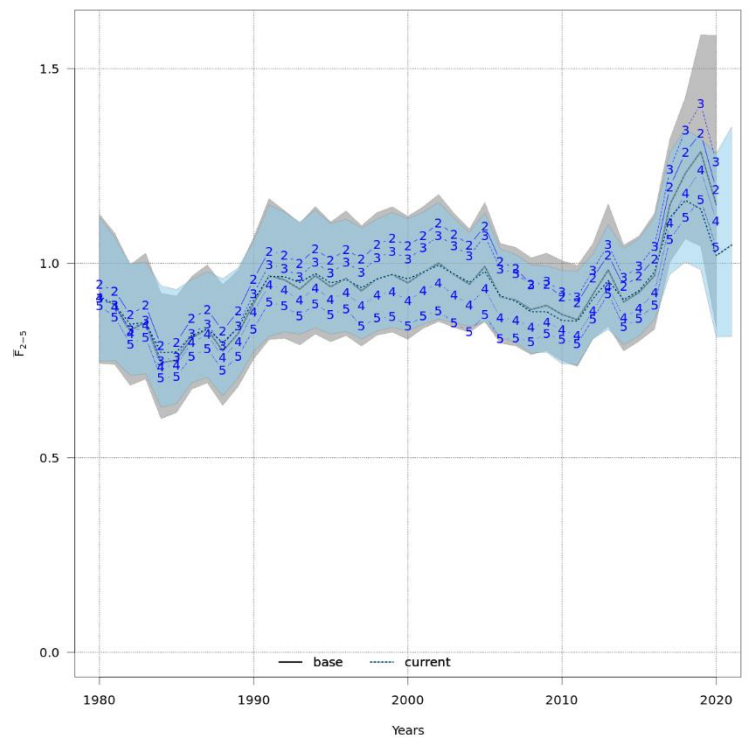


Figure 6.9. Cod in Division 7e-k. Fishing mortality.



stockassessment.org, Cod 7ek WGCSE2022, r15982, git: ec2c2a0c6dde

Figure 6.10. Cod in Division 7e–k. Final SAM outputs. Catch proportion-at-age. Age 0 are not included in the assessment.



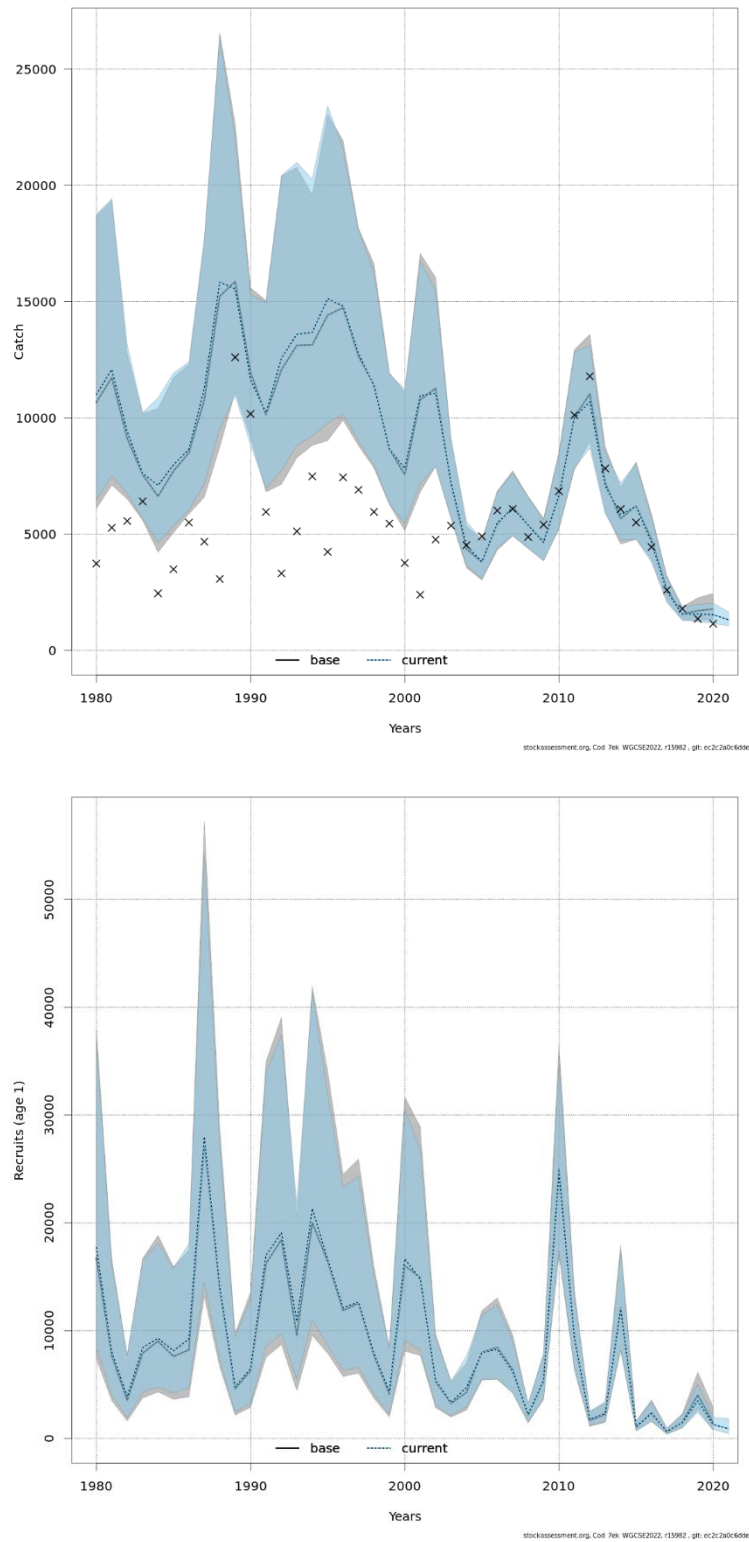
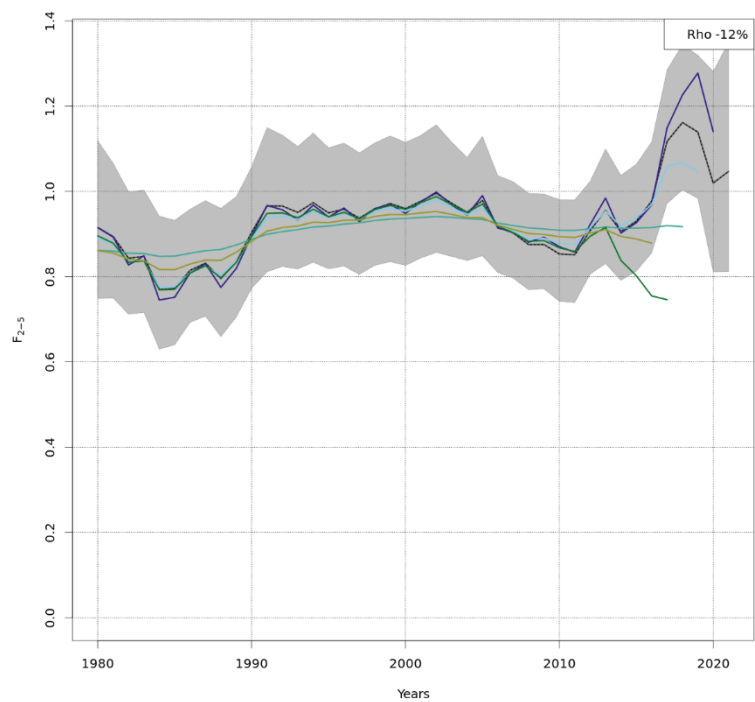
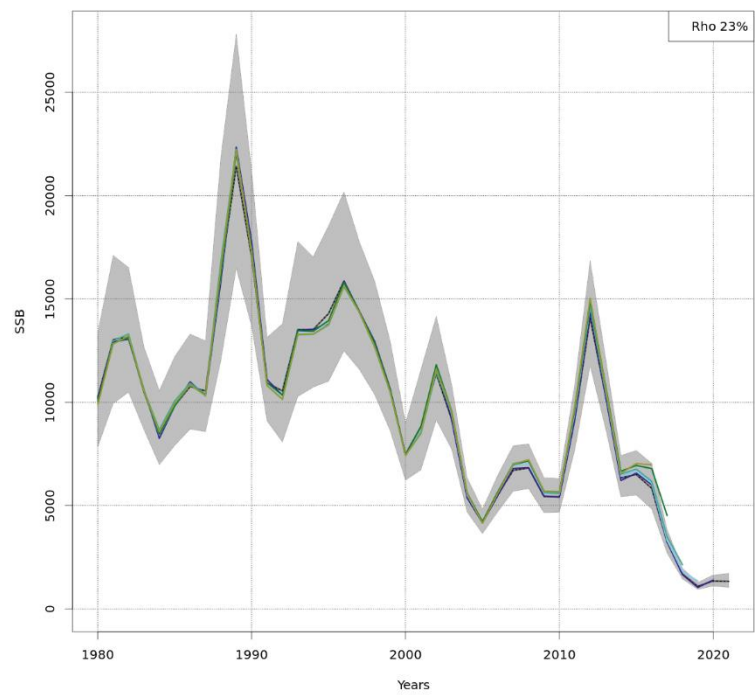


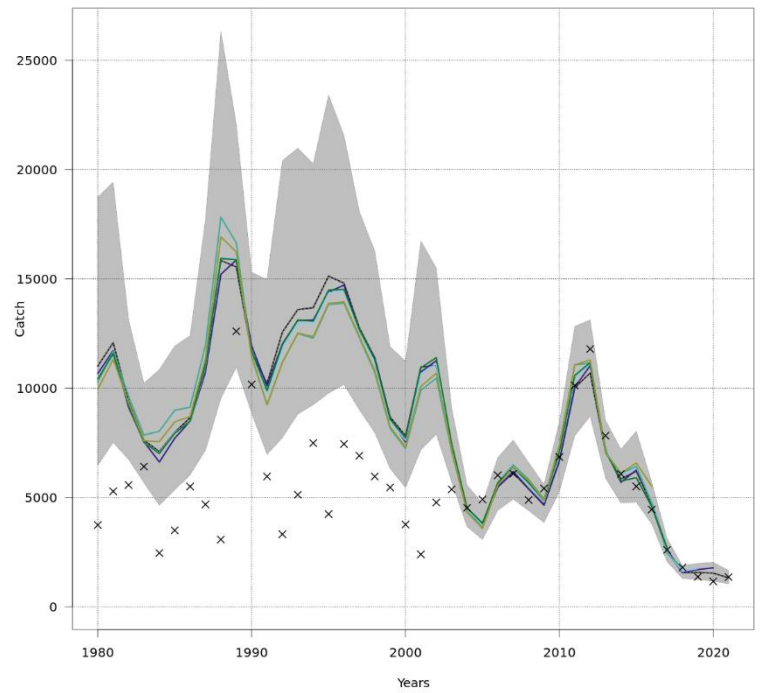
Figure 6.11. Cod in Division 7e-k. Final SAM outputs. SSB, F, R and catches estimates.



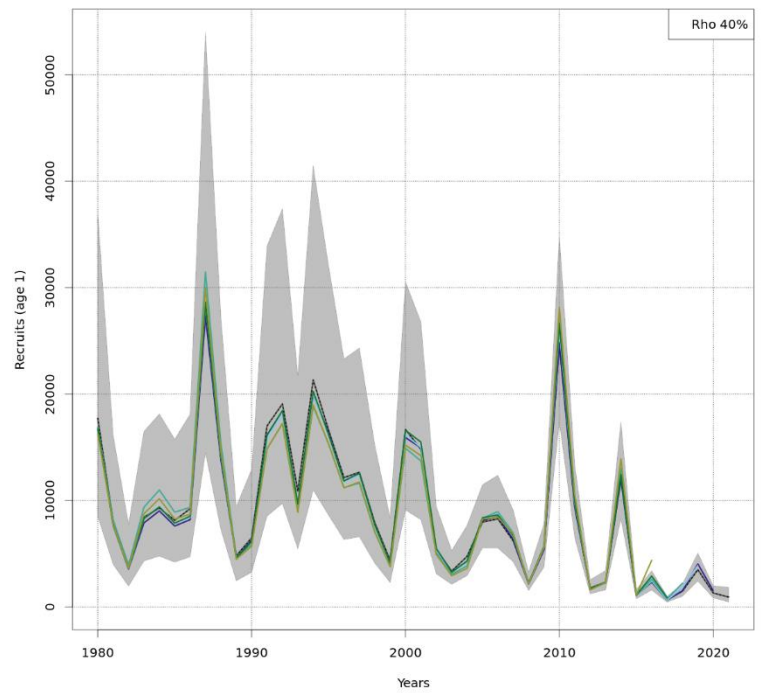
stockassessment.org, Cod 7ek WGCSE2022, r15962, gti: cr2c2a0c6d6e



stockassessment.org, Cod 7ek WGCSE2022, r15962, gti: cr2c2a0c6d6e

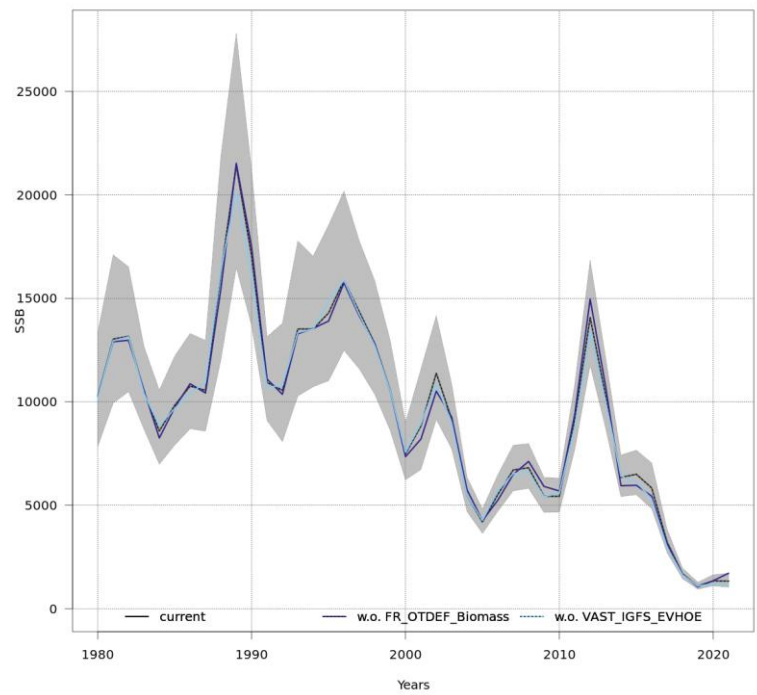


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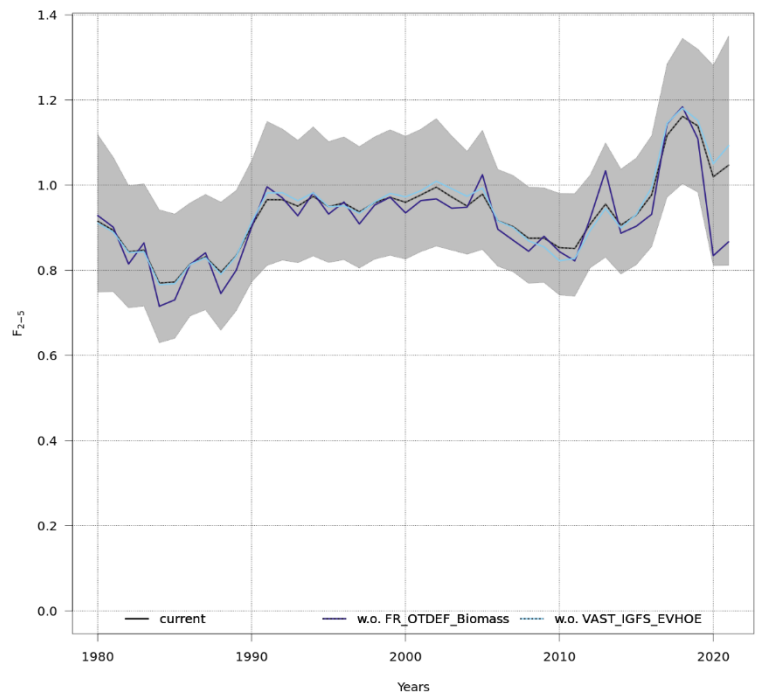


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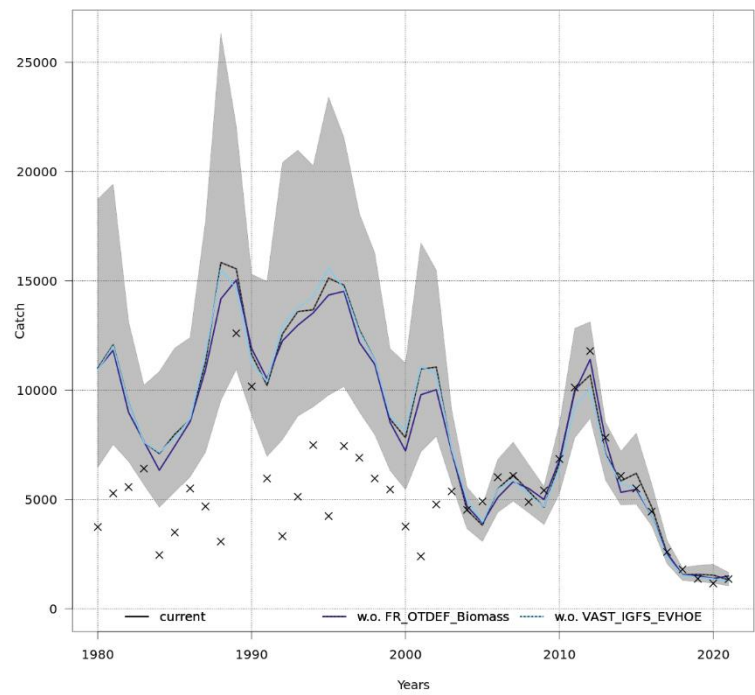
Figure 6.12a. Cod in Division 7e–k. Final SAM. Retrospective plots.



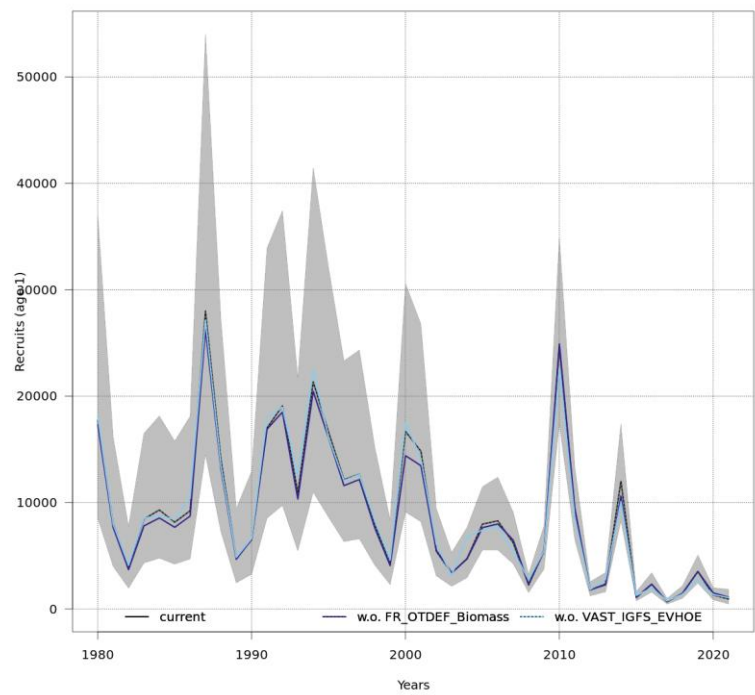
stockassessment.org, Cool 7ek WGCSE2022, r15982, git: ec2c2a0c6d0e



stockassessment.org, Cool 7ek WGCSE2022, r15982, git: ec2c2a0c6d0e



stockassessment.org, Cod 7e-k WGCSE2022, r15982, git: ec2c2a0c6d9e



stockassessment.org, Cod 7e-k WGCSE2022, r15982, git: ec2c2a0c6d9e

Figure 6.12b. Cod in Division 7e–k. Final SAM. Comparison between runs (runs with the two tuning indices, with only the survey index and with only the commercial tuning index).

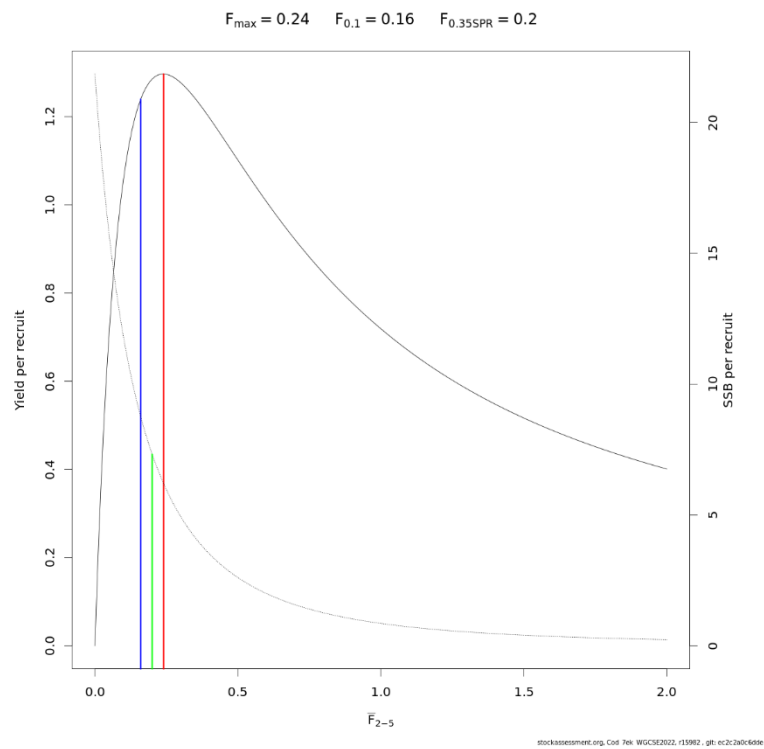
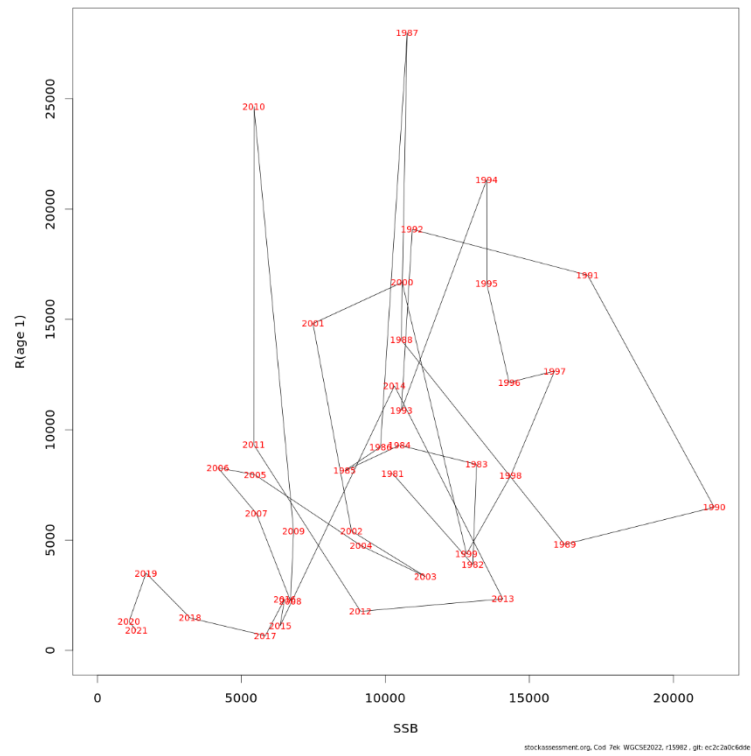


Figure 6.13. Cod in Division 7e-k. Stock–recruitment plots and yield per recruit information.

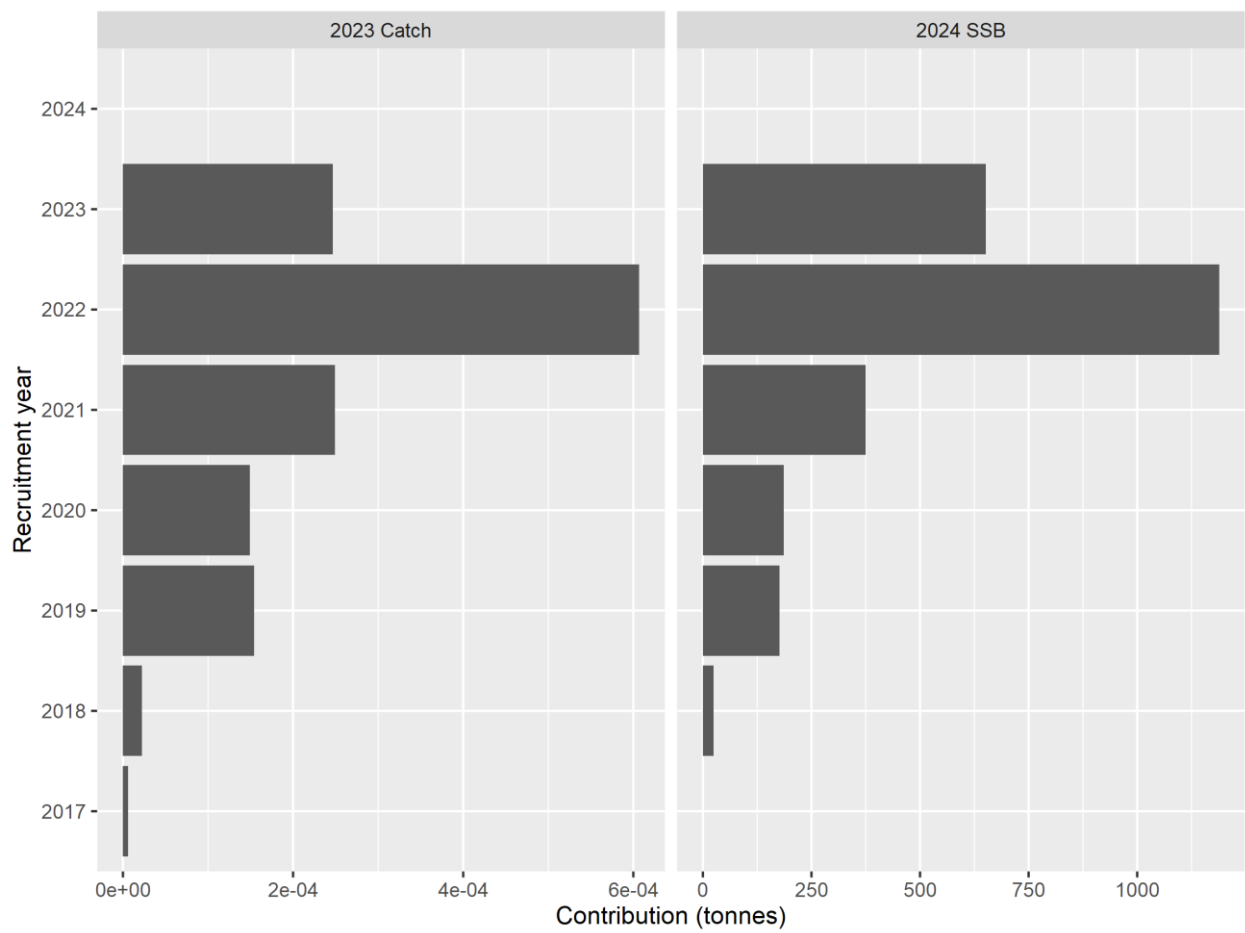


Figure 6.14. Cod in Division 7e–k. Forecast (a) yield in 2023 and (b) SSB in 2024.