Contents

8 Haddock in Divisions 7.b,c,e–k

Type of assessment in 2021

The Celtic Sea haddock (27.7b,c,e–k) assessment was benchmarked in 2020, with discard and landings data reviewed and updated from 2005 onwards.

The 2022 SAM assessment was undertaken in the web tool: www.stockassessment.org. The procedure detailed in the Stock Annex, performed in the preceding year was followed.

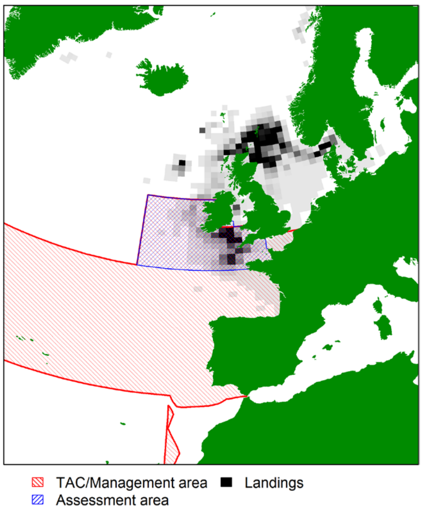
ICES advice applicable to 2022

Last year's full advice is available in the Report of the ICES Advisory Committee, 2021. ICES Advice 2021, had.27.7b–k. https://doi.org/10.17895/ices.advice.7764. The headline advice was as follows:

"ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 15 946 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by some of the relevant management authorities for this stock."

8.1 General

Stock description and management units



The basis for the stock assessment area 7.b,c,e–k is described in detail in the stock annex.

Figure 8.1 shows the spatial distribution of international haddock landings in the NE Atlantic for 2016. It is clear from the figure that the stock extends into Area 8 and it could be argued that landings from 8 should be included in the stock area. In recent years these landings varied between 20 and 300 t which is up to 4% of the total landings in the stock area.

The TAC for haddock is set for the combined Areas 7.b–k, 8, 10 and 10 and EU waters of CECAF 34.1.1. This does not correspond to the stock assessment area (7.b–k).

2022 management (Council Regulation (EU) 2022/109)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	7b-k, 8, 9 and 10; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	146	Analytical TAC	
France	8 762	Article 8(2) of this Regulation applies	
Ireland	2 920		
Union	11 828		
United Kingdom	2 550		
TAC	15 000		

Since 2009, a separate TAC is set for 7.a haddock; previously a separate allocation for 7.a existed within the TAC for 7, 8, 9 and 10.

The 2020 EU Council Regulation included Article 13, "Remedial measures for cod and whiting in the Celtic Sea" which will impact the Celtic Sea haddock fishery as these three species occupy similar areas. Article 13 implements spatial and fishing gear restrictions in an effort to reduce fishing pressure on cod and whiting.

8.2 The fishery

The official landings reported to ICES are given in Table 8.1. Before 2002, the TAC was well in excess of the landings in the TAC area. The TAC appeared to become restrictive for France in 2003–2004 and Ireland in 2001–2003. During 2005–2008 landings were well below the TAC. In 2009 and 2010, the total landings were still below the TAC, but the quota appeared to become restrictive again for Ireland and Belgium. Since 2011, the TAC has been close to the total landings, and can be assumed to be restrictive for all countries. In the last two years uptake by France has reduced to less than 50% and UK quota share increased substantially due to Brexit.

Figure 8.1 shows the distribution of international landings between 2015 and 2019. Most haddock landings were taken from the northern North Sea, Irish Sea, Rockall and from the Celtic Sea.

Figure 8.2 shows a longer time-series of official landings and TAC. The time-series is characterised by a number of peaks with rapid increases in the landings, mostly followed by rapid decreases within a few years, suggesting the fishery was taking advantage of sporadic events of very high recruitment. During the 1960s and 1970s, three such peaks in landings occurred: the landings increased from less than 4000 t to 10 000 t or more. During the 1980s and early 1990s, landings were relatively stable around 2000–4000 t. During the mid-1990s the haddock landings increased again to over 10 000 t, mirroring increased landings in the Irish Sea in that period. Since the late 1990s the landings have varied between 7000 and 10 000 t and in 2012, the landings were the highest on record at more than 18 000 t.

Working Group estimates of the landings and discards are given in Table 8.2 and shown in Figure 8.3. The discard estimate for 2010 was the highest on record at 16 547 tonnes, this was mainly a consequence of the 2009 cohort entering the fishery.

Table 8.3 and Figure 8.4 show that Irish commercial LPUE was relatively low between 2003 and 2007 after which it increased. Effort in the French gadoid fleet has declined considerably since the early 2000s as the result of a decommissioning scheme. The French and Irish 7.fgh fleets both showed an increase in LPUE as the strong 2009 cohort entered the fishery. These data are presented for auxiliary information only; these fleets are not used directly in the assessment.

8.2.1 Information from the industry

No updated information from industry was received.

8.3 Data

8.3.1 Landings and discard numbers-at-age

Catch sampling in 2021 increased compared to 2020 when it was impacted owing to the COVID 19 pandemic and is considered sufficient to describe the stock.

Discard and retained catch-at-age distributions are shown in Figure 8.5. Many of the discarded fish will be above the MLS, which is likely to be the result of restrictive quota.

Landings numbers-at-age are given in Table 8.4 and discard numbers-at-age are given in Table 8.5. Despite some uncertainty about the quality of the discard data, it is possible to track strong year classes in both the discards and the landings-at-age matrices. Figure 8.6 shows proportional representation of landings relative to catch (discards + landings) by age, 1993–2021. Discards account for a large proportion of the catch numbers up to age 3. Figure 8.7 shows the proportions-at-age that are discarded.

Sampled and unsampled catch (landings and discards) by country are shown in Figure 8.8.

Figure 8.9 shows that the raw stock weights-at-age which are fairly noisy, a 3-year running average was applied to the stock weights used in the assessment. There appear to be cyclical trends in the weights-at-age that follow cohorts (rather than year-effects).

8.3.2 Biological

The assumptions of natural mortality and maturity are described in the stock annex. The maturity ogive used in the assessment is quite sharp, with 0.39% of 2 year olds and 91% of 3 year olds mature (stock annex).

8.3.3 Surveys and commercial tuning fleets

The available surveys and commercial tuning fleets are described in detail in the stock annex. One survey index is used in the assessment: the FR-IRL-IBTS index, which is a combined index from the French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS surveys. This is standardised following the VAST procedure (stock annex).

The index data are given Table 8.6. The standardised indices are given by year in Figure 8.10 and by cohort in Figure 8.11. Figure 8.12 shows the scatterplot matrices of the log indices. These plots indicate that the internal consistency of the indices is robust.

8.4 Historical stock development

Model used: SAM

Software used: Stock Assessment.Org (https://www.stockassessment.org)

8.4.1 Data screening

The general approach to data screening and analysis was followed in addition to the data exploration tools available in the FLR package FLEDA. The results of the data screening are fully documented using R markdown and are available in the folder 'Data\Stock\had-7bce–k' in the ICES SharePoint.

8.4.2 Final update assessment

The final assessment was run with the same settings as established by WKCELTIC 2020 and described in the stock annex. While discards were combined with the landings and not supplied separately to the model, annual discard fractions were incorporated.

Figure 8.13 shows the residuals of that catch proportions-at-age. For age classes where discards dominate, the residuals are relatively large. There are no obvious pattern in the younger ages but the residuals in the middle of the time-series show a mostly positive evolution from the 2006 cohort. The strongest negativities residuals occur for the older age classes in 2006. Observed and assessment predicted catches are shown in Figure 8.14. The predicted catches were generally accurate while there was a tendency for under estimation from 2011–2018. The observed and predicted index CPUE values are shown in Figure 8.15. The assessment generally follows the survey index trends in age classes across the time-series.

In the proportions-at-age residual plots of the survey (FRA-IRL-WIBTS_VAST) there are no consistent patterns (Figure 8.16). The assessment generally follows the survey index trends in age classes across the time-series.

The SAM assessment is shown in Figure 8.17, detailing catch, landings, SSB F and recruits with 95% confidence intervals.

8.4.3 State of the stock

Table 8.7 shows the estimated fishing mortality-at-age and Table 8.8 shows the stock numbers-at-age. The stock summary is given in Table 8.9.

The spawning–stock biomass (SSB) peaked in 2011 as the very strong 2009 year class matured; this cohort was followed by three years of below-average recruitment which led to a rapid decline in SSB after 2011. Recent recruitment has varied around the average, with a notable peak in 2009 and in 2018. SSB appears to have stabilised, while fishing mortality (F) has been above F_{MSY} for the entire time-series but shows a declining trend.

8.5 Short-term projections

Because recruitment of haddock is characterised by sporadic events, the assumed median recruitment for the intermediate years introduces significant uncertainty for the SSB estimate.

Short-term projections were performed in SAM as a stochastic process. Recruitment was estimated at 275 943 in 2022 and 2023 respectively, (medians 1993–2021; thousands). The short-term predictions are expected to give a reasonably reliable estimate of landings and discards in 2022 (assuming average F 2019–2021 and average discard patterns seen in 2019–2021).

Intermediate year assumptions are given in Table 8.10. The management options are given in Table 8.11.

8.6 MSY evaluations and biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock at WKCELTIC (ICES, 2020). The results are summarized below:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	12 822	B_{pa}; in tonnes.	ICES (2020a)
	F_{MSY}	0.353	Based on simulation using a segmented regression stock–recruitment relationship (EqSim)	ICES (2020a)
Precautionary approach	B_{lim}	9227	Lowest observed SSB; in tonnes	ICES (2020a)
	B_{pa}	12 822	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$; $\sigma = 0.20$ (default setting); in tonnes	ICES (2020a)
	F_{lim}	1.40	F with 50% probability of SSB < B_{lim}	ICES (2020a)
	F_{pa}	0.71	$F_{p0.5}$; the F that leads to SSB ≥ B_{lim} with 95% probability	ICES (2020a)
EU MAP	MAP MSY $B_{trigger}$	12 822	MSY B_{pa}; in tonnes	EU (2019), ICES (2020a)
	MAP B_{lim}	9227	Lowest observed SSB; in tonnes	EU (2019), ICES (2020a)
	MAP F_{MSY}	0.353	F_{MSY}	EU (2019), ICES (2020a)
	MAP range F_{lower}	0.221	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}	0.521	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY	EU (2019), ICES (2020a)

8.7 Management plans

The EU multiannual plan (MAP) for the Western Waters (EU, 2019), incorporating the stock haddock 7.b,c,e–k has been agreed. This MAP "establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks", under article 17 states that "It is appropriate to establish the target fishing mortality (F) that corresponds to the objective of reaching and maintaining MSY as ranges of values which are consistent with achieving MSY(F_{MSY}). Those ranges, based on best available scientific advice, are necessary in order to provide flexibility to take account of developments in the scientific advice, to contribute to the implementation of the landing obligation and to take into account the characteristics of mixed fisheries."

8.8 Uncertainties and bias in assessment and forecast

8.8.1 Landings

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches, although the assessment is contingent on the accuracy of the landings statistics. Catch sampling in 2021 increased compared to 2020 when it was impacted owing to the COVID-19 pandemic and is considered sufficient to describe the stock.

Sampling indicated that stock weights-at-age decreased compared to those used for the 2021 assessment. This may have contributed to reduced SBB estimates in the assessment.

8.8.2 Discards

Irish discards have been monitored since 1995. The number of trips sampled has varied considerably over time (between three and 62 trips per year). Sample numbers were particularly low in 1995, 1999–2002 and in 2006. During the remaining years, the number of sampled trips was considered sufficient to give reliable estimates of discards.

French discard data exist from 2004 onwards but the data are not considered to be reliable before 2008. The time-series of French discards was reconstructed by assuming that 90% of one-year olds, 50% of two-year olds and 10% of three year olds were discarded throughout the time-series. These proportions were estimated from the available discard and retained catch data provided by France. Discards were estimated for the early part of the time-series at WKROUND (2012) and retained by WKCELTIC up to 2004.

Although recent discard estimates are considered to be more reliable, the problem remains that the number of observer trips is very small compared to the total number of trips (typically <1% of all trips are sampled). The level of uncertainty owing to the small sample sizes is likely to be high, but the cost of increasing discard coverage would be considerable. As mentioned sampling levels were considerably low in 2020.

8.8.3 Assessment bias

Figure 8.18 shows the retrospective of the ASAP analysis. The predicted catch shows little retrospective pattern neither does the SSB estimate with the Mohn's rho for SSB estimated to be low at 4%. The Recruitment however, has a relatively high Mohn's rho at 21% owing primarily to the last of five data reductions. F shows variable tendencies with removal of data years, however no overall pattern is discernible and the Mohn's rho is low at -4%.

The historical assessment results (Figure 8.19) shows a revision in estimated stock size for the 2022 assessment due to the addition of new data for 2021, recent low recruitment and older year classes being removed from the stock.

8.9 Forecast

The 2018 cohort is projected to account for 32% the projected catch in 2023, This strong cohort was picked up by both the Irish and French quarter 4 surveys in 2018 but its contribution only accounts for 15% of SSB in 2024.

Figure 8.20 shows the assessment and forecast of the final SAM run for the F_{MSY} catch option leading to an SSB of 48 157 tonnes in 2024 and advised catch of 11 901 tonnes.

The assumed recruitment in 2022 and 2023 used in the forecast would constitute a minor part of the projected catches in 2023 (8%) and approximately 31% of the SSB in 2024 (Figure 8.21).

8.10 Recommendation for next benchmark

8.10.1 Stock audit

The audit of the 2021 report did not raise any concerns.

8.10.2 Recommendations for future work

Future benchmarks should consider mixed fisheries and multispecies interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species.

Catch data should continue to be monitored for indirect evidence of improved selection patterns due to the augmented TCMs in the Celtic Sea. Direct monitoring of escapement through SMPs would also be useful.

It would be desirable to include discards separately in the assessment model in order to specify greater precision for the discard numbers-at-age than for the landings numbers-at-age. However, WKROUND (2012) concluded that this resulted in undesirable residual patterns. The benchmark workshop did not have sufficient time to fully evaluate this problem.

8.11 Management considerations

The stock size fluctuates strongly over the time. The size of the stock is determined to a large extent by recruitment, which has been erratic and in 2018 is shown to have been large. There is no discernible relationship between stock size and recruitment, as is the case with most haddock stocks.

Fishing mortality has been consistently above F_{MSY}, but this has not led to a decreasing trend in stock size, which suggests that the stock is robust to overfishing, however F has been increasing since 2015 and at current levels the SSB could quickly fall below $MSYB_{trigger}$ if recruitment were to be low for three or four years. The high recruitment seen in 2018 is moving through the fishery and the older year classes are being removed from the stock.

Discarding of undersize as well as marketable fish is a serious problem for this stock, with approximately $^2/_3$ in catch numbers and almost half the catch weight has been discarded on average over the past decade. Alternative or complimentary approaches to managing such strong, recruit-driven fluctuations are required, especially with regard to the EU landings obligation.

The minimum landing size of haddock is 30 cm, which is approximately the same as the mean length of two-year old haddock in the Celtic sea. Because gadoids are caught in a mixed fishery, restrictive quota in recent years have led to increased discarding of marketable fish as well as already considerable discarding of undersized fish. Technical measures have been introduced to reduce discards of undersize gadoids (110 mm square-mesh panel in the *Nephrops* fisheries and 100 mm in the gadoid fisheries). It is not clear whether this is sufficient to reduce discard mortality of future cohorts. It is important that technical measures are fully implemented and their effectiveness in reducing discards and impact on commercial catches are monitored and evaluated.

8.12 References

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing

Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008.

COUNCIL REGULATION (EU) 2020/123 of 27 January 2020, fixing for 2020 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters.

COUNCIL REGULATION (EU) 2021/703 of 26 April 2021, amending Regulations (EU) 2021/91 and (EU) 2021/92 as regards certain fishing opportunities for 2021 in Union and non-Union waters.

ICES. 2016a. 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.

ICES. 2016b. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. ICES Advice 2016 Book 5, ICES Special Request Advice, Published 5 February 2016.

Table 8.1. Haddock in 7.b,c, e–k. Official landings (quota uptake in brackets).

Year	BEL	ESP	FRA	IRL	UK*	Others	Total	TAC**
1994	123	0	2788	908	240	17	4076	
1995	189 (28%)	19	2964 (74%)	966 (72%)	266 (44%)	64	4468	6000
1996	133 (9%)	48	4527 (49%)	1468 (47%)	439 (31%)	38	6653	14000
1997	246 (16%)	54	6581 (71%)	2789 (90%)	569 (41%)	31	10270	14000
1998	142 (6%)	260	3674 (28%)	2788 (63%)	445 (22%)	52	7361	20000
1999	51 (2%)	88	2725 (19%)	2034 (42%)	278 (13%)	71	5247	22000
2000	90 (5%)	110	3088 (28%)	3066 (83%)	289 (17%)	13	6656	16600
2001	165 (12%)	646	4842 (61%)	3608 (135%)	422 (35%)	19	9702	12000
2002	132 (128%)		4348 (70%)	2188 (106%)	315 (34%)	106	7089	9300
2003	118 (130%)		5781 (106%)	1867 (103%)	393 (48%)	82	8241	8185
2004	136 (127%)		6130 (96%)	1715 (80%)	313 (33%)	159	8453	9600
2005	167 (130%)		4174 (54%)	2037 (80%)	292 (25%)	197	6867	11520
2006	99 (77%)		3191 (42%)	1874 (73%)	274 (24%)	183	5621	11520
2007	119 (93%)		4143 (54%)	1931 (75%)	385 (33%)	50	6628	11520
2008	109 (84%)		3638 (47%)	1800 (70%)	566 (49%)	121	6234	11579
2009	131 (102%)		5430 (70%)	2983 (116%)	716 (62%)	48	9308	11579
2010	170 (132%)		6240 (81%)	2609 (101%)	852 (74%)	128	9999	11579
2011	211 (143%)		8389 (95%)	3323 (112%)	1657 (124%)	129	13709	13316
2012	232 (125%)		11793 (106%)	4129 (112%)	1901 (114%)	166	18221	16645
2013	174 (111%)		8747 (93%)	2699 (86%)	1455 (103%)	23	13098	14148
2014	99 (94%)		6375 (101%)	2092 (99%)	785 (83%)	21	9372	9479
2015	118 (127%)		5679 (102%)	1657 (89%)	769 (92%)	6	8229	8342
2016	88 (109%)		4487 (93%)	1730 (107%)	692 (95%)	27	7024	7258
2017	110 (128%)		4885 (95%)	1677 (97%)	690 (89%)	12	7374	7751
2018	89 (116%)		4470 (97%)	1444 (94%)	583 (84%)	9	6595	6910
2019	90 (97%)		4259 (77%)	1323 (71%)	516 (62%)	74	6262	8329
2020	106 (88%)		3522 (49%)	2203 (91%)	543 (50%)	102	6476	10859
2021	156 (94%)		4249 (48%)	3379 (114%)	515 (21%)	149	8447	15000

*** UK Includes Channel Islands.**

**** TAC Applied to subareas 7–10 from 1995 to 2008 and to 7b–k, 8, 9 and 10 from 2009 onwards.**

Table 8.2. Haddock in 7.b,c, e–k. ICES estimate of the landings (lan) and discards (dis).

Year	BEL Lan	ESP Lan	FRA Lan	IRL Lan	UK Lan	Others Lan	Total Lan	FRA Dis*	IRL Dis**	Others Dis***	Total Dis****	Total CatCH
1993							3348	505	594	109	1208	4556
1994							4131	1116	594	176	1886	6017
1995							4470	730	1221	267	2218	6688
1996							6756	3170	713	426	4309	11065
1997							10827	2129	502	253	2883	13710
1998							7928	680	140	114	934	8862
1999							4970	477	54	55	586	5556
2000							7499	1587	727	189	2503	10002
2001							9278	2234	743	441	3418	12696
2002	134	85	3878	2070	301	20	6488	871	5651	552	7073	13561
2003	116	82	5960	1731	362	41	8292	1835	6941	680	9456	17748
2004	137	143	6336	1785	303	73	8777	1108	5156	486	6750	15527
2005	166	209	4101	2078	285	0	6839	1564	5818	2571	9953	16792
2006	98	194	3131	1899	269	1	5592	1313	2745	1841	5899	11491
2007	117	186	4134	2139	385	1	6961	372	2483	696	3552	10513
2008	108	166	4577	1984	558	0	7392	990	3741	2930	7660	15052
2009	129	49	5503	3270	711	2	9664	905	3320	3098	7322	16986
2010	170	115	6421	2899	821	3	10429	3260	4570	10870	18701	29130
2011	211	78	8381	3702	1551	35	13957	3963	4329	7515	15807	29764
2012	232	79	12293	4596	1929	67	19196	2754	2653	2878	8285	27481
2013	174	51	8738	3097	1458	20	13538	671	1116	2175	3962	17501
2014	99	3	6350	2543	849	2	9846	1732	1171	2715	5619	15464
2015	118	0	5683	2035	766	6	8608	2024	2519	2398	6941	15549
2016	88	0	4573	2271	689	27	7648	5482	2810	3773	12065	19713
2017	111	0	4895	2381	699	11	8099	2633	1928	2130	6691	14789
2018	89	0	4377	1989	578	12	7046	1920	1189	2688	5798	12844
2019	89	89	4548	2412	518	27	7683	1616	1445	542	3603	11259
2020	102	176	3815	3193	546	27	7859	1450	1873	937	4260	12119
2021	149	108	4257	4211	516	19	9260	706	1075	604	2385	11645

*** For 1993–2007 fixed discard ratios were used to estimate French discards.**

**** For 1993–1994, the mean Irish discards over 1995–1999 were used.**

***** Estimated from the proportion of the landings of `Others' between 1993 and 2012.**

****** Discard estimates are available from 2005; prior to 2005, discard estimates are based on limited sampling.**

Table 8.3. Haddock in 7.b,c, e–k. LPUE (kg/hour fishing) of haddock and effort (hours fishing x 1000) for Irish Otter trawls in 7.bc, 7.fgh and 7.jk, the French demersal fleet in 7.bc–ek and effort only for the UK trawl fleets (excluding beam trawls) in 7.e–k (effort in fishing days).

	FR GAD 7ek effort	FR GAD 7ek lpue	IRL OTB 7bc effort	IRL OTB 7bc lpue	IRL OTB 7fgh effort	IRL OTB 7fgh lpue	IRL OTB 7jk effort	IRL OTB 7jk lpue	UK Trawl 7e–k effort
1983	NA	NA	NA	NA	NA	NA	NA	NA	51.5
1984	NA	NA	NA	NA	NA	NA	NA	NA	161.8
1985	NA	NA	NA	NA	NA	NA	NA	NA	143.7
1986	NA	NA	NA	NA	NA	NA	NA	NA	123.5
1987	NA	NA	NA	NA	NA	NA	NA	NA	108.9
1988	NA	NA	NA	NA	NA	NA	NA	NA	112.9
1989	NA	NA	NA	NA	NA	NA	NA	NA	119.9
1990	NA	NA	NA	NA	NA	NA	NA	NA	133.2
1991	NA	NA	NA	NA	NA	NA	NA	NA	118.8
1992	NA	NA	NA	NA	NA	NA	NA	NA	129.9
1993	NA	NA	NA	NA	NA	NA	NA	NA	101.1
1994	NA	NA	NA	NA	NA	NA	NA	NA	88.5
1995	NA	NA	78	5.77	64	1.48	106	2.20	88.1
1996	NA	NA	47	4.16	60	5.35	73	3.24	89.5
1997	NA	NA	63	4.36	65	5.83	92	8.23	101.8
1998	NA	NA	79	5.71	72	4.09	99	5.88	94.6
1999	NA	NA	77	5.27	51	2.35	52	3.53	132.8
2000	306	6.12	74	4.73	61	10.43	72	4.25	141.1
2001	333	10.57	78	4.30	69	8.69	81	7.41	117.5
2002	289	10.63	63	2.81	79	3.22	108	5.50	113.1
2003	264	15.15	81	2.09	87	3.26	123	3.88	102.4
2004	217	19.39	82	2.51	97	3.49	108	3.35	105.5
2005	175	14.67	69	2.45	127	4.53	93	3.70	100.9
2006	167	10.64	60	2.56	119	4.19	89	3.59	106.3
2007	160	14.97	60	3.31	136	4.01	103	3.66	113.6
2008	148	19.60	48	4.36	127	4.56	84	4.60	93.7
2009	150	22.65	48	5.47	141	9.25	82	7.09	98.6

	FR GAD 7ek effort	FR GAD 7ek lpue	IRL OTB 7bc effort	IRL OTB 7bc lpue	IRL OTB 7fgh effort	IRL OTB 7fgh lpue	IRL OTB 7jk effort	IRL OTB 7jk lpue	UK Trawl 7e–k effort
2010	131	30.83	54	4.36	144	7.33	101	5.15	103.7
2011	216	22.90	40	6.39	129	10.51	84	5.58	87.1
2012	188	45.03	44	4.93	135	13.17	84	6.58	86.2
2013	215	27.40	42	5.38	126	8.69	80	4.92	40.3
2014	203	19.81	46	5.22	142	5.11	77	3.91	32.1
2015	NA	NA	31	4.42	150	4.95	78	2.91	21.2
2016	NA	NA	39	2.41	164	4.94	83	3.09	NA
2017	NA	NA	36	2.25	151	5.10	92	2.43	NA
2018	NA	NA	46	2.19	125	5.33	93	1.70	NA
2019	NA	NA	32	2.42	127	5.86	93	1.73	NA
2020	NA	NA	34	2.80	98	11.2	84	1.86	NA
2021	NA	NA	39	4.23	92	14.68	86	2.70	NA

Table 8.4. Haddock in 7.b,c, e–k. Landings numbers-at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	0	491	3291	948	810	255	129	129	45
1994	0	1277	5223	674	302	94	24	35	16
1995	0	4275	1622	1327	270	245	46	0	0
1996	0	3693	15998	818	313	93	32	10	9
1997	0	1353	9645	5553	716	354	139	144	110
1998	0	167	3184	7403	1443	307	178	86	61
1999	0	476	654	1464	2425	307	18	19	6
2000	0	2197	2996	784	741	1250	205	35	28
2001	0	4297	8638	1131	303	317	321	54	39
2002	0	879	4274	3400	765	39	89	74	26
2003	0	703	8791	2160	1226	116	43	49	51
2004	0	125	5948	4663	928	589	51	12	20
2005	0	1075	1732	4230	1821	280	75	1	3
2006	0	839	3250	1034	2189	484	42	28	0
2007	0	404	4617	2916	737	1310	161	33	4
2008	0	1692	3268	3736	1046	286	414	91	50
2009	0	338	7111	2760	1890	577	228	234	38
2010	0	1757	5192	6031	1036	580	257	110	123
2011	0	100	12726	3607	3410	661	261	129	132
2012	0	82	1135	19931	2559	1795	323	109	108
2013	0	86	465	1899	10533	861	468	96	44
2014	0	277	854	467	1511	5585	368	219	40
2015	0	41	4881	632	309	928	2030	257	80
2016	0	62	310	5200	216	143	546	682	92
2017	0	58	2019	1071	3930	135	117	246	312
2018	0	70	714	2833	926	1653	42	64	150
2019	0	513	1566	1257	2678	529	762	41	110
2020	0	120	4318	1449	755	1381	260	175	30
2021	0	285	1295	6691	740	569	640	248	169

Table 8.5. Haddock in 7.b,c, e–k. Discard numbers-at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	0	7617	2816	160	6	0	0	0	0
1994	0	15120	3069	170	5	0	0	0	0
1995	0	32830	1977	91	4	0	0	0	0
1996	0	20734	8976	187	9	0	0	0	0
1997	0	12613	10022	493	5	0	0	0	0
1998	0	3580	2348	445	5	0	0	0	0
1999	0	3742	1562	100	10	0	0	0	0
2000	0	29015	2521	64	3	0	0	0	0
2001	0	25234	6772	219	2	0	0	0	0
2002	0	21624	20729	249	7	0	0	0	0
2003	0	52412	11075	352	8	0	0	0	0
2004	0	11733	21598	1395	61	0	0	0	0
2005	0	30472	25291	6821	97	1	0	0	0
2006	0	20089	4529	11	10	4	1	0	0
2007	0	10748	8498	572	6	6	0	0	0
2008	0	34221	12620	1676	78	0	0	0	0
2009	0	21175	13989	592	64	0	0	0	0
2010	0	95699	19014	2742	34	1	0	0	0
2011	0	5881	58967	1675	262	16	1	0	1
2012	0	2732	5169	18518	153	55	2	0	0
2013	0	4076	2767	1372	4028	58	2	1	1
2014	0	20197	3315	507	631	732	4	1	0
2015	0	3590	18090	704	26	155	162	13	6
2016	0	27587	5222	8406	51	12	56	501	2
2017	0	3208	11913	1602	2121	31	2	4	3
2018	0	5287	5127	5306	491	215	0	2	2
2019	0	12878	2847	773	409	37	17	1	4
2020	0	2722	10938	597	28	25	1	1	0
2021	0	4890	3773	2799	23	12	1	0	0

Table 8.6. Haddock in 7.b,c, e–k. VAST survey data.

Year \Age	0	1	2	3	4	5	6	7
2003	34982.4	194259.7	15511.0	1334.3	1035.4	27.7	16.2	8.8
2004	103867.4	19061.2	23731.4	2359.3	957.7	523.2	886.2	10.5
2005	55665.8	31406.5	4458.3	6394.8	821.6	233.3	46.9	0.0
2006	31208.7	10366.1	6855.0	1490.4	1348.0	280.7	58.1	36.0
2007	247100.9	14940.9	3707.3	2046.6	679.5	886.7	100.0	15.6
2008	86672.2	55580.3	2482.9	657.1	744.0	288.1	749.1	203.1
2009	877972.9	20715.2	16571.4	592.8	357.3	310.6	403.0	185.2
2010	32993.8	304206.9	10352.3	5037.2	272.1	259.2	349.2	122.1
2011	20579.7	12717.4	79367.2	2428.1	1343.6	256.1	147.0	58.1
2012	7210.7	6947.1	4289.0	14181.3	768.1	722.3	111.8	58.9
2013	224645.3	2602.7	2864.8	1441.9	5204.1	408.2	395.8	52.3
2014	29933.8	57670.6	1177.0	963.1	1019.8	2106.0	338.0	139.1
2015	124666.7	27660.7	17862.8	641.1	402.0	756.3	1232.6	88.4
2016	17973.7	50953.4	13233.5	5759.2	457.2	235.0	931.0	287.3
2017	49415.3	6918.5	16135.7	3316.2	944.4	100.0	16.6	212.8
2018	268416.0	9928.8	1646.1	2772.4	1484.4	756.6	27.5	30.3
2019	86436.1	144323.1	4827.1	999.3	1753.2	561.8	342.3	26.5
2020	32867.8	34934.2	54667.9	990.0	552.9	1167.1	1263.0	375.1
2021	74261.7	15950.7	14723.3	12309.2	279.2	88.3	336.4	175.2

Table 8.7. Haddock in 7.b,c, e–k. Fishing mortality- (F) at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	-	0.336	0.733	0.58	0.577	0.568	0.549	0.611	0.611
1994	-	0.326	0.704	0.552	0.542	0.529	0.511	0.569	0.569
1995	-	0.322	0.698	0.552	0.539	0.525	0.508	0.563	0.563
1996	-	0.312	0.687	0.554	0.545	0.529	0.512	0.566	0.566
1997	-	0.324	0.725	0.611	0.622	0.614	0.602	0.662	0.662
1998	-	0.317	0.718	0.616	0.648	0.652	0.647	0.705	0.705
1999	-	0.298	0.681	0.583	0.618	0.626	0.625	0.674	0.674
2000	-	0.326	0.761	0.656	0.703	0.721	0.722	0.762	0.762
2001	-	0.332	0.791	0.692	0.753	0.775	0.783	0.818	0.818
2002	-	0.32	0.78	0.684	0.758	0.789	0.805	0.841	0.841
2003	-	0.308	0.754	0.673	0.758	0.84	0.873	0.911	0.911
2004	-	0.31	0.758	0.673	0.748	0.838	0.869	0.886	0.886
2005	-	0.301	0.717	0.605	0.632	0.673	0.667	0.671	0.671
2006	-	0.257	0.599	0.495	0.501	0.529	0.523	0.553	0.553
2007	-	0.242	0.572	0.478	0.464	0.476	0.466	0.5	0.5
2008	-	0.243	0.591	0.513	0.494	0.499	0.494	0.549	0.549
2009	-	0.224	0.556	0.508	0.505	0.517	0.514	0.581	0.581
2010	-	0.204	0.517	0.494	0.506	0.536	0.544	0.632	0.632
2011	-	0.184	0.476	0.481	0.514	0.566	0.591	0.71	0.71
2012	-	0.174	0.451	0.474	0.521	0.59	0.628	0.776	0.776
2013	-	0.164	0.424	0.442	0.485	0.553	0.594	0.754	0.754
2014	-	0.151	0.399	0.422	0.454	0.523	0.565	0.736	0.736
2015	-	0.138	0.369	0.406	0.436	0.501	0.548	0.731	0.731
2016	-	0.137	0.365	0.414	0.448	0.512	0.553	0.744	0.744
2017	-	0.133	0.364	0.424	0.471	0.539	0.568	0.759	0.759
2018	-	0.127	0.353	0.418	0.463	0.531	0.55	0.739	0.739
2019	-	0.11	0.312	0.387	0.44	0.512	0.534	0.724	0.724
2020	-	0.096	0.272	0.349	0.409	0.483	0.495	0.67	0.67
2021		0.098	0.277	0.361	0.437	0.531	0.544	0.735	0.735

Table 8.8. Haddock in 7.b,c, e–k. Stock numbers-at-age (start of year) (`1000).

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	137524	49768	13058	4520	1235	370	302	189	88
1994	392005	45842	17372	3505	1575	443	138	116	101
1995	475242	132728	15835	4817	1253	599	173	55	85
1996	165752	161429	46200	4372	1722	475	238	70	55
1997	59509	55715	59026	12579	1551	652	189	98	50
1998	87806	19777	19339	16615	4021	533	236	70	53
1999	359811	29275	6949	5319	5684	1297	182	83	41
2000	348755	122416	10656	1974	1874	2006	454	66	44
2001	475463	116929	42918	2772	632	612	643	146	36
2002	976184	159321	40207	10986	845	190	190	195	54
2003	241122	333972	57296	9927	3503	240	60	58	74
2004	341271	82024	116486	15061	3092	1045	66	17	35
2005	236237	113484	30131	30417	4683	902	274	16	14
2006	195043	79149	39074	8111	9976	1558	291	89	11
2007	681770	66138	29855	11916	3145	3913	600	117	37
2008	414184	226343	25472	9523	4513	1312	1610	253	66
2009	2316405	137399	85206	7960	3596	1777	556	665	124
2010	214532	782004	54019	27400	3056	1421	713	230	306
2011	86560	72897	305166	17851	10229	1263	559	280	203
2012	60869	28896	31230	104263	6815	3922	494	208	165
2013	604932	20796	11901	12313	39220	2628	1419	178	117
2014	225966	203091	8773	4354	5532	15239	1027	522	95
2015	496568	77258	84473	3331	1754	2505	5935	401	201
2016	102096	169264	34136	32327	1339	732	1074	2286	198
2017	143397	34294	69828	13695	12646	529	292	424	797
2018	869056	46502	14779	26598	5712	4964	199	113	397
2019	275943	294093	19140	5927	10804	2355	1913	78	172
2020	186296	90507	128613	7439	2491	4492	964	741	83
2021	304566	63104	40065	54649	3094	1043	1824	404	291

Table 8.9. Haddock in 7.b,c,e–k. Stock Summary: Estimated recruitment, spawning–stock biomass (SSB), and average fishing mortality.

Year	R(age 0)	Low	High	SSB	Low	High	F_{bar} (3–5)	Low	High	TSB	Low	High
1993	137524	67900	278540	9267	6188	13880	0.575	0.394	0.84	19783	13990	27975
1994	392005	247144	621773	10974	7617	15810	0.541	0.389	0.753	32099	23884	43139
1995	475242	300708	751076	11602	8259	16297	0.539	0.398	0.729	46548	35747	60612
1996	165752	106170	258771	20604	15368	27625	0.543	0.407	0.724	45167	36043	56599
1997	59509	38128	92881	25319	19321	33177	0.616	0.48	0.79	34879	27737	43860
1998	87806	56018	137632	19822	15556	25258	0.639	0.507	0.804	25763	20960	31666
1999	359811	231157	560067	13115	10534	16328	0.609	0.485	0.764	26487	21450	32706
2000	348755	225057	540440	11742	9688	14231	0.693	0.569	0.844	34376	27579	42848
2001	475463	312325	723813	18392	14106	23980	0.74	0.609	0.899	41599	33481	51686
2002	976184	650852	1464136	23438	18383	29883	0.743	0.612	0.903	62197	50211	77045
2003	241122	166214	349789	27763	22230	34672	0.757	0.617	0.928	73203	58226	92031
2004	341271	235849	493815	39966	31562	50608	0.753	0.599	0.947	63761	52722	77111
2005	236237	162874	342644	28620	23356	35071	0.637	0.515	0.787	55332	46724	65526
2006	195043	133225	285545	24306	20233	29198	0.508	0.397	0.65	45631	38857	53587
2007	681770	472854	982989	22460	19091	26424	0.473	0.372	0.601	66103	53945	81000
2008	414184	288369	594892	21044	17755	24942	0.502	0.408	0.619	75801	62525	91895
2009	2316405	1600195	3353174	32887	26829	40312	0.51	0.416	0.626	190901	145238	250919
2010	214532	138162	333116	39668	33456	47033	0.512	0.418	0.626	180396	141033	230746
2011	86560	60654	123532	98217	77185	124979	0.52	0.425	0.637	123094	99343	152522
2012	60869	41822	88590	71729	57593	89335	0.528	0.429	0.652	82248	67253	100586
2013	604932	421428	868340	46457	37571	57445	0.493	0.402	0.606	87387	72061	105973
2014	225966	154582	330313	29415	24229	35711	0.466	0.38	0.573	76165	63717	91046
2015	496568	346622	711378	40176	32827	49170	0.448	0.363	0.552	94519	78256	114162
2016	102096	70213	148455	37846	31556	45390	0.458	0.371	0.566	76953	64649	91599
2017	143397	97262	211414	44690	37221	53657	0.478	0.383	0.597	64019	54522	75172
2018	869056	576472	1310138	35005	29269	41866	0.471	0.374	0.593	95050	75318	119951
2019	275943	176134	432310	31040	26143	36854	0.446	0.346	0.575	107357	83826	137492
2020	186296	108999	318408	56954	43126	75217	0.414	0.302	0.568	86278	67596	110123
2021	304566	132001	702725	54513	40077	74148	0.443	0.305	0.643	82443	61512	110497

Table 8.10. Haddock in divisions 7.b,c,e–k . Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
F_{ages} 3–5 (2022)	0.443	Average F = (2019–2021) scaled to $F_{ages\ 3–5}$ in 2021
SSB (2023)	47 157	Short-term forecast; in tonnes
R_{age} 0 (2022, 2023)	275 943	Median resampled (1993–2021); in thousands*
Total catch (2022)	15 320	Short-term forecast; in tonnes
Projected landings (2022)	12 308	Short-term forecast, assuming average 2019–2021 landing pattern; in tonnes
Projected discards (2022)	3012	Short-term forecast, assuming average 2019–2021 discard pattern; in tonnes

*** Random resampling of a distribution may lead to different median estimates.**

Table 8.11. Haddock in divisions 7.b,c,e–k. Assumptions made for the interim year and in the forecast.

Haddock in divisions 7.b–k. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2023)	Projected landings (2023)	Projected discards (2023)	F_{total} (2023)	$F_{projected\ landings}$ (2023)	$F_{projected\ discards}$ (2023)	SSB (2024)	% SSB change *	% advice change ^
ICES advice basis									
EU MAP ^^: F_{MSY}	11901	9064	2837	0.353	0.309	0.044	48157	2.12	-25
F = MAP $F_{MSY\ lower}$	7862	6030	1832	0.221	0.194	0.027	52430	11.2	-26
F = MAP $F_{MSY\ upper}$	16424	12419	4005	0.521	0.457	0.064	43270	-8.2	-25.3
Other scenarios									
F = 0	0	0	0	0	0	0	61031	29.4	-100
F_{pa}	20787	15604	5183	0.71	0.62	0.088	38652	-18.0	30
F_{lim}	32583	23767	8816	1.400	1.23	0.17	26386	-44.0	104
$SSB_{2024} = B_{lim}$	50807	34676	16131	4.05	3.55	0.50	9227	-80.4	219
$SSB_{2024} = B_{pa} =$ MSY $B_{trigger}$	46662	32469	14193	3.08	2.70	0.38	12822	-72.8	193
F = F_{2022}	14401	10923	3478	0.44	0.39	0.06	45431	-3.66	-9.69
$SSB_{2024} = SSB_{2023}$	12788	9731	3057	0.384	0.337	0.047	47157	0.00	-19.8

*** SSB_{2024} forecast relative to SSB_{2023}.**

**** Numbers presented are estimations of the reference values.**

^ Advice values for 2022 relative to the corresponding 2021 values (MAP advice of 15 946, 10 570, and 21 988 tonnes, respectively; other values are relative to F_{MSY}).

^^ EU multiannual plan (MAP) for the Western Waters (EU, 2019).

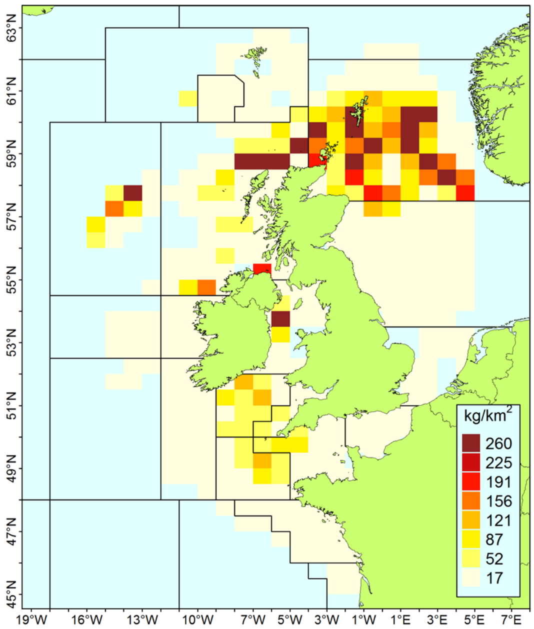


Figure 8.1. International haddock landings by ICES rectangle (all gears; 2016; data from https://stecf.jrc.ec.europa.eu/data-dissemination).

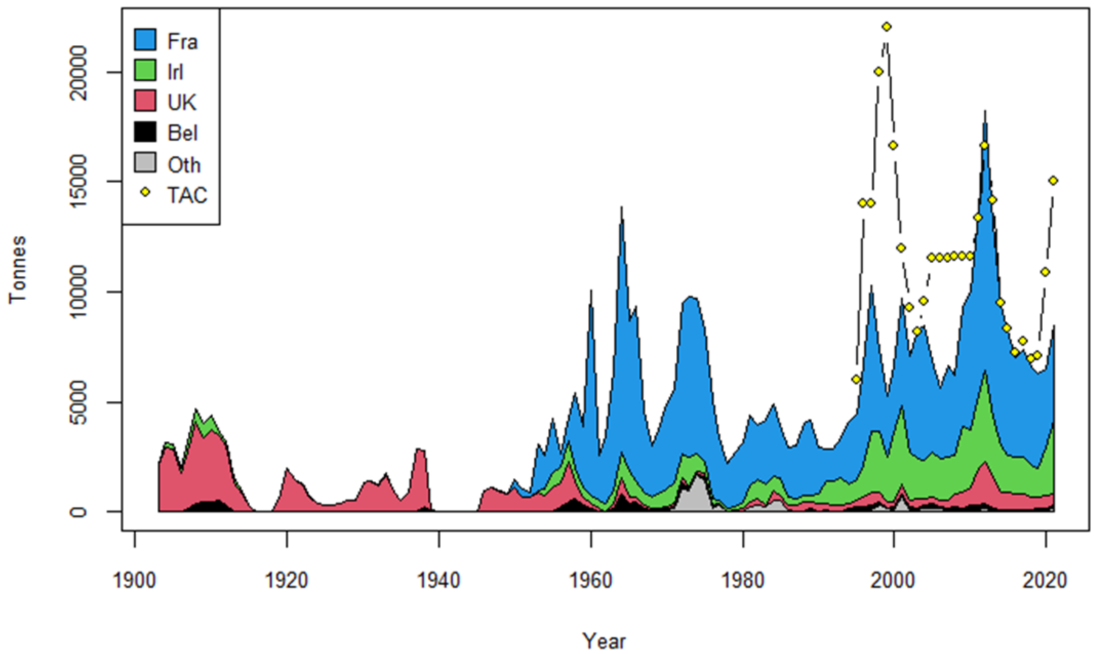


Figure 8.2. Haddock in 7.b,c,e–k. Official ICES landings and TAC of haddock in 7.b–k.

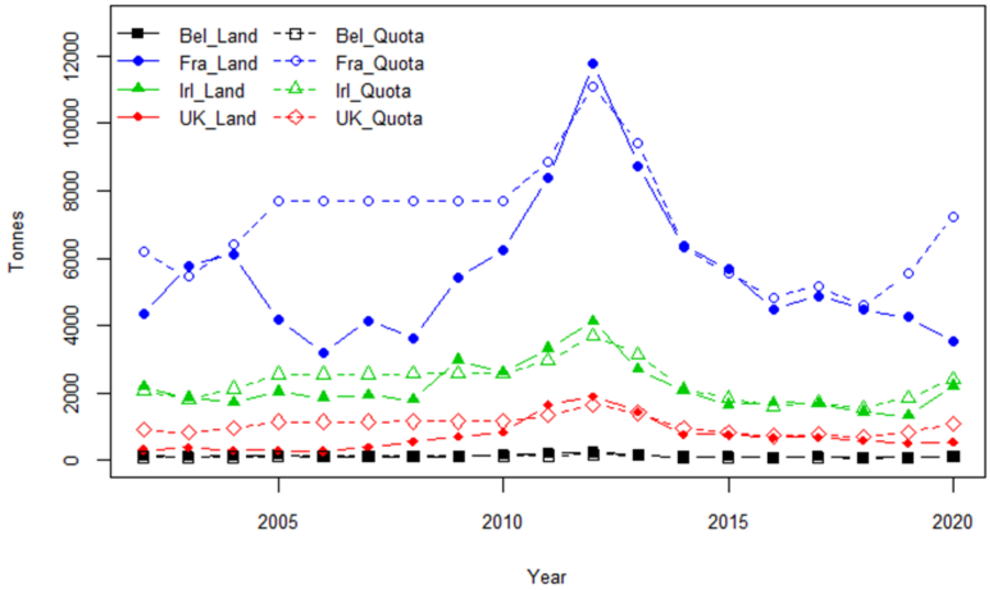


Figure 8.3. Haddock in 7.b,c,e–k. ICES estimates of landings and quota by country.

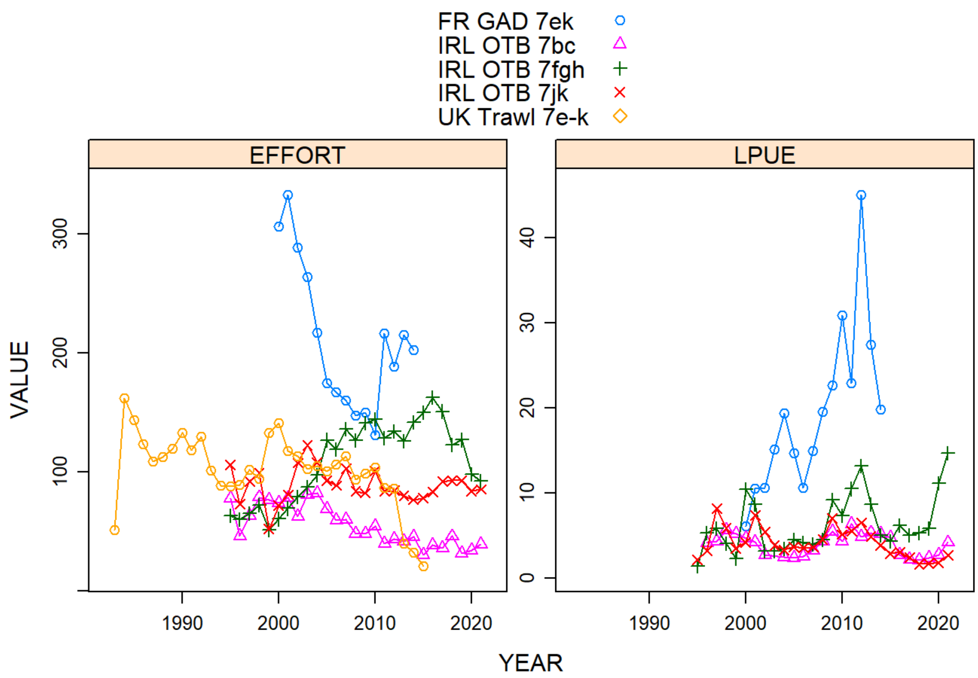


Figure 8.4. Haddock in 7.b,c,e–k. Effort ('1000h) of the Irish Otter trawl fleets, the French demersal otter trawl fleet and for UK trawl fleet (effort in fishing days, rescaled to other fleets) and LPUE (kg/h) for the Irish and French fleets.

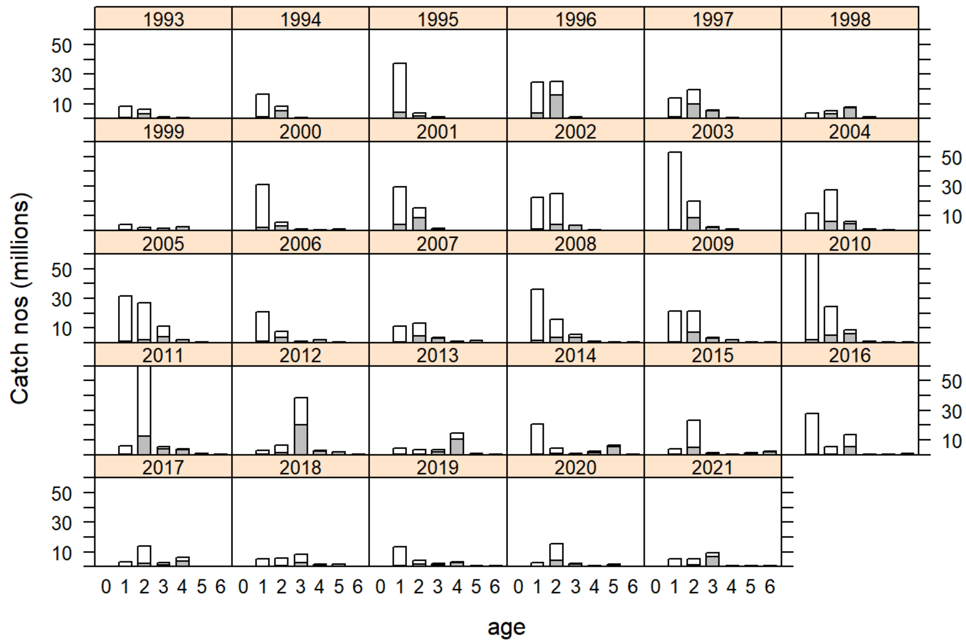


Figure 8.5. Haddock in 7.b,c,e–k. Discarding by number by age class (grey = landings, white = discards).

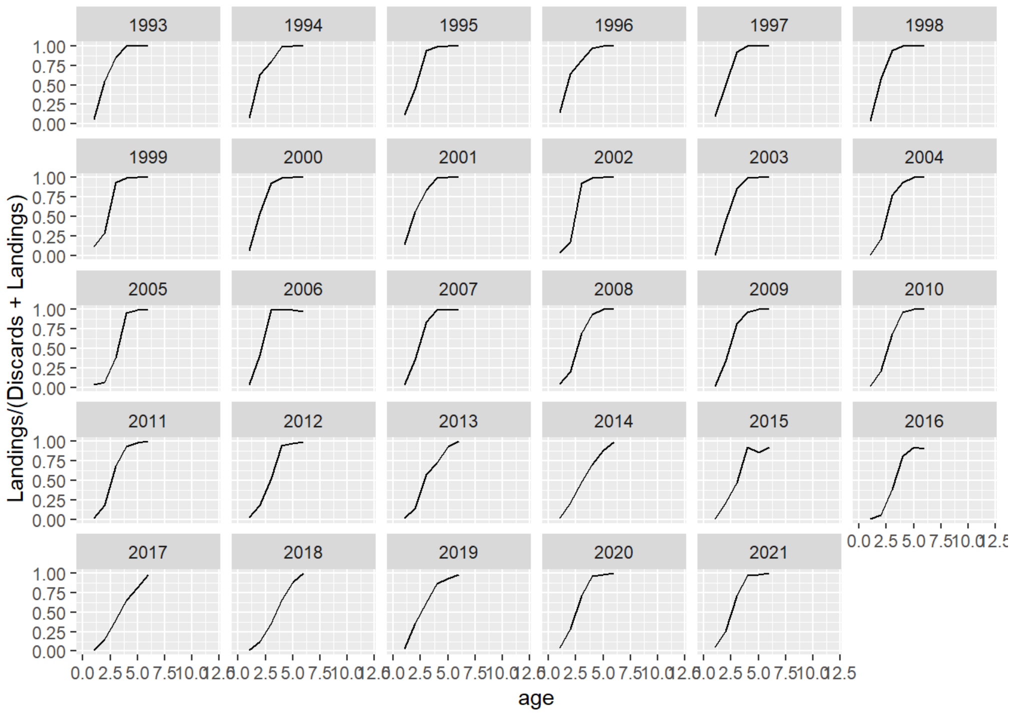


Figure 8.6. Haddock in 7.b,c,e–k. Proportional representation of landings relative to catch (discards + landings) by age, 1993–2021.

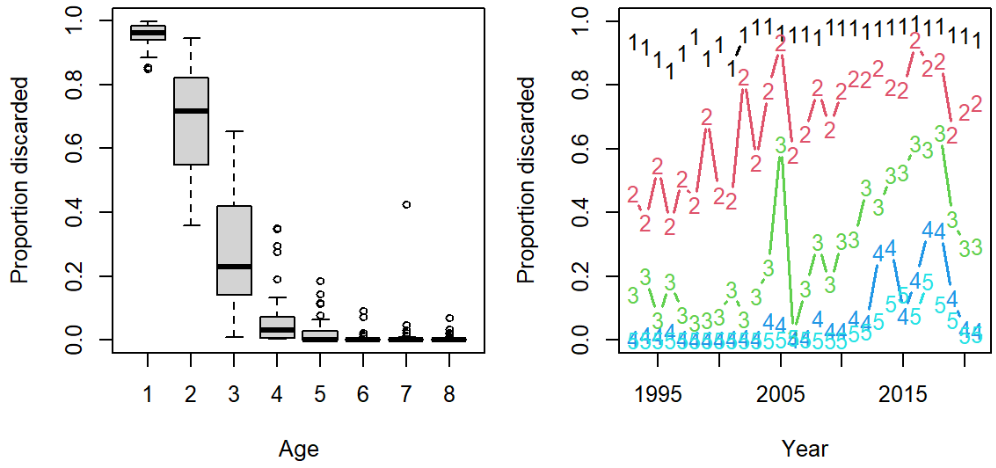


Figure 8.7. Haddock in 7.b,c,e–k. Proportion of discards by age (left) and year (right).

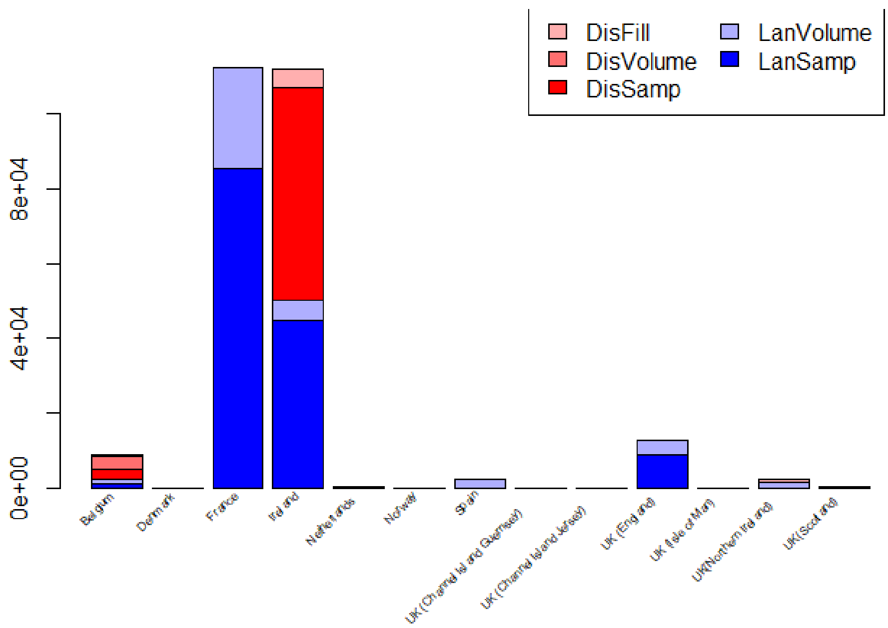


Figure 8.8. Haddock in 7.b,c,e–k . Distribution sampled and unsampled the catches by country and gear.

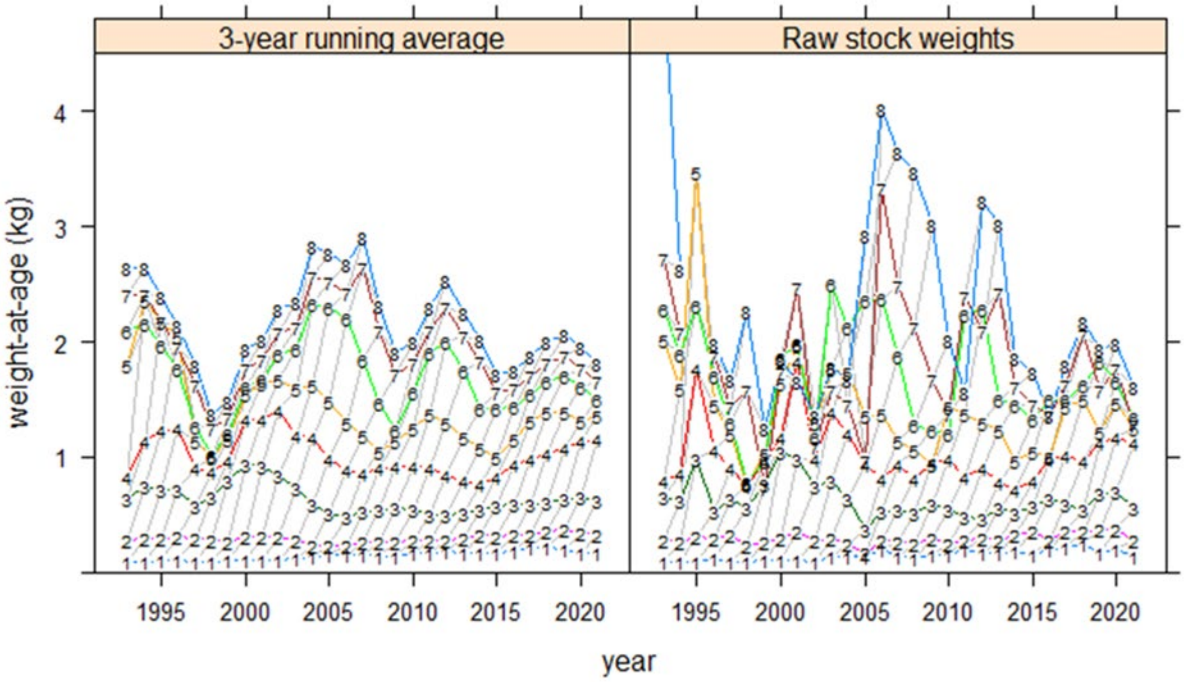


Figure 8.9. Haddock in 7.b,c,e–k. Raw stock weights-at-age (left) and the three-year running average stock weights (right).

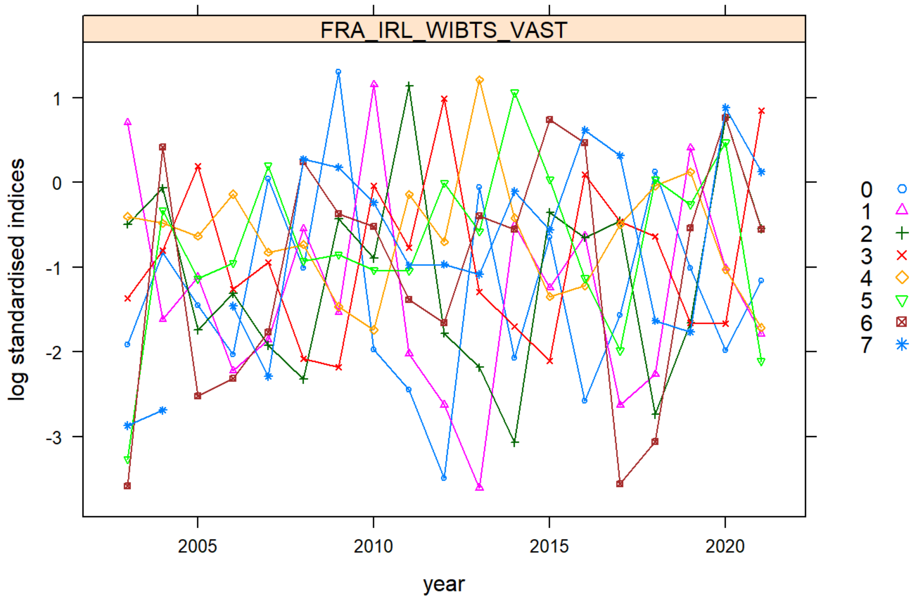


Figure 8.10. Haddock in 7.b,c,e–k. Log VAST standardised tuning fleets by year. The FRA-IRL-IBTS survey is the combined French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS survey.

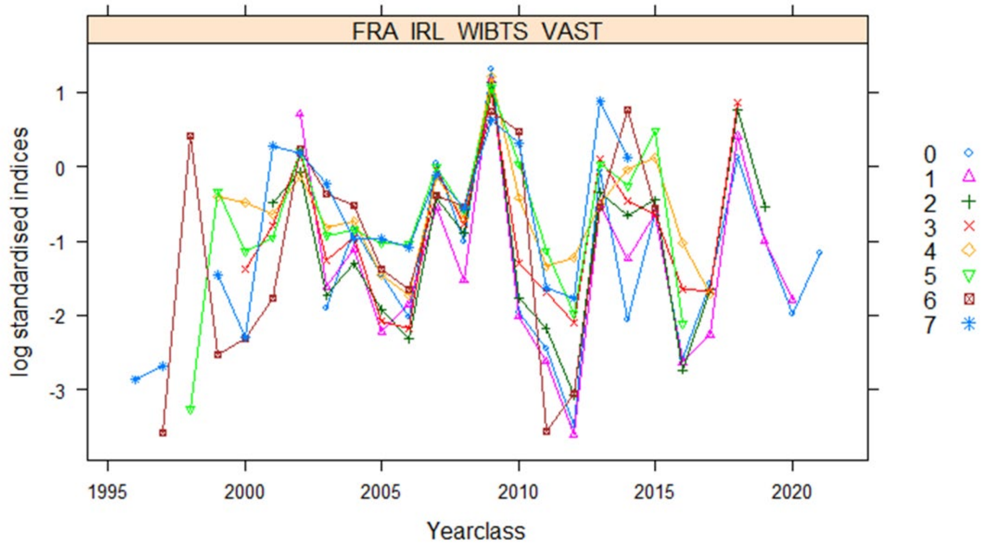


Figure 8.11. Haddock in 7.b,c,e–k. Log VAST standardised tuning fleets by cohort.

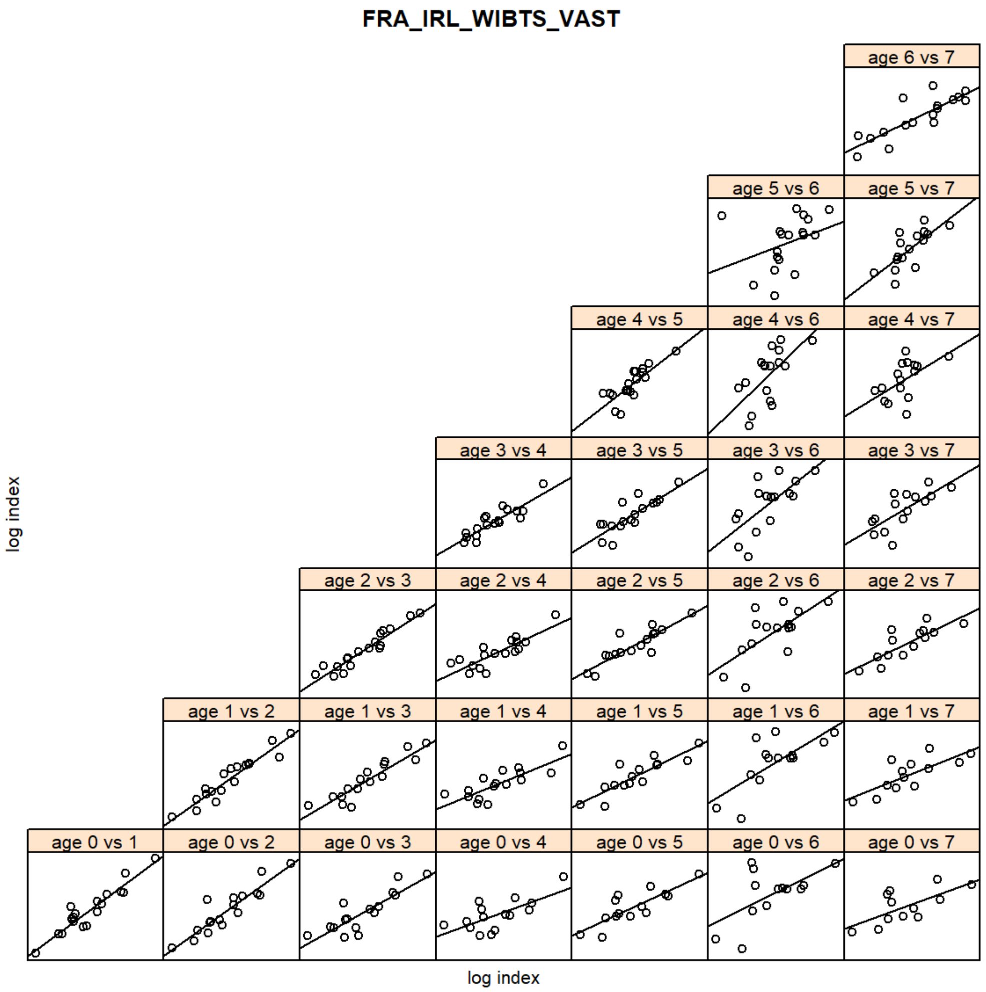


Figure 8.12. Haddock in 7.b,c,e–k. Scatterplot matrix of log indices of cohorts at different ages.

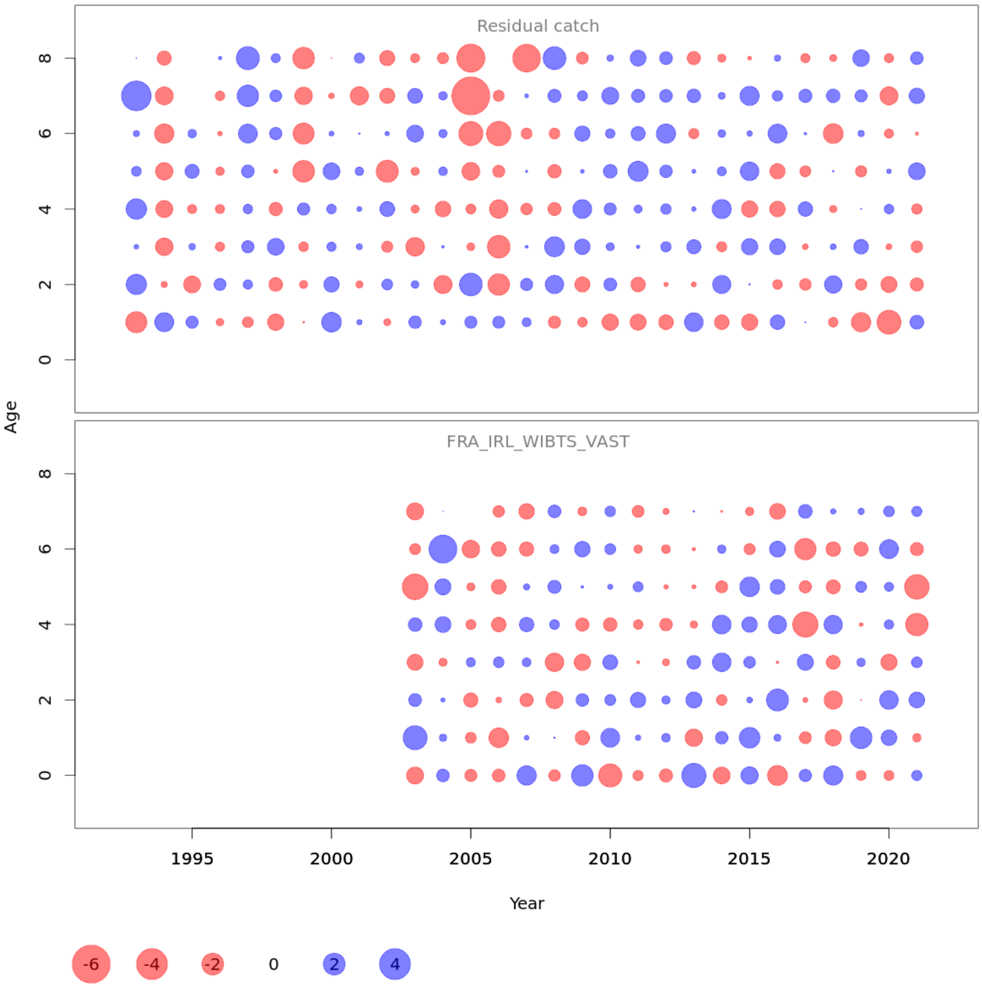


Figure 8.13. Haddock in 7.b,c,e–k. Residuals of the proportions-at-age in catch (upper) and survey (lower).

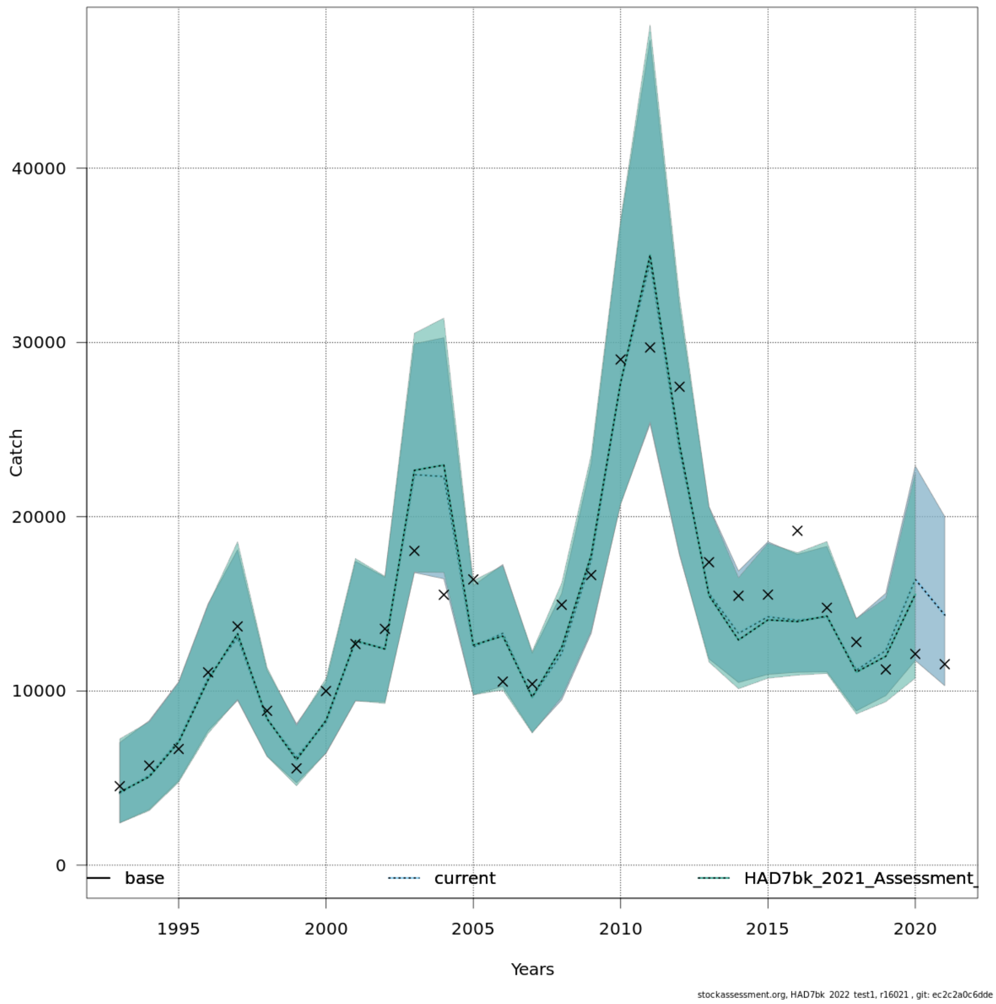


Figure 8.14. Haddock in 7.b,c,e–k. Observed (line) and predicted (x) catches.

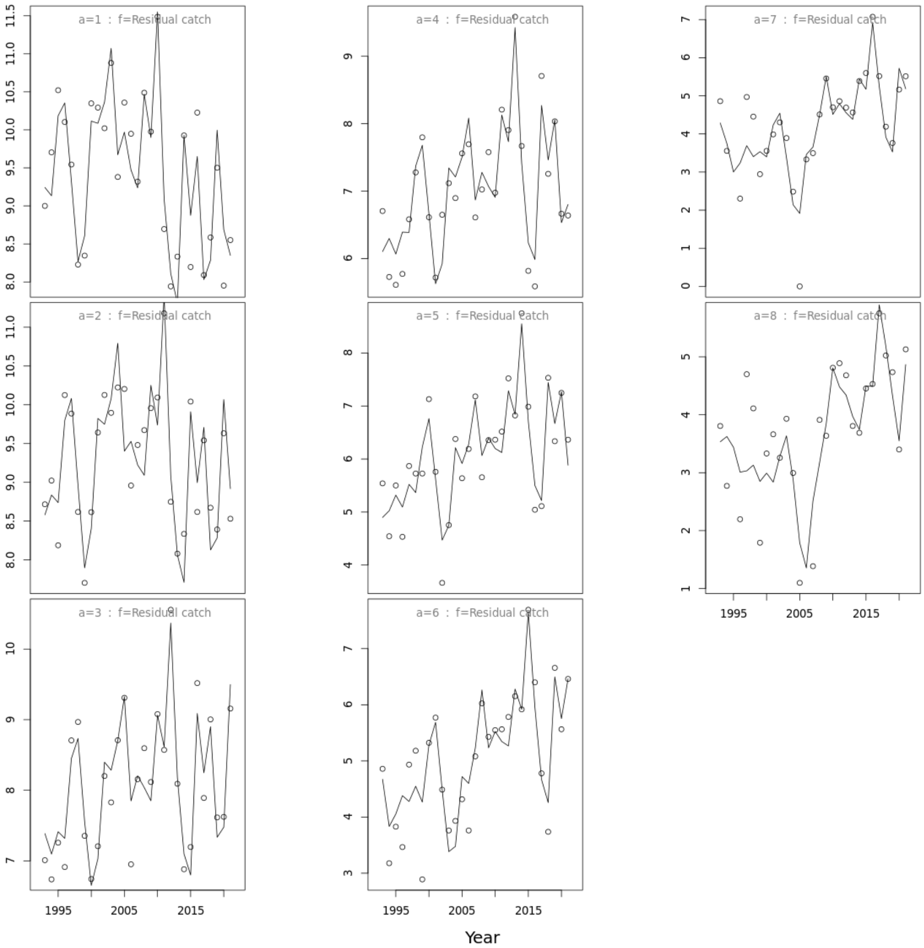


Figure 8.15. Haddock in 7.b,c,e–k. Observed and predicted (circles and line respectively) catch-at-age.

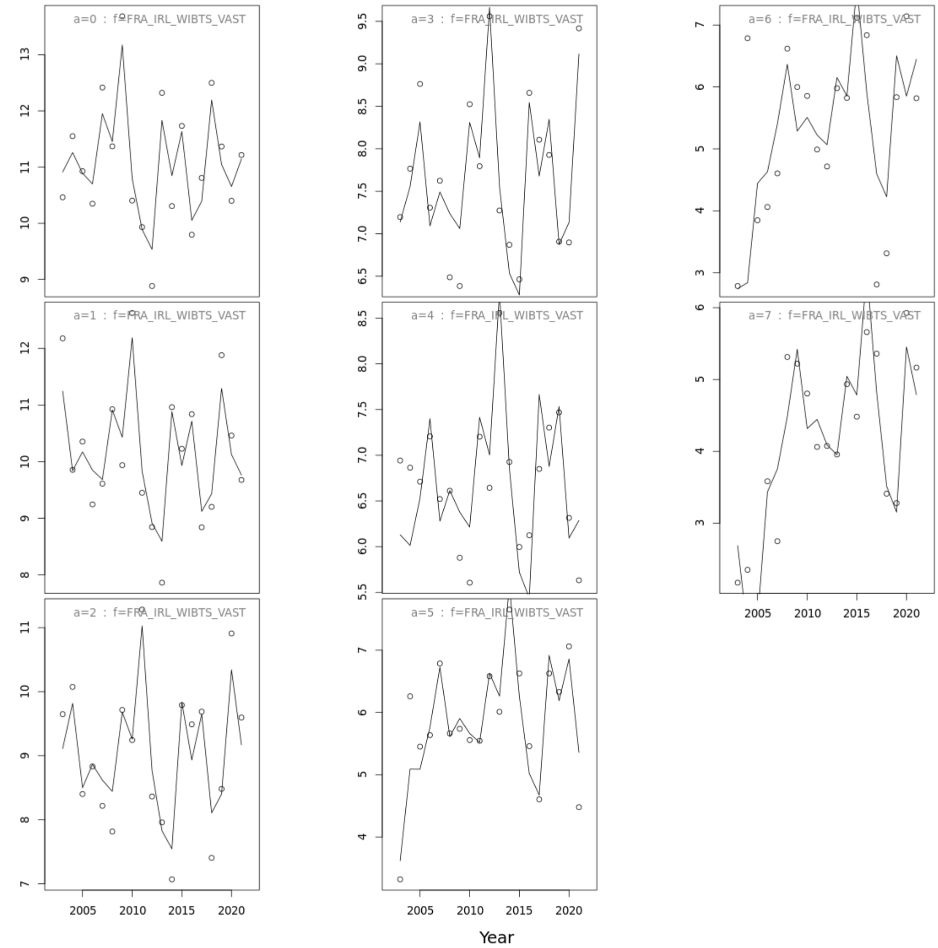


Figure 8.16. Haddock in 7.b,c,e–k. Observed and predicted (circles and line respectively) VAST survey indices.

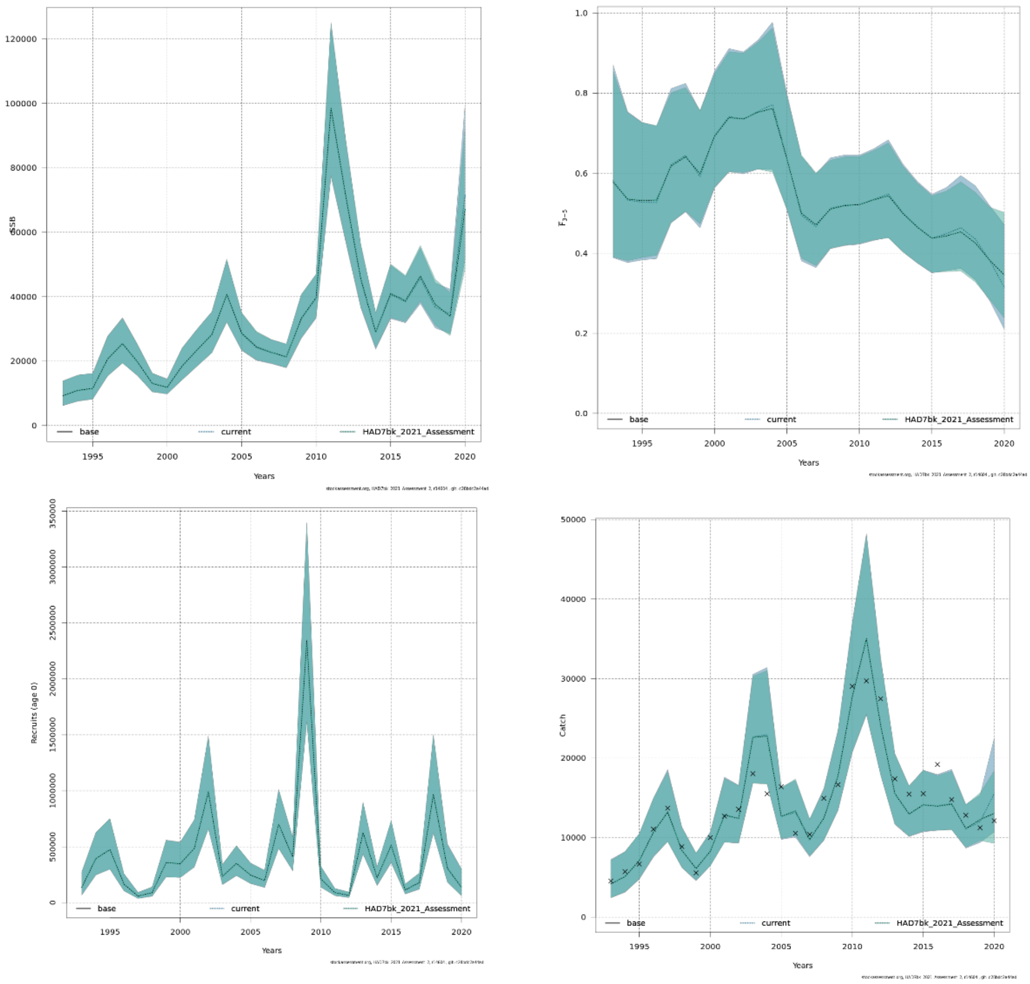


Figure 8.17. Haddock in 7.b,c,e–k. SAM assessment stock summary plots.

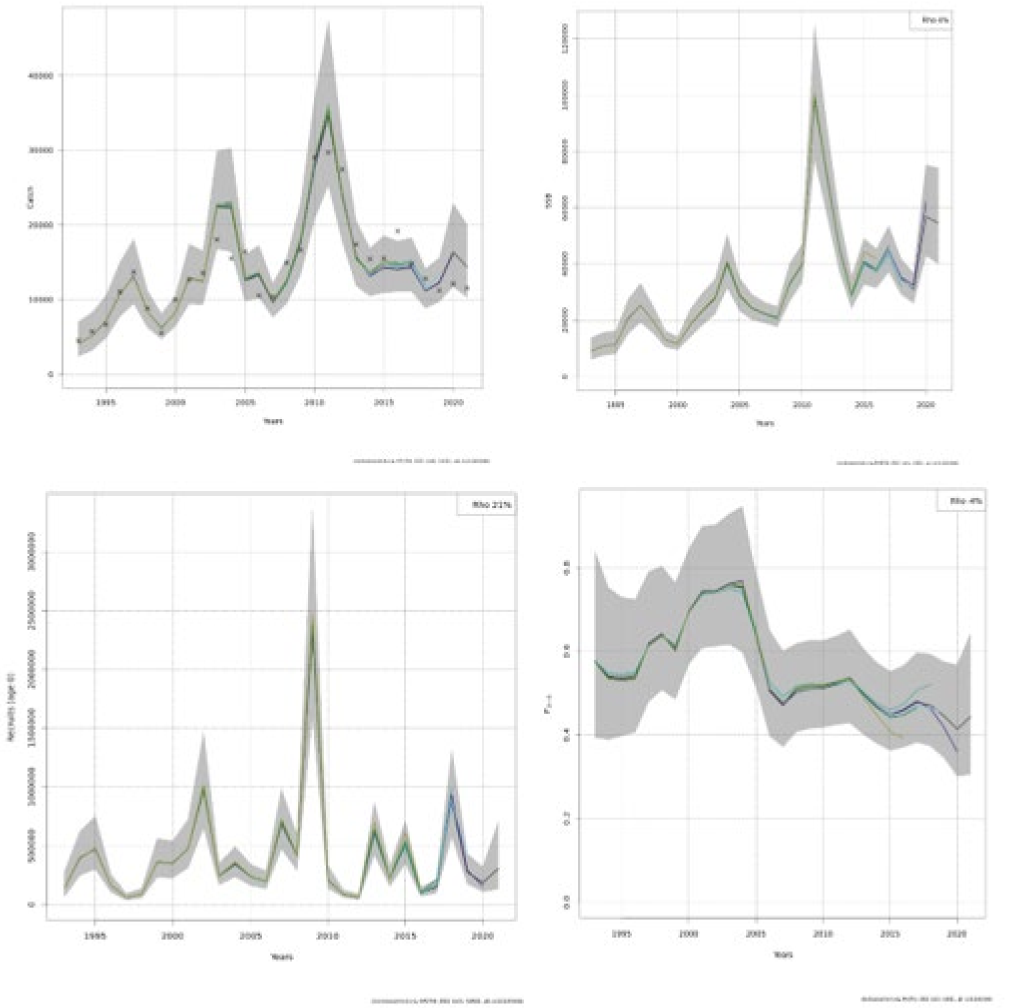


Figure 8.18. Haddock in 7.b,c,e–k. Retrospective analysis of the final SAM assessment run. Catch (top left), SSB (top right), recruitment (bottom left) and F (bottom right).

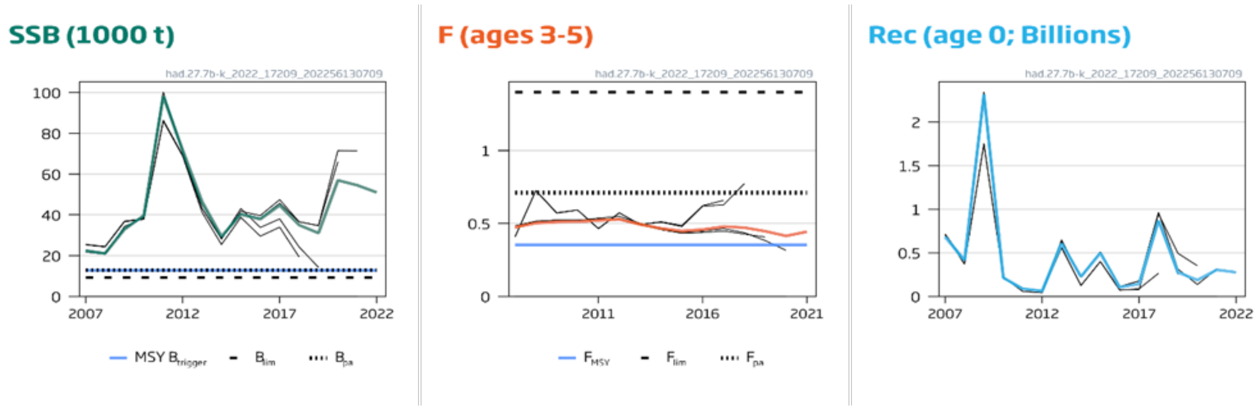


Figure 8.19. Haddock 7.b,c,e–k. Historical assessment results (final-year recruitment and SSB assumptions included). The assessment was benchmarked in 2020, prior to which a different method (ASAP based) was applied.

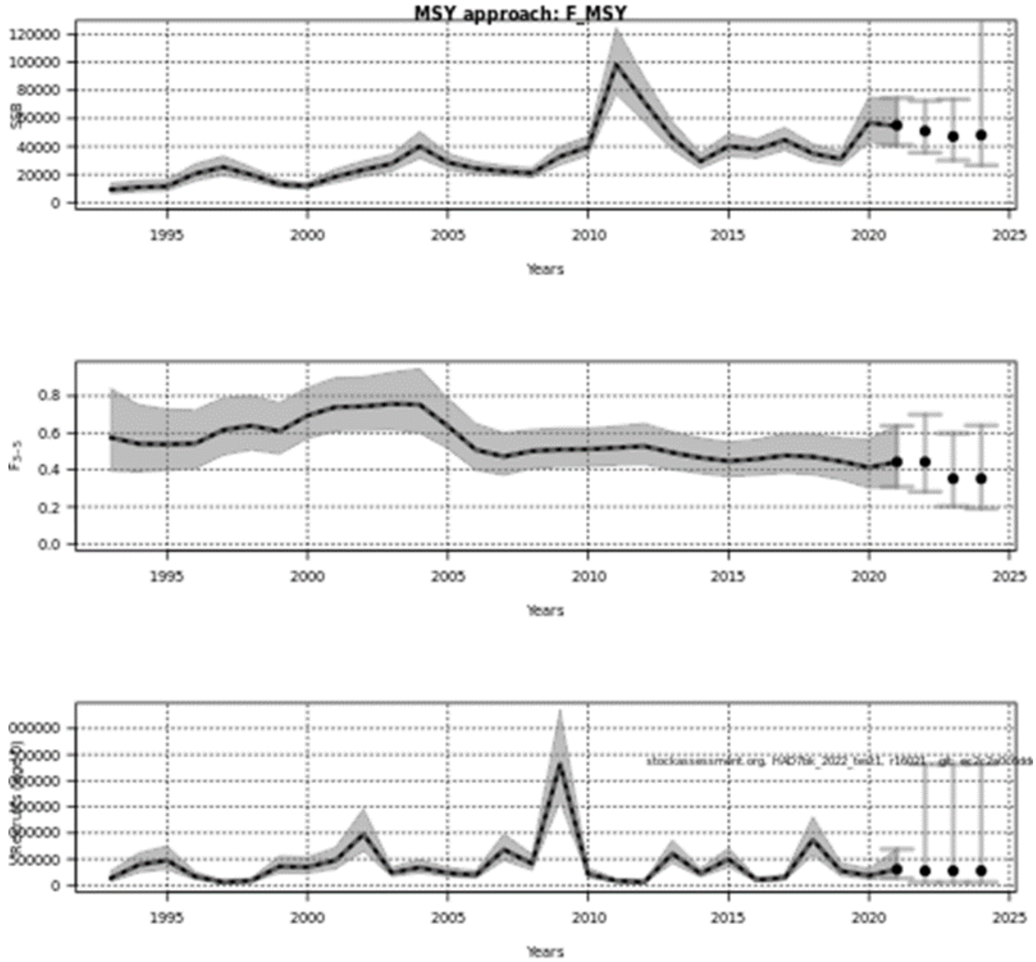


Figure 8.20. Haddock in 7.b,c,e–k. Assessment and forecast of the final SAM run. SSB (top), and F (middle) and recruitment (bottom).

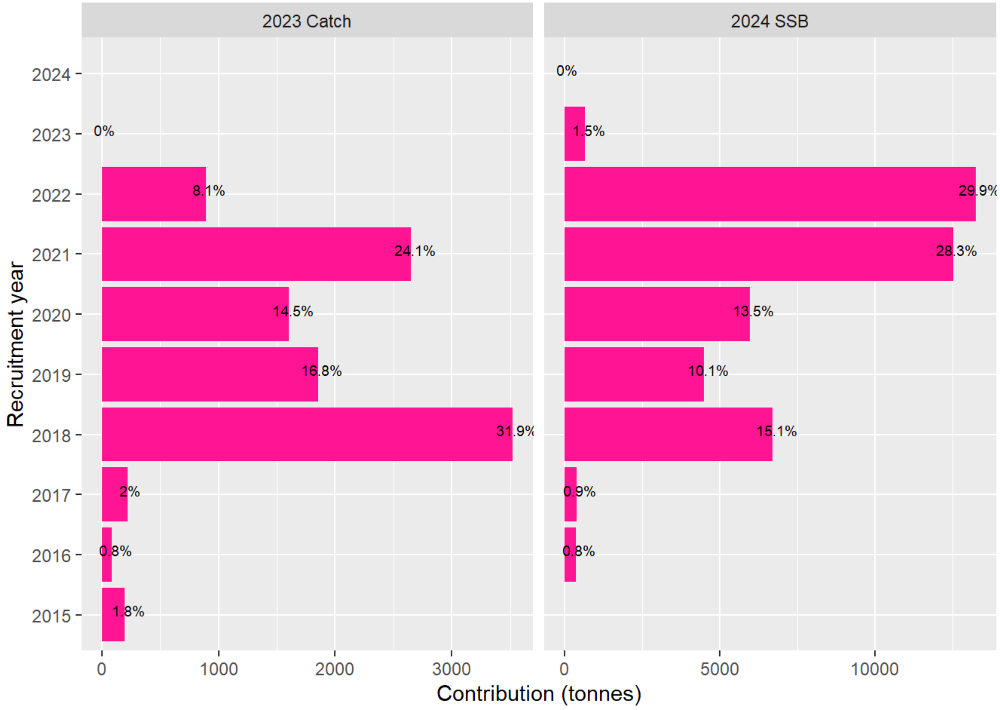


Figure 8.21. Haddock 7.b,c,e–k. Recruitment Contribution of recent year classes used in predictions, and the relative (%) contributions to catch and SSB (by weight) of these year classes.