4 Cod in the North Sea, West of Scotland, eastern English Channel, and Skagerrak (Northern Shelf)

cod.27.46a7d20 – *Gadus morhua* in Subarea 4, divisions 6.a and 7.d, and Subdivision 20

An error was found in the forecast calculation used to provide advice in June 2024. This was corrected in November 2024. Please see Annex 8.

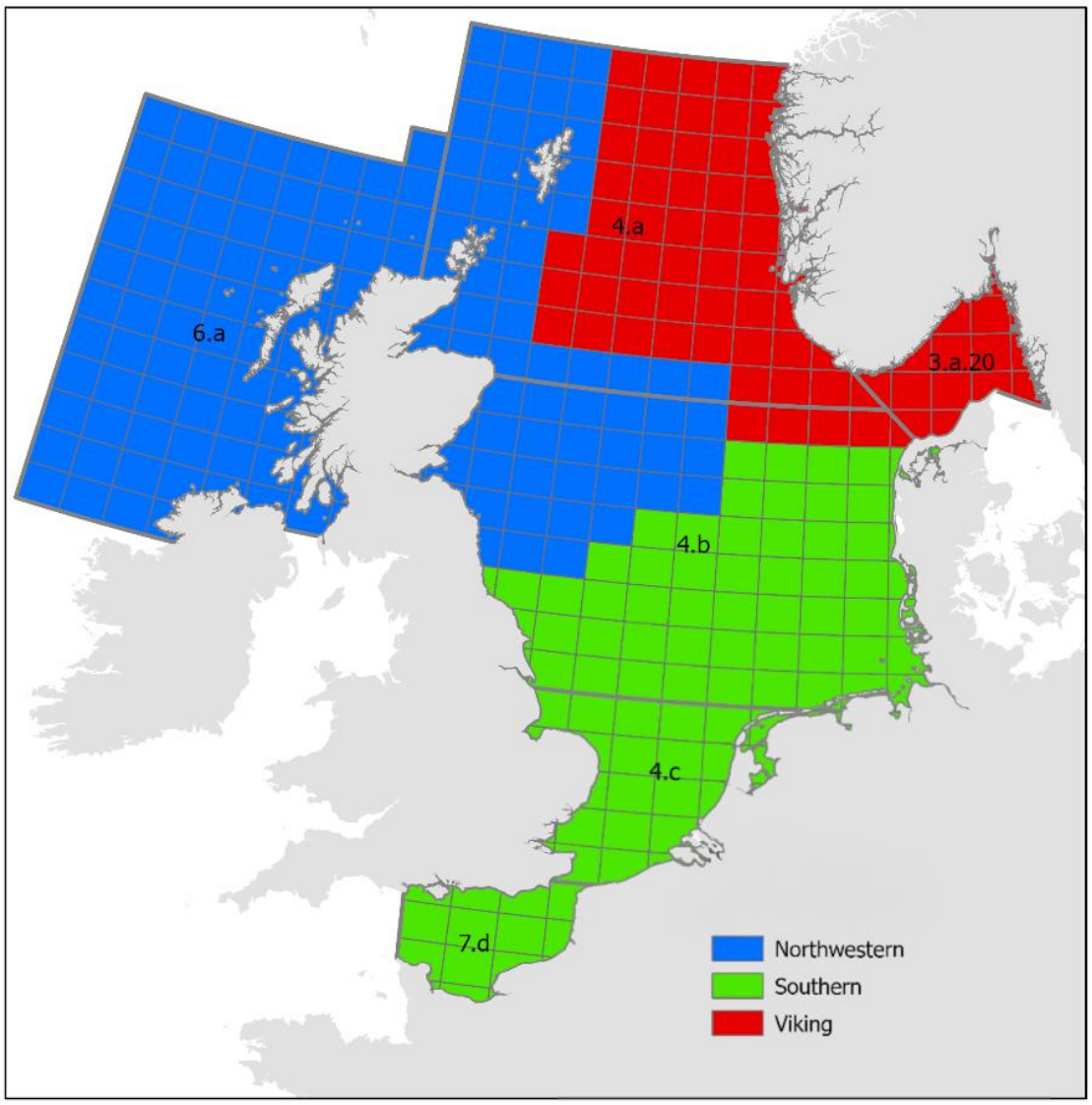
4.1 General

This assessment relates to substocks of cod in the North Sea (Subarea 4), West of Scotland (Division 6.a), the Skagerrak (Subdivision 20), and the eastern English Channel (Division 7.d). This assessment is presented as an update from last year. However, updated natural mortality estimates were provided for cod by WGSAM in 2024. Overall, this resulted in minor changes to stock size. Reference points were updated in response to the revision of the natural mortality inputs to the assessment.

A stock annex records more detail and references information on the stock definition, ecosystem aspects and the fisheries. This report section records only recent developments and new information presented to WGNSSK.

4.1.1 Stock definition

The Northern Shelf cod stock consists of reproductively isolated populations of Viking and Dogger cod, with the Dogger cod displaying phenotypic spatial structure either side of a 50 m bathocline in the central North Sea. Based on this, the multistock assessment adopts a three substock hypothesis, with substocks defined as Northwestern, Viking, and Southern (see Figure below), with different rates of sexual maturity, reproduction, and growth. A comprehensive summary of available information on stock definition can be found in ICES WKNSCodID (2020) and ICES WK6aCodID (2022).



Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Assumed distribution of substocks at spawning time.

4.1.2 Ecosystem aspects

Both the North Sea and the West of Scotland are characterized by episodic changes in productivity of key components of the ecosystem. Phytoplankton, zooplankton, demersal and pelagic fish have all exhibited such cycles in variability. Managers should expect long-term change and ensure that management plans have the potential to respond to new circumstances. For example, a regime shift occurred in the region in the mid-1980s, and evidence suggests another from around 1998, a time since which cod recruitment has been low. A summary of available information on ecosystem aspects is presented in the Stock Annex.

4.1.3 Fisheries

4.1.3.1 North Sea: Subarea 4, Division 7.d, and Subdivision 20

Cod are caught by virtually all the demersal gears in Subarea 4, Subdivision 20 (Skagerrak) and Division 7.d, including beam trawls, otter trawls, seine nets, gillnets, trammel nets, and lines. Most of these gears take a mixture of species. In some of them, cod is considered a bycatch (for

example in beam trawls targeting flatfish), and in others, the fisheries are directed mainly towards cod and other gadoids such as haddock and saithe (for example, in large-meshed otter trawls and some fixed gear fisheries). The main gears landing cod in the North Sea area are primarily TR1 (mainly operated by Scotland and Denmark), but also GN1 (mainly Denmark and Norway), TR2, and BT1. Cod are also an important target for marine recreational fisheries (see section 4.2.1.4).

4.1.3.2 West of Scotland: Division 6.a

The demersal fisheries in Division 6.a are predominantly conducted by otter trawlers (typically using 120 mm mesh) fishing for haddock, anglerfish, and whiting, with bycatches of cod, saithe, megrim, lemon sole, ling, and skate spp. There is a substantial trawl fishery for *Nephrops* in more inshore waters which uses a smaller mesh size (< 100 mm) and also has a bycatch of small cod, the majority of which are discarded. Fishing in the area is conducted mainly by vessels from Scotland, France, Ireland, Norway, and Spain with Scottish vessels taking the majority of cod catch. Typically, large trawl gear vessels targeting finfish are responsible for around 90% of cod catches in Division 6.a, the *Nephrops* fleet take approximately 4% and the remainder are taken by other gears, including longliners and gillnets.

4.1.3.3 Technical Conservation Measures

The recovery plan for cod (EC 1342/2008) triggered considerable improvements in selectivity and cod avoidance through incentives that were linked to the fishing effort regime and through national measures, such as the Scottish Conservation Credits Scheme. The Conservation Credits scheme was suspended on 20 November 2016 and the fishing effort regime discontinued in 2017 (EC 2094/2016). Further details of these measures are presented in the Stock Annex.

The expansion of the closed-circuit TV (CCTV) and FDF programmes in 2010–2016 in Scotland, Denmark, Germany, England, and the Netherlands is expected to have contributed to a reduction of cod mortality. The cod specific FDF scheme terminated at the end of 2016. Further details are presented in the Stock Annex.

Temporary and permanent spatial closures to protect cod have been a feature of cod recovery measures since the early 2000s. A seasonal closure (covering the main spawning period: February–April) in the Clyde was initially implemented as a temporary emergency EU measure to protect spawning cod. Since then, this measure has been implemented through a Scottish Statutory Instrument (SSI) and remains in place for 2024 and 2025. Since 2020, seasonal closures have been implemented to reduce fishing pressure on cod in the North Sea (EC 2021/92, EC 2022/109, EC 2023/194 and EC 2024/257). Details of other spatial closures that have been implemented for cod are presented in the Stock Annex.

A summary of information on cod fisheries in the North Sea and West of Scotland including past and current technical measures used for the management of cod is presented in the Stock Annex.

4.1.3.4 Pre-assessment meeting with industry representatives

Following the recommendations from ICES WKRRCOD (2022), a pre-assessment meeting was held with industry representatives 10April 2024. Industry representatives reported increasing cod abundance throughout the assessment area, but high predation from seals. It was noticed that storms were frequent in 2023, possibly resulting in lower catches that may not be representative of cod abundance. It was suggested to shift the border between the Viking and Southern substocks southwards to match an area of low abundance that may better represent the true boundary.

4.1.4 Management

Management of Northern Shelf cod is by TAC and technical measures. The agreed TACs for Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20 (Skagerrak) over the last ten years were as follows (Table 4.1a):

TAC (000t)	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
20 (Skager-rak)	4.0	4.2	4.8	5.7	8.0	4.2	2.1	1.9	1.9	3.1	3.6
2.a + 4	27.8	29.2	33.7	39.2	43.2	29.4	14.7	13.2	13.2	21.7	24.9
6.a	0	0	0	0	0	1.7	1.3	1.3	1.3	1.2	1.4
7.d	1.6	1.7	2.0	2.1	1.7	1.7	0.9	0.8	0.8	1.3	1.5

For 2014–2016, Council Regulations (EC) N°297/2013, N°432/2014, N°2015/104 and N°2016/72 allocated different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size as stipulated by Council Regulation (EC) N°43/2009. The effort regime has now been discontinued, and the TACs for 2017–2024 are given in Council Regulations (EC) N°2017/127, N°2018/120, N°2019/124, N°2020/123, N°2021/1239, N°2022/109 and N°2023/194, N°2024/257 respectively. From 2012 to 2018, the TAC for cod in Division 6.a was set to zero with allowance for a bycatch of cod to be landed provided that it does not comprise more than 1.5% of the live weight of the total catch retained on board per fishing trip. From 2015, this provision was not allowed for catches subject to the landing obligation. Since 2020, and in addition to TACs, remedial measures have been agreed by the EU, UK, and Norway to reduce the fishing pressure on cod in the North Sea. Details of these remedial measures are given in EC 2021/92, EC 2022/109, EC 2023/194 and EC 2024/257.

The EU landing obligation was implemented from 1 January 2017 for several gears, including otter trawlers with >100 mm mesh (TR1), beam trawlers with >120 mm mesh (BT1) and fixed gears. The EU landing obligation was fully implemented in the North Sea and Skagerrak from 1 January 2018 and in the eastern English Channel and West of Scotland from 1 January 2019, although a few exemptions exist. In 2019, a bycatch TAC of 1735 t was set for Division 6.a to allow mixed fisheries to continue. In 2020, this TAC reduced to 1279 t and remained at this level until 2023, although the quota share changed (as agreed under the EU-UK Trade and Cooperation Agreement). In 2024, the TAC for Division 6.a was increased to 1392 t.

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in the various fisheries. In these cases, management advice must consider both the state of individual stocks and their simultaneous exploitation in demersal fisheries. Stocks in the poorest condition, particularly those which suffer from reduced reproductive capacity, become the overriding concern for the management of mixed fisheries, where these stocks are exploited either as a targeted species or as bycatch.

4.1.4.1 Cod recovery and management plans

A Cod Recovery Plan which detailed the process of setting TACs for cod in the North Sea, Skagerrak, eastern English Channel and to the West of Scotland was in place until 2008 (EC 423/2004). In December 2008, the European Commission and Norway agreed on a new cod management plan that aimed to be consistent with the precautionary approach and was intended to achieve sustainable fisheries and high yield. In addition to the EU–Norway agreement, the EU implemented effort restrictions, reducing KW-days available to EU vessels in the main métiers catching cod in direct proportion to reductions in fishing mortality until the long-term phase of the

plan was reached (EC 1342/2008). A historical evaluation of the effectiveness of these plans (ICES WKROUNDMP, 2011; Kraak *et al*., 2013) concluded that the plans had not controlled F as envisaged.

In December 2012, the cod management plan was amended. Details are given in EC 1243/2012.

In November 2016, the cod management plan was amended to discontinue the effort regime set out in EC 1342/2008 as it became an obstacle to the implementation of the landing obligation. Details of the amended cod management plan are given in EC 2016/2094.

In July 2018, the European Union agreed to a multiannual management plan for demersal fisheries in the North Sea (MAP). However, the plan was not adopted by Norway and the UK. Details of the plan are given in EC 2018/973.

In March 2019, the European Union adopted a multiannual management plan for stocks fished in Western Waters and adjacent waters. Cod in Division 6.a are considered a bycatch species within this regulation. Details of the plan are given in EC 2019/472.

In 2023, it was decided to assess the previous North Sea and West of Scotland cod stocks as a combined Northern Shelf cod stock consisting of three substocks (Northwestern, Southern and Viking). Advice for substocks of Northern Shelf cod is given according to the ICES MSY approach and precautionary considerations for substocks in concurrent fisheries.

4.2 Data available

4.2.1 Catch

Landings data from human consumption fisheries for recent years as officially reported to ICES together with those estimated by the WG are given for each area separately and combined in Table 4.1a.

The total catch estimate for 2023 is 32 561 tonnes, and above the TAC of 27 218 tonnes. The catch is split as follows for the separate areas (tonnes):

	TAC	Landings	Discards*	BMS**
20–Skagerrak	3095	2803	770	2
4	21652	20985	6616	0
6.a	1210	1105	251	0
7.d	1261	31	0	0
Total	27218	24924	7637	2

*** Discards include BMS landings.**

****BMS landings uploaded to InterCatch.**

No discards or age data are available for substocks of Northern Shelf cod. Catch-at-age data are therefore prepared separately for cod in the North Sea, eastern English Channel and Skagerrak (27.47d20) and for cod to the West of Scotland (27.6a) according to the procedures established for single-stock assessments prior to 2023. Catch numbers for the total Northern Shelf cod stock are then taken as the sum of numbers-at-age from the North Sea and West of Scotland components and catch weights as the weighted average of the annual catch mean weights (weighted by the catch numbers-at-age). The sampling coverage for discard ratio, and landings and discards age compositions for 2023 is provided in Table 4.1b, along with the contributions to total

landings, discards and BMS from each area prior to raising. Raising procedures for the North Sea and West of Scotland components are described in the following sections.

Figure 4.1a plots reported landings and estimated discards (including BMS landings) used in the assessment. Landings in numbers-at-age are given in Table 4.2a. These data do not include industrial fishery bycatches landed for reduction purposes prior to 2002 (values from 2002 onwards were entered into InterCatch for all relevant nations except Norway, and were included in the raising, although the numbers were very small). Discard numbers-at-age (including BMS landings from 2016) are shown in Table 4.2b. The proportions of the estimated numbers discarded for ages 1–4 and the proportion of the estimated total discards by weight and number are shown in Figure 4.1b. Total catch numbers-at-age are shown in Table 4.2c. Reported landings, estimated discards (including BMS landings from 2016) and total catch (sum of landings and discards), given as SOPs in tonnage, are shown in Table 4.3.

4.2.1.1 North Sea (27.47d20) catch-at-age data

Prior to the use of InterCatch for discard estimation, discard numbers-at-age were estimated for areas 4 and 7.d by applying the Scottish discard ogives to the international landings-at-age, and were based on observer sampling estimates for Subdivision 20–Skagerrak. Discard raising for 2002–2023 was performed in InterCatch, with the different nations providing information by area, quarter, and métier. Sampling for discards and age compositions was poor in area 7.d in 2002–2003, and this necessitated combining areas 4 and 7.d in those years. The provision of discard information has vastly improved since the reform of the EU's data collection framework in 2008 (see http://datacollection.jrc.ec.europa.eu/) and covered 70% of the landings in 2023 – an improvement on the low coverage observed during the COVID-19 pandemic. All nations apart from Norway now provide discard information and age compositions were provided by all nations for 2023 data.

Norwegian discarding is illegal, so although this nation has accounted for 7–15% of cod landings over the period 2002–2023 (InterCatch data), it does not provide discard estimates. Nevertheless, the agreed procedure applied in InterCatch is that discards raising should include Norway (i.e. Norway will be allocated discards associated with landings in reported métiers). Furthermore, tagging and genetic studies have indicated that Norwegian coastal cod are different from North Sea cod and do not generally move into areas occupied by North Sea cod. Therefore, Norwegian coastal cod data have been removed from North Sea cod data by uploading only North Sea cod data into InterCatch for 2002 onwards, and by adjusting catches prior to 2002 to reflect the removal of Norwegian coastal cod data (an annual multiplicative adjustment of no more than 2.5% was made using Norwegian coastal cod data (see ICES WKNSEA, 2015, for more details).

For cod in 4, 20–Skagerrak and 7.d, ICES first raised concerns about the misreporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. The WG believes that underreporting of landings may have been significant in 1998 because of the abundance in the population of the relatively strong 1996 year-class as 2-year-olds. The landed weight and input numbers-at-age data for 1998 were adjusted to include an estimated 3000 tonnes of underreported catch. The 1998 catch estimates remain unchanged in the present assessment (apart from the adjustment for Norwegian coastal cod). The UK Buyers and Sellers legislation, introduced towards the end of 2005, is expected to have improved the accuracy of reported cod landings.

Since the WG has no basis to judge the overall extent of underreported catch over time, it has no alternative but to use its best estimates of landings, which in general are in line with the officially reported landings.

InterCatch

InterCatch was used for estimation of landings, discards (including BMS landings) and total catch-at-age and mean weight at age in 2023. Data co-ordinators from each nation were tasked to input data into InterCatch, disaggregated to quarter and métier. Allocations of discard ratios and age compositions for unsampled strata were then performed to obtain the data required for the assessment. The approach used for discard ratio allocations was to do it by area (20, 4 and 7.d), giving three broad categories. Annual discards were first matched to quarterly landings. Then, within each of these three categories, ignoring country and season, where métiers had some samples, these were pooled and allocated to unsampled records within that métier. At the end of this process, any remaining métiers were allocated an all samples pooled discard ratio for the given category.

The landings and discards imported in weight or raised for 2023 are as follows (tonnes):

Catch Category	Raised or Imported	CATON	Percentage
BMS landing	Imported	1.7	100
Discards	Imported	5405	73
Discards	Raised	1980	27
Landings	Imported	23819	100
Logbook Registered Discard	Imported	0	NA

A similar approach was used for allocating age compositions, except that there were six broad categories because discards (including BMS landings) were treated separately to landings. However, discard age compositions for Division 7.d had to be allocated from métiers in Subarea 4 as there was no discards age sampling in 7.d in 2023.

The landings and discards imported in weight or raised, with age distribution sampled or estimated for 2023 are as follows (tonnes):

Catch Category	Raised or Imported	Sampled or Estimated	CATON	Percentage
Logbook Registered Discard	Imported	Estimated	0	NA
Landings	Imported	Sampled	19634	82
Landings	Imported	Estimated	4184	18
Discards	Imported	Sampled	5293	72
Discards	Raised	Estimated	1980	27
Discards	Imported	Estimated	112	2
BMS landing	Imported	Sampled	0	NA
BMS landing	Imported	Estimated	2	100

4.2.1.2 West of Scotland (27.6a) catch-at-age data

National estimates of landings and where available, discards and associated age compositions are available in InterCatch from 2003 onwards, and prior to 2003 from historical assessment WGCSE files. Age composition data for landings and discards are typically provided by UK

(Scotland) and Ireland for the main métiers over the time-series, and France have provided discard estimates for 2009 onwards but no landings or discards age compositions.

Reported landings of cod in Division 6a are considered to have been significantly impacted by area misreporting since the mid-2000s (i.e. cod which are caught in Division 6a are incorrectly reported as being taken from the North Sea and elsewhere, resulting in the reported landings being an underestimate of actual landings from Division 6a). At the 2020 benchmark an approach was agreed which utilized VMS data and associated daily reported landings records to estimate an amount of area-misreported landings (ICES WKDEM, 2020). Catch data used in the previous West of Scotland assessment have been adjusted in the submission to InterCatch to account for area-misreporting i.e. the area-misreported quantity is added to the reported landings for Division 6a, and an equivalent quantity has been subtracted from the North Sea landings in most years. Late availability of estimated area-misreported landings between 2019 and 2021 meant that only landings for the West of Scotland cod stock were adjusted in these years. This is likely to result in a small amount of double accounting (< 2% of total landings in 2019 and 2020, and < 0.5% in 2021) when summing InterCatch data for 6a cod and N Sea cod for these years.

Since the adoption of the multistock assessment approach for Northern Shelf cod in 2023 (ICES WKBCOD 2023), area misreported landings are no longer relevant as commercial landings data from the North Sea and West of Scotland are combined prior to being input into the assessment. As such, no adjustment for area-misreporting was made for 2022–2023, nor will be made in future assessments of Northern Shelf cod.

Between the mid-1990s and mid 2000s there was believed to be significant underreporting of landings from Division 6.a due to restrictive TACs. Given the lack of estimates of underreporting, previous assessments of cod in this area have excluded total catches for this period (1995–2006) and estimated them within the assessment model.

InterCatch

The catch estimation process in InterCatch involves two stages: (i) allocating discard ratios to fleets for which only landings have been imported and (ii) age composition allocation by catch category (for unsampled catches). Age samples are allocated for landings and discards separately. Below Minimum Size landings are combined with discards for the purpose of age composition estimation.

To estimate discard ratios, discards are first automatically matched to landings by country, area, métier and season (year or quarter) in InterCatch. The resulting discard-landings ratios are then used to estimate discards for landings from fleets without discard estimates. Due to the mix of both quarterly and annual data submitted for each year, strata for allocating discard rates were independent of season. The strata by year are as follows: large mesh demersal target fleets were allocated a discard–landings ratio on the basis of the weighted average of all available ratios from large mesh demersal target fleets (weighted average of Scottish, Irish and French when available); small mesh fleets were allocated discard ratio on the basis of all available ratios from small mesh fleets (usually only Scottish *Nephrops* fleet); longline fleets are allocated discard proportions from other longline fleets (and when not available are allocated zero discard rate as observed discard rates appear very low compared with other fleets); all other fleets are given a weighted average of all available discard proportions.

The allocation of age compositions to un-sampled landings and discards follows the same stratification as described for the allocation of discard ratios. The exception being the longline fleets which were included in the 'other fleets' category as there were no age composition data provided.

The landings and discards imported in weight or raised, with age distribution sampled or estimated for 2023 are as follows (tonnes):

Catch Category	Raised or Imported	Sampled or Estimated	CATON	Percentage
Logbook Registered Discard	Imported	Estimated	0	NA
Landings	Imported	Sampled	976	88
Landings	Imported	Estimated	129	12
Discards	Imported	Sampled	242	96
Discards	Raised	Estimated	9	4
Discards	Imported	Estimated	0.067	0
BMS landing	Imported	Estimated	0	NA

4.2.1.3 Spatially and seasonally disaggregated landings

Landings data disaggregated by ICES rectangle are used to calculate the proportion of landings by substock for Northern Shelf cod. Landings data from quarter 1 are used to determine the relative substock proportions over time as it is assumed that the substocks do not mix in quarter 1. Spatially disaggregated landings data are available from 1995 onwards, with data available from eleven ICES countries (Belgium, Denmark, England (UK), France, Germany, Ireland, Netherlands, Northern Ireland (UK), Norway, Scotland (UK) and Sweden). Four countries are missing spatial landings data at the beginning of the time-series (i.e. Belgium, France, the Netherlands and Northern Ireland), and there are also missing spatial landings for Ireland between 2011–2013. For each of these countries, data gaps are filled based on a 3-year mean of the substock landings proportions and a 3-year mean of the quarter 1 landings proportions using the first years in the time-series with available data. These proportions are then applied to the ICES official landings data to get landings estimates for the missing years for each country. The relative quarter 1 substock proportions since 1995 are given in Figure 4.1c and for 2023 are calculated as 47% Northwestern, 49% Viking and 4% Southern. The Q1 substock proportions over time are as follows:

Year	Northwestern	Southern	Viking
1995	0.21	0.44	0.35
1996	0.23	0.47	0.29
1997	0.20	0.49	0.31
1998	0.20	0.51	0.29
1999	0.15	0.51	0.34
2000	0.17	0.45	0.38
2001	0.18	0.38	0.44
2002	0.23	0.32	0.45
2003	0.14	0.43	0.43
2004	0.11	0.42	0.47

Year	Northwestern	Southern	Viking
2005	0.11	0.37	0.52
2006	0.13	0.35	0.53
2007	0.19	0.37	0.44
2008	0.14	0.45	0.41
2009	0.14	0.45	0.42
2010	0.18	0.39	0.43
2011	0.25	0.28	0.47
2012	0.21	0.25	0.54
2013	0.29	0.18	0.53
2014	0.29	0.19	0.52
2015	0.27	0.25	0.48
2016	0.27	0.14	0.58
2017	0.30	0.05	0.64
2018	0.46	0.03	0.51
2019	0.50	0.02	0.48
2020	0.51	0.03	0.46
2021	0.41	0.06	0.53
2022	0.44	0.02	0.53
2023	0.47	0.04	0.49

Disaggregated landings data are also used to calculate the proportion of total landings by quarter (Figure 4.1d), which are input into the assessment. Generally speaking, the proportion of total landings taken in Q1 and Q2 has decreased over the years, with larger proportions being taken in Q3 and Q4 in recent years. The proportion of total landings by quarter (rounded) are given below, and are calculated as 19% Q1, 25% Q2, 31% Q3 and 25% Q4 for 2023:

Year	Q1	Q2	Q3	Q4
1995	0.21	0.32	0.27	0.20
1996	0.23	0.27	0.27	0.23
1997	0.20	0.28	0.27	0.25
1998	0.22	0.31	0.25	0.22
1999	0.29	0.27	0.24	0.20
2000	0.24	0.26	0.23	0.26

Year	Q1	Q2	Q3	Q4
2001	0.24	0.26	0.24	0.26
2002	0.22	0.27	0.25	0.26
2003	0.30	0.26	0.25	0.20
2004	0.26	0.24	0.22	0.28
2005	0.23	0.24	0.27	0.26
2006	0.23	0.23	0.30	0.24
2007	0.22	0.26	0.28	0.24
2008	0.26	0.29	0.26	0.18
2009	0.23	0.24	0.28	0.25
2010	0.22	0.26	0.25	0.27
2011	0.23	0.24	0.27	0.25
2012	0.23	0.27	0.28	0.22
2013	0.20	0.24	0.29	0.27
2014	0.16	0.24	0.31	0.29
2015	0.21	0.25	0.30	0.25
2016	0.21	0.24	0.29	0.26
2017	0.23	0.23	0.26	0.27
2018	0.24	0.24	0.27	0.26
2019	0.19	0.25	0.31	0.26
2020	0.19	0.25	0.29	0.27
2021	0.18	0.26	0.28	0.28
2022	0.19	0.25	0.29	0.27
2023	0.19	0.25	0.31	0.25

4.2.1.4 Recreational catches

Recreational catches were estimated for 2010–2023 from data provided by Belgium, Denmark, Germany, Sweden, Norway, the Netherlands, and UK, but are considered provisional and not included in the assessment due to length of time-series and unknown age structure and uncertainty. Further details are provided in the Stock Annex and ICES WKBCOD (2023). Estimates of commercial and recreational removals along with the percentage of recreational removals and percentage of recreational removals derived from imputation are as follows:

	Commercial removals (t)			Recreational removals (t)		
Year	Landings	Discards	Total	Total	% recr.	%imputed
2010	37115	13899	51014	1537	2.9	51
2011	32323	12515	44839	1357	2.9	82
2012	32363	10554	42916	1639	3.7	43
2013	30744	12073	42817	1966	4.4	74
2014	35048	13906	48954	3176	6.1	58
2015	37938	15038	52976	2313	4.2	77
2016	38754	13702	52456	1894	3.5	14
2017	38355	12202	50557	1685	3.2	29
2018	41147	10170	51317	1456	2.8	2
2019	33995	3677	37672	1352	3.5	26
2020	20185	4905	25090	1339	5.1	11
2021	15752	4360	20112	1392	6.5	35
2022	16148	6793	22941	1282	5.3	29
2023	24599	7630	32229	1183	3.5	51
Mean	31033	10102	41135	1684	4.1	42

4.2.2 Weight-at-age

Mean weights-at-age for landings, discards (including BMS landings from 2016) and catch are taken as a weighted average of the annual catch mean weights from the North Sea and West of Scotland (weighted by the catch numbers-at-age) and are given in Tables 4.4a–c. Long-term trends in mean catch weights-at-age by catch component for ages 1–7+ are plotted in Figure 4.2a, which indicates an overall decline from around 2010 for ages 3 and above. Ages 1 and 2 show little absolute variation over the long term.

Stock mean weights are derived by substock from the NS–IBTS, SWC-IBTS and SCOWCGFS survey data in Q1, together covering the North Sea, West of Scotland and Skagerrak. A bootstrap procedure is used to derive stock mean weights from the observed length distribution and estimated length-weight relationships, accounting for length-stratified sampling. Differences have been noted in the historic period due to the random allocation of CA records with missing haul IDs; however, a sensitivity analysis showed this to have no impact on stock weights in the recent period and minimal effect in the stock assessment (see Annex 8 in ICES WGNSSK, 2023). Stock mean weights used as input to the assessment are given in Tables 4.5a and plotted in Figure 4.2b.

4.2.3 Maturity and natural mortality

Annually varying maturity ogives are estimated for each substock based on the Q1 survey data (NS-IBTS, SWC-IBTS and SCOWCGFS) from 1983. Data are weighted following the procedures

described in ICES WKMOG (2008) and maturity ogives produced by fitting a GLMM to the weighted data. A sensitivity analysis shows some impact of randomly allocating CA records with missing haul IDs on the maturity ogives but minimal influence in the assessment (see Annex 8 in ICES WGNSSK, 2023). Furthermore, there are concerns about the quality of maturity records prior to 1991, although this does not impact the advice. The time-varying maturity ogives used as input to the assessment are given in Tables 4.5b and illustrated in Figure 4.2c.

Table 4.5c and Figure 4.2d show estimates of M based on multispecies considerations adopted for the assessment. Estimates of natural mortality are derived from multispecies analyses updated by the Working Group on Multispecies Stock Assessment Methods (WGSAM) every three years in so-called "key runs" to account for improved knowledge of predation on cod by other species (mainly seals, harbour porpoises and gurnards) and cannibalism. The last update occurred in 2023 but included an ad-hoc inflation of the Ms for cod to account for migrations to the West of Scotland, given that the distribution of the Northern Shelf cod stock is larger than the SMS model domain covering only the North Sea. This ad-hoc adjustment follows the methodology of the 2021–2022 assessments of the former North Sea cod stock but is inconsistent with the new stock definition and multi-stock assessment adopted since 2023, which explicitly includes the West of Scotland. The Ms from the 2023 key run were therefore considered inappropriate for Northern Shelf cod. In 2024, WGSAM provided an alternative model run without the M adjustment for use in the Northern Shelf cod assessment. This alternative run is almost identical to the official key run for everything except cod and provides Ms that benefit from improved knowledge of predation whilst retaining consistency with the multi-stock assessment and assumptions. Natural mortality estimates from the North Sea key run used as input to the assessment are given in Table 4.5c and Figure 4.2d and are assumed to apply to all three substocks of Northern Shelf cod.

4.2.4 Catch, effort and research vessel data

Only survey and combined commercial landings and discard information are analysed within the assessment presented.

Seven survey series are available for use within this assessment:

- North Sea International Bottom Trawl Survey in Q1 (NS-IBTS-Q1): covering the North Sea and Skagerrak from 1976. This multi-vessel survey uses a fixed station design of at least two tows per rectangle with the GOV trawl.
- Scottish West Coast Bottom Trawl Survey in Q1 (SWC-IBTS-Q1): covering the West of Scotland for the period 1985–2010. This survey used a fixed station design with the GOV trawl.
- Scottish West Coast Groundfish Survey in Q1 (SCOWCGFS-Q1): covering the West of Scotland from 2011. This survey series uses a more robust GOV groundgear (compared to the SWC-IBTS) and a random stratified design.
- North Sea International Bottom Trawl Survey in Q3 (NS-IBTS-Q3): covering the North Sea and Skagerrak from 1991. This multi-vessel survey uses a fixed station design of at least two tows per rectangle with the GOV trawl.
- Scottish West Coast Bottom Trawl Survey in Q4 (SWC-IBTS-Q4): covering the West of Scotland for the period 1996–2009. This survey used a fixed station design with the GOV trawl.
- Scottish West Coast Groundfish Survey in Q4 (SCOWCGFS-Q4): covering the West of Scotland from 2011. This survey series uses a more robust GOV groundgear (compared to the SWC-IBTS) and a random stratified design.
- Irish Groundfish Survey in Q4 (IE-IGFS-Q4): covering the southern part of Division 6.a from 2003. This survey uses a random stratified design and the GOV trawl.

Standardized age-based survey indices for Northern Shelf cod are calculated based on GAMs and Delta-distributions. The general methodology is described in Berg and Kristensen (2012) and Berg *et al*. (2014) and was run with R version 4.1.2 in the Windows Subsystem for Linux (WSL) based on the DATRAS[1] and surveyIndex packages. The Delta-GAM is fit to the survey data for Quarter 1 (NS-IBTS-Q1, SWC-IBTS-Q1 and SCOWCGFS-Q1) ages 1–7+, and Quarters 3 and 4 combined (NS-IBTS-Q3, SWC-IBTS-Q4, SCOWCGFS-Q4 and IE-IGFS-Q4) ages 0–7+. The final model formulation selected for Northern Shelf cod comprises a high resolution stationary spatial model with low resolution yearly independent deviations and includes ship, year, depth, time of day and haul-duration effects. The Q3+Q4 model also includes a gear effect to account for use of the Aberdeen trawl between 1992–1997. More details of the method used to produce Delta–GAM indices are provided in the Stock Annex and can be found in ICES WKBCOD (2023), as well as the above-mentioned publications.

Where historic records in the DATRAS CA (age) data are missing haul IDs, random allocations are made based on year, quarter, country, ship, and either ICES rectangle or roundfish area, to avoid losing age samples. A sensitivity analysis shows these random allocations to have minimal influence on the indices (see Annex 8 in ICES WGNSSK, 2023).

Maps showing the predicted distribution of cod in recent years are presented in Figures 4.3a-b. Retrospective analyses with three peels give average Mohn's rho values of 0 and -0.02 across all ages for the Q1 and Q3+Q4 models, respectively (Figures 4.3c-d). Indices by substock are produced by summing the spatial model predictions by year, age, and substock area. This is done for Q1 based on the assumption that any mixing during Q1 is small/negligible, and for age 0 in Q3+Q4 based on the assumption that age 0 cod will not have moved far since spawning. Mixing is expected for age 1+ fish outside Q1, and the Q3+Q4 indices therefore summed across the whole area to represent a mix of the three substocks. Because the first age in the multistock SAM assessment is age 1, estimates of age 0 cod from Q3+Q4 are retained as separate recruitment indices (one for each substock) and forward shifted to 1st January to represent age 1 cod the following year. The Delta–GAM indices and associated standard deviations used in the assessment are given in Tables 4.6a-c and plotted in Figures 4.3e-i. These show increased uncertainty about the youngest and oldest ages, which is carried through to the multistock SAM assessment. The latest values from the Q3+Q4 recruitment (2023 forward shifted to 2024) and Q1 (2024) indices indicate a weak incoming 2023 year-class.

4.3 Data analyses

4.3.1 Assessment audit

The assessment audit for Northern Shelf cod was completed, and no significant issues found for the assessment itself. Additional checks on the forecast will be carried out during the ICES WGMIXFISH-ADVICE meeting in 2024.

4.3.2 Exploratory survey-based analyses

Survey abundance indices are plotted in log-mean standardized form by year and cohort for each substock in the Q1 surveys in Figures 4.4a-c, together with log-abundance curves and associated negative gradients for the age range 2–4. Similar plots are shown for the Q3+Q4 surveys for all substocks combined in Figure 4.4d. The log-mean standardized curves track cohort signals well, although there is some loss of signal between the 2012 and 2013 cohorts associated with an

[1] http://rforge.net/DATRAS/

apparent positive year effect towards the end of 2016 (Q3+Q4) into the beginning of 2017 (Q1). This is most apparent for the Northwestern substock, with all ages except age 2 at a relatively high level in that year and is likely compounded by a single very large haul in the SCOWCGFS-Q1 survey. This positive year effect is apparent to a lesser extent for the other substocks, with all three displaying a larger recruitment in 2017. The log abundance curves showed a sharp decrease, with a substantial decrease in the negative gradient for ages 2–4, following the 2017 year-class, likely due to the reductions in catches from 2019 onwards. The negative gradients have, however, recently increased for all substocks.

Figures 4.5a-d show within-survey consistency (in cohort strength) for the Q1 substock indices and Q3+Q4 mixed index, respectively. These show generally good consistency, particularly for the Northwestern and Southern substocks where all correlations between adjacent ages are ≥0.7, justifying their use for survey tuning. There is some deterioration with age for all indices, but particularly for ages 5+ in both the Viking substock in Q1 and for the mixed-stock in Q3+Q4. Figure 4.5e shows between survey correlations for the recruitment indices (age 0 in Q3+Q4 forward shifted to represent age 1 on 1st January) and age 1 from the Q1 indices, indicating strong external consistency for all substocks.

4.3.3 Exploratory catch-at-age-based analyses

4.3.3.1 Catch-at-age matrix

The total catch-at-age matrix for the mixed-stock (Table 4.2c) is expressed as numbers-at-age, and proportions-at-age, standardized over time in Figure 4.6. It clearly shows the contribution of the 2005, 2009, 2013 and 2016 year-classes to catches and indicates a relative increase in the number of older fish in the catches in recent years.

4.3.3.2 Catch curve cohort trends

The top panel of Figure 4.7 presents the log catch curve plot for the catch-at-age data for the mixed-stock (all substocks) while the bottom panel plots the negative slope of a regression fitted to the ages 2–4, the age range used as the reference for mortality trends. These gradients show a sharp increase for the 2015–2016 cohorts and, similar to equivalent plots for the survey indices, a sharp decrease for the 2017-year class, likely due to the reductions in catches from 2019 onwards. The point representing the 2019 year- class (the last year-class to reach age 4 in the catches) is the lowest in the time series.

Figure 4.8 shows cohort correlations in the catch-at-age matrix for the mixed-stock, plotted as log-numbers. These correlations show good consistency within cohorts up to the plus-group, verifying the ability of the catch-at-age data to track relative cohort strengths over the full time-series.

4.3.4 Final assessment

The final assessment used multistock SAM (multistock State Space Assessment Model; Albertsen *et al.*, 2018) run with R *stockassessment* (version 0.12.2) and *multiStockassessment* (version 0.3.3) packages in R version 4.3.2. The data used in the assessment are given in Tables 4.2 and 4.4–4.6 and include mixed substock catch-at-age data, substock-wise Q1 indices, a mixed substock Q3+Q4 index, substock-wise Q3+Q4 forward-shifted recruitment indices, substock composition proportions from Q1 landings, proportions of landed weight per quarter, and substock-wise estimates of stock weights, maturity, and natural mortality (where the same natural mortalities are used for all three substocks). The stock-wise configuration (adopted for all three substocks) and stock complex configuration arguments are given in Tables 4.7a–b, respectively. All single-stock observations are set to NA and a fleet-to-stock key used to specify the vulnerability of each

substock to a catch, survey, or auxiliary fleet in the shared observations. The fleet-to-stock key is given in Table 4.7c.

Random walk processes are used to model recruitment and fishing mortality-at-age, where the random walks for fishing mortality are correlated among ages according to an AR(1) process and are connected between substocks via scaled selectivities with flexible F_{bar}. Where fleets cover a mixture of substocks, observations are predicted as the sum of substock-wise predictions according to the weights specified in the fleet-to-stock key (Table 4.7c). Modelled catches and Q1 and Q3+Q4 survey observations are correlated across ages according to an AR(1) structure (Berg and Nielsen, 2016). Substock composition proportions and seasonal landings proportions are modelled using additive logistic normal distributions and seasonal effects are estimated by substock and quarter. Stock weights, maturity and natural mortality are modelled as Gaussian Markov Random Field (GMRF) processes with cohort- and within year correlations. The GMRF for stock weights also includes an additional correlation across years in the plus group. Model fitting diagnostics are given in Table 4.7d.

Figures 4.9a–e show summary plots of the final assessment in terms of substock population trends. Estimates of fishing mortality-at-age, substock numbers-at-age, catches-at-age, stock weights-at-age, maturity-at-age and natural mortality-at-age for each substock are given in Tables 4.8–13 respectively, while summary tables for estimates of recruitment (age 1), TSB, SSB, catches and F_{bar} (2–4) by substock are given in Tables 4.14 (along with 95% confidence bounds). Mean fishing mortality split into ages by substock is shown in Figure 4.10a and selectivity in F is shown in Figure 4.10b, while log numbers-at-age and log catches-at-age are shown for each substock in Figures 4.11–4.12. Fits of the GMRF process for stock weights-, maturity- and natural mortality- at age by substock (along with 95% confidence bounds) are shown in Figures 4.13–4.15. Although the GMRFs for natural mortality are fit to the same input data for each substock, separate random effects are estimated, resulting in slight differences in M between substocks.

One-step-ahead quantile residuals are shown in Figure 4.16 and, for most fleets, show no discernible patterns. However, for the substock composition data from the Q1 landings, there is a tendency to over-predict one of the substocks at the beginning of the time-series and under-predict towards the end. Retrospective plots for SSB, average fishing mortality, recruitment-at-age 1 and TSB are shown in Figures 4.17a–d, respectively. Mohn's rho statistics based on five-year peels are calculated as follows:

	Northwest	South	Viking	Total
SSB	0.018	0.099	0.021	0.026
F_{bar}(2–4)	0.0006	0.040	0.001	0.018
R (age 1)	0.006	0.167	−0.188	-0.023

A comparison with last year's assessment (ICES WGNSSK, 2023) is provided for each substock in Figures 4.18a–c. Differences between the assessments are due to the addition of one year of catch, survey, and landings proportions data, use of an updated natural mortality time series, and slight revisions to the delta-GAM indices and GMRF processes. These changes result in a slight downscaling of SSB in recent years for the Southern and Viking substocks, a slight downscaling of fishing mortality in recent years for all substocks, and a slight upscaling of recruitment for the Northwestern and Viking substocks. Furthermore, there is a pronounced decrease in the Mohn's rho statistic for SSB for the Southern substock (from 0.21 to 0.09) due to the problematic 2017 and 2018 peels now falling outside the 5-year calculation window.

4.4 Historic stock trends

The historic substock and fishery trends are presented in Figures 4.9–12 and Tables 4.14.

For the Southern substock, a steady decline was estimated in SSB from around 18 500 tonnes in 1983 to 2 700 tonnes in 2020, followed by a small increase from 2021 to 2024. The Northwestern substock was estimated to be the largest component of the stock complex. From 1983 to 1997, SSB was estimated to fluctuate around 50 000 tonnes, followed by a large decline to 15 200 in 2005. Since then, there has been a generally increasing trend in SSB, except for the years 2017-2020. Throughout the period, the SSB of the Viking substock has been fluctuating around 13 000. Consequently, trends in the total stock complex SSB followed the trends in the Northwestern substock.

Trends in fishing mortality were similar across substocks. For all three substocks, F was steady or slightly increasing from 1983 to 1999, followed by a decline until 2014. From 2014 to 2018, F increased for all substocks, and decreased again in the final period. Throughout the period, F was estimated to be highest for the Southern substock, followed by the Northwestern substock and lowest for the Viking substock.

For all substocks, recruitment has fluctuated at a relatively low level from 1998, with the 1996 year-class being the last large year-class to contribute to the fishery. The 2024 recruitment (total of all sub-stocks) is estimated to be the lowest in the time series, indicating that the incoming 2023 cohort is very weak.

4.5 Recruitment estimates

Recruitments in the intermediate year (2024) were sampled from normal distributions about the assessment estimates and are reported as the median of those samples. Estimates of recruitment for subsequent years were simulated from a lognormal distribution with the same median and log-variance as the recruitment estimates from the 1997–2023 year-classes, reflecting recent low levels of recruitment.

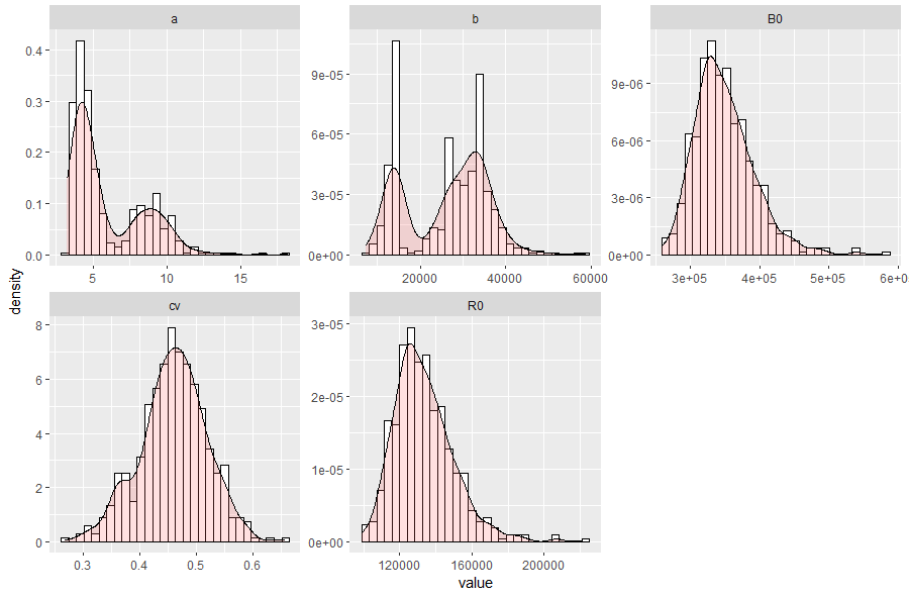
4.6 Biological reference points

Reference point estimation is performed with the EqSim software (ICES WGMG, 2013), in accordance with the ICES guidelines. Reference points were re-estimated for substocks of Northern Shelf cod at the 2024 meeting of WGNSSK following the adoption of updated natural mortalities. This was on the same basis as ICES WKBCOD (2023) but with two exceptions for the Northwestern substock: (1) to exclude the most recent stock recruitment pair (corresponding to the 2024 recruitment) and (2) to replace the estimated standard deviation of ln(SSB) with σ=0.2 in the calculation of B_{pa}.

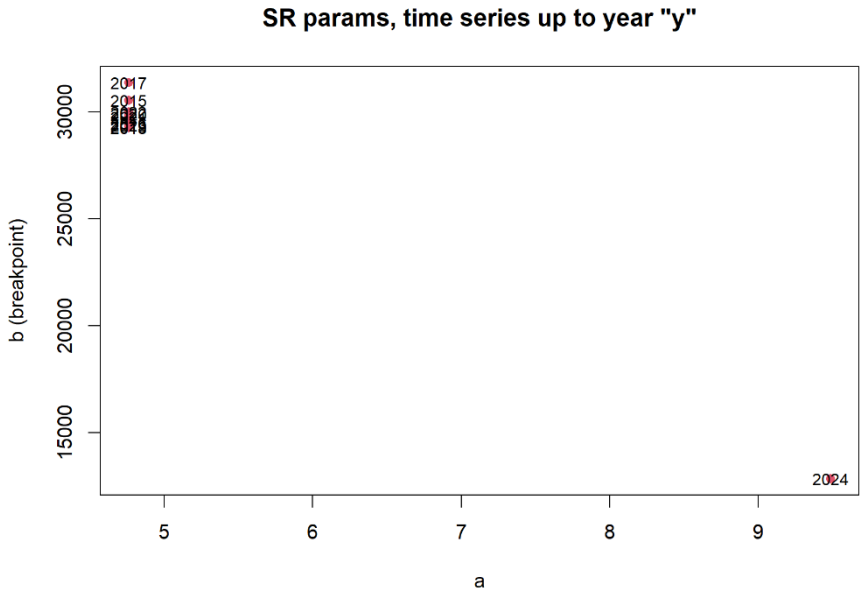
Reference points were estimated based on truncated recruitment time-series, given recruitment rates are significantly lower for all three substocks after 1997. Both the Northwestern and Southern substocks are characterised as Type 2 stocks and the B_{lim} of each taken as the estimated breakpoint of its segmented regression stock-recruitment relationship (B_{lim} = 29 378 t and B_{lim} = 14 002 t for the Northwestern and Southern substocks, respectively). For the Viking substock, B_{lim} was set as the mean SSB in the lower 50th percentile producing above average recruitment (B_{lim} = 9619 t), and the stock-recruitment relationship modelled as a segmented regression with the breakpoint fixed at this B_{lim}.

While the updates to natural mortality resulted in only slight revisions to the SSB time series, the addition of recent data shifted the breakpoint estimated for the Northwestern substock to a value

below any observed SSB. A bootstrap fit of the segmented regression model for the Northwestern substock shows the breakpoint to exhibit a bimodal distribution while a sensitivity analysis on the final year shows the switch between modes to occur upon the addition of the most recent stock recruit pair (corresponding to the 2024 recruitment). Given this point is both highly influential and more uncertain than past recruitments, it was decided to exclude the most recent recruitment from the stock-recruitment relationship and calculation of B_{lim} for the Northwestern substock.



Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Density distributions of the segmented regression parameters fitted to bootstrapped stock recruitment residuals for the Northwestern substock.

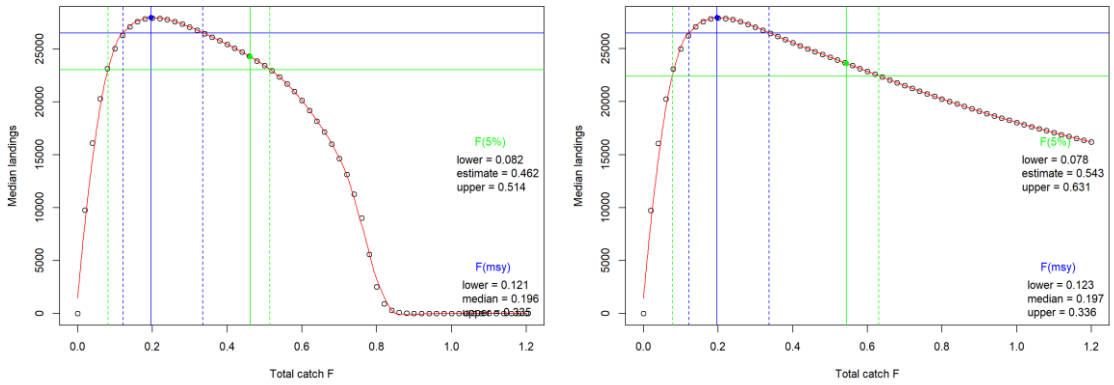


Cod in Subarea 4, divisions 6.a and 7.d and Subdivision 20. Segmented regression stock recruitment model parameters for the Northwestern substock using data from 1997 (corresponding to the 1998 recruitment) up to the year shown in the plot.

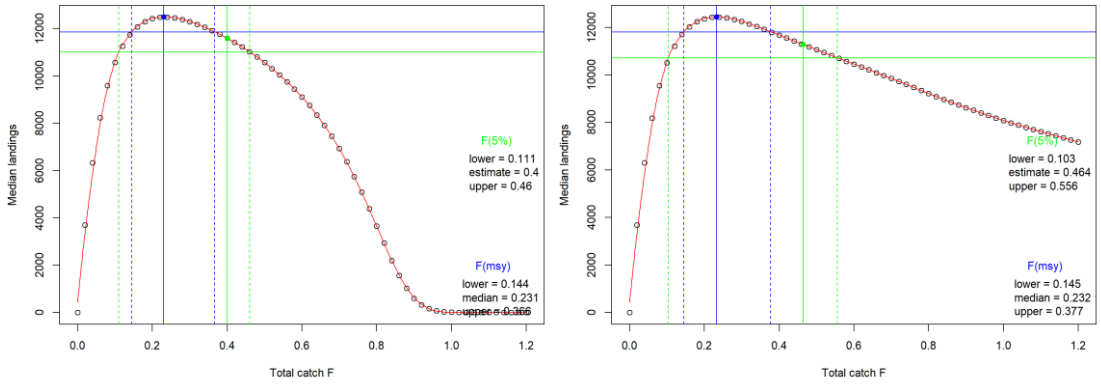
B_{pa} was calculated as $B_{pa} = B_{lim} \times \exp(1.645 \times \sigma)$. For the Southern and Viking substocks, σ was taken as the standard deviation of ln(SSB) in the terminal year of the assessment (σ=0.21 and σ=0.22 for the Southern and Viking substocks, respectively). Because the standard deviation of ln(SSB) for the Northwestern substock in the terminal year of the assessment is < 0.2 (σ=0.144), it was decided to calculate $B_{pa}=1.4B_{lim}$, which is equivalent to σ=0.2. This follows the work of ICES WKREBUILD2 (2023), that showed $B_{trigger}$ to be ineffective when too close to B_{lim}, and ICES WKNEWREF (in progress). This gives B_{pa} equal to 40 823 t, 19 851 t and 13 732 t for the Northwestern, Southern and Viking substocks, respectively.

The recent 10 years (2014–2023) were used for biological parameters for the Northwestern and Viking substocks, the recent 5 (2019–2023) for biological parameters for the Southern substock, and the recent three (2021–2023) for selectivity for all substocks. Discards for ages 3+ were added to the landings, as it can be assumed that they are above the minimum conservation reference size and therefore subject to the landing obligation. Where applicable, default values were used for the assessment error and autocorrelation of assessment error in the advisory year (cvF = 0.212 and phiF = 0.423). The estimations included autocorrelation in the recruitment residuals.

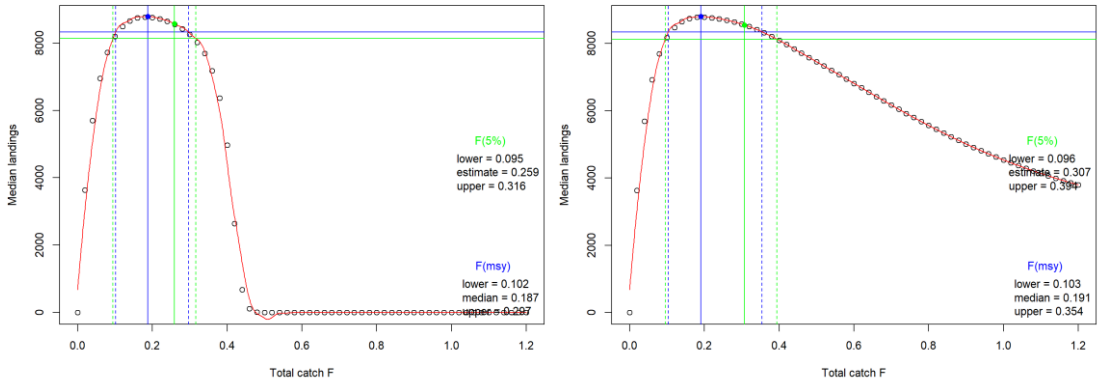
The median F_{MSY} values estimated by EqSim applying a fixed F harvest strategy were 0.196, 0.231 and 0.187 for the Northwestern, Southern and Viking substocks, respectively. The upper bounds of the F_{MSY} ranges giving at least 95% of the maximum yield were estimated at 0.335, 0.366 and 0.297 and the lower bounds at 0.121, 0.144 and 0.102. The median of the SSB estimates at F_{MSY} were 108 684 t, 55 425 t and 23 206 t, levels which have not been observed during the assessment period (1983–2024) for the Northwestern and Southern substocks. When applying the MSY harvest control rule with MSY $B_{trigger}$ values equal to B_{pa} (because the substocks have not been fished below F_{MSY}), the F_{pa} values are 0.543, 0.464 and 0.307, hence neither F_{MSY} nor $F_{MSY\ upper}$ were capped. EqSim runs applying a fixed F harvest strategy without assessment or advice error (cvF = phiF = 0) gave F_{lim} values of 0.666, 0.695 and 0.379.



Cod in Subarea 4, divisions 6.a and 7.d and Subdivision 20. Estimation of F_{MSY} and F_{pa} for the Northwestern substock.



Cod in Subarea 4, divisions 6.a and 7.d and Subdivision 20. Estimation of F_{MSY} and F_{pa} for the Southern substock.



Cod in Subarea 4, divisions 6.a and 7.d and Subdivision 20. Estimation of F_{MSY} and F_{pa} for the Viking substock.

Biological reference points and their technical basis are as follows:

Northwestern substock

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	40 823	B_{pa}; in tonnes	ICES WGNSSK (2024)
	F_{MSY}	0.196	EqSim analysis based on the recruitment period 1998–2023	ICES WGNSSK (2024)
	$F_{MSY\ lower}$	0.121	EqSim analysis based on the recruitment period 1998–2023	ICES WGNSSK (2024)
	$F_{MSY\ upper}$	0.335	EqSim analysis based on the recruitment period 1998–2023	ICES WGNSSK (2024)
Precautionary approach	B_{lim}	29 378	Estimated change point of a segmented regression fit to substock stock recruit pairs, excluding the 2024 recruitment; in tonnes	ICES WGNSSK (2024)
	B_{pa}	40 823	$B_{pa} = 1.4 \times B_{lim}$; in tonnes	ICES WGNSSK (2024)
	F_{lim}	0.666	F giving 50% probability of SSB < B_{lim}	ICES WGNSSK (2024)
	F_{pa}	0.543	F that provides a 95% probability for SSB to be above B_{lim} (with advice rule [AR])	ICES WGNSSK (2024)

Viking substock

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	13 732	B_{pa}; in tonnes	ICES WGNSSK (2024)
	F_{MSY}	0.187	EqSim analysis based on the recruitment period 1998–2024	ICES WGNSSK (2024)
	$F_{MSY\ lower}$	0.102	EqSim analysis based on the recruitment period 1998–2024	ICES WGNSSK (2024)
	$F_{MSY\ upper}$	0.297	EqSim analysis based on the recruitment period 1998–2024	ICES WGNSSK (2024)
Precautionary approach	B_{lim}	9619	Average SSB in the lower 50th percentile producing above average recruitment; in tonnes	ICES WGNSSK (2024)
	B_{pa}	13 732	$B_{pa} = B_{lim} \times e^{(1.645 \times \sigma)}$ where σ = multiSAM estimate of the standard deviation of ln(SSB) in the terminal year; in tonnes.	ICES WGNSSK (2024)
	F_{lim}	0.379	F giving 50% probability of SSB < B_{lim}	ICES WGNSSK (2024)
	F_{pa}	0.307	F that provides a 95% probability for SSB to be above B_{lim} (with advice rule [AR])	ICES WGNSSK (2024)

Southern substock

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	19 851	B_{pa}; in tonnes	ICES WGNSSK (2024)
	F_{MSY}	0.231	EqSim analysis based on the recruitment period 1998–2024	ICES WGNSSK (2024)
	$F_{MSY\ lower}$	0.144	EqSim analysis based on the recruitment period 1998–2024	ICES WGNSSK (2024)
	$F_{MSY\ upper}$	0.366	EqSim analysis based on the recruitment period 1998–2024	ICES WGNSSK (2024)
Precautionary approach	B_{lim}	14 002	Estimated change point of a segmented regression fit to substock stock recruit pairs; in tonnes	ICES WGNSSK (2024)
	B_{pa}	19 851	$B_{pa} = B_{lim} \times e^{(1.645 \times \sigma)}$ where σ = multiSAM estimate of the standard deviation of ln(SSB) in the terminal year; in tonnes	ICES WGNSSK (2024)
	F_{lim}	0.695	F giving 50% probability of SSB < B_{lim}	ICES WGNSSK (2024)
	F_{pa}	0.464	F that provides a 95% probability for SSB to be above B_{lim} (with advice rule [AR])	ICES WGNSSK (2024)

4.7 Short-term forecasts

Forecasting takes the form of short-term stochastic projections using the "modelforecast" function from the *multiStockassessment* R package (version 0.3.3). A total of 1000 samples are generated from the asymptotic normal approximation of survivors. These replicates are then simulated forward according to the model formulation and forecast assumptions (see table below) with the constraints on F set by the catch scenarios. The simulations are done in isolation. In each simulation, the median of the fishing mortality rate process, F, is set based on a deterministic forecast with non-linearity correction of past F and abundance, N, to hit the catch scenario target. In turn, realized F and abundance is simulated based on the model and forecast settings. Consequently, constraints set using predicted values, such as catch, will not be matched exactly by the realized catch due to process variability.

The intermediate year assumption was taken as $F_{status\ quo}$. This results in predicted catches for 2024 34% above the combined TAC in 2024 for the North Sea + West of Scotland + eastern English Channel + Skagerrak and is close to the 37% difference between model estimated catches and the TAC in 2023.

Forecast assumptions are as follows (note that the values that appear in Tables 4.15 are medians from the distributions that result from the stochastic forecast):

Model component/option	Setting
Method	Simulation based with 1000 replicates
Base year	Last year with catch data

Model component/option	Setting
Resample first year	Yes, N and F in the intermediate year are resampled from asymptotic normal distribution of the corresponding estimates
Maturity	Forecasted according to GMRF process
Natural mortality	Forecasted according to GMRF process
Stock weights	Forecasted according to GMRF process
Catch/landing/discard weights	Average of final three years (before intermediate year)
Landing fraction	Average of final three years (before intermediate year)
F and M before spawning	Average of final three years (before intermediate year)
Recruitment	Simulated from a lognormal with the same median and log-variance as recruitment from 1998 onward
Selectivity	Forecasted according to the SAM F process
F covariance	Stationary using asymptotic normal of estimates
Non-linearity correction	Yes
Intermediate year assumption	Determined by working group based on the best knowledge of the fishery at the time

Several catch scenarios were considered:

- Precautionary considerations to protect the Southern substock: $F_{bar,\ south}$ (2025) = $F_{MSY} \times SSB_{2025}/B_{trigger}$; $F_{bar,\ Northwest/Viking}$ (2025) = F(2024) × 0.39 (as $F_{bar,\ south}$ (2025) / $F_{bar,\ south}$ (2024) = 0.39)
- MSY approach: F_{bar} (2025) = $F_{MSY} \times \min\{1; SSB_{2025}/B_{trigger}\}$
- $F_{MSY\ lower}$ (with reduction): F_{bar} (2025) = $F_{MSY\ lower} \times \min\{1; SSB_{2025}/B_{trigger}\}$
- $F_{MSY\ upper}$: F_{bar} (2025) = $F_{MSY\ upper}$ (presented only for substocks with $SSB_{2025} > B_{trigger}$)
- Zero catch: F_{bar} (2025) = 0
- F_{pa}: F_{bar} (2025) = F_{pa}
- SSB (2026) = B_{lim}: F corresponding to SSB (2026) = B_{lim}
- SSB (2026) = $B_{trigger} = B_{pa}$: F corresponding to SSB (2026) = $B_{trigger} = B_{pa}$
- SSB (2026) = SSB (2025): F corresponding to SSB (2026) = SSB (2025)
- Status quo – constant F: F_{bar} (2025) = F_{bar} (2024)
- F_{MSY}: F_{bar} (2025) = F_{MSY} (where different from the MSY approach, i.e., for substocks where $SSB_{2025} < B_{trigger}$)
- $F_{MSY\ lower}$: F_{bar} (2025) = $F_{MSY\ lower}$ (where different from $F_{MSY\ lower}$ (with reduction), i.e., for substocks where $SSB_{2025} < B_{trigger}$)

For the MSY approach, $F_{MSY\ lower}$ and $F_{MSY\ upper}$ scenarios, the ICES advice rule was applied manually to median SSBs rather than following the full replicate approach inherent to the "modelforecast" function, which does not incorporate rebuilding and precautionary considerations when substocks are below B_{lim}. Forecast results are given for each substock in Tables 4.15, and plots of forecasted SSB, F, recruitment and catch are given in Figures 4.19a–d.

Change in advice

The catch derived from the sum of catch advice by substock in the precautionary considerations scenario for the Northwestern and Viking substocks, consistent with the MSY approach for the Southern substock, is equal to 19 321 tonnes, which is 14.9% lower than the combined advice given in 2023 (22 691 tonnes) and 38% lower than the combined TAC in 2024 for the North Sea + West of Scotland + eastern English Channel + Skagerrak (31 301 tonnes). This change in advice is due to:

1. Lower SSBs in 2024 than assumed in 2023. In the case of the Southern and Viking substocks, this follows the downward revision of the 2023 SSBs in the assessment and subsequent development of SSB while for the Northwestern substock this follows a decrease in the SSB from 2023 to 2024.
2. Lower incoming recruitments than assumed in 2023. For all substocks, the incoming recruitments for 2024 were estimated much lower than those simulated from lognormal distributions according to the forecast assumptions.
3. Lower F in the advice year. For the Southern substock, advice is based on the MSY approach. In this case, the re-estimation of reference points and slight downward revision of SSB leads to a lower SSB being compared to a higher MSY $B_{trigger}$, which then leads to a larger reduction being applied to a smaller F_{MSY} when following the MSY harvest control rule. For the Northwestern and Viking substocks, the common fishing mortality reduction of 61% is similar to the value from last year but applied to lower intermediate year fishing mortalities.

A comparison of numbers-at-age and biomasses-at-age from the current and previous assessment and forecast are shown in Tables 4.16a–b while comparisons of numbers, stock weights, biomasses and selectivity are presented in Figures 4.20–4.22a-d. A comparison of the assumed SSB, Fbar, total catch and recruitment is shown in Table 4.17 and Figures 4.20–4.22e.

4.8 Medium-term forecasts

Medium-term projections are not carried out for this stock.

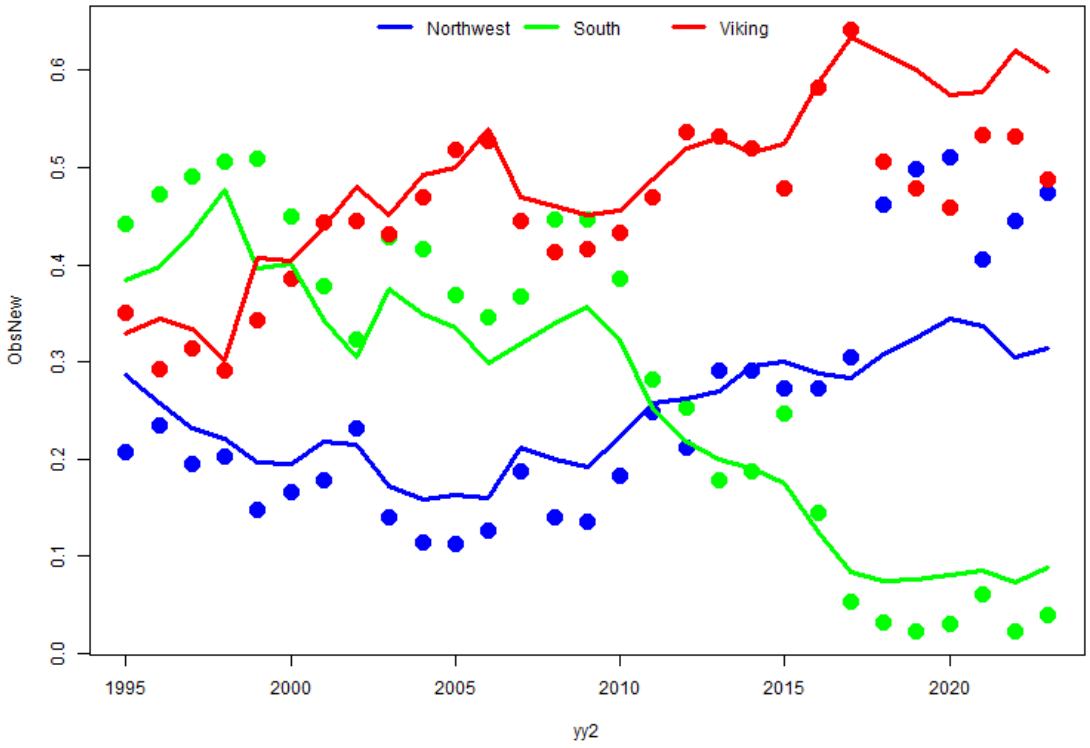
4.9 Quality of the assessment

The quality of the commercial landings and catch-at-age data for this stock deteriorated in the 1990s following reductions in the TAC without associated control of fishing effort. The WG considers the international landings figures for both the North Sea and West of Scotland components to have inaccuracies from the mid-1990s to the mid-2000s but no longer accounts for this within the assessment model (ICES WKNSEA, 2021).

Several historic records (from 1983–2003) in the DATRAS CA (age) data are missing haul IDs, which can preclude linking these records with the corresponding HH (hydro) records for subsequent analysis and assessment input preparation. Random haul allocations are made based on year, quarter, country, ship, and ICES rectangle or roundfish area to avoid losing age samples. A sensitivity analysis shows this to have some impact on the calculation of stock weights and maturity, mostly in the early period, but minimal influence on the indices and assessment (see Annex 8 in ICES WGNSSK, 2023). There are also concerns about the quality of maturity records prior to 1991, although this has no impact on the advice.

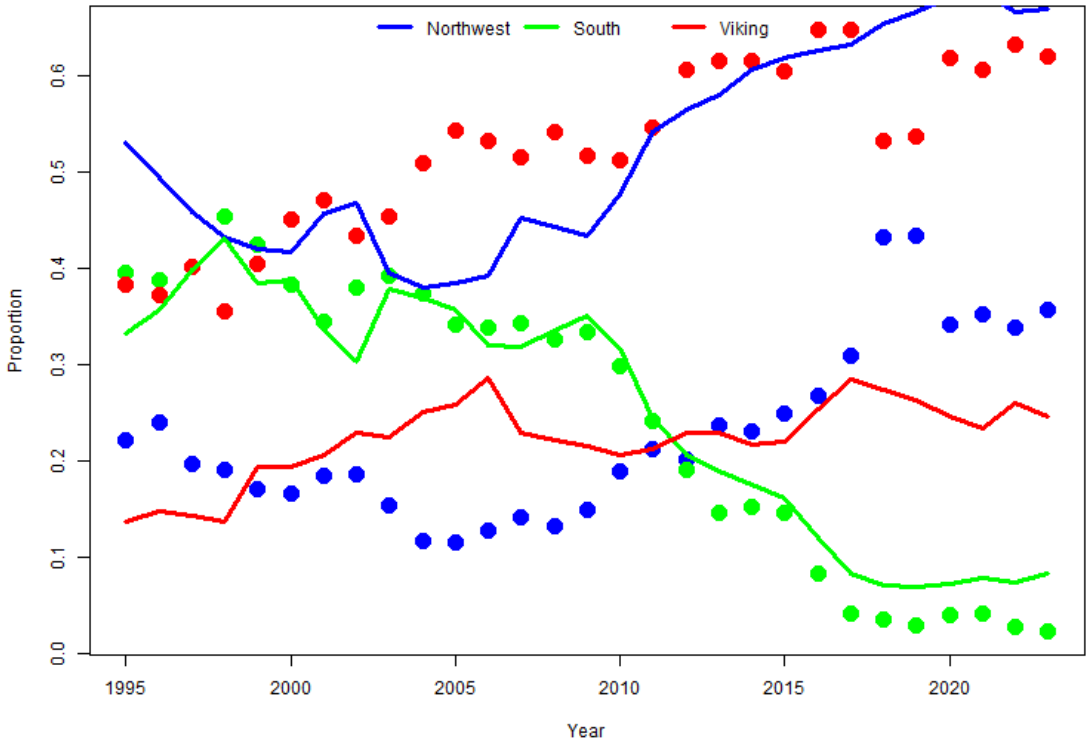
There is a lack of fit of the multistock SAM model to the substock composition data from the quarter 1 landings, which may be a consequence of assuming total stock landings fractions that

are not applicable to substocks. A sensitivity run that excluded the Q1 landings proportions for substocks was performed by ICES WKBCOD (2023) and gave similar assessment results, so the benchmark concluded that this aspect of lack-of-fit was not a serious concern. Furthermore, industry representatives have warned of potential mismatches between landings and abundance due to quota and management regulations.



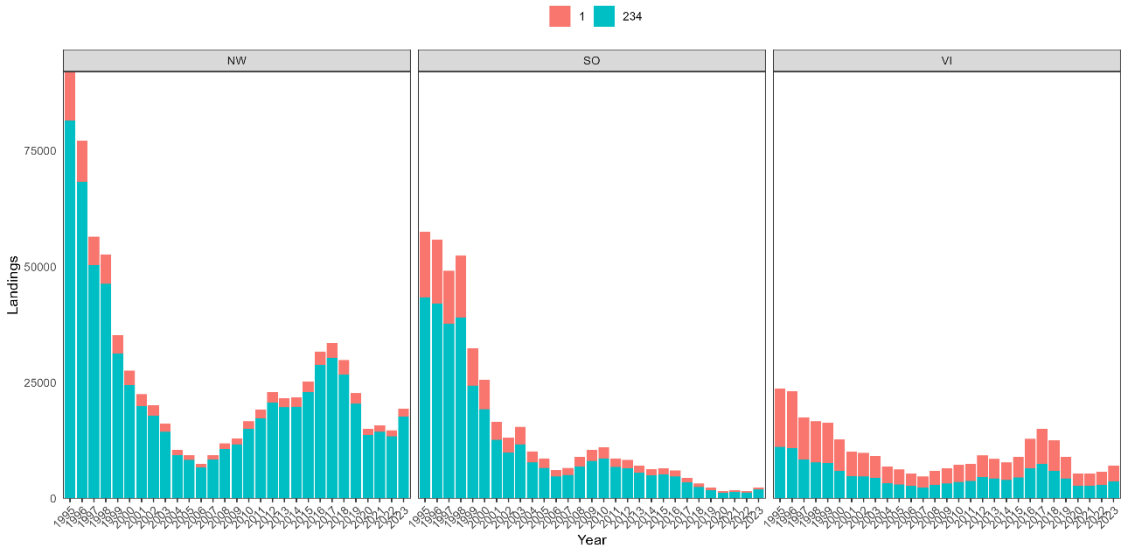
Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of modelled and observed substock landings proportions in quarter 1.

The multistock SAM assessment models the population dynamics of substocks, which are assumed to be reproductively isolated with no transfer of individuals between substocks. Aside from the assumption of geographic isolation during spawning in quarter 1, the model does not say anything about the distribution of substocks. Estimated annual landings by substock (lines) do not match the annual landings taken in the corresponding substock area (points), suggesting strong mixing during the other quarters and that catches taken in a substock area may include fish belonging to other substocks of origin. No genetic or tagging information is currently available that can be used to validate the model estimates of substock composition or substock origin of catches. Furthermore, it is difficult to make judgments on the quality of the assessment by substock with diagnostics that are available only for the combined stock (e.g. fits to the catch-at-age matrix and combined Q3+Q4 survey index). The IBTS Q1 survey reveals that cod aggregate near the border between the substock areas, adding uncertainty to the multistock assessment.

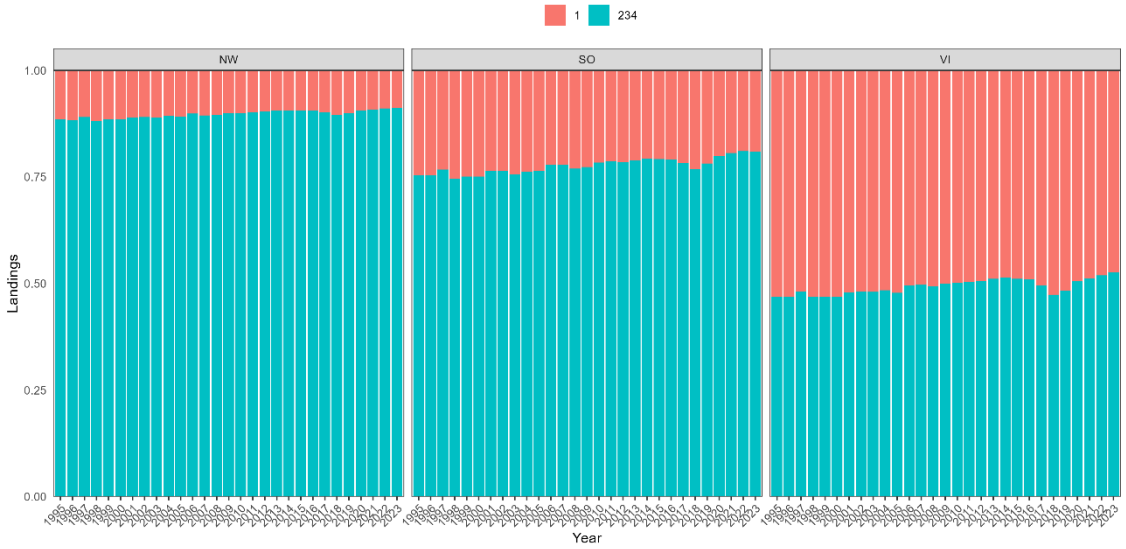


Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of annual modelled substock landings proportions derived from the multistock SAM fit to observed landings proportions by substock area. Note that annual landings proportions are not input to multistock SAM or used during model fitting.

The multistock SAM assessment estimates seasonal effects, allowing variation in fishing mortality rates by substock and quarter. Plots of absolute estimated landings and estimated landings proportions for quarter 1 against quarters 2–4 show a large proportion of the Viking substock to be landed in quarter 1 (~50%) while most of the Northwestern and Southern sub-stocks are landed in quarters 2–4 (~75–90%). No explanation for this pattern was found by the working group and no genetic information is currently available that can be used to validate these model estimates. Furthermore, while estimates of the substocks' spawning biomass are consistent with the trends apparent from the survey indices; estimates of recruitment and fishing mortality show strong correlations between substocks. This may follow from the limited data available to resolve the dynamics of the different substocks; however, the strong synchrony in recruitment may reflect similar spawning and nursery environments impacting all substocks, despite reproductive isolation (ICES WKNSCodID, 2020).



Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multi-stock SAM estimates of absolute landings in quarter 1 and quarters 2–4.



Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multi-stock SAM estimates of landings proportions in quarter 1 and quarters 2–4.

The multistock SAM assessment systematically overestimates total catches from 2011. This could be due to differences in substock catch weights that are not accounted for in the mixed substock assessment inputs and needs further exploration. Note any differences in observed catch between this table and others, e.g., Table 4.3, are due to decimal differences in catch numbers following log transformations.

Year	Observed catch	Estimated catch	% difference
2011	44836	49560	-9.5
2012	42918	51725	-17.0
2013	42811	50348	-15.0
2014	48956	48457	1.0

Year	Observed catch	Estimated catch	% difference
2015	52966	55637	-4.8
2016	52459	66267	-20.8
2017	50556	67890	-25.5
2018	51323	56027	-8.4
2019	37670	37905	-0.6
2020	25093	25719	-2.4
2021	20111	29849	-32.6
2022	22944	31286	-26.7
2023	32228	37423	-13.9

The multistock SAM assessment provides better model performance, in general, compared to a single-stock modelling approach and better reflects the underlying biology of Northern Shelf cod, for which there is clear evidence of substock structure (ICES WKNSCodID, 2020; ICES WK6aCodID, 2022).

4.10 Status of the stock

All substocks have shown an increase in SSB since 2020/2021. The SSB of the Northwestern and Viking substocks is above MSY $B_{trigger}$ but the SSB of the Southern substock is below B_{lim}.

Fishing mortality has declined from a peak in 2018 and is below the precautionary reference points, F_{lim} and F_{pa}, for all substocks. However, fishing mortality is still above F_{MSY}, the level that achieves the long-term objective of maximum yield, for all substocks.

Recruitment of 1-year old cod has varied considerably since the 1980s, but since 1998, average recruitment has been lower than any other time. The last larger recruitment observed during this period was the 2016-year class, most predominant in the Northwestern substock, while the 2024 recruitment (total of all sub-stocks) is estimated to be the lowest in the time series.

4.11 Management considerations

Cod has been fully under the EU landing obligation since 2018 in Subarea 4 and Subdivision 20, and since 2019 in divisions 6a and 7d although there are some *de minimis* exemptions in Subarea 4 and Subdivision 20 (see Section 4.1.4). BMS landings of cod reported to ICES are currently negligible. Discarding continues based on observations from sampling programmes, with the discard rate estimated at 23% of the total catch by weight in 2023.

It is uncertain whether if and to what extent the discontinuation of the days-at-sea regulation in 2017, which was part of the cod recovery plan, had an impact on the decline of the cod substocks in the late 2010s. Although F has reduced since 2018, recent catches have not been in line with ICES advice. The SSB of the Southern substock remains below B_{lim}, with an increased risk of impaired recruitment.

The Northern Shelf cod consists of reproductively isolated populations of Viking cod and Dogger cod, with the Dogger cod displaying phenotypic spatial structure either side of a 50 m

bathocline in the central North Sea (ICES WKNSCodID, 2020). Based on this, the multistock assessment adopts a three substock hypothesis, with substocks defined as Northwestern, Viking and Southern, with different rates of sexual maturity, reproduction, and growth. The multistock assessment only models the population dynamics of the substocks and does not say anything about the distribution of those substocks during Q2-4. Therefore, advice based on substocks should not be taken as advice based on substock areas.

Cod are taken by towed gears in mixed demersal fisheries, which include haddock, whiting, *Nephrops*, plaice, and sole. They are also taken in directed fisheries using fixed gears. It is important to consider both the species-specific assessments of these species for effective management, but also the broader mixed-fisheries context. This is not straightforward when stocks are managed via a series of single-species TACs that do not incorporate such mixed-stocks considerations. However, a reduction in effort on one stock may lead to a reduction or an increase in effort on another, and the implications of any change need to be considered carefully. The ICES WGMIXFISH Group monitors the consistency of the various single-species management plans under current effort schemes, to estimate the potential risks of quota over- and under-shooting for the different stocks.

Area-specific catch advice cannot be provided without additional data, including genetic samples routinely collected from both commercial fisheries and scientific surveys. Given that the degree of mixing between substocks cannot be quantified, the advice is based on an approach to protect the weakest substock. This involves applying a common fishing mortality reduction compared to the intermediate year across all the substocks in line with the mortality reduction for the Southern substock in the MSY approach scenario (−61%). Based on current fishing patterns, assumed stock-mixing, and single-stock assumptions, the substock catch advice would be reached simultaneously for the three substocks. However, deviations from the assumptions could result in different levels of reduction in fishing mortality for each substock. Therefore, management measures should be implemented to facilitate recovery of the vulnerable Southern substock.

4.12 Issues for future benchmarks

The stock was last benchmarked in 2023 and the primary changes consisted of updating the stock definition to combine the previous North Sea and West of Scotland cod stocks and use of a new assessment model (multistock SAM) to explicitly account for substock dynamics. Below is a list of issues that were either left unresolved from the last benchmark or have arisen during subsequent WGNSSK meetings. A scoring system has been developed to aid working groups in prioritizing stocks to be put forward for benchmark (see Annex 5 for further details). The current scoring for this stock is:

1. Assessment quality	2. Opportunity to improve	3. Benchmark preparedness	4. Perceived risks	5. Changing ecosystem and ability to include impact	6. Time since last benchmark	Total Score
3	3	2	5	0	0	3.4

4.12.1 Data

4.12.1.1 Stock identity

No genetic or tagging information is currently available that can be used to validate the model estimates of substock composition or substock origin of catches. ICES WKBCOD (2023)

recommended that genetic information be sampled on a regional basis. If it were to become available, genotype data can be included directly in the multistock SAM model.

4.12.1.2 Commercial catches

ICES WKBCOD (2023) recommended that national catch sampling programs take the new cod substock structure into account when planning future commercial catch sampling. Along with genetic samples and improved knowledge of mixing, this could allow catch numbers and weights at age to be provided by substock.

4.12.1.3 Maturity

There are concerns about the reliability of DATRAS maturity records prior to 1990. This does not impact the advice but should, nonetheless, be investigated.

ICES WKNSEA (2015) raised concerns that accounting for the increase in maturity may give the impression that the spawning stock is in better condition than it is given the possibility of lower fecundity of younger age groups and the potential for a maternal age effect on survival, and recommended exploration of the significance of spawner age on reproductive potential.

4.12.1.4 Natural mortality

Further work should be conducted to split natural mortality to substock, either by explicitly modelling three substocks in the SMS multispecies model or by post-processing the outputs of the multispecies keyrun. Further research is required to quantify seal predation on the Northwestern substock.

4.12.1.5 Surveys

Catchability issues and year effects have become apparent in the survey indices, with reduced cohort consistency and lower than expected catch rates of older fish in the late 2010s. This was not completely resolved by combining the former the North Sea and West of Scotland cod stocks. Age reading issues may contribute and should be investigated.

4.12.1.6 Recreational catches

Recreational catches are estimated to account for 2.8-6.4% of the total removals of this stock but are not included in the assessment due to length of time-series and unknown age structure and uncertainty (Section 4.2.1). Work on standardization of recreational inputs should be given relevance for future consideration in the assessment.

4.12.2 Assessment

It should be investigated how to improve the multistock SAM model fits to the quarter 1 landings by substock. This may involve substock specific landings fractions or catch weights at age. Furthermore, in the absence of new data, it could be explored to have Q1 and Q2–4 effects instead of seasonal effects per quarter.

ICES WKBCOD (2023) recommended to investigate if the optimal multistock SAM configuration is the same for each substock and to conduct simulation self-tests of the preferred model.

4.12.3 Forecast

Short-term forecasts in a given year tend to be more optimistic than realized values in subsequent years. Although recent catches have not been in line with ICES advice, potential biases in the forecasting procedure should be investigated.

4.13 References

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4.14 Tables and figures

Table 4.1a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Nominal landings (in tonnes) as officially reported to ICES, and as used by the Working Group.

Subarea 4																			
Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022***	2023***
Belgium	1722	1309	1008	894	946	666	653	862	1075	1258	1223	1103	695	817	727	666	544	298	572
Denmark	6291	5105	3430	3831	4402	5686	4863	4803	4536	5457	6026	6713	6119	5493	4967	3069	2023	2016	2998
France	664	354	659	573	950	782	619	369	287	637	517	391	401	583	450	265	284	260	320
Germany	2648	2537	1899	1736	2374	2844	2211	2385	1921	2257	2133	2083	2300	1510	824	757	775	714	1401
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	1660	1585	1523	1896	2649	2657	1928	1955	1344	1242	1403	1365	653	515	719	590	618	594	677
Norway	2900	2749	3057	4128	4234	4495	4898	4601	4080	4600	5404	5627	5521	5539	4509	2267	1651	2255	3486
Sweden	319	309	386	439	378	362	316	471	332	401	415	373	387	274	344	355	396	390	402
UK (E/W/NI)	1270	1491	1587	1546	2384	2553	2170	1630	2129	2962	0	0	0	0	0	0	0	0	0
UK (Scotland)	4936	6857	6511	7185	9051	11 567	10 140	10 564	10 619	10 517	0	0	0	0	0	0	0	0	0
UK (combined)	0	0	0	0	0	0	0	0	0	0	14 889	16 603	18 523	21 265	15 621	9114	6418	6913	11352
Others	69	812	18	35	59	32	2	0	0	0	0	2	1	0	0	1	0	40	6
BMS landings													1	8	30	21	2	1	2
Total nominal catch	22 479	23 108	20 079	22 261	27 425	31 645	27 799	27 640	26 322	29 331	32 011	34 260	34 599	35 997	28 160	17 083	12709	13 478	21214
Unallocated landings	376	−2029	−1023	−604	208	−665	−1125	−1013	−1006	−782	−767	−1225	−1490	−1553	83	−193	-130	−227	-229
ICES estimate of total landings	22 855	21 078	19 056	21 657	27 634	30 980	26 675	26 627	25 315	28 550	31 244	33 035	33 109	34 444	28 243	16 890	12 579	13 251	20985
Agreed TAC	27 300	23 205	19 957	22 152	28 798	33 552	26 842	26 475	26 475	27 799	29 189	33 651	39 220	43 156	29 437	14 718	13 246	13 246	21652
Division 6a																			
Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022***	2023***
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0	0	0	0	0	11	1	0	0	0	0	0	0
France	107	108	92	82	74	60	49	4	3	5	11	86	118	101	142	139	161	123	82
Germany	0	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	28	18	70	58	24	49	41	18	14	12	17	28	19	12	0	68	98	114	122
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Norway	17	30	30	65	18	20	8	2	24	13	59	39	14	37	47	4	0	2	14
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK (E/W/NI)	25	14	21	6	14	4	3	2	1	9	0	0	0	0	0	0	0	0	0
UK (Scotland)	243	318	260	232	104	115	107	135	130	121	0	0	0	0	0	0	0	0	0
UK (combined)	0	0	0	0	0	0	0	0	0	0	168	183	200	217	1224	736	923	915	878
Others	0	1	12	1	0	0	0	0	0	0	0	1	0	0	31	35	27	36	26
BMS landings																2			
Total nominal catch	420	492	488	445	235	248	208	162	172	161	256	348	352	367	1443	982	1210	1192	1121

Unallocated landings	96	13	27	117	50	110	133	65	93	234	272	261	323	624	617	292	55	9	-16
ICES estimate of total landings^^	516	504	515	561	284	358	341	227	266	394	528	609	675	990	2060	1273	1265	1201	1105
Agreed TAC*	721	613	490	402	302	240	182	0	0	0	0	0	0	0	1735	1279	1279	1279	1210
Division 7d																			
Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022***	2023***
Belgium	51	80	84	154	73	57	56	40	53	72	78	39	18	8	3	8	12	4	3
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
France	986	1124	1743	1326	1779	1606	1078	885	768	1270	1142	279	92	35	16	10	5	17	7
Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	9	9	59	30	35	45	51	40	38	50	52	40	22	10	3	2	1	1	2
Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK (E/W/NI)	184	267	174	144	133	127	125	99	100	156	0	0	0	0	0	0	0	0	0
UK (Scotland)	0	1	12	7	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0
UK (combined)	0	0	0	0	0	0	0	0	0	0	162	102	48	39	17	20	11	11	19
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BMS landings																0	0		0
Total nominal catch	1230	1480	2073	1662	2023	1836	1311	1064	959	1548	1434	459	180	92	38	40	28	32	31
Unallocated landings	29	−2	74	−33	−135	−128	8	56	−43	−112	−36	−38	−10	−8	−3	−8	9	6	0
ICES estimate of total landings	1259	1479	2147	1629	1887	1708	1319	1120	916	1436	1398	421	170	84	36	32	37	38	31
Agreed TAC^					1678	1955	1564	1543	1543	1620	1701	1961	2059	1733	1715	858	772	772	1261
Subdivision 20 **																			
Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022***	2023***
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denmark	3019	2513	2246	2553	3024	3286	3118	3178	3033	3430	3344	3696	3665	4222	2740	1856	1600	1515	2212
France	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	86	84	67	52	55	56	60	78	69	84	87	94	67	87	53	35	25	0	67
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	21	47	19	13	1	26	0	0	28	28	26	25	37	58	39	18	11	8	12
Norway	759	628	681	779	440	375	421	615	575	533	500	551	486	288	151	94	67	123	117
Sweden	488	373	371	366	459	459	518	520	529	570	571	641	557	670	355	224	238	1	377
UK (E/W/NI)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK (Scotland)	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
UK (combined)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	0	326	366	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BMS landings													1	4					0
Total nominal catch	4373	3970	3749	3763	3984	4201	4117	4390	4239	4646	4527	5006	4812	5325	3339	2226	1942	1646	2786
Unallocated landings	−375	−712	−730	−370	−190	−144	−161	−63	−85	41	36	−232	−97	159	26	15	31	270	18
ICES estimate of total landings	3998	3258	3020	3393	3794	4057	3956	4327	4154	4687	4563	4774	4715	5484	3364	2241	1973	1916	2803
Agreed TAC	3900	3315	2851	3165	4114	4793	3835	3783	3783	3972	4171	4807	5744	7995	4205	2103	1893	1893	3095

Subarea 4, Division 6.a, Division 7.d, and Subdivision 20																			
Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022***	2023***
Total nominal catch	28 502	29 050	26 389	28 131	33 667	37 930	33 436	33 256	31 692	35 686	38 228	40 073	39 943	41 781	32 981	20 331	15889	16 348	25151
ICES estimate of total landings	28 629	26 319	24 737	27 240	33 600	37 104	32 291	32 300	30 652	35 067	37 734	38 839	38 669	41 002	33 703	20 436	15854	16 406	24924
BMS landings	0	0	0	0	0	0	0	0	0	0	0	0	2	12	30	23	2	1	2
Sum of agreed TACs	31 921	27 133	23 298	25 719	34892	40 540	32 423	31 801	31 801	33 391	35 061	40 419	47 023	52 884	37 092	18 958	17190	17 190	27 218

*** TAC prior to 2010 is for the whole of Subdivision 5.b1 and subareas 6, 12, and 14. TAC from 2010 onwards is for Subdivision 5.b1 and Division 6.a only.**

**** Skagerrak/Kattegat split derived from national statistics prior to 2016.**

***** Official landings are preliminary.**

^ No agreed TAC in division 7d prior to 2009

^^ Includes ICES estimates of area misreporting from 2006–2021.

Table 4.1b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Sampling coverage for discard ratio, landings age composition and discards age composition by area and season (quarter or annual, depending on data stratification) for 2023, calculated as the weight in each area–season–métier stratum covered by the relevant sampling, then summed over métiers and expressed as a proportion of the total for the area–season (note the country dimension is not used). Also provided is the contribution of landings, discards and BMS in each area (by weight) to the total for that catch category (before raising is conducted).

Discard ratio coverage

Area/Season	Q1	Q2	Q3	Q4	annual
27.4	74%	73%	55%	81%	21%
27.3.a.20	76%	65%	66%	68%	
27.6.a	71%	72%	75%	74%	98%
27.7.d	28%	75%	70%	27%	0%

Landings age composition coverage

Area/Season	Q1	Q2	Q3	Q4	annual
27.4	0%	0%	0%	93%	21%
27.3.a.20	99%	96%	90%	97%	
27.6.a	60%	62%	34%	64%	98%
27.7.d	45%	0%	0%	0%	0%

Discards age composition coverage

Area/Season	Q1	Q2	Q3	Q4	annual
27.4	100%	93%	98%	99%	100%
27.3.a.20	97%	100%	97%	98%	
27.6.a	0%	0%	0%	0%	100%
27.7.d	0%	0%	0%	0%	0%

Contribution to total (before raising)

Area/Type	Landings	Discards	BMS
27.4	84%	87%	0%
27.3.a.20	11%	9%	0%
27.6.a	4%	4%	0%
27.7.d	0%	0%	0%

Table 4.2a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Landings numbers-at-age (Thousands).

	1	2	3	4	5	6	7+
1983	27823	132911	22574	13187	3271	1394	967
1984	66501	68386	33651	4686	3970	1197	858
1985	10150	122453	20157	8870	1509	1425	746
1986	100633	33794	36028	6202	3171	642	890
1987	32690	132610	10749	9594	1665	1127	589
1988	22370	63361	45906	3395	2754	690	483
1989	24089	37165	21914	10500	1107	1097	489
1990	12141	57807	12227	5222	2614	331	452
1991	14806	24873	18359	3454	1637	1110	423
1992	28569	33340	9098	5636	1110	540	463
1993	5016	57767	12183	3257	1729	450	382
1994	16308	26176	22430	3325	916	564	271
1995	16238	65400	13452	5853	860	297	232
1996	5211	38634	24255	3372	2038	424	313
1997	24856	29859	19379	6690	1287	752	244
1998	1554	84266	17086	6084	2435	520	315
1999	5962	10434	32671	4023	1466	638	343
2000	8851	22989	6521	6760	1011	388	211
2001	2260	21550	6199	1176	1104	143	133
2002	4762	8369	14353	2828	408	398	123
2003	491	9380	3645	3193	405	70	85
2004	1515	3611	5544	1539	965	157	57
2005	1046	8299	3081	1754	487	346	78
2006	1304	4498	4488	992	534	189	149
2007	784	6504	2318	1590	401	140	89
2008	338	3288	4236	1166	719	214	113
2009	520	4842	2849	2929	602	239	91
2010	1126	5117	4603	1602	1325	199	94
2011	1099	4569	4097	1426	615	456	84

	1	2	3	4	5	6	7+
2012	666	2230	5385	1986	637	251	165
2013	683	2696	3070	2630	875	191	129
2014	2240	4212	4449	1639	1311	334	110
2015	686	6428	4943	1963	766	603	176
2016	168	2052	5726	3202	1029	286	259
2017	351	2252	3284	3541	1707	399	210
2018	172	6015	3628	2117	1827	812	430
2019	871	1869	6139	1165	1071	546	491
2020	845	2899	1649	1530	465	322	215
2021	259	1424	1976	735	627	118	171
2022	166	837	1732	1291	463	273	147
2023	67	1675	1547	2237	1094	294	195

Table 4.2b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Discard numbers-at-age (including BMS landings from 2016; thousands).

	1	2	3	4	5	6	7+
1983	55792	11155	25	0	0	0	0
1984	538609	12529	5	0	0	0	0
1985	68489	36687	115	0	0	0	0
1986	564476	5775	303	0	0	0	0
1987	38992	61960	0	0	0	0	0
1988	15607	18143	218	0	0	0	0
1989	183163	8691	489	0	0	0	0
1990	38056	48285	78	0	0	0	0
1991	49991	8397	450	0	0	0	0
1992	109795	10024	5	0	0	0	0
1993	33712	28622	12	0	0	0	0
1994	323468	16810	160	0	0	0	0
1995	45381	43490	30	0	0	0	0
1996	14445	23108	764	0	0	0	0
1997	87630	13735	40	0	0	0	0

	1	2	3	4	5	6	7+
1998	16248	91231	1500	0	0	0	0
1999	31192	5635	8280	0	0	0	0
2000	39913	5542	0	0	0	0	0
2001	5636	33209	753	0	0	0	0
2002	27318	13435	3181	17	0	0	0
2003	5820	6108	782	55	0	0	0
2004	20574	8964	2007	122	6	0	0
2005	10340	8325	1795	149	66	12	2
2006	27948	35387	1990	53	7	1	1
2007	16453	24368	2703	517	54	27	2
2008	10911	9482	8008	226	15	11	0
2009	10199	9211	2771	796	58	24	12
2010	10277	9960	1403	81	36	0	0
2011	4239	8430	2180	183	7	8	2
2012	12178	5370	2028	192	5	1	1
2013	8363	6402	1076	564	107	40	19
2014	8669	7452	2078	279	104	7	0
2015	4244	9506	2586	252	73	66	22
2016	4320	5318	3299	351	44	1	0
2017	10007	3244	2183	716	138	14	2
2018	2858	9485	944	447	62	18	8
2019	4258	1698	944	22	5	0	0
2020	11192	4387	296	19	0	0	0
2021	2755	2826	422	7	10	0	0
2022	3206	2978	1780	205	19	0	0
2023	2315	4252	1532	403	29	0	0

Table 4.2c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Catch numbers-at-age (thousands).

	1	2	3	4	5	6	7+
1983	83615	144066	22599	13187	3271	1394	967

	1	2	3	4	5	6	7+
1984	605110	80915	33656	4686	3970	1197	858
1985	78639	159140	20272	8870	1509	1425	746
1986	665109	39569	36331	6202	3171	642	890
1987	71682	194571	10749	9594	1665	1127	589
1988	37977	81504	46124	3395	2754	690	483
1989	207252	45856	22403	10500	1107	1097	489
1990	50197	106092	12305	5222	2614	331	452
1991	64797	33269	18809	3454	1637	1110	423
1992	138364	43364	9103	5636	1110	540	463
1993	38728	86389	12196	3257	1729	450	382
1994	339777	42986	22590	3325	916	564	271
1995	61620	108890	13482	5853	860	297	232
1996	19656	61741	25019	3372	2038	424	313
1997	112487	43595	19419	6690	1287	752	244
1998	17801	175497	18586	6084	2435	520	315
1999	37155	16069	40950	4023	1466	638	343
2000	48764	28531	6521	6760	1011	388	211
2001	7895	54759	6952	1176	1104	143	133
2002	32080	21805	17534	2845	408	398	123
2003	6311	15488	4427	3247	405	70	85
2004	22089	12574	7550	1661	971	158	57
2005	11385	16624	4876	1903	553	358	80
2006	29253	39885	6479	1045	541	190	150
2007	17237	30872	5021	2107	455	167	91
2008	11249	12770	12244	1392	734	225	113
2009	10719	14053	5620	3724	660	263	103
2010	11403	15077	6006	1683	1362	199	94
2011	5338	12999	6277	1608	621	464	86
2012	12845	7600	7412	2178	641	252	166

	1	2	3	4	5	6	7+
2013	9046	9098	4146	3194	982	231	148
2014	10909	11664	6527	1918	1415	342	110
2015	4930	15934	7529	2215	839	669	198
2016	4488	7371	9025	3553	1074	287	259
2017	10358	5496	5467	4257	1845	412	212
2018	3030	15500	4571	2564	1889	830	438
2019	5129	3568	7082	1187	1075	546	491
2020	12037	7286	1944	1549	465	322	215
2021	3014	4250	2398	743	637	118	171
2022	3371	3815	3512	1496	482	273	147
2023	2383	5926	3079	2640	1124	295	195

Table 4.3. Cod in Subarea 4, Divisions 6.a and 7.d, and Subdivision 20. Reported landings, estimated discards (including BMS landings from 2016) and total catch (landings + discards) as SOP values in tonnes. Note any differences in values between Table 4.3 and those given in the report and advice are due to SOP correction.

Year	Landings	Discards	Catch
1963	129642	12347	141988
1964	148555	4922	153477
1965	203152	29526	232677
1966	237301	37986	275287
1967	274661	23377	298037
1968	311283	17563	328846
1969	221348	4795	226143
1970	237648	17737	255385
1971	337142	84089	421230
1972	366854	33810	400664
1973	250139	30224	280362
1974	226843	39759	266602
1975	217412	37149	254561
1976	250417	72669	323086
1977	220942	139341	360284

Year	Landings	Discards	Catch
1978	308168	32625	340793
1979	282104	162517	444620
1980	311634	294529	606163
1981	357480	57379	414859
1982	323875	54579	378454
1983	278939	21628	300567
1984	248342	151333	399675
1985	232961	32261	265221
1986	213099	138867	351966
1987	235011	30094	265105
1988	203615	10873	214487
1989	156747	63732	220479
1990	137010	27318	164328
1991	112369	18821	131190
1992	121826	37972	159798
1993	130261	21550	151811
1994	118843	98869	217712
1995	145836	31848	177684
1996	134148	14093	148240
1997	129468	33683	163151
1998	150351	40641	190992
1999	98309	13711	112019
2000	72544	14181	86725
2001	50787	13611	64398
2002	55395	12380	67775
2003	31712	4065	35777
2004	28318	8796	37114
2005	28679	9973	38652
2006	26167	12380	38547

Year	Landings	Discards	Catch
2007	24730	32070	56800
2008	27376	26021	53396
2009	33469	22131	55600
2010	37115	13899	51014
2011	32323	12515	44839
2012	32363	10554	42916
2013	30744	12073	42817
2014	35048	13906	48954
2015	37938	15038	52976
2016	38754	13702	52456
2017	38355	12202	50557
2018	41147	10170	51317
2019	33995	3677	37672
2020	20185	4905	25090
2021	15752	4360	20112
2022	16148	6793	22941
2023	24599	7630	32229

Table 4.4a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Landings weights-at-age (kg).

	1	2	3	4	5	6	7+
1983	0.628	0.931	1.892	3.935	6.464	8.387	10.667
1984	0.599	1.021	2.233	4.106	6.247	8.400	11.063
1985	0.595	0.942	2.170	4.254	6.375	8.420	11.319
1986	0.584	0.872	1.888	3.580	6.236	8.149	10.829
1987	0.610	0.988	2.031	3.737	6.061	8.291	11.700
1988	0.595	0.921	2.025	3.347	6.068	7.930	11.303
1989	0.676	1.059	1.948	3.663	5.452	7.896	10.766
1990	0.732	0.997	2.199	3.884	6.002	7.970	11.092
1991	0.667	1.079	2.095	3.991	6.146	8.039	10.442
1992	0.698	1.154	2.550	4.229	6.243	8.414	10.566

	1	2	3	4	5	6	7+
1993	0.704	1.081	2.519	4.555	6.509	8.078	10.194
1994	0.675	1.085	2.249	4.491	7.119	8.435	10.216
1995	0.716	1.026	2.244	4.364	7.183	8.958	10.859
1996	0.697	1.123	2.176	4.109	6.662	8.464	10.566
1997	0.653	0.969	2.143	3.862	6.265	8.347	10.688
1998	0.555	0.927	1.733	3.524	5.404	7.577	10.104
1999	0.641	0.944	1.680	3.327	5.751	7.435	9.318
2000	0.618	1.027	1.770	3.247	4.930	7.502	9.918
2001	0.722	1.003	2.312	3.711	5.870	7.341	9.837
2002	0.629	1.002	1.862	3.751	5.558	7.978	10.101
2003	0.582	1.077	1.905	3.365	5.760	6.731	9.751
2004	0.722	1.071	2.091	3.261	5.208	7.451	9.714
2005	0.747	1.159	1.959	3.654	5.237	7.214	10.170
2006	0.791	1.199	2.239	3.892	5.688	7.239	9.575
2007	0.829	1.181	2.370	4.055	6.055	8.239	9.939
2008	1.067	1.388	2.471	4.077	6.225	7.396	10.330
2009	0.788	1.413	2.675	4.154	6.118	7.495	10.515
2010	0.716	1.295	2.672	4.221	6.047	8.302	10.194
2011	0.862	1.331	2.529	4.595	6.476	7.827	9.902
2012	0.938	1.369	2.357	4.189	6.391	8.110	9.554
2013	0.883	1.240	2.462	4.163	6.186	8.335	9.907
2014	0.699	1.213	2.385	4.157	5.659	7.421	9.524
2015	0.596	1.214	2.296	4.108	5.922	6.877	9.221
2016	0.800	1.316	2.342	3.863	5.734	7.319	8.284
2017	0.753	1.120	2.374	3.914	5.399	6.836	9.388
2018	0.609	1.066	1.949	3.850	5.627	6.813	8.358
2019	0.769	1.120	2.150	3.721	5.482	7.123	8.011
2020	0.756	1.358	1.928	3.842	5.448	6.609	8.777
2021	0.748	1.328	2.570	3.901	5.389	7.110	8.780

	1	2	3	4	5	6	7+
2022	0.699	1.317	2.582	3.901	4.860	6.745	9.062
2023	0.644	1.203	2.209	4.131	5.559	6.637	9.476

Table 4.4b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Discard weights-at-age (includes BMS landings from 2016; kg).

	1	2	3	4	5	6	7+
1983	0.296	0.458	0.534	0.000	0.000	0.000	0.000
1984	0.270	0.469	0.509	0.000	0.000	0.000	0.000
1985	0.269	0.376	0.652	0.000	0.000	0.000	0.000
1986	0.242	0.365	0.437	0.000	0.000	0.000	0.000
1987	0.211	0.353	0.000	0.000	0.000	0.000	0.000
1988	0.300	0.336	0.459	0.000	0.000	0.000	0.000
1989	0.326	0.431	0.484	0.000	0.000	0.000	0.000
1990	0.246	0.371	0.526	0.000	0.000	0.000	0.000
1991	0.311	0.366	0.393	0.000	0.000	0.000	0.000
1992	0.308	0.417	2.353	0.000	0.000	0.000	0.000
1993	0.274	0.430	0.947	0.000	0.000	0.000	0.000
1994	0.287	0.362	0.483	0.000	0.000	0.000	0.000
1995	0.314	0.404	0.553	0.000	0.000	0.000	0.000
1996	0.340	0.380	0.515	0.000	0.000	0.000	0.000
1997	0.313	0.453	0.616	0.000	0.000	0.000	0.000
1998	0.352	0.375	0.481	0.000	0.000	0.000	0.000
1999	0.257	0.389	0.422	0.000	0.000	0.000	0.000
2000	0.297	0.422	0.000	0.000	0.000	0.000	0.000
2001	0.232	0.361	0.406	0.000	0.000	0.000	0.000
2002	0.244	0.324	0.413	2.205	0.000	0.000	0.000
2003	0.263	0.346	0.497	0.528	0.000	0.000	0.000
2004	0.236	0.271	0.686	0.864	3.852	11.300	0.000
2005	0.301	0.565	0.814	2.223	4.255	6.509	8.100
2006	0.226	0.118	0.852	2.593	5.093	5.527	11.061
2007	0.286	0.821	1.713	3.984	6.540	10.245	15.507

	1	2	3	4	5	6	7+
2008	0.403	0.739	1.717	3.014	5.303	9.341	5.128
2009	0.378	0.990	2.025	3.549	6.498	8.084	13.047
2010	0.291	0.825	1.611	3.153	4.933	8.369	6.728
2011	0.276	0.704	2.147	3.483	5.511	5.047	7.102
2012	0.226	0.575	1.960	3.569	6.456	8.579	11.610
2013	0.280	0.815	1.619	3.279	4.267	8.419	7.065
2014	0.294	0.802	1.964	3.102	3.901	4.561	4.423
2015	0.331	0.777	1.788	3.236	4.091	5.328	6.896
2016	0.318	0.950	1.793	3.270	4.613	5.439	0.000
2017	0.232	0.808	2.007	3.149	3.865	6.008	5.036
2018	0.279	0.628	1.587	3.325	5.078	4.980	4.359
2019	0.322	0.554	1.381	2.295	2.805	0.000	0.000
2020	0.219	0.477	0.976	3.709	0.000	0.000	0.000
2021	0.294	0.932	1.961	5.079	4.754	0.000	0.000
2022	0.277	0.774	1.642	2.903	4.109	0.000	11.371
2023	0.261	0.805	1.612	2.606	2.625	9.718	11.309

Table 4.4c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Catch weights-at-age (kg).

	1	2	3	4	5	6	7+
1983	0.406	0.894	1.891	3.935	6.464	8.387	10.667
1984	0.307	0.935	2.233	4.106	6.247	8.400	11.063
1985	0.310	0.812	2.161	4.254	6.375	8.420	11.319
1986	0.293	0.798	1.876	3.580	6.236	8.149	10.829
1987	0.393	0.786	2.031	3.737	6.061	8.291	11.700
1988	0.474	0.791	2.018	3.347	6.068	7.930	11.303
1989	0.366	0.941	1.916	3.663	5.452	7.896	10.766
1990	0.364	0.712	2.188	3.884	6.002	7.970	11.092
1991	0.393	0.899	2.055	3.991	6.146	8.039	10.442
1992	0.389	0.984	2.550	4.229	6.243	8.414	10.566
1993	0.329	0.866	2.517	4.555	6.509	8.078	10.194

	1	2	3	4	5	6	7+
1994	0.305	0.802	2.237	4.491	7.119	8.435	10.216
1995	0.420	0.777	2.240	4.364	7.183	8.958	10.859
1996	0.435	0.845	2.126	4.109	6.662	8.464	10.566
1997	0.388	0.807	2.140	3.862	6.265	8.347	10.688
1998	0.370	0.641	1.632	3.524	5.404	7.577	10.104
1999	0.319	0.749	1.425	3.327	5.751	7.435	9.318
2000	0.355	0.909	1.770	3.247	4.930	7.502	9.918
2001	0.373	0.614	2.106	3.711	5.870	7.341	9.837
2002	0.301	0.585	1.598	3.742	5.558	7.978	10.101
2003	0.289	0.789	1.656	3.317	5.760	6.731	9.751
2004	0.270	0.500	1.718	3.084	5.199	7.462	9.714
2005	0.342	0.861	1.537	3.542	5.119	7.191	10.123
2006	0.251	0.240	1.813	3.827	5.681	7.226	9.589
2007	0.311	0.897	2.017	4.037	6.113	8.565	10.061
2008	0.423	0.906	1.978	3.904	6.207	7.493	10.325
2009	0.398	1.136	2.355	4.024	6.151	7.549	10.803
2010	0.333	0.984	2.424	4.169	6.017	8.302	10.194
2011	0.397	0.924	2.396	4.469	6.466	7.780	9.827
2012	0.263	0.808	2.248	4.134	6.392	8.112	9.565
2013	0.325	0.941	2.243	4.007	5.977	8.350	9.547
2014	0.377	0.950	2.251	4.004	5.531	7.361	9.523
2015	0.368	0.953	2.122	4.009	5.763	6.724	8.960
2016	0.336	1.052	2.142	3.804	5.687	7.310	8.284
2017	0.249	0.935	2.227	3.785	5.283	6.809	9.339
2018	0.298	0.798	1.875	3.758	5.609	6.774	8.284
2019	0.397	0.850	2.048	3.695	5.471	7.123	8.011
2020	0.257	0.827	1.784	3.841	5.448	6.609	8.777
2021	0.333	1.065	2.462	3.913	5.379	7.110	8.780
2022	0.298	0.894	2.106	3.764	4.830	6.745	9.063

	1	2	3	4	5	6	7+
2023	0.272	0.917	1.912	3.899	5.483	6.642	9.478

Table 4.5a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Stock weights-at-age (kg) by substock.

Northwestern

	1	2	3	4	5	6	7+
1983	0.071	0.567	1.466	4.184	7.200	11.631	11.909
1984	0.047	0.433	1.803	4.314	6.957	9.499	13.263
1985	0.074	0.360	1.840	4.349	5.776	9.383	13.579
1986	0.051	0.554	1.562	3.489	6.646	8.892	10.835
1987	0.093	0.340	1.393	4.403	7.238	9.507	12.622
1988	0.088	0.530	1.555	3.500	7.306	8.655	12.834
1989	0.074	0.413	1.431	3.594	5.761	9.289	12.522
1990	0.048	0.382	1.413	4.232	6.949	8.465	11.710
1991	0.084	0.523	1.665	4.031	7.375	10.535	13.640
1992	0.051	0.621	2.071	4.731	6.837	10.119	12.464
1993	0.039	0.468	2.167	5.054	7.677	9.878	15.262
1994	0.041	0.402	1.727	5.396	8.546	9.439	12.803
1995	0.061	0.269	1.223	4.383	6.450	10.228	15.940
1996	0.089	0.552	1.443	4.306	6.762	8.076	12.753
1997	0.023	0.375	1.688	4.160	7.396	9.580	11.918
1998	0.110	0.307	1.830	4.522	7.196	9.747	10.861
1999	0.099	0.464	0.657	2.519	7.310	9.313	12.125
2000	0.079	0.547	1.983	2.551	5.165	8.473	13.456
2001	0.099	0.384	1.489	4.401	5.688	6.640	11.016
2002	0.089	0.370	1.338	4.173	5.390	9.245	11.269
2003	0.094	0.495	0.905	2.896	5.847	8.925	13.488
2004	0.071	0.344	1.389	3.975	6.485	11.960	
2005	0.086	0.391	1.283	2.452	5.596	9.849	13.197
2006	0.067	0.484	1.377	2.696	5.341	4.621	10.933
2007	0.065	0.396	1.683	4.005	6.212	8.405	

	1	2	3	4	5	6	7+
2008	0.075	0.573	1.794	5.081	7.015		8.908
2009	0.070	0.493	1.533	3.546	6.698		10.908
2010	0.089	0.625	1.994	3.512	6.005	7.176	11.638
2011	0.093	0.512	1.999	4.211	5.788	8.388	10.097
2012	0.113	0.679	1.545	3.659	6.153	8.215	10.997
2013	0.098	0.773	2.004	3.645	5.598	6.548	8.824
2014	0.065	0.607	1.881	3.604	5.187	6.951	8.911
2015	0.081	0.577	1.685	3.727	5.934	6.682	7.718
2016	0.072	0.722	1.751	3.507	5.803	7.617	9.559
2017	0.065	0.627	1.937	4.032	5.816	6.723	8.662
2018	0.071	0.394	1.752	3.319	5.361	5.867	7.933
2019	0.064	0.442	1.289	3.818	5.346	7.754	9.006
2020	0.077	0.512	1.876	3.383	5.028	8.197	12.794
2021	0.098	0.485	2.003	4.015	5.783	6.874	9.520
2022	0.126	0.430	1.315	4.686	6.057	8.330	11.333
2023	0.108	0.532	1.493	3.188	6.227	7.807	8.915
2024	0.106	0.436	1.332	2.801	4.818	7.160	9.720

Southern

	1	2	3	4	5	6	7+
1983	0.078	0.700	2.210	4.792	7.362	10.719	11.646
1984	0.084	0.590	1.848	3.462	7.467	9.968	12.626
1985	0.049	0.558	2.297	4.983	7.176	10.654	12.065
1986	0.067	0.319	1.769	3.854	7.294	10.322	11.937
1987	0.083	0.455	1.101	5.049	7.491	11.143	12.375
1988	0.058	0.716	2.133	3.492	7.695	10.851	12.979
1989	0.062	0.795	2.239	3.905	7.007	10.097	13.268
1990	0.076	0.625	2.479	4.393	7.221	10.983	12.449
1991	0.058	0.737	1.941	4.872	7.604	10.340	14.490
1992	0.066	0.279	1.939	5.550	7.568	11.248	12.046

	1	2	3	4	5	6	7+
1993	0.043	0.606	2.400	5.378	8.353	12.788	13.224
1994	0.039	0.410	1.987	5.257	8.648	9.979	13.049
1995	0.045	0.336	1.323	4.481	7.007	10.323	12.725
1996	0.044	0.499	1.494	2.862	6.715	10.565	15.874
1997	0.029	0.198	2.202	3.560	7.036	7.588	10.432
1998	0.040	0.378	0.919	3.472	8.779	9.444	15.010
1999	0.145	0.611	1.567	3.528	7.874	9.447	11.899
2000	0.059	0.524	1.651	3.732	4.594	9.268	12.919
2001	0.145	0.327	1.206	2.999	7.424	9.001	10.516
2002	0.087	0.430	1.764	5.136	8.212	10.702	12.245
2003	0.091	0.641	1.208	4.672	7.288	11.877	12.954
2004	0.052	0.185	2.025	3.523	7.823	8.803	15.298
2005	0.054	0.545	1.620	3.528	6.584	11.293	13.721
2006	0.070	0.742	2.376	4.142	8.861	7.507	11.964
2007	0.078	0.364	2.247	4.470	6.673	12.440	11.673
2008	0.110	1.032	2.045	3.821	6.252	9.229	13.911
2009	0.075	0.924	2.715	4.495	6.640	9.159	14.362
2010	0.078	0.681	2.865	5.287	6.646	10.455	13.435
2011	0.070	0.566	2.140	5.524	7.972	9.266	11.561
2012	0.067	1.073	2.371	4.011	8.668	10.934	9.161
2013	0.063	0.559	2.601	3.762	5.702	8.556	13.071
2014	0.068	0.857	2.415	4.248	7.246	5.540	8.567
2015	0.113	0.871	1.869	3.862	6.708	11.000	16.266
2016	0.100	0.878	2.611	3.835	7.436	8.011	10.038
2017	0.060	0.559	1.600	3.350	4.869	10.261	13.098
2018	0.105	0.498	1.155	2.696	6.543	8.345	12.632
2019	0.059	0.510	1.791	2.768	4.530	8.886	10.398
2020	0.070	0.508	1.621	3.595	3.653		9.783
2021	0.087	0.649	1.549	2.378	8.295	10.768	7.197

	1	2	3	4	5	6	7+
2022	0.079	0.721	1.976	3.705	6.451	9.469	
2023	0.097	0.573	1.536	3.704	6.486	9.450	
2024	0.117	0.484	1.646	2.648	6.758	9.370	11.461

Viking

	1	2	3	4	5	6	7+
1983	0.059	0.463	1.580	3.276	5.216	8.275	9.398
1984	0.040	0.374	1.561	2.673	4.761	7.623	14.969
1985	0.047	0.311	1.189	3.163	4.718	7.514	7.157
1986	0.045	0.296	1.042	2.630	4.079	5.142	10.312
1987	0.064	0.341	1.103	3.146	4.452	6.572	11.094
1988	0.076	0.190	1.076	2.719	4.525	6.270	6.782
1989	0.060	0.317	0.799	2.915	4.018	7.514	10.088
1990	0.060	0.347	1.190	3.119	5.063	7.391	10.109
1991	0.052	0.422	1.380	2.817	5.423	6.792	9.605
1992	0.054	0.540	1.631	3.884	4.862	7.931	9.327
1993	0.054	0.333	1.340	3.361	4.529	7.919	11.079
1994	0.036	0.359	1.262	3.961	6.211	8.841	11.081
1995	0.043	0.345	1.115	3.177	5.474	7.842	12.139
1996	0.031	0.317	1.230	3.642	5.244	7.713	12.408
1997	0.040	0.311	1.185	3.328	5.074	7.635	11.886
1998	0.064	0.241	1.180	3.424	5.410	7.375	12.030
1999	0.048	0.270	0.815	2.690	4.961	6.884	9.613
2000	0.040	0.380	1.172	2.739	4.841	5.932	9.385
2001	0.070	0.349	1.496	3.034	4.326	5.283	10.369
2002	0.051	0.298	0.830	3.054	6.140	9.110	9.281
2003	0.051	0.384	0.946	2.423	5.308	5.371	11.602
2004	0.058	0.367	1.374	3.239	4.653	6.247	14.717
2005	0.060	0.449	1.273	2.950	5.010	7.428	9.344
2006	0.054	0.439	1.464	3.133	4.379	7.137	10.175

	1	2	3	4	5	6	7+
2007	0.048	0.445	0.943	3.456	5.349	5.929	10.306
2008	0.050	0.529	1.501	3.231	5.517	7.087	11.413
2009	0.051	0.477	1.589	3.684	4.614	6.170	9.989
2010	0.049	0.524	1.584	3.413	4.696	5.929	10.108
2011	0.045	0.403	1.448	3.672	4.390	7.236	11.513
2012	0.059	0.470	1.376	3.247	5.413	7.169	9.416
2013	0.053	0.420	1.277	3.177	4.494	6.299	8.857
2014	0.045	0.436	1.458	3.466	5.641	8.571	10.677
2015	0.058	0.463	1.568	3.307	4.546	7.818	7.377
2016	0.064	0.517	1.566	3.134	4.349	6.571	9.697
2017	0.050	0.545	1.596	3.318	4.580	6.619	10.256
2018	0.053	0.484	1.071	3.062	5.521	6.942	10.011
2019	0.061	0.424	1.229	2.722	6.248	7.517	10.600
2020	0.057	0.516	1.393	3.669	5.763	5.952	9.824
2021	0.049	0.429	1.367	2.723	5.456	6.271	9.069
2022	0.054	0.371	1.425	3.227	4.998	8.204	10.468
2023	0.054	0.427	1.103	2.889	5.542	7.583	15.105
2024	0.054	0.299	1.282	2.816	4.754	7.235	9.191

Table 4.5b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Proportion mature by age group and substock.

Northwestern

	1	2	3	4	5	6	7+
1983	0.003	0.039	0.272	0.304	0.724	0.807	0.905
1984	0.002	0.021	0.133	0.440	0.648	0.684	0.877
1985	0.002	0.028	0.144	0.458	0.557	0.787	0.871
1986	0.002	0.112	0.099	0.185	0.463	0.721	0.851
1987	0.003	0.019	0.260	0.541	0.742	0.781	0.895
1988	0.002	0.039	0.169	0.460	0.563	0.760	0.889
1989	0.131	0.270	0.335	0.642	0.895	0.880	0.973
1990	0.003	0.082	0.225	0.551	0.750	0.807	0.788

	1	2	3	4	5	6	7+
1991	0.005	0.090	0.402	0.559	0.830	0.893	0.943
1992	0.016	0.338	0.656	0.897	0.946	0.966	0.983
1993	0.014	0.115	0.762	0.877	0.943	0.960	0.979
1994	0.017	0.303	0.688	0.886	0.952	0.968	0.984
1995	0.008	0.079	0.438	0.810	0.890	0.924	0.960
1996	0.013	0.181	0.582	0.857	0.939	0.955	0.977
1997	0.017	0.268	0.821	0.932	0.964	0.977	0.988
1998	0.013	0.152	0.648	0.837	0.932	0.951	0.972
1999	0.031	0.576	0.536	0.899	0.961	0.975	0.987
2000	0.030	0.350	0.814	0.899	0.963	0.977	0.988
2001	0.015	0.247	0.633	0.871	0.914	0.958	0.979
2002	0.021	0.262	0.695	0.890	0.948	0.967	0.983
2003	0.023	0.287	0.649	0.879	0.949	0.967	0.983
2004	0.018	0.388	0.728	0.901	0.955	0.971	0.986
2005	0.021	0.379	0.730	0.882	0.951	0.971	0.985
2006	0.035	0.532	0.848	0.938	0.973	0.984	0.992
2007	0.017	0.237	0.701	0.886	0.943	0.964	0.982
2008	0.024	0.469	0.689	0.919	0.961	0.975	0.988
2009	0.016	0.268	0.708	0.887	0.936	0.964	0.982
2010	0.013	0.382	0.812	0.907	0.960	0.973	0.986
2011	0.028	0.268	0.779	0.935	0.968	0.979	0.988
2012	0.028	0.533	0.722	0.899	0.969	0.979	0.989
2013	0.037	0.636	0.794	0.971	0.978	0.987	0.993
2014	0.028	0.194	0.609	0.903	0.938	0.966	0.982
2015	0.022	0.366	0.617	0.865	0.930	0.960	0.982
2016	0.010	0.298	0.464	0.814	0.931	0.954	0.970
2017	0.016	0.500	0.695	0.862	0.895	0.970	0.975
2018	0.012	0.239	0.688	0.787	0.942	0.945	0.980
2019	0.026	0.450	0.715	0.914	0.957	0.976	0.988

	1	2	3	4	5	6	7+
2020	0.035	0.251	0.819	0.922	0.964	0.977	0.988
2021	0.022	0.279	0.509	0.886	0.899	0.960	0.979
2022	0.042	0.555	0.789	0.940	0.972	0.978	0.991
2023	0.023	0.397	0.690	0.841	0.945	0.967	0.984
2024	0.014	0.176	0.637	0.807	0.952	0.961	0.979

Southern

	1	2	3	4	5	6	7+
1983	0.001	0.021	0.218	0.468	0.692	0.629	0.973
1984	0.000	0.033	0.264	0.581	0.383	0.851	0.978
1985	0.001	0.023	0.319	0.698	0.768	0.775	0.975
1986	0.001	0.067	0.342	0.561	0.653	0.521	0.976
1987	0.000	0.010	0.264	0.567	0.790	0.647	0.977
1988	0.001	0.065	0.195	0.603	0.624	0.738	0.966
1989	0.038	0.158	0.376	0.585	0.907	0.747	0.993
1990	0.002	0.206	0.279	0.559	0.740	0.841	0.979
1991	0.002	0.154	0.627	0.751	0.920	0.936	0.994
1992	0.002	0.223	0.708	0.908	0.943	0.945	0.996
1993	0.002	0.079	0.443	0.808	0.899	0.899	0.991
1994	0.002	0.098	0.614	0.827	0.879	0.899	0.992
1995	0.003	0.093	0.458	0.834	0.894	0.903	0.992
1996	0.002	0.065	0.460	0.767	0.883	0.891	0.990
1997	0.002	0.139	0.582	0.692	0.861	0.861	0.991
1998	0.002	0.054	0.406	0.720	0.842	0.861	0.988
1999	0.004	0.327	0.650	0.838	0.948	0.947	0.994
2000	0.011	0.284	0.646	0.928	0.962	0.964	0.997
2001	0.003	0.240	0.635	0.908	0.947	0.946	0.996
2002	0.009	0.513	0.835	0.949	0.974	0.977	0.998
2003	0.008	0.342	0.669	0.915	0.960	0.960	0.997
2004	0.004	0.159	0.872	0.930	0.950	0.960	0.997

	1	2	3	4	5	6	7+
2005	0.015	0.541	0.825	0.931	0.975	0.977	0.998
2006	0.009	0.339	0.854	0.935	0.969	0.971	0.998
2007	0.007	0.272	0.843	0.942	0.966	0.968	0.998
2008	0.041	0.564	0.932	0.968	0.986	0.988	0.999
2009	0.011	0.327	0.815	0.951	0.973	0.974	0.998
2010	0.007	0.233	0.785	0.938	0.954	0.962	0.997
2011	0.021	0.140	0.839	0.947	0.970	0.971	0.998
2012	0.017	0.556	0.882	0.964	0.982	0.983	0.999
2013	0.017	0.393	0.875	0.958	0.978	0.979	0.998
2014	0.009	0.545	0.910	0.964	0.981	0.981	0.999
2015	0.057	0.817	0.950	0.982	0.993	0.993	1.000
2016	0.018	0.480	0.897	0.963	0.981	0.982	0.999
2017	0.014	0.415	0.871	0.955	0.976	0.978	0.998
2018	0.012	0.477	0.845	0.953	0.976	0.977	0.998
2019	0.008	0.319	0.823	0.933	0.965	0.968	0.998
2020	0.006	0.265	0.737	0.911	0.953	0.956	0.997
2021	0.024	0.581	0.907	0.971	0.985	0.986	0.999
2022	0.026	0.559	0.906	0.967	0.985	0.986	0.999
2023	0.015	0.551	0.881	0.960	0.980	0.982	0.999
2024	0.017	0.548	0.887	0.964	0.982	0.983	0.999

Viking

	1	2	3	4	5	6	7+
1983	0.003	0.025	0.065	0.229	0.560	0.852	0.915
1984	0.005	0.033	0.203	0.440	0.702	0.919	0.953
1985	0.003	0.011	0.102	0.332	0.633	0.887	0.911
1986	0.002	0.024	0.041	0.200	0.548	0.850	0.907
1987	0.004	0.027	0.145	0.378	0.711	0.901	0.944
1988	0.002	0.021	0.077	0.327	0.343	0.814	0.894
1989	0.141	0.040	0.082	0.288	0.705	0.909	0.965

	1	2	3	4	5	6	7+
1990	0.003	0.027	0.129	0.295	0.536	0.876	0.908
1991	0.003	0.017	0.153	0.327	0.707	0.887	0.935
1992	0.045	0.089	0.415	0.734	0.852	0.974	0.982
1993	0.003	0.026	0.121	0.433	0.594	0.892	0.920
1994	0.007	0.045	0.260	0.644	0.813	0.952	0.970
1995	0.004	0.027	0.231	0.615	0.732	0.874	0.945
1996	0.012	0.129	0.406	0.831	0.853	0.972	0.983
1997	0.010	0.121	0.440	0.644	0.827	0.967	0.979
1998	0.026	0.103	0.478	0.824	0.915	0.979	0.987
1999	0.016	0.274	0.327	0.752	0.929	0.978	0.987
2000	0.010	0.218	0.597	0.696	0.839	0.969	0.978
2001	0.019	0.124	0.349	0.646	0.895	0.970	0.982
2002	0.018	0.233	0.402	0.756	0.927	0.978	0.987
2003	0.008	0.052	0.289	0.541	0.852	0.951	0.971
2004	0.011	0.127	0.652	0.642	0.850	0.956	0.982
2005	0.012	0.090	0.517	0.825	0.915	0.973	0.982
2006	0.007	0.108	0.286	0.685	0.817	0.963	0.978
2007	0.037	0.186	0.381	0.719	0.934	0.974	0.988
2008	0.017	0.281	0.527	0.721	0.910	0.979	0.988
2009	0.015	0.086	0.414	0.753	0.885	0.967	0.983
2010	0.011	0.082	0.428	0.677	0.909	0.956	0.980
2011	0.014	0.077	0.471	0.717	0.885	0.970	0.982
2012	0.008	0.071	0.209	0.649	0.857	0.956	0.974
2013	0.008	0.069	0.260	0.693	0.817	0.962	0.975
2014	0.010	0.054	0.300	0.710	0.849	0.962	0.976
2015	0.009	0.120	0.285	0.701	0.834	0.958	0.977
2016	0.006	0.068	0.173	0.581	0.767	0.934	0.969
2017	0.008	0.061	0.394	0.697	0.796	0.960	0.972
2018	0.010	0.060	0.274	0.690	0.896	0.963	0.977

	1	2	3	4	5	6	7+
2019	0.015	0.213	0.427	0.759	0.909	0.976	0.984
2020	0.009	0.076	0.459	0.792	0.876	0.968	0.982
2021	0.006	0.065	0.241	0.452	0.796	0.942	0.968
2022	0.006	0.043	0.175	0.532	0.838	0.940	0.965
2023	0.006	0.059	0.232	0.486	0.774	0.942	0.964
2024	0.006	0.052	0.232	0.461	0.719	0.928	0.961

Table 4.5c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Natural mortality by age group. Values are assumed to apply to all substocks.

	1	2	3	4	5	6	7+
1983	1.112	0.77	0.277	0.21	0.2	0.2	0.2
1984	0.982	0.711	0.257	0.201	0.2	0.2	0.2
1985	1.09	0.731	0.265	0.201	0.2	0.2	0.2
1986	0.944	0.694	0.268	0.211	0.2	0.2	0.2
1987	0.989	0.696	0.268	0.212	0.2	0.2	0.2
1988	1.047	0.721	0.269	0.229	0.2	0.2	0.2
1989	0.953	0.753	0.286	0.215	0.2	0.2	0.2
1990	1.009	0.769	0.285	0.22	0.2	0.2	0.2
1991	1.006	0.771	0.29	0.201	0.2	0.2	0.2
1992	0.916	0.742	0.254	0.2	0.2	0.2	0.2
1993	0.99	0.729	0.249	0.2	0.2	0.2	0.2
1994	0.985	0.726	0.269	0.2	0.2	0.2	0.2
1995	0.98	0.733	0.277	0.2	0.2	0.2	0.2
1996	1.074	0.764	0.28	0.2	0.2	0.2	0.2
1997	0.965	0.721	0.263	0.211	0.2	0.2	0.2
1998	1.083	0.757	0.296	0.218	0.2	0.2	0.2
1999	1.049	0.829	0.311	0.225	0.2	0.2	0.2
2000	0.899	0.775	0.296	0.236	0.2	0.2	0.2
2001	0.942	0.759	0.322	0.227	0.2	0.2	0.2
2002	1.029	0.857	0.39	0.233	0.2	0.2	0.2
2003	1.115	0.961	0.45	0.258	0.2	0.2	0.2

	1	2	3	4	5	6	7+
2004	1.205	1.033	0.484	0.312	0.2	0.2	0.2
2005	1.273	1.085	0.508	0.272	0.2	0.2	0.2
2006	1.251	1.069	0.469	0.262	0.2	0.2	0.2
2007	1.303	1.07	0.466	0.2	0.2	0.2	0.2
2008	1.356	1.121	0.489	0.26	0.2	0.2	0.2
2009	1.291	1.117	0.468	0.201	0.2	0.2	0.2
2010	1.178	0.981	0.437	0.2	0.2	0.2	0.2
2011	1.283	1.054	0.386	0.201	0.2	0.2	0.2
2012	1.35	1.12	0.541	0.201	0.2	0.2	0.2
2013	1.35	1.116	0.502	0.204	0.2	0.2	0.2
2014	1.252	1.046	0.472	0.204	0.202	0.2	0.2
2015	1.289	1.07	0.51	0.207	0.205	0.202	0.2
2016	1.299	1.069	0.474	0.285	0.2	0.2	0.2
2017	1.201	0.988	0.406	0.241	0.204	0.2	0.2
2018	1.35	1.088	0.479	0.26	0.2	0.2	0.2
2019	1.266	1.03	0.454	0.272	0.2	0.2	0.2
2020	1.143	0.926	0.431	0.247	0.2	0.2	0.2
2021	1.223	0.956	0.481	0.205	0.2	0.2	0.2
2022	1.354	1.05	0.546	0.277	0.2	0.2	0.2
2023*							
2024*							

***A new SMS run was performed for cod in 2024 with data up to 2022. Natural mortality is modelled as a GMRF process in multistock SAM, allowing for estimation of missing values in 2023–2024.**

Table 4.6a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM tuning indices and standard deviations by substock in Q1.

Northwestern

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
1983	487.940	6678.633	909.373	525.755	201.951	177.535	36.132	0.256	0.475	0.326	0.322	0.342	0.369	0.252
1984	1718.435	2435.606	1155.219	215.491	173.884	88.096	46.511	0.593	0.344	0.351	0.339	0.281	0.348	0.412
1985	99.519	5748.034	756.110	714.055	84.617	89.248	9.942	0.264	0.151	0.164	0.191	0.189	0.198	0.215
1986	1915.021	1231.057	1970.937	371.368	189.993	60.894	34.250	0.176	0.172	0.162	0.158	0.160	0.170	0.217
1987	889.279	5657.964	635.510	541.987	88.248	64.840	22.468	0.229	0.144	0.212	0.237	0.183	0.186	0.198
1988	114.574	3078.046	1667.998	210.960	126.159	51.836	28.041	0.203	0.253	0.162	0.215	0.163	0.171	0.185
1989	2611.486	1158.599	1670.680	439.642	58.665	73.709	29.804	0.163	0.162	0.192	0.177	0.167	0.174	0.215
1990	372.005	5233.119	363.474	305.989	132.362	25.490	35.034	0.208	0.162	0.160	0.241	0.209	0.200	0.201
1991	276.518	1024.286	1232.381	163.988	124.536	50.101	18.651	0.238	0.171	0.176	0.224	0.279	0.235	0.204
1992	1524.530	1613.435	405.293	301.309	48.972	30.597	23.469	0.160	0.175	0.183	0.233	0.235	0.267	0.250
1993	822.000	5737.475	766.680	131.218	58.711	21.335	7.546	0.194	0.164	0.192	0.192	0.191	0.237	0.287
1994	1165.064	1644.814	1232.637	283.438	58.135	26.908	15.226	0.174	0.179	0.198	0.210	0.170	0.187	0.229
1995	915.402	4331.020	1493.431	514.710	99.528	14.970	6.243	0.206	0.160	0.224	0.279	0.243	0.244	0.591
1996	304.538	2357.300	1183.826	175.440	101.019	20.486	6.979	0.205	0.187	0.189	0.218	0.208	0.222	0.298
1997	3790.724	1297.437	660.455	296.615	84.785	51.873	12.276	0.175	0.201	0.215	0.247	0.255	0.270	0.250
1998	112.466	4261.733	412.889	165.896	76.438	16.989	13.880	0.175	0.149	0.170	0.221	0.200	0.201	0.268

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
1999	146.788	476.620	1531.559	102.654	62.802	15.673	18.386	0.254	0.187	0.149	0.195	0.225	0.240	0.263
2000	937.717	768.043	317.689	285.062	33.305	21.739	14.437	0.196	0.166	0.253	0.175	0.195	0.257	0.253
2001	209.282	1782.844	319.335	105.774	97.996	14.165	11.268	0.454	0.174	0.183	0.307	0.291	0.341	0.477
2002	520.082	618.746	972.852	108.750	21.693	17.770	2.304	0.226	0.189	0.188	0.213	0.271	0.339	0.323
2003	121.718	1224.542	206.426	212.828	58.156	13.333	13.321	0.381	0.206	0.154	0.183	0.221	0.251	0.261
2004	519.171	442.701	301.443	94.654	76.086	9.592	2.704	0.225	0.191	0.214	0.309	0.268	0.239	0.444
2005	139.711	575.124	179.643	84.073	16.829	23.183	3.898	0.288	0.190	0.204	0.283	0.289	0.326	0.366
2006	921.249	297.255	231.207	78.535	21.036	11.475	15.530	0.190	0.238	0.217	0.317	0.314	0.313	0.330
2007	234.758	1735.215	273.078	106.503	17.813	10.415	5.702	0.219	0.169	0.175	0.236	0.269	0.272	0.358
2008	194.881	413.915	950.069	96.102	34.681	6.519	2.496	0.260	0.224	0.216	0.231	0.260	0.252	0.311
2009	262.656	594.921	242.078	162.611	17.631	9.624	6.074	0.324	0.199	0.240	0.256	0.253	0.260	0.341
2010	805.236	1244.649	337.599	56.369	48.525	11.794	2.561	0.222	0.197	0.206	0.255	0.232	0.240	0.321
2011	126.172	1868.171	701.136	128.434	68.298	41.079	8.174	0.221	0.171	0.197	0.203	0.214	0.229	0.287
2012	372.076	745.804	1543.281	364.780	103.108	28.625	29.869	0.241	0.174	0.182	0.200	0.224	0.245	0.376
2013	704.392	789.431	556.310	575.580	193.724	21.463	9.209	0.213	0.198	0.209	0.209	0.190	0.183	0.234
2014	598.914	1055.662	520.918	202.240	173.042	35.685	9.996	0.203	0.213	0.217	0.232	0.220	0.242	0.321
2015	590.497	1707.977	1178.173	411.666	185.383	106.011	19.430	0.206	0.152	0.192	0.215	0.255	0.271	0.308
2016	414.239	1091.467	1562.752	661.742	119.826	39.954	30.444	0.275	0.205	0.198	0.211	0.186	0.210	0.236

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
2017	2360.276	712.538	1341.850	1173.552	871.448	126.922	79.519	0.168	0.177	0.204	0.186	0.228	0.261	0.341
2018	175.070	1770.954	424.277	410.948	185.857	101.285	44.195	0.249	0.191	0.200	0.213	0.218	0.203	0.226
2019	571.614	319.553	627.004	81.167	65.037	23.095	10.029	0.239	0.168	0.185	0.224	0.244	0.263	0.321
2020	659.849	946.308	241.949	214.136	31.717	12.177	10.982	0.197	0.187	0.198	0.209	0.219	0.296	0.346
2021	530.917	991.089	714.696	142.147	71.952	33.898	22.419	0.209	0.171	0.185	0.195	0.204	0.229	0.262
2022	272.887	1032.081	825.181	261.807	69.151	50.111	18.016	0.416	0.342	0.358	0.419	0.501	0.531	0.700
2023	235.402	1230.686	821.553	499.649	148.305	48.568	24.431	0.227	0.162	0.187	0.197	0.194	0.232	0.246
2024	137.629	759.559	691.360	312.425	211.079	79.123	18.329	0.271	0.169	0.181	0.207	0.184	0.192	0.231

Southern

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
1983	2094.090	3951.210	270.546	214.813	89.513	146.613	54.454	0.162	0.150	0.150	0.156	0.140	0.169	0.177
1984	8468.896	1178.035	458.687	81.923	109.259	64.345	48.750	0.155	0.161	0.162	0.157	0.153	0.178	0.201
1985	285.875	4224.060	256.569	143.387	51.004	99.164	25.725	0.185	0.136	0.154	0.159	0.153	0.168	0.193
1986	7268.649	551.104	459.904	169.601	75.386	53.711	24.501	0.125	0.134	0.143	0.154	0.142	0.167	0.193
1987	4568.184	5270.556	120.290	226.000	37.841	73.017	38.468	0.166	0.166	0.149	0.174	0.144	0.154	0.181
1988	1580.567	1420.888	1021.924	25.442	93.546	86.896	26.956	0.189	0.209	0.182	0.184	0.160	0.188	0.199
1989	2866.858	1222.184	522.236	280.504	32.529	72.678	29.904	0.150	0.195	0.175	0.150	0.143	0.156	0.208
1990	550.298	1386.742	340.446	143.356	170.148	41.764	48.814	0.193	0.188	0.189	0.191	0.154	0.180	0.197

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
1991	1174.847	448.866	298.622	118.166	51.746	107.106	29.128	0.224	0.173	0.150	0.165	0.155	0.164	0.197
1992	3301.556	856.978	141.019	113.699	51.443	26.285	36.777	0.156	0.169	0.183	0.197	0.172	0.191	0.184
1993	1094.358	1198.897	133.039	67.637	68.030	28.531	13.535	0.197	0.168	0.160	0.178	0.166	0.224	0.241
1994	2857.254	411.895	306.015	78.615	60.397	56.736	14.901	0.158	0.189	0.174	0.189	0.187	0.209	0.250
1995	1421.590	1479.875	436.791	93.382	52.619	33.824	21.107	0.179	0.157	0.177	0.178	0.188	0.222	0.434
1996	781.250	546.614	579.787	100.937	63.399	29.512	26.493	0.185	0.173	0.164	0.184	0.174	0.237	0.295
1997	4758.571	837.157	264.706	140.158	38.870	40.933	16.976	0.131	0.158	0.186	0.174	0.171	0.200	0.257
1998	120.666	2420.073	408.044	135.342	93.362	33.022	29.550	0.184	0.148	0.176	0.172	0.168	0.198	0.246
1999	411.013	285.267	726.206	62.915	57.156	28.256	53.923	0.228	0.197	0.148	0.160	0.166	0.220	0.249
2000	682.818	483.939	106.886	230.717	45.268	38.837	41.746	0.182	0.190	0.159	0.154	0.166	0.168	0.211
2001	418.944	750.376	178.904	44.040	37.704	11.037	17.383	0.214	0.177	0.170	0.188	0.188	0.216	0.257
2002	859.270	329.840	151.094	63.082	11.265	30.488	16.195	0.180	0.160	0.151	0.193	0.215	0.237	0.258
2003	107.386	659.378	104.589	68.530	22.776	10.174	16.305	0.240	0.174	0.154	0.194	0.221	0.240	0.279
2004	678.469	284.054	352.007	63.220	40.424	14.662	8.269	0.206	0.156	0.156	0.172	0.189	0.250	0.331
2005	455.313	283.568	74.904	129.322	11.284	29.621	3.780	0.195	0.193	0.179	0.188	0.205	0.238	0.373
2006	890.217	250.166	127.795	34.773	12.078	9.885	20.071	0.168	0.219	0.215	0.232	0.270	0.303	0.340
2007	706.681	303.878	154.924	41.771	12.705	20.752	7.357	0.208	0.172	0.196	0.246	0.256	0.272	0.361
2008	632.725	319.684	146.957	93.709	52.012	18.184	14.680	0.204	0.234	0.164	0.201	0.173	0.214	0.280

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
2009	138.965	476.753	232.630	78.955	31.438	25.755	26.618	0.255	0.190	0.174	0.186	0.177	0.232	0.264
2010	495.409	150.093	254.222	79.908	39.302	28.027	15.730	0.228	0.218	0.195	0.206	0.219	0.230	0.270
2011	229.551	384.278	62.068	79.006	45.835	24.338	9.668	0.291	0.231	0.204	0.228	0.218	0.231	0.292
2012	200.322	343.064	228.933	41.409	49.739	26.401	10.789	0.209	0.191	0.169	0.199	0.208	0.242	0.279
2013	241.696	200.558	135.140	98.420	63.162	18.292	15.047	0.309	0.210	0.206	0.192	0.198	0.219	0.293
2014	627.691	218.957	108.066	44.633	61.215	13.665	2.959	0.193	0.254	0.220	0.224	0.232	0.284	0.507
2015	144.292	564.758	146.795	62.123	32.463	20.627	6.299	0.217	0.202	0.190	0.224	0.255	0.276	0.308
2016	67.069	67.353	175.241	45.000	50.016	30.361	26.647	0.309	0.250	0.211	0.201	0.207	0.229	0.247
2017	898.867	81.238	88.142	53.649	40.962	21.315	20.582	0.173	0.235	0.266	0.242	0.264	0.296	0.340
2018	66.278	221.156	43.967	22.683	31.692	15.187	11.669	0.310	0.236	0.285	0.278	0.283	0.306	0.326
2019	234.827	51.006	85.189	8.204	8.934	8.176	6.133	0.268	0.226	0.269	0.312	0.317	0.382	0.466
2020	553.245	83.493	44.022	18.726	3.908	2.399	5.588	0.247	0.228	0.296	0.322	0.418	0.512	0.555
2021	360.331	204.229	64.444	14.443	8.544	7.062	7.034	0.259	0.219	0.255	0.292	0.335	0.385	0.457
2022	390.483	148.264	82.569	30.897	10.753	9.855	4.846	0.250	0.253	0.312	0.318	0.424	0.474	0.526
2023	266.834	512.632	89.440	33.988	24.769	11.332	5.825	0.305	0.208	0.194	0.259	0.317	0.330	0.370
2024	104.870	164.742	127.109	25.755	33.709	21.309	7.399	0.274	0.219	0.206	0.222	0.220	0.291	0.341

Viking

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
1983	1265.702	7320.007	1386.209	490.998	132.441	88.168	37.839	0.277	0.200	0.184	0.181	0.160	0.188	0.235
1984	1522.777	2924.062	981.445	241.009	146.322	41.990	22.126	0.213	0.165	0.152	0.163	0.153	0.190	0.279
1985	221.084	6923.168	1359.030	485.871	114.562	73.881	17.774	0.280	0.162	0.165	0.166	0.173	0.177	0.236
1986	2328.191	1472.689	1851.695	710.230	238.096	101.046	45.379	0.243	0.197	0.151	0.155	0.148	0.163	0.189
1987	512.210	6385.499	266.661	285.842	108.022	46.211	14.036	0.194	0.189	0.148	0.148	0.160	0.163	0.208
1988	1726.789	1634.884	1229.498	115.789	134.982	56.284	40.873	0.297	0.162	0.168	0.172	0.160	0.180	0.193
1989	2306.576	1732.918	1289.783	486.835	87.355	85.796	32.813	0.228	0.179	0.157	0.152	0.150	0.161	0.208
1990	802.746	3352.686	517.491	191.950	116.098	20.826	41.247	0.255	0.158	0.178	0.176	0.161	0.181	0.197
1991	1190.651	1390.938	817.447	209.441	76.286	49.912	29.665	0.279	0.186	0.164	0.161	0.163	0.170	0.221
1992	2970.889	1362.572	331.130	202.116	50.943	20.294	36.461	0.237	0.181	0.165	0.181	0.186	0.222	0.237
1993	1738.689	5831.322	498.065	157.201	111.774	32.303	14.495	0.302	0.164	0.149	0.163	0.158	0.196	0.256
1994	2325.442	1150.367	707.045	194.721	81.400	29.457	19.935	0.226	0.169	0.158	0.164	0.177	0.211	0.272
1995	3147.564	7808.774	732.195	272.414	53.955	19.413	19.201	0.225	0.178	0.155	0.164	0.154	0.213	0.458
1996	846.175	4163.181	1232.930	186.817	100.845	25.490	16.823	0.268	0.183	0.177	0.163	0.172	0.197	0.273
1997	2967.410	2196.755	575.732	202.703	74.845	38.957	11.768	0.194	0.174	0.159	0.160	0.183	0.199	0.219
1998	392.273	7445.452	443.057	191.137	90.700	32.261	23.452	0.259	0.172	0.164	0.168	0.168	0.196	0.241
1999	1131.633	414.619	1541.391	163.809	75.982	31.122	31.586	0.286	0.209	0.158	0.153	0.168	0.191	0.224
2000	1231.870	1697.601	150.249	420.405	91.851	48.939	32.089	0.205	0.176	0.168	0.174	0.174	0.176	0.214

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
2001	756.228	2796.209	434.559	72.359	70.522	19.290	14.893	0.270	0.156	0.168	0.176	0.175	0.194	0.256
2002	2068.441	1088.881	1062.481	122.564	23.528	18.999	8.943	0.309	0.221	0.160	0.163	0.201	0.246	0.297
2003	222.987	913.420	257.528	275.888	83.882	16.378	20.739	0.283	0.213	0.166	0.166	0.176	0.194	0.264
2004	1956.364	642.034	339.984	88.643	95.617	39.485	11.385	0.275	0.207	0.192	0.189	0.191	0.217	0.307
2005	518.068	1230.197	251.216	116.138	44.396	49.490	22.436	0.261	0.205	0.179	0.160	0.190	0.222	0.257
2006	1760.055	606.524	386.683	69.793	39.799	24.844	34.984	0.286	0.244	0.196	0.190	0.219	0.229	0.263
2007	684.284	2287.758	336.453	105.215	55.304	30.985	31.982	0.282	0.186	0.167	0.185	0.213	0.229	0.287
2008	672.584	560.251	640.007	122.434	70.985	16.304	6.931	0.269	0.195	0.183	0.170	0.174	0.213	0.270
2009	560.629	761.525	209.040	215.075	62.720	28.601	18.320	0.314	0.199	0.180	0.192	0.192	0.202	0.230
2010	1015.457	1222.392	307.565	108.030	93.833	27.620	6.564	0.280	0.182	0.180	0.185	0.183	0.193	0.299
2011	265.061	1617.638	311.918	122.886	45.374	51.049	10.361	0.350	0.184	0.184	0.210	0.185	0.218	0.270
2012	1260.662	762.303	847.292	252.949	81.506	21.253	14.347	0.231	0.159	0.158	0.193	0.179	0.210	0.256
2013	483.820	1560.062	444.630	337.527	150.671	43.209	19.279	0.239	0.197	0.160	0.168	0.156	0.179	0.219
2014	594.321	1323.094	457.051	191.508	177.446	62.169	19.722	0.217	0.215	0.177	0.211	0.220	0.249	0.324
2015	555.415	2491.358	772.837	254.957	75.741	44.749	9.369	0.219	0.181	0.159	0.176	0.173	0.201	0.248
2016	258.187	814.526	1310.768	437.291	160.364	53.903	48.368	0.257	0.181	0.166	0.161	0.143	0.169	0.220
2017	1163.845	636.669	571.487	510.434	245.731	44.767	24.600	0.183	0.174	0.162	0.167	0.162	0.188	0.242
2018	162.231	1893.100	282.606	144.939	100.413	61.719	24.788	0.301	0.163	0.158	0.188	0.166	0.187	0.192

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
2019	192.828	292.076	489.763	62.035	52.066	28.901	13.647	0.280	0.164	0.162	0.191	0.218	0.242	0.295
2020	1273.414	609.971	149.153	167.850	35.200	10.213	24.112	0.284	0.181	0.170	0.176	0.198	0.224	0.309
2021	330.306	2709.393	634.056	150.160	68.763	33.825	29.556	0.253	0.180	0.166	0.181	0.188	0.210	0.240
2022	467.758	809.893	1263.887	344.791	64.018	37.763	21.706	0.326	0.215	0.208	0.216	0.219	0.255	0.388
2023	515.709	1987.770	602.660	467.397	107.689	29.263	15.425	0.326	0.228	0.186	0.203	0.195	0.226	0.271
2024	62.421	694.899	642.116	245.767	185.427	68.250	17.127	0.341	0.183	0.177	0.188	0.173	0.187	0.219

Table 4.6b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM tuning indices and standard deviations for the Northern Shelf cod stock (all substocks) in Q3+Q4.

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
1992	14277.824	1823.391	473.352	231.202	75.833	53.006	37.438	0.106	0.136	0.145	0.150	0.185	0.223	0.420
1993	3044.854	3660.936	772.451	200.236	87.938	27.715	47.270	0.130	0.130	0.185	0.205	0.209	0.226	0.389
1994	16611.958	2335.626	1132.404	194.718	45.881	33.313	22.486	0.117	0.124	0.152	0.233	0.232	0.318	0.781
1995	8722.007	5965.496	1480.845	666.940	85.640	22.189	36.647	0.120	0.123	0.254	0.297	0.342	0.319	0.504
1996	4170.208	2159.583	816.903	253.499	143.765	26.317	12.701	0.131	0.136	0.136	0.173	0.242	0.250	0.991
1997	24412.900	2046.902	828.245	314.578	68.237	39.524	22.306	0.140	0.151	0.167	0.203	0.222	0.253	0.658
1998	817.206	7176.263	574.042	148.648	79.217	28.684	20.812	0.145	0.126	0.139	0.182	0.231	0.236	0.443
1999	3334.735	458.606	1567.640	145.496	36.496	13.837	7.385	0.167	0.135	0.138	0.168	0.260	0.309	0.594
2000	5569.785	988.921	106.833	260.111	28.604	27.766	30.829	0.251	0.251	0.191	0.226	0.349	0.508	1.056
2001	1580.408	1868.790	352.650	76.617	43.118	26.141	37.885	0.186	0.134	0.140	0.213	0.246	0.278	0.680

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
2002	4505.680	863.840	771.813	212.689	49.032	17.900	5.519	0.182	0.138	0.136	0.163	0.186	0.290	0.862
2003	696.275	1116.556	260.393	190.810	85.606	66.523	28.660	0.155	0.143	0.153	0.181	0.225	0.267	0.544
2004	3185.547	707.353	450.303	81.308	69.109	19.860	0.000	0.191	0.138	0.155	0.198	0.196	0.256	#N/A
2005	1124.641	746.497	208.005	117.300	27.642	33.480	13.462	0.174	0.138	0.150	0.163	0.211	0.267	0.675
2006	4393.996	735.084	528.048	101.651	14.909	14.611	11.897	0.132	0.142	0.183	0.177	0.261	0.862	0.999
2007	2376.908	2638.209	436.702	167.706	62.915	36.803	27.319	0.191	0.156	0.158	0.160	0.184	0.212	0.499
2008	2553.977	1127.644	1081.024	210.542	77.275	25.081	12.063	0.184	0.157	0.144	0.156	0.179	0.213	0.799
2009	2089.633	831.245	282.605	258.828	49.510	23.002	29.895	0.194	0.162	0.175	0.206	0.214	0.237	0.500
2010	2670.464	1691.903	545.063	193.101	115.980	23.766	4.095	0.126	0.145	0.170	0.180	0.232	0.247	0.808
2011	1115.444	2971.414	1475.166	348.978	141.370	122.209	14.515	0.149	0.121	0.174	0.157	0.231	0.248	0.685
2012	2368.991	954.786	1343.535	440.895	95.587	19.756	27.245	0.174	0.142	0.135	0.137	0.188	0.239	0.582
2013	2122.963	1100.328	523.566	635.270	175.727	67.948	35.423	0.143	0.153	0.141	0.152	0.189	0.217	0.549
2014	2659.548	1578.346	747.703	311.803	220.466	90.985	54.545	0.138	0.131	0.150	0.145	0.157	0.164	0.384
2015	1443.613	3007.419	1297.103	487.317	150.116	143.110	58.376	0.150	0.123	0.139	0.138	0.160	0.181	0.468
2016	1061.540	1204.111	1728.280	1212.009	209.755	125.710	85.350	0.163	0.135	0.134	0.153	0.162	0.172	0.395
2017	4844.088	617.886	700.712	541.156	302.172	52.910	55.553	0.128	0.135	0.155	0.149	0.166	0.180	0.494
2018	739.736	1902.009	373.891	461.214	291.684	159.028	20.584	0.148	0.137	0.134	0.186	0.201	0.199	0.522
2019	1620.285	391.028	532.882	140.380	79.212	45.773	30.532	0.127	0.138	0.151	0.160	0.184	0.214	0.605

	1	2	3	4	5	6	7+	1	2	3	4	5	6	7+
2020	2941.713	1178.558	204.820	242.536	69.354	29.670	31.107	0.167	0.130	0.147	0.161	0.189	0.212	0.506
2021	1386.041	2502.909	725.916	167.225	114.551	18.777	23.317	0.132	0.135	0.144	0.150	0.158	0.224	0.658
2022	2899.163	970.557	989.579	425.249	107.192	84.538	23.799	0.152	0.139	0.149	0.162	0.197	0.207	0.575
2023	1418.414	1505.409	659.464	522.589	188.838	40.855	26.447	0.165	0.133	0.141	0.140	0.167	0.204	0.622

Table 4.6c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM recruitment indices and standard deviations by substock. These indices consist of age 0 cod from the Q3+Q4 surveys forward shifted to represent age 1 on 1st January.

	Northwestern	Southern	Viking	Northwestern	Southern	Viking
1993	1785.863	1557.694	3496.033	0.322	0.293	0.329
1994	1052.254	3561.443	1926.993	0.460	0.340	0.343
1995	2641.165	4171.815	5488.680	0.276	0.355	0.270
1996	392.906	3644.603	3331.003	0.611	0.337	0.392
1997	3696.775	8497.434	5419.703	0.275	0.375	0.326
1998	31.448	46.587	126.736	0.508	0.446	0.455
1999	252.327	2908.418	4741.383	0.461	0.584	0.430
2000	329.224	392.184	1186.184	0.387	0.541	0.407
2001	61.471	311.904	819.432	0.873	0.697	1.023
2002	72.464	10192.630	2694.625	0.674	0.615	0.481
2003	23.818	207.730	200.479	0.635	0.993	0.467
2004	45.062	1456.929	2700.610	0.676	0.847	0.464
2005	30.248	1266.227	350.886	0.745	0.754	0.462
2006	1458.418	386.997	1550.507	0.461	0.524	0.460
2007	66.443	1594.095	902.468	0.656	0.633	0.519
2008	54.695	5090.079	1060.548	0.670	0.564	0.432
2009	56.347	56.103	433.389	0.725	1.353	0.553
2010	108.410	310.097	790.121	0.482	0.911	0.552
2011	3.024	27.547	118.228	0.705	0.901	0.688
2012	10.385	222.512	3971.370	0.899	0.972	0.461
2013	47.390	473.902	274.114	0.638	0.932	0.489
2014	69.543	85.354	103.850	0.772	0.751	0.511
2015	152.913	55.583	315.528	0.398	0.686	0.513
2016	36.837	14.712	18.190	0.737	0.948	0.603
2017	2444.143	263.340	459.047	0.320	0.576	0.380
2018	88.512	24.723	158.024	0.637	1.013	0.482
2019	97.494	22.917	71.453	0.611	1.056	0.686

	Northwestern	Southern	Viking	Northwestern	Southern	Viking
2020	481.526	230.030	1354.319	0.341	0.588	0.428
2021	435.726	95.654	423.706	0.336	0.656	0.469
2022	119.324	167.109	1879.976	0.423	0.668	0.613
2023	84.299	102.359	2922.798	0.569	0.976	0.665
2024	11.966	36.527	38.603	0.625	0.856	0.583

Table 4.7a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM final run stock-wise configuration. All three substocks were given the same stock-wise configuration.

```
# Configuration saved: Thu May  2 11:16:57 2024
#
# Where a matrix is specified rows corresponds to fleets and columns to ages.
# Same number indicates same parameter used
# Numbers (integers) starts from zero and must be consecutive
# Negative numbers indicate that the parameter is not included in the model
#
$minAge
# The minimium age class in the assessment
 1

$maxAge
# The maximum age class in the assessment
 7

$maxAgePlusGroup
# Is last age group considered a plus group for each fleet (1 yes, or 0 no).
 1 1 1 1 1 0 0 0 0 0

$keyLogFsta
# Coupling of the fishing mortality states processes for each age (normally only
# the first row (= fleet) is used).
# Sequential numbers indicate that the fishing mortality is estimated individually
# for those ages; if the same number is used for two or more ages, F is bound for
# those ages (assumed to be the same). Binding fully selected ages will result in a
# flat selection pattern for those ages.
   0   1   2   3   4   5   6
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$keyLogFmu
#
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$keyLogFrho
#
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$corFlag
# Correlation of fishing mortality across ages (0 independent, 1 compound symmetry,
# 2 AR(1), 3 separable AR(1).
# 0: independent means there is no correlation between F across age
```

```
# 1: compound symmetry means that all ages are equally correlated;
# 2: AR(1) first order autoregressive - similar ages are more highly correlated than
# ages that are further apart, so similar ages have similar F patterns over time.
# if the estimated correlation is high, then the F pattern over time for each age
# varies in a similar way. E.g if almost one, then they are parallel (like a
# separable model) and if almost zero then they are independent.
# 3: Separable AR - Included for historic reasons . . .  more later
 2

$keyLogFpar
# Coupling of the survey catchability parameters (nomally first row is
# not used, as that is covered by fishing mortality).
  -1  -1  -1  -1  -1  -1  -1
   0   1   2   3   3   4   4
   5   6   7   7   7   8   9
  10  11  12  13  14  15  15
  16  17  17  17  17  17  17
  18  -1  -1  -1  -1  -1  -1
  19  -1  -1  -1  -1  -1  -1
  20  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$keyQpow
# Density dependent catchability power parameters (if any).
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$keyVarF
# Coupling of process variance parameters for log(F)-process (Fishing mortality
# normally applies to the first (fishing) fleet; therefore only first row is used)
   0   0   1   1   1   1   1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$keyVarLogN
# Coupling of the recruitment and survival process variance parameters for the
# log(N)-process at the different ages. It is advisable to have at least the first age
# class (recruitment) separate, because recruitment is a different process than
# survival.
 0 1 1 1 1 1 1

$keyVarLogP
#


$keyVarObs
# Coupling of the variance parameters for the observations.
# First row refers to the coupling of the variance parameters for the catch data
# observations by age
# Second and further rows refers to coupling of the variance parameters for the
# index data observations by age
   0   1   2   2   2   2   2
   3   4   4   4   5   5   6
```

```
   7   8   8   8   9  10  10
  11  12  13  13  13  13  13
  14  14  15  15  15  16  16
  17  -1  -1  -1  -1  -1  -1
  18  -1  -1  -1  -1  -1  -1
  19  -1  -1  -1  -1  -1  -1
  20  20  20  -1  -1  -1  -1
  21  21  -1  -1  -1  -1  -1

$obsCorStruct
# Covariance structure for each fleet ("ID" independent, "AR" AR(1), or "US" for unstruc-
tured). | Possible values are: "ID" "AR" "US"
 "AR" "AR" "AR" "AR" "AR" "ID" "ID" "ID" "US" "US"

$keyCorObs
# Coupling of correlation parameters can only be specified if the AR(1) structure is
chosen above.
# NA's indicate where correlation parameters can be specified (-1 where they cannot).
#1-2 2-3 3-4 4-5 5-6 6-7
   0   1   2   2   2   2
   3   4   4   5   5   5
   6   6   7   7   8   8
   9   9   9   9   9   9
  10  11  11  11  11  11
  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1

$stockRecruitmentModelCode
# Stock recruitment code (0 for plain random walk, 1 for Ricker, 2 for Beverton-Holt, 3
piece-wise constant, 61 for segmented regression/hockey stick, 62 for AR(1), 63 for bent
hyperbola / smooth hockey stick, 64 for power function with degree < 1, 65 for power
function with degree > 1, 66 for Shepher, 67 for Deriso, 68 for Saila-Lorda, 69 for
```

```
sigmoidal Beverton-Holt, 90 for CMP spline, 91 for more flexible spline, and 92 for most
flexible spline).
 0

$noScaledYears
# Number of years where catch scaling is applied.
 0

$keyScaledYears
# A vector of the years where catch scaling is applied.


$keyParScaledYA
# A matrix specifying the couplings of scale parameters (nrow = no scaled years, ncols =
no ages).

$fbarRange
# lowest and higest age included in Fbar
 2 4

$keyBiomassTreat
# To be defined only if a biomass survey is used (0 SSB index, 1 catch index, 2 FSB index,
3 total catch, 4 total landings, 5 TSB index,  6 TSN index, and 10 Fbar idx).
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1

$obsLikelihoodFlag
# Option for observational likelihood | Possible values are: "LN" "ALN" "Dirichlet"
 "LN" "LN" "LN" "LN" "LN" "LN" "LN" "LN" "ALN" "ALN"

$fixVarToWeight
# If weight attribute is supplied for observations this option sets the treatment (0
relative weight, 1 fix variance to weight).
 0

$fracMixF
# The fraction of t(3) distribution used in logF increment distribution
 0

$fracMixN
# The fraction of t(3) distribution used in logN increment distribution (for each age
group)
 0 0 0 0 0 0 0

$fracMixObs
# A vector with same length as number of fleets, where each element is the fraction of
t(3) distribution used in the distribution of that fleet
 0 0 0 0 0 0 0 0 0 0

$constRecBreaks
# For stock-recruitment code 3: Vector of break years between which recruitment is at
constant level. The break year is included in the left interval. For spline stock-
```

```
recruitment: Vector of log-ssb knots. (This option is only used in combination with stock-
recruitment code 3, 90-92, and 290)


$predVarObsLink
# Coupling of parameters used in a prediction-variance link for observations.
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  NA  NA  NA  NA  NA  NA  NA
  NA  NA  NA  NA  NA  NA  NA
  NA  NA  NA  NA  NA  NA  NA
  NA  NA  NA  NA  NA  NA  NA
  NA  NA  NA  NA  NA  NA  NA

$stockWeightModel
# Integer code describing the treatment of stock weights in the model (0 use as known, 1
use as observations to inform stock weight process (GMRF with cohort and within year
correlations)), 2 to add extra correlation to plusgroup
 2

$keyStockWeightMean
# Coupling of stock-weight process mean parameters (not used if stockWeightModel==0)
 0 1 2 3 4 5 6

$keyStockWeightObsVar
# Coupling of stock-weight observation variance parameters (not used if stockWeight-
Model==0)
 0 0 0 0 0 0 0

$catchWeightModel
# Integer code describing the treatment of catch weights in the model (0 use as known, 1
use as observations to inform catch weight process (GMRF with cohort and within year
correlations)), 2 to add extra correlation to plusgroup
 0

$keyCatchWeightMean
# Coupling of catch-weight process mean parameters (not used if catchWeightModel==0)
  NA  NA  NA  NA  NA  NA  NA

$keyCatchWeightObsVar
# Coupling of catch-weight observation variance parameters (not used if catchWeight-
Model==0)
  NA  NA  NA  NA  NA  NA  NA

$matureModel
# Integer code describing the treatment of proportion mature in the model (0 use as known,
1 use as observations to inform proportion mature process (GMRF with cohort and within
year correlations on logit(proportion mature))), 2 to add extra correlation to plusgroup
 2

$keyMatureMean
# Coupling of mature process mean parameters (not used if matureModel==0)
 0 1 2 3 4 5 6

$mortalityModel
# Integer code describing the treatment of natural mortality in the model (0 use as known,
1 use as observations to inform natural mortality process (GMRF with cohort and within
year correlations)), 2 to add extra correlation to plusgroup
 1

$keyMortalityMean
#
 0 1 2 3 3 3 3

$keyMortalityObsVar
```

```
# Coupling of natural mortality observation variance parameters (not used if mortali-
tyModel==0)
 0 0 0 0 0 0 0

$keyXtraSd
# An integer matrix with 4 columns (fleet year age coupling), which allows additional
uncertainty to be estimated for the specified observations

$logNMeanAssumption
# Flags indicating what the population model should correspond to. 0: Median, 1: Mean,
2: Mode. Two values are are given to differentiate recruitment and other ages.
 0 0

$initState
# Flag indicating whether initial parameters should be added for the latent processes.
 0

$recruitmentAutocorrelation
# Number of auto-correlation parameters for recruitment. The auto-regressive process is
forced to be stationary with real characteristic roots.
 0

$keyLogFseason
#
   0   0   0   0   0   0   0
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$seasonTimes
#
 0 0.25 0.5 0.75 1

$isFishingSeason
#
 1 1 1 1

$seasonFirstYear
#
 -Inf

$seasonFixedEffect
#
 1

$keyMatureObsVar
#
```

Table 4.7b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM final run stock-complex configuration arguments.

```
$newtonsteps
0

$rm.unidentified
FALSE

$lower
list(initLogN = 10, shared_lfsSd = -3, logSdLogObs = -5, logitArea = -5, sigmaObsParUS =
-3, transfIRARdist = -3, seasonMu = -8)

$upper
list(initLogN = 15, transfIRARdist = 3, logSdMO = 5, logSdLogObs = 2, logitArea = 5,
```

```
sigmaObsParUS = 3)

$starting
list()

$shared_keys
c("keyLogFpar", "keyQpow", "keyVarF", "keyVarLogN", "keyVarObs", "keyCorObs", "sea-
sonRho", "seasonSd", "keyLogFmu", "keyLogFrho", "keyStockWeightObsVar", "procSdSW",
"phiSW", "procSdMO", "phiMO", "sdMO", "keyMortalityObsVar", "procSdNM", "phiNM", "keyMor-
talityMean", "sigmaObsParUS", "rec_transphi", "predVarObsLink", "keyXtraSd")

$shared_selectivity
4L

$shared_seasonality
0L

$shared_stockrecruitment
FALSE

$shared_oneFScalePars
TRUE

$shared_initN
FALSE

$shared_proportionalHazard
~poly(Age,3)

$skip_stock_observations
TRUE

$initN
2L

$initF
FALSE

$inner.control
list(maxit = 2000)
```

Finally, the following fleet-to-stock key was passed to the fitting procedure with the shared observations:

Table 4.7c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM final run fleet-to-stock key.

	North-west	South	Viking
Catch	1	1	1
Survey_Q34	1	1	1
Survey_Q1_NW	1	0	0
Survey_Q1_SO	0	1	0
Survey_Q1_VI	0	0	1
Survey_Rec_NW	1	0	0
Survey_Rec_SO	0	0.75	0
Survey_Rec_VI	0	0.25	1
AUX_SeasonProp	1	1	1
AUX_SubNew	1	1	1

Table 4.7d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM final run model fitting diagnostics.

Model fitting		
log(L)	#par	AIC
1486.899	146	-2681.798

Table 4.8. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20: Multistock SAM final run estimated fishing mortality-at-age for each substock.

Northwestern

	1	2	3	4	5	6	7+	Fbar
1983	0.289	0.932	0.776	0.756	0.632	0.671	1.01	0.821
1984	0.333	1.073	0.914	0.879	0.761	0.817	1.184	0.955
1985	0.328	1.055	0.921	0.871	0.751	0.802	1.125	0.949
1986	0.329	1.071	0.984	0.923	0.792	0.822	1.089	0.993
1987	0.302	0.999	0.95	0.883	0.756	0.788	0.981	0.944
1988	0.276	0.916	0.915	0.835	0.725	0.74	0.855	0.888
1989	0.293	0.982	0.989	0.916	0.795	0.793	0.851	0.962
1990	0.308	1.048	1.043	0.989	0.88	0.863	0.866	1.027
1991	0.292	1.004	1.025	0.986	0.912	0.913	0.883	1.005
1992	0.269	0.932	0.956	0.923	0.864	0.877	0.826	0.937
1993	0.264	0.938	0.972	0.904	0.85	0.861	0.782	0.938
1994	0.257	0.926	1.012	0.918	0.857	0.863	0.756	0.952
1995	0.269	1.017	1.131	0.994	0.914	0.901	0.763	1.048
1996	0.263	1.032	1.203	1.04	0.967	0.943	0.785	1.092
1997	0.232	0.917	1.12	1	0.937	0.903	0.73	1.012
1998	0.24	0.968	1.22	1.115	1.058	0.987	0.761	1.101
1999	0.231	0.944	1.249	1.178	1.13	1.062	0.799	1.124
2000	0.213	0.881	1.175	1.189	1.187	1.111	0.816	1.082
2001	0.181	0.755	1.007	1.033	1.05	1.005	0.74	0.931
2002	0.175	0.731	0.983	1.008	1.003	0.983	0.717	0.907
2003	0.155	0.652	0.904	0.945	0.938	0.919	0.662	0.834
2004	0.149	0.629	0.891	0.925	0.928	0.91	0.638	0.815
2005	0.132	0.558	0.809	0.834	0.873	0.867	0.598	0.733
2006	0.12	0.511	0.736	0.744	0.813	0.835	0.574	0.664
2007	0.109	0.464	0.698	0.704	0.778	0.812	0.556	0.622
2008	0.11	0.478	0.757	0.763	0.877	0.925	0.628	0.666
2009	0.097	0.419	0.698	0.727	0.865	0.936	0.644	0.615

	1	2	3	4	5	6	7+	Fbar
2010	0.085	0.369	0.642	0.679	0.836	0.909	0.64	0.563
2011	0.073	0.309	0.56	0.612	0.775	0.85	0.606	0.494
2012	0.071	0.303	0.556	0.616	0.797	0.867	0.623	0.491
2013	0.067	0.284	0.532	0.594	0.772	0.825	0.608	0.47
2014	0.059	0.251	0.479	0.53	0.685	0.721	0.542	0.42
2015	0.059	0.251	0.481	0.528	0.683	0.702	0.538	0.42
2016	0.065	0.279	0.54	0.589	0.76	0.753	0.584	0.469
2017	0.076	0.336	0.655	0.726	0.927	0.9	0.701	0.572
2018	0.086	0.385	0.758	0.833	1.091	1.06	0.855	0.659
2019	0.073	0.326	0.655	0.731	0.975	0.972	0.808	0.571
2020	0.057	0.249	0.502	0.58	0.78	0.794	0.67	0.444
2021	0.044	0.19	0.388	0.468	0.641	0.663	0.584	0.349
2022	0.04	0.171	0.35	0.431	0.594	0.63	0.565	0.318
2023	0.04	0.172	0.352	0.436	0.599	0.643	0.575	0.32

Southern

	1	2	3	4	5	6	7+	Fbar
1983	0.385	1.272	1.072	1.029	0.809	0.755	0.919	1.125
1984	0.451	1.487	1.282	1.215	0.988	0.934	1.092	1.328
1985	0.442	1.455	1.287	1.198	0.97	0.912	1.033	1.313
1986	0.439	1.459	1.357	1.254	1.011	0.923	0.988	1.356
1987	0.397	1.341	1.292	1.182	0.951	0.872	0.876	1.271
1988	0.357	1.215	1.229	1.105	0.901	0.809	0.756	1.183
1989	0.379	1.297	1.324	1.208	0.985	0.864	0.749	1.276
1990	0.401	1.396	1.407	1.313	1.098	0.948	0.768	1.372
1991	0.376	1.321	1.366	1.294	1.125	0.991	0.774	1.327
1992	0.338	1.198	1.245	1.184	1.041	0.93	0.707	1.209
1993	0.322	1.17	1.228	1.125	0.994	0.885	0.649	1.174
1994	0.307	1.131	1.252	1.118	0.981	0.869	0.615	1.167
1995	0.317	1.226	1.382	1.196	1.033	0.896	0.613	1.268

	1	2	3	4	5	6	7+	Fbar
1996	0.311	1.247	1.472	1.254	1.095	0.94	0.632	1.325
1997	0.271	1.098	1.359	1.195	1.052	0.892	0.582	1.217
1998	0.289	1.192	1.522	1.37	1.222	1.002	0.624	1.361
1999	0.286	1.196	1.604	1.489	1.343	1.11	0.675	1.429
2000	0.271	1.147	1.55	1.545	1.45	1.193	0.708	1.414
2001	0.232	0.989	1.337	1.35	1.29	1.087	0.646	1.225
2002	0.227	0.97	1.321	1.334	1.248	1.076	0.634	1.208
2003	0.201	0.865	1.215	1.251	1.167	1.006	0.585	1.11
2004	0.197	0.85	1.221	1.248	1.177	1.015	0.575	1.107
2005	0.173	0.749	1.1	1.117	1.099	0.96	0.535	0.989
2006	0.158	0.688	1.005	1.001	1.027	0.928	0.515	0.898
2007	0.145	0.631	0.962	0.956	0.993	0.911	0.504	0.85
2008	0.152	0.672	1.079	1.071	1.156	1.072	0.588	0.941
2009	0.137	0.607	1.026	1.052	1.175	1.12	0.622	0.895
2010	0.126	0.555	0.978	1.02	1.179	1.128	0.641	0.851
2011	0.108	0.472	0.866	0.932	1.109	1.071	0.616	0.757
2012	0.108	0.468	0.871	0.951	1.156	1.106	0.642	0.763
2013	0.102	0.443	0.842	0.925	1.131	1.063	0.633	0.737
2014	0.091	0.392	0.758	0.825	1.003	0.928	0.564	0.658
2015	0.091	0.395	0.767	0.829	1.007	0.911	0.564	0.664
2016	0.099	0.435	0.853	0.918	1.112	0.969	0.607	0.735
2017	0.113	0.509	1.006	1.099	1.318	1.126	0.708	0.871
2018	0.124	0.571	1.139	1.233	1.517	1.296	0.845	0.981
2019	0.102	0.465	0.947	1.04	1.304	1.143	0.767	0.817
2020	0.078	0.346	0.706	0.804	1.016	0.909	0.62	0.619
2021	0.059	0.259	0.537	0.638	0.821	0.747	0.531	0.478
2022	0.052	0.228	0.474	0.575	0.744	0.694	0.503	0.426
2023	0.052	0.231	0.477	0.582	0.752	0.709	0.513	0.43

Viking

	1	2	3	4	5	6	7+	Fbar
1983	0.069	0.554	0.673	0.696	0.553	0.616	1.321	0.641
1984	0.078	0.625	0.777	0.793	0.652	0.735	1.516	0.732
1985	0.076	0.609	0.776	0.778	0.637	0.714	1.427	0.721
1986	0.077	0.618	0.828	0.825	0.673	0.732	1.382	0.757
1987	0.069	0.566	0.786	0.775	0.631	0.69	1.222	0.709
1988	0.062	0.512	0.746	0.723	0.596	0.638	1.051	0.66
1989	0.066	0.549	0.808	0.794	0.655	0.685	1.047	0.717
1990	0.069	0.582	0.846	0.851	0.72	0.74	1.058	0.76
1991	0.066	0.558	0.831	0.848	0.746	0.783	1.079	0.746
1992	0.06	0.516	0.773	0.792	0.704	0.75	1.006	0.694
1993	0.059	0.521	0.787	0.777	0.695	0.737	0.954	0.695
1994	0.058	0.516	0.823	0.792	0.703	0.741	0.926	0.71
1995	0.06	0.565	0.918	0.856	0.748	0.773	0.933	0.78
1996	0.058	0.56	0.952	0.874	0.772	0.79	0.937	0.795
1997	0.049	0.484	0.862	0.817	0.728	0.735	0.847	0.721
1998	0.05	0.499	0.919	0.891	0.804	0.785	0.864	0.77
1999	0.048	0.489	0.945	0.945	0.862	0.849	0.911	0.793
2000	0.045	0.457	0.89	0.956	0.907	0.889	0.931	0.768
2001	0.038	0.391	0.761	0.828	0.8	0.804	0.843	0.66
2002	0.036	0.371	0.728	0.792	0.749	0.77	0.8	0.63
2003	0.033	0.341	0.689	0.764	0.721	0.741	0.761	0.598
2004	0.032	0.331	0.686	0.755	0.72	0.74	0.739	0.59
2005	0.029	0.3	0.636	0.696	0.692	0.721	0.708	0.544
2006	0.026	0.275	0.579	0.621	0.645	0.695	0.68	0.492
2007	0.023	0.246	0.541	0.579	0.608	0.665	0.65	0.456
2008	0.024	0.254	0.588	0.629	0.686	0.759	0.734	0.49
2009	0.021	0.226	0.55	0.608	0.687	0.78	0.764	0.461
2010	0.019	0.198	0.503	0.565	0.661	0.754	0.756	0.422
2011	0.016	0.168	0.444	0.514	0.619	0.712	0.723	0.375

	1	2	3	4	5	6	7+	Fbar
2012	0.016	0.165	0.442	0.52	0.639	0.729	0.747	0.376
2013	0.015	0.155	0.424	0.501	0.62	0.694	0.73	0.36
2014	0.013	0.135	0.375	0.44	0.541	0.597	0.639	0.317
2015	0.013	0.135	0.376	0.438	0.538	0.581	0.634	0.316
2016	0.014	0.154	0.435	0.504	0.618	0.642	0.709	0.365
2017	0.018	0.196	0.558	0.656	0.796	0.811	0.9	0.47
2018	0.021	0.229	0.66	0.769	0.957	0.975	1.12	0.553
2019	0.018	0.194	0.569	0.673	0.853	0.892	1.056	0.479
2020	0.013	0.144	0.424	0.52	0.665	0.709	0.853	0.363
2021	0.01	0.107	0.32	0.41	0.534	0.579	0.726	0.279
2022	0.009	0.097	0.291	0.38	0.498	0.554	0.708	0.256
2023	0.009	0.097	0.288	0.379	0.495	0.556	0.71	0.255

Table 4.9. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM final run estimated population numbers-at-age (start of year; thousands) for each substock.

Northwestern

	1	2	3	4	5	6	7+	Total
1983	495298	126085	23369	8212	3132	1364	571	658030
1984	731798	105151	31381	5614	4201	1239	715	880099
1985	218380	192471	15789	11089	1805	1764	535	441833
1986	640603	54574	31810	5467	3470	742	804	737471
1987	375906	176079	10611	8989	1749	1198	503	575035
1988	144239	109216	28701	3454	2739	749	560	289658
1989	522792	41199	23104	7963	1156	1123	500	597838
1990	158532	144918	7563	6063	2651	421	599	320747
1991	224142	41185	19539	2438	1769	893	367	290334
1992	545175	63591	7197	4589	866	562	424	622405
1993	256660	152504	12754	2341	1304	341	342	426245
1994	541219	72718	24285	3887	802	438	261	643610
1995	323505	147116	15239	6970	1199	279	258	494565
1996	160403	85069	21930	3529	2185	388	208	273712

	1	2	3	4	5	6	7+	Total
1997	604981	43491	13036	4898	1047	671	213	668336
1998	68241	164816	7947	3155	1408	332	305	246204
1999	97186	19295	24699	1757	877	343	241	144398
2000	204024	27473	4135	4280	456	236	184	240788
2001	66796	64694	5033	1108	990	110	127	138859
2002	96924	21179	13831	1566	318	288	77	134183
2003	57124	27846	3925	3184	447	95	117	92738
2004	88633	16947	4921	1177	942	135	73	112828
2005	72243	21944	3352	1210	361	307	73	99490
2006	276519	18008	4442	976	367	127	139	300578
2007	88303	72725	4029	1479	358	136	102	167131
2008	100705	20474	15429	1316	558	142	91	138714
2009	179004	24174	4369	3865	487	177	89	212165
2010	218282	48253	5716	1381	1464	182	87	275365
2011	98277	64920	11870	1804	653	518	99	178141
2012	151571	27861	18274	4198	787	253	231	203176
2013	203996	36967	7690	6429	1759	279	193	257313
2014	254748	52739	10420	3124	2712	616	193	324553
2015	154994	73182	17029	4232	1441	1107	332	252316
2016	102382	41952	20937	8177	1818	580	578	176423
2017	278245	25204	12280	7780	3331	693	487	328019
2018	64731	63875	6477	4586	2392	1026	480	143566
2019	140963	15246	12565	1893	1534	585	458	173245
2020	185038	38554	4394	3554	742	479	330	233090
2021	133990	49308	10897	2092	1426	275	331	198319
2022	159469	36972	15120	4680	1126	593	269	218229
2023	100437	42978	11526	6803	2334	541	368	164988
2024	54778	26936	12081	5006	3367	1091	387	103647

Southern

	1	2	3	4	5	6	7+	Total
1983	333710	76879	10072	2626	762	278	107	424435
1984	697319	72915	11247	1889	820	240	139	784569
1985	139006	155487	8194	2370	446	252	105	305857
1986	852569	29922	15837	1869	605	145	106	901052
1987	324312	207766	3381	3160	410	187	86	539301
1988	243305	76446	26062	712	755	152	89	347522
1989	301331	63294	10758	5275	230	244	89	381221
1990	133154	76132	8748	1972	1248	82	123	221459
1991	138965	33074	8676	1654	389	322	74	183153
1992	244712	34188	4434	1752	361	94	114	285656
1993	166349	62087	4547	1107	479	97	69	234734
1994	400617	44715	8782	1081	329	153	59	455735
1995	260675	102914	7708	1859	302	103	79	373641
1996	214822	65846	14334	1476	479	87	72	297117
1997	570869	55775	9098	2484	345	134	60	638764
1998	55411	160940	9393	1906	632	105	78	228466
1999	120647	16094	21665	1470	419	146	77	160517
2000	110199	32245	2631	2889	279	97	78	148418
2001	68127	33588	4643	474	423	48	56	107360
2002	141871	21147	5511	917	98	93	38	169676
2003	50888	38846	3400	1102	176	24	41	94478
2004	88220	14712	6780	697	268	43	25	110745
2005	91520	20968	2322	1133	136	72	23	116174
2006	109822	23319	3758	480	242	37	35	137693
2007	131227	26588	4039	927	145	72	28	163028
2008	117884	30628	4988	973	313	49	40	154877
2009	47672	26986	5253	1096	255	80	36	81379
2010	76401	11501	5045	1187	312	65	37	94549
2011	52857	21119	2388	1101	344	77	32	77918

	1	2	3	4	5	6	7+	Total
2012	55077	13954	4880	701	317	92	35	75057
2013	52969	13386	2981	1242	243	72	39	70932
2014	64288	12893	3036	762	390	59	35	81463
2015	21374	17567	3150	905	271	112	34	43413
2016	14653	5403	3809	835	316	82	55	25154
2017	28873	3651	1260	887	250	80	50	35051
2018	11840	6897	798	290	219	53	41	20137
2019	15641	2779	1217	153	63	37	26	19917
2020	22995	3991	643	271	42	14	20	27974
2021	22481	6156	1088	199	90	13	14	30040
2022	48501	5915	1606	376	82	31	11	56524
2023	31277	13082	1648	570	164	32	18	46791
2024	16844	8046	3596	562	248	63	22	29380

Viking

	1	2	3	4	5	6	7+	Total
1983	102434	32403	8721	3384	1368	644	285	149240
1984	117928	34517	9796	2680	1518	576	339	167354
1985	32873	42562	9962	3657	979	668	279	90981
1986	111063	10416	11314	3688	1396	447	324	138648
1987	55818	41166	2811	3356	1179	578	230	105137
1988	52091	20746	11016	1128	1269	489	298	87037
1989	78558	16671	7188	3451	532	603	287	107289
1990	40276	27378	4860	2048	1203	224	349	76338
1991	44541	13369	6862	1667	654	477	206	67776
1992	85330	14757	3570	2163	577	241	254	106891
1993	56219	29859	4056	1355	829	245	171	92734
1994	104065	18662	7540	1469	570	322	157	132784
1995	75266	36071	5565	2513	513	230	183	120340
1996	50355	23429	8359	1648	866	199	155	85012

	1	2	3	4	5	6	7+	Total
1997	121012	16124	5621	2107	626	332	123	145944
1998	16964	44626	4432	1767	764	265	174	68993
1999	42242	5150	12258	1471	630	274	174	62199
2000	60872	13878	1461	2845	525	239	155	79975
2001	26921	23377	3756	567	679	167	131	55598
2002	38247	9236	7224	1228	218	222	104	56480
2003	25472	12562	2715	2344	512	90	116	43811
2004	52104	8345	3329	926	806	215	75	65800
2005	35914	14610	2318	981	372	325	112	54632
2006	71575	9862	3649	738	350	164	171	86509
2007	31532	20150	2700	1056	356	148	131	56074
2008	39521	7937	5588	971	496	167	106	54785
2009	46626	10134	2122	1924	448	192	106	61551
2010	69332	12817	2772	838	828	187	97	86872
2011	35509	21425	3888	1178	399	378	98	62876
2012	60065	9810	6657	1825	603	184	175	79318
2013	63054	15041	3198	2385	916	264	142	85001
2014	78800	18105	4294	1297	1094	366	157	104113
2015	41047	25630	6437	1939	657	504	202	76415
2016	25391	11664	9266	3286	1052	320	304	51283
2017	55794	7080	4178	3706	1889	446	244	73337
2018	18149	16489	2386	1504	1290	707	251	40776
2019	33346	4760	4615	762	528	392	285	44688
2020	71410	10012	1562	1398	331	168	213	85095
2021	34468	22071	3765	784	525	142	151	61907
2022	48389	10163	7770	1869	428	245	126	68988
2023	22487	13474	3720	3109	929	217	154	44091
2024	7418	5904	4624	1752	1522	493	158	21871

Table 4.10. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20: Multistock SAM final run estimated catches-at-age (thousands) for each substock.

Northwestern

	1	2	3	4	5	6	7+
1983	67812	51457	10851	3883	1311	596	326
1984	117476	47559	16310	2939	2003	620	447
1985	34042	86218	8235	5771	853	871	325
1986	104058	24938	17251	2940	1700	373	480
1987	56189	76973	5630	4692	830	585	282
1988	19589	44728	14842	1731	1263	350	288
1989	76654	17419	12473	4248	568	551	257
1990	23984	63309	4211	3390	1390	218	311
1991	32542	17533	10776	1369	950	479	193
1992	75220	26056	3850	2480	449	294	214
1993	34278	63057	6909	1249	670	177	166
1994	70197	29900	13398	2094	414	227	124
1995	43484	63925	8929	3942	644	149	123
1996	20648	37030	13270	2048	1215	213	101
1997	70949	17683	7603	2764	571	358	99
1998	8038	68526	4808	1890	826	187	145
1999	11232	7741	15031	1081	534	202	119
2000	22917	10630	2435	2636	285	142	92
2001	6386	22458	2677	631	578	63	60
2002	8630	6915	7041	875	181	162	35
2003	4358	7977	1844	1692	244	51	50
2004	6236	4564	2249	607	511	73	31
2005	4387	5266	1424	590	188	160	29
2006	15351	4026	1787	445	183	65	54
2007	4377	14978	1563	662	173	68	39
2008	4979	4259	6308	616	292	77	38
2009	7981	4539	1701	1778	253	96	38

	1	2	3	4	5	6	7+
2010	8912	8443	2122	608	743	98	37
2011	3325	9578	4021	737	315	266	40
2012	4906	3942	5889	1723	387	131	96
2013	6193	4942	2405	2564	847	140	78
2014	7096	6457	3026	1141	1201	283	72
2015	4272	8948	4930	1533	637	499	123
2016	3085	5652	6720	3145	865	274	228
2017	10013	4065	4648	3498	1803	369	219
2018	2530	11337	2675	2251	1428	602	247
2019	4872	2400	4696	849	857	327	227
2020	5230	4947	1348	1362	360	235	144
2021	2864	4898	2661	687	603	119	131
2022	2953	3235	3315	1412	450	248	104
2023	1872	3773	2555	2073	937	229	144

Southern

	1	2	3	4	5	6	7+
1983	59484	38344	5751	1514	379	132	58
1984	146574	40172	7122	1198	463	131	83
1985	28309	84708	5191	1492	249	135	61
1986	178686	16476	10295	1201	346	79	60
1987	61919	109358	2142	1964	226	98	45
1988	41992	37729	16063	425	403	76	42
1989	55810	32073	6858	3312	130	127	42
1990	25604	39894	5744	1294	750	45	59
1991	25395	16824	5621	1084	237	182	36
1992	41679	16570	2768	1097	211	51	52
1993	26764	29840	2824	674	271	51	29
1994	61484	21109	5479	656	185	80	24
1995	40985	50767	5037	1170	175	55	32

	1	2	3	4	5	6	7+
1996	32473	32586	9648	952	287	48	30
1997	78122	25770	5903	1555	202	71	24
1998	7815	77190	6373	1276	403	60	32
1999	17107	7594	14957	1020	280	88	34
2000	15546	14968	1789	2031	193	61	36
2001	8258	14186	2905	313	277	29	24
2002	16235	8520	3338	600	63	55	16
2003	5010	13890	1919	690	109	14	16
2004	8180	5033	3772	429	167	25	10
2005	7307	6416	1207	663	82	40	8
2006	8034	6683	1867	266	140	20	12
2007	8687	7112	1955	508	82	39	10
2008	8024	8476	2580	565	194	29	16
2009	3011	6950	2656	639	159	49	15
2010	4579	2855	2507	682	195	39	16
2011	2673	4523	1108	600	208	46	13
2012	2705	2904	2181	387	196	55	15
2013	2464	2663	1306	672	148	43	17
2014	2742	2356	1247	383	222	32	13
2015	909	3225	1296	453	155	60	13
2016	676	1082	1707	437	191	46	23
2017	1544	847	639	520	165	49	23
2018	673	1718	429	180	155	35	21
2019	757	598	588	86	42	23	12
2020	887	691	256	131	24	7	8
2021	647	819	346	83	45	6	5
2022	1185	682	453	142	38	14	4
2023	770	1517	470	218	77	14	7

Viking

	1	2	3	4	5	6	7+
1983	4123	9851	3766	1541	528	270	193
1984	5491	11677	4699	1338	662	273	245
1985	1475	14110	4768	1803	420	311	196
1986	5154	3521	5653	1884	623	212	224
1987	2327	13005	1355	1642	502	262	149
1988	1935	6006	5117	524	518	210	178
1989	3157	5051	3509	1714	233	272	171
1990	1671	8633	2446	1066	563	107	209
1991	1762	4075	3416	870	314	237	125
1992	3158	4259	1708	1080	266	116	147
1993	2024	8718	1969	668	378	117	96
1994	3643	5416	3751	733	262	154	87
1995	2739	11216	2963	1321	246	113	102
1996	1720	7187	4549	878	425	99	87
1997	3614	4428	2877	1069	295	158	64
1998	501	12453	2344	947	385	132	92
1999	1223	1390	6561	815	333	143	95
2000	1689	3572	753	1582	287	129	86
2001	629	5272	1724	288	342	84	68
2002	821	1934	3139	603	105	109	52
2003	484	2357	1109	1113	240	43	56
2004	930	1487	1335	430	377	103	36
2005	567	2346	873	434	169	152	52
2006	1029	1463	1290	303	151	75	77
2007	400	2699	908	419	148	66	57
2008	502	1081	1995	405	224	81	50
2009	537	1247	725	794	203	95	52
2010	719	1437	893	329	365	90	47
2011	309	2030	1141	430	168	176	46

	1	2	3	4	5	6	7+
2012	506	899	1880	672	259	87	84
2013	499	1297	874	852	385	121	67
2014	557	1393	1068	417	415	150	67
2015	287	1971	1597	619	248	202	86
2016	201	1023	2622	1150	441	138	141
2017	556	787	1463	1589	946	226	133
2018	203	2086	935	718	727	403	156
2019	325	524	1623	330	277	212	171
2020	546	858	437	504	147	78	112
2021	195	1418	818	236	197	57	71
2022	241	582	1524	520	152	94	58
2023	111	766	728	864	328	84	72

Table 4.11. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM final run estimated stock weights-at-age (kg) for each substock.

Northwestern

	1	2	3	4	5	6	7+
1983	0.07	0.547	1.545	4.176	7.137	10.789	12.542
1984	0.054	0.453	1.774	4.07	6.883	9.508	12.639
1985	0.072	0.387	1.697	4.233	6.211	9.274	12.574
1986	0.056	0.491	1.537	3.805	6.734	8.87	12.381
1987	0.086	0.379	1.473	4.148	6.866	9.278	12.422
1988	0.082	0.504	1.488	3.594	7.012	8.933	12.477
1989	0.071	0.446	1.536	3.724	6.04	9.244	12.495
1990	0.058	0.427	1.494	4.103	6.802	8.681	12.55
1991	0.081	0.496	1.654	3.999	7.164	9.88	12.744
1992	0.057	0.579	1.941	4.494	6.889	9.87	12.897
1993	0.045	0.452	2.045	4.887	7.463	9.67	13.108
1994	0.045	0.376	1.682	4.927	8.024	9.613	13.055
1995	0.064	0.315	1.345	4.277	6.831	10.011	13.057
1996	0.076	0.488	1.403	4.057	6.857	8.648	12.729

	1	2	3	4	5	6	7+
1997	0.033	0.412	1.662	4.005	7.11	9.316	12.384
1998	0.091	0.29	1.531	4.221	6.968	9.478	12.164
1999	0.092	0.488	0.877	2.953	6.903	9.202	12.125
2000	0.076	0.527	1.744	2.702	5.271	8.644	12.066
2001	0.086	0.416	1.575	4.056	5.547	7.306	11.822
2002	0.084	0.402	1.35	3.965	5.888	8.62	11.716
2003	0.083	0.474	1.125	3.215	6.294	8.695	11.791
2004	0.071	0.396	1.364	3.459	6.194	10.092	11.67
2005	0.081	0.417	1.301	2.844	5.404	8.965	11.557
2006	0.068	0.488	1.435	3.013	5.342	6.025	11.149
2007	0.07	0.433	1.688	3.859	5.854	7.867	10.744
2008	0.076	0.514	1.651	4.485	6.595	7.886	10.515
2009	0.076	0.507	1.583	3.708	6.567	8.184	10.524
2010	0.086	0.566	1.834	3.626	6.049	7.671	10.479
2011	0.094	0.521	1.85	4.078	5.868	8.083	10.261
2012	0.108	0.629	1.606	3.784	6.024	7.876	10.066
2013	0.094	0.688	1.892	3.634	5.669	7.036	9.715
2014	0.072	0.585	1.877	3.786	5.401	7.084	9.454
2015	0.084	0.543	1.708	3.828	5.881	6.918	9.271
2016	0.076	0.624	1.734	3.648	5.778	7.465	9.304
2017	0.066	0.559	1.838	3.89	5.657	7.008	9.299
2018	0.071	0.416	1.711	3.586	5.645	6.588	9.341
2019	0.069	0.46	1.38	3.731	5.569	7.595	9.586
2020	0.077	0.499	1.725	3.454	5.374	7.812	9.961
2021	0.09	0.473	1.834	3.961	5.788	7.173	9.988
2022	0.108	0.465	1.407	4.306	6.086	7.941	10.052
2023	0.098	0.531	1.456	3.274	6.178	7.797	9.973
2024	0.098	0.487	1.454	3.091	5.154	7.484	10.009

Southern

	1	2	3	4	5	6	7+
1983	0.078	0.659	2.084	4.566	7.323	10.455	12.278
1984	0.077	0.6	2.003	3.856	7.539	10.069	12.369
1985	0.051	0.553	2.126	4.553	7.158	10.443	12.398
1986	0.066	0.367	1.845	4.11	7.496	10.244	12.471
1987	0.081	0.492	1.303	4.5	7.455	10.74	12.598
1988	0.067	0.667	1.935	3.492	7.606	10.616	12.756
1989	0.067	0.692	2.197	3.976	6.968	10.299	12.861
1990	0.076	0.603	2.361	4.416	7.214	10.545	12.902
1991	0.058	0.648	2.067	4.778	7.659	10.338	13.019
1992	0.065	0.39	2.075	5.019	7.899	10.938	12.95
1993	0.047	0.553	2.065	4.96	8.212	11.691	13.022
1994	0.042	0.408	1.933	4.754	8.318	10.463	13.046
1995	0.048	0.365	1.413	4.197	7.375	10.59	13.002
1996	0.041	0.458	1.498	3.164	6.769	10.322	13.005
1997	0.035	0.262	1.852	3.606	6.698	8.659	12.658
1998	0.049	0.368	1.083	3.662	7.671	9.521	12.647
1999	0.106	0.515	1.507	3.17	7.198	9.8	12.457
2000	0.062	0.547	1.652	3.626	5.368	9.554	12.386
2001	0.107	0.406	1.516	3.421	7.083	8.976	12.26
2002	0.084	0.496	1.698	4.337	7.55	10.354	12.419
2003	0.072	0.595	1.441	4.276	7.287	11.069	12.681
2004	0.057	0.313	1.918	3.516	7.61	9.561	12.908
2005	0.061	0.526	1.571	3.828	6.546	10.668	12.801
2006	0.068	0.628	2.111	3.9	7.979	8.635	12.632
2007	0.085	0.463	2.124	4.255	6.808	11.295	12.532
2008	0.105	0.84	1.969	3.999	6.636	9.571	12.664
2009	0.079	0.849	2.616	4.303	6.83	9.396	12.571
2010	0.078	0.658	2.712	5.086	6.92	9.985	12.295
2011	0.078	0.605	2.135	5.221	7.977	9.46	11.917

	1	2	3	4	5	6	7+
2012	0.07	0.829	2.193	4.029	8.082	10.45	11.576
2013	0.07	0.591	2.461	4.012	6.013	9.176	11.601
2014	0.076	0.705	2.199	4.307	7.099	7.105	11.369
2015	0.103	0.749	1.981	4.056	6.82	10.04	11.579
2016	0.089	0.745	2.301	3.763	7.141	8.73	11.423
2017	0.064	0.553	1.728	3.655	5.604	9.767	11.415
2018	0.088	0.506	1.374	2.958	6.327	8.425	11.224
2019	0.063	0.533	1.73	2.83	4.986	8.73	10.813
2020	0.072	0.507	1.615	3.615	4.618	7.912	10.487
2021	0.084	0.604	1.639	2.901	7.206	9.086	10.245
2022	0.078	0.639	1.91	3.609	6.231	9.389	10.52
2023	0.088	0.567	1.658	3.736	6.479	9.169	10.757
2024	0.103	0.543	1.723	3.055	6.621	9.2	10.948

Viking

	1	2	3	4	5	6	7+
1983	0.055	0.45	1.45	3.199	5.192	7.845	10.253
1984	0.042	0.38	1.447	2.935	4.894	7.354	10.375
1985	0.045	0.32	1.192	3.127	4.588	7.116	9.929
1986	0.045	0.315	1.084	2.78	4.395	5.837	9.889
1987	0.054	0.333	1.09	2.972	4.48	6.433	9.761
1988	0.065	0.254	1.089	2.75	4.65	6.401	9.529
1989	0.058	0.352	0.907	2.903	4.346	7.066	9.745
1990	0.059	0.379	1.173	2.939	4.908	6.97	9.934
1991	0.055	0.432	1.353	2.94	5.201	6.899	10.075
1992	0.053	0.471	1.509	3.549	4.951	7.575	10.275
1993	0.052	0.362	1.406	3.516	5.043	7.595	10.624
1994	0.04	0.364	1.256	3.695	5.837	8.069	10.895
1995	0.042	0.341	1.187	3.226	5.541	7.851	11.136
1996	0.035	0.326	1.216	3.372	5.244	7.678	11.214

	1	2	3	4	5	6	7+
1997	0.04	0.306	1.179	3.253	5.164	7.513	11.123
1998	0.055	0.267	1.117	3.209	5.229	7.297	10.929
1999	0.049	0.315	0.91	2.784	4.899	7.001	10.595
2000	0.043	0.376	1.147	2.694	4.639	6.388	10.402
2001	0.059	0.332	1.335	3.047	4.607	6.025	10.363
2002	0.052	0.334	0.953	3.105	5.361	7.791	10.377
2003	0.051	0.383	1.043	2.578	5.076	6.3	10.64
2004	0.058	0.378	1.289	3.027	4.653	6.632	10.741
2005	0.058	0.434	1.272	3.001	4.923	7.107	10.47
2006	0.055	0.416	1.401	3.168	4.554	7.028	10.405
2007	0.052	0.436	1.121	3.392	5.161	6.347	10.37
2008	0.053	0.475	1.44	3.107	5.249	7.023	10.345
2009	0.054	0.454	1.518	3.487	4.706	6.594	10.239
2010	0.051	0.468	1.517	3.401	4.912	6.338	10.162
2011	0.049	0.404	1.432	3.573	4.755	7.006	10.118
2012	0.057	0.427	1.35	3.287	5.253	6.936	9.939
2013	0.054	0.423	1.319	3.264	4.889	6.676	9.815
2014	0.05	0.43	1.402	3.309	5.381	7.617	9.806
2015	0.059	0.44	1.46	3.253	4.769	7.449	9.681
2016	0.063	0.481	1.485	3.22	4.627	6.688	9.837
2017	0.053	0.48	1.5	3.391	4.79	6.658	9.956
2018	0.054	0.443	1.213	3.281	5.384	6.894	10.039
2019	0.06	0.42	1.304	2.962	5.594	7.312	10.138
2020	0.057	0.471	1.342	3.448	5.31	6.602	10.175
2021	0.05	0.423	1.383	2.988	5.432	6.752	10.23
2022	0.054	0.372	1.354	3.266	5.033	7.768	10.484
2023	0.052	0.405	1.159	3.031	5.32	7.38	10.778
2024	0.053	0.337	1.27	2.898	4.839	7.25	10.55

Table 4.12. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM final run estimated maturity-at-age for each substock.

Northwestern

	1	2	3	4	5	6	7+
1983	0.002	0.039	0.271	0.306	0.723	0.806	0.904
1984	0.002	0.023	0.135	0.44	0.648	0.686	0.878
1985	0.003	0.029	0.142	0.456	0.558	0.785	0.87
1986	0.002	0.108	0.102	0.191	0.466	0.722	0.853
1987	0.003	0.023	0.259	0.537	0.737	0.78	0.893
1988	0.005	0.042	0.171	0.463	0.568	0.763	0.892
1989	0.121	0.263	0.332	0.639	0.889	0.875	0.963
1990	0.005	0.088	0.229	0.552	0.752	0.81	0.799
1991	0.007	0.094	0.404	0.563	0.831	0.893	0.941
1992	0.014	0.334	0.654	0.893	0.943	0.963	0.979
1993	0.015	0.12	0.76	0.877	0.943	0.96	0.979
1994	0.015	0.3	0.685	0.884	0.95	0.966	0.981
1995	0.009	0.084	0.442	0.811	0.892	0.927	0.964
1996	0.014	0.183	0.583	0.856	0.938	0.954	0.976
1997	0.017	0.267	0.816	0.928	0.962	0.974	0.984
1998	0.015	0.155	0.649	0.84	0.934	0.953	0.976
1999	0.031	0.572	0.538	0.898	0.959	0.973	0.985
2000	0.029	0.35	0.812	0.897	0.961	0.975	0.986
2001	0.016	0.249	0.634	0.872	0.916	0.959	0.98
2002	0.021	0.263	0.694	0.889	0.947	0.966	0.982
2003	0.024	0.288	0.649	0.879	0.949	0.967	0.983
2004	0.019	0.388	0.727	0.9	0.955	0.971	0.985
2005	0.023	0.38	0.731	0.883	0.952	0.971	0.986
2006	0.033	0.528	0.844	0.935	0.971	0.981	0.989
2007	0.019	0.241	0.703	0.888	0.944	0.966	0.984
2008	0.023	0.466	0.688	0.917	0.959	0.974	0.986
2009	0.017	0.271	0.709	0.887	0.938	0.965	0.983

	1	2	3	4	5	6	7+
2010	0.014	0.38	0.81	0.907	0.959	0.972	0.986
2011	0.028	0.27	0.778	0.934	0.967	0.978	0.988
2012	0.029	0.531	0.723	0.901	0.969	0.979	0.989
2013	0.036	0.631	0.792	0.966	0.975	0.984	0.991
2014	0.028	0.198	0.612	0.903	0.94	0.967	0.984
2015	0.022	0.364	0.615	0.864	0.931	0.96	0.981
2016	0.012	0.299	0.468	0.814	0.931	0.954	0.971
2017	0.016	0.496	0.693	0.86	0.896	0.968	0.975
2018	0.014	0.242	0.689	0.79	0.942	0.946	0.98
2019	0.026	0.447	0.715	0.912	0.955	0.974	0.986
2020	0.034	0.252	0.816	0.92	0.962	0.975	0.987
2021	0.024	0.281	0.513	0.888	0.903	0.962	0.982
2022	0.041	0.551	0.785	0.936	0.969	0.975	0.988
2023	0.023	0.397	0.69	0.843	0.946	0.967	0.984
2024	0.015	0.179	0.637	0.808	0.95	0.961	0.979

Southern

	1	2	3	4	5	6	7+
1983	0.001	0.022	0.219	0.467	0.692	0.63	0.973
1984	0.001	0.034	0.265	0.58	0.389	0.848	0.977
1985	0.001	0.026	0.318	0.695	0.764	0.773	0.976
1986	0.001	0.064	0.34	0.562	0.655	0.525	0.976
1987	0.001	0.014	0.265	0.566	0.788	0.647	0.975
1988	0.003	0.065	0.196	0.604	0.627	0.739	0.969
1989	0.032	0.156	0.374	0.584	0.903	0.747	0.989
1990	0.003	0.208	0.284	0.562	0.744	0.843	0.982
1991	0.003	0.156	0.627	0.751	0.918	0.933	0.992
1992	0.002	0.22	0.705	0.904	0.94	0.943	0.994
1993	0.003	0.082	0.446	0.809	0.899	0.9	0.992
1994	0.002	0.098	0.612	0.826	0.88	0.898	0.992

	1	2	3	4	5	6	7+
1995	0.003	0.094	0.458	0.833	0.893	0.902	0.991
1996	0.003	0.068	0.46	0.766	0.882	0.891	0.99
1997	0.002	0.137	0.58	0.693	0.86	0.861	0.99
1998	0.003	0.059	0.41	0.722	0.844	0.862	0.989
1999	0.005	0.323	0.648	0.838	0.946	0.945	0.993
2000	0.009	0.283	0.648	0.925	0.96	0.962	0.996
2001	0.006	0.243	0.638	0.909	0.949	0.948	0.996
2002	0.009	0.508	0.832	0.946	0.972	0.974	0.997
2003	0.007	0.342	0.673	0.915	0.96	0.961	0.997
2004	0.007	0.164	0.869	0.929	0.951	0.96	0.997
2005	0.014	0.537	0.824	0.931	0.973	0.975	0.997
2006	0.01	0.34	0.854	0.935	0.968	0.971	0.998
2007	0.01	0.275	0.844	0.943	0.967	0.969	0.998
2008	0.037	0.56	0.928	0.966	0.983	0.985	0.998
2009	0.011	0.329	0.816	0.951	0.972	0.974	0.998
2010	0.008	0.235	0.786	0.938	0.955	0.963	0.998
2011	0.02	0.145	0.838	0.947	0.97	0.97	0.998
2012	0.018	0.553	0.879	0.962	0.981	0.981	0.998
2013	0.018	0.396	0.876	0.958	0.978	0.979	0.998
2014	0.012	0.546	0.909	0.964	0.981	0.981	0.998
2015	0.054	0.81	0.947	0.98	0.99	0.991	0.999
2016	0.019	0.482	0.898	0.964	0.981	0.983	0.999
2017	0.014	0.416	0.871	0.955	0.976	0.978	0.998
2018	0.012	0.475	0.844	0.952	0.975	0.976	0.998
2019	0.009	0.319	0.822	0.933	0.965	0.968	0.998
2020	0.009	0.268	0.74	0.913	0.955	0.957	0.997
2021	0.024	0.578	0.904	0.968	0.983	0.984	0.998
2022	0.026	0.559	0.905	0.967	0.984	0.985	0.998
2023	0.016	0.551	0.881	0.96	0.98	0.981	0.998

	1	2	3	4	5	6	7+
2024	0.017	0.547	0.887	0.963	0.981	0.982	0.999

Viking

	1	2	3	4	5	6	7+
1983	0.003	0.026	0.068	0.231	0.562	0.853	0.916
1984	0.004	0.031	0.2	0.437	0.7	0.917	0.949
1985	0.003	0.014	0.102	0.333	0.633	0.887	0.913
1986	0.003	0.024	0.045	0.204	0.55	0.851	0.909
1987	0.004	0.026	0.143	0.375	0.707	0.898	0.94
1988	0.005	0.022	0.079	0.328	0.349	0.818	0.899
1989	0.131	0.039	0.083	0.288	0.702	0.905	0.959
1990	0.005	0.032	0.129	0.296	0.538	0.876	0.912
1991	0.006	0.022	0.156	0.331	0.708	0.889	0.936
1992	0.039	0.085	0.409	0.728	0.847	0.968	0.975
1993	0.005	0.031	0.126	0.437	0.6	0.896	0.927
1994	0.007	0.045	0.258	0.641	0.809	0.948	0.966
1995	0.006	0.031	0.233	0.616	0.735	0.878	0.949
1996	0.012	0.127	0.404	0.826	0.852	0.969	0.979
1997	0.012	0.121	0.441	0.647	0.83	0.967	0.98
1998	0.026	0.104	0.477	0.822	0.913	0.977	0.986
1999	0.017	0.272	0.329	0.752	0.927	0.977	0.986
2000	0.011	0.216	0.594	0.696	0.841	0.97	0.979
2001	0.02	0.125	0.351	0.649	0.895	0.97	0.982
2002	0.017	0.229	0.401	0.753	0.923	0.976	0.985
2003	0.01	0.057	0.293	0.543	0.853	0.953	0.974
2004	0.011	0.126	0.647	0.643	0.85	0.957	0.98
2005	0.013	0.091	0.515	0.822	0.912	0.971	0.981
2006	0.01	0.109	0.288	0.687	0.821	0.964	0.979
2007	0.036	0.185	0.381	0.718	0.931	0.973	0.986
2008	0.017	0.278	0.525	0.721	0.909	0.978	0.986

	1	2	3	4	5	6	7+
2009	0.015	0.088	0.415	0.753	0.884	0.967	0.983
2010	0.012	0.083	0.427	0.678	0.908	0.957	0.98
2011	0.013	0.077	0.468	0.716	0.884	0.969	0.98
2012	0.009	0.072	0.212	0.65	0.857	0.957	0.974
2013	0.008	0.069	0.261	0.692	0.818	0.961	0.975
2014	0.01	0.056	0.3	0.709	0.848	0.961	0.975
2015	0.009	0.117	0.284	0.699	0.833	0.958	0.976
2016	0.007	0.07	0.177	0.581	0.769	0.935	0.969
2017	0.008	0.062	0.392	0.695	0.797	0.958	0.972
2018	0.011	0.063	0.276	0.69	0.895	0.963	0.977
2019	0.015	0.209	0.426	0.757	0.908	0.975	0.982
2020	0.01	0.077	0.457	0.789	0.875	0.967	0.981
2021	0.007	0.065	0.242	0.457	0.797	0.942	0.969
2022	0.007	0.044	0.177	0.532	0.835	0.939	0.965
2023	0.007	0.058	0.232	0.485	0.774	0.941	0.964
2024	0.007	0.052	0.232	0.462	0.72	0.928	0.961

Table 4.13. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM final run estimated natural mortality-at-age for each substock.

Northwestern

	1	2	3	4	5	6	7+
1983	1.081	0.753	0.273	0.207	0.2	0.2	0.2
1984	1.017	0.725	0.262	0.203	0.2	0.2	0.2
1985	1.047	0.723	0.265	0.203	0.2	0.2	0.2
1986	0.976	0.702	0.268	0.21	0.2	0.2	0.2
1987	0.991	0.704	0.269	0.214	0.2	0.2	0.2
1988	1.018	0.722	0.272	0.222	0.2	0.2	0.2
1989	0.977	0.748	0.283	0.216	0.2	0.2	0.2
1990	0.998	0.765	0.284	0.215	0.2	0.2	0.2
1991	0.99	0.763	0.282	0.204	0.2	0.2	0.2
1992	0.946	0.744	0.261	0.201	0.2	0.2	0.2

	1	2	3	4	5	6	7+
1993	0.981	0.735	0.256	0.2	0.2	0.2	0.2
1994	0.986	0.73	0.268	0.2	0.2	0.2	0.2
1995	0.996	0.738	0.275	0.2	0.2	0.2	0.2
1996	1.04	0.753	0.278	0.202	0.2	0.2	0.2
1997	1	0.738	0.273	0.21	0.2	0.2	0.2
1998	1.051	0.764	0.293	0.217	0.2	0.2	0.2
1999	1.024	0.802	0.307	0.225	0.2	0.2	0.2
2000	0.939	0.784	0.306	0.232	0.2	0.2	0.2
2001	0.962	0.787	0.332	0.23	0.2	0.2	0.2
2002	1.032	0.863	0.387	0.238	0.2	0.2	0.2
2003	1.113	0.955	0.44	0.26	0.2	0.2	0.2
2004	1.195	1.021	0.475	0.29	0.2	0.2	0.2
2005	1.253	1.065	0.491	0.272	0.2	0.2	0.2
2006	1.26	1.067	0.473	0.254	0.2	0.2	0.2
2007	1.3	1.075	0.47	0.22	0.2	0.2	0.2
2008	1.326	1.103	0.479	0.238	0.2	0.2	0.2
2009	1.28	1.089	0.463	0.209	0.2	0.2	0.2
2010	1.22	1.019	0.439	0.202	0.2	0.2	0.2
2011	1.277	1.053	0.421	0.202	0.2	0.2	0.2
2012	1.328	1.097	0.501	0.202	0.2	0.2	0.2
2013	1.327	1.095	0.495	0.205	0.201	0.2	0.2
2014	1.273	1.056	0.48	0.207	0.202	0.2	0.2
2015	1.285	1.06	0.492	0.218	0.204	0.201	0.2
2016	1.286	1.054	0.467	0.26	0.202	0.2	0.2
2017	1.247	1.02	0.431	0.249	0.203	0.2	0.2
2018	1.308	1.061	0.462	0.258	0.201	0.2	0.2
2019	1.257	1.018	0.455	0.262	0.2	0.2	0.2
2020	1.19	0.956	0.446	0.245	0.2	0.2	0.2
2021	1.237	0.972	0.482	0.225	0.2	0.2	0.2

	1	2	3	4	5	6	7+
2022	1.314	1.029	0.522	0.26	0.201	0.2	0.2
2023	1.309	1.037	0.509	0.259	0.204	0.201	0.201
2024	1.309	1.04	0.498	0.257	0.208	0.202	0.201

Southern

	1	2	3	4	5	6	7+
1983	1.083	0.759	0.273	0.208	0.2	0.2	0.2
1984	1.018	0.725	0.263	0.203	0.2	0.2	0.2
1985	1.048	0.725	0.265	0.203	0.2	0.2	0.2
1986	0.977	0.704	0.268	0.21	0.2	0.2	0.2
1987	0.994	0.704	0.269	0.214	0.2	0.2	0.2
1988	1.019	0.724	0.273	0.222	0.2	0.2	0.2
1989	0.977	0.748	0.283	0.216	0.2	0.2	0.2
1990	0.998	0.763	0.284	0.215	0.2	0.2	0.2
1991	0.991	0.762	0.282	0.204	0.2	0.2	0.2
1992	0.948	0.745	0.261	0.201	0.2	0.2	0.2
1993	0.981	0.733	0.256	0.2	0.2	0.2	0.2
1994	0.986	0.729	0.268	0.2	0.2	0.2	0.2
1995	0.996	0.736	0.275	0.2	0.2	0.2	0.2
1996	1.039	0.751	0.278	0.202	0.2	0.2	0.2
1997	0.998	0.736	0.273	0.21	0.2	0.2	0.2
1998	1.048	0.762	0.293	0.217	0.2	0.2	0.2
1999	1.023	0.801	0.306	0.225	0.2	0.2	0.2
2000	0.939	0.783	0.306	0.232	0.2	0.2	0.2
2001	0.961	0.787	0.332	0.23	0.2	0.2	0.2
2002	1.032	0.86	0.386	0.238	0.2	0.2	0.2
2003	1.113	0.951	0.44	0.26	0.2	0.2	0.2
2004	1.195	1.019	0.475	0.29	0.2	0.2	0.2
2005	1.251	1.063	0.492	0.272	0.2	0.2	0.2
2006	1.262	1.068	0.473	0.254	0.2	0.2	0.2

	1	2	3	4	5	6	7+
2007	1.299	1.076	0.47	0.219	0.2	0.2	0.2
2008	1.327	1.105	0.478	0.238	0.2	0.2	0.2
2009	1.283	1.091	0.463	0.209	0.2	0.2	0.2
2010	1.221	1.021	0.439	0.203	0.2	0.2	0.2
2011	1.278	1.055	0.421	0.202	0.2	0.2	0.2
2012	1.327	1.1	0.501	0.202	0.2	0.2	0.2
2013	1.327	1.098	0.497	0.205	0.201	0.2	0.2
2014	1.273	1.061	0.482	0.207	0.202	0.2	0.2
2015	1.285	1.066	0.494	0.218	0.204	0.201	0.2
2016	1.284	1.056	0.469	0.26	0.202	0.2	0.2
2017	1.245	1.019	0.432	0.249	0.203	0.2	0.2
2018	1.305	1.059	0.463	0.258	0.201	0.2	0.2
2019	1.257	1.019	0.455	0.262	0.2	0.2	0.2
2020	1.19	0.958	0.447	0.245	0.2	0.2	0.2
2021	1.237	0.975	0.482	0.225	0.2	0.2	0.2
2022	1.315	1.031	0.523	0.26	0.201	0.2	0.2
2023	1.313	1.037	0.512	0.259	0.205	0.201	0.201
2024	1.313	1.041	0.501	0.257	0.208	0.202	0.201

Viking

	1	2	3	4	5	6	7+
1983	1.082	0.757	0.274	0.208	0.2	0.2	0.2
1984	1.016	0.723	0.263	0.203	0.2	0.2	0.2
1985	1.047	0.722	0.265	0.203	0.2	0.2	0.2
1986	0.975	0.703	0.268	0.21	0.2	0.2	0.2
1987	0.991	0.703	0.269	0.214	0.2	0.2	0.2
1988	1.02	0.721	0.273	0.222	0.2	0.2	0.2
1989	0.978	0.747	0.283	0.217	0.2	0.2	0.2
1990	0.999	0.763	0.284	0.215	0.2	0.2	0.2
1991	0.992	0.763	0.282	0.204	0.2	0.2	0.2

	1	2	3	4	5	6	7+
1992	0.947	0.745	0.261	0.201	0.2	0.2	0.2
1993	0.981	0.734	0.256	0.2	0.2	0.2	0.2
1994	0.987	0.73	0.268	0.2	0.2	0.2	0.2
1995	0.997	0.739	0.275	0.2	0.2	0.2	0.2
1996	1.04	0.754	0.278	0.202	0.2	0.2	0.2
1997	0.999	0.739	0.273	0.21	0.2	0.2	0.2
1998	1.053	0.763	0.293	0.217	0.2	0.2	0.2
1999	1.025	0.804	0.306	0.224	0.2	0.2	0.2
2000	0.94	0.785	0.306	0.232	0.2	0.2	0.2
2001	0.963	0.787	0.332	0.23	0.2	0.2	0.2
2002	1.033	0.861	0.387	0.238	0.2	0.2	0.2
2003	1.114	0.951	0.44	0.26	0.2	0.2	0.2
2004	1.196	1.019	0.476	0.29	0.2	0.2	0.2
2005	1.254	1.067	0.492	0.271	0.2	0.2	0.2
2006	1.262	1.069	0.475	0.254	0.2	0.2	0.2
2007	1.301	1.076	0.47	0.219	0.2	0.2	0.2
2008	1.327	1.103	0.478	0.238	0.2	0.2	0.2
2009	1.283	1.091	0.463	0.209	0.2	0.2	0.2
2010	1.221	1.02	0.438	0.203	0.2	0.2	0.2
2011	1.28	1.054	0.42	0.202	0.2	0.2	0.2
2012	1.33	1.097	0.501	0.202	0.2	0.2	0.2
2013	1.323	1.098	0.496	0.205	0.201	0.2	0.2
2014	1.269	1.056	0.481	0.207	0.202	0.2	0.2
2015	1.282	1.057	0.492	0.218	0.204	0.201	0.2
2016	1.281	1.049	0.468	0.26	0.202	0.2	0.2
2017	1.239	1.014	0.431	0.249	0.203	0.2	0.2
2018	1.303	1.054	0.462	0.258	0.201	0.2	0.2
2019	1.253	1.015	0.455	0.262	0.2	0.2	0.2
2020	1.186	0.952	0.446	0.246	0.2	0.2	0.2

	1	2	3	4	5	6	7+
2021	1.234	0.969	0.481	0.225	0.2	0.2	0.2
2022	1.316	1.023	0.522	0.261	0.201	0.2	0.2
2023	1.316	1.024	0.507	0.259	0.205	0.201	0.201
2024	1.315	1.029	0.496	0.258	0.208	0.202	0.201

Table 4.14. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multi-stock SAM final run estimated stock and management metrics for each sub-stock, together with the lower and upper bounds of the pointwise 95% confidence intervals. Estimated recruitment, total stock biomass (TSB), spawning stock biomass (SSB), catches and average fishing mortality for ages 2 to 4 (Fbar 2–4).

Northwestern

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
1983	495298	331866	739213	218330	159001	299795	57510	41162	80349	126299	88053	181156	0.821	0.722	0.935
1984	731798	440324	1216212	215152	162594	284699	53508	38441	74480	151625	107022	214817	0.955	0.8	1.141
1985	218380	135755	351294	198257	154476	254447	52365	38752	70758	139363	105314	184420	0.949	0.805	1.119
1986	640603	399239	1027886	172357	135212	219706	36064	27154	47896	112167	82850	151859	0.993	0.844	1.168
1987	375906	239276	590555	181193	141810	231514	48798	36655	64964	124772	92506	168293	0.944	0.802	1.112
1988	144239	91821	226581	154907	120617	198945	37661	28684	49446	94108	71653	123600	0.888	0.751	1.051
1989	522792	335455	814748	144481	113575	183797	61405	47804	78876	94126	69564	127361	0.962	0.816	1.135
1990	158532	101243	248239	136385	106300	174985	44330	33733	58255	89714	67870	118589	1.027	0.87	1.211
1991	224142	144648	347324	106860	84232	135568	43392	33017	57026	67872	52292	88094	1.005	0.856	1.18
1992	545175	362555	819783	119360	93835	151828	56638	43839	73175	82717	59787	114441	0.937	0.8	1.097
1993	256660	174113	378342	135522	105906	173419	55045	42590	71143	96416	72585	128072	0.938	0.795	1.107
1994	541219	342855	854348	125785	99005	159809	67004	51738	86775	90923	68362	120928	0.952	0.813	1.116
1995	323505	212139	493333	131917	103675	167852	50488	38600	66038	112458	84352	149929	1.048	0.895	1.226
1996	160403	104493	246226	119705	94096	152285	57778	44936	74291	87884	67831	113865	1.092	0.932	1.279
1997	604981	394959	926684	95298	74991	121104	56845	43484	74310	76347	55315	105375	1.012	0.863	1.186

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
1998	68241	45207	103012	96201	74929	123511	42380	32697	54931	68728	51778	91228	1.101	0.95	1.277
1999	97186	62091	152118	57369	45393	72506	33739	26335	43224	40077	31545	50916	1.124	0.971	1.3
2000	204024	135222	307833	55529	43625	70681	28241	22060	36154	34051	25855	44846	1.082	0.932	1.255
2001	66796	43309	103020	52857	41136	67916	23024	18021	29416	28596	21996	37176	0.931	0.8	1.085
2002	96924	61416	152962	46805	36714	59670	25943	20025	33609	23820	18538	30606	0.907	0.774	1.064
2003	57124	37195	87732	37595	29407	48064	20596	15961	26577	18461	14251	23917	0.834	0.705	0.986
2004	88633	56400	139287	31855	24765	40975	18998	14585	24747	13198	10161	17143	0.815	0.688	0.965
2005	72243	45556	114563	28365	21755	36983	15194	11598	19905	12726	9600	16870	0.733	0.618	0.871
2006	276519	187058	408765	41258	31024	54868	17587	13377	23123	11789	8610	16142	0.664	0.55	0.801
2007	88303	56100	138990	54436	41609	71216	21646	16663	28120	22643	16841	30445	0.622	0.517	0.748
2008	100705	65302	155301	55298	42890	71295	33575	25720	43829	23627	18035	30952	0.666	0.555	0.8
2009	179004	120973	264873	52596	41124	67269	26489	20233	34681	22184	17112	28759	0.615	0.515	0.734
2010	218282	150900	315752	72774	57175	92629	34448	26860	44180	24615	19150	31639	0.563	0.47	0.675
2011	98277	66115	146085	81438	64210	103289	42145	32929	53940	27599	21524	35387	0.494	0.409	0.596
2012	151571	99931	229897	88203	70053	111056	54149	42685	68693	29293	22910	37455	0.491	0.407	0.593
2013	203996	139401	298522	96423	76620	121343	64351	50782	81546	29313	23029	37311	0.47	0.389	0.567
2014	254748	175446	369895	101501	80697	127667	49063	38536	62466	29610	23237	37731	0.42	0.347	0.508
2015	154994	108068	222297	117200	93589	146769	64905	51485	81824	34838	27446	44222	0.42	0.346	0.51

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
2016	102382	70574	148525	120336	95880	151031	68337	53679	86996	42159	33192	53547	0.469	0.389	0.567
2017	278245	193655	399783	113539	90623	142249	74980	58735	95717	43977	34538	55995	0.572	0.475	0.689
2018	64731	44779	93573	83425	66692	104356	50610	39717	64490	37418	29407	47612	0.659	0.544	0.797
2019	140963	99062	200586	58509	46959	72899	39059	30730	49647	25570	20316	32183	0.571	0.476	0.684
2020	185038	126041	271651	64274	51599	80063	33528	26684	42127	17851	14170	22487	0.444	0.368	0.536
2021	133990	92930	193191	77177	61998	96073	37053	29606	46375	20652	16020	26623	0.349	0.281	0.433
2022	159469	106331	239164	90168	72228	112565	59638	47506	74868	20855	16158	26917	0.318	0.251	0.401
2023	100437	63697	158368	94065	75119	117789	60982	48240	77090	24961	19193	32463	0.32	0.244	0.42
2024	54778	18421	162895	80898	61786	105922	54257	40640	72436						

Southern

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
1983	333710	209351	531941	119424	83959	169870	18326	11732	28627	79455	51380	122869	1.125	0.931	1.359
1984	697319	394843	1231511	137842	96580	196733	17831	11696	27183	108223	68131	171907	1.328	1.072	1.645
1985	139006	80288	240665	128445	88042	187390	20988	13907	31675	98539	65026	149322	1.313	1.068	1.615
1986	852569	507803	1431409	111578	78392	158813	20034	13439	29864	92651	56773	151202	1.356	1.103	1.668
1987	324312	196289	535834	153253	105785	222021	15438	9751	24442	124731	82264	189121	1.271	1.036	1.561
1988	243305	152336	388596	128584	92571	178607	20651	13994	30474	87101	61909	122543	1.183	0.961	1.457

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
1989	301331	175749	516647	113746	83524	154903	33021	23201	46996	78047	55153	110444	1.276	1.043	1.562
1990	133154	78696	225298	96789	69231	135319	29319	20330	42281	60822	42694	86647	1.372	1.115	1.689
1991	138965	80365	240295	62592	45084	86898	27325	18595	40153	44278	31173	62893	1.327	1.083	1.627
1992	244712	140196	427146	52655	37240	74452	22530	15058	33709	46494	30142	71719	1.209	0.983	1.486
1993	166349	105031	263468	62958	43943	90200	16909	11223	25478	47294	31799	70339	1.174	0.953	1.446
1994	400617	241328	665046	62396	45291	85960	21073	14259	31144	53147	35888	78704	1.167	0.949	1.436
1995	260675	161707	420213	73180	52682	101654	19033	13035	27790	75174	52389	107868	1.268	1.044	1.54
1996	214822	140321	328878	70219	50847	96971	20130	13856	29246	68739	49897	94696	1.325	1.096	1.602
1997	570869	363360	896883	64796	47419	88542	21745	14774	32006	71833	49463	104319	1.217	1.009	1.468
1998	55411	34719	88434	85890	60521	121893	18632	12668	27403	70192	49435	99665	1.361	1.137	1.63
1999	120647	74112	196400	63755	47062	86369	32964	23196	46846	38436	28807	51283	1.429	1.193	1.713
2000	110199	66678	182128	42724	31336	58251	20853	14625	29734	30649	22268	42184	1.414	1.171	1.707
2001	68127	43551	106572	33724	24615	46205	13249	9254	18969	21144	15361	29104	1.225	1.001	1.499
2002	141871	92001	218773	37949	28277	50928	19118	13665	26749	18400	13515	25052	1.208	0.99	1.474
2003	50888	31987	80960	38461	28479	51941	17548	12846	23972	18753	13907	25287	1.11	0.902	1.367
2004	88220	53241	146180	27888	20615	37728	17023	12136	23878	13676	10274	18204	1.107	0.888	1.378
2005	91520	57646	145300	26573	19074	37021	14947	10475	21328	13020	9267	18294	0.989	0.785	1.245
2006	109822	66306	181899	34578	24650	48506	16193	11251	23304	9078	6332	13015	0.898	0.705	1.143

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
2007	131227	84694	203324	38170	27909	52201	16558	11691	23449	16013	11300	22691	0.85	0.672	1.075
2008	117884	75767	183415	54836	40683	73914	30755	22452	42127	19966	14629	27249	0.941	0.742	1.192
2009	47672	27703	82034	48082	35545	65041	26164	19167	35715	19428	14444	26132	0.895	0.708	1.132
2010	76401	47264	123500	36499	27041	49265	21379	15212	30046	14917	11087	20070	0.851	0.661	1.095
2011	52857	32746	85320	31609	23244	42984	15406	10713	22155	12404	9147	16820	0.757	0.579	0.989
2012	55077	32455	93469	32868	24165	44706	22451	16219	31079	11403	8476	15341	0.763	0.582	1.001
2013	52969	31560	88898	26539	19338	36420	16924	11984	23900	10329	7583	14069	0.737	0.555	0.979
2014	64288	38506	107334	27530	20013	37869	17779	12505	25277	9203	6623	12790	0.658	0.496	0.874
2015	21374	12382	36898	28643	20664	39703	23622	16912	32996	9388	6735	13087	0.664	0.495	0.89
2016	14653	8139	26381	20847	15155	28675	16416	11671	23091	8291	6063	11338	0.735	0.544	0.994
2017	28873	16536	50414	12051	8566	16953	8560	5793	12647	5986	4344	8249	0.871	0.65	1.168
2018	11840	6793	20636	8778	6086	12660	5653	3765	8488	4331	3040	6170	0.981	0.732	1.314
2019	15641	9101	26881	5936	4132	8527	3518	2313	5351	2824	1976	4036	0.817	0.61	1.094
2020	22995	13121	40298	6206	4318	8920	2712	1804	4078	2009	1399	2884	0.619	0.456	0.839
2021	22481	13282	38051	8866	6142	12797	5254	3575	7722	2594	1774	3793	0.478	0.343	0.667
2022	48501	27578	85300	12916	9054	18424	7212	4958	10492	2770	1908	4023	0.426	0.3	0.604
2023	31277	14507	67436	16586	11295	24356	10105	6932	14730	3931	2694	5736	0.43	0.296	0.625
2024	16844	5320	53334	16470	10674	25415	11981	7838	18314						

Viking

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
1983	102434	59223	177173	58777	37699	91640	14743	9473	22945	31403	19719	50010	0.641	0.535	0.768
1984	117928	64076	217037	55271	36226	84328	19132	12463	29370	37730	23887	59594	0.732	0.595	0.899
1985	32873	17424	62017	50424	33337	76268	14799	9721	22527	37401	24169	57876	0.721	0.591	0.88
1986	111063	59185	208416	42801	28686	63861	11250	7474	16934	29712	19619	44997	0.757	0.618	0.927
1987	55818	30621	101746	40975	27044	62082	13728	9225	20428	26995	17270	42197	0.709	0.583	0.863
1988	52091	28138	96434	35621	23753	53419	9271	6212	13835	24573	16017	37700	0.66	0.542	0.805
1989	78558	42854	144010	36295	24194	54448	12406	8298	18547	24164	15796	36967	0.717	0.587	0.876
1990	40276	21763	74537	35407	23453	53453	10563	7044	15841	22792	14875	34922	0.76	0.624	0.926
1991	44541	24150	82148	31184	20778	46802	10484	6941	15837	19984	13161	30343	0.746	0.614	0.906
1992	85330	46261	157395	31804	21119	47895	15291	10209	22902	18536	12075	28456	0.694	0.572	0.842
1993	56219	31566	100127	32050	21151	48567	9011	5950	13646	20596	13190	32158	0.695	0.569	0.848
1994	104065	58174	186157	33481	22546	49721	13064	8715	19584	21191	14074	31907	0.71	0.585	0.862
1995	75266	41478	136576	36872	24839	54736	12546	8407	18722	26157	17603	38866	0.78	0.647	0.94
1996	50355	28359	89413	32940	22328	48597	16742	11337	24725	24687	16813	36250	0.795	0.664	0.953
1997	121012	68916	212492	30311	20600	44600	14435	9798	21266	19110	12964	28172	0.721	0.604	0.861
1998	16964	9675	29743	31303	21190	46242	15700	10742	22947	19336	13032	28689	0.77	0.649	0.913

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
1999	42242	23632	75509	25767	17697	37515	13764	9486	19971	17358	11979	25152	0.793	0.666	0.945
2000	60872	35112	105531	22733	15619	33087	12592	8670	18288	13547	9292	19751	0.768	0.644	0.915
2001	26921	15092	48021	21608	14749	31656	8998	6231	12994	11470	7832	16798	0.66	0.55	0.792
2002	38247	21031	69558	19734	13615	28603	10200	7090	14674	10630	7375	15322	0.63	0.52	0.764
2003	25472	14300	45374	19387	13382	28088	8359	5825	11995	9748	6760	14058	0.598	0.492	0.727
2004	52104	28883	93995	19239	13186	28069	10351	7194	14894	7687	5308	11131	0.59	0.486	0.718
2005	35914	20450	63072	19638	13356	28873	9602	6662	13840	7580	5147	11163	0.544	0.444	0.667
2006	71575	40347	126973	20027	13592	29509	7731	5356	11160	6249	4243	9204	0.492	0.394	0.614
2007	31532	17702	56168	21175	14201	31574	9368	6451	13604	8101	5498	11936	0.456	0.368	0.564
2008	39521	22209	70328	21787	14810	32050	12078	8276	17626	9239	6341	13462	0.49	0.397	0.604
2009	46626	26067	83400	21505	14520	31850	10984	7412	16277	9056	6198	13230	0.461	0.375	0.567
2010	69332	39940	120355	22800	15311	33953	10064	6797	14901	8615	5868	12650	0.422	0.342	0.521
2011	35509	20295	62128	25706	17221	38372	11529	7749	17153	9557	6491	14072	0.375	0.304	0.464
2012	60065	33883	106476	28780	19389	42719	11770	7897	17543	11028	7516	16181	0.376	0.304	0.465
2013	63054	36296	109540	29402	19723	43832	13674	9104	20538	10706	7222	15873	0.36	0.29	0.447
2014	78800	45542	136346	32227	21624	48029	14497	9639	21805	9643	6494	14321	0.317	0.254	0.395
2015	41047	23680	71152	38249	25633	57075	16526	11089	24627	11411	7700	16910	0.316	0.253	0.395
2016	25391	14427	44685	41549	28015	61624	17634	11838	26266	15817	10649	23492	0.365	0.294	0.452

	R(age 1) ('000)	Low	High	TSB (tonnes)	Low	High	SSB (tonnes)	Low	High	Catches (tonnes)	Low	High	Fbar (2-4)	Low	High
2017	55794	31886	97628	39658	26970	58315	23851	16145	35236	17926	12093	26572	0.47	0.376	0.587
2018	18149	10313	31939	30464	20744	44739	18041	12236	26599	14278	9809	20782	0.553	0.44	0.695
2019	33346	18697	59474	20993	14242	30944	13032	8757	19394	9510	6547	13814	0.479	0.383	0.598
2020	71410	40154	126996	20728	13892	30928	9904	6652	14747	5860	4001	8583	0.363	0.29	0.454
2021	34468	19548	60775	23969	15843	36263	7623	5086	11424	6603	4366	9986	0.279	0.218	0.357
2022	48389	25464	91953	28380	18957	42489	10143	6772	15192	7661	5049	11624	0.256	0.196	0.334
2023	22487	10112	50008	28577	18985	43017	12840	8571	19235	8531	5607	12979	0.255	0.189	0.344
2024	7418	2174	25306	25937	16794	40058	14031	9102	21629						

Table 4.15. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Catch scenarios for each substock based on the multistock SAM assessment and assuming $F_{status\ quo}$ in the intermediate year. Units are tonnes (SSB, landings, discards and catch) or thousands (recruitment).

Northwestern

Forecast assumptions

variable	value
Fbar(2024)	0.321
SSB(2025)	65 657
R(2024)	55 429
R(2025)	103 054
Catch(2024)	27 290
Landings(2024)	22 636
Discards(2024)	4654

Catch scenarios

Basis	Catch (2025)	F_{total} (2025)	SSB (2026)	% SSB change	% advice change
$F=F_{2024}$ x 0.39	12158	0.122	84212	28	-10.1
F_{MSY}	18272	0.193	76298	16.2	35
$F_{MSY\ lower}$	11864	0.119	84419	29	-12.3
$F_{MSY\ upper}$	28377	0.331	63549	-3.2	110
F = 0	0	0	99830	52	-100
F_{pa}	40511	0.536	48931	-25	199
$SSB(2026)=B_{lim}$	57046	0.96	29860	-55	320
$SSB(2026)=B_{trigger}=B_{pa}$	46716	0.68	41434	-37	250
$F=F_{2024}$	27450	0.32	64868	-1.20	103
SSB(2026)=SSB(2025)	26328	0.3	65876	0.33	95

Southern

Forecast assumptions

variable	value
Fbar(2024)	0.43
SSB(2025)	14 330
R(2024)	16 430

variable	value
R(2025)	53 893
Catch(2024)	5476
Landings(2024)	3846
Discards(2024)	1630

Catch scenarios

Basis	Catch (2025)	F_{total} (2025)	SSB (2026)	% SSB change	% advice change
F_{MSY} x SSB(2025) / $B_{trigger}$	3074	0.167	21693	51	-22
$F_{MSY\ lower}$ x SSB(2025) / $B_{trigger}$	1984	0.104	23222	62	-49
F = 0	0	0	26143	82	-100
F_{pa}	7372	0.464	15971	11.5	88
SSB(2026)=B_{lim}	8823	0.58	14126	-1.42	125
SSB(2026)=$B_{trigger}$=B_{pa}	4278	0.24	19590	37	9.1
F=F_{2024}	6813	0.43	16746	16.9	74
SSB(2026)=SSB(2025)	8554	0.55	14455	0.87	118
F_{MSY}	4111	0.231	20303	42	4.8
$F_{MSY\ lower}$	2689	0.144	22183	55	-31

Viking

Forecast assumptions

variable	value
Fbar(2024)	0.253
SSB(2025)	17617
R(2024)	7247
R(2025)	38541
Catch(2024)	9255
Landings(2024)	8171
Discards(2024)	1084

Catch scenarios

Basis	Catch (2025)	F_{total} (2025)	SSB (2026)	% SSB change	% advice change
$F=F_{2024}$ x 0.39	4089	0.099	22034	25	-22
F_{MSY}	7310	0.186	18841	6.9	40
$F_{MSY\ lower}$	4293	0.102	21850	24	-18.1
$F_{MSY\ upper}$	10573	0.296	15571	-11.6	102
F = 0	0	0	26234	49	-100
F_{pa}	10823	0.306	15289	-13.2	107
$SSB(2026)=B_{lim}$	16828	0.59	9682	-45	220
$SSB(2026)=B_{trigger}=B_{pa}$	12414	0.36	13787	-22	137
$F=F_{2024}$	9182	0.26	16856	-4.3	75
SSB(2026)=SSB(2025)	8434	0.21	17594	-0.131	61

Table 4.16a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Ratio of numbers-at-age from stock assessment and forecast results from WGNSSK 2023 and WGNSSK 2024.

Northwestern

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	1.17	1.16	1.2	1.26	1.27	1.26	1.25	1.31	1.12	0.54
2	1.15	1.11	1.13	1.14	1.13	1.12	1.19	1.15	1.09	1.04
3	1.09	1.07	1.06	1.08	1.08	1.08	1.12	1.16	1.05	0.88
4	0.98	1.01	1.02	1.03	1.04	1	0.99	1.01	0.98	0.91
5	0.97	0.96	0.98	0.99	0.99	0.97	0.95	0.96	1.03	0.93
6	0.97	0.95	0.95	0.97	0.98	0.97	0.92	0.91	0.94	1.08
7+	0.92	0.93	0.93	0.94	0.93	0.92	0.9	0.87	0.82	0.82

Southern

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	1.07	1.02	1.03	1.12	1.11	1.04	1.11	0.99	0.81	0.32
2	1.02	1.03	1	0.99	1.02	0.99	0.99	1.02	0.82	0.72
3	1.02	0.98	1.02	0.99	1	1.01	1.01	0.97	0.93	0.69
4	0.95	0.95	0.96	1.01	1	0.95	0.94	0.88	0.82	0.73
5	0.97	0.95	0.94	0.97	1.01	0.97	0.92	0.93	0.85	0.8

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
6	0.98	0.95	0.95	0.96	0.98	1	0.95	0.91	0.92	0.87
7+	1	1	1	1.01	1.02	1.01	1	0.97	0.91	0.88

Viking

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	1.16	1.13	1.14	1.25	1.26	1.18	1.26	1.34	0.67	0.21
2	1.12	1.1	1.08	1.08	1.11	1.08	1.09	1.12	1.13	0.56
3	1.05	1.02	1.02	1.02	1.04	1.04	1.05	1.01	0.98	1.03
4	0.96	0.97	0.96	0.96	0.97	0.97	0.95	0.95	0.78	0.88
5	0.97	0.98	0.96	0.96	0.95	0.97	0.95	0.94	0.93	0.71
6	1	1	1.01	1.03	1.02	0.96	0.99	0.96	0.96	1.01
7+	1.06	1.03	1.03	1.05	1.07	1.05	1.01	0.99	0.92	0.89

Table 4.16b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Ratio of biomass-at-age from stock assessment and forecast results from WGNSSK 2023 and WGNSSK 2024.

Northwestern

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	1.17	1.16	1.2	1.26	1.27	1.26	1.29	1.5	1.02	0.62
2	1.15	1.11	1.12	1.14	1.13	1.12	1.2	1.23	1.08	0.86
3	1.09	1.07	1.06	1.08	1.08	1.08	1.11	1.19	1.01	0.75
4	0.98	1.01	1.02	1.02	1.04	1	0.98	0.99	0.95	0.76
5	0.97	0.96	0.98	0.98	0.99	0.96	0.95	0.95	1	0.83
6	0.97	0.95	0.95	0.97	0.98	0.97	0.92	0.91	0.93	1
7+	0.93	0.93	0.93	0.94	0.93	0.92	0.89	0.86	0.81	0.8

Southern

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	1.07	1.02	1.03	1.12	1.12	1.04	1.1	0.98	0.8	0.43
2	1.02	1.03	0.99	0.98	1.02	0.99	0.97	0.98	0.77	0.62
3	1.02	0.98	1.01	0.99	0.99	1.01	1.03	0.93	0.88	0.61
4	0.95	0.95	0.96	1.01	1	0.95	0.95	1.03	0.83	0.6

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
5	0.97	0.95	0.93	0.96	1.01	0.97	0.92	0.95	0.87	0.82
6	0.98	0.95	0.95	0.96	0.98	1.01	0.96	0.91	0.97	0.91
7+	1	1	1	1.01	1.02	1.02	1.02	0.99	0.93	0.9

Viking

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	1.16	1.13	1.15	1.25	1.26	1.18	1.26	1.33	0.64	0.21
2	1.12	1.1	1.08	1.08	1.11	1.08	1.08	1.11	1.11	0.47
3	1.05	1.03	1.02	1.02	1.04	1.04	1.04	1	0.97	1.01
4	0.96	0.96	0.96	0.96	0.96	0.97	0.94	0.95	0.77	0.83
5	0.97	0.98	0.96	0.96	0.95	0.97	0.95	0.94	0.92	0.68
6	1	1	1.01	1.03	1.02	0.96	0.98	0.95	0.95	0.99
7+	1.07	1.03	1.03	1.05	1.06	1.05	0.99	0.96	0.88	0.85

Table 4.17. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Summary of forecast assumptions from the current (WGNSSK 2024) and previous (WGNSSK 2023) assessments.

Northwestern

	Year	Current assessment (2024)	Previous assessment (2023)
Assumed recruitment	2023	100437	89832
	2024	55429	103602
Catch	2023	24961	27344
SSB	2023	60982	55629
	2024	62574	72052
F	2023	0.32	0.343
Target F	2024	0.321	0.132

Southern

	Year	Current assessment (2024)	Previous assessment (2023)
Assumed recruitment	2023	31277	38463
	2024	16430	51255
Catch	2023	3931	5837

	Year	Current assessment (2024)	Previous assessment (2023)
SSB	2023	10105	8712
	2024	9792	14790
F	2023	0.43	0.463
Target F	2024	0.43	0.181

Viking

	Year	Current assessment (2024)	Previous assessment (2023)
Assumed recruitment	2023	22487	33651
	2024	7247	35075
Catch	2023	8531	10728
SSB	2023	12840	16612
	2024	16509	19857
F	2023	0.255	0.285
Target F	2024	0.253	0.112

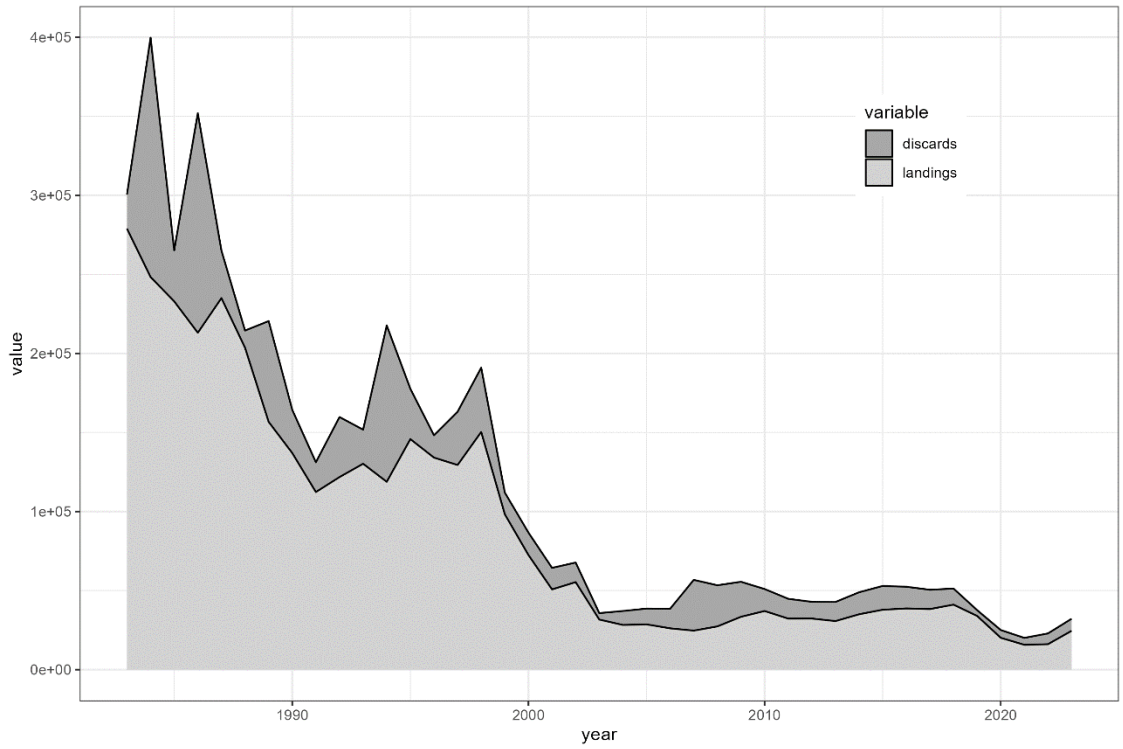
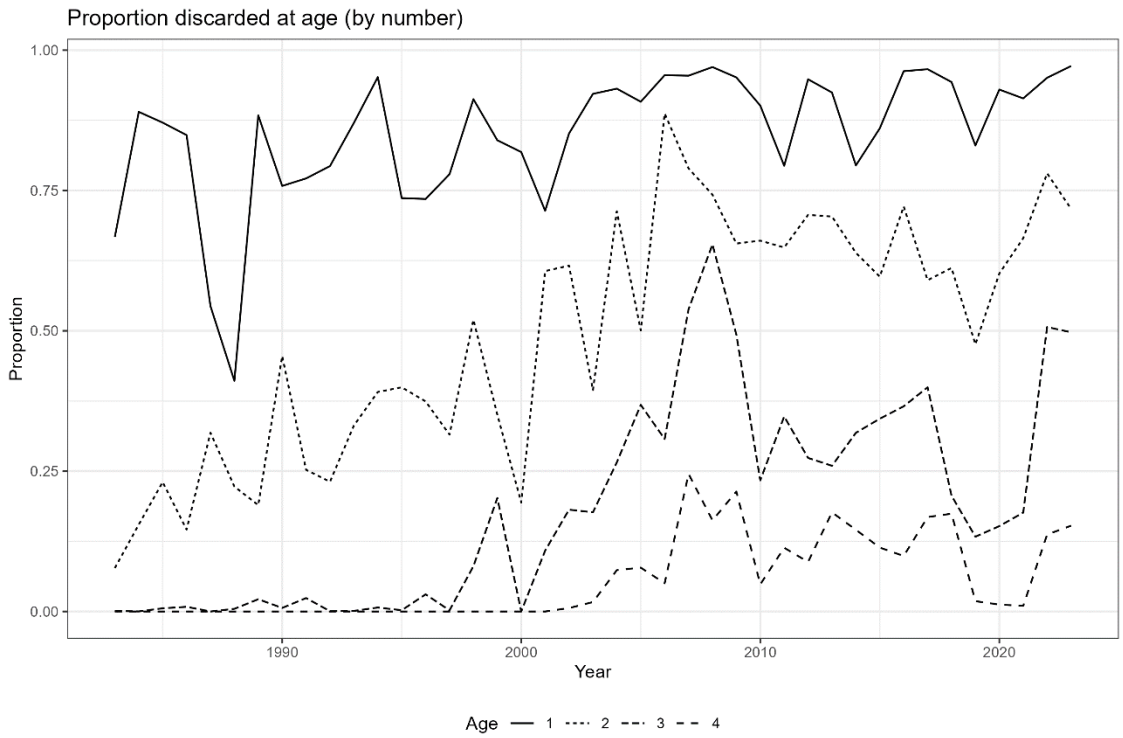


Figure 4.1a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Stacked area plot of reported landings and estimated discards (including BMS landings; in tonnes).



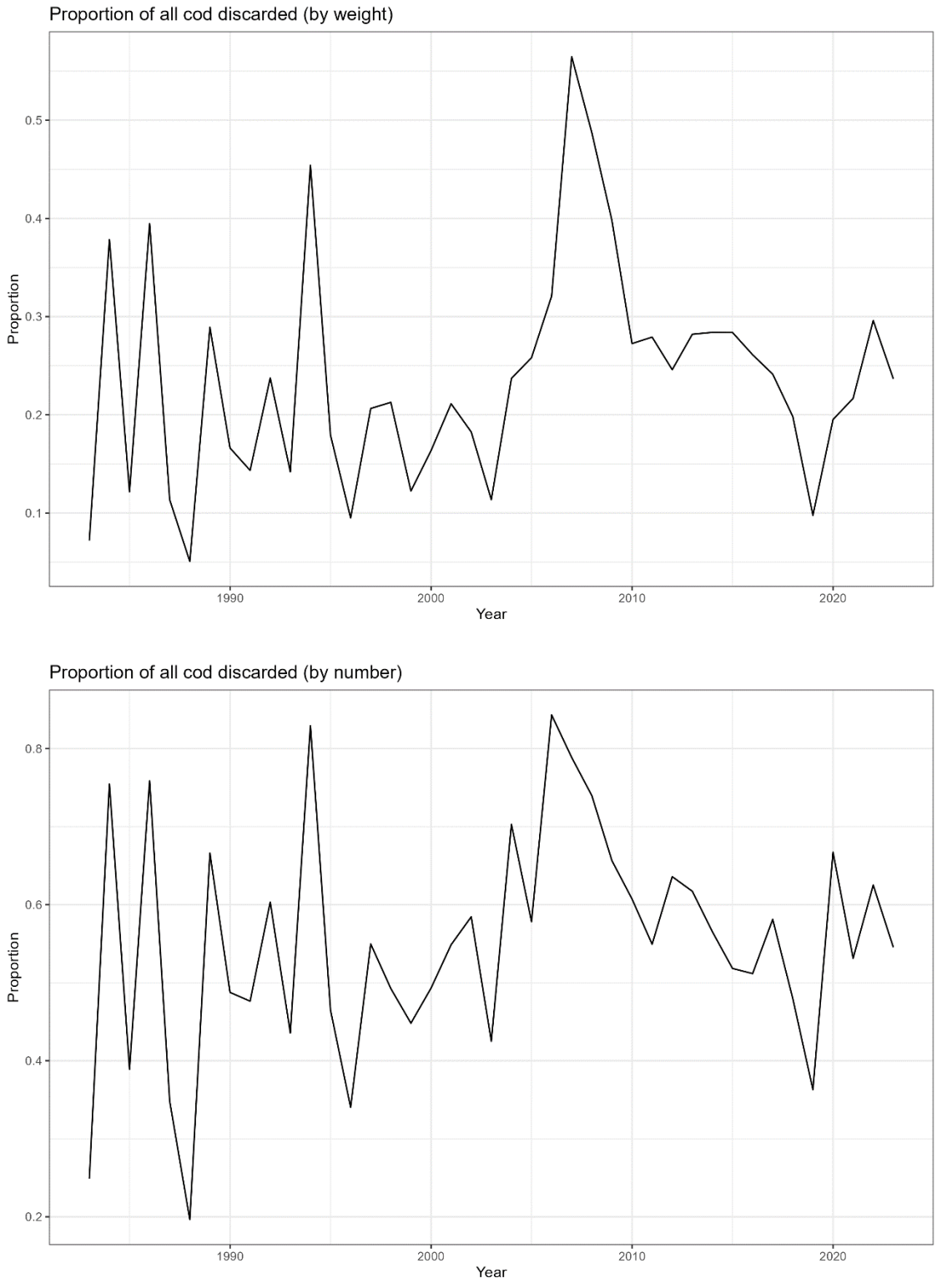


Figure 4.1b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. (Top) Proportion of total numbers caught at age that are discarded; (middle) proportion of total weight caught that is discarded; and (bottom) proportion of the total numbers caught that are discarded.

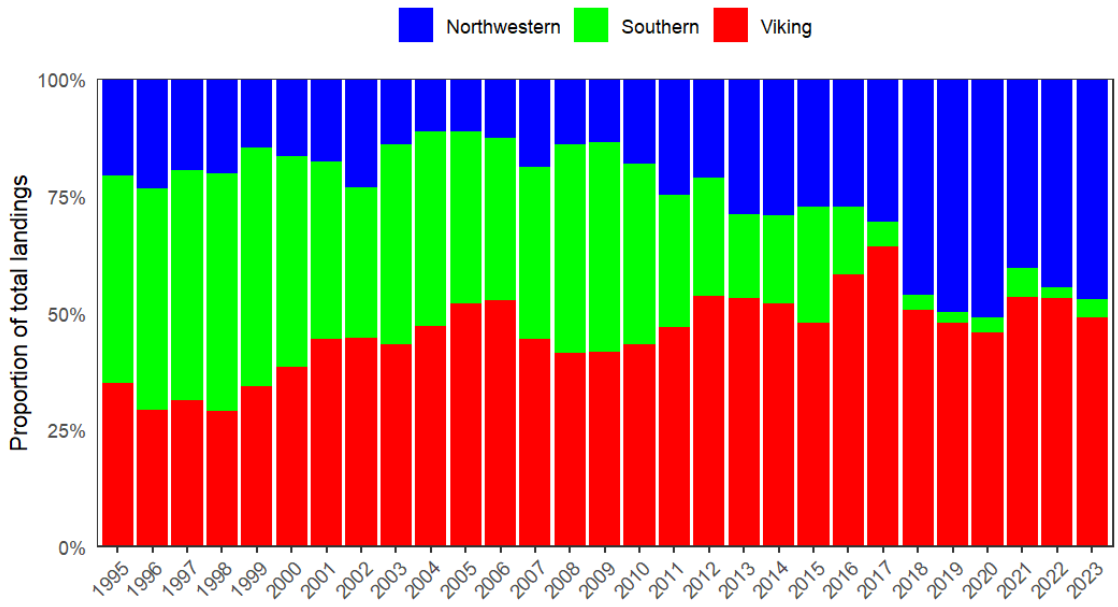


Figure 4.1c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Proportion of commercial landings by substock for the period 1995–2023. Commercial landings data from Q1 only are used to estimate substock compositions as it is assumed substocks do not mix in Q1.

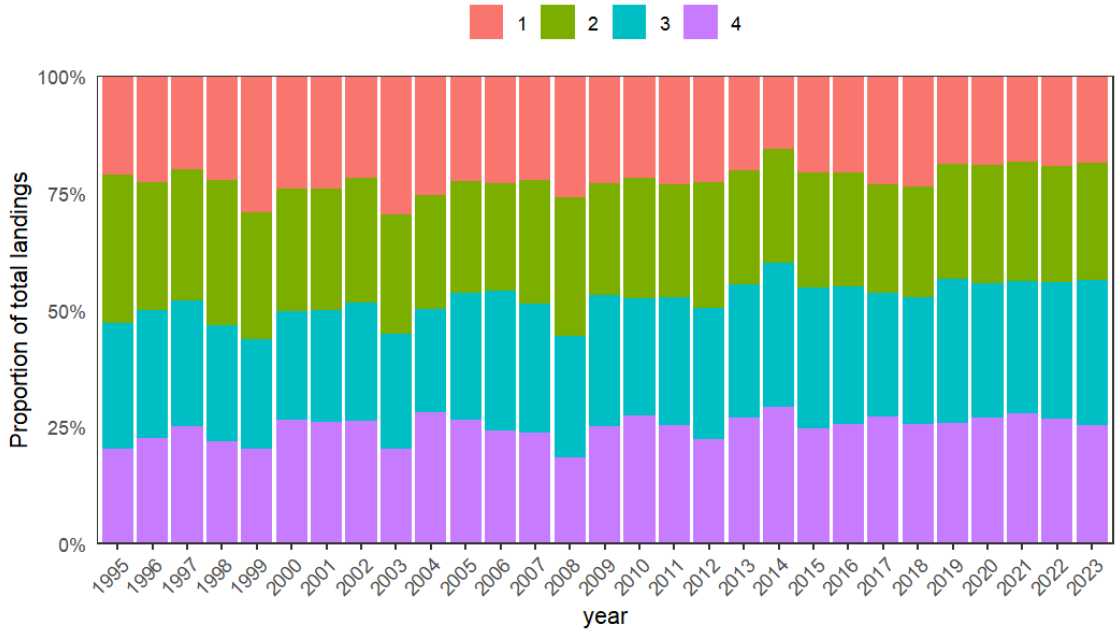


Figure 4.1d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Proportion of commercial landings by quarter for the period 1995–2023.

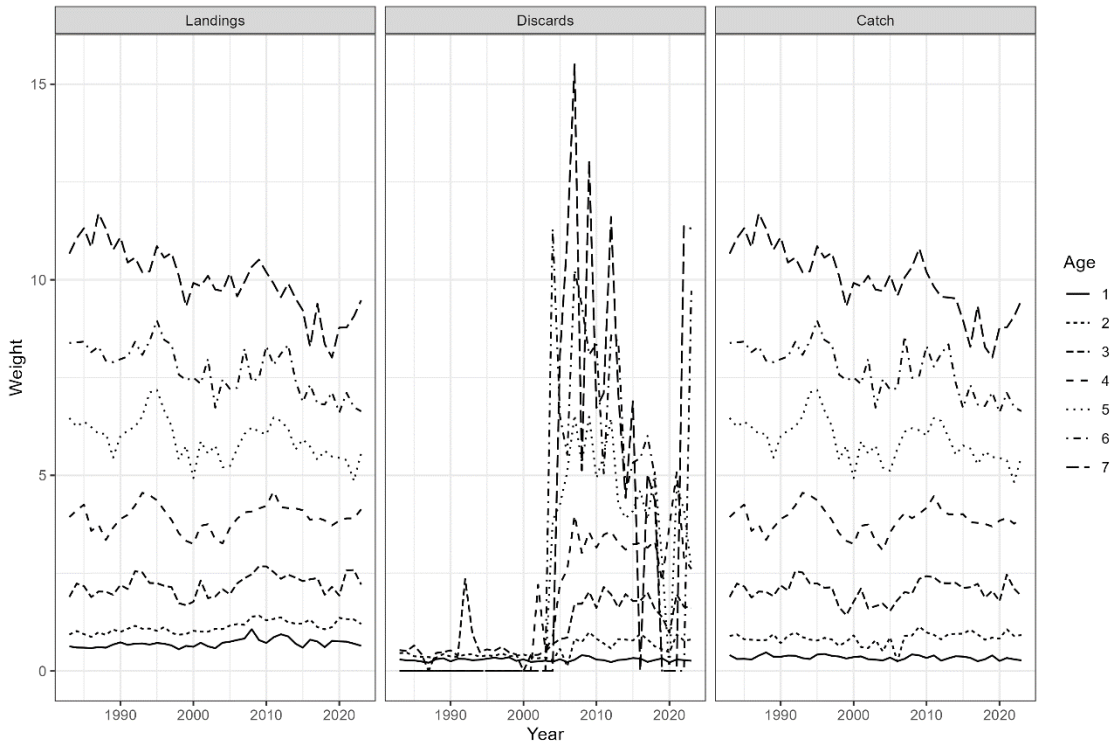


Figure 4.2a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Mean weights-at-age by catch component for ages 1–7+.

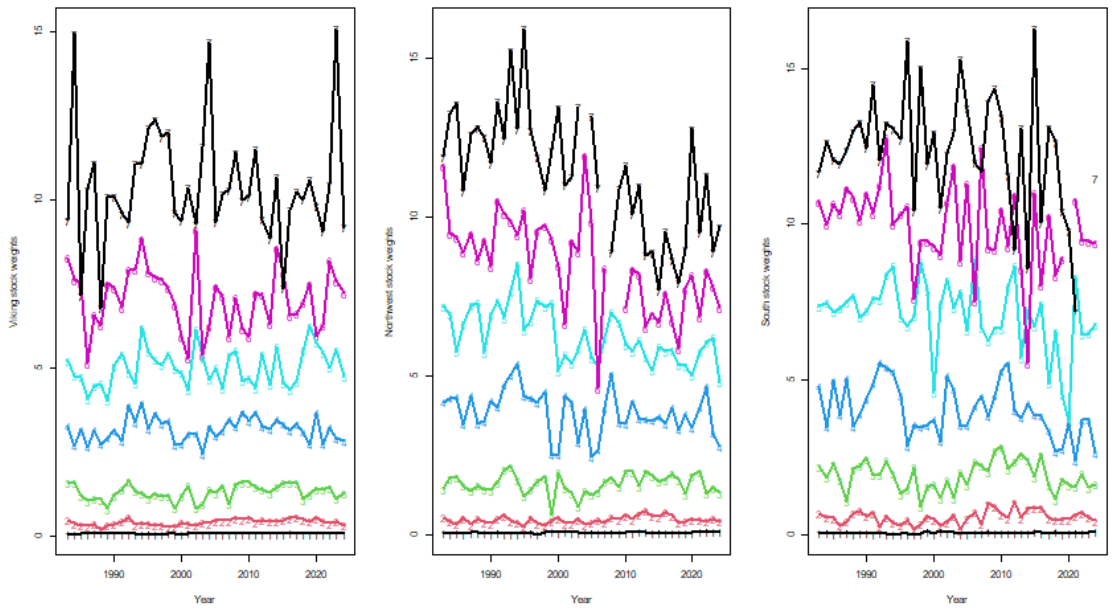


Figure 4.2b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Mean weights-at-age for each substock, as input to the multistock SAM assessment.

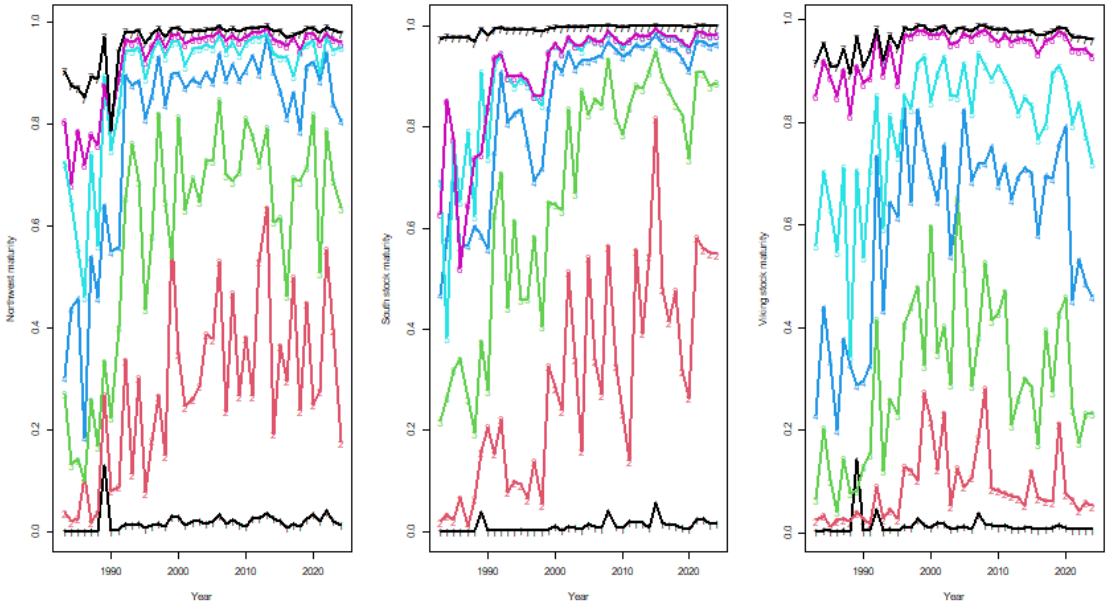


Figure 4.2c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Annually varying maturity-at-age for each sub-stock, as input to the multistock SAM assessment.

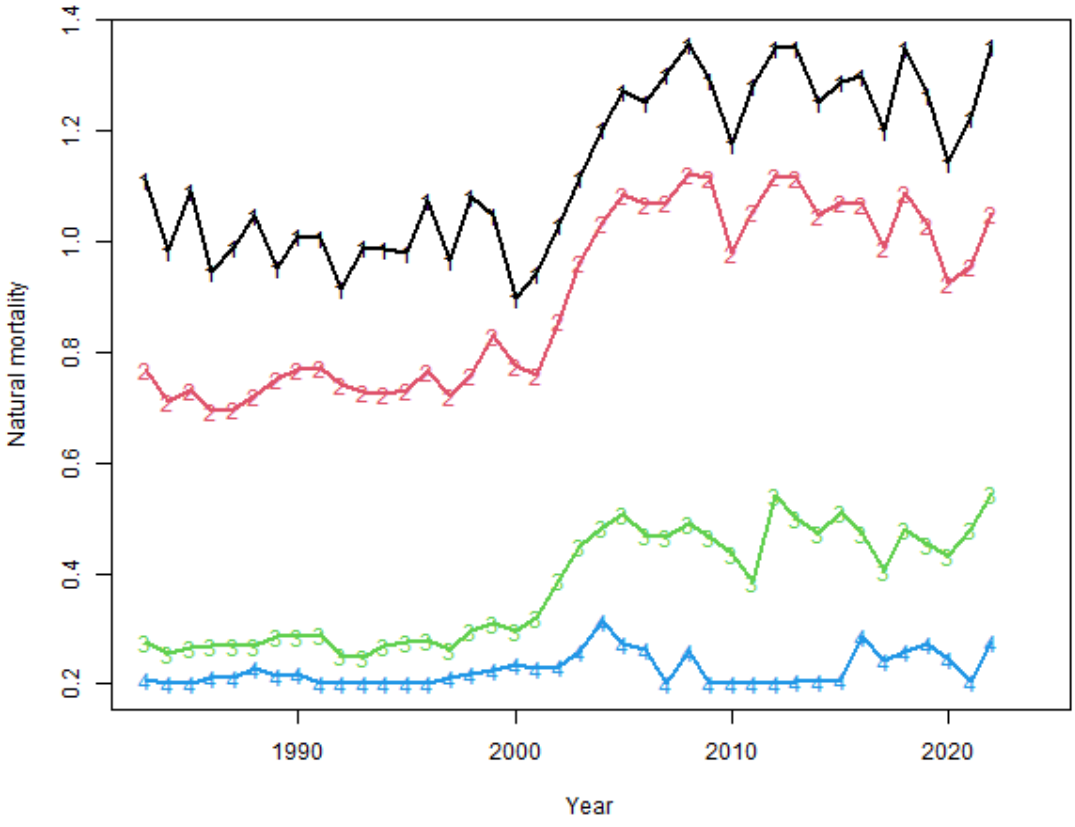


Figure 4.2d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Annually varying natural mortality from the SMS run for Northern Shelf cod, as input to the multistock SAM assessment. Values are assumed to apply to all three substocks

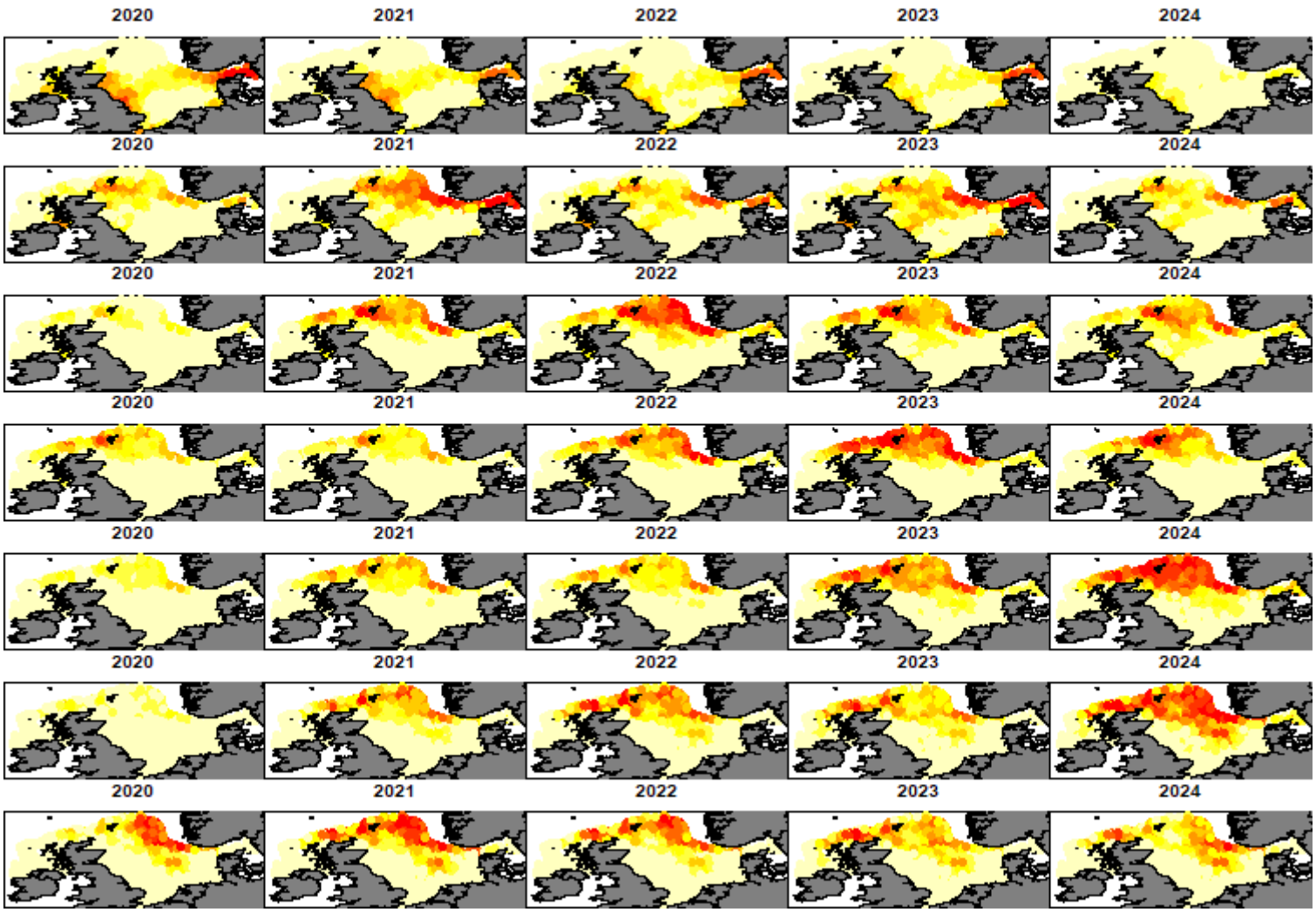


Figure 4.3a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM survey abundances of cod ages 1–7+ (top to bottom) in Q1.

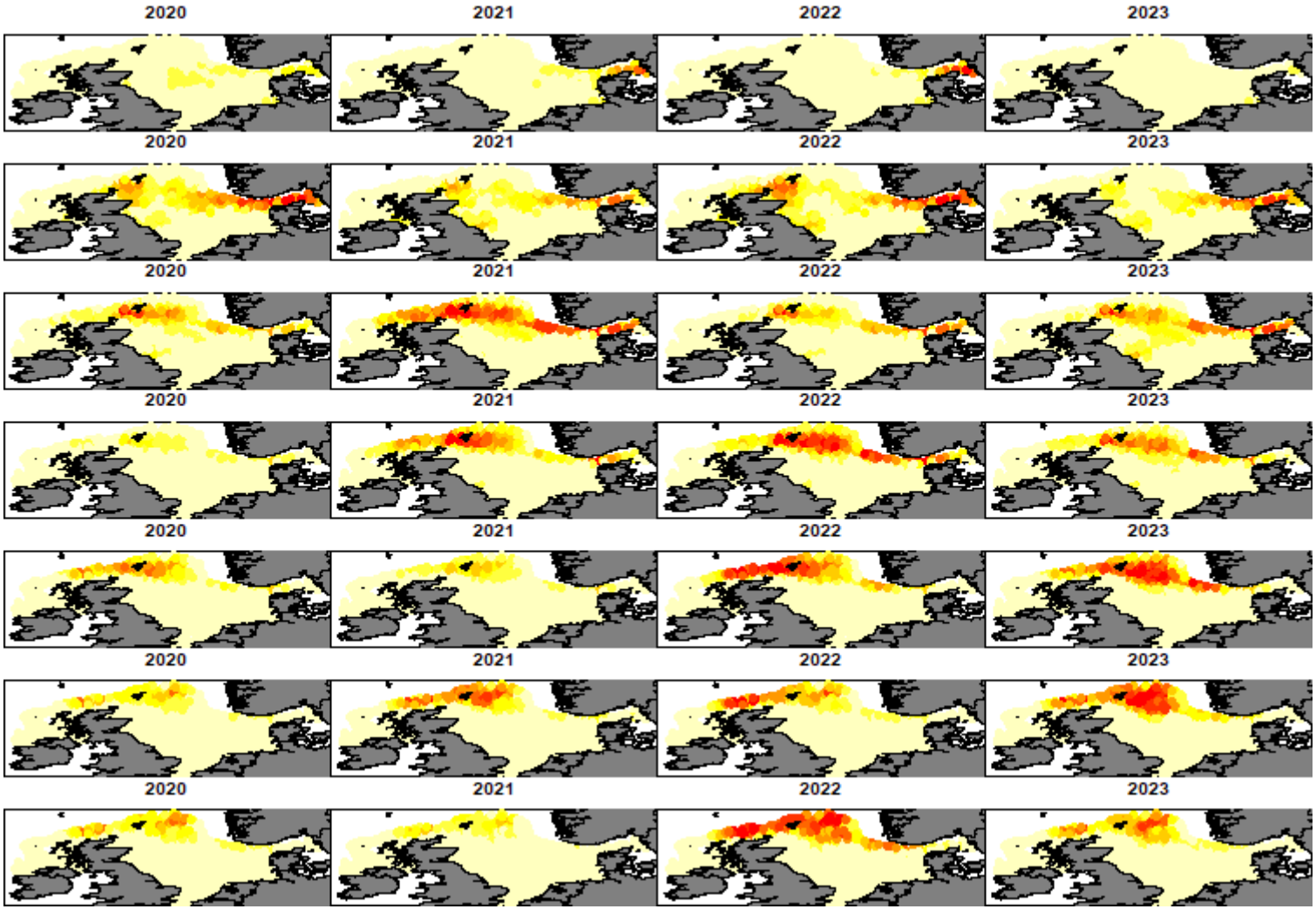


Figure 4.3b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM survey abundances of cod ages 0–6 (top to bottom) in Q3+Q4.

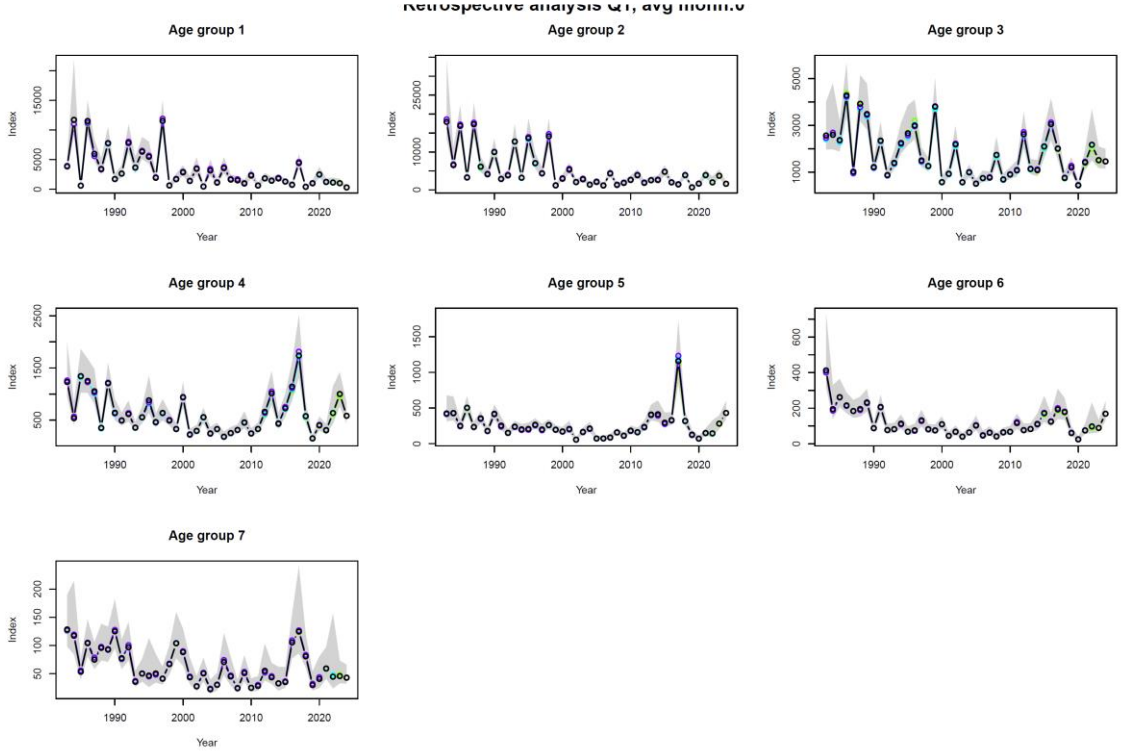


Figure 4.3c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Retrospective estimates (3 years) from the Delta-GAM model for Q1, together with corresponding pointwise 95% confidence intervals.

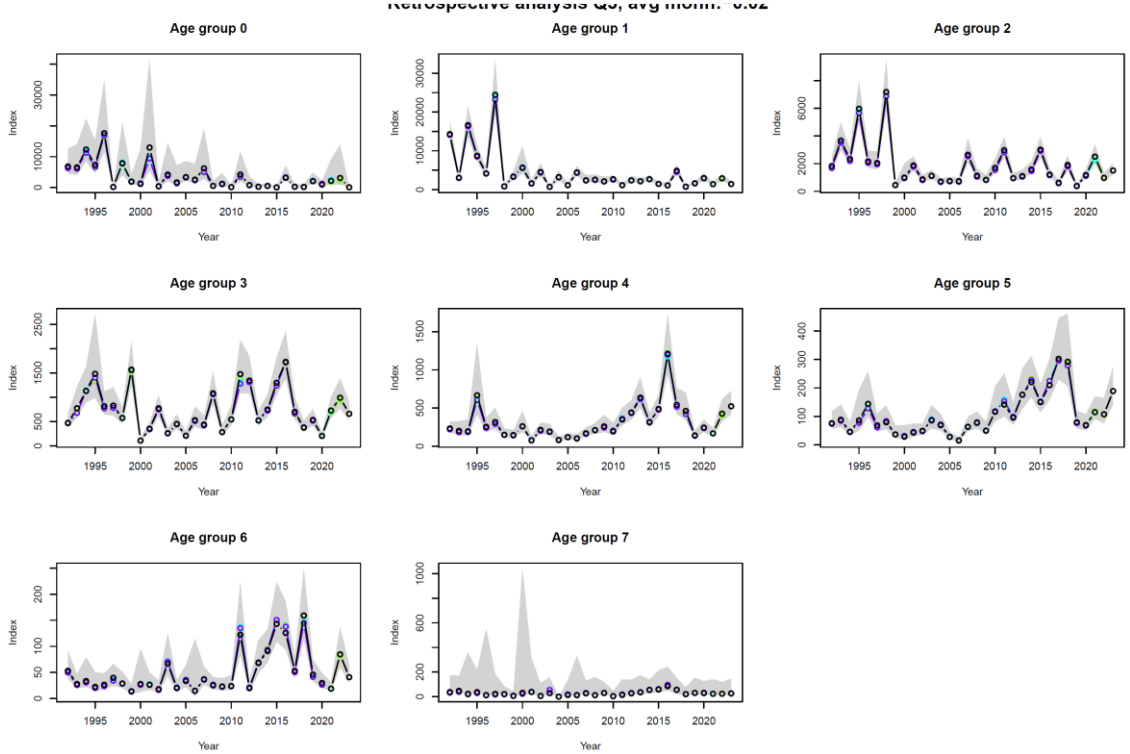


Figure 4.3d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Retrospective estimates (3 years) from the Delta-GAM model for Q3+Q4, together with corresponding pointwise 95% confidence intervals.

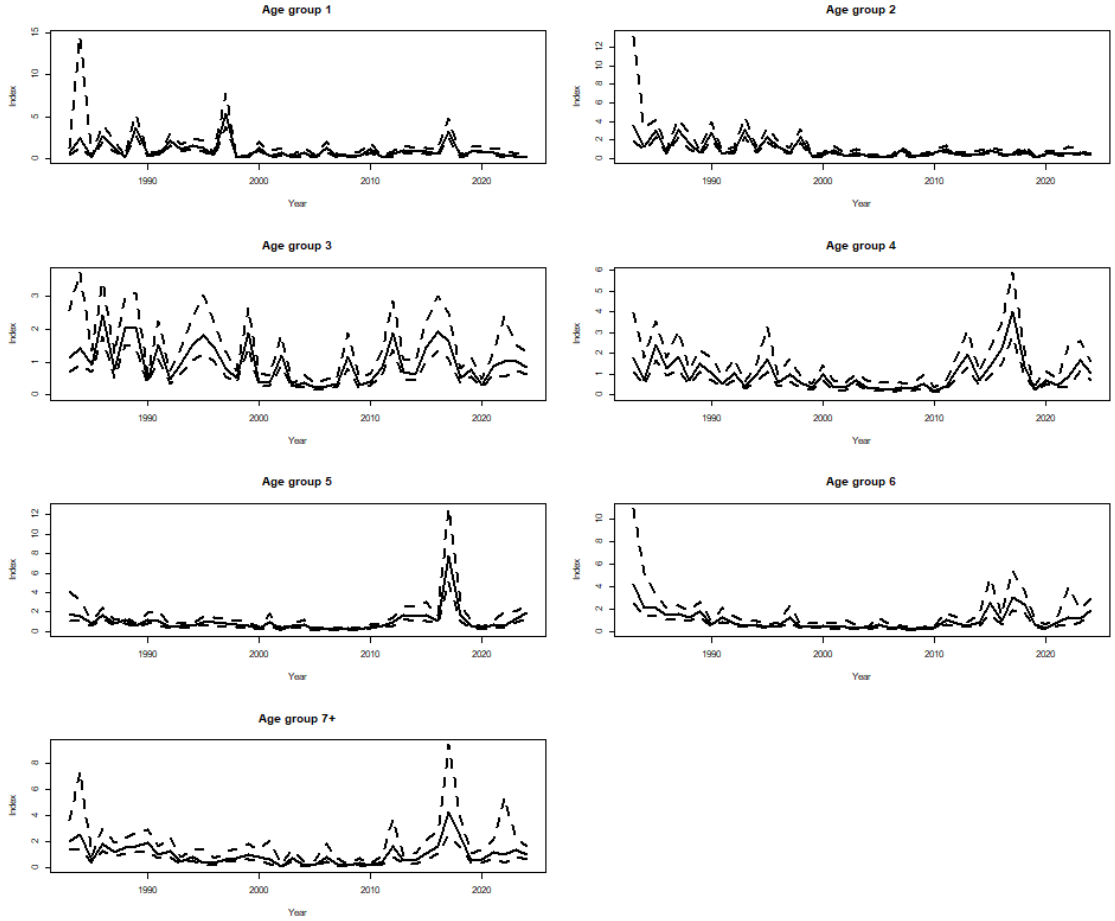


Figure 4.3e. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM survey indices for the Northwestern substock in Q1.

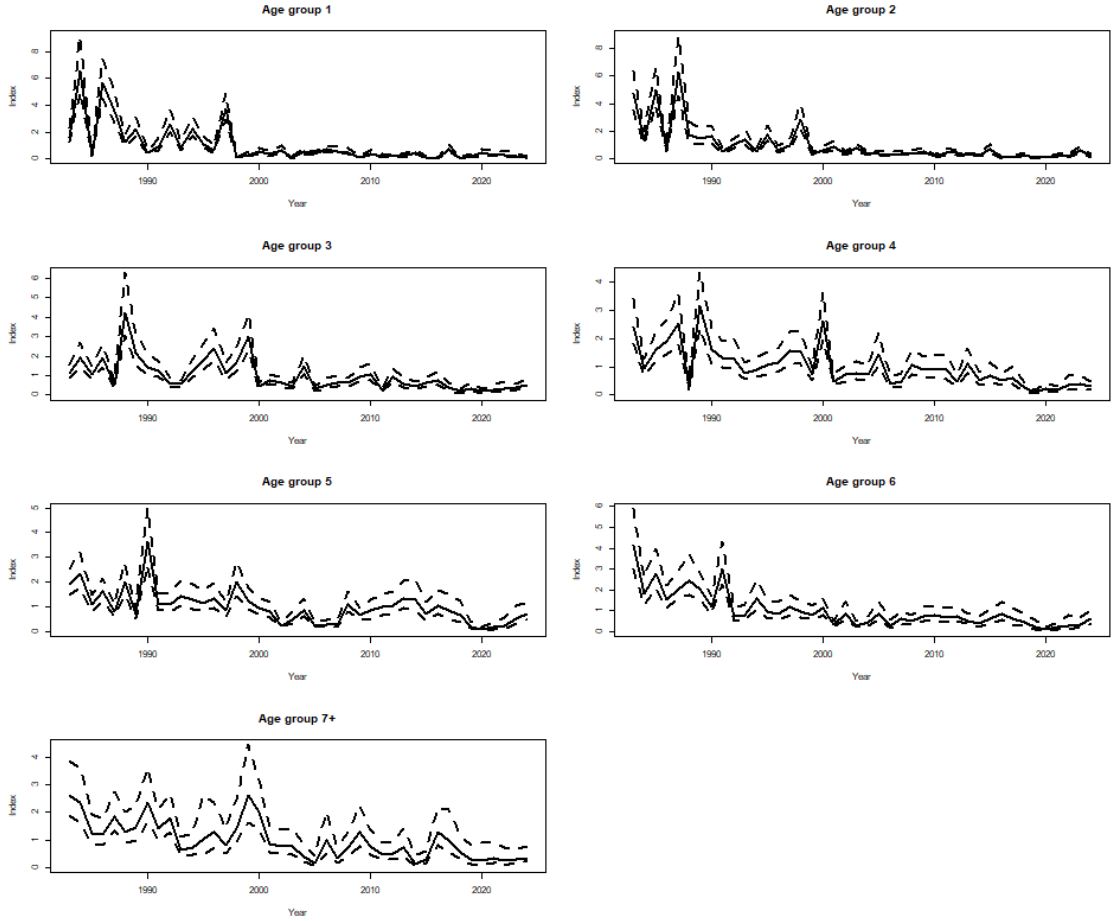


Figure 4.3f. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM survey indices for the Southern sub-stock in Q1.

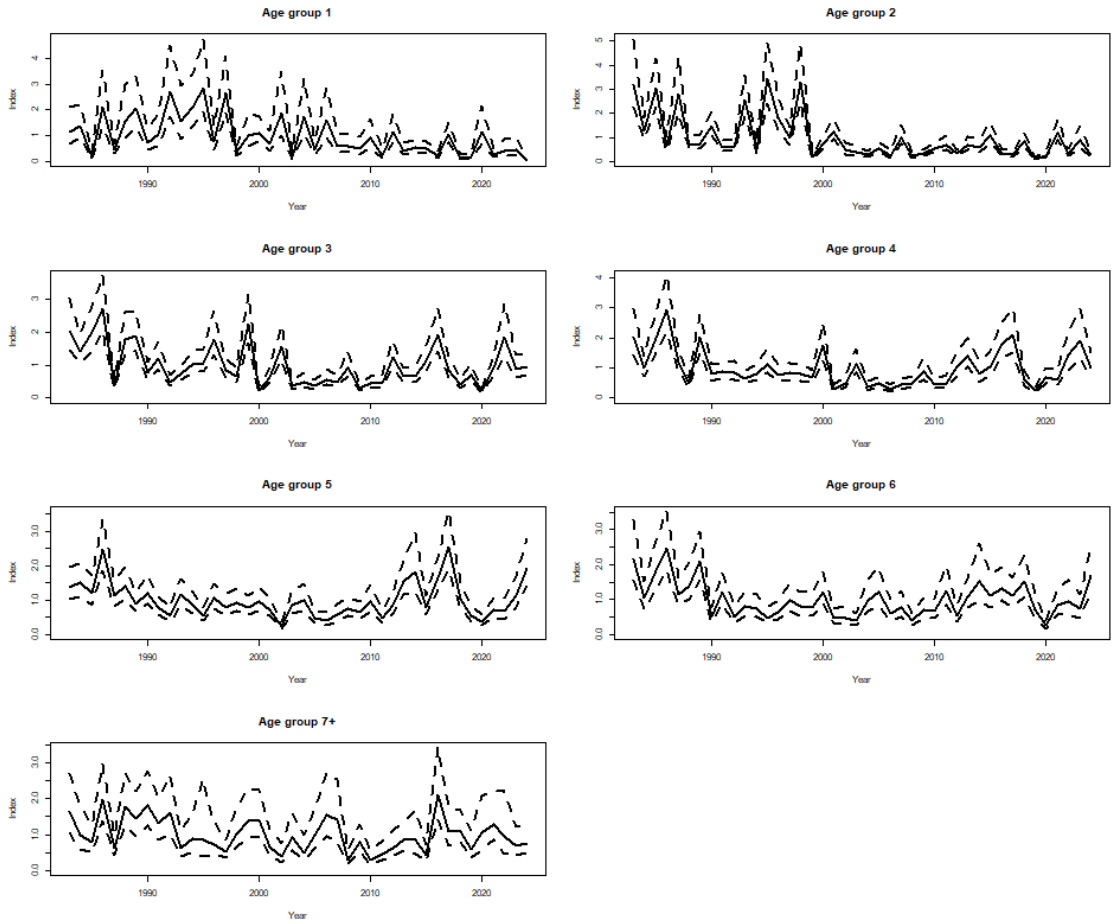


Figure 4.3g. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM survey indices for the Viking substock in Q1.

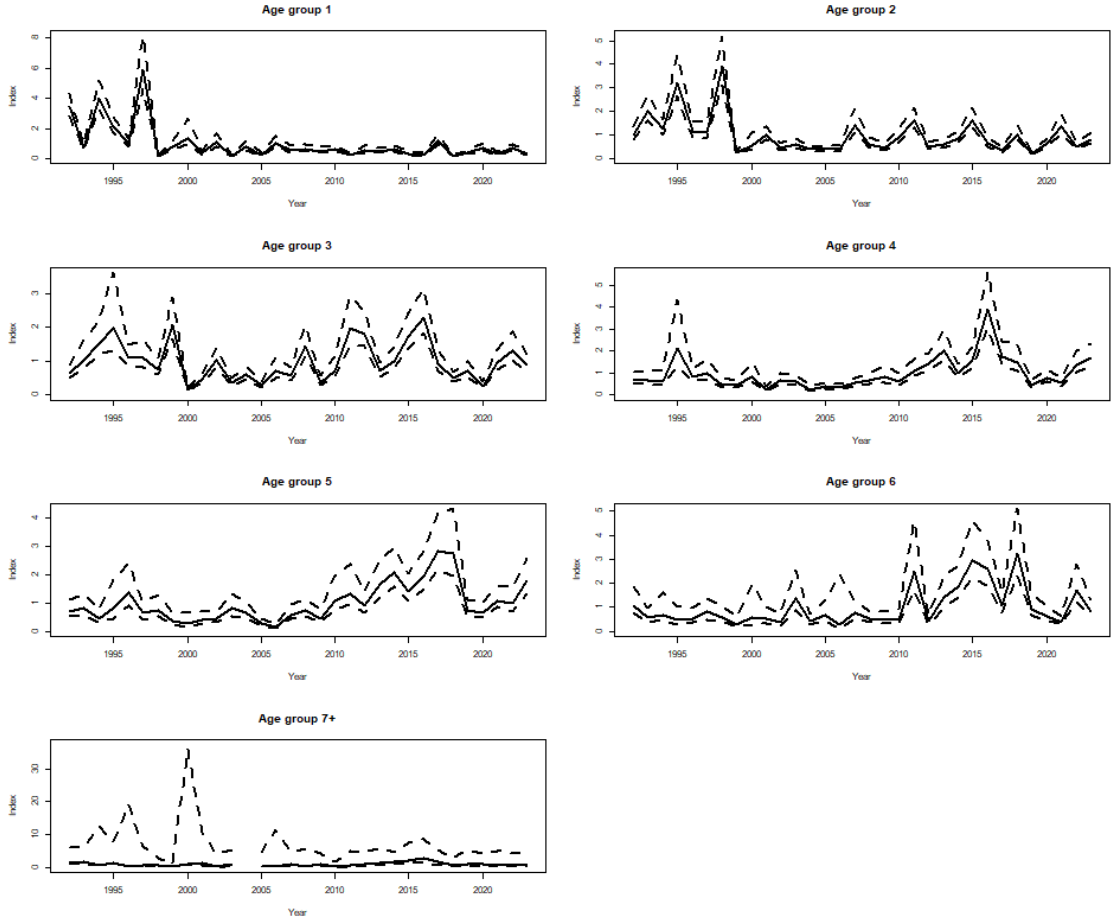
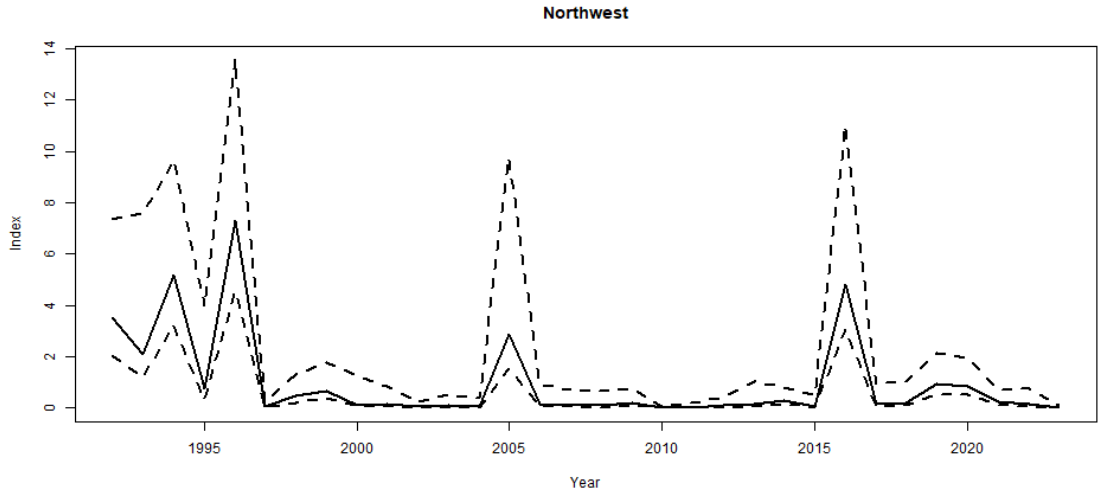


Figure 4.3h. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM survey indices for the Northern Shelf cod stock (all substocks) in Q3+Q4.



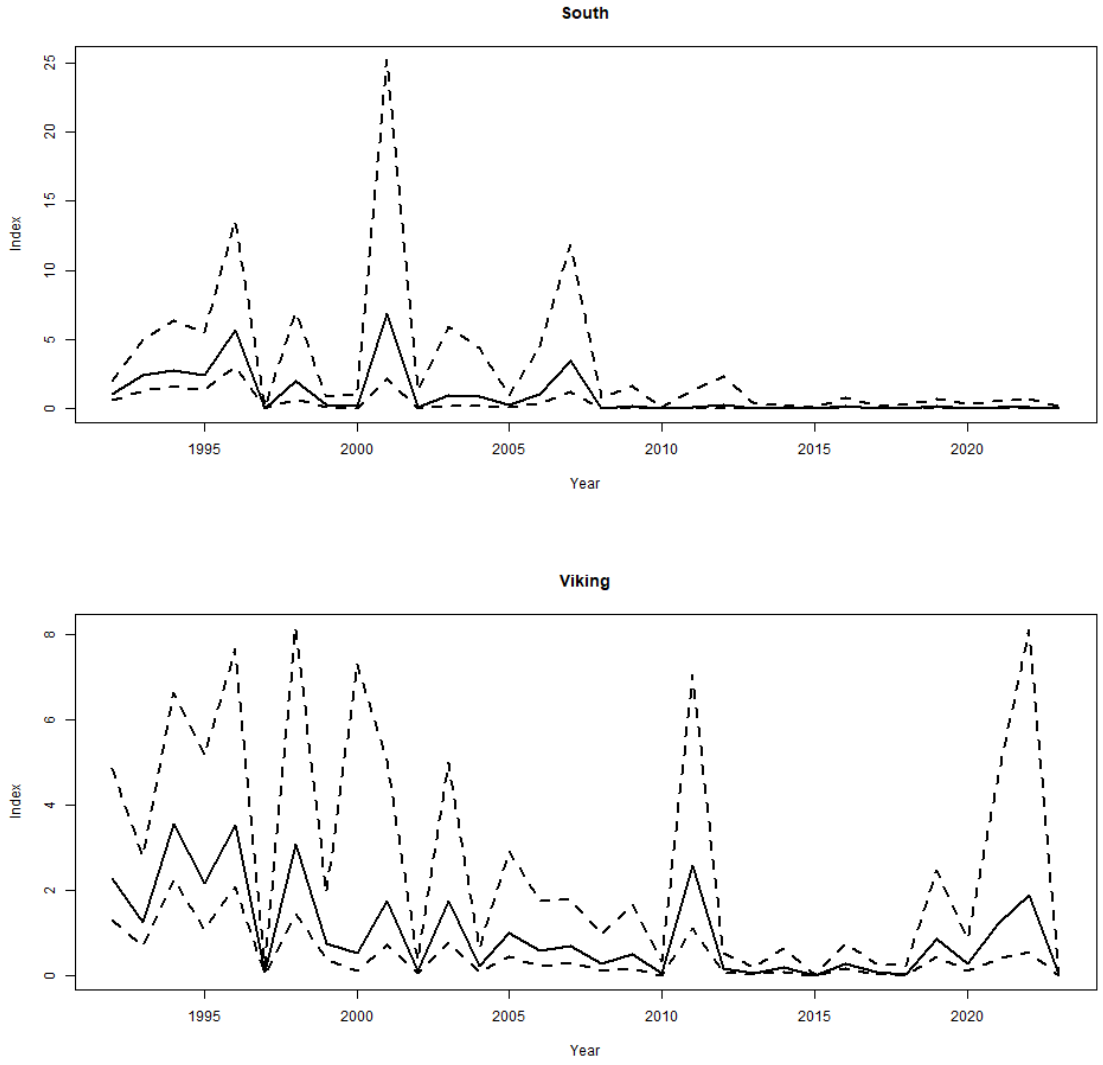


Figure 4.3i. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Delta-GAM indices for substocks of Northern Shelf cod at age 0 in Q3+Q4. These indices are forward shifted in the multistock SAM assessment to represent age 1 cod 1st January the following year.

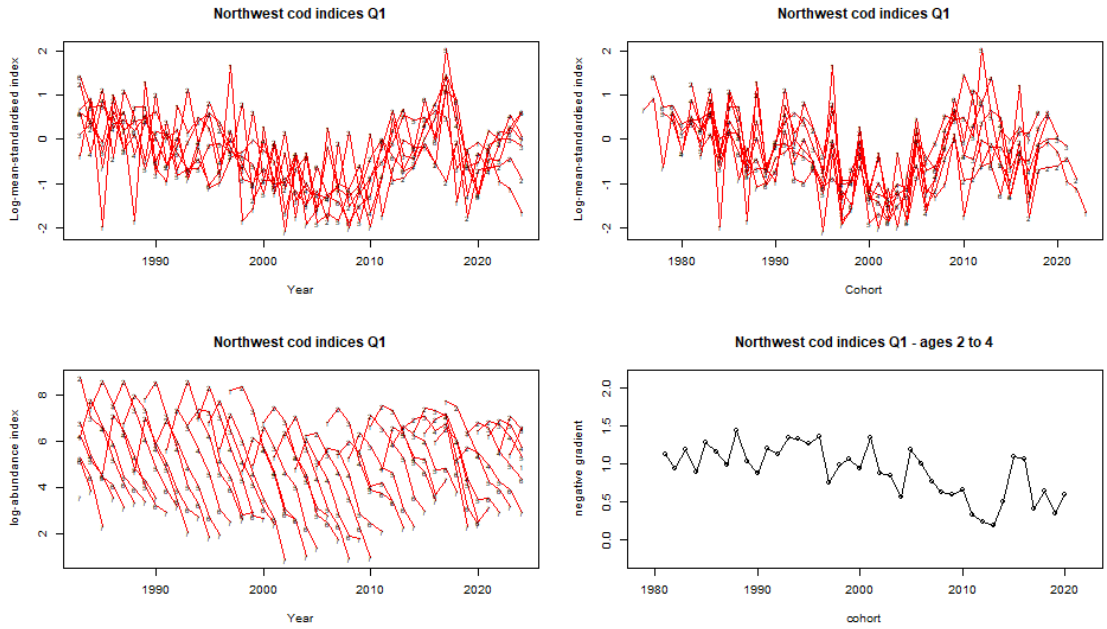


Figure 4.4a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Log mean standardized indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2–4 (bottom right), for the Northwestern substock in Q1.

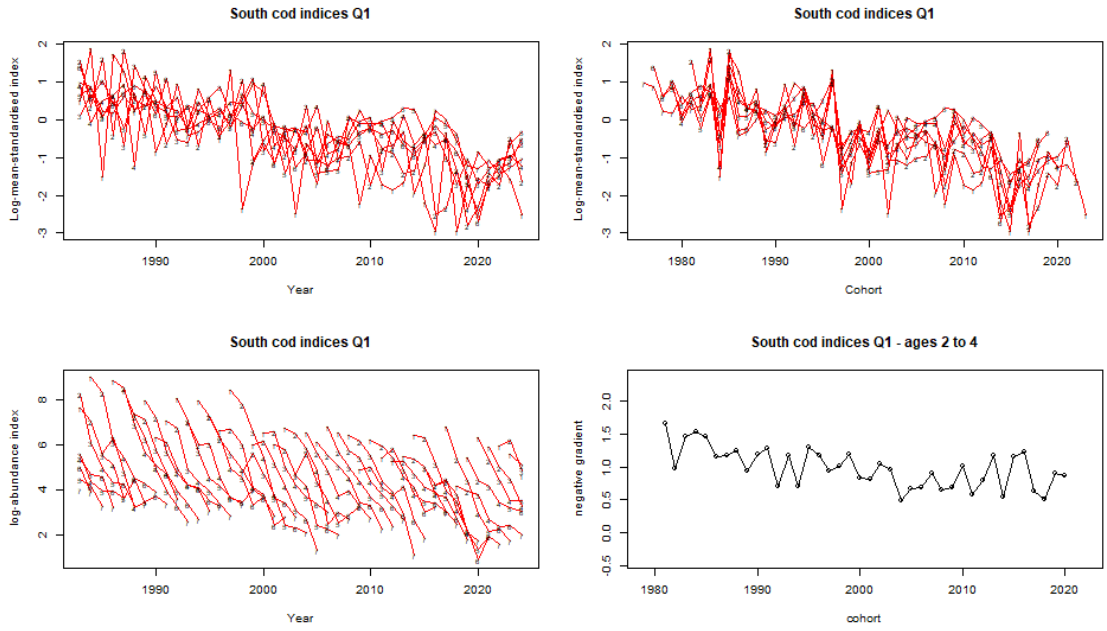


Figure 4.4b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Log mean standardized indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2–4 (bottom right), for the Southern substock in Q1.

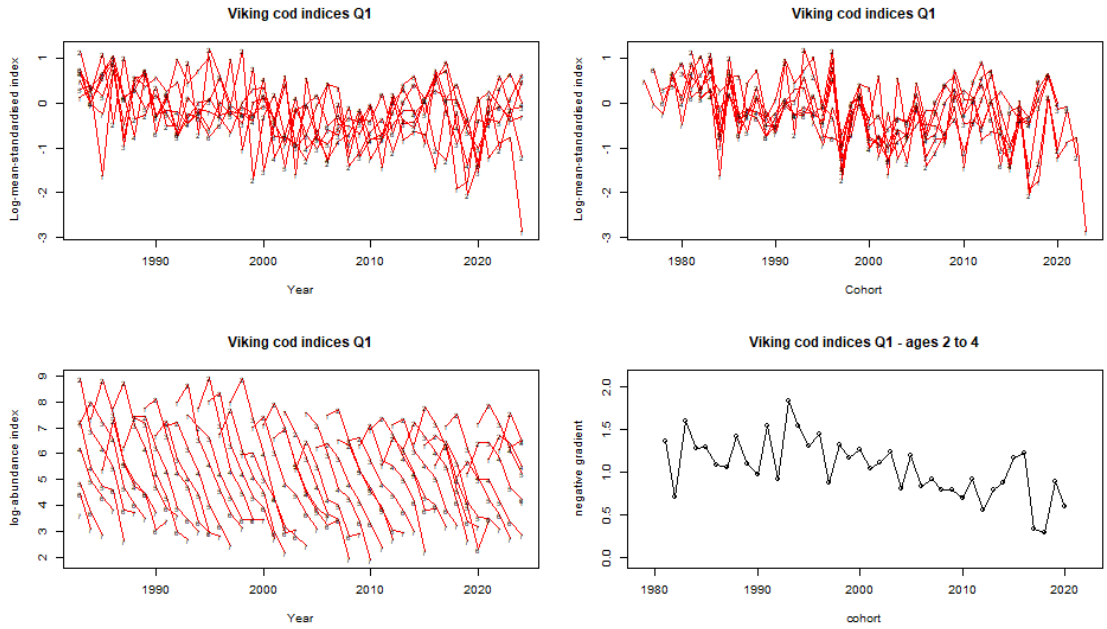


Figure 4.4c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Log mean standardized indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2–4 (bottom right), for the Viking substock in Q1.

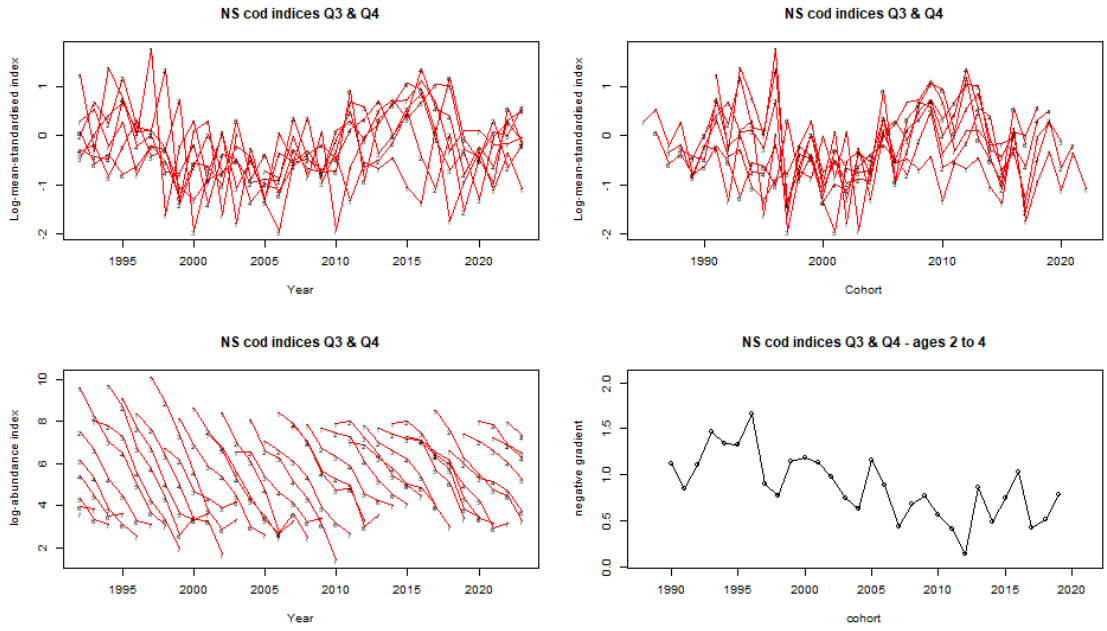


Figure 4.4d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Log mean standardized indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2–4 (bottom right), in the Q3+Q4 surveys (all substocks).

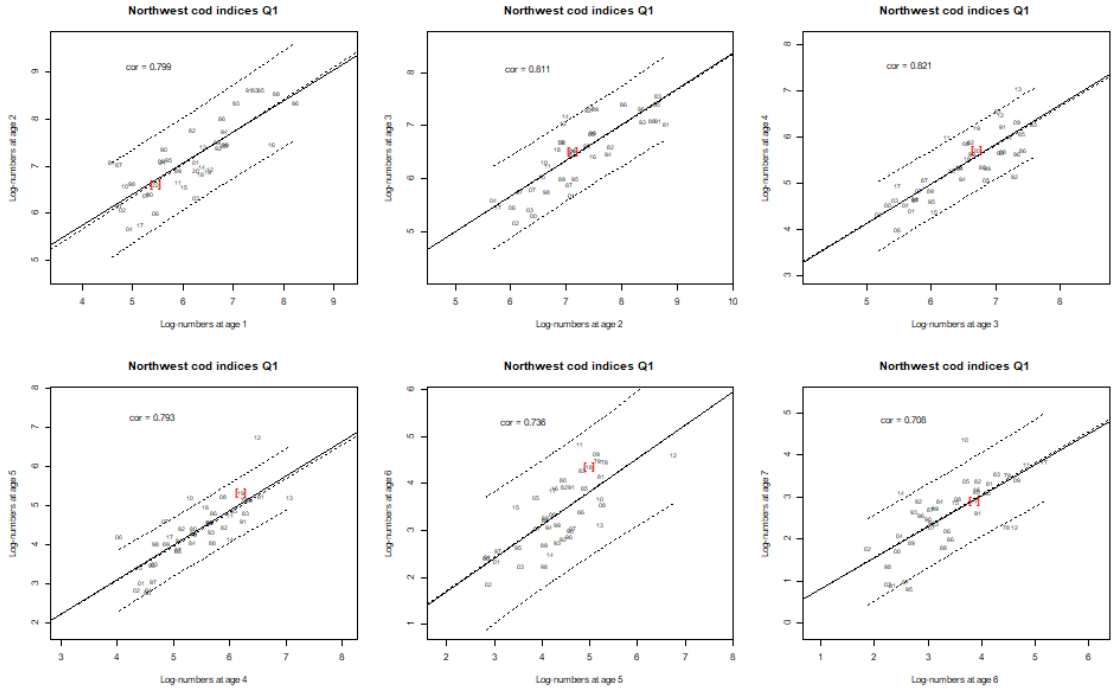


Figure 4.5a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Within survey correlations for the Northwestern substock in Q1 for the period 1983–2024. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data point appears in red square brackets.

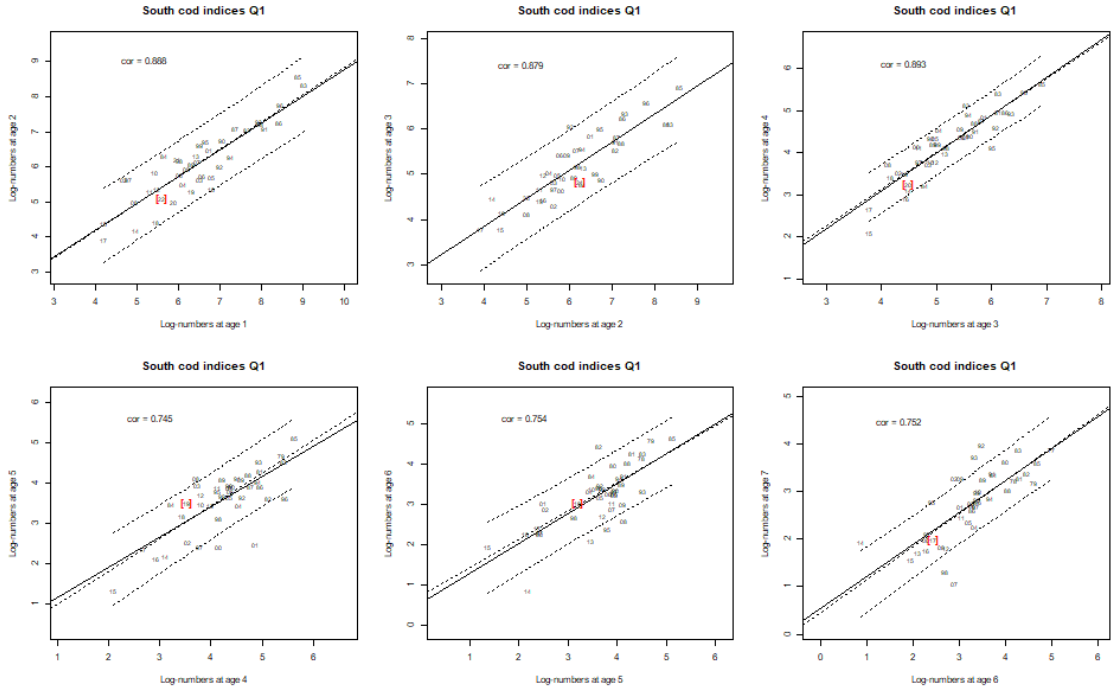


Figure 4.5b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Within survey correlations for the Southern substock in Q1 for the period 1983–2024. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data point appears in red square brackets.

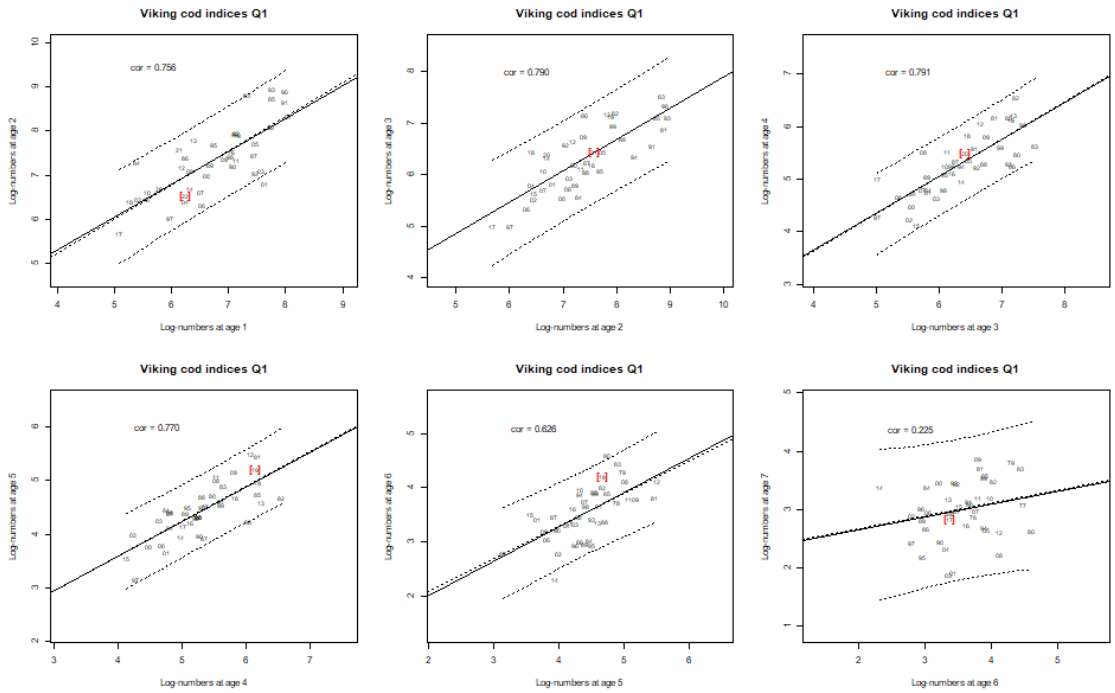


Figure 4.5c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Within survey correlations for the Viking substock in Q1 for the period 1983–2024. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data point appears in red square brackets.

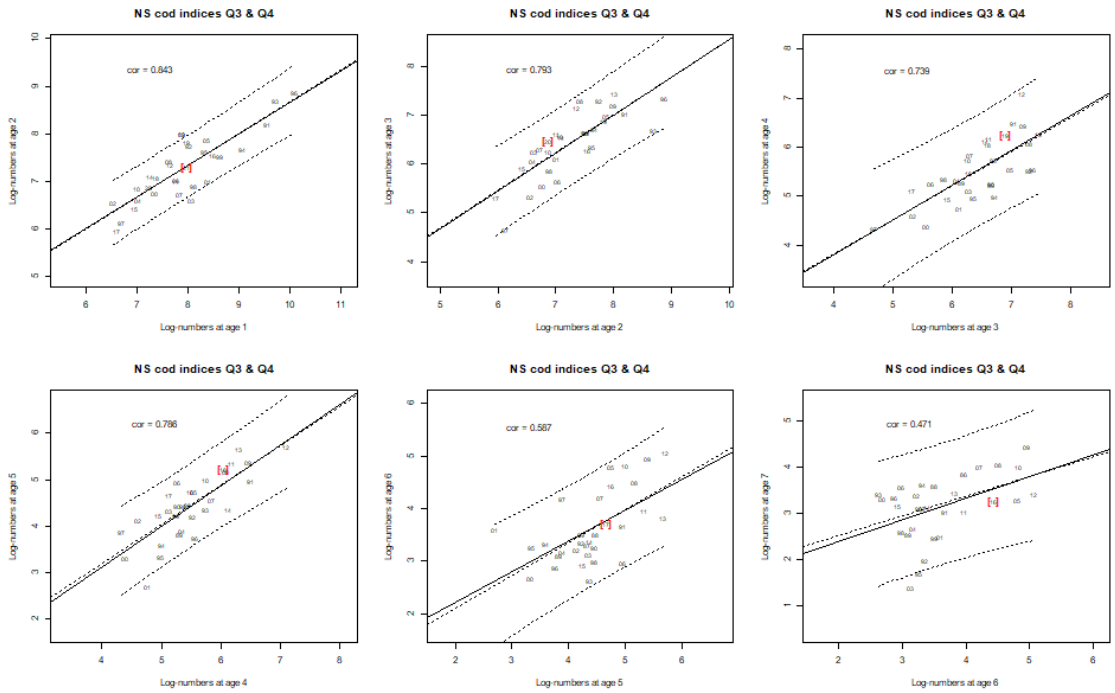


Figure 4.5d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Within survey correlations for the Northern Shelf stock (all substocks) in Q3+Q4 for the period 1992–2023. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data point appears in red square brackets.

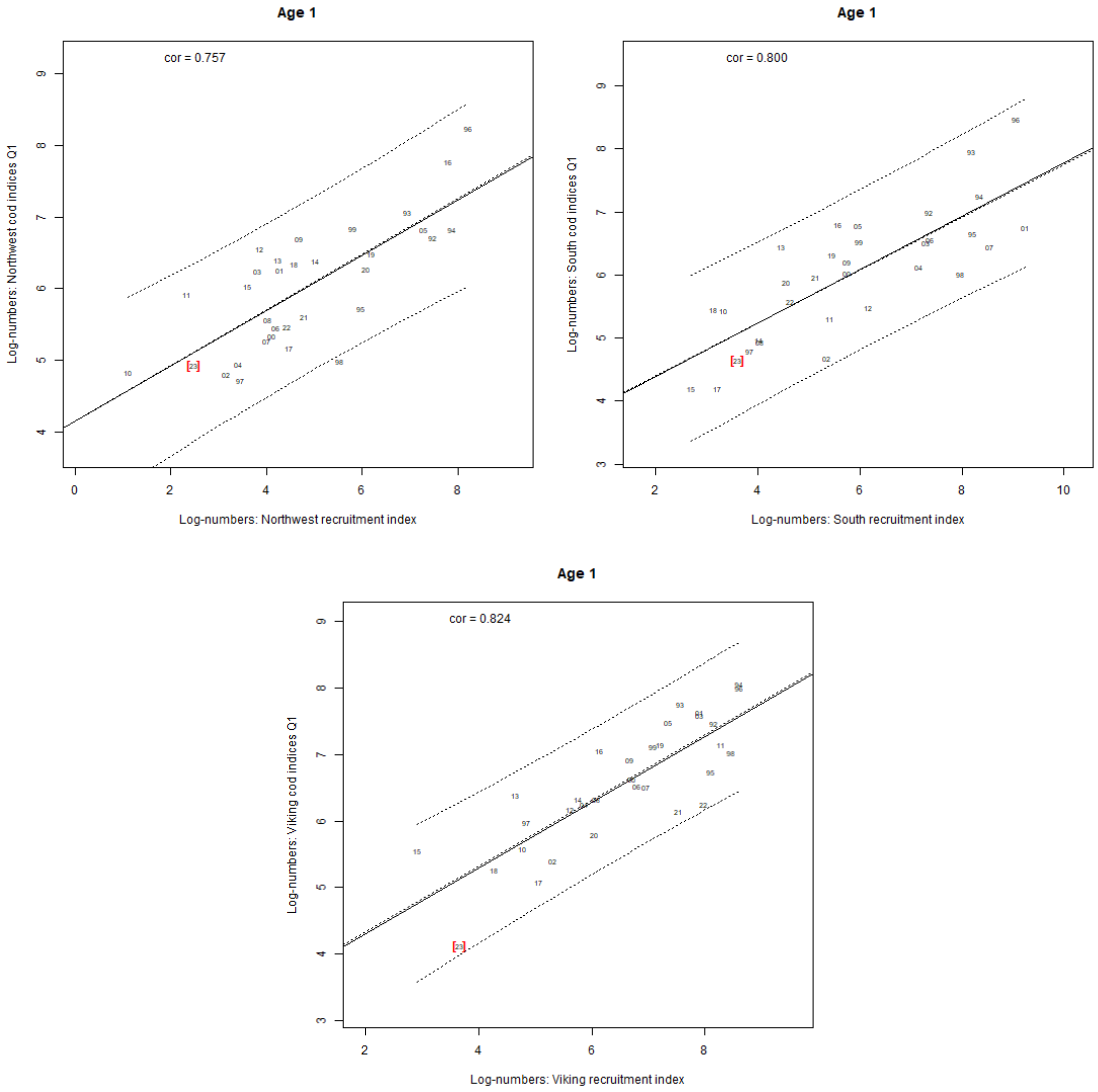


Figure 4.5e. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Between-survey correlations for the Q1 age 1 and Q3+Q4 recruitment indices (age 0 forward shifted to 1st January the following year) by substock for the period 1993–2024. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, and the broken line nearest to it a robust linear regression line. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data point appears in red square brackets.

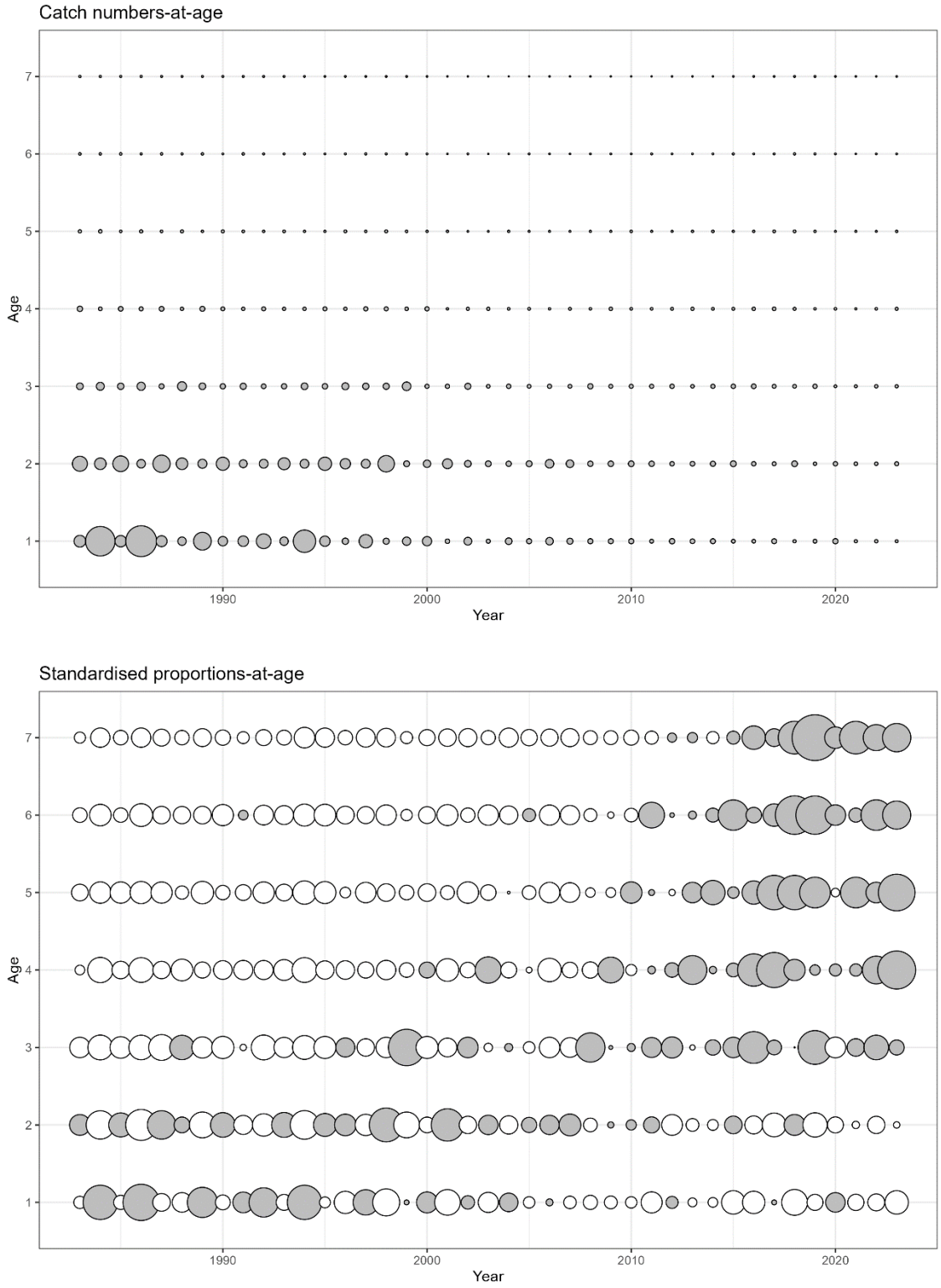


Figure 4.6. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Total catch-at-age matrix expressed for the mixed-stock (all substocks) as (top) numbers-at-age and (bottom) proportions-at-age, which have been standardized over time (for each age, this is achieved by subtracting the mean proportion-at-age over the time series and dividing by the corresponding variance). Grey bubbles indicate proportions above the mean over the time series at each age.

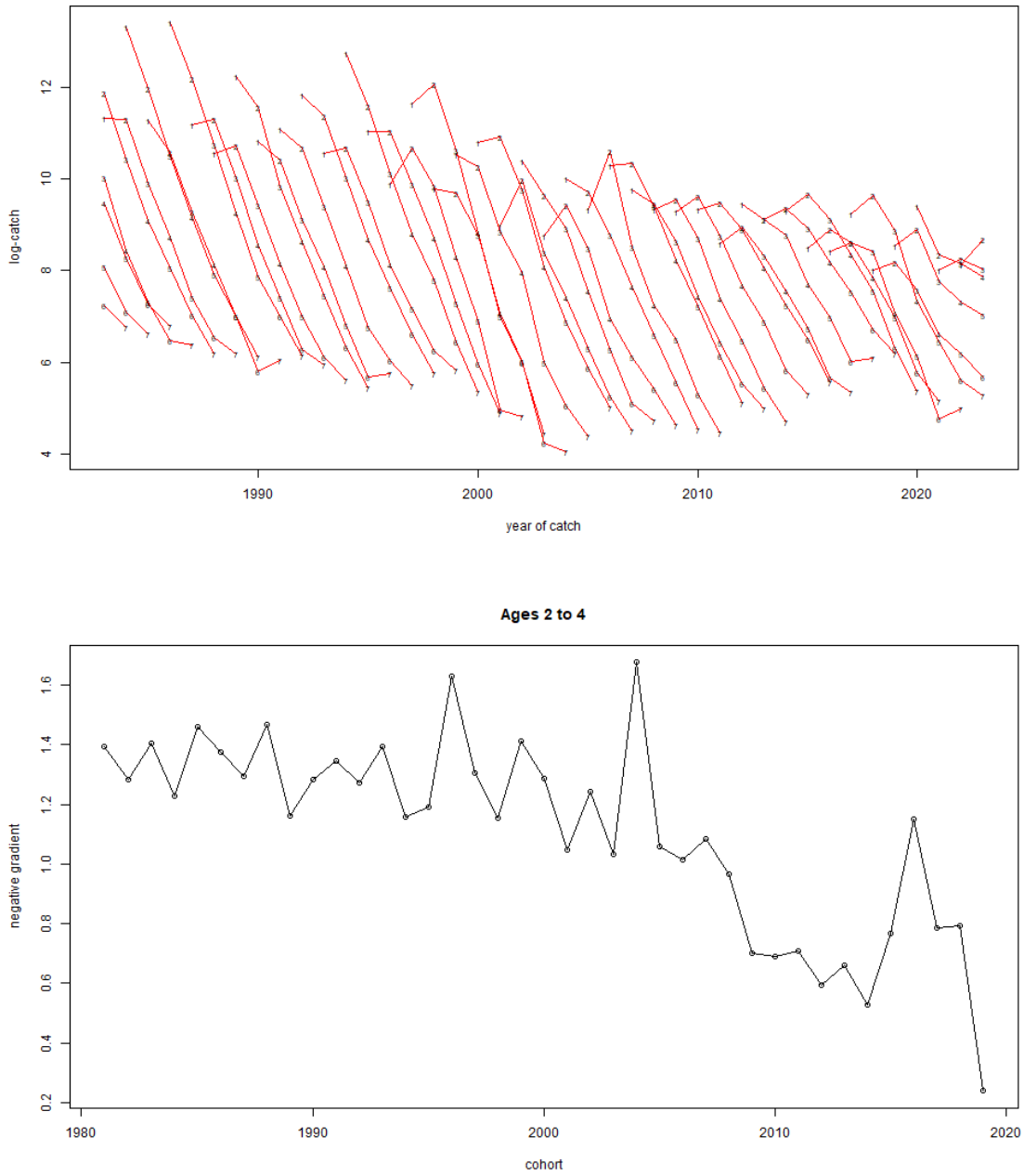


Figure 4.7. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Log-catch cohort curves for the mixed-stock (all substocks; top panel) and the associated negative gradients for each cohort across the reference fishing mortality of age 2–4.

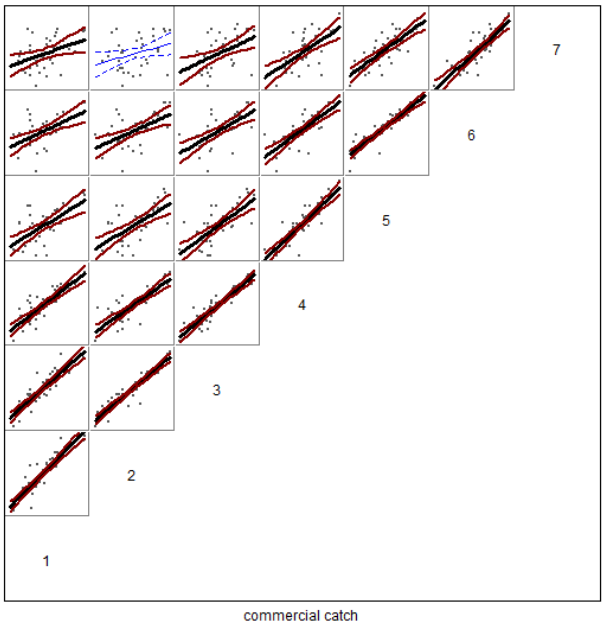


Figure 4.8. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Correlations in the catch-at-age matrix.

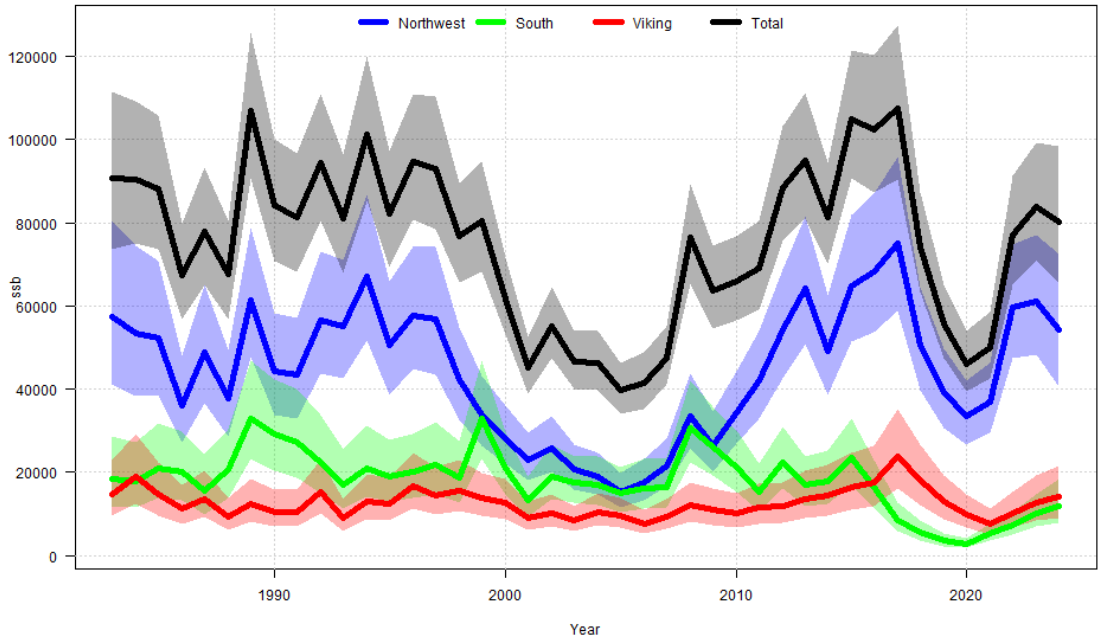


Figure 4.9a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Estimated SSB from the multistock SAM assessment for each substock and the total stock combined, with pointwise 95% confidence intervals.

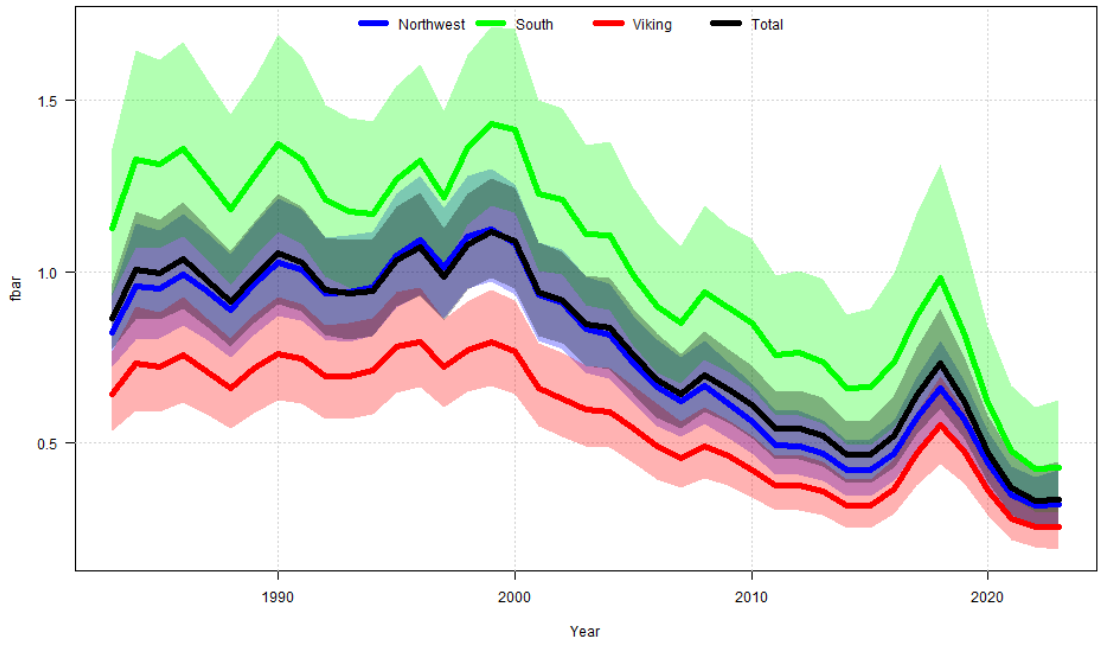


Figure 4.9b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Estimated F(2–4) from the multistock SAM assessment for each substock and the total stock combined, with pointwise 95% confidence intervals.

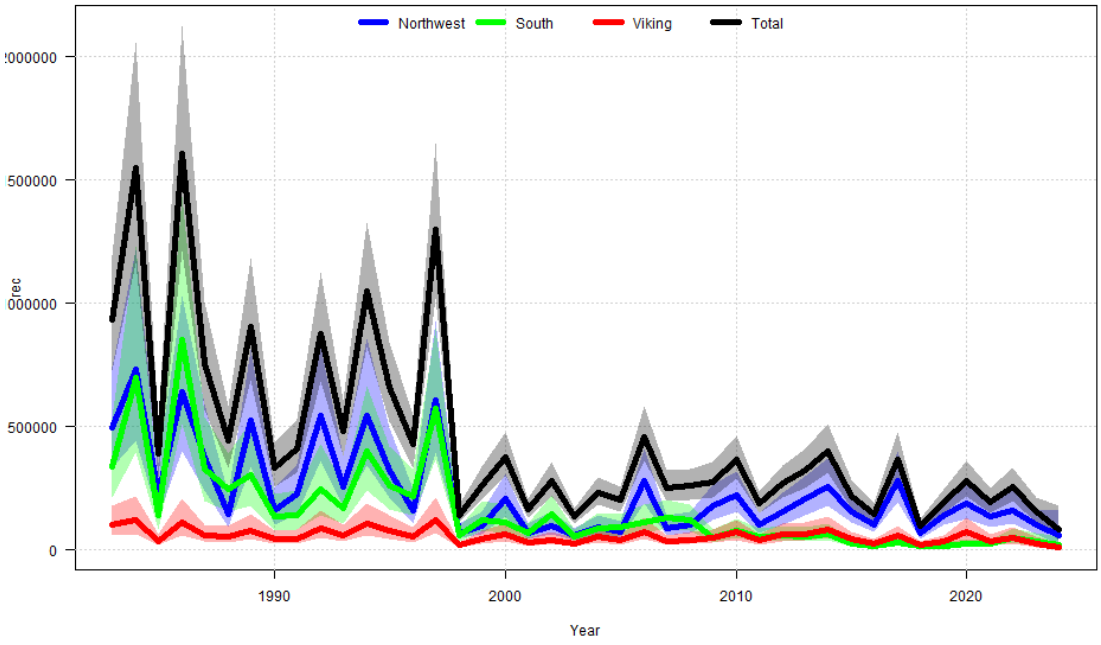


Figure 4.9c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Estimated recruitment (age 1) from the multistock SAM assessment for each substock and the total stock combined, with pointwise 95% confidence intervals.

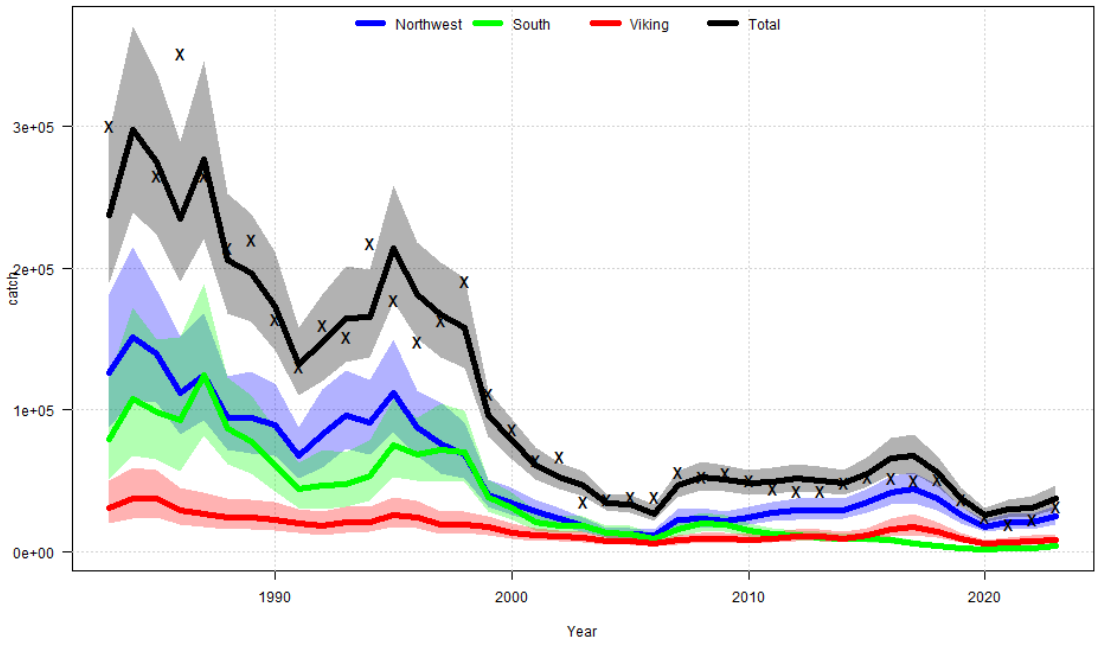


Figure 4.9d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Estimated catches from the multistock SAM assessment for each substock and the total stock combined, with pointwise 95% confidence intervals. Observed catches for the total stock are shown with crosses.

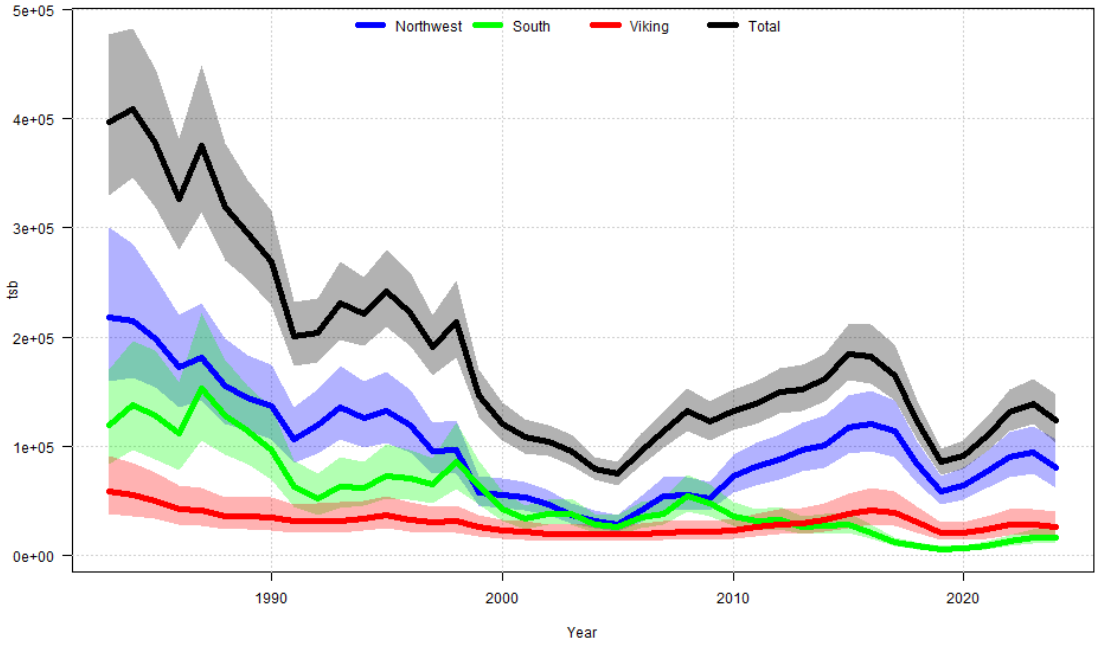


Figure 4.9e. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Estimated TSB from the multistock SAM assessment for each substock and the total stock combined, with pointwise 95% confidence intervals.

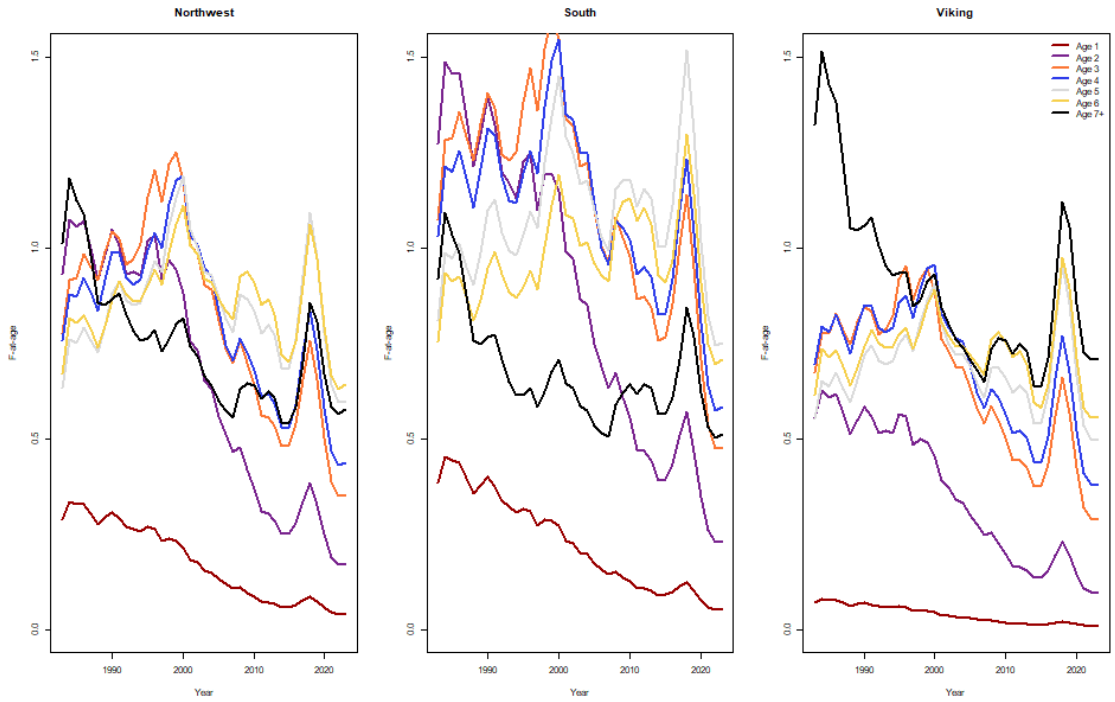


Figure 4.10a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM estimates of fishing mortality-at-age for each substock.

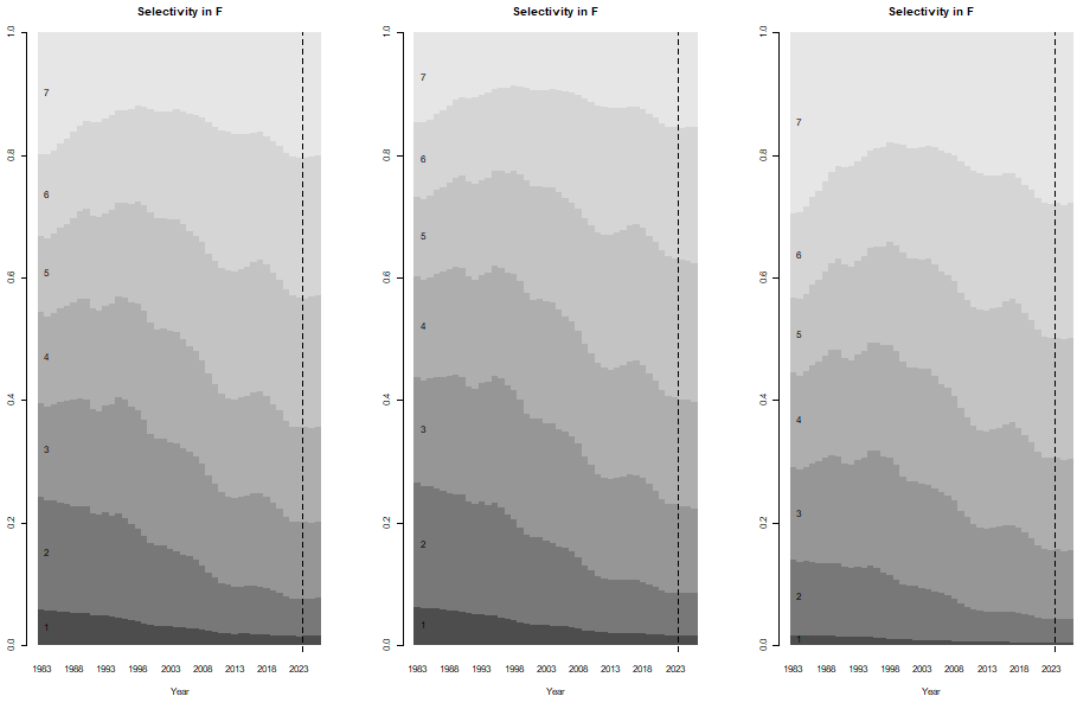


Figure 4.10b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM estimates of selectivity for each substock, derived as the proportions of total fishing mortality-at-age over time. The dashed line represents the beginning of the forecast period.

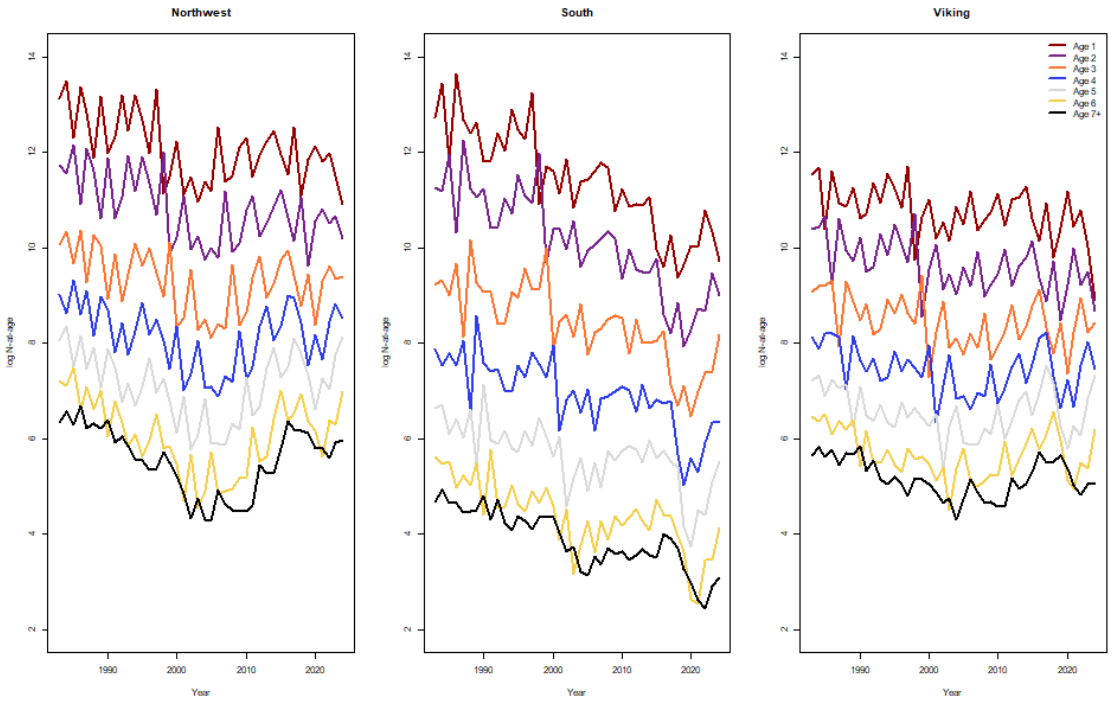


Figure 4.11. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM estimates of log numbers-at-age for each substock.

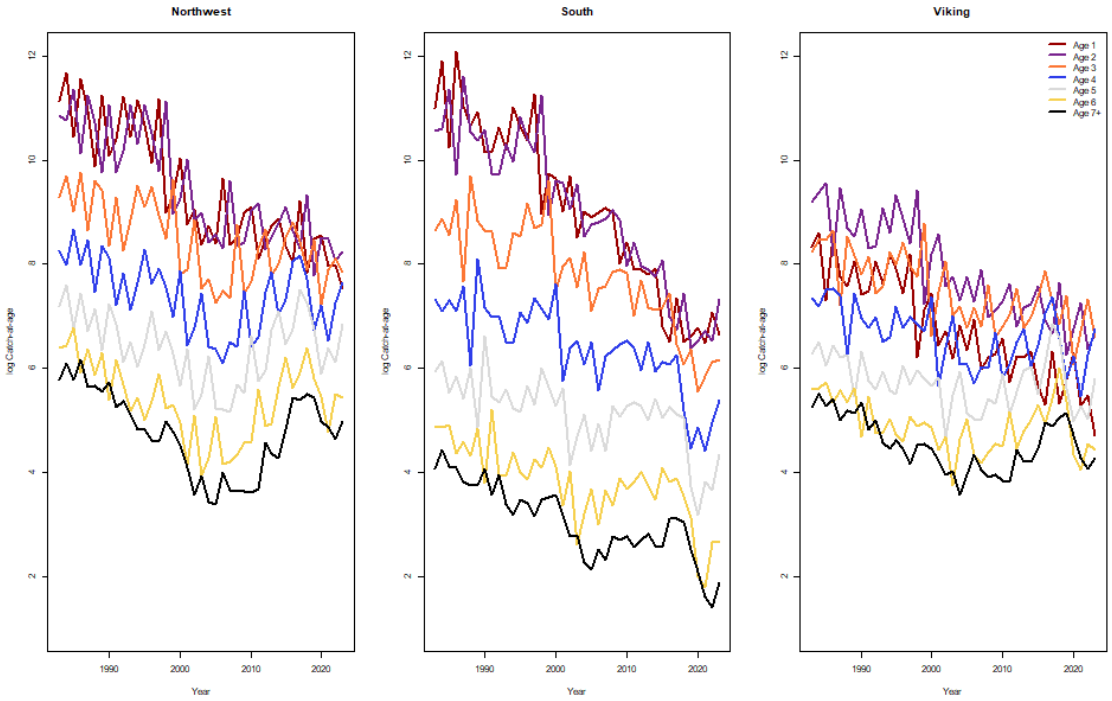


Figure 4.12. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM estimates of log catches-at-age for each substock.

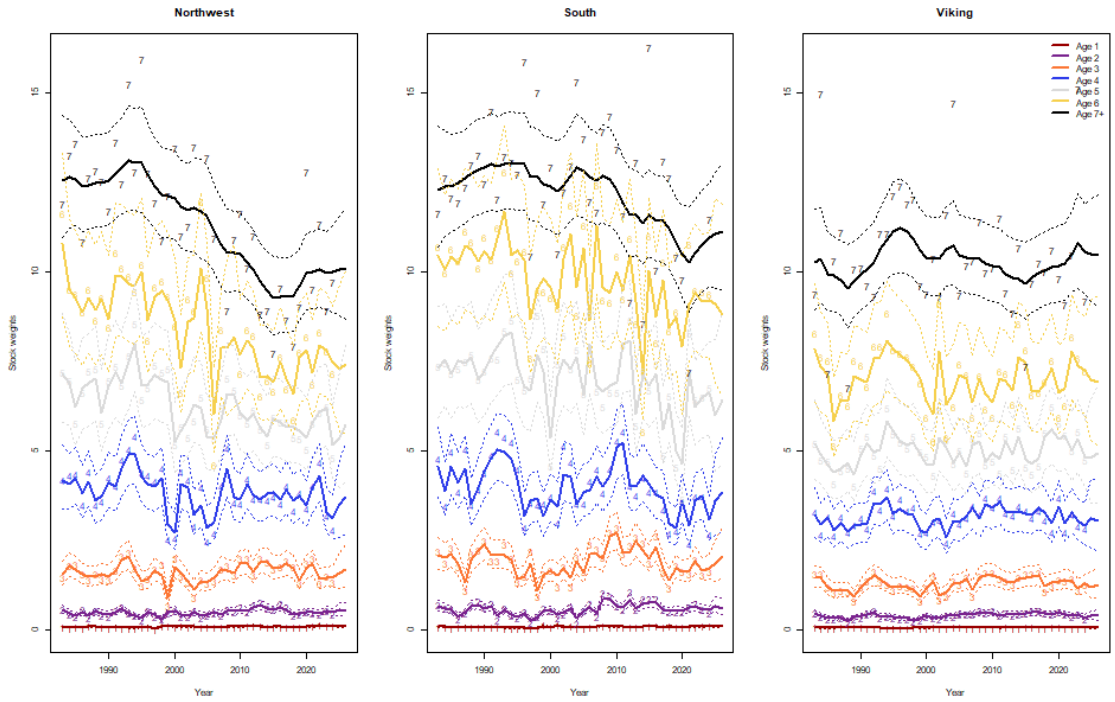


Figure 4.13. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM fits to stock weight data. Numbers are the input data shown in Table 4.5a and Figure 4.2b. The solid lines are the multistock SAM estimates of stock weights-at-age, extending to the forecast period, with the dotted lines showing 95% confidence intervals.

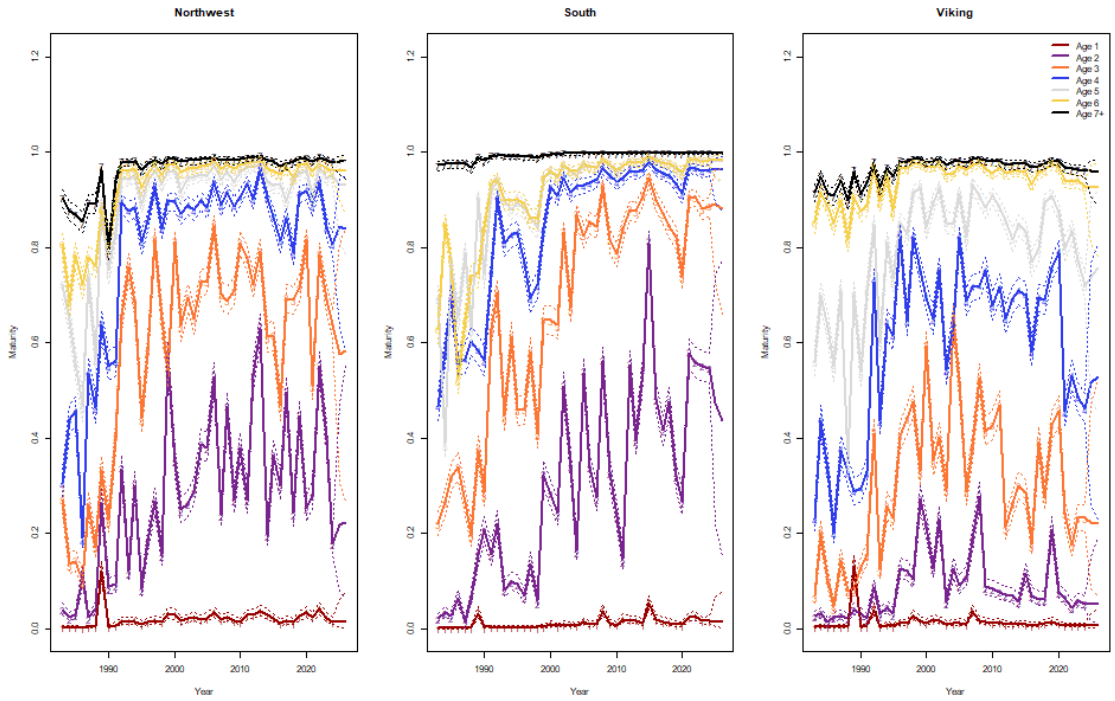


Figure 4.14. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM fits to maturity data. Numbers are the input data shown in Table 4.5b and Figure 4.2c. The solid lines are the multistock SAM estimates of maturity-at-age, extending to the forecast period, with the dotted lines showing 95% confidence intervals.

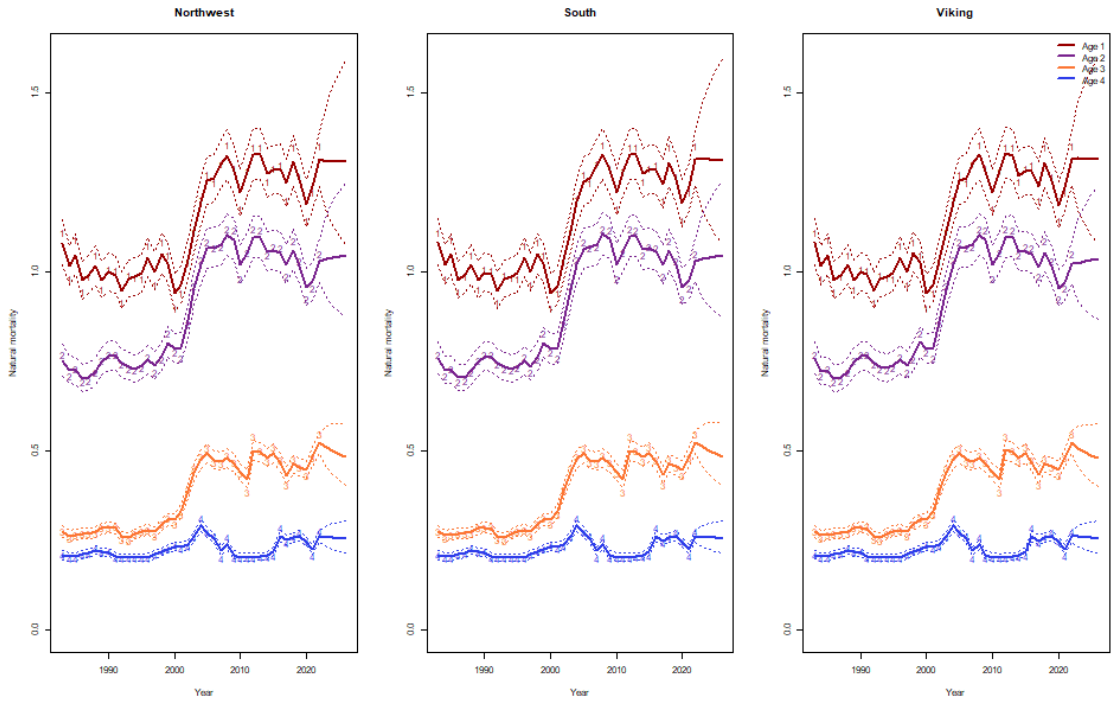


Figure 4.15. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Multistock SAM fits to natural mortality data. Numbers are the input data shown in Table 4.5c and Figure 4.2d. The solid lines are the multistock SAM estimates of natural mortality-at-age, extending to the forecast period, with the dotted lines showing 95% confidence intervals.

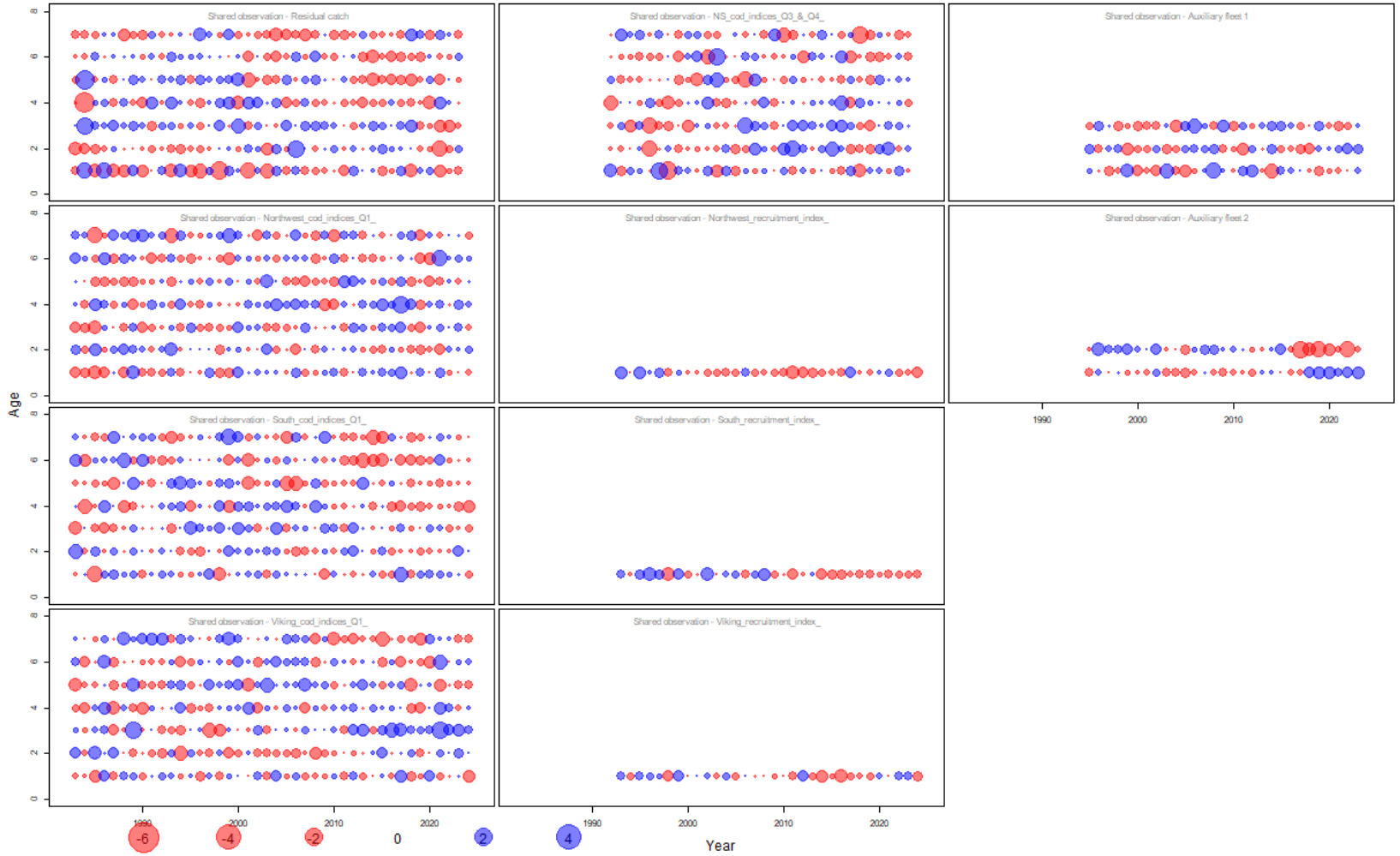


Figure 4.16. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. One step ahead (OSA) residuals for the multistock SAM assessment for total catch, seven survey tuning indices, landings proportions by quarter for all substocks combined (Auxiliary fleet 1) and by substock for Q1 (Auxiliary fleet 2). Blue circles indicate a positive residual and red circles a negative residual.

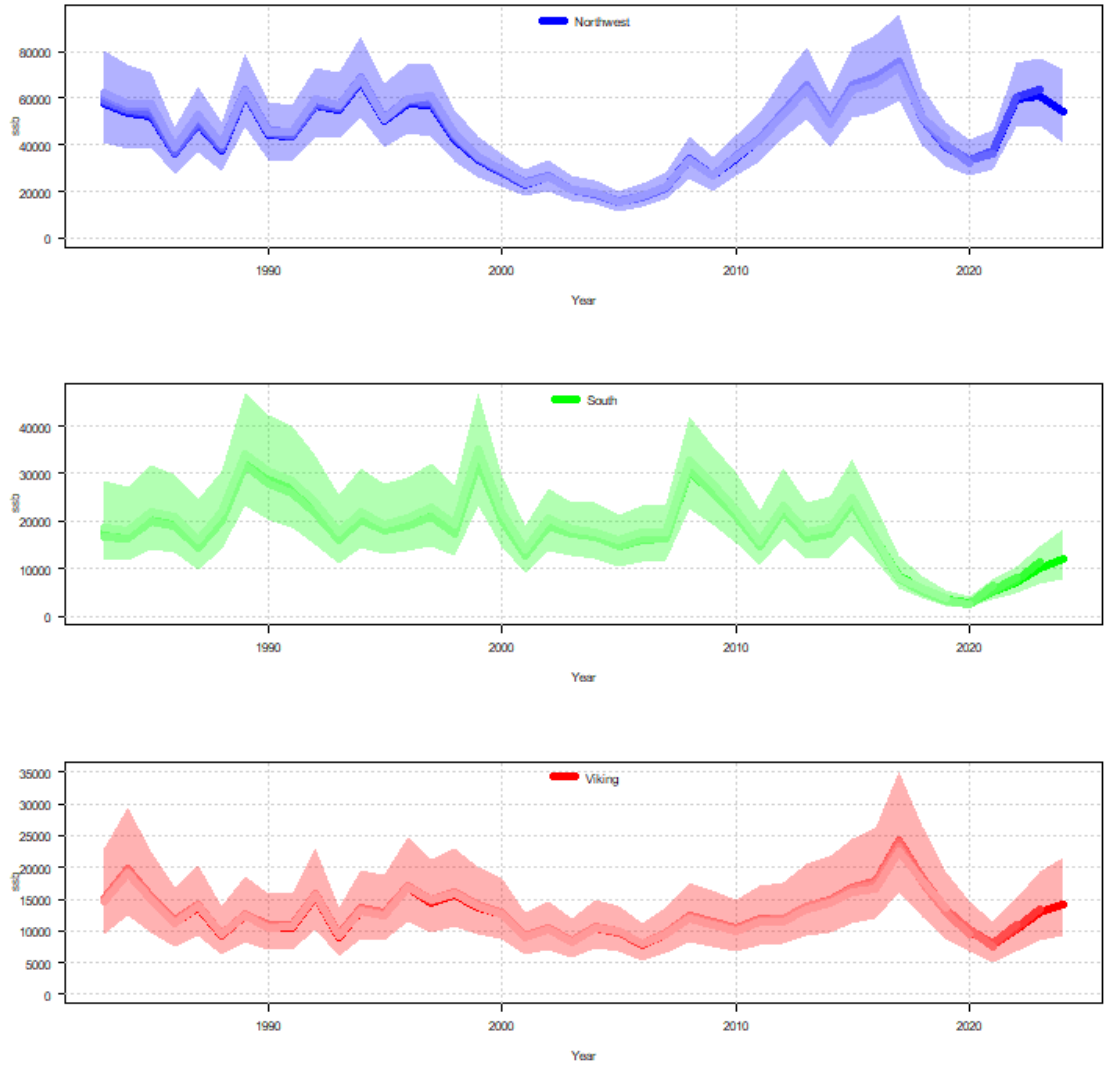


Figure 4.17a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Retrospective estimates (5 years) of SSB from the multistock SAM assessment for each substock, together with corresponding pointwise 95% confidence intervals.

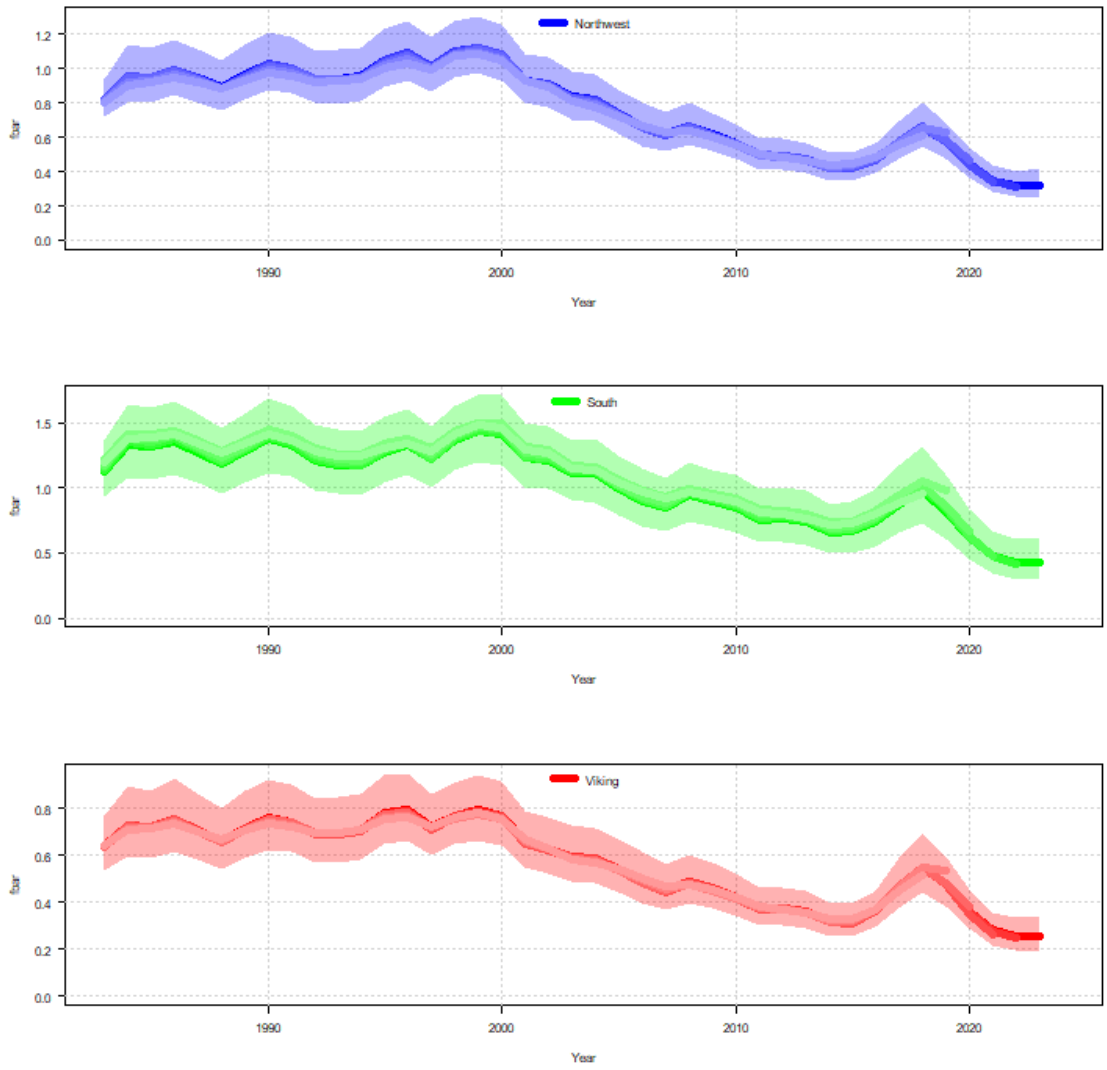


Figure 4.17b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Retrospective estimates (5 years) of F(2–4) from the multistock SAM assessment for each substock, together with corresponding pointwise 95% confidence intervals.

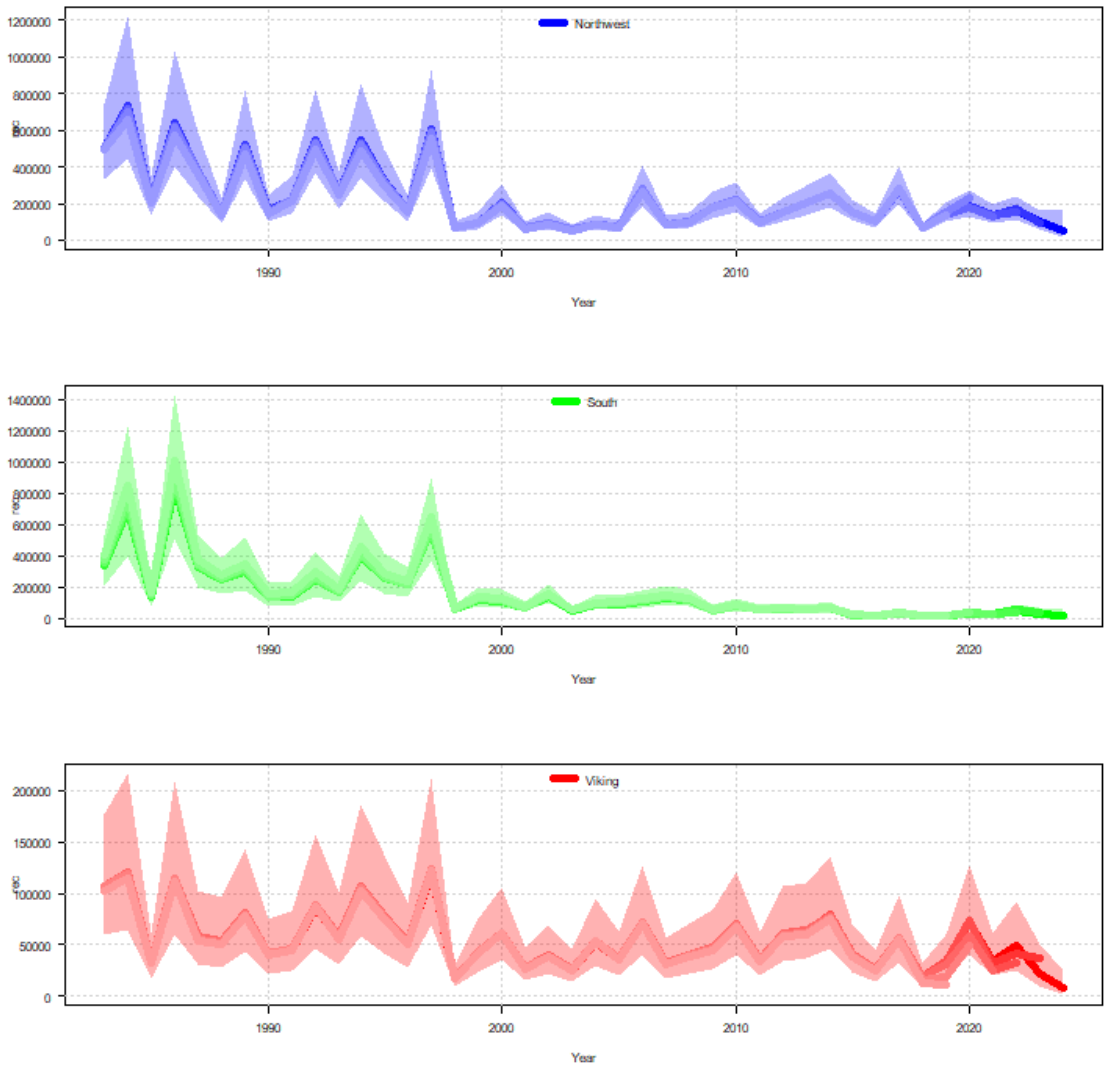


Figure 4.17c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Retrospective estimates (5 years) of recruitment from the multistock SAM assessment for each substock, together with corresponding pointwise 95% confidence intervals.

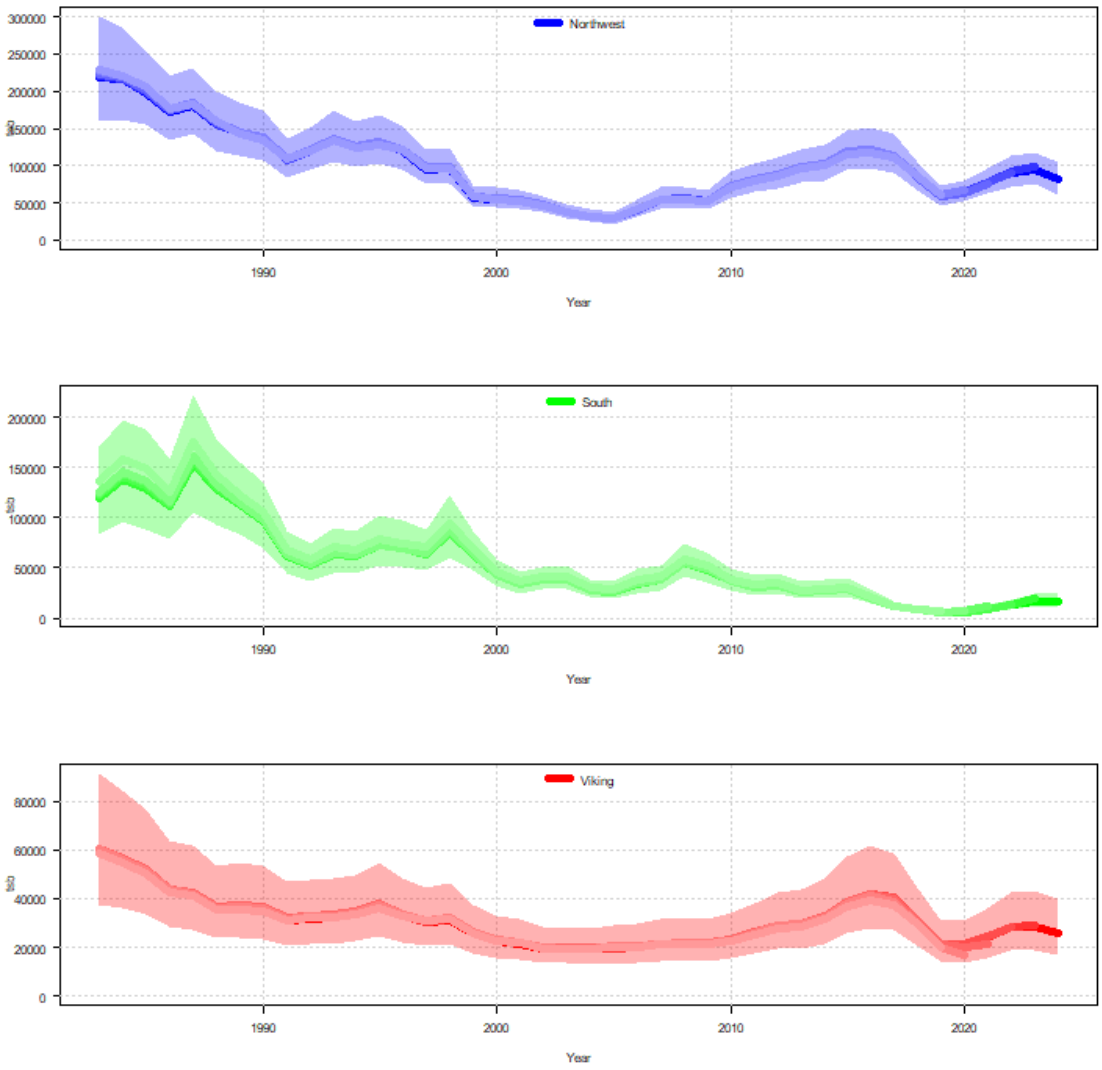


Figure 4.17d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Retrospective estimates (5 years) of TSB from the multistock SAM assessment for each substock, together with corresponding pointwise 95% confidence intervals.

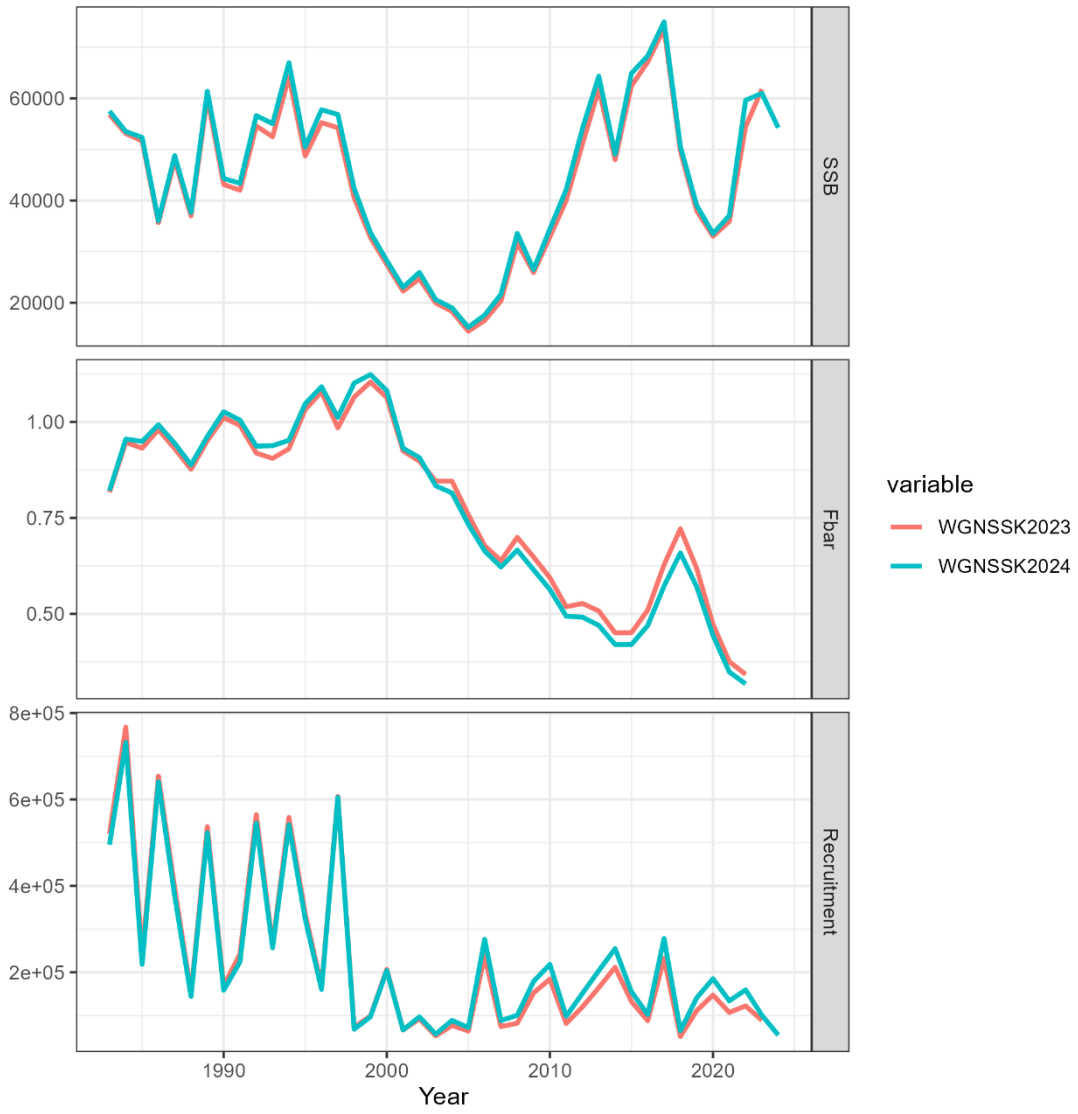


Figure 4.18a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of the final multistock SAM assessment for 2024 with the final multistock SAM assessment from 2023 (ICES WGNSSK 2023) for the Northwestern substock. Estimated yearly SSB (top), average fishing mortality (middle) and recruitment age 1 (bottom).

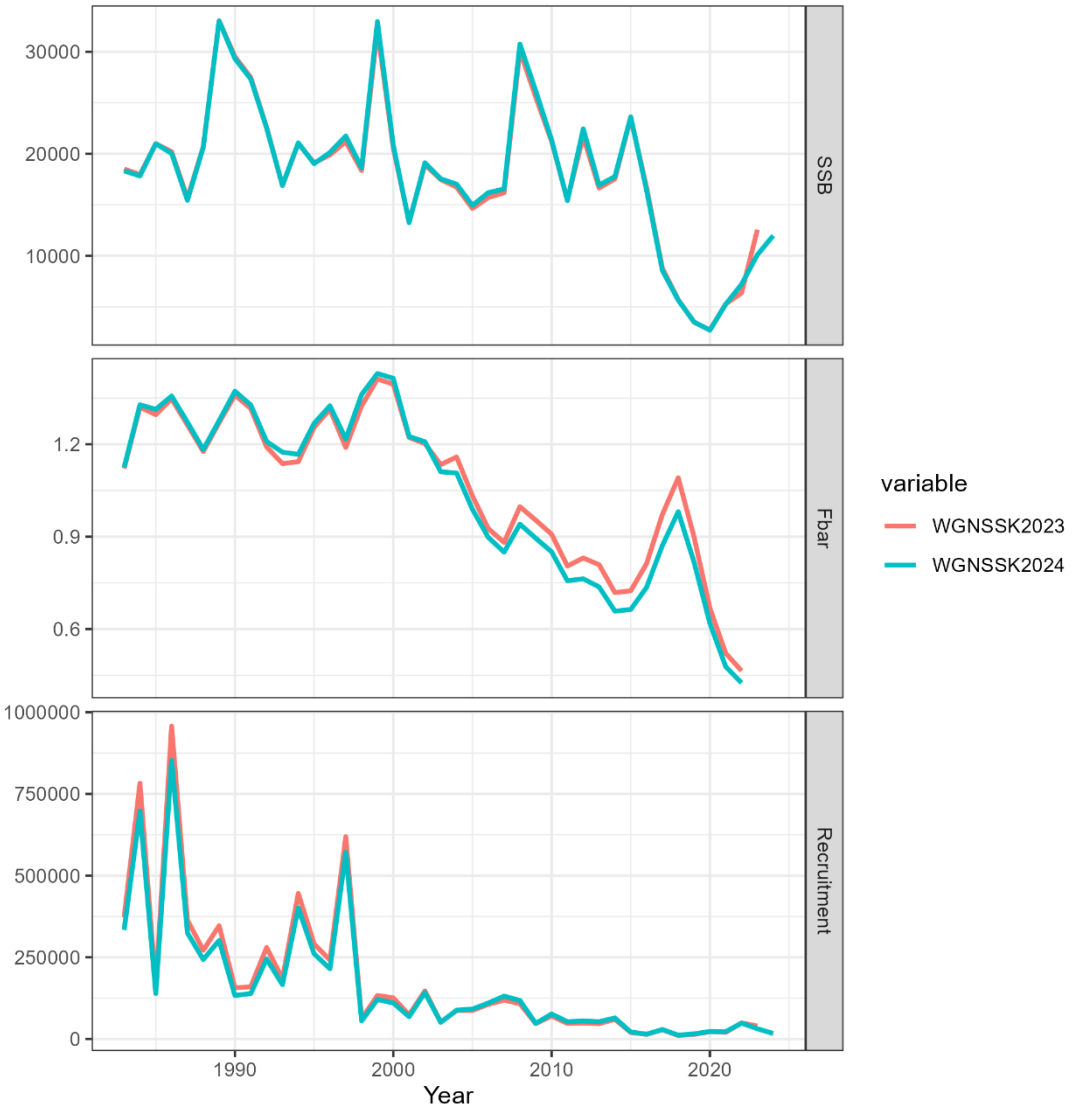


Figure 4.18b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of the final multistock SAM assessment for 2024 with the final multistock SAM assessment from 2023 (ICES WGNSSK 2023) for the Southern substock. Estimated yearly SSB (top), average fishing mortality (middle) and recruitment age 1 (bottom).

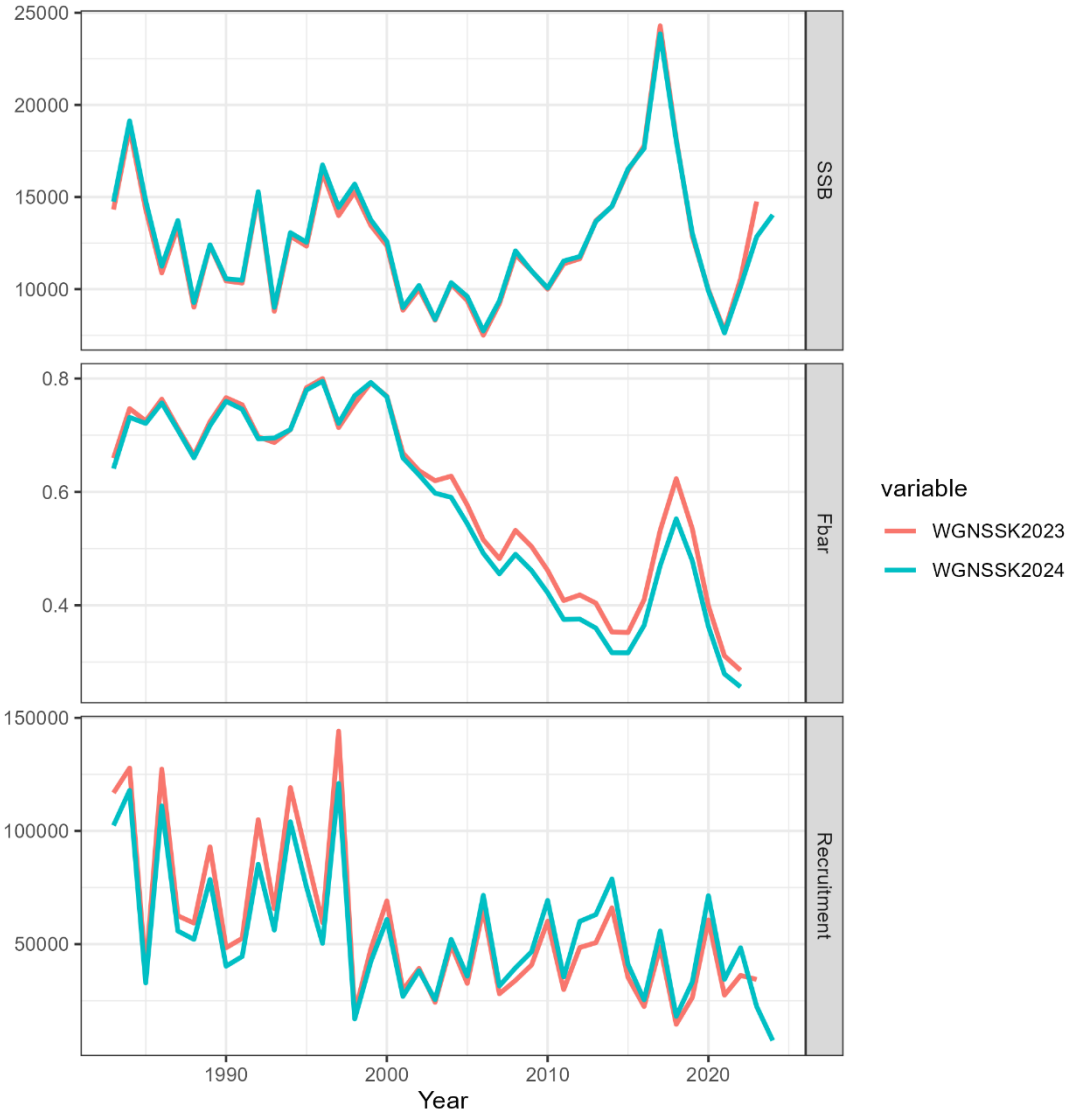


Figure 4.18c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of the final multistock SAM assessment for 2024 with the final multistock SAM assessment from 2023 (ICES WGNSSK 2023) for the Viking substock. Estimated yearly SSB (top), average fishing mortality (middle) and recruitment age 1 (bottom).

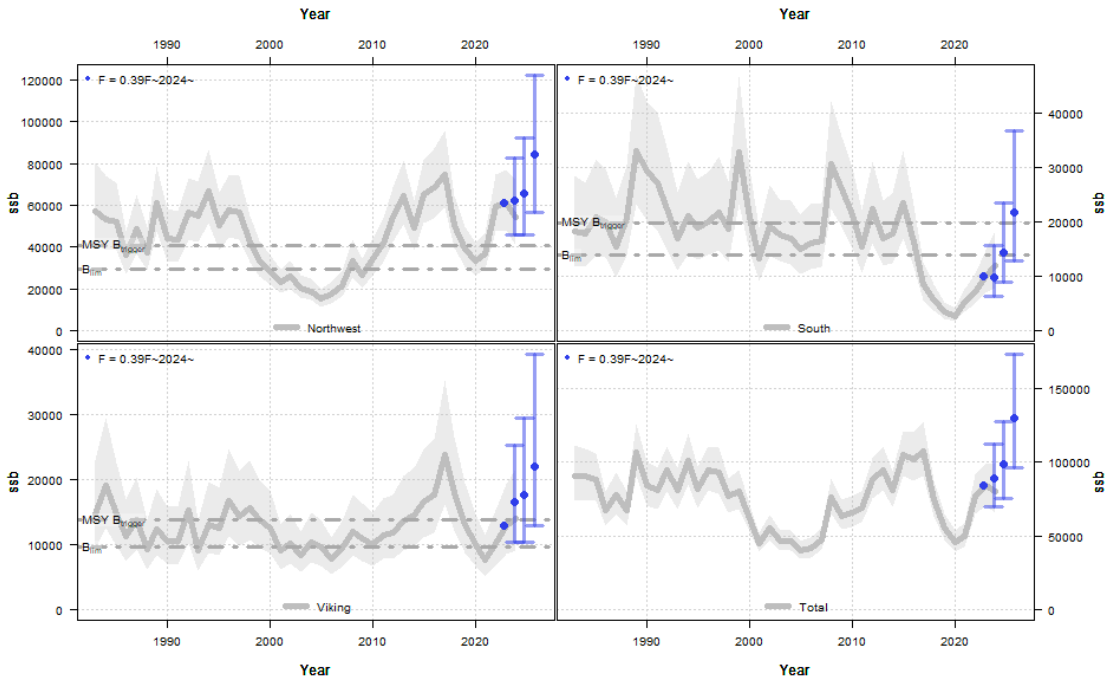


Figure 4.19a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Forecasted SSB for each substock and the total stock combined following the MSY approach for the Southern substock and precautionary considerations to protect the Southern substock for the Northwestern and Viking substocks.

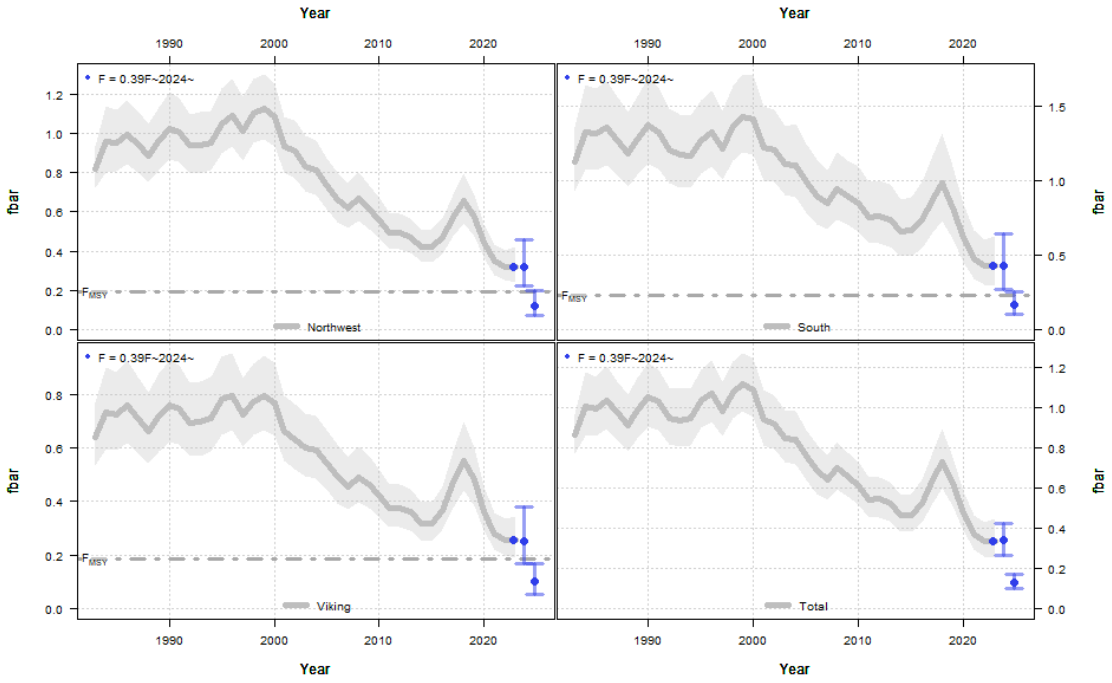


Figure 4.19b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Forecasted F(2–4) for each substock and the total stock combined following the MSY approach for the Southern substock and precautionary considerations to protect the Southern substock for the Northwestern and Viking substocks.

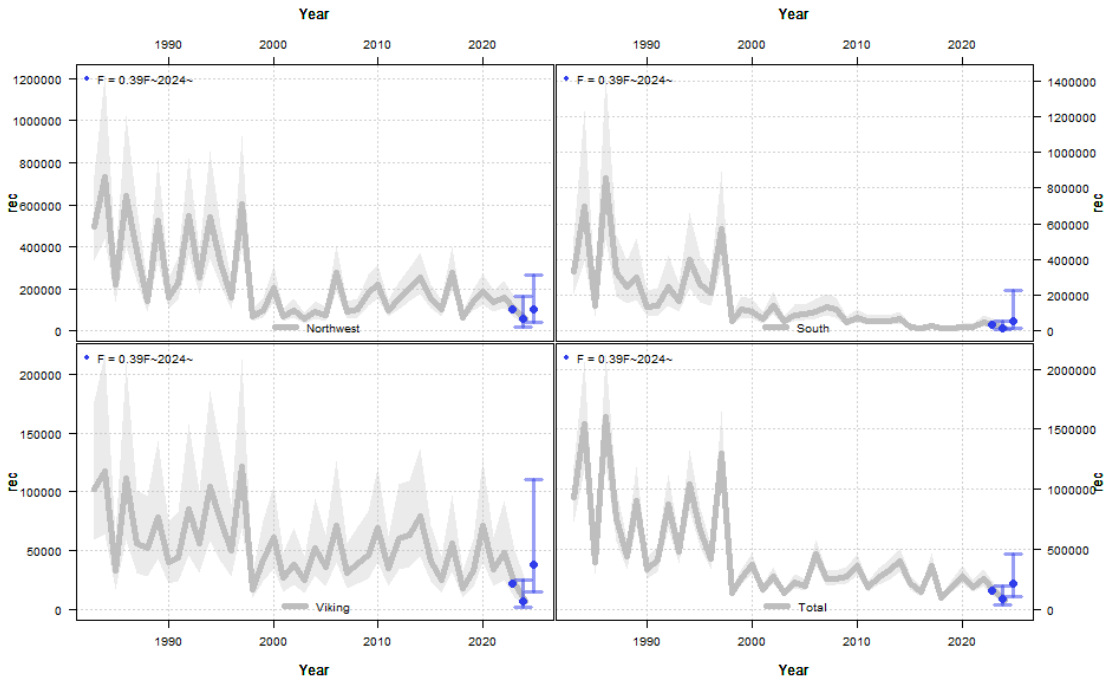


Figure 4.19c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Forecasted recruitment for each substock and the total stock combined following the MSY approach for the Southern substock and precautionary considerations to protect the Southern substock for the Northwestern and Viking substocks.

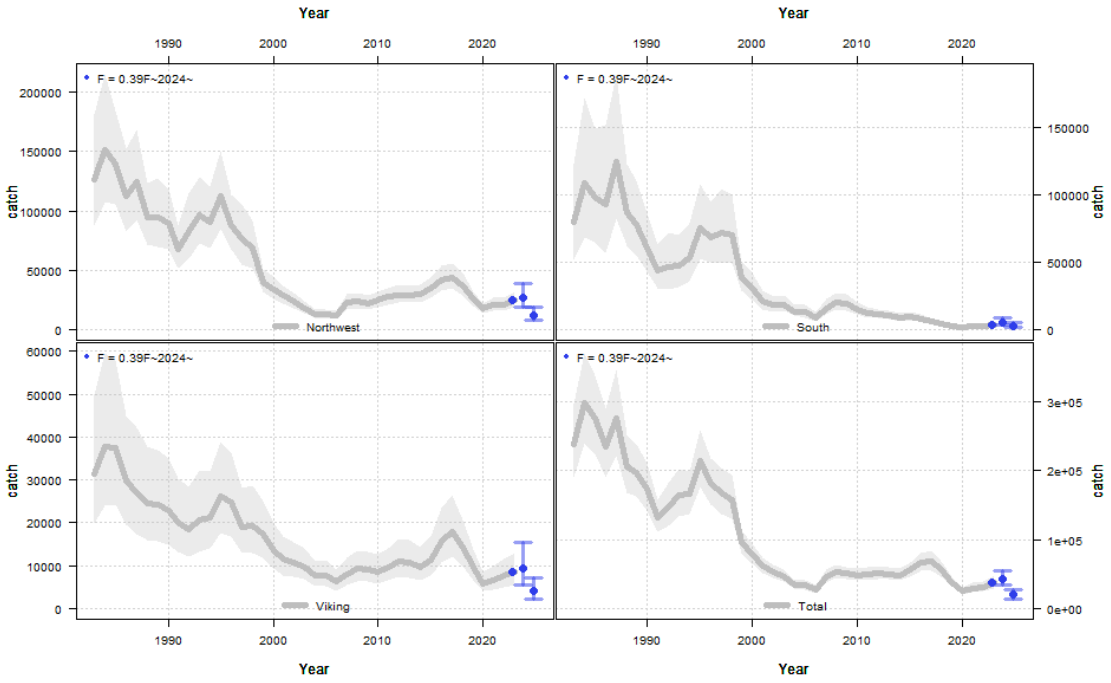


Figure 4.19d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Forecasted catches for each substock and the total stock combined following the MSY approach for the Southern substock and precautionary considerations to protect the Southern substock for the Northwestern and Viking substocks.

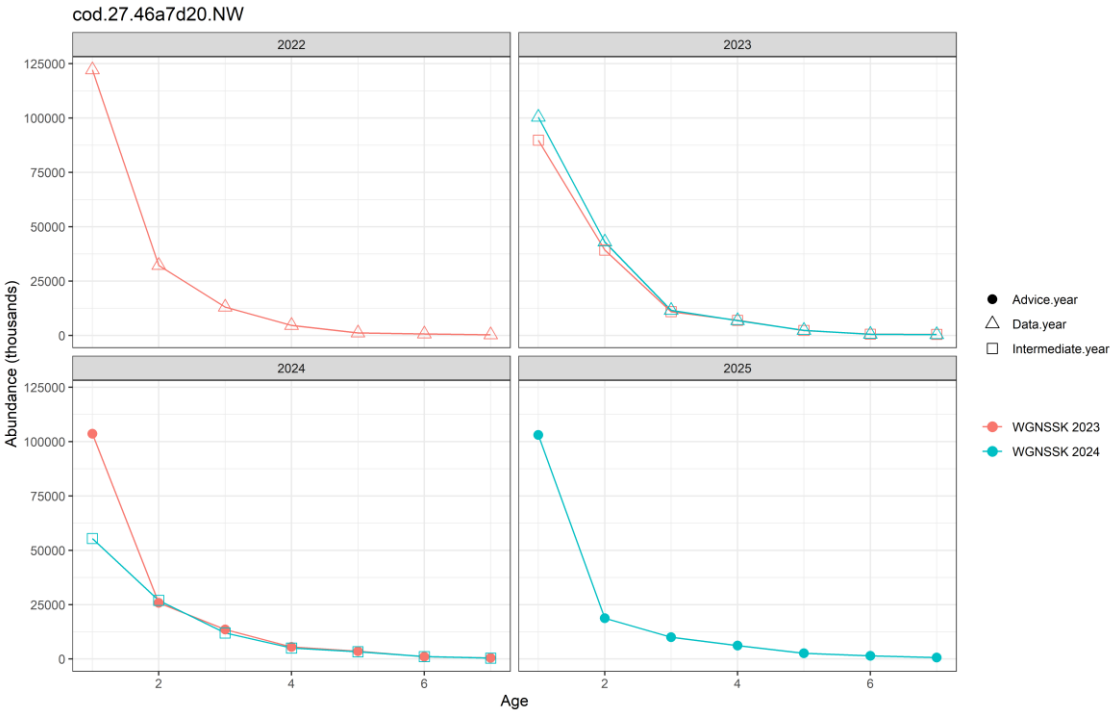


Figure 4.20a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of numbers-at-age from previous stock assessment and forecast results (WGNSSK 2023) and current stock assessment and forecast results (WGNSSK 2024) for the Northwestern substock.

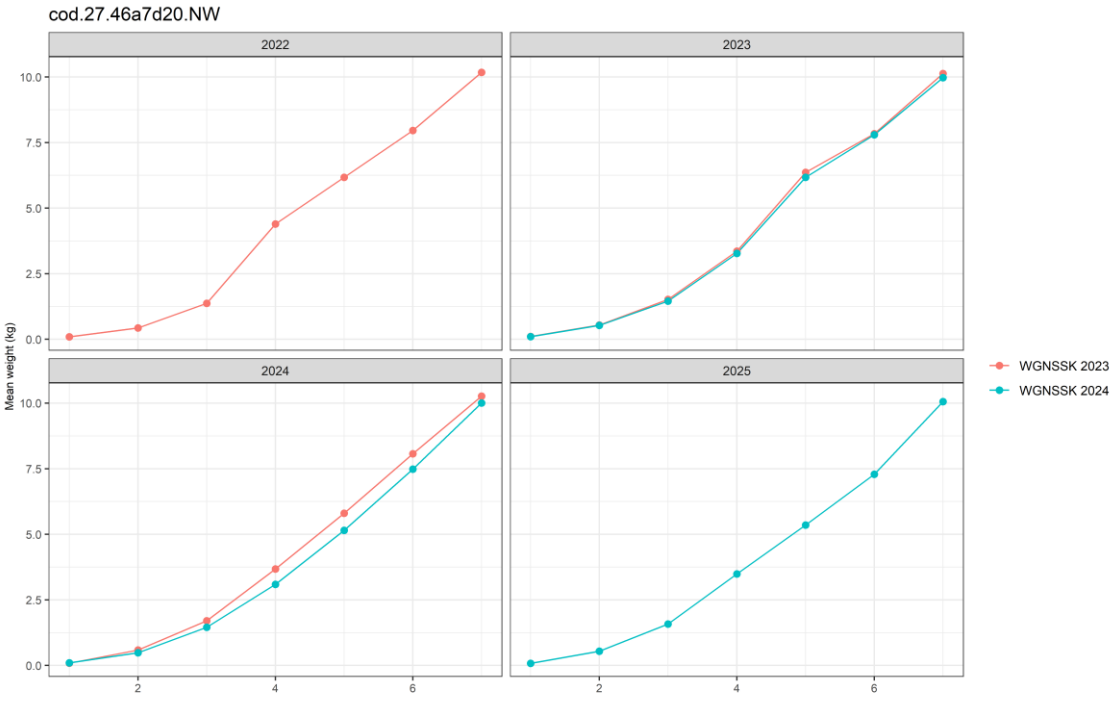


Figure 4.20b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of mean weights-at-age in the stock from the previous assessment (WGNSSK 2023) and current assessment (WGNSSK 2024) for the Northwestern substock. These weights are re-simulated in the forecasts.

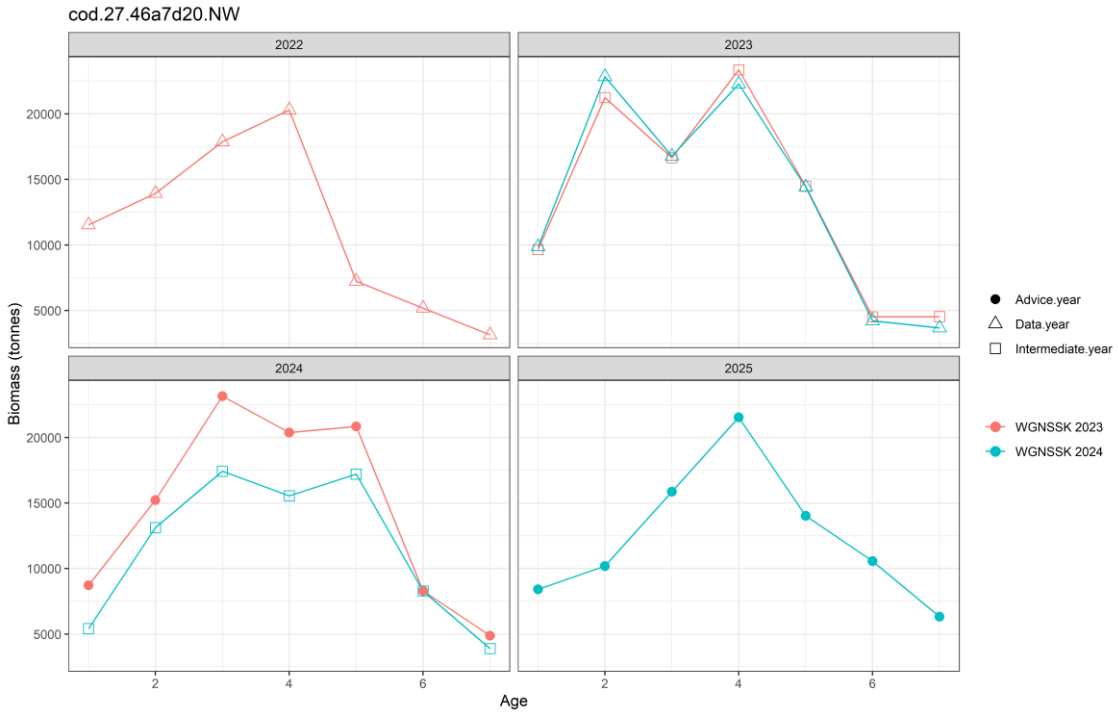


Figure 4.20c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of biomass-at-age from previous stock assessment and forecast results (WGNSSK 2023) and current stock assessment and forecast results (WGNSSK 2024) for the Northwestern substock.

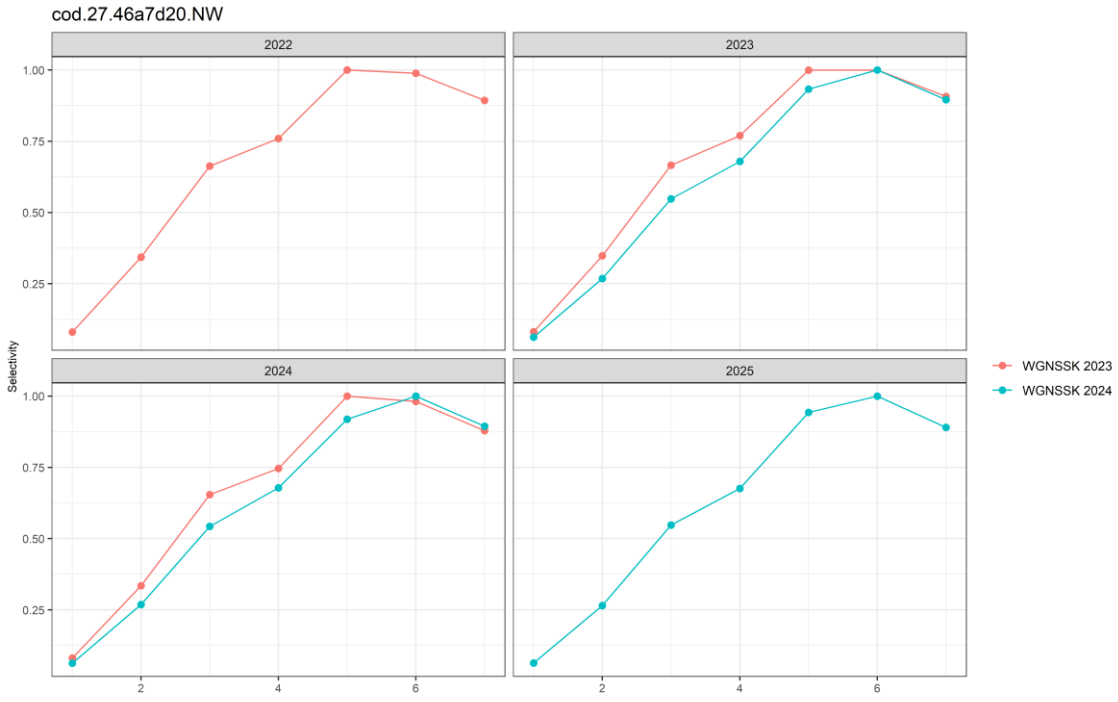


Figure 4.20d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of selectivity used in the previous forecast (WGNSSK 2023) and current forecast (WGNSSK 2024) for the Northwestern substock.

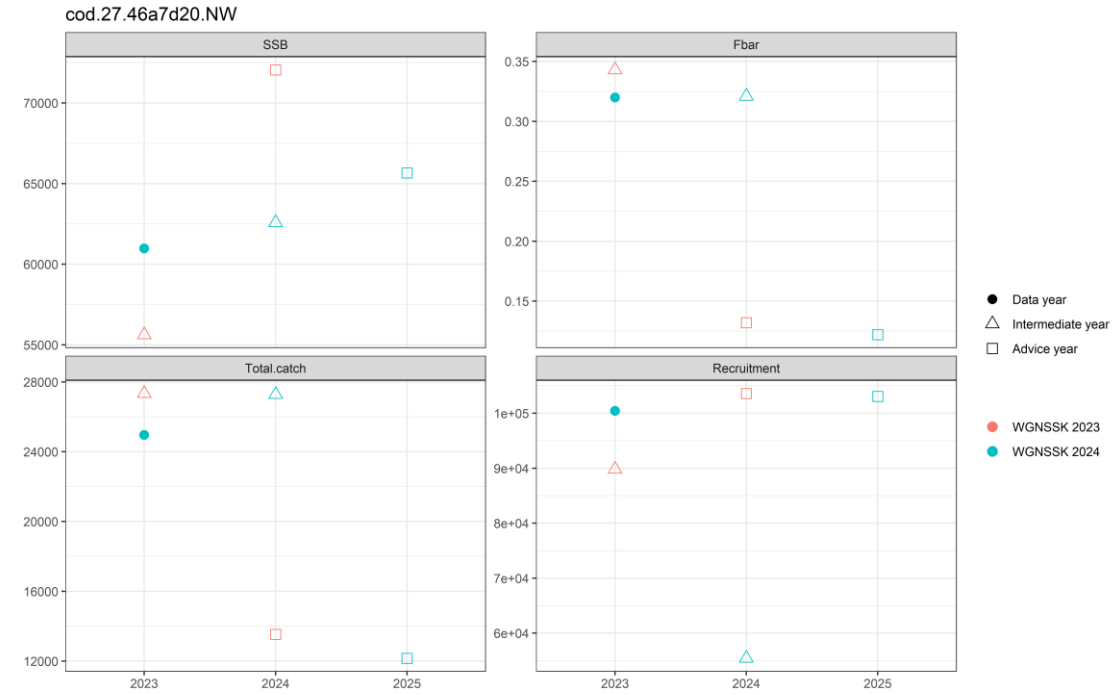


Figure 4.20e. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of SSB, Fbar, total catch and recruitment assumptions used in the previous forecast (WGNSSK 2023) and current forecast (WGNSSK 2024) for the Northwestern substock.

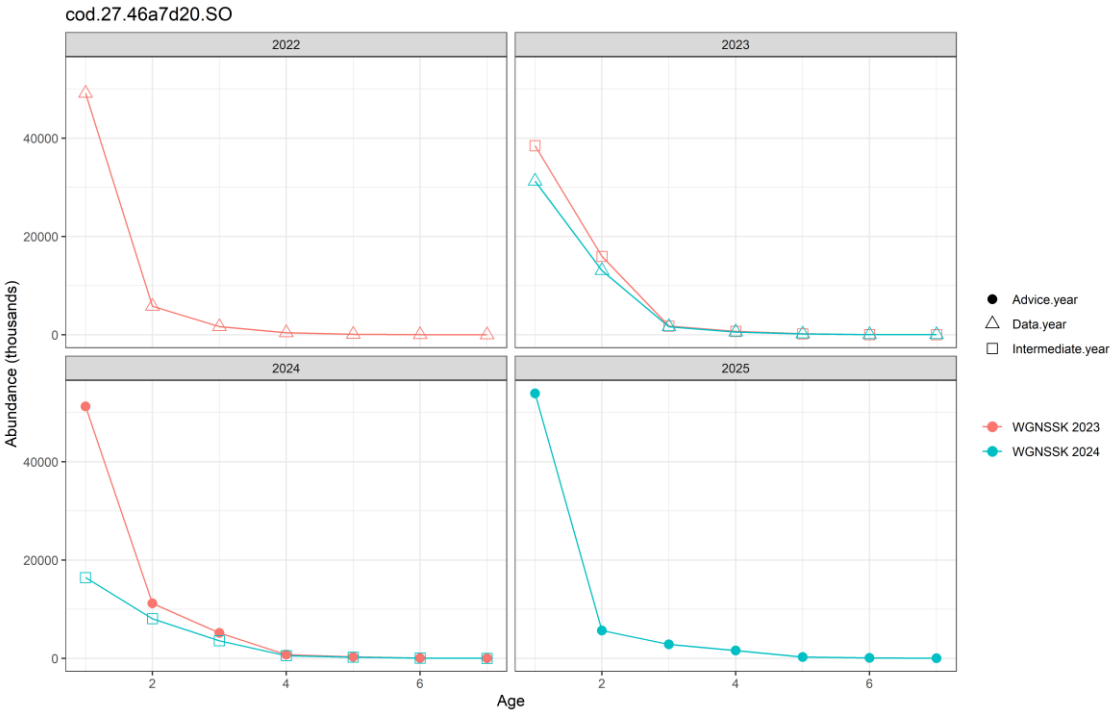


Figure 4.21a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of numbers-at-age from previous stock assessment and forecast results (WGNSSK 2023) and current stock assessment and forecast results (WGNSSK 2024) for the Southern substock.

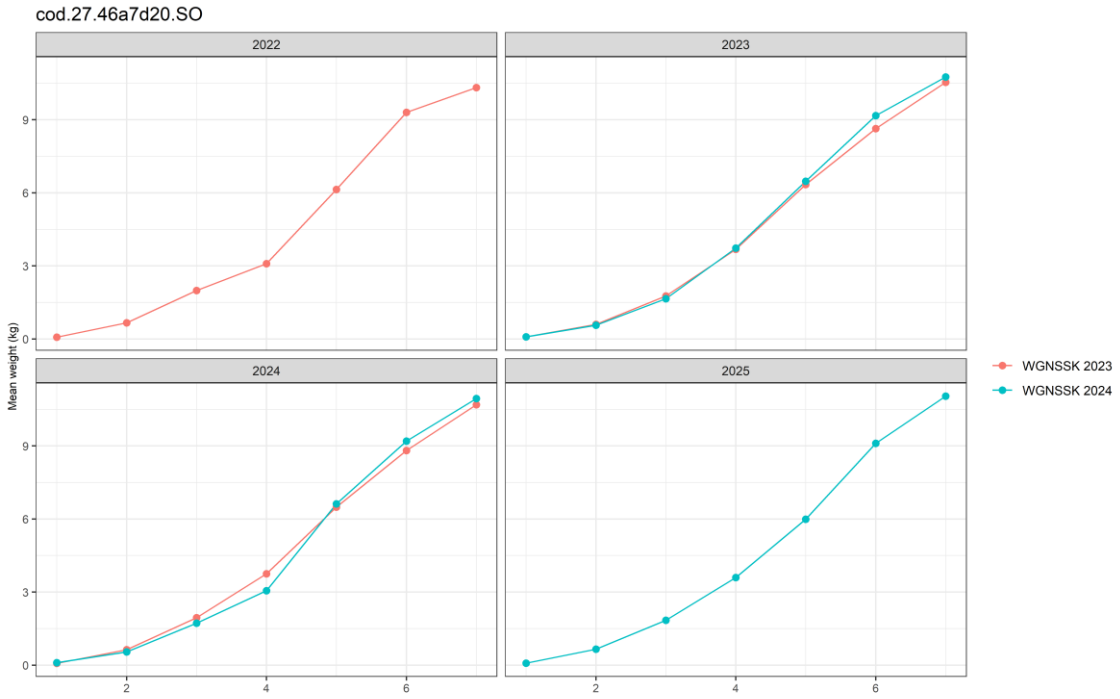


Figure 4.21b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of mean weights-at-age in the stock from the previous assessment (WGNSSK 2023) and current assessment (WGNSSK 2024) for the Southern substock. These weights are re-simulated in the forecasts.

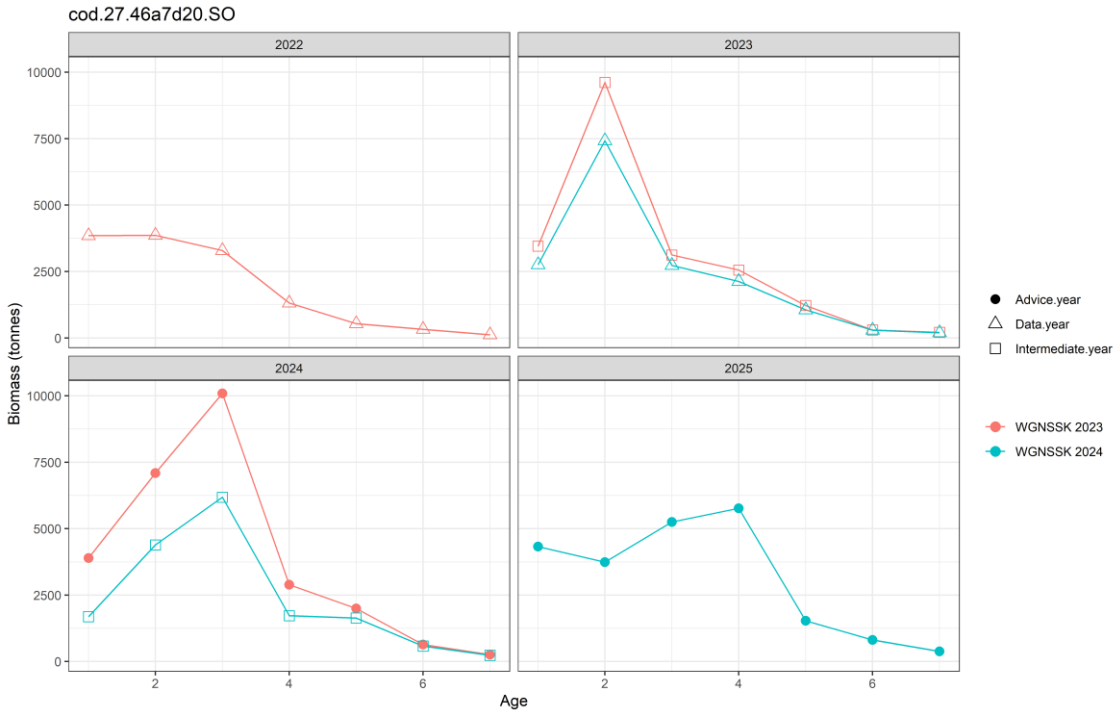


Figure 4.21c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of biomass-at-age from previous stock assessment and forecast results (WGNSSK 2023) and current stock assessment and forecast results (WGNSSK 2024) for the Southern substock.

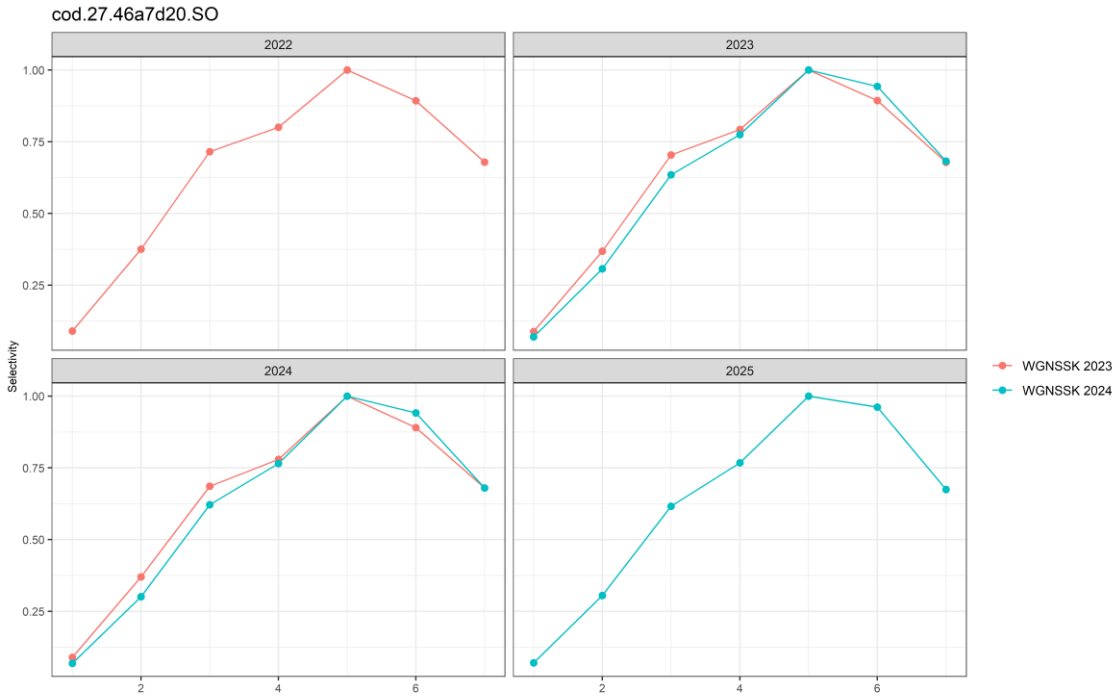


Figure 4.21d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of selectivity used in the previous forecast (WGNSSK 2023) and current forecast (WGNSSK 2024) for the Southern substock.

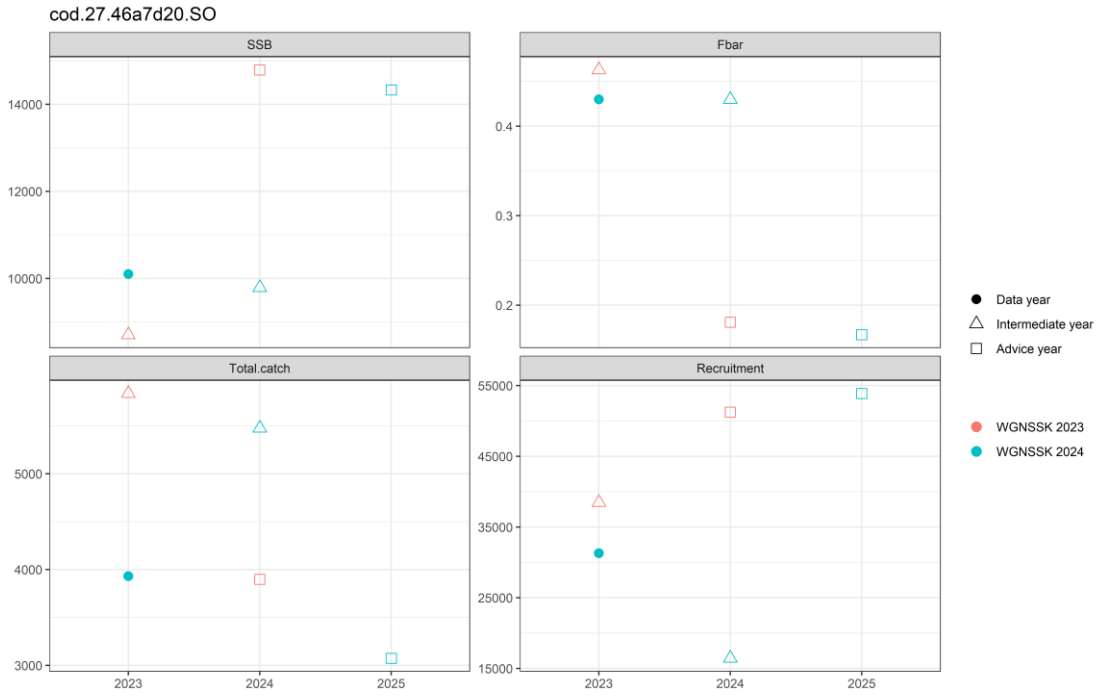


Figure 4.21e. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of SSB, Fbar, total catch and recruitment assumptions used in the previous forecast (WGNSSK 2023) and current forecast (WGNSSK 2024) for the Southern substock.

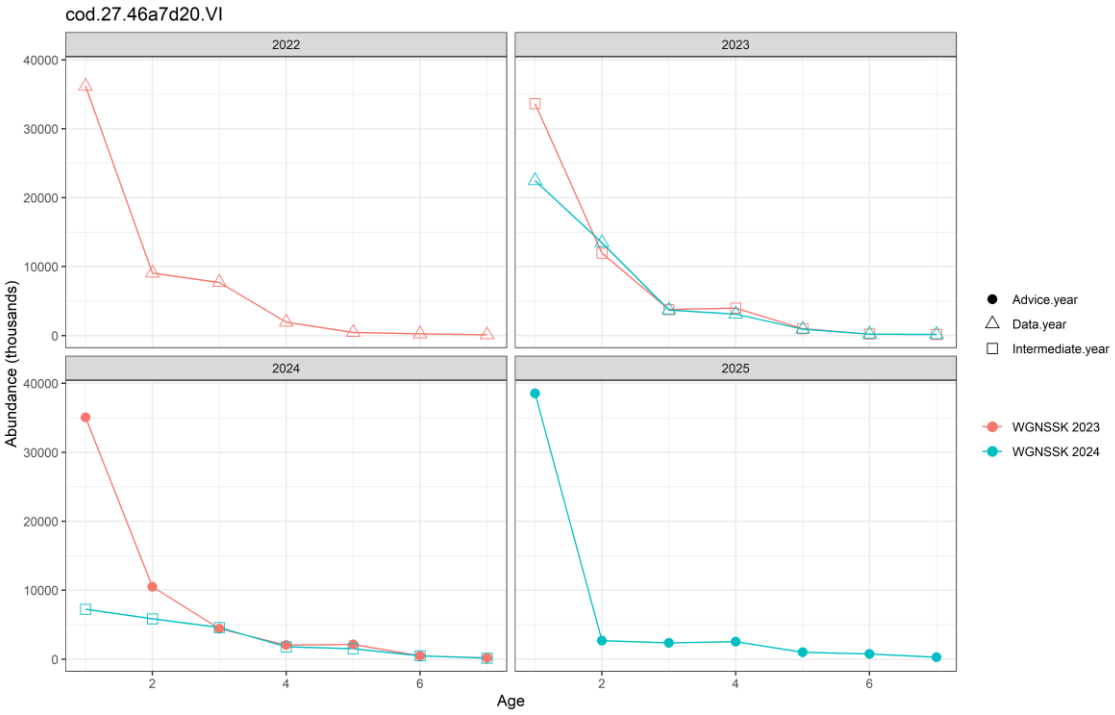


Figure 4.22a. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of numbers-at-age from previous stock assessment and forecast results (WGNSSK 2023) and current stock assessment and forecast results (WGNSSK 2024) for the Viking substock.

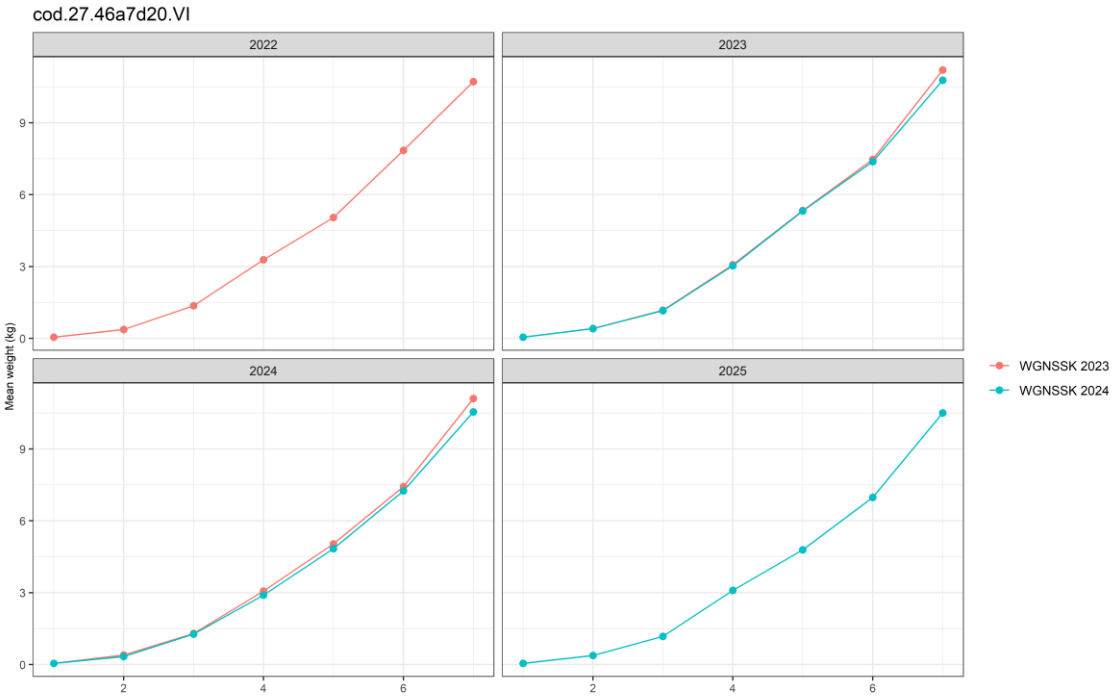


Figure 4.22b. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of mean weights-at-age in the stock from the previous assessment (WGNSSK 2023) and current assessment (WGNSSK 2024) for the Viking substock. These weights are re-simulated in the forecasts.

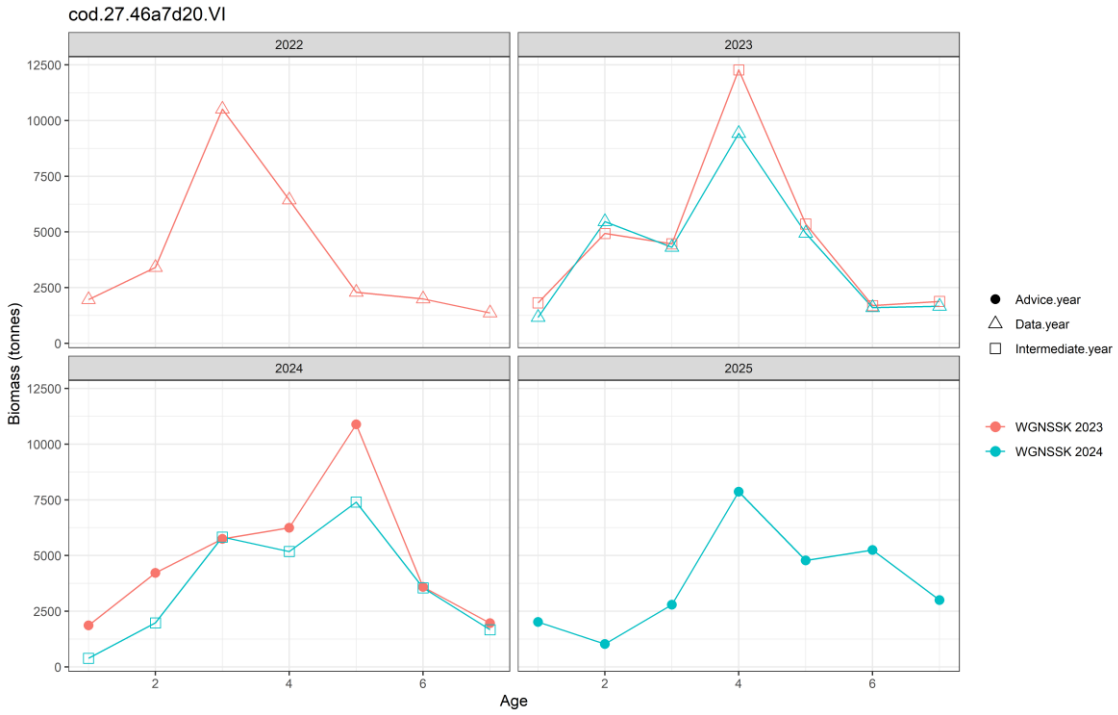


Figure 4.22c. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of biomass-at-age from previous stock assessment and forecast results (WGNSSK 2023) and current stock assessment and forecast results (WGNSSK 2024) for the Viking substock.

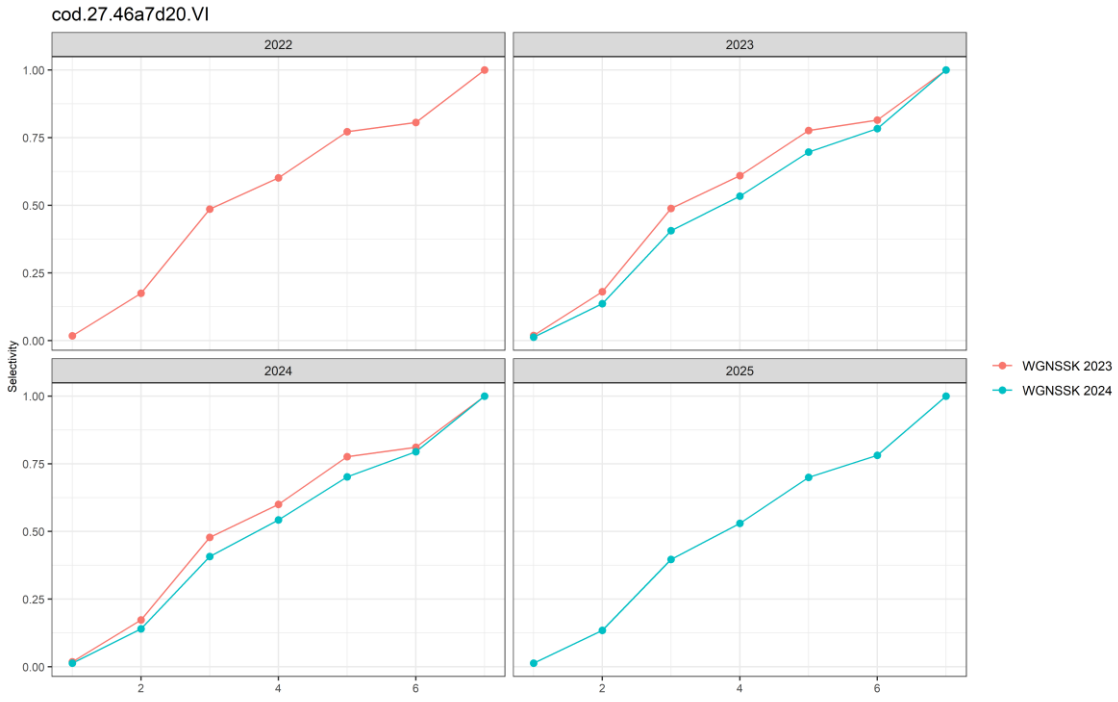


Figure 4.22d. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of selectivity used in the previous forecast (WGNSSK 2023) and current forecast (WGNSSK 2024) for the Viking substock.

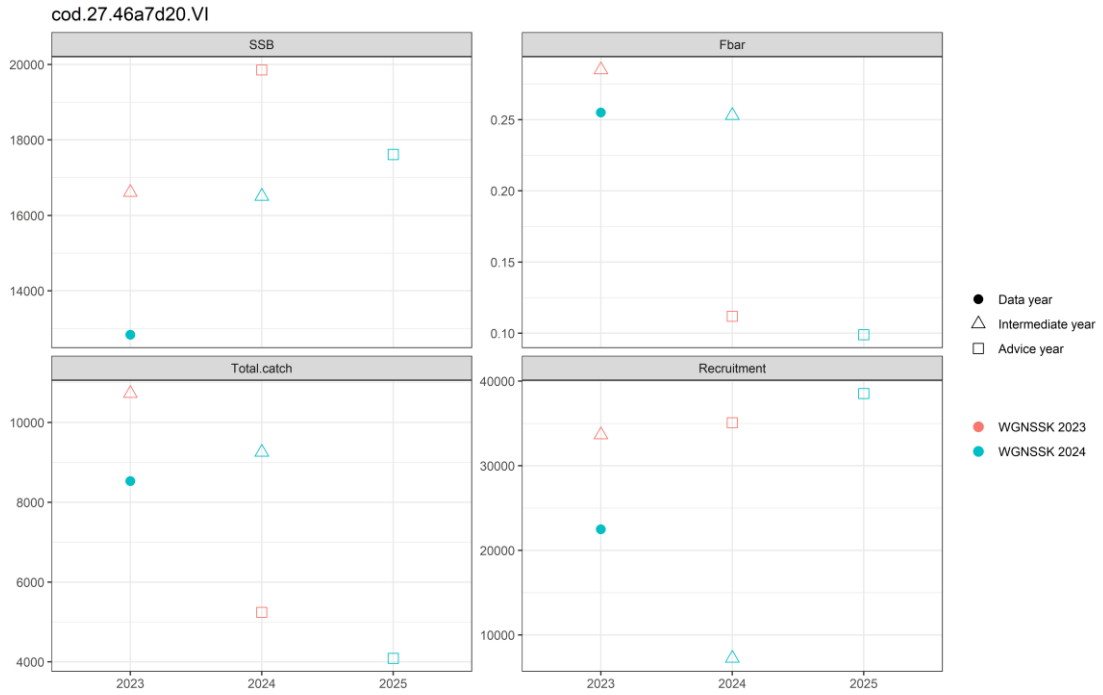


Figure 4.22e. Cod in Subarea 4, divisions 6.a and 7.d, and Subdivision 20. Comparison of SSB, Fbar, total catch and recruitment assumptions used in the previous forecast (WGNSSK 2023) and current forecast (WGNSSK 2024) for the Viking substock.

Contents