IMR/PINRO
6
2022
Joint Report Series

JOINT

REPORT

Report of the Joint Russian-Norwegian Working Group on Arctic Fisheries (JRN-AFWG) 2022

Institute of Marine Research – IMR

Polar branch of the FSBSI “VINRO” (“PINRO”)

Tittel (norsk og engelsk):

Report of the Joint Russian-Norwegian Working Group on Arctic Fisheries (JRN-AFWG) 2022

Rapportserie:	**År - Nr.:**	**Dato:**	**Distribusjon:**
IMR-PINRO	2022-6	06.09.2022	Åpen

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Antall sider:

208

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Samarbeid med

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1 - Executive Summary

On 30 th March 2022 all Russian participation in ICES was temporally suspended. Although the announcement of the suspension stressed the role of ICES as a “multilateral science organization”, this suspension applied not only to research activities, but also to the ICES work providing fisheries advice for the sustainable management of fish stocks and ecosystems. As a result of the suspension, the ICES AFWG provided advice only for saithe, coastal cod north, coastal cod south, and golden redfish (*Sebastes norvegicus*). Northeast Arctic (NEA) cod, haddock and beaked redfish (*Sebastes mentella*) assessments have been conducted outside of ICES in a newly constituted Joint Russian-Norwegian Working Group on Arctic Fisheries (JRN-AFWG). Although this work has been conducted independently of ICES, the methodologies agreed at ICES benchmarks and agreed HCRs (Harvest Control Rules) have been followed in providing this advice.

Advice on fishing opportunities for NEA cod

The NEA cod stock is continuing to decline following a period of moderate recruitment. Following the agreed HCR, the advice is constrained by the interannual stability constraint criteria of 20% annual change in quota. Advice is that catches in 2023 should not exceed 556 784 tonnes. A further decline of catches from 2023 to 2024 and then a stabilization of stock and catch levels is projected.

Advice on fishing opportunities for NEA haddock

Advice is that catches in 2023 should not exceed 170 067 tonnes, down 5% from the advice for 2022. The haddock total stock biomass is declining as the relatively large 2016 yearclass is caught. Model estimates suggest a run of average to very weak yearclasses since 2016, and the stock is therefore expected to decline over the medium term.

Advice on fishing opportunities for beaked redfish (*Sebastes mentella)*

Several issues were identified in providing the advice on beaked redfish. First, insufficient age reading in the catches was impacting on the quality of the assessment. This was addressed by using the length data converted with a time-averaged age-length conversion. Secondly, the fishing selectivity has changed significantly since the reference points were last estimated, with the F_{19+} (the F_{bar} used in reporting and management) representing an increasing fraction of the catch. As a result, it was not possible to directly apply the previous target F_{19+} . Instead, a status quo F approach was applied, in order to keep the overall fishing pressure roughly constant. Following this approach, catches in 2023 should be no more than 66 779 tonnes, and no more than 70 164 tonnes in 2024. The overall stock is in a healthy state, with biomasses continuing to rise.

2 - Introduction

This report presents the details of the stock assessments conducted for Northeast Arctic cod, haddock and beaked redfish (*Sebastes mentella*) in ICES subareas 1 and 2. Due to the temporary suspension of Russian scientists from ICES, this is a joint Russian-Norwegian advice and explicitly not an ICES advice. However, the assessment methodology has followed the standard ICES procedure, using the models approved at ICES benchmarks and the Harvest Control Rules which have been evaluated as precautionary by ICES.

The work presented here would typically form a part of the ICES Arctic Fisheries Working Group (AFWG). In order to keep continuity with previous reports, and to minimize the chances of errors arising from renumbering given the tight deadline to prepare this report, the chapter numbers for each stock chapter are maintained from the last AFWG report (ICES 2021). This also allows for anyone with previous AFWG experience to locate information rapidly and easily. As a result, this report contains Chapter 1 (executive summary), Chapter 2 (this introduction), Chapter 3 (Northeast Arctic cod), Chapter 4 (Northeast Arctic haddock), and Chapter 6 (beaked redfish, *S. mentella*).

The meeting was chaired by Daniel Howell, from IMR Norway, and was attended by Anatoly Chetyrkin, Anatoly Filin, Yuri Kovalev, Alexey Russkikh, Natalia Yaragina, and Dmitri Vasilyev from VNIRO, Russia, and Bjarte Bogstad, Johanna Fall, Jane Godiksen, Hannes Höffle, and Edda Johannesen from IMR, Norway. The meeting was conducted on-line in two sessions: 16 th – 20th June 2022 and 25 th -30 th August 2022.

3 - Northeast Arctic Cod (Subareas 1 and 2)

3.1 - Status of the fisheries

3.1.1 - Historical development of the fisheries (Table 3.1)

From a level of about 900 000 t in the mid-1970s, total catch declined steadily to around 300 000 t in 1983—1985 (Table 3.1). Catches increased to above 500 000 t in 1987 before dropping to 212 000 t in 1990, the lowest level recorded in the post-war period. The catches increased rapidly from 1991 onwards, stabilized around 750 000 t in 1994—1997 but decreased to about 414 000 t in 2000. From 2000—2009, the reported catches were between 400 000 and 520 000 t, in addition there were unreported catches (see below). Catches have been above the long-term average since 2011 and have decreased from a peak of 986 449 tonnes in 2014 to 693 000 tonnes in 2019-2020 before increasing to 767 000 tonnes in 2022. The fishery is conducted both with an international trawler fleet and with coastal vessels using traditional fishing gears. Quotas were introduced in 1978 for the trawler fleets and in 1989 for the coastal fleets. In addition to quotas, the fishery is regulated by a minimum catch size, a minimum mesh size in trawls and Danish seines, a maximum bycatch of undersized fish, closure of areas having high densities of juveniles and by seasonal and area restrictions.

3.1.2 - Reported catches prior to 2022 (Tables 3.1-3.4, Figure 3.1)

The provisional catch of cod in Subarea 1 and divisions 2.a and 2.b for 2021 reported to the working group is 810 755 t (including both NEA cod and NCC catches).

Reported catch figures used for the assessment of Northeast Arctic cod:

The historical practice (considering catches between 62°N and 67°N for the whole year and catches between 67°N and 69°N for the second half of the year to be Norwegian coastal cod) has been used for estimating the Norwegian landings of Northeast Arctic cod up to and including 2011 (Table 3.2). The catches of coastal cod subtracted from total cod catches in Subarea 1 and divisions 2.a and 2.b for the period 1960—2021 are given in Table 3.2. For 2012–2021 the Norwegian catches have been analysed by an ECA-version designed for simultaneously providing estimates of catch numbers-at-age for each of the two stocks.

Coastal cod catches in 2021 for the southern and northern area combined were 42 044 tonnes using the current conversion factors between round and gutted weight, and this amount was as in previous years subtracted from the total cod catch north of 62° N to get the figure for NEA cod used in that assessment (Table 3.1 and 3.2). The figure for total coastal cod catch in 2021 using the revised conversion factors, as decided at WKBarFar 2021 and used in the coastal cod assessment was 42 044 tonnes (ICES AFWG 2022 Table 2.1a), which is 3.3 % below the value of 43 471 tonnes using the current conversion factors.

These values for coastal cod are now inconsistent with the coastal cod catches presented in ICES AFWG 2022 Chapter 2, as the coastal cod catch time series were revised at WKBarFar, but not the NEA cod time series. At WKBarFar, the proposal for revision of NEA cod catch data series was rejected, as Norwegian data for many years and age groups (especially ages 12+ in years prior to 2013) were changed considerably and the reason for this was not sufficiently explained. WKBarFar recommended that when the revision of the historical Norwegian catch data is ready it should be submitted to ICES for review, ideally by a review attached to the AFWG.

The catch by area is shown in Table 3.1, and further split into trawl and other gears in Table 3.3. The distribution of catches by areas and gears in 2021 was similar to 2020. The nominal landings by country are given in Table 3.4.

There is information on cod discards (see ICES AFWG 2021 section 0.4) but it was not included in the assessment because these data are fragmented and different estimates are in contradiction with each other. Moreover the level of discards is relatively small in the recent period and inclusion of these estimates in the assessment should not change our perception on NEA cod stock size.

In summer/autumn 2018, a Norwegian vessel caught 441 t of cod in the Jan Mayen EEZ, which is a part of ICES area 2a, mostly by long-line. Cod is known to occasionally occur in this area, but rarely in densities which are suitable for commercial fisheries. The cod caught in this area in 2018 was large (65-110 cm), and otolith readings and genetics both showed this cod to be a mix of Northeast Arctic and Icelandic cod. Norway did in 2019-2020 carry out an experimental long-line fishery during four different periods in each year in order to investigate further the occurrence of cod in this area in space and time as well as stock identity. The size distribution and genetic composition of the cod caught in this area in 2019-2021 was similar to that in 2018, although there was somewhat more smaller cod (< 65 cm) in 2020-2021 than in 2019. Most of the cod caught in April-May 2019 was spawning or spent, while most cod caught in March 2020 had not started spawning. Cod spawning in this area has not been observed prior to 2019. Total catches in 2019 amounted to 628 t, in 2020 to 522 t and in 2021 to 146 t. The 2018 catches in this area were partly counted against the Norwegian TAC for cod north of 62° N , while the 2019 and 2020 TAC for this area comes in addition to the Norwegian TAC for cod as agreed by JNRFC. There has been varying practice considering including those catches in the assessment, they were included in 2020 but the plan is to exclude them for all years in future assessments. Regulations for the fishery in this area for 2022 have not yet been decided upon.

3.1.3 - Unreported catches of Northeast Arctic cod (Table 3.1)

In the years 2002—2008 certain quantities of unreported catches (IUU catches) have been added to the reported landings. More details on this issue are given in the Working group reports for that period.

There are no reliable data on level of IUU catches outside the periods 1990—1994 and 2002—2008, but it is believed that their level was not substantial enough to influence on historical stock assessment.

According to reports from the Norwegian-Russian analysis group on estimation of total catches the total catches of cod since 2009 were very close to officially reported landings.

3.1.4 - TACs and advised catches for 2021 and 2022

The Joint Norwegian-Russian Fisheries Commission (JNRFC) agreed on a cod TAC of 885 600 t for 202 1 , and in addition 21 000 t Norwegian coastal cod. The total reported catch of 800 427 t in 2021 was 106 173 t below the agreed TAC. Since 2015 JNRFC has decided that Norway and Russia can transfer to next year or borrow from last year 10% of the cod country's quota. That may lead to some deviation between agreed TAC and reported catch. As an extraordinary measure due to expected underfishing of the TAC in 2021, JNRFC decided that it should be possible to transfer 15% of the TAC between 2021 and 2022.

The advice for 2022 given by ACOM in 2021 was 708 480 t based on the agreed harvest control rule. The quota established by JNRFC for 2022 was set equal to the advice. In addition, the TAC for Norwegian Coastal Cod was set to the same value for 2022 as for 2021: 21 000 t.

3.2 - Status of research

3.2.1 - Fishing effort and CPUE (Table A1, Figure 3.4-3.5)

CPUE series of the Norwegian and Russian trawl fisheries are given in Table A1. The data reflect the total trawl effort (Figure 3.4), both for Norway and Russia. The Norwegian series is given as a total for all areas. Norwegian data for 2011–2021 are not necessarily compatible with data for 2007 and previous years. Norwegian CPUE declined from 2020 to 2021 and reached the lowest level in the 2011-2021 time series (Figure 3.5).

3.2.2 - Survey results - abundance and size at age (Tables 3.5, A2-A14)

Some survey results for 2021 were revised since AFWG 2021, for a summary of this, see section 3.2.3.

Joint Barents Sea winter survey (bottom trawl and acoustics) Acronyms: BS-NoRu-Q1 (BTr) and BS-NoRu-Q1 (Aco)

The survey was carried out as planned with good spatial coverage.

Before 2000 this survey was made without participation from Russian vessels, while in 2001—2005, 2008—2016 and 2018-2022 Russian vessels have covered important parts of the Russian zone. In 2006—2007 the survey was carried out only by Norwegian vessels. In 2007, 2016, 2021 and 2022 the Norwegian vessels were not allowed to cover the Russian EEZ. The method for adjustment for incomplete area coverage in 2007 is described in the 2007 report. The same method was used to adjust the 1997-1998 survey indices in the 2016 revision (Mehl et al. 2016). Table 3.5 shows areas covered in the time-series and the additional areas implied in the method used to adjust for missing coverage in the Russian Economic Zone. In 5 of the 8 adjusted years (including 2021) the adjustments were not based on area ratios, but the “index ratio by age” was used. This means that the index by age for the covered area was scaled by the observed ratio between total index and the index for the same area observed in the years prior to the survey. The adjustments for 2017 were based on average index rations by age for 2014–2016. Adjustments were also made in 2020-2021 using the average index ratios by age for 2018-2019 and 2019-2020, respectively.

Regarding the older part of this time-series it should be noted that the survey prior to 1993 covered a smaller area (Jakobsen *et al*. 1997), and the number of young cod (particularly 1- and 2-year old fish) was probably underestimated. Other changes in the survey methodology through time are described by Jakobsen *et al.* (1997), while the surveys for the years 2007—2012 and 2013—2018 are reported in Mehl *et al.* (2013, 2014, 2015, 2016, 2017a). Note that the change from 35 to 22 mm mesh size in the codend in 1994 is not corrected for in the time-series. This mainly affects the age 1 indices.

With the recent expansion of the cod distribution it is likely that in recent years the coverage in the February survey (BS-NoRu-Q1 (BTr) and BS-NoRu-Q1 (Aco)) has been incomplete, in particular for the younger ages. This could cause a bias in the assessment, but the magnitude is unknown. The 2014–2022 surveys covered considerably larger areas than earlier winter surveys, and showed that most age groups of cod (particularly ages 1 and 2) were distributed far outside the standard survey area. The bottom trawl survey estimates including the extended area for 2014-2022 were used in the tuning data separately from the same index before 2014, as decided at WkBarFar 2021.

Lofoten acoustic survey on spawners Acronym: Lof-Aco-Q1

The estimated abundance indices from the Norwegian acoustic survey off Lofoten and Vesterålen (the main spawning area for this stock) in March/April are given in Table A4. A description of the survey, sampling effort and details of the estimation procedure can be found in Korsbrekke (1997). The 2022 survey results in biomass terms was 182 thousand tonnes, this is 21 % below the 2021 level and the lowest since 2006.

Russian autumn survey Acronym: RU-BTr-Q4

Abundance estimates from the Russian autumn survey (November-December) are given in Table A9 (acoustic estimates) and Table A10 (bottom trawl estimates). The entire bottom trawl time-series was in 2007 revised backwards to 1982 (Golovanov *et al*., 2007, WD3), using the same method as in the revision presented in 2006, which went back to 1994. The new swept area indices reflect Northeast Arctic cod stock dynamics more precisely compared to the previous one - catch per hour trawling. The Russian autumn survey in 2006 was carried out with reduced area coverage. Divisions 2a and 2b were adequately investigated in the survey in contrast to Subarea 1, where the survey covered approximately 40% of the long-term average area coverage. The Subarea 1 survey indices were calculated based on actual covered area (40 541 sq. miles). The 2007 AFWG decided to use the “final" year class indices without any correction because of satisfactory internal correspondence between year class abundances at age 2—9 years according to the 2006 survey and ones due to the previous surveys.

This survey was not conducted in 2016 , but was carried out in 2017, when 79% of the standard survey area was covered (Sokolov *et al* 2018, WD 11). The index shows a reliable internal consistence and it was decided to use it in the assessment. This survey was not carried out in 2018-2021 and will likely be discontinued.

Joint Ecosystem survey Acronym: Eco-NoRu-Q3 (Btr)

Swept area bottom trawl estimates from the joint Norwegian-Russian ecosystem survey in August-September for the period 2004–2021 are given in Table A14. This survey normally covers the entire distribution area of cod at that time of the year.

In 2014 this survey had an essential problem with area coverage in the north-west region because of difficult ice conditions. In the area covered by ice in 2014 a substantial part of population was distributed during 2013 survey. So, based on those observations AFWG decided in 2015 to exclude 2014 year from that tuning series in current assessment. In 2016 there was incomplete coverage in the international waters and close to the Murman coast. An adjustment for this incomplete coverage was made based on interpolation from adjacent areas (Kovalev *et al* 2017, WD 12). At this time of the year, usually a relatively small part of the cod stock is found in the area which was not covered in 2016. In 2017 and 2019 the coverage was close to complete, although the far northeastern part of the survey area (west of the north island of Novaya Zemlya) was not covered due to military restrictions. In 2018, a large area in the eastern part of the Barents Sea was not covered Thus it was decided not to include 2018 data from this survey in the assessment.

The coverage in 2020 was less synoptic than usual, as explained in Section 0.6. As the survey indices from the BESS 2020 showed an unexplainable large decline compared to the 2019 indices, it was considered to exclude 2020 indices from this survey, but it was decided to keep them in and re-evaluate next year whether they should still be included in the assessment. The 2021 coverage was good, although as in several previous years, most of the international waters in the Barents Sea was not covered. The mentioned re-evaluation has not been carried out.

The survey indices are calculated both the BioFox and StoX calculation methods, and as in earlier years, the Biofox series was used in the tuning. A research recommendation from WkBarFar was to unify these two methods for estimating indices from ecosystem survey. However, the benchmark decided to use weight at age from the StoX in calculations of weight at age used in the assessment.

Survey results - length and weight-at-age (Tables A5-A8, A11-A12, A15)

Length-at-age is shown in Table A5 for the Norwegian survey in the Barents Sea in winter, in Table A7 for the Lofoten survey and in Table A11 for the Russian survey in October-December. Weight-at-age is shown in Table A6 for the Norwegian survey in the Barents Sea in winter, in Table A8 for the Lofoten survey, Table A12 for the Russian survey in October-December and Table A15 for the BESS survey (calculated using StoX).

Length and weight at age in the Lofoten survey increased from 2021 to 2022 for age groups 5-6 and 8-11. The size at age in the BESS survey was about the same in 2021 as in 2020.

3.2.3 - Revision of 2021 survey results

Some errors in StoX software were found in summer 2021, affecting the 2021 winter survey results (bottom trawl and acoustic) for cod and haddock and thus a revised assessment was carried out in September 2021 for both stocks (as described in the AFWG 2021 report executive summary). Also an error in calculating the 12+ group for the bottom trawl survey for use in the tuning was corrected. After that some additional errors in StoX software have been found and corrected, final estimates for 2021 are in the survey report which is now published (Fall et al. 2022). In addition, the 2020 ecosystem survey indices and weight at age as well as the 2021 Lofoten survey indices and weight at age have been revised.

3.2.4 - Age reading

The joint Norwegian-Russian work on cod otolith reading has continued, with regular exchanges of otoliths and age readers (see ICES AFWG 2021 chapter 0.7). The results of fifteen years of annual comparative age readings are described in Yaragina *et al*. (2009). Zuykova *et al*. (2009) re-read old otoliths and found no significant difference in contemporary and historical age determination and subsequent length at age. However, age at first maturation in the historical material as determined by contemporary readers is younger than that determined by historical readers. Taking this difference into account would thus have effect on the spawning stock-recruitment relationship and thus on the

biological reference points. The overall percentage agreement for the 2017–2018 exchange was 87.7% (WD 8, ICES 2020). The main reason for cod ageing discrepancies between Russian and Norwegian specialists remains the same, representing the latest summer growth zone, and different interpretations of the false zones. The general trend is that the Russian readers assign slightly lower ages than the Norwegian readers compared to the modal age for all age groups. This is opposite of what we have seen in previous readings, where the Russian readers has tended to be slightly overestimating the age compared to the Norwegian readers.

The trend with bias in NEA cod age determination registered for some years of the period 1992–2018 between experts of both countries is a solid argument to continue comparative cod age reading between PINRO and IMR to monitor the situation. The German participant has expressed an intention to join the age reading cooperation in future.

3.3 - Data available for use in assessment

Data for the period 1946–1983 are taken from the AFWG 2001 report (ICES CM 2001/ACFM:19) and were not revised at the WKBarFar benchmark in 2021.

3.3.1 - Catch-at-age (Table 3.6)

For 2021, age compositions from all areas were available from Norway, Russia, Spain and Germany.

There is still a concern about the biological sampling from parts of the Norwegian fishery that may be too low. Also the split between NEA cod and coastal cod may be affected by the sampling coverage.

3.3.2 - Survey indexes available for use in assessment (Table 3.13, A13)

The following survey data series were available:

Fleet code	Name	Place	Season	Age	Years
Fleet 15*	Joint bottom trawl survey	Barents Sea	Feb-Mar	3–12+	1981–2013, 2014-2022
Fleet 16	Joint acoustic survey	Barents Sea+Lofoten	Feb-Mar	3–12+	1985–2022
Fleet 18	Russian bottom trawl surv.	Total area	Oct-Dec	3–12+	1982–2017
Fleet 007	Ecosystem surv.	Total area	Aug-Sep	3–12+	2004–2021

*Survey indices for Fleet 15 were divided by two series (before and after 2014) in model tuning as decided at WKBarFar 2021.

The tuning fleet file is shown in Table 3.13. Note that the joint acoustic survey (sum of Barents Sea and Lofoten acoustic survey indices) is given in Table A13.

Survey indices for Fleet 15 have been multiplied by a factor 100, while survey indices for Fleets 007, 16 and 18 have been multiplied by a factor 10. This is done to keep the dynamics of the surveys even for very low indices, because some models (e.g. XSA) adds 1.0 to the indices before the logarithm is taken.

3.3.3 - Weight-at-age (Tables 3.7-3.9, A2, A4, A6, A8, A12).

Catch weights

For 2021, weight-at-age in the catch for areas 1, 2a and 2b was provided by Norway, Russia, Spain and Germany (Table 3.7). For ages up to and including 11, observations are used. Following the WKBarFar 2021 decision, weight at age in catch for the years 1983-present for ages 12-15+ are calculated by a cohort-based von Bertalanffy approach used to replace previous fixed values.

Stock weights

For ages 1—11 stock weights-at-age at the start of year y ($W_{a,y}$) for 1983—2022 are calculated combining, when

available, weight at age from the Winter, Lofoten, Russian autumn and ecosystem surveys. The details are given in the Stock Annex. For ages 12-15+ a similar approach as for weight at age in the catch was used.

3.3.4 - Natural mortality including cannibalism (Table 3.12, Table 3.17)

A natural mortality (M) of 0.2 + cannibalism was used. Cannibalism is assumed to only affect natural mortality of ages 3-6.

2021 data are available and 2020 data have been updated.

The method used for calculation of the prey consumption by cod described by Bogstad and Mehl (1997) is used to calculate the consumption of cod by cod for use in cod stock assessment. The consumption is calculated based on cod stomach content data taken from the joint PINRO-IMR stomach content database (methods described in Mehl and Yaragina 1992). On average about 9000 cod stomachs from the Barents Sea have been analysed annually in the period 1984—2021.

These data are used to calculate the per capita consumption of cod by cod for each half-year (by prey age groups 0—6 and predator age groups 1–11+). It was assumed that the mature part of the cod stock is found outside the Barents Sea for three months during the first half of the year. Thus, consumption by cod in the spawning period was omitted from the calculations.

An iterative procedure was applied to include the per capita consumption data in the SAM run. It is described in detail in Stock Annex.

For the cod assessment data from annual sampling of cod stomachs has been used for estimating cannibalism, since the 1995 assessment. The argument has been raised that the uncertainty in such calculations are so large that they introduce too much noise in the assessment. A rather comprehensive analysis of the usefulness of this was presented in Appendix 1 in the 2004 AFWG report. The conclusion was that it improves the assessment.

The data on cod cannibalism for the historical period (1946—1983) was included in assessment during the benchmark to make the time-series consistent (ICES 2015a, WKARCT 2015). These estimates were based on hindcasted values of NEA cod natural mortality at ages 3—5 using PINRO data base on food composition from cod stomach for the historical period (Yaragina *et al*. 2018).

3.3.5 - Maturity-at-age (Tables 3.10-3.11)

Historical (pre–1982) Norwegian and Russian time-series on maturity ogives were reconstructed by the 2001 AFWG meeting (ICES CM 2001/ACFM:19). The Norwegian maturity ogives were constructed using the Gulland method for individual cohorts, based on information on age at first spawning from otoliths. For the time period 1946—1958 only the Norwegian data were available. The Russian proportions mature-at-age, based on visual examinations of gonads, were available from 1959.

Since 1982 Russian and Norwegian survey data have been used (Table 3.10). For the years 1985—2022, Norwegian maturity-at-age ogives have been obtained by combining the Barents Sea winter survey and the Lofoten survey. Russian maturity ogives from the autumn survey as well as from commercial fishery for November-February are available from 1984 until present. The Norwegian maturity ogives tend to give a higher percent mature-at-age compared to the Russian ogives, which is consistent with the generally higher growth rates observed in cod sampled by the Norwegian surveys. The percent mature-at-age for the Russian and Norwegian surveys have been arithmetically averaged for all years, except 1982—1983 when only Norwegian observations were used and 1984 when only Russian observations were used.

Russian data for the autumn survey for 2018 and later years were not available as the survey was not conducted. In WD1 5 , 2019, updated correction factors to allow for this when calculating the combined maturity-at-age in 2019 were calculated, based on historical differences between Norwegian and Russian data. These correction factors were then applied to the Norwegian data for 2020-2022.

The approach used for calculating maturity at age is the same as previously used and consistent with the approach used to estimate the weight-at-age in the stock, except that no data from the BESS survey are used. However, since survey data, both abundance indices and proportion mature, have been revised, the entire time series of ogives back to 1994 was revised at the benchmark. The proportions of mature cod for age 13–15 are set to 1 for the period 1984–present.

Maturity-at-age for cod has been variable the last five years, particularly for ages 6–9. According to the combined data, maturity at age decreased in 2015–2016, then increased, but decreased again from 2019 to 2022 for most age groups (Table 3.11).

3.4 - Assessment using SAM

3.4.1 - SAM settings (Table 3.14)

The SAM model settings optimised by WKBarFar are shown in Table 3.14.

3.4.2 - SAM diagnostics (Figure 3.1 and 3.2 a-c)

Residuals for the SAM run are shown in Figure 3.2a, while retrospective plots of F, SSB and recruitment are shown in Figure 3.2b. Figure 3.2c shows the catchability by survey and age group and Figure 3.2d compares observed and modelled catches in tonnes.

The retrospective pattern is generally very good (Figure 3.2b), with values of Mohn's rho of 0-2% both for SSB, R and F.

The observed catch in tonnes in 2021 is higher than modelled, and just inside the confidence interval.

3.4.3 - Results of assessment (Tables 3.15-3.18, 3.20 , Figure 3.1)

Summaries of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment since 1946 are given in Table 3.18 and Figure 3.1.

The fishing mortalities and population numbers are given in Tables 3.15 and 3.16.

The estimated $F_{5\text{-}10}$ in 2021 is 0.48, which is above F_{pa} (Table 3.18). Fishing mortality has been increasing slowly in recent years. The spawning stock biomass in 2022 is estimated to be 833 kt (Table 3.20), which is high but much lower than the peak in 2013 (2,271 kt). One should bear in mind that in the early part of the time-series (before the 1980s) the fraction at age of mature fish was considerably lower.

Total stock biomass in 2022 is estimated to 1,98 5 kt, which is close to the long-term mean and well below the highest level observed after 1955 (3,766 kt in 2013).

It is noted that the exploitation pattern is still dome-shaped with a marked decrease in selectivity above age 12, although the dome-shape is not as strong than in assessments made before the 2021 benchmark.

M values (M = 0.2+cannibalism mortality) are given in Table 3.17. For ages 3—5 the M matrix in 1946—1983 also includes M2 since the benchmark meeting in 2015 (WKARCT 2015).

3.5 - Reference points and harvest control rules

The current reference points for Northeast Arctic cod were estimated by SGBRP (ICES CM 2003/ACFM:11) and adopted by ACFM at the May 2003 meeting.

At the 46th session of JRNFC a new version of the management rule was adopted (see section 3.7.3). The TAC advice for 2022 is based on the agreed harvest control rule.

3.5.1 - Biomass reference points

The values adopted by ACFM in 2003 are B_{lim} = 220 000 t, B_{pa} = 460 000 t. (ICES CM 2003/ACFM:11).

3.5.2 - Fishing mortality reference points

The values adopted by ACFM in 2003 are F_{lim} = 0.74 and F_{pa} = 0.40. (ICES CM 2003/ACFM:11). The F_{msy} for NEA cod was estimated by WKBaRFar 2021 to be in the range 0.40 - 0.60.

3.5.3 - Harvest control rule

The history of how the harvest control rule has developed is given in the 2017 AFWG report. JNRFC in 2015 asked ICES to explore the consequences of 10 different harvest control rules. This was done by WKNEAMP (ICES 2015b, 2016). JNRFC in 2016 adopted one of the rules explored by WKNEAMP (Rule 6 in that report).

The current rule reads as follows:

The TAC is calculated as the average catch predicted for the coming 3 years using the target level of exploitation (F_{tr}).

The target level of exploitation is calculated according to the spawning stock biomass (SSB) in the first year of the forecast as follows:

- if SSB < B_{pa}, then F_{tr} = SSB / B_{pa} × F_{msy} ;

- if B_{pa} ≤ SSB ≤ 2×B_{pa}, then F_{tr} = F_{msy} ;

- if 2×B_{pa} < SSB < 3×B_{pa}, then F_{tr} = F_{msy} × (1 + 0.5 × (SSB - 2×B_{pa}) / B_{pa});

- if SSB ≥ 3×B_{pa}, then F_{tr} = 1.5 × F_{msy} ;

where F_{msy}=0.40 and B_{pa} =460 000 tonnes.

If the spawning stock biomass in the present year, the previous year and each of the three years of prediction is above B_{pa}, the TAC should not be changed by more than +/- 20% compared with the previous year's TAC. In this case, F_{tr} should however not be below 0.30.

3.6 - Prediction

3.6.1 - Prediction input (Tables 3.16, 3.19a , Figure 3. 3)

The input data to the short-term prediction with management option table (2022—2025) are given in Table 3.19a. For 2022 stock weights and maturity were calculated from surveys as described in Sections 3.3.2 and 3.3.4.

Catch weights in 2022 onwards and stock weights in 2023 and onwards for age 3–11 are predicted by the method described by Brander (2002), where the latest observation of weights by cohort are used together with average annual increments to predict the weight of the cohort the following year. The method is given by the equation

W(a+1,y+1)=W(a,y) + Incr(a), where Incr(a) is a "medium term" average of Incr(a,y)= W(a+1,y+1)-W(a,y)

This method was introduced in the cod prediction in the 2003 working group. Since 2005 working group an average of the 3 most recent values of annual increments have been used for predicting stock weights. For catch weights the last 5-year period for averaging the increments is used (changed from 10-year period at the benchmark).

The maturity ogive for the years 2023—2025 was predicted by using the 2020-2022 average. The exploitation pattern in 2022 and later years was set equal to the previous 5 years according to the benchmark decision and as described at Stock Annex.

The stock number-at-age in 2022 was taken from the final SAM run (Table 3.16) for ages 4 and older. The recruitment at age 3 in the years 2022—2025 was estimated as described in section 3.7.2. Figure 3. 3 shows the development in

natural mortality due to cannibalism for cod (prey) age groups 1-3 together with the abundance of capelin in the period 1984—2021. There was no clear trend in natural mortality, and the average M values for the last 3 years are used to predict natural mortality of age groups 3—6 for years 2022—2025 (based on benchmark decision, WKARCT 2015 and unchanged at WKBaRFar 2021).

The assessment shows a slightly increasing F from 2015 to 2021. In accordance with the benchmark decision (WKARCT 2015, not reviewed at WKBarFar 2021) and with support from AFWG-2019 WD 11 (Kovalev and Chetyrkin, 2019), the last year's assessment F in terminal year 2021 (*status quo*) is used for F in the intermediate year (2022). Table 3.19 shows input data to the predictions. The results of prediction show that the catch in 2022 predicted using F_{sq} is about 68 kt less than the agreed TAC. As the coastal cod catch in recent years has been about 20 kt higher than the TAC of 21 kt, this means that if the total TAC for Northeast arctic cod and Coastal cod will be taken, the predicted catch using F_{sq} will be about 48 kt below the TAC. Reported catches so far in 2022 indicate that the catches will be somewhat above the TAC of 708 480 tonnes, as the TAC in 2021 was underfished and a considerable amount (105 584 tonnes) was transferred to 2022.

3.6.2 - Recruitment prediction (Table 3.19b-d)

At the 2008 AFWG meeting it was decided to use a hybrid model, which is a weighted arithmetic mean of different recruitment models. It was agreed to use the same approach this year. The input data for those models are the following time-series; ice coverage, intensity of interaction between the arctic and boreal oceanic systems on the shelf of the Barents Sea, temperature and oxygen saturation at the Kola section. Input data to he prediction are presented in Tables 3.19b-c and prognosis from all the models, including the hybrid is presented in Table 3.19d. Since 2014 the hybrid model is based on objective weighting of different sub-models and includes the RCT3 model (see AFWG report 2021 section 1.4 for details). The numbers-at-age 3 calculated by the hybrid method were: 476 million for the 2019 year class, 566 million for the 2020 year class, 383 million for the 2021 year class and 315 million for the 2022 year class (Table 3.19d).

Although age 3 indices from the winter bottom trawl and acoustic surveys are now also included in the SAM tuning, it was decided at the benchmark to continue using in the predictions recruitment estimates at age 3 in the assessment year (intermediate year in prediction) from the hybrid model. The difference between the SAM estimate and the hybrid model estimate of age 3 in 2022 was large (189 vs. 476 million individuals).

The values used for the 2019 and 2020 year classes in the prediction are higher than the very low survey indices for those year classes at age 1 and 2 indicate.

3.6.3 - Prediction results (Tables 3.20-3.21)

The catch corresponding to F_{sq} in 2022 is 641 kt (Table 3.20). The resulting SSB in 2023 is 751 kt, which is 10 % lower than the SSB in 2022. Table 3.20 shows the short-term consequences over a range of F-values in 2023. The detailed outputs corresponding to F_{sq} in 2022 and the F corresponding to the HCR and F_{pa} in 2023 is given in Table 3.21. Summarised results are shown in the text table below.

Since SSB in 2022 is between B_{pa} =460 000 t and 2 × B_{pa} = 920 000 t, F = 0.40 is used in the 3-year prediction, giving catches of 487 049, 476 906 and 468 560 tonnes in 2023, 2024 and 2025, respectively. The average of this is 477 505 tonnes. According to the HCR the maximum year-to-year decrease in TAC is limited by 20 % which corresponds to a TAC of 566 784 tonnes for 2023. The resulted TAC for 2023 in accordance with the management plan is shown in the table below.

Cod in subareas 1 and 2. Annual catch options. All weights are in tonnes.

Basis	Total catch (2023)	Ftotal (2023)	SSB(2024)	% SSB change *	% TAC change **	% Advice change ***
ICES advice basis						
Management plan^	566 784	0.48	668 851	-11	-20	-20

Basis	Total catch (2023)	Ftotal (2023)	SSB(2024)	% SSB change *	% TAC change **	% Advice change ***
Other options						
MSY approach: F_{MSY}	487 049	0.40	731 342	-3	-31	-31
F = 0	0	0	1 134 101	51	-100	-100
F = F2021	564 475	0.4810	670 645	-11	-20	-20
F_{pa}	487 049	0.40	731 342	-3	-31	-31
F_{lim}	775 883	0.74	510 976	-32	10	10

Weights in tonnes.

^ 20 % decrease from TAC 2022

*** SSB 2024 relative to SSB 2023.**

**** Catch 2023 relative to TAC 2022**

***** Advice for 2023 relative to advice for 2022**

This catch forecast covers all catches. It is then implied that all types of catches are to be counted against this TAC. It also means that if any overfishing is expected to take place, the above calculated TAC should be reduced by the expected amount of overfishing.

3.6.4 - Medium-term predictions

The medium-term prediction indicates that if the HCR is followed, the stock size should stop declining and stabilize from 2024 onwards, around the following values: total stock 1.7 million tonnes and SSB 700 000 tonnes, with corresponding catch levels around 450 000 tonnes.

3.7 – Comparison with last year's assessment and prediction

3.7.1 - Comparison to 2021 assessment (Figure 3.7)

The text tables below compare this year's estimates with the final 2021 AFWG estimates for numbers at age (millions), total biomass, spawning biomass (thousand tonnes) in 2021, as well as reference F for the year 2020.

		N(2021)															
Assessment year (specification)	F(2020)	age3	age4	age5	age6	age7	age8	age9	age10	age11	age12	age13	age14	age15	TSB (2021)	SSB (2021)	F (2021)
AFWG 2021	0.435	557*	371	332	191	143	57	30	27	9	3.1	1.3	0.8	3.3	2121	902	0.647**
Rus-Nor WG 2022	0.428	406	369	330	200	155	58	30	28	11	3.5	1.5	0.9	3.0	2133	936	0.481
Ratio 2022 WG/ 2021 AFWG	0.98	0.73	0.99	0.99	1.05	1.09	1.02	1.00	1.02	1.30	1.11	1.19	1.16	0.90	1.01	1.04	0.74
*estimated by recruitment models **assuming FTAC constr.																	

In the current assessment, the number at ages 10-14 was adjusted upwards slightly compared to the 2021 AFWG assessment. For younger ages, the changes went in both directions, but mostly there was a decrease from 2021 assessment, with ages 6 and 7 being the main exception. On the other hand, the plus group in 2021 was adjusted downwards. TSB, SSB and F were very close to the previous assessment.

3.7.2 - Comparison to prediction

The change in the advice is large compared to last year. The advice for 2023 is 566 784 tonnes, while the advice for 2022 given by ICES was 708 480 tonnes.

The assessed stock in 2022 in comparison with the assessment in 2021 was very similar. The main tendency for stock

decrease in coming years was similar. The average catch predicted for the coming 3 years, using the mentioned target level of exploitation (Ftr) in the HCR resulted in TAC advice equal to 566 784 t. This value corresponds to the - 20 % limit on year-to-year TAC change stated in the HCR, and is higher than the value without applying such a constraint (477 505 t).

3.8 - Concerns with the assessment

The WG realizes that imprecise input data, in particular the catch-at-age matrix, and discontinuation of some surveys as well as incomplete spatial coverage and reduced synopticity in surveys could be a main obstacle to producing precise stock assessments, regardless of which model is used.

3.9 - Additional assessment methods

All models use the same tuning data.

3.9.1 - TISVPA (Tables 3.22-3.24, Figure 3.6a-c)

This year the TISVPA model was applied to NEA cod with the same settings as last year and using the same data as SAM except that natural mortality values from cannibalism were taken from the SAM runs. During WG the results of exploratory runs using the TISVPA model were discussed. The residuals of the model approximation of catch-at-age and “fleets” data are presented in Figure 3.6a. Likelihood profiles for different data source are presented in Figure 3.6b. Retrospective run results are shown in Figure 3.6c. The results (Tables 3.22-3.24) generally support the results of the SAM model, with a similar SSB estimate but a lower TSB estimate in 2022 as well as a higher F estimate in 2021.

3.9.2 - Model comparisons (Figures 3.2a, 3.6a, 3.7)

Figure 3.7 compares the results of SAM and TISVPA, showing F, SSB, TSB and recruitment. F in 2021 and SSB in 2022 is very similar for all models, while TSB and recruitment in recent years is lower in TISVPA than in SAM. Both models demonstrates a stable retrospective pattern (F igures 3.2a, 3.6c).

3.10 - New and revised data sources

This section describes some data sources, which could be revised or included in the assessment in the future.

3.10.1 - Consistency between NEA cod and coastal cod catch data (Table 3.2)

Consistency between the catch data used for NEA cod and coastal cod should be ensured. The revised catch figures used in the coastal cod assessment do not correspond to the difference between the total cod catch and the catch used in the NEA cod assessment (Table 3.2). These discrepancies will be adjusted when the NEA cod catch series are revised (section 3.2.2).

3.10.2 - Discard and bycatch data

Work on updating discard and bycatch data series is ongoing. Revised bycatch estimates in numbers for the period 2005-2020 are described in AFWG-2021 Section 0.6. At WKARCT in 2015 it was, however, decided not to include those data in the catch-at-age matrix.

The bycatch mainly consists of age 1 and 2 fish, but the bycatch is generally small compared to other reported sources of mortality: catches, discards and the number of cod eaten by cod. From 1992 onwards, bycatches of age 3 and older fish are negligible, because use of sorting grids was made mandatory. However, in 1985, bycatches of age 5 and 6 cod were about one third of the reported catches for those age groups. The year class for which the bycatches were highest, was the 1983 year class (total bycatch of age 2 and older fish of about 60 million, compared to a stock estimate of about 1300 million at age 3.

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3.12 – Tables and figures

Table 3.1. Northeast Arctic COD. Total catch (t) by fishing areas and unreported catch.

Year	Subarea 1	Division 2.a	Division 2.b	Unreported catches	Total catch
1961	409 694	153 019	220 508		783 221
1962	548 621	139 848	220 797		909 266
1963	547 469	117 100	111 768		776 337
1964	206 883	104 698	126 114		437 695
1965	241 489	100 011	103 430		444 983
1966	292 253	134 805	56 653		483 711
1967	322 798	128 747	121 060		572 605
1968	642 452	162 472	269 254		1 074 084
1969	679 373	255 599	262 254		1 197 226
1970	603 855	243 835	85 556		933 246
1971	312 505	319 623	56 920		689 048
1972	197 015	335 257	32 982		565 254
1973	492 716	211 762	88 207		792 685
1974	723 489	124 214	254 730		1 102 433
1975	561 701	120 276	147 400		829 377
1976	526 685	237 245	103 533		867 463
1977	538 231	257 073	109 997		905 301
1978	418 265	263 157	17 293		698 715
1979	195 166	235 449	9 923		440 538
1980	168 671	199 313	12 450		380 434
1981	137 033	245 167	16 837		399 037
1982	96 576	236 125	31 029		363 730
1983	64 803	200 279	24 910		289 992
1984	54 317	197 573	25 761		277 651

Year	Subarea 1	Division 2.a	Division 2.b	Unreported catches	Total catch
1985	112 605	173 559	21 756		307 920
1986	157 631	202 688	69 794		430 113
1987	146 106	245 387	131 578		523 071
1988	166 649	209 930	58 360		434 939
1989	164 512	149 360	18 609		332 481
1990	62 272	99 465	25 263	25 000	212 000
1991	70 970	156 966	41 222	50 000	319 158
1992	124 219	172 532	86 483	130 000	513 234
1993	195 771	269 383	66 457	50 000	581 611
1994	353 425	306 417	86 244	25 000	771 086
1995	251 448	317 585	170 966		739 999
1996	278 364	297 237	156 627		732 228
1997	273 376	326 689	162 338		762 403
1998	250 815	257 398	84 411		592 624
1999	159 021	216 898	108 991		484 910
2000	137 197	204 167	73 506		414 870
2001	142 628	185 890	97 953		426 471
2002	184 789	189 013	71 242	90 000	535 045
2003	163 109	222 052	51 829	115 000	551 990
2004	177 888	219 261	92 296	117 000	606 445
2005	159 573	194 644	121 059	166 000	641 276
2006	159 851	204 603	104 743	67 100	537 642
2007	152 522	195 383	97 891	41 087	486 883
2008	144 905	203 244	101 022	15 000	464 171
2009	161 602	207 205	154 623		523 431
2010	183 988	271 337	154 657		609 983
2011	198 333	328 598	192 898		719 829
2012	247 938	331087	148 638		727 663
2013	360 673	421678	183 858		966 209
2014	320 347	468 934	197 168		986 449
2015	272405	375328	216651		864384
2016	321347	351468	176607		849422
2017	309902	360477	197898		868276
201 8	249397	321548	207681		778627
201 9	234985	318539	139084		692609
2020	234029	298707	160166		692903
2021[1]	281198	268942	217144		767284

Data provided by Working Group members
[1] Provisional figure

Table 3.2. Catches of Norwegian Coastal Cod in subareas 1 and 2, 10 3 tonnes, which are removed from the NEA cod assessment.

Year	Norwegian catches of cod removed from the NEAC cod -assessment
v1960–70	38.6
1971–79	no data
1980	40
1981	49
1982	42
1983	38
1984	33
1985	28
1986	26
1987	31
1988	22
1989	17
1990	24
1991	25
1992	35
1993	44
1994	48
1995	39
1996	32
1997	36
1998	29
1999	23
2000	19
2001	14
2002	20
2003	19
2004	14
2005	13
2006	15
2007	13
2008	13
2009	15
2010	13.5
2011	18.8
2012	35.5
2013	30.1
2014	33.6
2015	35.8
2016	54.9
2017	51.0
2018	36.3
2019	40.1
2020	45.3
2021	42.0

Table 3.3. Northeast Arctic COD. Total nominal catch ('000 t) by trawl and other gear for each

Year	Subarea 1		Division 2.a		Division 2.b	
	Trawl	Others	Trawl	Others	Trawl	Others
1967	238	84.8	38.7	90	121.1	-
1968	588.1	54.4	44.2	118.3	269.2	-
1969	633.5	45.9	119.7	135.9	262.3	-
1970	524.5	79.4	90.5	153.3	85.6	-
1971	253.1	59.4	74.5	245.1	56.9	-

1972	158.1	38.9	49.9	285.4	33	-
1973	459	33.7	39.4	172.4	88.2	-
1974	677	46.5	41	83.2	254.7	-
1975	526.3	35.4	33.7	86.6	147.4	-
1976	466.5	60.2	112.3	124.9	103.5	-
1977	471.5	66.7	100.9	156.2	110	-
1978	360.4	57.9	117	146.2	17.3	-
1979	161.5	33.7	114.9	120.5	8.1	-
1980	133.3	35.4	83.7	115.6	12.5	-
1981	91.5	45.1	77.2	167.9	17.2	-
1982	44.8	51.8	65.1	171	21	-
1983	36.6	28.2	56.6	143.7	24.9	-
1984	24.5	29.8	46.9	150.7	25.6	-
1985	72.4	40.2	60.7	112.8	21.5	-
1986	109.5	48.1	116.3	86.4	69.8	-
1987	126.3	19.8	167.9	77.5	129.9	1.7
1988	149.1	17.6	122	88	58.2	0.2
1989	144.4	19.5	68.9	81.2	19.1	0.1
1990	51.4	10.9	47.4	52.1	24.5	0.8
1991	58.9	12.1	73	84	40	1.2
1992	103.7	20.5	79.7	92.8	85.6	0.9
1993	165.1	30.7	155.5	113.9	66.3	0.2
1994	312.1	41.3	165.8	140.6	84.3	1.9
1995	218.1	33.3	174.3	143.3	160.3	10.7
1996	248.9	32.7	137.1	159	147.7	6.8
1997	235.6	37.7	150.5	176.2	154.7	7.6
1998	219.8	31	127	130.4	82.7	1.7
1999	133.3	25.7	101.9	115	107.2	1.8
2000	111.7	25.5	105.4	98.8	72.2	1.3
2001	119.1	23.5	83.1	102.8	95.4	2.5
2002	147.4	37.4	83.4	105.6	69.9	1.3
2003	146	17.1	107.8	114.2	50.1	1.8
2004	154.4	23.5	100.3	118.9	88.8	3.5
2005	132.4	27.2	87	107.7	115.4	5.6
2006	141.8	18.1	91.2	113.4	100.1	4.6
2007	129.6	22.9	84.8	110.6	91.6	6.3
2008	123.8	21.1	94.8	108.4	95.3	5.7
2009	130.1	31.5	102	105.2	142.1	11.4
2010	151.1	32.9	130	141.4	149.2	5.4
2011	158.1	38.4	163.5	167	181	11.9
2012	212.1	35.9	172.7	158.4	133.8	14.9
2013	308.5	52.2	216.9	204.7	159.7	24.1
2014	268.8	51.5	246.8	222.1	177.9	19.3
2015	224.3	48.1	192.2	183.2	197.7	19.0
2016	285.5	35.8	181.7	169.8	156.3	20.3
2017	265.4	44.5	189.5	171.0	180.0	17.9
201 8	204.7	44.7	156.7	164.9	192.0	15.6
201 9	199.4	35.6	177.8	140.7	128.9	10.1
2020	199.4	34.6	157.2	141.5	153.5	6.7
2021 [1]	220.8	60.4	120.2	148.7	202.1	15.1

Data provided by Working Group members
[1] Provisional figures

Year	Faroe Islands	France	German Dem. Rep.	Fed. Rep. Germany	Norway	Poland	United Kingdom	Russia [2]		Others	Total all countries
1961	3 934	13 755	3 921	8 129	268 377	-	158 113	325 780		1 212	783 221

1962	3 109	20 482	1 532	6 503	225 615	-	175 020	476 760		245	909 266
1963	-	18 318	129	4 223	205 056	108	129 779	417 964		-	775 577
1964	-	8 634	297	3 202	149 878	-	94 549	180 550		585	437 695
1965	-	526	91	3 670	197 085	-	89 962	152 780		816	444 930
1966	-	2 967	228	4 284	203 792	-	103 012	169 300		121	483 704
1967	-	664	45	3 632	218 910	-	87 008	262 340		6	572 605
1968	-	-	225	1 073	255 611	-	140 387	676 758		-	1 074 084
1969	29 374	-	5 907	5 543	305 241	7 856	231 066	612 215		133	1 197 226
1970	26 265	44 245	12 413	9 451	377 606	5 153	181481	276 632		-	933 246
1971	5 877	34 772	4 998	9 726	407 044	1 512	80 102	144 802		215	689 048
1972	1 393	8 915	1 300	3405	394 181	892	58 382	96 653		166	565 287
1973	1 916	17 028	4 684	16 751	285 184	843	78 808	387 196		276	792 686
1974	5 717	46 028	4 860	78 507	287 276	9 898	90 894	540 801		38 453	1 102 434
1975	11 309	28 734	9 981	30 037	277 099	7435	101 843	343 580		19 368	829 377
1976	11 511	20 941	8 946	24 369	344 502	6 986	89 061	343 057		18 090	867 463
1977	9 167	15 414	3 463	12 763	388 982	1 084	86 781	369 876		17 771	905 301
1978	9 092	9 394	3 029	5 434	363 088	566	35 449	267 138		5 525	698 715
1979	6 320	3 046	547	2 513	294 821	15	17 991	105 846		9 439	440 538
1980	9 981	1 705	233	1 921	232 242	3	10 366	115 194		8 789	380 434
						Spain					
1981	12 825	3 106	298	2 228	277 818	14 500	5 262	83 000		-	399 037
1982	11 998	761	302	1 717	287 525	14 515	6 601	40 311		-	363 730
1983	11 106	126	473	1 243	234 000	14 229	5 840	22 975		-	289 992
1984	10 674	11	686	1 010	230 743	8 608	3 663	22 256		-	277 651
1985	13 418	23	1 019	4 395	211 065	7 846	3 335	62 489		4 330	307 920
1986	18 667	591	1 543	10 092	232 096	5 497	7 581	150 541		3 505	430 113
1987	15 036	1	986	7 035	268 004	16 223	10 957	202 314		2 515	523 071
1988	15 329	2 551	605	2 803	223 412	10 905	8 107	169 365		1 862	434 939
1989	15 625	3 231	326	3 291	158 684	7 802	7 056	134 593		1 273	332 481
1990	9 584	592	169	1437	88 737	7 950	3 412	74 609		510	187 000
1991	8 981	975	**Greenland**	2 613	126 226	3 677	3 981	119 427 [3]		3 278	269 158
1992	11 663	2	3 337	3 911	168 460	6 217	6 120	182 315	**Iceland**	1 209	383 234
1993	17435	3 572	5 389	5 887	221 051	8 800	11 336	244 860	9 374	3 907	531 611
1994	22 826	1 962	6 882	8 283	318 395	14 929	15 579	291 925	36 737	28 568	746 086
1995	22 262	4 912	7462	7428	319 987	15 505	16 329	296 158	34 214	15 742	739 999
1996	17 758	5 352	6 529	8 326	319 158	15 871	16 061	305 317	23 005	14 851	732 228
1997	20 076	5 353	6426	6 680	357 825	17 130	18 066	313 344	4 200	13 303	762 403
1998	14 290	1 197	6 388	3 841	284 647	14 212	14 294	244 115	1423	8 217	592 624
1999	13 700	2 137	4 093	3 019	223 390	8 994	11 315	210 379	1 985	5 898	484 910
2000	13 350	2 621	5 787	3 513	192 860	8 695	9 165	166 202	7 562	5 115	4 14 870
2001	12 500	2 681	5 727	4 524	188 431	9 196	8 698	183 572	5 917	5 225	426 471
2002	15 693	2 934	6419	4 517	202 559	8 414	8 977	184 072	5 975	5 484	445 045
2003	19 427	2 921	7 026	4 732	191 977	7 924	8 711	182 160	5 963	6 149	436 990
2004	19 226	3 621	8 196	6 187	212 117	11 285	14 004	201 525	7 201	6 082	489 445
2005	16 273	3 491	8 135	5 848	207 825	9 349	10 744	200 077	5 874	7 660	475 276
2006	16 327	4 376	8 164	3 837	201 987	9 219	10 594	203 782	5 972	6 271	470 527
2007	14 788	3 190	5951	4619	199 809	9 496	9298	186 229	7316	5 101	445 796
2008	15 812	3 149	5 617	4 955	196 598	9 658	8 287	190 225	7 535	7 336	449 171
2009	16 905	3 908	4 977	8 585	224 298	12 013	8 632	229 291	7 380	7442	523 431
2010	15 977	4 499	6 584	8 442	264 701	12 657	9 091	267 547	11 299	9 185	609 983
2011	13 429	1 173	7 155	4 621	331 535	13 291	8 210	310 326	12 734	17 354 [4]	719 829
2012 [5]	17523	2841	8520	8 500	315 739	12814	11166	329 943	9536	11 081	727 663
2013	13833	7858	7885	8 010	438 734	15042	12536	432 314	14734	15 263	966 209
2014	33298	8149	10864	6 225	431 846	16378	14762	433 479	18205	13 243	986 449

2015	26568	7480	7055	6427	377 983	19905	11778	381 188	16120	9 880	864 384
2016	24084	7946	8607	6 336	348 949	14640	13583	394 107	16031	15 139	849 422
2017	28637	9554	13638	5 977	357419	144 14	16731	396 180	11925	13 802	868 276
2018	26152	6605	12743	9 768	333 539	13143	11533	340 364	10708	14 071	778 627
2019	22270	6371	7553	8 470	282 120	13939	11214	316 813	12294	11 565	692 609
2020	21679	5796	7391	9 725	289 472	11403	12113	312 683	9734	12 908	692 903
2021 [1]	21767	4459	8246	6 190	337 931	11080	5426	352 064	8933	11 188	767 284

[1] Provisional figures.
[2] USSR prior to 1991.
[3] Includes Baltic countries.
[4] Includes unspecified EU catches.
[5] Revised figures.

Table 3.5. Barents Sea winter survey. Area covered ('000 square nautical miles) and areas implied in the method used to adjust for missing coverage in Russian Economic Zone. In 4 of the 5 adjusted years the adjustments were not based on area ratios, but the "index ratio by age" was used. This means that the index by age (for the area outside REZ) was scaled by the observed ratio between total index and the index outside REZ observed in the years prior to the survey.

Year	Area covered	Additional area implied in adjustment	Adjustment method
1981-92	88.1		
1993	137.6		
1994	161.1		
199 5	191.9		
1996	166.1		
1997	88.4	56.2	Index ratio by age
1998	100.4	51.1	Index ratio by age
1999	118.5		
2000	163.2		
2001	164.7		
2002	157.4		
2003	147.4		
2004	164.4		
2005	179.9		
2006	170.1	18.1	Partly covered strata raised to full strata area
2007	123.9	56.7	Index ratio by age
2008	165.2		
2009	171.8		
2010	160.5		
2011	174.3		
2012	151.3	16.7	Index ratio by age
2013	20 3.6		
2014	2 66.8		
2015	243.3		
2016	228.0		
2017	184.4	37.5	Index ratio by age
2018	236.3		

Year	Area covered	Additional area implied in adjustment	Adjustment method
2019	241.2		
2020	203.2	25.1	Index ratio by age
2021	242.9	10.9	Index ratio by age
2022	242.4		

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1946	4008	10387	18906	16596	13843	15370	59845	22618	10093	9573	5460	1927	750
1947	710	13192	43890	52017	45501	13075	19718	47678	31392	9348	9330	4622	4103
1948	140	3872	31054	55983	77375	21482	15237	9815	30041	7945	4491	3899	4205
1949	991	6808	35214	100497	83283	29727	13207	5606	8617	13154	3657	1895	2167
1950	1281	10954	29045	45233	62579	30037	19481	9172	6019	4133	6750	1662	1450
1951	24687	77924	64013	46867	37535	33673	23510	10589	4221	1288	1002	3322	611
1952	24099	120704	113203	73827	49389	20562	24367	15651	8327	3565	647	467	1044
1953	47413	107659	112040	55500	22742	16863	10559	10553	5637	1752	468	173	156
1954	11473	155171	146395	100751	40635	10713	11791	8557	6751	2370	896	268	123
1955	3902	37652	201834	161336	84031	30451	13713	9481	4140	2406	867	355	128
1956	10614	24172	129803	250472	86784	51091	14987	7465	3952	1655	1292	448	166
1957	17321	33931	27182	70702	87033	39213	17747	6219	3232	1220	347	299	173
1958	31219	133576	71051	40737	38380	35786	13338	10475	3289	1070	252	40	141
1959	32308	77942	148285	53480	18498	17735	23118	9483	3748	997	254	161	98
1960	37882	97865	64222	67425	23117	8429	7240	11675	4504	1843	354	102	226
1961	45478	132655	123458	51167	38740	17376	5791	6778	5560	1682	910	280	108
1962	42416	170566	167241	89460	28297	21996	7956	2728	2603	1647	392	280	103
1963	13196	106984	205549	95498	35518	16221	11894	3884	1021	1025	498	129	157
1964	5298	45912	97950	58575	19642	9162	6196	3553	783	172	387	264	131
1965	15725	25999	78299	68511	25444	8438	3569	1467	1161	131	61	79	197
1966	55937	55644	34676	42539	37169	18500	5077	1495	380	403	77	9	70
1967	34467	160048	69235	22061	26295	25139	11323	2329	687	316	225	40	14
1968	3709	174585	267961	107051	26701	16399	11597	3657	657	122	124	70	46
1969	2307	24545	238511	181239	79363	26989	13463	5092	1913	414	121	23	46
1970	7164	10792	25813	137829	96420	31920	8933	3249	1232	260	106	39	35
1971	7754	13739	11831	9527	59290	52003	12093	2434	762	418	149	42	25
1972	35536	45431	26832	12089	7918	34885	22315	4572	1215	353	315	121	40
1973	294262	131493	61000	20569	7248	8328	19130	4499	677	195	81	59	55
1974	91855	437377	203772	47006	12630	4370	2523	5607	2127	322	151	83	62
1975	45282	59798	226646	118567	29522	9353	2617	1555	1928	575	231	15	37
1976	85337	114341	79993	118236	47872	13962	4051	936	558	442	139	26	53
1977	39594	168609	136335	52925	61821	23338	5659	1521	610	271	122	92	54
1978	78822	45400	88495	56823	25407	31821	9408	1227	913	446	748	48	51
1979	8600	77484	43677	31943	16815	8274	10974	1785	427	103	59	38	45
1980	3911	17086	81986	40061	17664	7442	3508	3196	678	79	24	26	8
1981	3407	9466	20803	63433	21788	9933	4267	1311	882	109	37	3	1
1982	8948	20933	19345	28084	42496	8395	2878	708	271	260	27	5	5
1983	3108	19594	20473	17656	17004	18329	2545	646	229	74	58	20	5
1984	6942	14240	18807	20086	15145	8287	5988	783	232	153	49	12	8
1985	24634	45769	27806	19418	11369	3747	1557	768	137	36	31	32	8
1986	28968	70993	78672	25215	11711	4063	976	726	557	136	28	34	14
1987	13648	137106	98210	61407	13707	3866	910	455	187	227	21	59	20
1988	9828	22774	135347	54379	21015	3304	1236	519	106	69	43	14	5
1989	5085	17313	32165	81756	27854	5501	827	290	41	13	1	11	16
1990	1911	7551	12999	17827	30007	6810	828	179	59	15	6	5	2
1991	4963	10933	16467	20342	19479	25193	3888	428	48	12	1	1	2

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1992	21835	36015	27494	23392	18351	13541	18321	2529	264	82	3	9	1
1993	10094	46182	63578	33623	14866	9449	6571	12593	1749	377	63	22	1
1994	6531	59444	102548	59766	32504	10019	6163	3671	7528	995	121	19	4
1995	4879	42587	115329	98485	32036	7334	3014	1725	1174	1920	222	41	1
1996	7655	28782	80711	100509	54590	10545	2023	930	462	230	809	84	1
1997	12827	36491	69633	83017	65768	28392	4651	1151	373	213	144	238	1
1998	31887	88874	48972	40493	34513	26354	6583	965	197	69	42	22	53
1999	7501	77714	92816	31139	15778	15851	8828	1837	195	40	34	8	30
2000	4701	33094	93044	47210	12671	6677	4787	1647	321	71	11	1	14
2001	5044	35019	62139	62456	22794	5266	1773	1163	343	85	6	7	22
2002	2348	31033	76175	67656	42122	11527	1801	529	223	120	21	9	6
2003	7263	20885	64447	71109	36706	14002	2887	492	142	97	21	43	1
2004	2090	38226	50826	68350	50838	18118	6239	1746	295	127	39	16	8
2005	5815	19768	113144	61665	44777	20553	6285	2348	562	100	21	24	7
2006	8548	47207	33625	78150	31770	15667	7245	1788	737	210	26	45	155
2007	25473	43817	62877	26303	34392	11240	4080	1381	505	285	44	13	35
2008	8459	51704	40656	35072	14037	20676	5503	1794	715	229	42	26	13
2009	4866	38711	83998	46639	20789	8417	8920	1957	872	987	76	21	20
2010	1778	16193	53855	75853	36797	17062	4784	4325	3034	913	189	49	35
2011	1418	8033	32472	70938	73875	21116	11708	5058	3237	600	434	12	0
2012	2695	10462	16646	40372	70014	48315	12326	5214	1926	1124	317	70	24
2013	2903	13659	22752	21020	54231	74451	47124	9143	2963	694	449	89	145
2014	5234	19226	38407	36633	29901	56109	47540	22738	3717	1169	313	210	157
2015	4315	31383	41181	51209	33745	22530	23609	24553	16071	2510	468	134	254
2016	2076	11291	50231	43609	35265	23417	14592	20105	15862	4781	871	249	308
2017	6535	13128	28365	66504	46136	28507	15307	10073	12169	6465	1927	399	285
2018	6120	28569	27128	33816	54328	28323	16208	9722	7132	3740	2295	840	271
2019	4389	21405	48422	29849	26548	39759	17395	8883	4606	2109	715	564	322
2020	3992	22446	37649	52454	31009	20904	23618	11768	6130	1572	591	310	278
2021	2983	17935	54005	59732	59136	22397	14744	13589	4919	1737	678	228	344

Year	Age													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
Norway														
1983	0.41	0.82	1.32	2.05	2.82	3.94	5.53	7.70	9.17	11.46	16.59	16.42	16.96	24.46
1984	1.16	1.47	1.97	2.53	3.13	3.82	4.81	5.95	7.19	7.86	8.46	7.99	9.78	10.64
1985	0.34	0.99	1.43	2.14	3.27	4.68	6.05	7.73	9.86	11.87	14.16	14.17	13.52	15.33
1986	0.30	0.67	1.34	2.04	3.14	4.60	5.78	6.70	7.52	9.74	10.68	12.86	9.59	16.31
1987	0.24	0.48	0.88	1.66	2.72	4.35	6.21	8.78	9.78	12.50	13.75	15.12	10.43	19.95
1988	0.36	0.56	0.83	1.31	2.34	3.84	6.50	8.76	9.97	11.06	14.43	19.02	12.89	10.16
1989	0.53	0.75	0.90	1.17	1.95	3.20	4.88	7.82	9.40	11.52	11.47		19.47	14.68
1990	0.40	0.81	1.22	1.59	2.14	3.29	4.99	7.83	10.54	14.21	17.63	7.97	14.64	
1991	0.63	1.37	1.77	2.31	3.01	3.68	4.63	6.06	8.98	12.89	17.00		14.17	16.63
1992	0.41	1.10	1.79	2.45	3.22	4.33	5.27	6.21	8.10	10.51	11.59		15.81	6.52
1993	0.30	0.83	1.70	2.41	3.35	4.27	5.45	6.28	7.10	7.82	10.10	16.03	19.51	17.68
1994	0.30	0.82	1.37	2.23	3.35	4.27	5.56	6.86	7.45	7.98	9.53	12.16	11.45	19.79
1995	0.44	0.78	1.26	1.87	2.80	4.12	5.15	5.96	7.90	8.67	9.20	11.53	17.77	21.11
1996	0.29	0.90	1.15	1.67	2.58	4.08	6.04	6.62	7.96	9.36	10.55	11.41	9.51	24.24
1997	0.35	0.78	1.14	1.56	2.25	3.48	5.35	7.38	7.55	8.30	11.15	8.64	12.80	
1998	0.38	0.68	1.03	1.64	2.23	3.24	4.85	6.88	9.18	9.84	15.78	14.37	13.77	15.58
1999	0.46	0.88	1.16	1.65	2.40	3.12	4.26	6.00	6.52	10.64	14.05	12.67	9.20	17.22
2000	0.31	0.65	1.23	1.80	2.54	3.58	4.49	5.71	7.54	7.86	12.71	14.71	15.40	20.26
2001	0.30	0.77	1.18	1.83	2.75	3.64	4.88	5.93	7.43	8.90	10.22	11.11	13.03	18.85
2002	0.31	0.90	1.40	1.90	2.60	3.55	4.60	5.80	7.40	9.56	8.71	12.92	8.42	17.61
2003	0.55	0.88	1.39	2.01	2.63	3.59	4.83	5.57	7.262	9.36	9.52	9.52	10.68	21.66
2004	0.54	1.08	1.41	1.95	2.69	3.46	4.77	6.72	7.90	8.66	12.21	14.02	16.50	11.37
2005	0.58	0.92	1.38	1.86	2.61	3.54	4.57	6.41	8.24	9.89	11.04	14.08	11.81	20.08
2006	0.51	0.97	1.45	2.06	2.71	3.56	4.57	5.53	6.61	7.53	8.55	8.44	9.82	12.31
2007	0.53	1.07	1.70	2.37	3.26	4.36	5.45	6.71	8.08	8.56	9.75	11.72	12.72	15.58
2008	0.65	1.12	1.70	2.44	3.32	4.41	5.61	6.84	8.25	9.31	10.54	12.45	13.59	21.15
2009	0.56	0.98	1.47	2.10	2.83	3.90	5.06	5.76	7.31	7.79	7.81	10.68	11.83	14.76
2010	0.55	0.95	1.46	2.06	2.93	4.02	5.40	6.44	7.19	8.43	9.11	10.46	11.39	15.55
2011	0.53	1.09	1.50	2.06	2.85	3.70	5.01	6.26	7.33	8.34	9.87	13.23		
2012		0.83	1.32	1.92	2.65	3.52	4.71	6.34	8.11	9.92	11.31	13.45	15.75	
2013	0.43	0.95	1.40	2.00	2.64	3.44	4.51	5.67	7.29	8.80	10.33	11.38	12.56	
2014	0.59	1.07	1.55	2.15	2.80	3.70	4.57	5.78	6.97	8.35	9.46	10.99	12.28	15.49
2015	0.64	0.96	1.42	1.96	2.57	3.30	4.13	5.49	6.46	7.18	8.63	10.37	12.24	14.60
2016	0.59	0.96	1.46	1.99	2.71	3.57	4.56	5.78	6.82	8.08	9.33	10.01	11.68	14.79
2017	0.55	0.99	1.53	2.06	2.69	3.64	4.72	5.91	6.91	7.88	9.41	10.93	11.78	15.07
2018	0.62	1.05	1.51	2.11	2.80	3.48	4.54	5.80	6.97	7.64	9.11	10.29	11.35	14.05
2019	0.51	0.96	1.43	2.02	2.72	3.60	4.51	5.80	6.91	7.94	8.89	10.94	11.55	14.49
2020	0.58	0.94	1.42	2.01	2.66	3.50	4.59	5.77	7.03	8.46	9.78	10.97	12.74	16.08
2021	0.39	0.75	1.27	1.86	2.55	3.42	4.52	5.86	7.13	8.55	10.09	11.79	12.98	15.75

Table 3.7. Northeast Arctic COD. Weights-at-age (kg) in landings from various countries (continued)

Year	Age													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
Russia (trawl only)														
1983	0.65	1.05	1.58	2.31	3.39	4.87	6.86	8.72	10.40	12.07	14.43			
1984	0.53	0.88	1.45	2.22	3.21	4.73	6.05	8.43	10.34	12.61	14.95			
1985	0.33	0.77	1.31	1.84	2.96	4.17	5.94	6.38	8.58	10.28				
1986	0.29	0.61	1.14	1.75	2.45	4.17	6.18	8.04	9.48	11.33	12.35	14.13		
1987	0.24	0.52	0.88	1.42	2.07	2.96	5.07	7.56	8.93	10.80	13.05	18.16		
1988	0.27	0.49	0.88	1.32	2.06	3.02	4.40	6.91	9.15	11.65	12.53	14.68		
1989	0.50	0.73	1.00	1.39	1.88	2.67	4.06	6.09	7.76	9.88				
1990	0.45	0.83	1.21	1.70	2.27	3.16	4.35	6.25	8.73	10.85	13.52			
1991	0.36	0.64	1.05	2.03	2.85	3.77	4.92	6.13	8.36	10.44	15.84	19.33		
1992	0.55	1.20	1.44	2.07	3.04	4.24	5.14	5.97	7.25	9.28	11.36			
1993	0.48	0.78	1.39	2.06	2.62	4.07	5.72	6.79	7.59	11.26	14.79	17.71		
1994	0.41	0.81	1.24	1.80	2.55	2.88	4.96	6.91	8.12	10.28	12.42	16.93		
1995	0.37	0.77	1.21	1.74	2.37	3.40	4.71	6.73	8.47	9.58	12.03	16.99		
1996	0.30	0.64	1.09	1.60	2.37	3.42	5.30	7.86	8.86	10.87	11.80			
1997	0.30	0.57	1.00	1.52	2.18	3.30	4.94	7.15	10.08	11.87	13.54			
1998	0.33	0.68	1.06	1.60	2.34	3.39	5.03	6.89	10.76	12.39	13.61	14.72		
1999	0.24	0.58	0.98	1.41	2.17	3.26	4.42	5.70	7.27	10.24	14.12			
2000	0.18	0.48	0.85	1.44	2.16	3.12	4.44	5.79	7.49	9.66	10.36			
2001	0.12	0.31	0.62	1.00	1.53	2.30	3.31	4.57	6.55	8.11	9.52	11.99		
2002	0.20	0.60	1.05	1.46	2.14	3.27	4.47	6.23	8.37	10.06	12.37			
2003	0.23	0.63	1.06	1.78	2.40	3.41	4.86	6.28	7.55	11.10	13.41	12.12	14.51	
2004	0.30	0.57	1.09	1.55	2.37	3.20	4.73	6.92	8.41	9.77	11.08			
2005	0.33	0.65	0.98	1.50	2.10	3.08	4.31	5.81	8.42	10.37	13.56	14.13		
2006	0.27	0.68	1.05	1.49	2.25	3.16	4.54	5.90	8.59	10.31	12.31			
2007	0.23	0.67	1.12	1.66	2.25	3.31	4.57	6.27	8.20	10.02	12.36	12.42		
2008	0.28	0.64	1.16	1.74	2.65	3.58	4.74	5.73	7.32	8.07	9.52	12.52		
2009	0.31	0.64	1.09	1.58	2.11	3.19	4.80	6.58	7.97	9.84	11.51			
2010	0.25	0.57	1.00	1.64	2.28	3.14	4.53	5.98	8.03	9.71	10.70	13.53		
2011	0.25	0.62	1.05	1.56	2.18	2.95	4.33	6.21	8.04	10.13	12.25	15.18		
2012	0.29	0.60	1.07	1.66	2.25	2.95	4.17	6.23	8.58	11.08	12.24	14.07	15.22	16.39
2013	0.33	0.63	1.05	1.54	2.26	3.09	4.08	5.47	7.37	9.59	12.57	15.54	17.05	
2014	0.32	0.61	1.05	1.61	2.26	3.15	4.00	5.24	7.13	9.46	11.18	14.47		
2015	0.30	0.60	0.97	1.49	2.11	3.13	4.64	5.78	7.13	9.53	12.12	16.71	17.37	
2016	0.26	0.55	0.97	1.53	2.20	3.19	4.50	6.12	7.97	9.55	10.95	14.35	14.74	17.25
2017	0.33	0.63	1.03	1.56	2.24	3.24	4.67	6.34	7.74	9.40	11.12	14.43	16.67	11.91
2018	0.33	0.68	1.06	1.62	2.40	3.22	4.66	6.23	7.79	8.91	10.26	11.26	13.41	10.14
2019	0.29	0.62	1.10	1.60	2.33	3.22	4.44	6.45	8.10	9.60	11.02	13.83	10.65	10.65
2020	0.27	0.47	0.93	1.44	2.05	2.95	4.28	5.73	7.59	8.45	10.66	12.26	12.18	12.23
2021	0.19	0.44	0.76	1.35	2.02	2.81	4.25	6.26	7.81	9.59	10.67	10.86	13.62	12.31

Table 3.7. Northeast Arctic COD. Weights-at-age (kg) in landings from various countries (continued)

Year	Age													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
Germany (Division IIa and IIb)														
1994		0.68	1.04	2.24	3.49	4.51	5.79	6.93	8.16	8.46	8.74	9.48	15.25	
1995		0.44	0.84	1.5	2.72	3.81	4.46	4.81	7.37	7.69	8.25	9.47		
1996		0.84	1.15	1.64	2.53	3.58	4.13	3.9	4.68	6.98	6.43	11.32		
1997		0.43	0.92	1.42	2.01	3.15	4.04	5.16	4.82	3.96	7.04	8.8		
1998	0.23	0.73	1.17	1.89	2.72	3.25	4.13	5.63	6.5	8.57	8.42	11.45	8.79	
1999[1]		0.853	1.448	1.998	2.65	3.473	4.156	5.447	6.82	5.902		8.01		
2000[2]	0.26	0.73	1.36	2.04	2.87	3.67	4.88	5.78	7.05	8.45	8.67	9.33	6.88	
2001	0.38	0.80	1.21	1.90	2.74	3.90	4.99	5.69	7.15	7.32	11.72	9.11	6.60	
2002	0.35	1.00	1.31	1.80	2.53	3.64	4.38	5.07	6.82	9.21	7.59	13.18	19.17	19.20
2003	0.22	0.44	1.04	1.71	2.31	3.27	4.93	6.17	7.77	9.61	9.99	12.29	13.59	
2004[2]	0.22	0.73	1.01	1.75	2.58	3.33	4.73	6.32	7.20	8.45	9.20	11.99	10.14	13.11
2005[3]	0.57	0.77	1.13	1.66	2.33	3.36	4.38	5.92	6.65	7.26	10.01	11.14		
2006[2]	0.71	0.91	1.39	1.88	2.56	3.77	5.33	6.68	9.14	10.89	11.51	16.83	18.77	
2007[3]	0.59	1.35	1.79	2.51	3.53	4.00	4.95	6.55	7.54	9.71	11.40	11.57	23.34	15.61
2008[3]	0.23	0.51	1.14	1.76	2.57	3.15	4.40	5.43	7.18	8.39	10.15	10.03	10.99	14.26
2009[3]	0.35	0.60	1.19	1.83	2.96	4.08	5.61	6.97	8.55	9.13	10.54	13.34	10.30	17.06
2010[3]	0.36	0.67	0.93	1.71	2.46	3.21	4.93	6.75	7.80	8.70	8.53	10.17	12.36	14.11
2011[1]			1.75	3.09	3.30	3.28	4.13	4.99	6.61	7.91	9.38	10.79	14.67	14.91
2013[3]			1.03	1.37	1.87	2.65	3.45	4.49	7.26	11.42	12.86	13.07		
2014[4]		0.68	0.96	1.39	1.69	3.06	4.07	5.65	8.15	10.36	13.07	13.52		
2015[4]	0.82	1.05	1.67	2.33	3.56	4.50	5.41	6.20	6.39					
2016[1]		1.38	2.60	3.55	4.81	6.33	7.61	8.90	9.26	10.83	13.41	16.84	17.03	17.76
2017[1]		1.58	2.79	3.93	3.93	4.77	6.35	8.16	9.09	10.39	11.24	12.48	14.39	13.04
2018[3]	0.58	1.16	1.76	2.45	3.34	4.13	5.81	7.16	8.99	9.96	10.85	11.73	14.01	17.79
2019[1]		0.82	1.37	1.80	2.26	3.49	4.45	5.44	7.08	9.25	9.39	13.30	12.24	15.25
2020[5]			1.6	1.63	2.48	3.13	5.01	5.93	8.36	9.31	12.16	12.96	12.77	14.08
2021[2]		0.68	1.3	1.52	2.25	3.22	4.58	6.49	7.43	10.37	11.73	14.64	14.34	15.74

[1] Division IIa only
[2] IIa and IIb combined
[3] I,IIa and IIb combined
[4] Division II b only
[5] I and IIa combined

Table 3.7. Northeast Arctic COD. Weights at age (kg) in landings from various countries (continued)

Year	Age													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
Spain (Division IIb)														
1994	0.43	1.08	1.38	2.32	2.47	2.68	3.46	5.20	7.04	6.79	7.20	8.04	10.46	15.35
1995	0.42	0.51	0.98	1.99	3.41	4.95	5.52	8.62	9.21	11.42	9.78	8.08		
1996		0.66	1.12	1.57	2.43	3.17	3.59	4.44	5.48	6.79	8.10			
1997[1]	0.51	0.65	1.22	1.68	2.60	3.39	4.27	6.67	7.88	11.34	13.33	10.03	8.69	
1998	0.47	0.74	1.15	1.82	2.44	3.32	3.71	5.00	7.26					
1999[1]	0.21	0.69	1.06	1.69	2.50	3.32	4.72	5.76	6.77	7.24	7.63			
2000[1]	0.23	0.61	1.24	1.75	2.47	3.12	4.65	6.06	7.66	10.94	11.40	7.20		
2001	0.23	0.64	1.25	1.95	2.86	3.55	4.95	6.46	8.50	11.07	13.09			
2002	0.16	0.55	1.00	1.48	2.17	3.29	4.47	5.35	8.29	12.23	9.01	12.16	15.2	
2003		0.58	1.05	1.70	2.33	3.33	4.92	6.24	9.98	13.07	14.74	14.17		
2004[1]	0.31	0.56	0.80	1.28	1.96	2.59	3.72	5.36	5.28	7.41		11.43		
2005[1]		0.63	1.14	1.85	2.48	3.43	4.25	5.38	8.41	11.19	15.04	16.93		
2006	0.30	0.61	0.99	1.46	2.04	2.55	3.39	3.50	4.70	6.36				
2007	0.42	0.60	1.20	1.76	2.40	3.18	3.96	5.19	6.61	9.48	7.65	12.65	15.74	19.66
2009[1]	0.12	0.45	0.95	1.60	2.18	3.36	4.52	6.04	7.30	9.42	10.35	11.47	12.54	
2010[2]	0.18	0.56	1.11	1.73	2.36	3.36	5.14	6.88	8.64	9.65	6.83			
2011[1]		0.45	0.90	1.26	1.84	2.55	4.08	5.61	8.17	8.14	7.31	8.91		
2012[2]		0.40	0.84	1.29	1.96	2.78	3.71	4.99	7.42		7.19	9.32		
2013	0.17	0.72	1.06	1.63	2.36	3.14	3.90	4.36	6.55					
2014	0.24	0.43	0.74	1.27	1.85	2.60	3.56	4.51	5.52	7.18	9.42	9.26	13.16	15.05
2015[2]		0.40	0.80	1.19	1.79	2.45	3.38	4.41	5.85	6.64	7.48	6.77		
2016[3]	0.11	0.38	0.76	1.20	1.72	2.50	3.39	4.96	7.11	8.56				
2017[2]	0.12	0.42	0.75	1.17	1.69	2.50	3.39	4.47	5.69	5.93	6.00	10.91	13.57	10.52
2018[2]	0.19	0.45	0.83	1.30	1.86	2.57	3.55	4.92	5.51	7.84	7.08	7.28		
2019[2]	0.19	0.39	0.90	1.30	1.85	2.65	3.48	4.83	5.96	5.67	7.04	8.36		
2021[2]		0.36	0.60	1.20	1.83	2.49	3.11	4.55	6.10	6.50	7.03		9.013	17.13
[1] IIa and IIb combined [2] I,IIa and IIb combined [3] I and IIb combined														
Iceland (Sub-area I)														
1994	0.42	0.85	1.44	2.77	3.54	4.08	5.84	6.37	7.02	7.48	7.37			
1995		1.17	0.91	1.60	2.28	3.61	4.73	6.27			6.26			
1996		0.36	0.99	1.55	2.83	3.79	4.81	5.34	7.25	7.68	9.08	8.98	10.52	
1997	0.42	0.43	0.76	1.60	2.40	3.45	4.40	5.74	6.15		8.28	10.52	9.89	
UK (England & Wales)														
1995[1]			1.47	2.11	3.47	5.57	6.43	7.17	8.12	8.05	10.2	10.1		
1996[2]			1.55	1.81	2.42	3.61	6.3	6.47	7.83	7.91	8.93	9.38	10.9	
1997[2]			1.93	2.17	3.07	4.17	4.89	6.46		12.3	8.44			
[1]Division IIa and IIb [2]Division IIa														
Poland (Division IIb)														
2006	0.18	0.51	0.89	1.55	2.23	3.6	5.28	6.95	8.478	11	10.8	15.6	18.9	
2008		0.49	0.90	1.45	2.24	2.79	3.82	4.68	5.015	6.45	7.02	7.22	5.99	6.91
2009			1.02	1.72	2.65	3.81	5.23	6.91	8.862	11.1	13.6	16.5		
2010			1.39	1.66	2.29	2.98	3.92	5.18	6.313	6.66	8.72	9.05		
2011			0.99	1.50	2.17	3.15	4.43	7.45	7.28					
2016[1]		0.84	1.59	2.29	2.81	3.91	4.78	5.61	6.709	7.89	8.54	11.6	13.7	16.09
2017[2]		0.71	1.23	1.52	2.47	3.52	4.78	6.97	9.193	9.95	10.9	14.1		
2018[3]		0.74	1.15	1.66	2.45	3.55	4.48	6.06	6.31	7.59	7.91	8.28	8.52	9.40
2019[1]				1.57	2.00	2.69	4.04	5.61	7.23	9.13	11.62	12.41	13.46	11.47
[1] Division IIa [2] Division IIa and IIb [3] I and IIb combined														

Table 3.8. Northeast Arctic COD. Catch weights at age (kg)

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1946	0.35	0.59	1.11	1.69	2.37	3.17	3.98	5.05	5.92	7.2	8.15	8.13	9.25
1947	0.32	0.56	0.95	1.5	2.14	2.92	3.65	4.56	5.84	7.42	8.85	8.79	10
1948	0.34	0.53	1.26	1.93	2.46	3.36	4.22	5.31	5.92	7.09	8.43	8.18	9.43
1949	0.37	0.67	1.11	1.66	2.5	3.23	4.07	5.27	5.99	7.08	8.22	8.26	8.7
1950	0.39	0.64	1.29	1.7	2.36	3.48	4.52	5.62	6.4	7.96	8.89	9.07	10.27
1951	0.4	0.83	1.39	1.88	2.54	3.46	4.88	5.2	7.14	8.22	9.39	9.5	9.52
1952	0.44	0.8	1.33	1.92	2.64	3.71	5.06	6.05	7.42	8.43	10.19	10.13	10.56
1953	0.4	0.76	1.28	1.93	2.81	3.72	5.06	6.34	7.4	8.67	10.24	11.41	11.93
1954	0.44	0.77	1.26	1.97	3.03	4.33	5.4	6.75	7.79	10.67	9.68	9.56	11.11
1955	0.32	0.57	1.13	1.73	2.75	3.94	4.9	7.04	7.2	8.78	10.08	11.02	12.11
1956	0.33	0.58	1.07	1.83	2.89	4.25	5.55	7.28	8	8.35	9.94	10.25	11.56
1957	0.33	0.59	1.02	1.82	2.89	4.28	5.49	7.51	8.24	9.25	10.61	10.82	12.07
1958	0.34	0.52	0.95	1.92	2.94	4.21	5.61	7.35	8.67	9.58	11.63	11	13.83
1959	0.35	0.72	1.47	2.68	3.59	4.32	5.45	6.44	7.17	8.63	11.62	11.95	13
1960	0.34	0.51	1.09	2.13	3.38	4.87	6.12	8.49	7.79	8.3	11.42	11.72	13.42
1961	0.31	0.55	1.05	2.2	3.23	5.11	6.15	8.15	8.68	9.6	11.95	13.18	13.42
1962	0.32	0.55	0.93	1.7	3.03	5.03	6.55	7.7	9.27	10.56	12.72	13.48	14.44
1963	0.32	0.61	0.96	1.73	3.04	4.96	6.44	7.91	9.62	11.31	12.74	13.19	14.29
1964	0.33	0.55	0.95	1.86	3.25	4.97	6.41	8.07	9.34	10.16	12.89	13.25	14
1965	0.38	0.68	1.03	1.49	2.41	3.52	5.73	7.54	8.47	11.17	13.72	13.46	14.12
1966	0.44	0.74	1.18	1.78	2.46	3.82	5.36	7.27	8.63	10.66	14.15	14	15
1967	0.29	0.81	1.35	2.04	2.81	3.48	4.89	7.11	9.03	10.59	13.83	14.15	16.76
1968	0.33	0.7	1.48	2.12	3.14	4.21	5.27	6.65	9.01	9.66	14.85	16.3	17
1969	0.44	0.79	1.23	2.03	2.9	3.81	5.02	6.43	8.33	10.71	14.21	15	17
1970	0.37	0.91	1.34	2	3	4.15	5.59	7.6	8.97	10.99	14.07	14.61	16
1971	0.45	0.88	1.38	2.16	3.07	4.22	5.81	7.13	8.62	10.83	12.95	14.25	15.97
1972	0.38	0.77	1.43	2.12	3.23	4.38	5.83	7.62	9.52	12.09	13.67	13.85	16
1973	0.38	0.91	1.54	2.26	3.29	4.61	6.57	8.37	10.54	11.62	13.9	14	15.84
1974	0.32	0.66	1.17	2.22	3.21	4.39	5.52	7.86	9.82	11.41	13.24	13.7	14.29
1975	0.41	0.64	1.11	1.9	2.95	4.37	5.74	8.77	9.92	11.81	13.11	14	14.29
1976	0.35	0.73	1.19	2.01	2.76	4.22	5.88	9.3	10.28	11.86	13.54	14.31	14.28
1977	0.49	0.9	1.43	2.05	3.3	4.56	6.46	8.63	9.93	10.9	13.67	14.26	14.91
1978	0.49	0.81	1.45	2.15	3.04	4.46	6.54	7.98	10.15	10.85	13.18	14	15
1979	0.35	0.7	1.24	2.14	3.15	4.29	6.58	8.61	9.22	10.89	14.34	14.5	15.31
1980	0.27	0.56	1.02	1.72	3.02	4.2	5.84	7.26	8.84	9.28	14.45	15	15.5
1981	0.49	0.98	1.44	2.09	2.98	4.85	6.57	9.16	10.82	10.77	13.93	15	16
1982	0.37	0.66	1.35	1.99	2.93	4.24	6.46	8.51	12.24	10.78	14.04	15	16
1983	0.84	1.37	2.09	2.86	3.99	5.58	7.77	9.29	11.55	11.42	12.8	14.18	15.55
1984	1.42	1.93	2.49	3.14	3.91	4.91	6.02	7.4	8.13	11.42	12.8	14.18	15.55
1985	0.94	1.37	2.02	3.22	4.63	6.04	7.66	9.81	11.8	11.42	12.8	14.18	15.55
1986	0.64	1.27	1.88	2.79	4.49	5.84	6.83	7.69	9.81	11.42	12.8	14.18	15.55
1987	0.49	0.88	1.55	2.33	3.44	5.92	8.6	9.6	12.17	11.42	12.8	14.18	15.55
1988	0.54	0.85	1.32	2.24	3.52	5.35	8.06	9.51	11.36	11.42	12.8	14.18	15.55
1989	0.74	0.96	1.31	1.92	2.93	4.64	7.52	9.12	11.08	11.42	12.8	14.18	15.55
1990	0.81	1.22	1.64	2.22	3.24	4.68	7.3	9.84	13.25	11.42	12.8	14.18	15.55
1991	1.05	1.45	2.15	2.89	3.75	4.71	6.08	8.82	11.8	11.42	12.8	14.18	15.55
1992	1.16	1.57	2.21	3.1	4.27	5.19	6.14	7.77	10.12	11.42	12.8	14.18	15.55
1993	0.81	1.52	2.16	2.79	4.07	5.53	6.47	7.19	7.98	11.457	12.8	14.18	15.55
1994	0.82	1.3	2.06	2.89	3.21	5.2	6.8	7.57	8.01	9.955	13.012	14.18	15.55
1995	0.77	1.2	1.78	2.59	3.81	4.99	6.23	8.05	8.74	9.774	11.388	14.546	15.55
1996	0.79	1.11	1.61	2.46	3.82	5.72	6.74	8.04	9.28	10.451	11.19	12.819	16.045
1997	0.67	1.04	1.53	2.22	3.42	5.2	7.19	7.73	8.61	11.145	11.926	12.608	14.234

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1998	0.68	1.05	1.62	2.3	3.3	4.86	6.87	9.3	10.3	10.754	12.676	13.394	14.011
1999	0.63	1.01	1.54	2.34	3.21	4.29	6	6.73	10.08	11.151	12.255	14.191	14.839
2000	0.57	1.04	1.61	2.34	3.34	4.48	5.72	7.52	8.02	11.93	12.682	13.743	15.675
2001	0.66	1.05	1.62	2.51	3.51	4.78	6.04	7.54	9	10.23	13.519	14.197	15.206
2002	0.72	1.13	1.56	2.31	3.52	4.78	6.2	7.66	9.14	10.379	11.687	15.081	15.681
2003	0.67	1.12	1.83	2.5	3.58	5.04	6.36	8.2	10.71	10.167	11.848	13.138	16.602
2004	0.72	1.13	1.61	2.43	3.27	4.72	6.71	7.98	9.19	10.84	11.619	13.31	14.571
2005	0.69	1.08	1.57	2.21	3.26	4.44	6.23	8.19	9.72	10.626	12.347	13.066	14.752
2006	0.72	1.16	1.6	2.39	3.32	4.54	5.47	6.78	7.7	10.8	12.116	13.842	14.494
2007	0.74	1.21	1.83	2.51	3.82	5.04	6.58	8.08	8.94	10.349	12.304	13.596	15.309
2008	0.77	1.27	1.87	2.82	3.79	5.12	6.22	7.75	8.4	10.139	11.816	13.795	15.052
2009	0.75	1.17	1.74	2.42	3.86	5.35	6.43	8.01	8.67	10.055	11.588	13.276	15.261
2010	0.78	1.2	1.74	2.44	3.4	5.04	6.25	7.32	8.53	10.378	11.496	13.033	14.715
2011	0.78	1.31	1.72	2.37	3.2	4.62	6.18	7.47	8.57	10.387	11.847	12.935	14.459
2012	0.67	1.14	1.73	2.34	3.12	4.4	6.28	8.24	10.35	10.367	11.857	13.309	14.356
2013	0.71	1.17	1.67	2.36	3.19	4.22	5.58	7.31	9.08	11.029	11.835	13.32	14.75
2014	0.79	1.2	1.73	2.34	3.28	4.21	5.49	6.98	8.67	10.823	12.551	13.297	14.761
2015	0.78	1.09	1.55	2.18	3.14	4.46	5.61	6.62	7.34	10.215	12.328	14.058	14.737
2016	0.78	1.14	1.66	2.26	3.25	4.5	5.98	7.31	8.54	9.372	11.67	13.822	15.536
2017	0.71	1.15	1.66	2.32	3.32	4.67	6.13	7.15	8.14	9.597	10.752	13.121	15.288
2018	0.86	1.17	1.71	2.5	3.31	4.61	6.03	7.32	8.06	9.707	10.998	12.137	14.552
2019	0.68	1.15	1.66	2.39	3.33	4.45	6.11	7.29	8.41	9.806	11.117	12.401	13.513
2020	0.709	1.084	1.604	2.195	3.092	4.39	5.731	7.218	8.406	9.989	11.226	12.529	13.793
2021	0.527	0.896	1.487	2.159	2.982	4.364	6.048	7.348	8.796	9.991	11.424	12.645	13.928

Table 3.9. Northeast Arctic COD. Stock weights at age (kg)

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1946	0.35	0.59	1.11	1.69	2.37	3.17	3.98	5.05	5.92	7.2	8.146	8.133	9.253
1947	0.32	0.56	0.95	1.5	2.14	2.92	3.65	4.56	5.84	7.42	8.848	8.789	9.998
1948	0.34	0.53	1.26	1.93	2.46	3.36	4.22	5.31	5.92	7.09	8.43	8.181	9.433
1949	0.37	0.67	1.11	1.66	2.5	3.23	4.07	5.27	5.99	7.08	8.218	8.259	8.701
1950	0.39	0.64	1.29	1.7	2.36	3.48	4.52	5.62	6.4	7.96	8.891	9.07	10.271
1951	0.4	0.83	1.39	1.88	2.54	3.46	4.88	5.2	7.14	8.22	9.389	9.502	9.517
1952	0.44	0.8	1.33	1.92	2.64	3.71	5.06	6.05	7.42	8.43	10.185	10.134	10.563
1953	0.4	0.76	1.28	1.93	2.81	3.72	5.06	6.34	7.4	8.67	10.238	11.409	11.926
1954	0.44	0.77	1.26	1.97	3.03	4.33	5.4	6.75	7.79	10.67	9.68	9.557	11.106
1955	0.32	0.57	1.13	1.73	2.75	3.94	4.9	7.04	7.2	8.78	10.077	11.023	12.105
1956	0.33	0.58	1.07	1.83	2.89	4.25	5.55	7.28	8	8.35	9.944	10.248	11.564
1957	0.33	0.59	1.02	1.82	2.89	4.28	5.49	7.51	8.24	9.25	10.605	10.825	12.075
1958	0.34	0.52	0.95	1.92	2.94	4.21	5.61	7.35	8.67	9.58	11.631	11	13.832
1959	0.35	0.72	1.47	2.68	3.59	4.32	5.45	6.44	7.17	8.63	11.621	11.95	13
1960	0.34	0.51	1.09	2.13	3.38	4.87	6.12	8.49	7.79	8.3	11.422	11.719	13.424
1961	0.31	0.55	1.05	2.2	3.23	5.11	6.15	8.15	8.68	9.6	11.952	13.181	13.422
1962	0.32	0.55	0.93	1.7	3.03	5.03	6.55	7.7	9.27	10.56	12.717	13.482	14.44
1963	0.32	0.61	0.96	1.73	3.04	4.96	6.44	7.91	9.62	11.31	12.737	13.193	14.287
1964	0.33	0.55	0.95	1.86	3.25	4.97	6.41	8.07	9.34	10.16	12.886	13.251	14
1965	0.38	0.68	1.03	1.49	2.41	3.52	5.73	7.54	8.47	11.17	13.722	13.465	14.118
1966	0.44	0.74	1.18	1.78	2.46	3.82	5.36	7.27	8.63	10.66	14.148	14	15
1967	0.29	0.81	1.35	2.04	2.81	3.48	4.89	7.11	9.03	10.59	13.829	14.146	16.756
1968	0.33	0.7	1.48	2.12	3.14	4.21	5.27	6.65	9.01	9.66	14.848	16.3	17
1969	0.44	0.79	1.23	2.03	2.9	3.81	5.02	6.43	8.33	10.71	14.211	15	17

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1970	0.37	0.91	1.34	2	3	4.15	5.59	7.6	8.97	10.99	14.074	14.611	16
1971	0.45	0.88	1.38	2.16	3.07	4.22	5.81	7.13	8.62	10.83	12.945	14.25	15.973
1972	0.38	0.77	1.43	2.12	3.23	4.38	5.83	7.62	9.52	12.09	13.673	13.852	16
1973	0.38	0.91	1.54	2.26	3.29	4.61	6.57	8.37	10.54	11.62	13.904	14	15.841
1974	0.32	0.66	1.17	2.22	3.21	4.39	5.52	7.86	9.82	11.41	13.242	13.704	14.291
1975	0.41	0.64	1.11	1.9	2.95	4.37	5.74	8.77	9.92	11.81	13.107	14	14.293
1976	0.35	0.73	1.19	2.01	2.76	4.22	5.88	9.3	10.28	11.86	13.544	14.311	14.284
1977	0.49	0.9	1.43	2.05	3.3	4.56	6.46	8.63	9.93	10.9	13.668	14.255	14.906
1978	0.49	0.81	1.45	2.15	3.04	4.46	6.54	7.98	10.15	10.85	13.177	14	15
1979	0.35	0.7	1.24	2.14	3.15	4.29	6.58	8.61	9.22	10.89	14.344	14.5	15.315
1980	0.27	0.56	1.02	1.72	3.02	4.2	5.84	7.26	8.84	9.28	14.448	15	15.5
1981	0.49	0.98	1.44	2.09	2.98	4.85	6.57	9.16	10.82	10.77	13.932	15	16
1982	0.37	0.66	1.35	1.99	2.93	4.24	6.46	8.51	12.24	10.78	14.041	15	16
1983	0.37	0.92	1.6	2.44	3.82	4.76	6.17	7.7	9.25	12.621	14.544	16.466	18.388
1984	0.42	1.16	1.81	2.79	3.78	4.57	6.17	7.7	9.25	12.621	14.544	16.466	18.388
1985	0.413	0.875	1.603	2.81	4.059	5.833	7.685	10.117	14.29	12.621	14.544	16.466	18.388
1986	0.311	0.88	1.47	2.467	3.915	5.81	6.58	6.833	11.004	12.621	14.544	16.466	18.388
1987	0.211	0.498	1.254	2.047	3.431	5.137	6.523	9.3	13.15	12.621	14.544	16.466	18.388
1988	0.212	0.404	0.79	1.903	2.977	4.392	7.812	12.112	13.107	12.621	14.544	16.466	18.388
1989	0.299	0.52	0.868	1.477	2.686	4.628	7.048	9.98	9.25	12.621	14.544	16.466	18.388
1990	0.398	0.705	1.182	1.719	2.458	3.565	4.71	7.801	8.956	12.621	14.544	16.466	18.388
1991	0.518	1.136	1.743	2.428	3.214	4.538	6.88	10.719	9.445	12.621	14.544	16.466	18.388
1992	0.44	0.931	1.812	2.716	3.895	5.176	6.774	9.598	12.427	12.621	14.544	16.466	18.388
1993	0.344	1.172	1.82	2.823	4.031	5.497	6.765	8.571	10.847	12.621	14.544	16.466	18.388
1994	0.237	0.757	1.419	2.458	3.845	5.374	6.648	7.653	8.136	12.916	16.114	16.466	18.388
1995	0.197	0.487	1.141	2.118	3.504	4.915	6.949	9.051	9.775	11.409	15.248	18.62	18.388
1996	0.206	0.482	0.98	2.041	3.52	5.507	7.74	9.922	10.63	12.093	13.533	17.659	21.171
1997	0.211	0.537	1.11	1.876	3.381	5.258	8.546	10.653	10.776	13.232	14.313	15.745	20.122
1998	0.242	0.561	1.179	1.936	2.944	4.583	7.092	10.7	12.042	13.771	15.607	16.617	18.021
1999	0.209	0.514	1.183	2.007	3.037	4.479	6.512	10.028	11.117	14.698	16.215	18.057	18.981
2000	0.194	0.465	1.218	1.963	3.064	4.12	5.746	7.157	9.961	14.589	17.26	18.733	20.557
2001	0.284	0.513	1.21	2.25	3.299	5.066	6.373	9.29	11.456	13.317	17.138	19.887	21.294
2002	0.23	0.603	1.184	2.138	3.336	4.81	6.912	8.809	10.475	12.534	15.703	19.752	22.549
2003	0.233	0.551	1.317	2.022	3.239	4.984	6.727	8.422	14.226	12.524	14.815	18.164	22.403
2004	0.24	0.55	1.074	2.038	2.911	4.402	6.263	8.535	10.197	12.371	14.803	17.176	20.674
2005	0.225	0.61	1.083	1.87	3.002	3.971	5.789	8.127	12.759	12.611	14.63	17.163	19.594
2006	0.252	0.591	1.219	2.014	3.028	4.434	5.999	7.774	9.954	13.679	14.902	16.97	19.58
2007	0.249	0.663	1.329	2.127	3.183	4.59	6.477	8.88	12.124	12.261	16.111	17.274	19.368
2008	0.286	0.726	1.418	2.41	3.331	4.914	6.747	8.851	10.393	12.776	14.504	18.617	19.701
2009	0.274	0.652	1.353	2.312	3.803	5.103	6.75	9.252	10.119	12.323	15.09	16.83	21.168
2010	0.258	0.608	1.208	2.01	3.088	4.903	6.498	7.992	9.689	12.467	14.574	17.483	19.214
2011	0.225	0.6	1.097	1.926	2.861	4.403	6.531	8.648	9.885	12.508	14.738	16.909	19.929
2012	0.227	0.555	1.182	1.834	2.831	4.124	6.056	8.584	11.498	12.249	14.785	17.092	19.3
2013	0.247	0.577	1.134	1.998	2.841	4.015	5.523	8.077	10.304	13.207	14.491	17.144	19.501
2014	0.216	0.577	1.137	1.791	2.781	3.85	5.245	6.992	9.378	12.746	15.578	16.816	19.558
2015	0.229	0.54	1.134	1.934	2.753	4.081	5.315	7.135	8.947	11.778	15.056	18.025	19.198
2016	0.21	0.536	1.001	1.812	2.72	3.958	5.64	7.064	8.569	10.885	13.954	17.445	20.522
2017	0.255	0.675	1.107	1.896	2.826	4.158	5.7	7.628	9.071	10.634	12.934	16.216	19.888
2018	0.286	0.62	1.188	1.949	2.768	4.059	5.749	7.38	9.097	10.8	12.646	15.073	18.54
2019	0.24	0.603	1.085	1.82	3.025	4.296	5.891	7.293	9.667	11.186	12.837	14.749	17.28
2020	0.148	0.503	1.055	1.692	2.59	4.064	5.617	7.673	9.313	11.306	13.278	14.964	16.922
2021	0.17	0.437	0.954	1.718	2.669	3.804	5.822	7.396	9.334	11.187	13.415	15.459	17.159
2022	0.293	0.48	0.929	1.616	2.741	3.933	5.744	8.012	9.648	11.255	13.279	15.613	17.706

Table 3.10. Northeast Arctic COD. Basis for maturity ogives (percent) used in the assessment. Norwegian and Russian data.

Norway								
	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1982	0	5	10	34	65	82	92	100
1983	5	8	10	30	73	88	97	100
Russia								
	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1984	0	5	18	31	56	90	99	100
1985	0	1	10	33	59	85	92	100
1986	0	2	9	19	56	76	89	100
1987	0	1	9	23	27	61	81	80
1988	0	1	3	25	53	79	100	100
1989	0	0	2	15	39	59	83	100
1990	0	2	6	20	47	62	81	95
1991	0	3	1	23	66	82	96	100
1992	0	1	8	31	73	92	95	100
1993	0	3	7	21	56	89	95	99
1994	0	1	8	30	55	84	95	98
1995	0	0	4	23	61	75	94	97
1996	0	0	1	22	56	82	95	100
1997	0	0	1	10	48	73	90	100
1998	0	0	2	15	47	87	97	96
1999	0	0.2	1.3	9.9	38.4	74.9	94	100
2000	0	0	6	19.2	51.4	84	95.5	100
2001	0.1	0.1	3.9	27.9	62.3	89.4	96.3	100
2002	0.1	1.9	10.9	34.4	68.1	82.8	97.6	100
2003	0.2	0	11	29.2	65.9	89.6	95.1	100
2004	0	0.7	8	33.8	63.3	83.4	96.4	96.4
2005	0	0.6	4.6	24.2	61.5	84.9	95.3	98.1
2006	0	0	6.1	29.6	59.6	89.5	96.4	100
2007	0	0.4	5.7	20.8	60.4	83.5	96	100

2008	0	0.5	4	24.6	48.3	84.4	94.7	98.7
2009	0	0	6	28	66	85	97	100
2010	0	0.2	1.5	22.8	47	77.4	90.2	95.5
2011	0	0	2.2	20.7	50.4	73.7	90.6	95.6
2012	0.2	0	1.5	10.8	43.9	76.1	90.8	96.4
2013	0	0	0.6	10.6	41.8	70.6	89.8	96.9
2014	0	0	1.9	14.1	45.9	76	92	97.5
2015	0	0.2	0.2	7.9	27	60.8	83.4	93.7
2016	0	0	0.2	5.2	22.4	44.1	74.8	92.5
2017*	0	0	0.8	6.3	20.8	51.6	80.4	98.6
2018	0	0.5	2.5	23.6	53.9	79.4	92.5	96.0
2019**	0	0	4.5	11.9	56.4	91.8	95.1	100
2020**	0	0.4	1.7	15.8	43.8	71.2	74.9	84.9
2021**	0	0	2.7	16.1	44.1	72.2	87.1	88.1
2022**	0	0	0.8	11.6	59.7	72.6	80.4	96.2

***Not used in inputs (instead ratios presented in WD 10, 2017 used for further calculations) **Not used in inputs (instead ratios presented in WD 15, 2019 used for further calculations)**

Norway								
	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1985	0.31	1.36	8.94	38.33	51.27	85.13	100	79.2
1986	2.92	7	7.85	18.85	49.72	66.52	35.59	80.09
1987	0	0.07	4.49	12.42	16.28	31.23	19.32	
1988	0	2.35	6.16	40.54	53.63	45.36	100	100
1989	1.52	0.67	3.88	30.65	70.36	82.02	100	100
1990	1.52	0.67	4.18	22	57.45	80.95	100	100
1991	0.1	3.4	13.93	38.03	75.52	90.12	95.39	100
1992	0.22	1.85	21.04	52.83	86.95	96.52	99.83	100
1993	0	2.6	10.37	52.6	84.8	97.25	99.3	99.73
1994	0.51	0.33	15.78	36.92	62.84	88.44	97.56	100
1995	0	0.62	8.19	51.48	63.75	81.11	98.01	99.34
1996	0.03	0	2.82	29.56	70.22	82.06	100	100
1997	0	0	1.48	17.91	73.31	93.01	99.12	100
1998	0.12	0.68	3.17	15.42	47.31	75.73	94.3	100
1999	0.42	0.16	1.6	27.46	70.48	94.57	98.99	100
2000	0	0.11	8.15	30.23	77.3	81.95	100	100
2001	0.49	0.51	9.03	43.81	62.52	74.36	94.13	100
2002	0.27	0.73	5.94	43.22	68.4	85.31	92.52	100
2003	0.02	0.18	6.5	35.97	68.56	87.97	96.3	100

2004	0.24	1.36	10.23	54.56	81.84	90.94	98.76	98.91
2005	0	0.27	9	55.16	81.77	93.51	98.03	100
2006	0	0.22	5.92	44.25	69.85	89.89	96.65	100
2007	0.12	0.33	8.7	47.88	84.29	91.68	99.11	100
2008	0	0.27	9.27	34.13	61.39	88.04	91.17	100
2009	0	0	9	46	85	86	98	99
2010	0	0.36	7.5	41.75	67.7	90.1	95.29	98.55
2011	0	0.2	5.2	48	77.7	89.7	97.3	97.2
2012	0	0	7.7	32.2	67.5	81	90.9	96.3
2013	0	0.3	1	20.2	55.3	80	91.8	99.3
2014	0	0.4	2	13.3	56.7	85	93.8	98.7
2015	0	0	1.9	10.9	29.2	79.1	93.1	99.6
2016	0.07	0. 2	1.0	6.4	28.5	71.3	86. 1	98.6
2017	0	0.2	0.5	18	54.8	81.4	95.9	100
2018	0	0.1	3.0	16.2	38.3	61.0	93.7	98.9
2019	0	0. 4	4 .0	24 . 0	6 8. 6	93 . 2	9 6 .7	9 9 . 8
2020	0	0.44	3.18	13.68	42.51	80.06	91.18	94.03
2021	0.28	0.25	0.79	17.11	43.21	68.80	90.75	98.63
2022	1.55	0	1.19	9.54	44.22	70.17	77.19	98.50

Table 3.11. Northeast Arctic cod. Proportion mature-at-age

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1946	0	0	0.01	0.03	0.06	0.11	0.18	0.44	0.65	0.86	0.96	0.96	1
1947	0	0	0.01	0.03	0.06	0.13	0.16	0.42	0.75	0.91	0.95	1	1
1948	0	0	0.01	0.03	0.07	0.13	0.25	0.47	0.73	0.91	0.97	1	1
1949	0	0	0.01	0.03	0.09	0.17	0.29	0.54	0.79	0.88	0.97	1	1
1950	0	0	0.01	0.03	0.09	0.23	0.35	0.52	0.79	0.95	0.97	1	1
1951	0	0	0.01	0.03	0.1	0.24	0.4	0.58	0.72	0.85	0.96	1	1
1952	0	0	0.01	0.03	0.08	0.22	0.41	0.63	0.82	0.92	0.97	1	1
1953	0	0	0.01	0.03	0.07	0.19	0.4	0.64	0.84	0.94	0.97	1	1
1954	0	0	0.01	0.03	0.08	0.16	0.37	0.68	0.87	0.93	0.96	1	1
1955	0	0	0.01	0.03	0.07	0.13	0.26	0.53	0.83	0.92	0.97	1	1
1956	0	0	0.01	0.03	0.06	0.12	0.14	0.41	0.67	0.91	0.96	1	1
1957	0	0	0.01	0.03	0.06	0.09	0.12	0.22	0.6	0.82	0.97	1	1
1958	0	0	0.01	0.03	0.06	0.1	0.1	0.3	0.5	0.82	0.97	1	1
1959	0	0	0.01	0.04	0.12	0.34	0.49	0.67	0.84	0.87	1	1	1
1960	0	0.01	0.03	0.06	0.1	0.19	0.45	0.69	0.77	0.85	0.99	1	1
1961	0	0	0.01	0.06	0.12	0.31	0.65	0.91	0.98	0.98	1	0.96	1
1962	0	0	0.01	0.05	0.15	0.34	0.61	0.81	0.92	0.97	1	0.932	1
1963	0	0.01	0.01	0.03	0.07	0.28	0.42	0.81	0.98	0.98	1	0.966	1
1964	0	0	0	0.03	0.13	0.37	0.66	0.89	0.95	0.99	1	1	1
1965	0	0	0	0.01	0.06	0.2	0.55	0.73	0.99	0.98	1	1	1
1966	0	0	0.01	0.02	0.06	0.22	0.35	0.74	0.94	0.94	1	1	1
1967	0	0	0	0.03	0.07	0.14	0.38	0.64	0.89	0.9	1	1	1
1968	0	0	0.03	0.05	0.09	0.19	0.39	0.58	0.82	1	1	1	1
1969	0	0	0	0.02	0.04	0.12	0.34	0.55	0.74	0.95	1	1	1
1970	0	0.01	0	0.01	0.07	0.23	0.58	0.81	0.89	0.91	1	1	1
1971	0	0	0.01	0.05	0.11	0.3	0.59	0.79	0.86	0.88	1	1	1

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1972	0.01	0.02	0.02	0.01	0.1	0.34	0.64	0.81	0.94	1	1	1	1
1973	0	0	0	0.02	0.16	0.53	0.81	0.92	0.95	0.98	1	1	1
1974	0	0	0	0.01	0.03	0.21	0.5	0.96	1	0.96	1	1	1
1975	0	0	0.01	0.02	0.09	0.21	0.56	0.78	0.79	0.95	1	1	1
1976	0	0	0	0.05	0.12	0.29	0.45	0.84	0.83	1	0.9	1	1
1977	0	0	0.02	0.08	0.26	0.54	0.76	0.87	0.93	0.94	0.9	1	1
1978	0	0	0	0.02	0.13	0.44	0.71	0.77	0.81	0.89	0.8	1	1
1979	0	0	0	0.03	0.13	0.39	0.77	0.89	0.83	0.78	0.9	1	1
1980	0	0	0	0.02	0.13	0.35	0.65	0.82	1	0.9	0.9	1	1
1981	0	0	0.02	0.07	0.2	0.54	0.8	0.97	1	1	1	1	1
1982	0	0.05	0.1	0.34	0.65	0.82	0.92	1	1	1	1	1	1
1983	0.01	0.08	0.1	0.3	0.73	0.88	0.97	1	1	1	1	1	1
1984	0	0.05	0.18	0.31	0.56	0.9	0.99	1	1	1	1	1	1
1985	0	0.01	0.09	0.36	0.55	0.85	0.96	0.9	1	1	1	1	1
1986	0	0.05	0.08	0.19	0.53	0.71	0.62	0.9	1	1	1	1	1
1987	0	0.01	0.07	0.18	0.22	0.46	0.5	0.75	1	1	1	1	1
1988	0	0.02	0.05	0.33	0.53	0.62	1	1	1	1	1	1	1
1989	0.008	0.003	0.029	0.228	0.547	0.705	0.915	1	1	1	1	1	1
1990	0.008	0.013	0.051	0.21	0.522	0.715	0.905	0.975	1	1	1	1	1
1991	0.001	0.032	0.075	0.305	0.708	0.861	0.957	1	1	1	1	1	1
1992	0.001	0.014	0.145	0.419	0.8	0.943	0.974	1	1	1	1	1	1
1993	0	0.028	0.087	0.368	0.704	0.931	0.972	0.994	1	1	1	1	1
1994	0	0.005	0.119	0.336	0.583	0.876	0.965	0.99	1	1	1	1	1
1995	0	0.005	0.06	0.373	0.614	0.748	0.955	0.98	1	1	1	1	1
1996	0	0	0.016	0.252	0.619	0.817	0.975	1	1	1	1	1	1
1997	0	0	0.014	0.14	0.597	0.842	0.95	0.967	1	1	1	1	1
1998	0	0.005	0.031	0.168	0.468	0.828	0.956	0.98	1	1	1	1	1
1999	0	0.001	0.014	0.17	0.506	0.841	0.961	1	1	1	1	1	1
2000	0	0	0.066	0.261	0.699	0.872	0.978	1	1	1	1	1	1
2001	0.001	0.006	0.069	0.378	0.646	0.851	0.955	1	1	1	1	1	1
2002	0.001	0.015	0.085	0.412	0.695	0.846	0.97	1	1	1	1	1	1
2003	0.001	0	0.089	0.331	0.662	0.882	0.96	1	1	1	1	1	1
2004	0	0.009	0.092	0.438	0.728	0.883	0.973	0.974	1	1	1	1	1
2005	0	0.003	0.066	0.366	0.72	0.897	0.971	0.991	1	1	1	1	1
2006	0	0.015	0.061	0.367	0.633	0.907	0.961	1	1	1	1	1	1
2007	0	0.007	0.076	0.37	0.719	0.884	0.977	1	1	1	1	1	1
2008	0.005	0.008	0.082	0.309	0.539	0.869	0.928	0.994	1	1	1	1	1
2009	0	0	0.081	0.362	0.745	0.859	0.978	0.997	0.994	1	1	1	1
2010	0.005	0.006	0.06	0.335	0.552	0.838	0.931	0.971	0.983	1	1	1	1
2011	0	0	0.04	0.339	0.644	0.798	0.932	0.963	0.991	1	1	1	1
2012	0.001	0	0.058	0.209	0.544	0.799	0.93	0.967	0.99	1	1	1	1
2013	0	0	0.01	0.156	0.482	0.763	0.913	0.982	0.985	1	1	1	1
2014	0	0	0.025	0.137	0.516	0.806	0.935	0.984	0.996	1	1	1	1
2015	0	0.001	0.004	0.074	0.282	0.681	0.891	0.963	0.984	1	1	1	1
2016	0	0	0.002	0.057	0.256	0.569	0.832	0.955	0.984	1	1	1	1
2017	0	0.018	0.003	0.148	0.463	0.749	0.931	0.99	1	1	1	1	1
2018	0	0.003	0.028	0.207	0.478	0.731	0.916	0.971	1	1	1	1	1
2019	0	0	0.01	0.126	0.466	0.842	0.942	0.968	0.996	1	1	1	1
2020	0	0	0.014	0.112	0.356	0.775	0.904	0.955	1	1	1	1	1
2021	0.002	0.002	0.006	0.14	0.386	0.657	0.893	0.974	0.959	1	1	1	1
2022	0.014	0	0.01	0.079	0.402	0.674	0.756	0.975	1	1	1	1	1

Table 3.12. The Northeast Arctic cod stock's consumption of cod in million individuals

Year/age	0	1	2	3	4	5	6
1984	0.000	444.762	22.413	0.215	0.000	0.000	0.000
1985	1640.656	355.672	71.640	0.197	0.000	0.000	0.000
1986	69.757	1124.070	344.039	87.494	0.000	0.000	0.000
1987	653.270	195.414	327.523	14.417	0.000	0.000	0.000
1988	32.270	486.636	26.545	1.794	0.000	0.000	0.000
1989	951.957	142.708	0.000	0.000	0.000	0.000	0.000
1990	0.000	109.640	23.395	0.000	0.000	0.000	0.000
1991	118.283	138.556	182.041	1.618	0.000	0.000	0.000
1992	3146.005	895.002	143.733	4.186	0.000	0.000	0.000
1993	3873.449	18295.167	481.048	46.764	1.310	0.421	0.000
1994	7995.878	7040.209	651.179	130.171	49.810	7.942	0.414
1995	8203.729	14920.465	760.378	211.699	67.237	3.747	0.224
1996	10262.163	21819.039	1477.810	136.650	52.797	18.510	1.073
1997	3085.037	17766.618	1906.346	165.963	15.744	1.222	0.221
1998	93.400	5763.644	582.473	205.453	23.546	1.464	0.469
1999	638.739	2123.471	305.400	50.915	4.206	0.004	0.000
2000	1922.963	2563.006	189.068	38.518	14.035	3.856	0.042
2001	94.754	2404.601	114.855	23.869	11.687	1.802	0.923
2002	7577.578	457.445	405.246	41.402	5.339	0.811	0.017
2003	5410.402	4128.090	107.755	24.181	0.000	0.000	0.000
2004	6508.732	2408.361	568.160	20.494	10.483	1.329	0.226
2005	2482.844	3044.786	133.839	80.494	4.571	5.544	0.515
2006	3337.557	2142.281	151.324	6.303	2.034	0.075	0.000
2007	2303.122	1155.510	190.498	75.021	3.467	0.129	0.000
2008	14440.722	705.310	86.363	97.361	32.164	4.257	0.000
2009	9638.868	7372.324	143.606	67.084	20.765	5.160	0.221
2010	4184.771	7169.263	302.549	54.174	28.158	17.068	2.263
2011	12568.831	4440.178	454.816	174.000	41.050	10.833	5.172
2012	21164.775	11987.450	1023.341	102.819	31.120	4.405	0.000
2013	26821.152	4829.477	1570.783	176.292	17.040	7.576	1.143
2014	36459.076	6138.927	739.187	196.524	53.594	5.211	0.064
2015	1561.202	10659.102	310.688	68.954	40.190	17.007	1.676
2016	12135.291	2572.774	508.646	12.104	18.929	27.716	6.542
2017	21969.340	1627.847	395.871	119.199	8.193	4.490	3.073
2018	7518.078	13952.051	284.751	36.890	2.311	0.280	0.000
2019	892.162	8908.822	873.433	57.069	6.070	0.019	0.000
2020	3533.239	3025.881	360.127	158.725	47.745	11.827	0.613
2021	25896.500	1928.189	258.702	79.301	28.025	16.039	1.928

Table 3.13. Northeast Arctic COD. Tuning data

North-East Arctic cod (Sub-areas I and II) (run name: XSAASA01)										
104										
FLT15_I: NorBarTrSur_I										
1981	2022									
1	1	0.085	0.189							
3	12									
1	1640	2330	4000	3840	480	100	30	NA	NA	NA
1	2830	2770	2360	1550	1600	140	20	NA	NA	NA
1	2495	5234	4333	1696	582	321	97	NA	NA	NA
1	9749	2828	2144	1174	407	40	8	NA	NA	NA
1	16679	12598	1992	767	334	21	7	NA	NA	NA
1	80500	14393	6414	830	191	34	4	NA	NA	NA
1	24038	39115	5435	1570	200	45	3	NA	NA	NA
1	14803	8049	17331	2048	358	53	3	NA	NA	NA
1	4636	7586	3779	9019	982	94	10	NA	NA	NA
1	2835	3487	3459	2056	2723	161	38	NA	NA	NA
1	4585	3367	2565	2149	1215	1267	61	NA	NA	NA
1	15826	5771	1782	1283	767	429	272	NA	NA	NA
1	27389	14013	7248	1583	624	389	223	NA	NA	NA
1	29392	30704	15333	4572	795	261	148	55	55	13
1	28284	24236	25101	7642	1798	242	107	50	61	19
1	16308	11743	13859	10888	2443	264	37	17	12	16
1	31799	6844	7426	5999	2667	485	64	91	8	NA
1	35510	16694	3167	2615	1752	816	79	52	4	4
1	18848	18075	6139	1271	681	514	101	26	2	6
1	24581	13003	11173	2675	456	184	121	33	10	5
1	18279	19511	8290	3796	945	117	44	19	4	1
1	11836	13756	10895	4579	1440	220	32	18	5	2
1	37670	12631	9393	6688	1750	467	102	17	4	4
1	6388	18462	5346	4324	3059	685	165	28	7	2
1	24888	5506	10297	2238	1636	381	92	30	4	10
1	11649	11538	2832	4342	1372	524	136	24	18	18
1	36113	12773	6851	1365	2360	682	230	41	11	10
1	19437	30059	11190	4024	1734	811	179	36	3	3
1	12628	19670	22023	6069	1790	902	524	51	17	7
1	3681	11425	15480	14450	3956	1124	367	160	58	12
1	8540	5037	12970	13866	10351	1637	436	120	82	39
1	7572	6459	3371	9069	13258	4861	902	226	88	111
1	6884	11409	6318	4043	6454	7638	3352	222	287	84
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FLT15_II: NorBarTrSur_II										
2014	2022									
1	1	0.085	0.189							
3	12									
1	22685	9379	8859	5639	3274	5305	3619	981	101	120
1	14407	22825	14729	11353	7443	2922	5351	1808	338	98
1	9937	13548	18831	11347	7233	2856	1317	1606	677	180
1	17925	6215	8454	9016	3782	2633	818	326	261	451
1	13941	18478	6181	6417	7388	2588	928	587	129	419
1	28157	17915	22190	7965	3296	3831	815	262	54	70
1	23773	16024	13156	11488	4983	2426	2044	453	166	243
1	11150	11935	11231	5428	3798	1357	727	353	125	103
1	5198	8868	8660	6651	4460	3042	570	229	208	255

FLT16: NorBarLofAcSur										
1985		2022								
1	1	0.085	0.26							
3	12									
1	1530	1416	204	151	157	33	13	10	5	NA
1	4996	1343	684	116	77	31	3	NA	4	NA
1	628	2049	502	174	14	30	7	NA	NA	NA
1	504	355	578	109	40	3	0	1	NA	NA
1	170	344	214	670	166	32	5	2	NA	NA
1	148	206	262	269	668	73	6	3	NA	NA
1	502	346	293	339	367	500	37	2	2	NA
1	1765	658	215	184	284	254	824	43	17	NA
1	3572	1911	1131	354	255	252	277	442	49	NA
1	3239	3745	2293	961	234	118	103	42	187	29
1	1377	1395	2036	1016	281	47	45	29	26	81
1	994	896	1128	974	462	59	11	4	9	15
1	1586	442	503	459	510	215	23	7	1	8
1	3912	1898	449	415	349	271	51	10	2	1
1	1476	1303	523	139	118	187	99	10	2	1
1	2948	1673	1492	546	146	69	50	13	6	2
1	1774	1606	851	621	191	27	8	6	3	1
1	614	1062	1011	713	366	94	12	8	6	0
1	3067	1168	1271	1461	677	235	38	4	1	2
1	334	852	349	456	480	217	88	24	2	7
1	1250	333	693	341	438	180	75	18	1	3
1	648	538	186	420	176	159	87	23	3	10
1	585	304	308	129	466	151	80	33	9	4
1	1999	2887	1166	789	248	352	55	28	17	7
1	1078	1825	1415	560	415	128	266	36	17	4
1	228	880	1614	1750	618	314	108	125	40	29
1	404	283	674	1595	2727	645	233	68	75	9
1	828	494	344	895	2266	1335	257	104	38	28
1	606	845	724	541	1336	2338	1617	215	111	88
1	2869	1242	1115	777	553	1490	1739	980	146	105
1	1387	2356	1300	1442	964	498	969	686	325	127
1	563	769	1199	664	594	409	356	565	344	286
1	1115	424	444	742	486	484	268	167	146	230
1	1090	1499	540	584	775	456	193	141	61	137
1	2036	1254	1446	639	493	739	273	218	65	111
1	1173	1173	819	943	506	509	495	195	84	80
1	649	591	558	402	369	163	114	144	82	35
1	294	530	570	504	476	345	116	68	53	39

FLT18: RusSweptArea										
1982	2021									
1	1	0.9	1							
3	12									
1	1413	1525	721	198	551	174	37	19	15.1	1.5
1	520	642	506	358	179	252	94	NA	NA	NA
1	1189	700	489	357	154	69	61	17	14.6	7.4
1	1188	1592	1068	365	165	37	8	16	1.5	20.9
1	1622	1532	1493	481	189	42	2	6	NA	NA
1	557	3076	900	701	184	60	25	4	0.7	3.3
1	993	938	2879	583	260	47	24	NA	NA	NA

1	490	978	1062	1454	1167	299	112	47	18.5	11.7
1	167	487	627	972	1538	673	153	49	9.1	1.7
1	1077	484	532	583	685	747	98	14	2.6	NA
1	675	308	239	273	218	175	25	25	4	0.1
1	1604	1135	681	416	354	87	3	7	0.6	0.7
1	1363	1309	1019	354	128	49	21	11	5.7	2.2
1	589	1065	1395	849	251	83	19	18	9.5	5.8
1	733	784	1035	773	348	132	19	5	12	1.6
1	1342	835	613	602	348	116	32	30	NA	NA
1	2028	1363	788	470	259	130	48	5	NA	0.9
1	1587	2072	980	301	123	94	42	4	NA	NA
1	1839	1286	1786	773	114	52	23	9	3.9	0.4
1	1224	1557	1290	1061	304	50	14	5	25.4	13.1
1	980	1473	1473	896	600	182	29	8	0.8	0.5
1	1246	1057	1166	1203	535	241	40	9	3.1	1.1
1	329	1576	880	1111	776	279	93	23	3.6	2.5
1	1408	631	1832	744	605	244	88	28	6.4	1.1
1	927	1613	777	1801	662	342	161	43	17.5	7.4
1	2579	1617	1903	846	1525	553	226	86	49	18.5
1	2203	3088	1635	1472	830	863	291	115	33	19
1	974	2317	3687	2016	1175	620	413	205	65	41
1	334	1070	2505	3715	1817	789	395	299	155.9	75.2
1	882	508	1432	3065	3300	917	439	176	175.5	105.4
1	815	1114	839	2122	3358	1878	432	195	45.7	76.3
1	747	1174	1177	884	2349	3132	1367	306	92.4	98.5
1	1399	1368	1725	1483	1111	1929	1297	383	93.4	55.1
1	657	1583	1742	1932	1610	925	1158	761	241.6	113.6
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	1456	884	1063	1952	1231	567	266	120	119.8	103.8
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FLT007: Ecosystem_2018corr										
2004	2021									
1	1	0.65	0.75							
3	12									
1	1477	4215	1502	798	402	101	22	5	1.3	2
1	2166	558	1009	280	156	57	12	5	1.2	0.5
1	1861	2056	599	698	176	81	26	6	2.5	0.4
1	5862	1592	791	246	269	60	22	9	1.5	2.4
1	6526	4834	1323	511	128	175	33	9	2.3	3.9
1	2023	2806	2896	1017	319	127	73	26	8.1	5.1
1	568	1770	3972	4249	1427	385	105	68	15.9	6.2
1	1236	1015	2402	3004	1784	323	77	18	13.4	8.7
1	2291	1464	700	1508	1652	845	127	44	15.5	20.8
1	2491	1836	1257	632	1182	1302	538	91	33.2	24.6
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	1744	2252	1413	726	486	262	353	266	78.7	27
1	772	937	1216	701	444	272	138	132	54.2	30.2
1	3750	1415	1049	1209	626	280	112	64	44.5	71.7
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	4166	2323	2151	766	422	444	161	49	21.9	29.5
1	1395	1356	934	829	308	142	107	31	10.3	14.8
1	847	998	811	457	336	124	47	50	23.8	16.8

```
# 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
```

```
$minAge
# The minimium age class in the assessment
3
```

$maxAge
The maximum age class in the assessment
15

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

$keyLogFsta
Coupling of the fishing mortality states (nomally only first row is used).
0 1 2 3 4 5 6 7 8 9 10 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 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 -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, or 2 AR(1)
0

$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 -1 -1 -1 -1 -1 -1
0 1 2 3 4 5 6 7 8 8 -1 -1 -1
9 10 11 12 13 14 15 16 17 17 -1 -1 -1
18 19 20 21 22 23 24 25 26 26 -1 -1 -1
27 28 29 30 31 32 33 34 35 35 -1 -1 -1
36 37 38 39 40 41 42 43 44 44 -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 -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 -1 -1 -1 -1 -1 -1 -1 -1

$keyVarF
Coupling of process variance parameters for log(F)-process (nomally only first row is used)
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 -1 -1 -1 -1 -1 -1 -1 -1 -1

$keyVarLogN
Coupling of process variance parameters for log(N)-process
0 1 1 1 1 1 1 1 1 1 1 1 1

$keyVarObs
Coupling of the variance parameters for the observations.
0 1 2 2 2 2 2 2 3 3 4 4 4
5 6 6 6 6 7 7 7 7 7 -1 -1 -1
5 6 6 6 6 7 7 7 7 7 -1 -1 -1
8 8 8 8 8 8 9 9 9 9 -1 -1 -1
10 10 10 10 10 10 11 11 11 11 -1 -1 -1
12 12 12 12 12 12 12 12 12 12 -1 -1 -1

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

$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).
#3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 12-13 13-14 14-15
NA NA NA NA NA NA NA NA NA NA NA
0 0 0 0 1 1 2 2 3 -1 -1 -1
0 0 0 0 1 1 2 2 3 -1 -1 -1
4 4 4 5 6 6 6 7 8 -1 -1 -1
9 9 9 9 9 10 10 10 11 -1 -1 -1
12 12 12 13 13 13 14 14 15 -1 -1 -1

$stockRecruitmentModelCode
Stock recruitment code (0 for plain random walk, 1 for Ricker, and 2 for Beverton-Holt).
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
5 10

$keyBiomassTreat
To be defined only if a biomass survey is used (0 SSB index, 1 catch index, and 2 FSB index).
-1 -1 -1 -1 -1 -1

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

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

Table 3.15. Northeast Arctic cod. Fishing mortality

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	FBAR5-10
1946	0.003	0.020	0.070	0.138	0.272	0.249	0.380	0.396	0.573	0.562	0.626	0.645	0.645	0.251
1947	0.002	0.021	0.090	0.188	0.387	0.294	0.450	0.446	0.692	0.635	0.689	0.780	0.780	0.309
1948	0.001	0.021	0.096	0.220	0.463	0.346	0.511	0.451	0.713	0.694	0.742	0.923	0.923	0.348
1949	0.002	0.030	0.138	0.301	0.472	0.367	0.460	0.477	0.771	0.751	0.789	1.029	1.029	0.369
1950	0.002	0.043	0.164	0.314	0.436	0.363	0.480	0.538	0.838	0.855	0.816	1.151	1.151	0.383
1951	0.009	0.079	0.232	0.344	0.446	0.392	0.496	0.567	0.781	0.866	0.841	1.200	1.200	0.413
1952	0.014	0.104	0.276	0.430	0.475	0.408	0.522	0.638	0.843	0.920	0.844	1.201	1.201	0.458
1953	0.020	0.112	0.251	0.360	0.403	0.374	0.474	0.613	0.813	0.823	0.798	1.021	1.021	0.412
1954	0.017	0.116	0.267	0.384	0.424	0.358	0.489	0.707	0.831	0.822	0.790	0.929	0.929	0.438
1955	0.015	0.108	0.295	0.493	0.496	0.508	0.565	0.750	0.895	0.866	0.791	0.862	0.862	0.518
1956	0.018	0.122	0.349	0.579	0.558	0.597	0.588	0.740	0.892	0.986	0.825	0.804	0.804	0.568
1957	0.021	0.137	0.292	0.529	0.547	0.587	0.536	0.675	0.880	0.914	0.823	0.718	0.718	0.528
1958	0.035	0.181	0.359	0.544	0.540	0.512	0.509	0.692	0.829	0.880	0.720	0.629	0.629	0.526
1959	0.035	0.203	0.425	0.525	0.527	0.528	0.552	0.721	0.787	0.801	0.707	0.643	0.643	0.546
1960	0.036	0.212	0.407	0.511	0.496	0.547	0.525	0.755	0.854	0.802	0.697	0.711	0.711	0.54
1961	0.038	0.225	0.490	0.577	0.547	0.644	0.696	0.849	0.897	0.863	0.742	0.749	0.749	0.634
1962	0.036	0.225	0.581	0.747	0.632	0.683	0.795	1.008	0.935	0.845	0.775	0.738	0.738	0.741
1963	0.024	0.194	0.581	0.795	0.754	0.771	0.892	1.080	1.079	0.851	0.802	0.735	0.735	0.812
1964	0.019	0.159	0.413	0.554	0.584	0.698	0.933	0.883	0.977	0.802	0.882	0.756	0.756	0.678
1965	0.023	0.144	0.365	0.460	0.473	0.590	0.786	0.799	0.805	0.670	0.892	0.759	0.759	0.579
1966	0.030	0.141	0.288	0.390	0.469	0.601	0.753	0.791	0.714	0.655	0.799	0.675	0.675	0.549
1967	0.029	0.155	0.266	0.331	0.465	0.639	0.828	0.811	0.770	0.665	0.793	0.609	0.609	0.557
1968	0.025	0.176	0.355	0.433	0.496	0.634	0.848	0.832	0.748	0.600	0.800	0.631	0.631	0.6
1969	0.026	0.183	0.403	0.481	0.628	0.810	1.005	0.922	0.834	0.631	0.757	0.620	0.620	0.708

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	FBAR5-10
1970	0.034	0.164	0.376	0.466	0.588	0.823	0.996	0.933	0.796	0.577	0.712	0.630	0.630	0.697
1971	0.030	0.155	0.307	0.356	0.505	0.808	0.981	0.920	0.802	0.605	0.690	0.616	0.616	0.646
1972	0.051	0.184	0.334	0.403	0.429	0.719	1.056	1.011	0.895	0.652	0.745	0.635	0.635	0.659
1973	0.132	0.226	0.386	0.440	0.460	0.699	0.920	0.861	0.845	0.674	0.756	0.620	0.620	0.628
1974	0.159	0.297	0.481	0.520	0.510	0.625	0.669	0.869	0.910	0.714	0.893	0.628	0.628	0.612
1975	0.115	0.276	0.506	0.621	0.640	0.730	0.724	0.729	0.937	0.778	0.954	0.596	0.596	0.658
1976	0.142	0.307	0.529	0.615	0.686	0.851	0.875	0.674	0.797	0.821	0.942	0.674	0.674	0.705
1977	0.128	0.335	0.631	0.677	0.707	0.900	1.126	0.857	0.895	0.809	1.053	0.810	0.810	0.816
1978	0.110	0.253	0.568	0.735	0.766	0.892	1.217	0.946	1.301	1.007	1.203	0.917	0.917	0.854
1979	0.056	0.202	0.410	0.622	0.711	0.804	1.094	0.991	1.293	1.095	1.127	1.011	1.011	0.772
1980	0.038	0.157	0.346	0.628	0.724	0.810	0.999	1.056	1.228	0.997	1.164	0.907	0.907	0.761
1981	0.032	0.141	0.284	0.583	0.784	0.970	1.158	0.974	1.070	0.937	1.046	0.835	0.835	0.792
1982	0.040	0.158	0.287	0.643	0.841	0.917	1.131	0.827	0.822	0.925	0.866	0.822	0.822	0.774
1983	0.028	0.164	0.301	0.550	0.904	1.078	1.067	0.846	0.713	0.726	0.802	0.866	0.866	0.791
1984	0.024	0.155	0.331	0.583	1.060	1.166	1.165	0.897	0.746	0.702	0.670	0.892	0.892	0.867
1985	0.037	0.160	0.389	0.667	0.945	1.147	0.933	0.780	0.758	0.655	0.593	0.950	0.950	0.81
1986	0.031	0.170	0.454	0.764	0.909	1.140	0.930	1.040	0.887	0.851	0.586	1.074	1.074	0.873
1987	0.038	0.153	0.467	0.823	1.011	1.112	0.895	1.245	0.975	1.001	0.635	1.259	1.259	0.926
1988	0.034	0.126	0.334	0.637	0.931	1.014	1.023	1.346	0.956	0.914	0.730	1.213	1.213	0.881
1989	0.030	0.106	0.252	0.459	0.641	0.828	0.816	0.997	0.752	0.708	0.697	1.432	1.432	0.665
1990	0.020	0.092	0.179	0.310	0.418	0.499	0.549	0.590	0.650	0.610	0.624	1.309	1.309	0.424
1991	0.020	0.101	0.213	0.345	0.435	0.471	0.504	0.481	0.494	0.592	0.569	1.261	1.261	0.408
1992	0.024	0.114	0.280	0.429	0.528	0.554	0.563	0.556	0.515	0.698	0.538	1.250	1.250	0.485
1993	0.014	0.110	0.315	0.522	0.617	0.657	0.691	0.707	0.686	0.823	0.676	1.223	1.223	0.585
1994	0.012	0.109	0.322	0.596	0.920	0.913	0.869	0.846	0.908	0.930	0.777	1.207	1.207	0.744
1995	0.014	0.116	0.323	0.606	0.930	0.894	0.947	0.918	1.006	0.959	0.857	1.118	1.118	0.77
1996	0.021	0.133	0.352	0.619	0.885	0.937	0.854	1.094	0.959	0.958	0.927	1.025	1.025	0.79
1997	0.022	0.168	0.444	0.683	0.897	1.199	1.125	1.260	1.027	1.015	0.923	0.931	0.931	0.935
1998	0.026	0.180	0.471	0.710	0.855	1.159	1.133	1.306	1.049	0.892	0.827	0.779	0.779	0.939
1999	0.015	0.148	0.460	0.680	0.869	1.099	1.218	1.289	0.950	0.875	0.685	0.686	0.686	0.936
2000	0.009	0.113	0.363	0.586	0.831	1.016	1.103	1.176	0.840	0.890	0.544	0.665	0.665	0.846
2001	0.009	0.095	0.293	0.531	0.754	0.922	0.884	1.038	0.725	0.757	0.432	0.694	0.694	0.737
2002	0.008	0.090	0.276	0.520	0.772	0.881	0.831	0.780	0.615	0.714	0.378	0.651	0.651	0.677
2003	0.010	0.088	0.284	0.474	0.726	0.807	0.768	0.727	0.556	0.614	0.348	0.615	0.615	0.631
2004	0.010	0.090	0.292	0.499	0.762	0.850	0.885	0.921	0.615	0.649	0.327	0.509	0.509	0.702
2005	0.011	0.102	0.317	0.515	0.733	0.858	0.937	0.862	0.646	0.710	0.325	0.454	0.454	0.704
2006	0.016	0.102	0.280	0.440	0.613	0.730	0.787	0.763	0.648	0.731	0.347	0.528	0.528	0.602
2007	0.017	0.091	0.240	0.347	0.446	0.536	0.550	0.516	0.619	0.708	0.353	0.446	0.446	0.439
2008	0.011	0.069	0.162	0.275	0.367	0.442	0.475	0.427	0.568	0.661	0.363	0.360	0.360	0.358
2009	0.010	0.058	0.132	0.220	0.315	0.351	0.450	0.360	0.516	0.709	0.397	0.303	0.303	0.305
2010	0.009	0.049	0.106	0.177	0.278	0.373	0.387	0.409	0.579	0.580	0.449	0.275	0.275	0.289
2011	0.006	0.048	0.105	0.160	0.253	0.348	0.438	0.519	0.543	0.486	0.435	0.223	0.223	0.304
2012	0.006	0.046	0.118	0.160	0.239	0.322	0.411	0.470	0.526	0.447	0.407	0.213	0.213	0.287
2013	0.007	0.048	0.122	0.189	0.267	0.358	0.436	0.501	0.539	0.451	0.386	0.232	0.232	0.312
2014	0.008	0.053	0.141	0.227	0.311	0.387	0.411	0.499	0.578	0.489	0.391	0.244	0.244	0.329
2015	0.010	0.055	0.148	0.267	0.321	0.389	0.357	0.487	0.719	0.554	0.408	0.257	0.257	0.328
2016	0.009	0.052	0.147	0.255	0.337	0.411	0.397	0.533	0.803	0.609	0.440	0.275	0.275	0.347
2017	0.010	0.056	0.150	0.268	0.350	0.467	0.462	0.567	0.862	0.675	0.473	0.282	0.282	0.377
2018	0.011	0.058	0.156	0.263	0.359	0.446	0.502	0.616	0.828	0.725	0.498	0.273	0.273	0.39
2019	0.009	0.060	0.155	0.251	0.365	0.478	0.495	0.648	0.773	0.716	0.483	0.248	0.248	0.399
2020	0.009	0.059	0.165	0.276	0.394	0.498	0.561	0.677	0.760	0.713	0.489	0.227	0.227	0.428
2021	0.009	0.058	0.190	0.335	0.458	0.531	0.665	0.710	0.665	0.730	0.506	0.225	0.225	0.481
mean(2019-2021)	0.009	0.059	0.170	0.287	0.405	0.502	0.574	0.678	0.733	0.720	0.493	0.233		

Table 3.16. Northeast Arctic COD Stock number-at-age (Thous)

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	TOTAL
1946	1138875	674081	370253	171071	77923	84274	227182	80736	36040	30588	18820	8099	2000	2919941
1947	583558	680325	497592	297864	133321	53420	56274	132766	45831	17380	14684	8425	4527	2525967
1948	441494	334537	463090	345955	206880	75300	34934	29910	69650	18411	7667	6095	4982	2038904
1949	624817	287962	262924	354790	229043	104064	42924	16918	15966	28256	7438	3005	3613	1981720
1950	1024284	394353	228830	186924	208751	114784	57080	22791	8661	6119	11091	2737	1942	2268347
1951	2440524	781190	310474	177015	114631	111085	65962	28218	10898	2983	2092	4039	1193	4050304
1952	2338131	1141327	462833	189831	115697	61717	61087	33229	13122	4214	1024	728	1278	4424220
1953	2420273	1119433	641186	245573	90830	59973	33132	28534	13937	4524	1346	356	476	4659572
1954	830203	1390947	711109	388377	137888	48822	34597	17286	12923	5054	1647	496	244	3579593
1955	383411	549468	924667	435537	224018	75037	30516	18096	6931	4700	1836	617	240	2655074
1956	747357	246123	395235	552161	212319	112876	35660	14592	7025	2276	1660	691	298	2328273
1957	1431849	405217	151010	208946	238722	95012	49161	15404	5681	2356	663	596	362	2604980
1958	935015	718102	249309	95731	100349	109399	40988	23289	6425	1909	779	227	381	2281903
1959	1313367	488473	429348	141060	47105	47622	54789	20175	9519	2299	638	319	268	2554982
1960	1480277	626162	253703	208036	69352	23042	22952	25329	8039	3646	863	256	262	2721918
1961	1552082	708191	348243	134365	102561	36277	11320	12019	9805	2784	1376	361	209	2919593
1962	1252752	814278	391966	168873	64364	49223	15627	4557	4402	3277	940	542	221	2771023
1963	902995	703924	457020	166096	62880	28846	20762	5758	1328	1469	1160	350	301	2352889
1964	469311	410065	369897	179554	54927	21651	10574	6930	1520	350	515	433	257	1525983
1965	873429	248981	258596	200116	83090	23791	8209	3222	2390	451	122	172	266	1702835
1966	1844528	563298	165848	144515	106254	44069	10951	3047	1179	896	192	39	163	2884978
1967	1313542	1272090	394780	105642	80359	55306	20425	4376	1137	492	389	73	81	3248692
1968	183211	1017152	891189	279158	72101	42178	23728	7296	1617	422	206	146	70	2518475
1969	110531	138123	705341	495907	154507	41024	19604	8552	2640	651	194	74	95	1677244
1970	206006	85838	88150	370015	238493	64476	15111	5825	2766	915	280	75	75	1078028
1971	403526	145144	57803	45378	174631	103392	22564	4584	1860	1030	428	113	66	960519
1972	1047601	312098	104886	37239	27220	81787	36152	6971	1530	696	466	182	80	1656907
1973	1724173	750354	211954	63718	21193	15847	32371	9746	1981	500	297	180	115	2832429
1974	566400	1214266	515633	122915	35325	11310	6618	10166	3411	701	207	118	131	2487201
1975	608427	366220	673009	258385	61542	18442	5360	3071	3306	1119	283	68	110	1999342
1976	605952	445112	227118	312536	108504	26032	7494	2266	1302	1000	417	88	83	1737904
1977	372123	418084	273454	112868	137242	43313	8837	2623	1047	526	346	136	73	1370672
1978	624267	247635	219350	112571	47592	55805	14040	2251	895	385	210	98	77	1325175
1979	202902	448677	155381	91009	40852	17651	18414	3270	697	186	116	51	57	979264
1980	130635	155356	302011	87204	39255	16107	6539	5038	982	154	48	31	31	743392
1981	144064	102751	112715	174459	38044	15653	6028	2072	1395	231	47	12	20	597492
1982	183023	126006	83624	63543	81754	15265	4647	1519	643	379	74	13	11	560502
1983	141058	137105	92372	51865	28760	28245	4914	1238	568	230	118	26	9	486509
1984	442631	115250	83610	54129	24596	10622	7710	1355	440	242	95	42	12	740735
1985	532740	387974	82267	44912	24259	6360	2798	1916	439	166	101	41	18	1083990
1986	1374811	406174	244982	46445	19117	7413	1597	1007	753	177	74	47	19	2102615
1987	359158	1008264	256617	109598	16431	6818	1788	572	288	255	62	35	19	1759905
1988	335224	239845	594077	118852	32968	5011	1735	625	134	90	73	27	12	1328672
1989	158192	229165	148067	304366	55075	9916	1483	487	126	40	29	27	10	906983
1990	131207	128891	129652	95524	141230	22928	2918	536	138	48	16	11	7	653107
1991	297393	126695	97871	86051	61714	81767	11481	1381	249	55	22	7	4	764688
1992	716809	272016	101011	69155	48733	33921	46453	6094	809	133	25	10	3	1295172
1993	990119	504157	241432	72816	36846	23561	15535	24035	3061	437	58	13	3	1912071
1994	752658	734832	400366	147087	39093	15947	10672	6403	9877	1336	162	24	4	2118459
1995	539812	493577	525544	232089	63132	12508	5327	3446	2230	3255	428	61	7	1881416
1996	405894	304709	337363	283121	104043	19861	4303	1589	1123	624	1029	148	18	1463825
1997	783453	210101	205596	183110	120012	37458	6314	1652	441	339	195	335	49	1549057

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	TOTAL
1998	1059540	477806	127297	98038	70990	41641	9521	1630	360	132	95	62	121	1887233
1999	630159	604406	264735	62506	32948	26060	11642	2527	347	99	46	33	69	1635579
2000	749764	410834	377249	122599	24473	11241	7424	2656	587	110	33	19	42	1707031
2001	593562	535126	291773	185130	52027	9006	3415	1939	671	202	35	16	26	1672928
2002	375075	431865	368919	186553	82287	20388	3117	1189	572	253	79	19	17	1470332
2003	759779	288708	288362	235921	84519	30369	6787	1147	449	268	99	46	15	1696468
2004	243027	577509	215419	182849	116496	33995	10997	2654	492	230	130	56	27	1383882
2005	697364	186451	407267	136600	94486	39298	11278	4002	854	216	101	82	41	1578040
2006	539345	470095	141844	232607	68968	34190	13769	3414	1374	382	86	63	72	1506209
2007	1259517	439814	305605	89468	120749	30555	12807	4650	1222	587	154	49	67	2265243
2008	1017985	976289	337459	169025	53247	63615	15827	5829	2023	562	231	89	60	2642242
2009	590038	795485	745082	250581	90127	34070	29401	8128	3178	984	244	129	86	2547533
2010	204469	459238	654988	553101	170159	55001	19389	15158	4830	1699	380	138	131	2138680
2011	362283	183687	382331	539606	392561	87459	32100	10950	8494	2154	819	186	166	2002795
2012	509539	278784	148118	318532	409532	223437	45996	16640	5549	4081	1091	445	228	1961972
2013	472255	373104	228605	130017	244523	268796	139194	24118	9004	2645	2147	595	463	1895465
2014	860386	362190	300542	184030	103257	172721	150851	68053	11898	4168	1358	1195	695	2221343
2015	457348	579081	304387	216038	134295	69381	100654	78138	32311	5632	2050	746	1214	1981275
2016	289567	320014	424662	218679	138182	78203	45580	55989	36842	12667	2647	1107	1235	1625374
2017	788999	244082	231861	292021	149931	80467	42529	25522	24811	13794	5622	1394	1425	1902457
2018	510445	552851	192821	163927	191443	89215	41563	22753	11788	8282	5617	2810	1673	1795188
2019	666503	381061	401157	154720	95668	112423	49075	20655	9896	4265	3148	2686	2608	1903864
2020	568171	447081	288610	261056	106551	57499	59802	24839	9196	3707	1728	1571	3143	1832953
2021	406025	368619	329704	200343	155439	57711	29745	28086	11291	3488	1496	881	2950	1595778
2022		274930	264131	197664	122520	81092	26996	12661	11264	4775	1378	739	2511	1189669

Table 3.17. Northeast Arctic COD. Natural mortality used in final run

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1946	0.49	0.304	0.226	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1947	0.544	0.325	0.231	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1948	0.493	0.305	0.226	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1949	0.434	0.282	0.221	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1950	0.316	0.236	0.21	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1951	0.724	0.394	0.247	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1952	0.715	0.391	0.246	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1953	0.537	0.322	0.23	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1954	0.388	0.264	0.217	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1955	0.406	0.271	0.218	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1956	0.59	0.342	0.235	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1957	0.725	0.395	0.247	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1958	0.562	0.332	0.232	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1959	0.713	0.39	0.246	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1960	0.704	0.387	0.245	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1961	0.609	0.35	0.237	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1962	0.52	0.315	0.229	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1963	0.788	0.419	0.253	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1964	0.603	0.348	0.236	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1965	0.416	0.275	0.219	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1966	0.353	0.25	0.214	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1967	0.271	0.219	0.206	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1968	0.224	0.201	0.202	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

1969	0.206	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1970	0.293	0.227	0.208	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1971	0.256	0.213	0.205	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1972	0.323	0.239	0.211	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1973	0.217	0.2	0.201	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1974	0.217	0.2	0.201	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1975	0.232	0.204	0.203	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1976	0.224	0.2	0.202	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1977	0.249	0.21	0.204	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1978	0.234	0.204	0.203	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1979	0.208	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1980	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1981	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1982	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1983	0.203	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1984	0.201	0.2	0.219	0.21	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1985	0.205	0.224	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1986	0.27	0.216	0.254	0.232	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1987	0.256	0.237	0.22	0.273	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1988	0.223	0.211	0.243	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1989	0.2	0.23	0.2	0.233	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1990	0.2	0.2	0.206	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1991	0.2	0.2	0.2	0.207	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1992	0.207	0.2	0.2	0.202	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1993	0.241	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1994	0.348	0.261	0.215	0.22	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1995	0.531	0.315	0.228	0.203	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1996	0.524	0.327	0.244	0.218	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1997	0.421	0.269	0.242	0.227	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1998	0.429	0.274	0.22	0.269	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999	0.264	0.234	0.238	0.224	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2000	0.248	0.212	0.244	0.226	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2001	0.236	0.22	0.2	0.231	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2002	0.278	0.212	0.2	0.224	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2003	0.239	0.2	0.2	0.212	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2004	0.25	0.215	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2005	0.298	0.212	0.215	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2006	0.203	0.228	0.2	0.207	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2007	0.247	0.2	0.247	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2008	0.258	0.213	0.2	0.233	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2009	0.274	0.209	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2010	0.296	0.235	0.207	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2011	0.423	0.313	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2012	0.38	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2013	0.393	0.235	0.205	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2014	0.37	0.294	0.212	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2015	0.356	0.262	0.235	0.204	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2016	0.216	0.256	0.265	0.216	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2017	0.395	0.218	0.214	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2018	0.272	0.212	0.2	0.216	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2019	0.306	0.217	0.213	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2020	0.431	0.236	0.2	0.21	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2021	0.402	0.272	0.256	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 3.18. Northeast Arctic COD. Summary table

Year	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-10
1946	1138875	3931401	952394	706000	0.7413	0.251
1947	583558	3385179	903494	882017	0.9762	0.309
1948	441494	3351125	785218	774295	0.9861	0.348
1949	624817	2890579	595220	800122	1.3442	0.369
1950	1024284	2790520	536083	731982	1.3654	0.383
1951	2440524	3704792	494974	827180	1.6712	0.413
1952	2338131	4130639	488811	876795	1.7937	0.458
1953	2420273	4106311	412127	695546	1.6877	0.412
1954	830203	4208114	408122	826021	2.024	0.438
1955	383411	3542239	328050	1147841	3.499	0.518
1956	747357	3322443	281511	1343068	4.7709	0.568
1957	1431849	2814500	212384	792557	3.7317	0.528
1958	935015	2359498	205396	769313	3.7455	0.526
1959	1313367	2726727	434343	744607	1.7143	0.546
1960	1480277	2353678	384643	622042	1.6172	0.54
1961	1552082	2351974	386423	783221	2.0269	0.634
1962	1252752	2178272	315358	909266	2.8833	0.741
1963	902995	2010999	216125	776337	3.5921	0.812
1964	469311	1509320	200521	437695	2.1828	0.678
1965	873429	1454087	108075	444930	4.1169	0.579
1966	1844528	2217369	120996	483711	3.9978	0.549
1967	1313542	2732291	128675	572605	4.45	0.557
1968	183211	3286062	222846	1074084	4.8198	0.6
1969	110531	2824248	148914	1197226	8.0397	0.708
1970	206006	2165403	242143	933246	3.8541	0.697
1971	403526	1658704	330542	689048	2.0846	0.646
1972	1047601	1610511	353348	565254	1.5997	0.659
1973	1724173	2280602	334063	792685	2.3729	0.628
1974	566400	2186032	158939	1102433	6.9362	0.612
1975	608427	2093891	133486	829377	6.2132	0.658
1976	605952	1943280	167229	867463	5.1873	0.705
1977	372123	1935049	336160	905301	2.6931	0.816
1978	624267	1588450	227984	698715	3.0648	0.854
1979	202902	1137982	180487	440538	2.4408	0.772
1980	130635	853030	108443	380434	3.5081	0.761
1981	144064	964831	161275	399038	2.4743	0.792
1982	183023	750810	321134	363730	1.1326	0.774
1983	141058	747305	311281	289992	0.9316	0.791
1984	442631	830891	243444	277651	1.1405	0.867
1985	532740	1004865	195314	307920	1.5765	0.81
1986	1374811	1407704	164104	430113	2.621	0.873
1987	359158	1241250	115090	523071	4.5449	0.926
1988	335224	1009357	191447	434939	2.2718	0.881
1989	158192	956390	237375	332481	1.4007	0.665
1990	131207	909733	302447	212000	0.7009	0.424
1991	297393	1344239	635130	319158	0.5025	0.408
1992	716809	1690371	803817	513234	0.6385	0.485
1993	990119	2205391	702294	581611	0.8282	0.585
1994	752658	2120954	572233	771086	1.3475	0.744
1995	539812	1855549	534987	739999	1.3832	0.77

Year	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-10
1996	405894	1700023	551598	732228	1.3275	0.79
1997	783453	1542431	545940	762403	1.3965	0.935
1998	1059540	1359999	386207	592624	1.5345	0.939
1999	630159	1206925	281001	484910	1.7257	0.936
2000	749764	1228857	255917	414868	1.6211	0.846
2001	593562	1481581	383996	426471	1.1106	0.737
2002	375075	1598087	521728	535045	1.0255	0.677
2003	759779	1685729	572476	551990	0.9642	0.631
2004	243027	1571565	666767	606445	0.9095	0.702
2005	697364	1521981	580090	641276	1.1055	0.704
2006	539345	1547352	584912	537642	0.9192	0.602
2007	1259517	1877119	652597	486883	0.7461	0.439
2008	1017985	2568546	724270	464171	0.6409	0.358
2009	590038	3109989	1016900	523430	0.5147	0.305
2010	204469	3355623	1250449	609983	0.4878	0.289
2011	362283	3592388	1814926	719830	0.3966	0.304
2012	509539	3673800	2037769	727663	0.3571	0.287
2013	472255	3766466	2271239	966209	0.4254	0.312
2014	860386	3504846	2164925	986449	0.4557	0.329
2015	457348	3348812	1761651	864384	0.4907	0.328
2016	289567	2926799	1417485	849422	0.5992	0.347
2017	788999	2867063	1446266	868276	0.6004	0.377
2018	510445	2677304	1314594	778627	0.5923	0.39
2019	666503	2587148	1267579	692609	0.5464	0.399
2020	568171	2318488	1045938	692903	0.6625	0.428
2021	406025	2132863	936281	767284	0.8195	0.481
Arith. Mean	737200	2229299	576163	673724	2.0158	0.591

Year	Age	N	M	Mat	PF	PM	SWT	Sel	CWT
2022	3	476000	0.380	0.014	0	0	0.293	0.010	0.499
	4	274930	0.242	0.000	0	0	0.48	0.058	0.869
	5	264131	0.223	0.010	0	0	0.929	0.163	1.381
	6	197664	0.203	0.079	0	0	1.616	0.279	2.141
	7	122520	0.2	0.402	0	0	2.741	0.385	3.033
	8	81092	0.2	0.674	0	0	3.933	0.484	4.219
	9	26996	0.2	0.756	0	0	5.744	0.537	5.850
	10	12661	0.2	0.975	0	0	8.012	0.644	7.317
	11	11264	0.2	1	0	0	9.648	0.778	8.453
	12	4775	0.2	1	0	0	11.361	0.712	10.303
	13	1378	0.2	1	0	0	13.279	0.490	11.400
	14	739	0.2	1	0	0	15.613	0.251	12.838
	15	2511	0.2	1	0	0	17.706	0.251	14.058
2023	3	566000	0.380	0.005	0	0	0.227	0.010	0.597
	4		0.242	0.001	0	0	0.580	0.058	0.841
	5		0.223	0.010	0	0	0.945	0.163	1.354
	6		0.203	0.110	0	0	1.573	0.279	2.035
	7		0.2	0.381	0	0	2.539	0.385	3.014
	8		0.2	0.702	0	0	3.913	0.484	4.269
	9		0.2	0.851	0	0	5.606	0.537	5.704
	10		0.2	0.968	0	0	7.661	0.644	7.119
	11		0.2	0.986	0	0	9.990	0.778	8.422
	12		0.2	1	0	0	11.495	0.712	9.959
	13		0.2	1	0	0	13.459	0.490	11.712
	14		0.2	1	0	0	15.448	0.251	12.814
	15		0.2	1	0	0	17.818	0.251	14.251
2024	3	383000	0.380	0.005	0	0	0.214	0.010	0.597
	4		0.242	0.001	0	0	0.515	0.058	0.841
	5		0.223	0.010	0	0	1.045	0.163	1.354
	6		0.203	0.110	0	0	1.589	0.279	2.035
	7		0.2	0.381	0	0	2.496	0.385	3.014
	8		0.2	0.702	0	0	3.712	0.484	4.269
	9		0.2	0.851	0	0	5.586	0.537	5.704
	10		0.2	0.968	0	0	7.523	0.644	7.119
	11		0.2	0.986	0	0	9.639	0.778	8.422
	12		0.2	1	0	0	11.836	0.712	9.959
	13		0.2	1	0	0	13.592	0.490	11.712
	14		0.2	1	0	0	15.627	0.251	12.814
	15		0.2	1	0	0	17.653	0.251	14.251

Year	Cod3	OxSatt39	DOxSatt13	ITwt43	Icet15	explcet40
1962	1252752	-0.19	-6.6	1.86	0.5	0
1963	902995	-0.94	-2.37	1.59	1.5	0
1964	469311	1.63	1.23	2.47	9	0
1965	873429	0.88	-0.2	3.91	15.7	0
1966	1844528	-1.09	-3.98	7.97	5.3	0
1967	1313542	-0.23	-2.84	8.23	5	9.3
1968	183211	1.5	-0.13	3.78	15.5	0
1969	110531	0.85	0.63	1.77	15.9	0
1970	206006	-0.17	-0.23	3.51	19.8	7.9
1971	403526	0.06	-0.12	-0.13	18.8	2.7
1972	1047601	-3.32	-6.59	14.55	-0.6	428.9
1973	1724173	-2.1	-10.37	19.14	1.8	768.6

Year	Cod3	OxSatt39	DOxSatt13	ITwt43	Icet15	explcet40
1974	566400	1.06	-1.73	2.4	2	0
1975	608427	1.9	0.78	-2.64	-1.2	0
1976	605952	1.33	-1.28	-3.07	-1.9	0
1977	372123	-0.07	-1.84	-2.44	2.5	0
1978	624267	1.19	0.1	1.05	-1	0
1979	202902	0.5	-1.48	-0.12	3.5	0
1980	130635	-0.31	-2.72	1.98	12.9	0
1981	144064	0.76	-0.18	1.94	14.7	0
1982	183023	0.8	0.61	-3.15	8	0.1
1983	141058	0.78	0.22	1.87	12.2	8.5
1984	442631	-2.21	-2.35	-3.08	12.9	0
1985	532740	-0.1	-1.17	3.59	-1.2	0.1
1986	1374811	-2.14	-4.39	1.39	-8.5	2.9
1987	359158	-0.33	-1.69	2.12	0.6	0
1988	335224	0.87	-1.4	-2.34	3.8	0
1989	158192	0.32	-3.42	-5.17	10.5	0
1990	131207	1.11	-1.32	-4.21	10.5	0
1991	297393	0.88	0.7	2.42	6.5	0
1992	716809	1.34	0.48	1.37	-0.9	0
1993	990119	-1.98	-3.86	6.12	-0.6	0
1994	752658	-0.5	-2.26	8.25	-4.9	0
1995	539812	0.83	-2.42	4.36	1.8	0
1996	405894	0.86	-0.08	0.55	0.7	0
1997	783453	0.88	0.17	3.11	-7.3	0
1998	1059540	0.3	-6.08	-2.32	-2.5	0
1999	630159	-0.72	-2.4	-6.81	2.9	0
2000	749764	1.86	1.55	-2.29	13.6	0
2001	593562	0.62	0.05	-6.04	2.3	0
2002	375075	-0.88	-0.98	3.63	-9.9	0.8
2003	759779	-0.39	-0.64	8.5	-5.8	0
2004	243027	-2.2	-2.53	-4.62	-1.4	0
2005	697364	-1.65	-1.82	-1.45	4.9	0
2006	539345	-1.18	-1.65	-4	-6	0
2007	1259517	-1.39	-4.42	7.42	-12.3	0
2008	1017985	-1.14	-1.59	3.39	-18	0
2009	590038	0.79	-1.83	-1.61	-17.5	0
2010	204469	-0.38	-2.6	-8.94	-9	0
2011	362283	0.83	-0.07	-5	-4.3	0
2012	509539	0.91	-0.13	-5.05	-4.3	0
2013	472255	0.04	-0.09	1.44	-10.5	0
2014	860386	-0.46	-1	1.43	-17.8	0
2015	457348	-1.26	-1.62	-2.22	-10.5	0
2016	289567	-1.31	-1.92	-7.52	-5.8	0
2017	788999	-0.33	-0.64	-1.69	-14.4	0
2018	510445	-1.24	-1.41	0.1	-20.9	0
2019	666503	-0.63	-1.08	-1.71	-13.2	0
2020	568171	-2.02	-2.19	-6.35	-13.6	0
2021	406025	-0.8	-1.08	-1.33	-9.2	0
2022	NA	-1.55	-2.1	-2.47	-12.8	0
2023	NA	-1.52	-2.85	-4.18	-8.5	0
2024	NA	-0.31	NA	-5.63	NA	0
2025	NA	-0.35	NA	-7.5	NA	0

Table 3.19c. Northeast Arctic COD. Input for the short term prediction using RCT3

yearclass	recruitment	BST1	BST2	BST3	BSA1	BSA2	BSA3
1982	533	NA	NA	NA	NA	NA	NA
1983	1375	NA	NA	NA	NA	NA	NA
1984	359	NA	NA	NA	NA	NA	NA
1985	335	NA	NA	NA	NA	NA	NA
1986	158	NA	NA	NA	NA	NA	NA
1987	131	NA	NA	NA	NA	NA	NA
1988	297	NA	NA	NA	NA	NA	NA
1989	717	NA	NA	NA	NA	NA	NA
1990	990	NA	NA	NA	NA	NA	NA
1991	753	NA	NA	294	NA	NA	324
1992	540	NA	557	283	NA	624	138
1993	406	1044	541	163	903	212	99
1994	783	5356	792	318	2175	272	159
1995	1060	5899	1423	355	1826	565	391
1996	630	5044	496	188	1699	475	148
1997	750	2491	350	246	2524	232	295
1998	594	473	242	183	365	263	177
1999	375	129	78	118	153	52	61
2000	760	713	419	377	364	209	307
2001	243	34	66	64	19	53	33
2002	697	3022	243	249	1505	117	125
2003	539	323	217	116	161	139	65
2004	1260	853	289	361	500	158	59
2005	1018	674	370	194	411	47	200
2006	590	595	102	126	85	94	108
2007	204	69	36	37	51	26	23
2008	362	389	95	85	205	44	40
2009	510	1028	226	76	620	91	83
2010	472	617	100	69	266	40	61
2011	860	703	143	227	497	89	287
2012	457	436	191	144	313	211	139
2013	290	1246	343	99	1759	211	56
2014	789	1642	306	179	1904	202	112
2015	510	312	129	139	241	73	109
2016	667	645	501	282	439	280	204
2017	568	2714	559	238	2058	362	117
2018	406	1791	274	112	1437	158	65
2019	NA	165	35	52	93	29	29
2020	NA	81	66	NA	46	43	NA
2021	NA	668	NA	NA	525	NA	NA

Table 3.19d. Overview of available prognoses of NEA cod recruitment (in million individuals of age 3) from different models.

Model	Variable	Years	2022	2023	2024	2025
TitovEL	Age 3	4	610	543	383	315
	weight		0.318	0.512	1	1
TitovES	Age 3	2	624	590		
	weight		0.304	0.488		
RCT3	Age 3	3	244	337	505	
	weight		0.378			
Hybrid	Age 3	4	**476**	**566**	**383**	**315**

Table 3.20. Northeast Arctic COD. Management option table.

2022					
Biomass (t)	**SSB (t)**	**FMult**	**FBar**	**Landings (t)**	
1984724	832958	1	0.481	640700	
2023				**2024**	
Biomass	**SSB**	**FBar**	**Landings**	**Biomass**	**SSB**
1793327	751297	0.00	0	2283565	1134101
		0.05	72129	2200360	1072502
		0.10	140660	2121527	1014542
		0.15	205801	2046806	959991
		0.20	267747	1975955	908634
		0.25	326679	1908745	860271
		0.30	382768	1844965	814716
		0.35	436175	1784414	771794
		0.40	487049	1726907	731342
		0.45	535531	1672268	693208
		0.50	581755	1620333	657249
		0.55	625843	1570949	623332
		0.60	667913	1523970	591333
		0.65	708075	1479262	561135
		0.70	746432	1436698	532630
		0.75	783080	1396158	505715
		0.80	818111	1357530	480296
		0.85	851611	1320710	456282
		0.90	883661	1285597	433589
		0.95	914335	1252100	412141

Table 3.21. Northeast Arctic COD. Detailed prediction output assuming Fsq in 20 22 and HCR in 2023.

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)
Fbar age range: 5-10 Year: 2022 F multiplier: 1 Fbar: 0.4810							
3	0.011	4382	2	476000	139	6664	2
4	0.067	15944	14	274930	132	0	0
5	0.189	40924	57	264131	245	2641	2
6	0.323	49604	106	197664	319	15615	25
7	0.446	40267	122	122520	336	49253	135

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)
8	0.561	31836	134	81092	319	54656	215
9	0.622	11449	67	26996	155	20409	117
10	0.746	6105	45	12661	101	12344	99
11	0.901	6151	52	11264	109	11264	109
12	0.825	2463	25	4775	54	4775	54
13	0.567	546	6	1378	18	1378	18
14	0.291	170	2	739	12	739	12
15+	0.291	577	8	2511	44	2511	44
Total	NA	210418 (thous)	641(thou. tonnes)	1476661 (thous)	1985 (thou. tonnes)	182250 (thous)	833 (thou. tonnes)
Fbar age range: 5-10 Year: 2023 F multiplier: 1.01 Fbar: 0.4835							
3	0.011	5237	3	566000	129	3019	1
4	0.068	18770	16	322026	187	215	0
5	0.190	31420	43	201831	191	2018	2
6	0.324	44095	90	174933	275	19301	30
7	0.449	38549	116	116806	297	44542	113
8	0.564	25305	108	64204	251	45072	176
9	0.625	16135	92	37899	212	32252	181
10	0.749	5742	41	11866	91	11486	88
11	0.905	2695	23	4919	49	4851	48
12	0.829	1940	19	3747	43	3747	43
13	0.570	682	8	1714	23	1714	23
14	0.292	148	2	640	10	640	10
15+	0.292	459	7	1990	35	1990	35
Total	NA	191177 (thous)	567 (thou. tonnes)	1508574 (thous)	1793 (thou. tonnes)	170846 (thous)	751 (thou. tonnes)

Table 3.22. Northeast Arctic COD. Assessments results by means of TISVPA

Year	B(3+)	SSB	R(3)	F(5-10)
1984	832475	257128	423540	0.794
1985	997042	201878	562013	0.640
1986	1371608	182219	1088448	0.787
1987	1217892	133125	288771	1.030
1988	989270	219074	216731	0.977
1989	919430	242343	174394	0.463
1990	988089	331327	228120	0.310
1991	1576090	725896	407282	0.226
1992	1954099	942530	706308	0.409
1993	2417354	833487	919721	0.619

Year	B(3+)	SSB	R(3)	F(5-10)
1994	2202724	648104	714627	0.822
1995	1862607	561769	483248	0.763
1996	1769846	611779	389590	0.732
1997	1653878	660891	645301	1.064
1998	1310048	430437	795960	1.077
1999	1113365	290190	482785	0.922
2000	1092663	249331	566302	0.641
2001	1341324	375817	483100	0.515
2002	1477950	507382	421038	0.507
2003	1578393	545747	669974	0.506
2004	1521547	640634	273873	0.599
2005	1485862	579150	529460	0.603
2006	1510903	599171	529677	0.628
2007	1804575	636829	1260970	0.490
2008	2532511	690152	1237491	0.349
2009	3180322	983447	837192	0.334
2010	3450733	1173373	482215	0.367
2011	3636614	1657124	607215	0.321
2012	3752025	1901044	677845	0.290
2013	3879833	2114406	800478	0.299
2014	3609887	2017731	1012919	0.331
2015	3427586	1611365	497349	0.358
2016	3054495	1319476	359955	0.331
2017	3073171	1483256	732593	0.398
2018	2807889	1385292	510018	0.437
2019	2608769	1327529	530801	0.386
2020	2276282	1090178	368720	0.406
2021	2023565	971926	255602	0.530
2022	1577540	787739		

Table 3.23. NEA cod TISVPA estimates of abundance at age (thousands)

Year	3	4	5	6	7	8	9	10	11	12	13	14	15
1984	423540	135475	77073	45251	24243	12654	9060	1440	660	412	198	36	24
1985	562013	339808	97750	45065	19561	6752	3332	2368	464	352	170	113	28
1986	1088448	439315	233334	56057	20761	6829	2177	1296	1094	229	248	106	44
1987	288771	807686	293966	115554	22666	7077	2096	737	406	382	75	162	55
1988	216731	213153	524049	145983	35973	6050	2108	737	157	137	113	40	14
1989	174394	165787	150616	284854	60443	9627	1628	615	173	35	48	55	79
1990	228120	138858	117403	95106	154533	25579	3449	655	267	100	17	36	14
1991	407282	185090	106944	83202	61237	97223	14463	2034	376	165	67	10	19

Year	3	4	5	6	7	8	9	10	11	12	13	14	15
1992	706308	329545	142724	74206	51266	34497	58289	8483	1277	258	121	52	6
1993	919721	558121	241106	93966	40988	25889	16301	30789	4419	755	139	91	4
1994	714627	713450	416255	143703	48128	19010	11208	6726	13079	1835	295	65	14
1995	483248	498374	495670	246587	63316	13694	5954	3276	1937	4053	576	142	3
1996	389590	280514	327233	292254	116764	23190	4683	1944	989	538	1536	288	3
1997	645301	225111	179090	187075	142900	47128	8457	1837	644	335	203	633	3
1998	795960	412991	141348	84808	74507	47580	12041	1942	411	130	68	58	141
1999	482785	495248	244147	69239	31006	25706	11901	3363	465	124	34	23	86
2000	566302	363702	323873	113974	25926	10989	6834	2385	1012	155	53	4	53
2001	483100	436767	264068	172682	49870	9675	3623	1873	651	497	63	33	102
2002	421038	376872	318886	162943	81958	21007	3469	1516	631	254	306	44	29
2003	669974	316334	277940	196002	76114	31310	7627	1320	766	317	111	220	5
2004	273873	520975	240139	173789	99040	32288	12769	3538	615	469	172	72	36
2005	529460	211153	384639	152377	85195	38108	11351	4595	1334	242	260	106	31
2006	529677	387746	153767	217638	74087	32976	13406	4013	1570	562	106	183	630
2007	1260970	424821	269442	95745	106990	32504	12800	4518	1585	555	250	63	170
2008	1237491	964878	311010	158248	54529	54430	16087	6442	2227	797	211	163	81
2009	837192	948353	732626	216807	94049	31657	26730	8427	3583	1172	446	137	131
2010	482215	631431	733100	520182	135327	56469	18030	13975	4998	2098	259	298	213
2011	607215	356825	481574	537231	345907	76533	30143	10155	7387	1817	985	79	0
2012	677845	396238	252910	359807	368609	211181	42902	14792	4356	3426	986	487	167
2013	800478	461064	283877	190409	253330	235295	125950	23966	7629	2046	1851	566	922
2014	1012919	537603	351039	209639	134605	157336	128477	63054	11807	3740	1087	1150	860
2015	497349	695648	383153	248119	138557	82752	80923	64432	31047	6155	1975	638	1208
2016	359955	344880	506831	264221	155082	82398	46705	43675	30885	12144	2828	1208	1495
2017	732593	287981	255836	341890	171641	92871	46365	25315	19253	12614	5745	1606	1147
2018	510018	488492	218871	178786	215496	96968	48310	24005	11943	6318	5023	3102	1001
2019	530801	383163	367726	152573	110772	121786	51320	23778	11112	4205	2210	2308	1318
2020	368720	387242	287531	250662	96645	65067	63376	26380	11469	5250	1778	1212	1087
2021	255602	235570	285109	197022	152009	51599	34042	30961	11737	4464	2856	960	1449
2022		168893	162960	173593	107260	70946	21980	14530	13053	5159	2083	1725	580

Table 3.24. NEA cod TISVPA estimates of fishing mortality coefficients

Year	3	4	5	6	7	8	9	10	11	12	13	14	15	F(5-10)
1984	0.022	0.134	0.317	0.546	0.982	0.988	0.980	0.950	0.301	0.917	0.456	0.456	0.456	0.794
1985	0.021	0.122	0.307	0.451	0.621	0.911	0.769	0.782	0.697	0.232	0.376	0.376	0.376	0.640
1986	0.021	0.154	0.386	0.627	0.749	0.878	1.125	0.956	0.883	0.749	0.439	0.439	0.439	0.787
1987	0.026	0.154	0.508	0.838	1.138	1.104	1.087	1.503	1.102	0.964	0.517	0.517	0.517	1.030
1988	0.025	0.162	0.411	0.903	1.197	1.297	1.020	1.032	1.244	0.902	0.489	0.489	0.489	0.977
1989	0.014	0.089	0.238	0.360	0.578	0.594	0.540	0.466	0.436	0.478	0.252	0.252	0.252	0.463

Year	3	4	5	6	7	8	9	10	11	12	13	14	15	F(5-10)
1990	0.008	0.059	0.158	0.259	0.313	0.415	0.371	0.347	0.283	0.258	0.167	0.167	0.167	0.310
1991	0.007	0.038	0.111	0.186	0.247	0.254	0.292	0.268	0.235	0.188	0.123	0.123	0.123	0.226
1992	0.010	0.068	0.166	0.314	0.445	0.516	0.460	0.550	0.461	0.386	0.211	0.211	0.211	0.409
1993	0.014	0.086	0.258	0.404	0.662	0.822	0.827	0.740	0.832	0.654	0.309	0.309	0.309	0.619
1994	0.017	0.113	0.282	0.559	0.726	1.061	1.131	1.171	0.927	1.008	0.388	0.388	0.388	0.822
1995	0.016	0.106	0.300	0.476	0.785	0.844	1.037	1.136	1.055	0.810	0.383	0.383	0.383	0.763
1996	0.021	0.103	0.290	0.526	0.678	0.954	0.858	1.088	1.070	0.950	0.390	0.390	0.390	0.732
1997	0.027	0.175	0.371	0.703	1.126	1.229	1.560	1.394	1.688	1.540	0.537	0.537	0.537	1.064
1998	0.030	0.176	0.502	0.660	1.046	1.407	1.227	1.618	1.270	1.419	0.538	0.538	0.538	1.077
1999	0.023	0.182	0.457	0.840	0.851	1.106	1.192	1.085	1.229	0.960	0.486	0.486	0.486	0.922
2000	0.018	0.112	0.370	0.563	0.798	0.658	0.699	0.759	0.647	0.683	0.342	0.342	0.342	0.641
2001	0.014	0.097	0.241	0.502	0.604	0.700	0.502	0.542	0.539	0.451	0.272	0.272	0.272	0.515
2002	0.012	0.083	0.242	0.379	0.653	0.651	0.644	0.475	0.475	0.456	0.255	0.255	0.255	0.507
2003	0.013	0.075	0.208	0.387	0.491	0.720	0.612	0.619	0.425	0.410	0.243	0.243	0.243	0.506
2004	0.014	0.097	0.228	0.407	0.637	0.684	0.882	0.757	0.702	0.459	0.284	0.284	0.284	0.599
2005	0.016	0.092	0.263	0.390	0.574	0.764	0.699	0.926	0.725	0.647	0.289	0.289	0.289	0.603
2006	0.016	0.108	0.267	0.494	0.594	0.749	0.860	0.802	0.978	0.730	0.317	0.317	0.317	0.628
2007	0.013	0.087	0.236	0.365	0.544	0.543	0.581	0.673	0.582	0.664	0.258	0.258	0.258	0.490
2008	0.009	0.065	0.173	0.293	0.363	0.450	0.391	0.425	0.450	0.382	0.194	0.194	0.194	0.349
2009	0.008	0.054	0.160	0.271	0.375	0.394	0.426	0.378	0.381	0.390	0.185	0.185	0.185	0.334
2010	0.008	0.055	0.150	0.285	0.396	0.469	0.429	0.474	0.389	0.380	0.200	0.200	0.200	0.367
2011	0.007	0.044	0.130	0.224	0.347	0.410	0.422	0.394	0.404	0.323	0.183	0.183	0.000	0.321
2012	0.007	0.040	0.107	0.198	0.280	0.371	0.383	0.402	0.349	0.346	0.173	0.173	0.173	0.290
2013	0.007	0.048	0.112	0.190	0.291	0.354	0.414	0.435	0.425	0.357	0.191	0.191	0.191	0.299
2014	0.008	0.051	0.145	0.213	0.297	0.396	0.423	0.509	0.496	0.467	0.225	0.225	0.225	0.331
2015	0.009	0.060	0.153	0.277	0.333	0.401	0.470	0.515	0.577	0.541	0.264	0.264	0.264	0.358
2016	0.009	0.056	0.151	0.245	0.363	0.371	0.390	0.466	0.473	0.509	0.258	0.258	0.258	0.331
2017	0.012	0.068	0.177	0.306	0.409	0.527	0.467	0.502	0.561	0.548	0.321	0.321	0.321	0.398
2018	0.014	0.085	0.195	0.322	0.460	0.525	0.590	0.531	0.529	0.570	0.356	0.356	0.356	0.437
2019	0.012	0.083	0.200	0.286	0.384	0.464	0.458	0.523	0.438	0.422	0.315	0.315	0.315	0.386
2020	0.015	0.082	0.228	0.350	0.407	0.465	0.490	0.494	0.523	0.423	0.332	0.332	0.332	0.406
2021	0.014	0.092	0.242	0.408	0.562	0.653	0.651	0.664	0.622	0.562	0.304	0.304	0.304	0.530

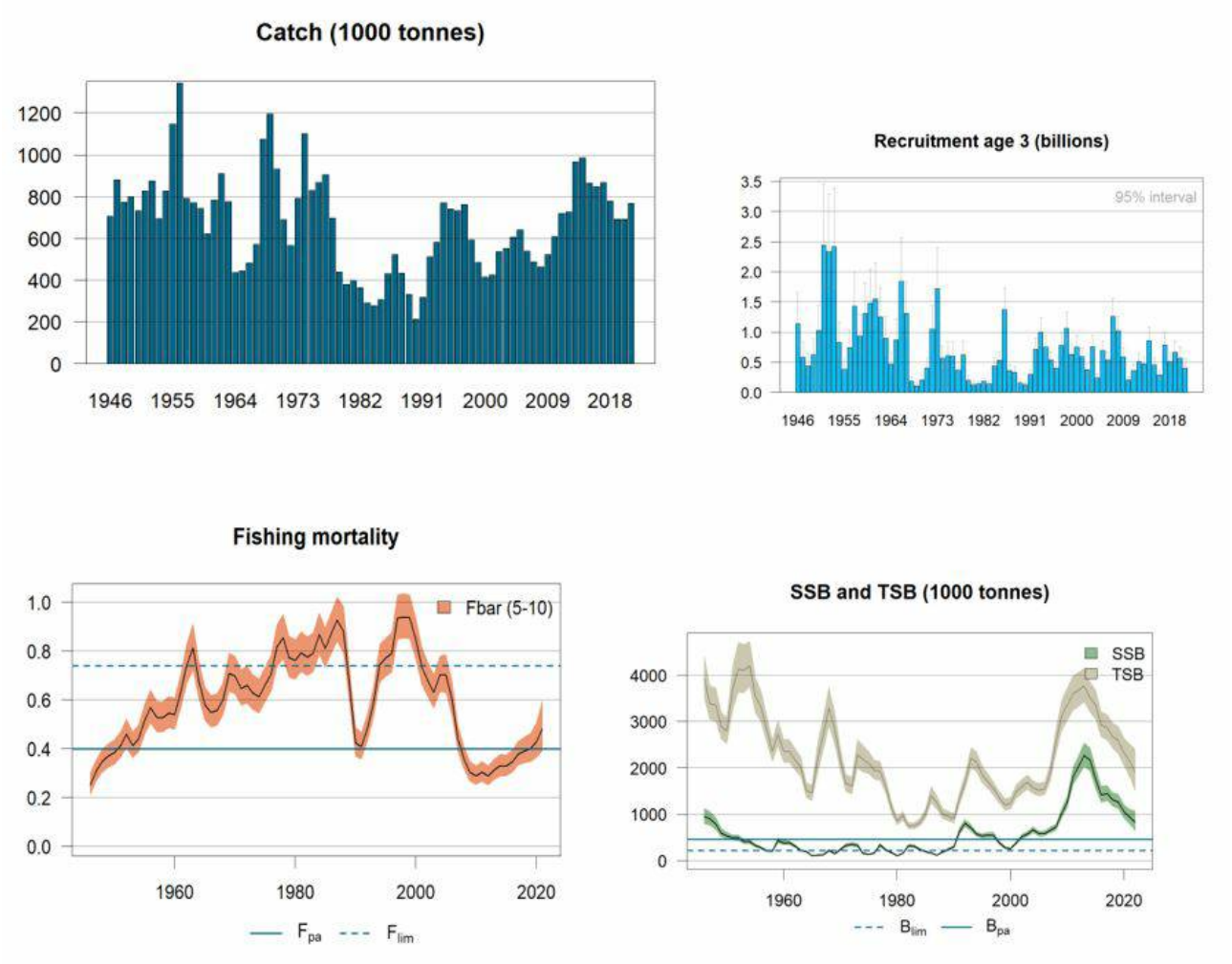


Figure 3.1. Standard plots for Northeast Arctic cod (ICES subareas 1 and 2)

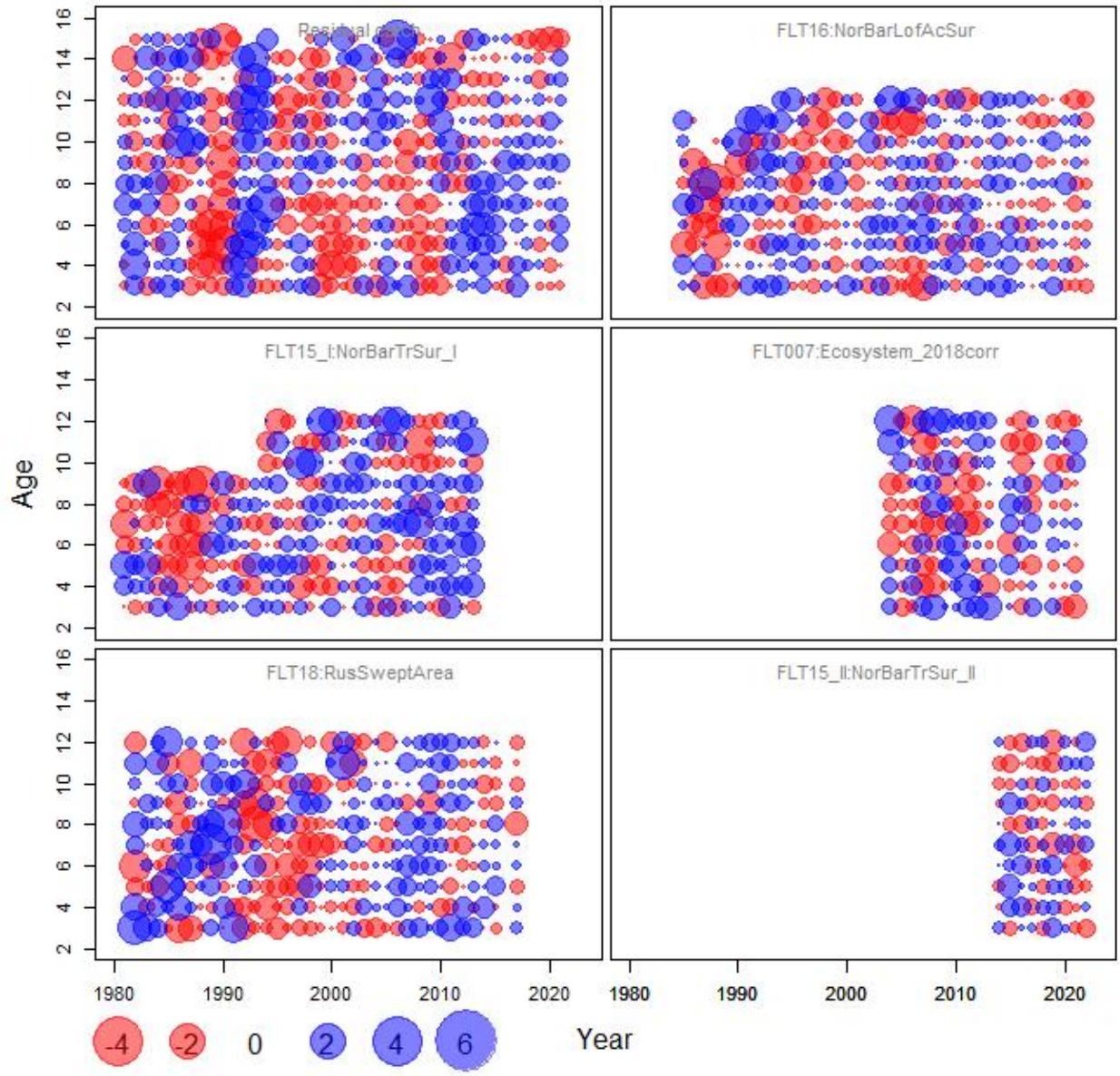
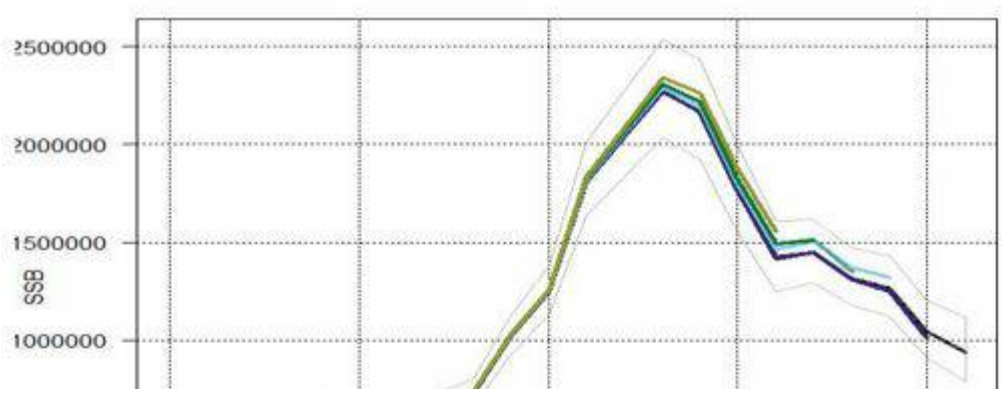


Figure 3.2a. Standardized one-observation-ahead residuals for log-catches and log-indices (Thygesen et al . 2017) in the final SAM run



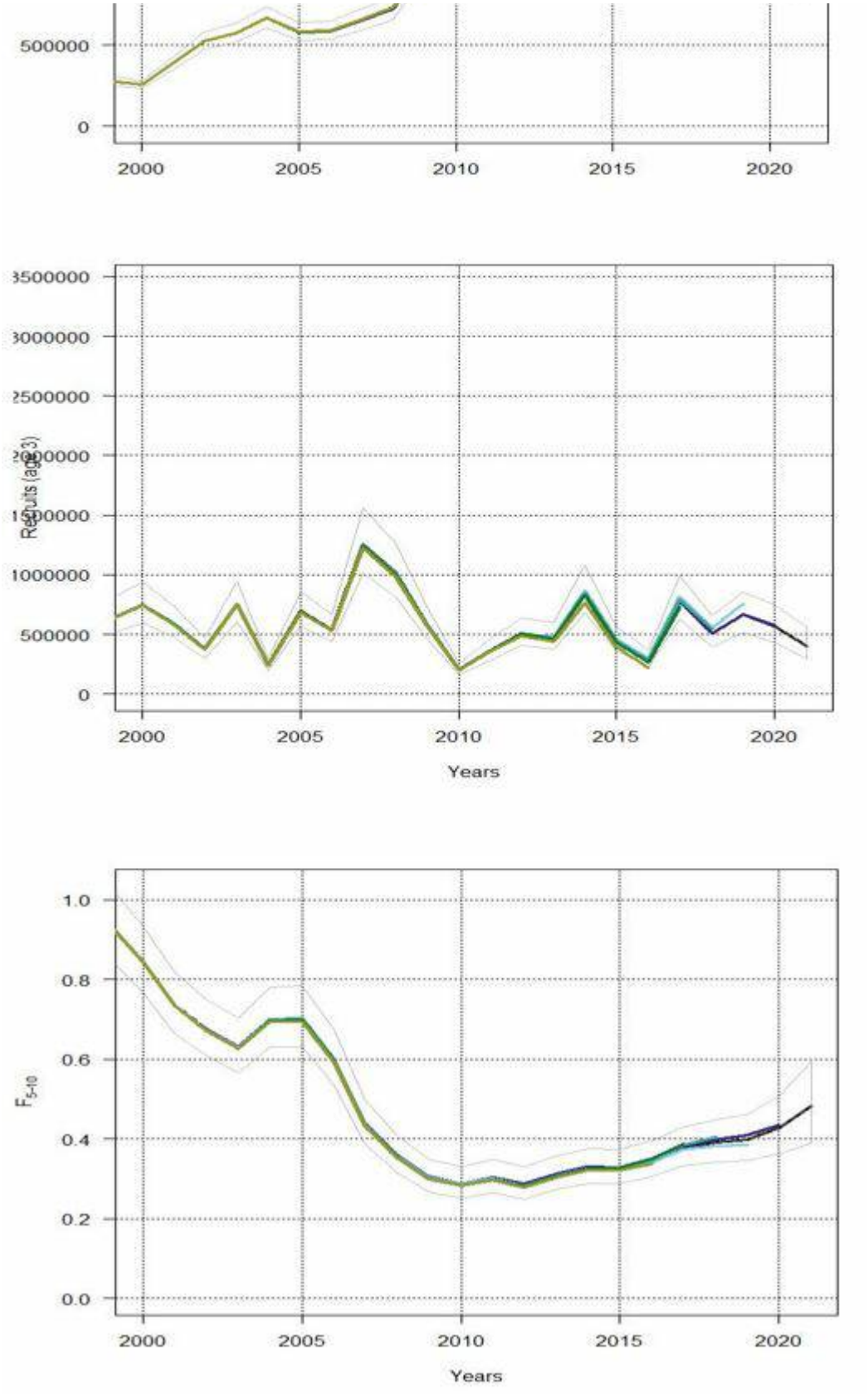


Figure 3.2b. NEA cod SSB, R and Fbar model retrospective pattern for final SAM run.

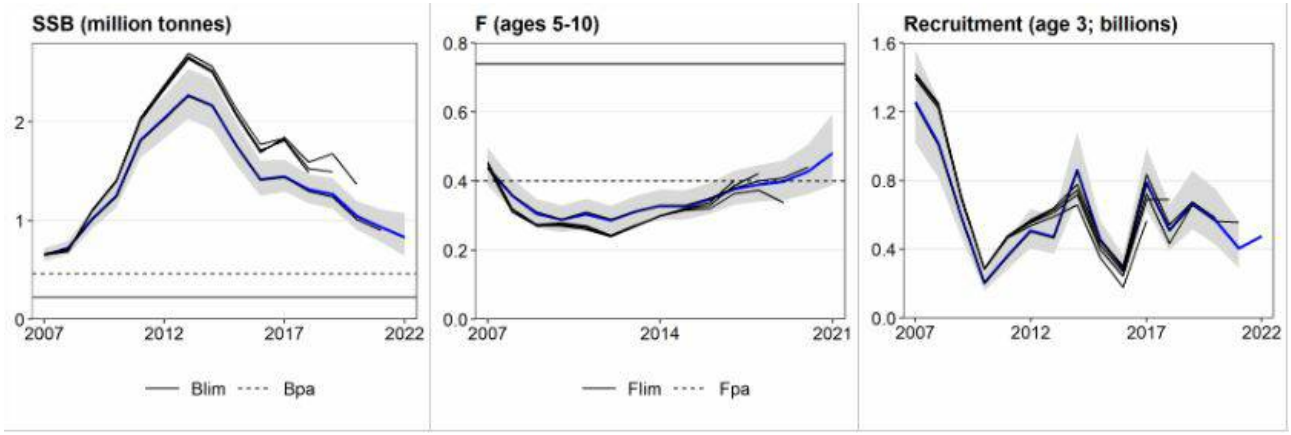


Figure 3.2c. NEA cod SSB, Fbar and R historical retrospective pattern for final SAM run.

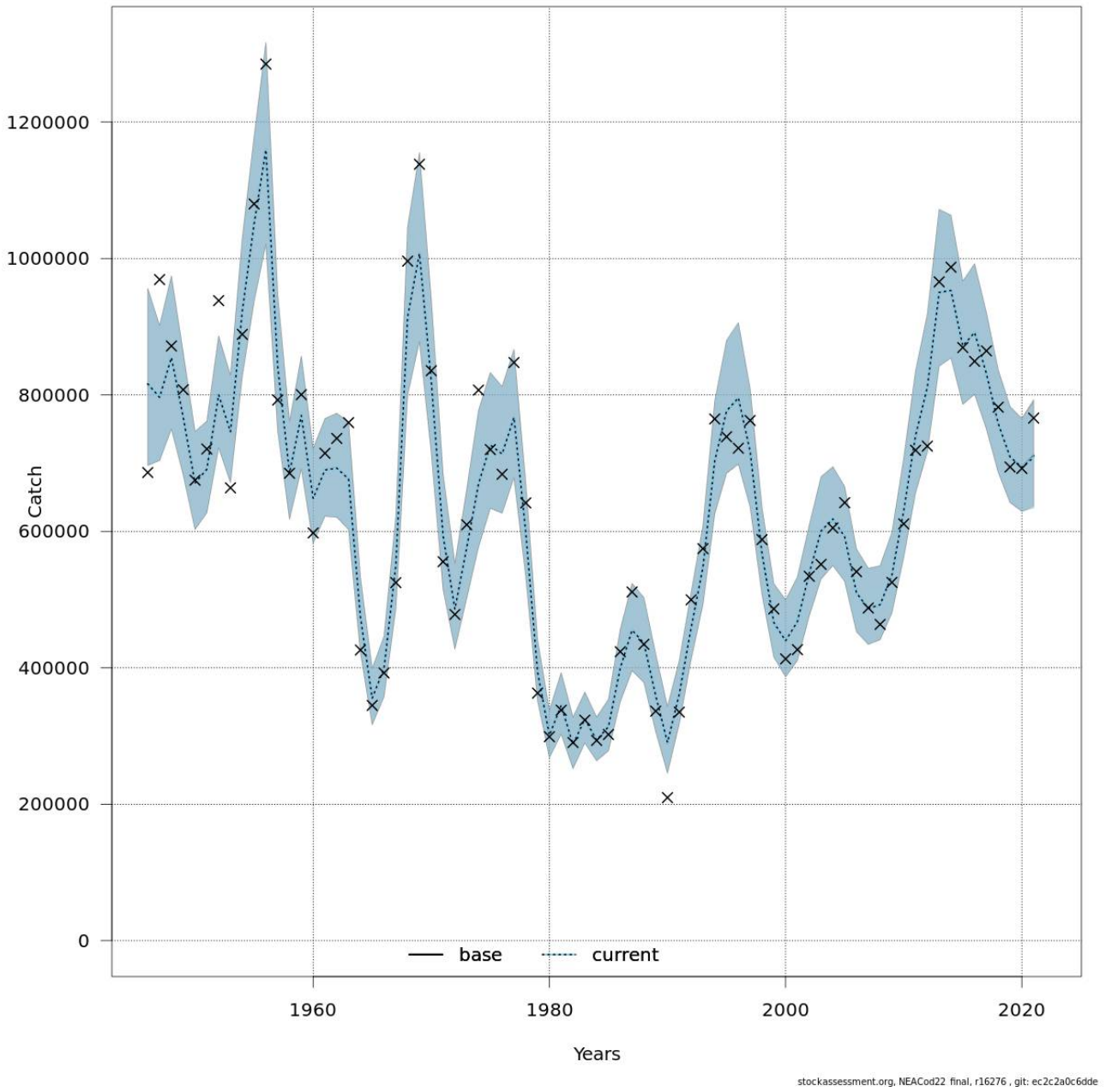


*Figure 3.2d. NEA cod final SAM run fit. Total catch in weight. Modelled catches from the final run and point wise 95% confidence intervals are shown by line and shaded area. The yearly observed total catch weight (crosses) are calculated as Catch(y)=sum(W(a,y)*C(a,y)).*

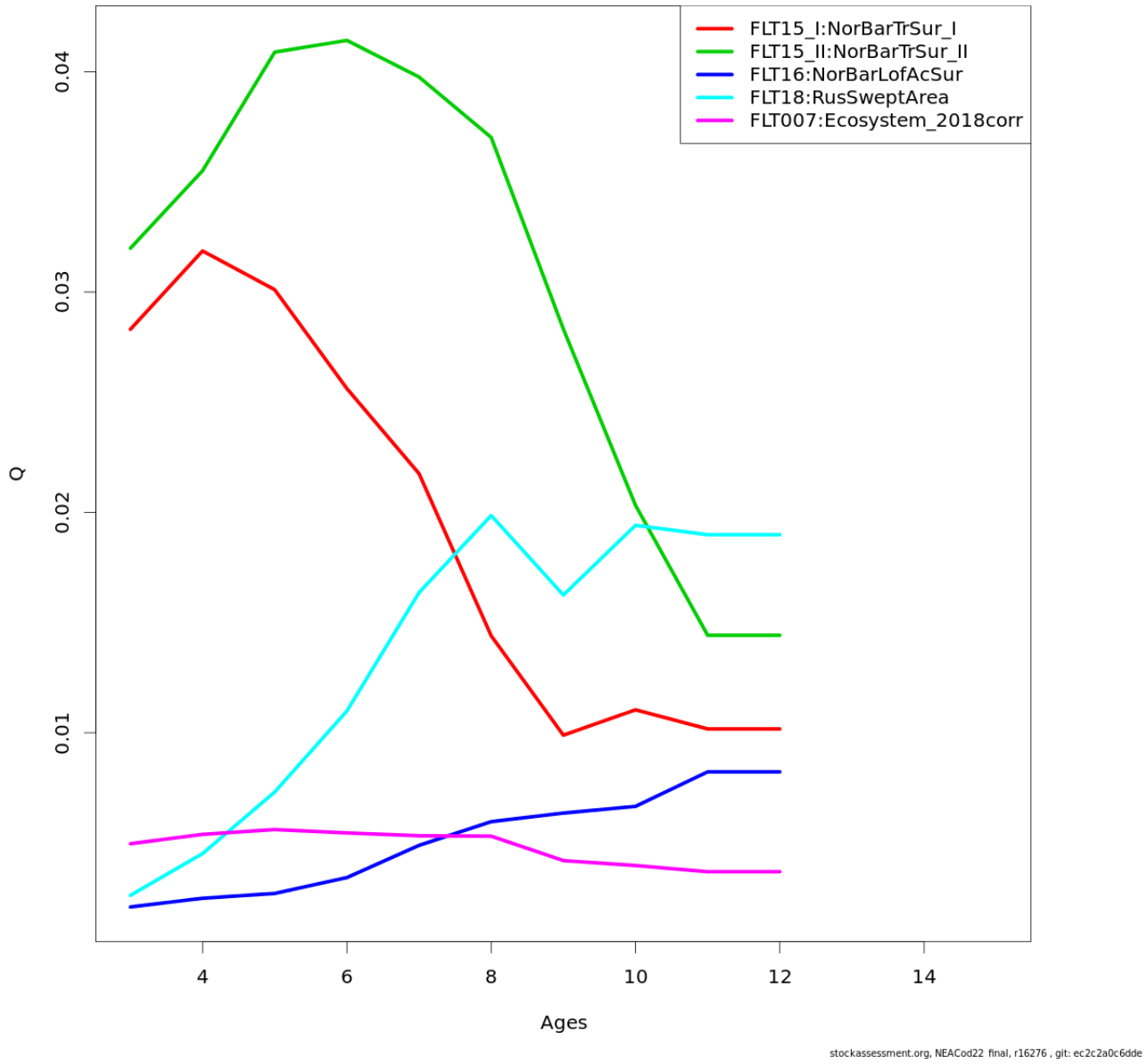


Figure 3.2e. NEA cod. Catchability of different fleets used for final SAM run fit.

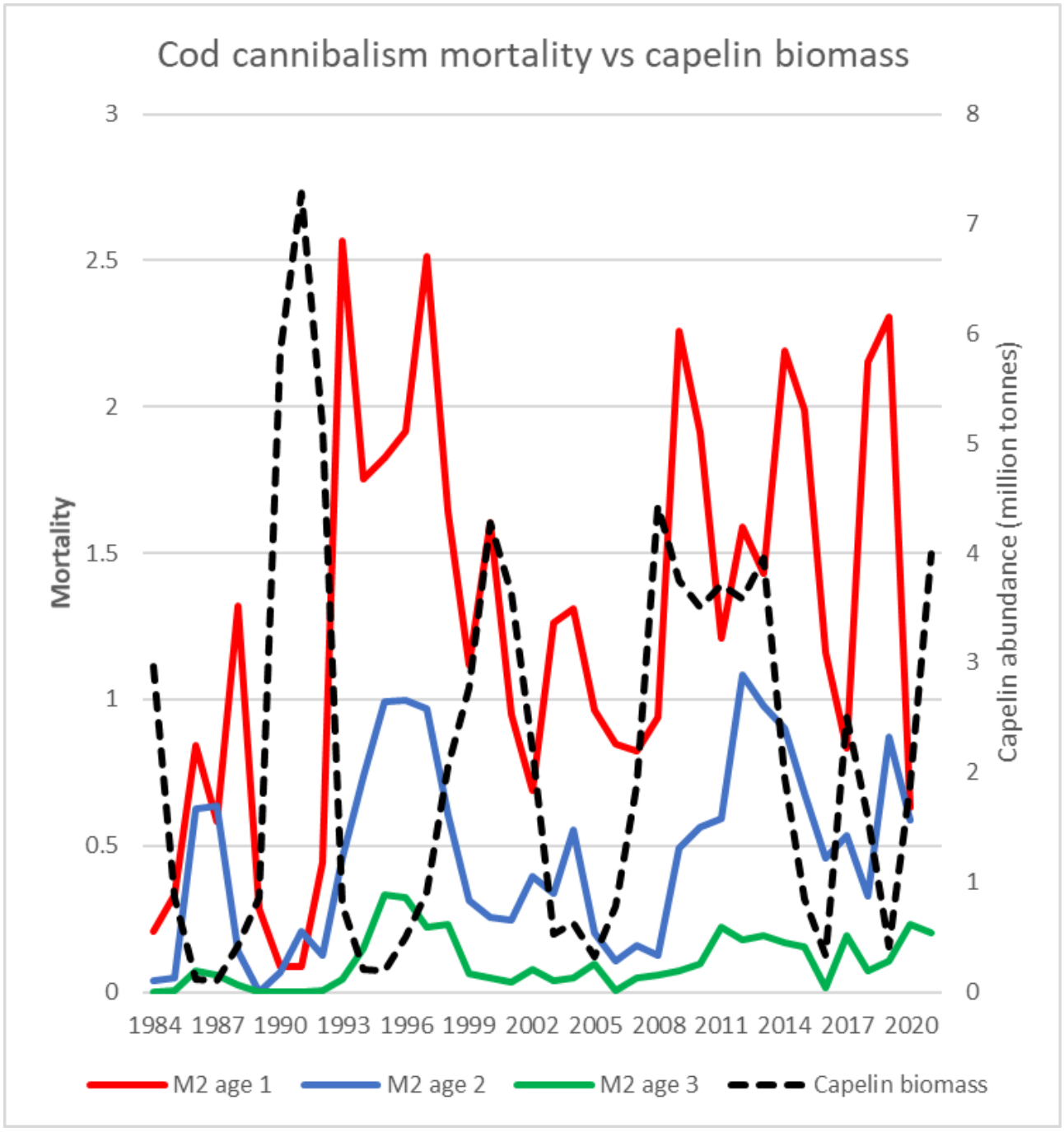


Figure 3.3. NEA cod cannibalism mortality vs. capelin abundance.

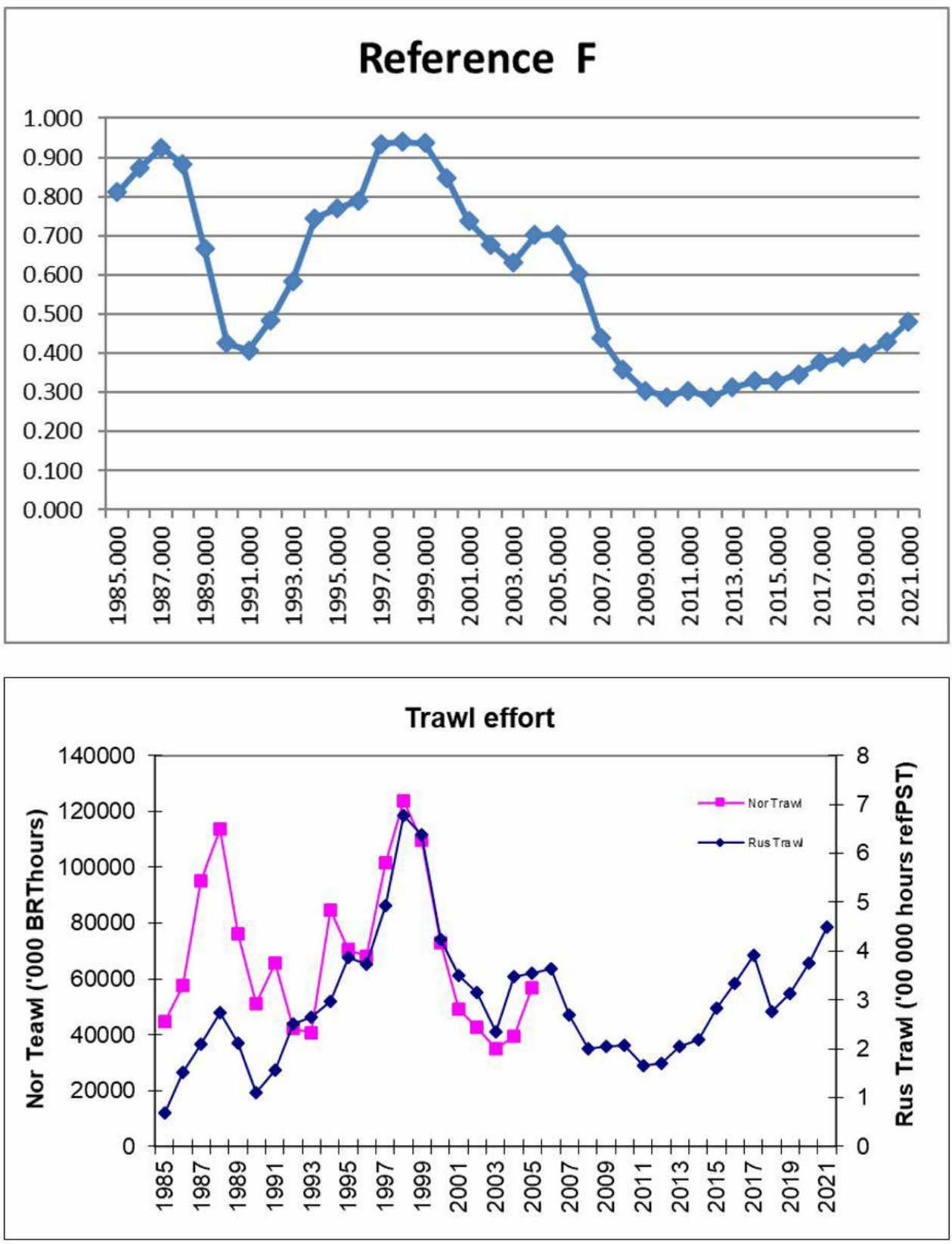


Figure 3.4. Northeast Arctic cod. Fishing mortality (F5-10) (top panel) and trawl efforts in 1985–2020 (bottom panel).

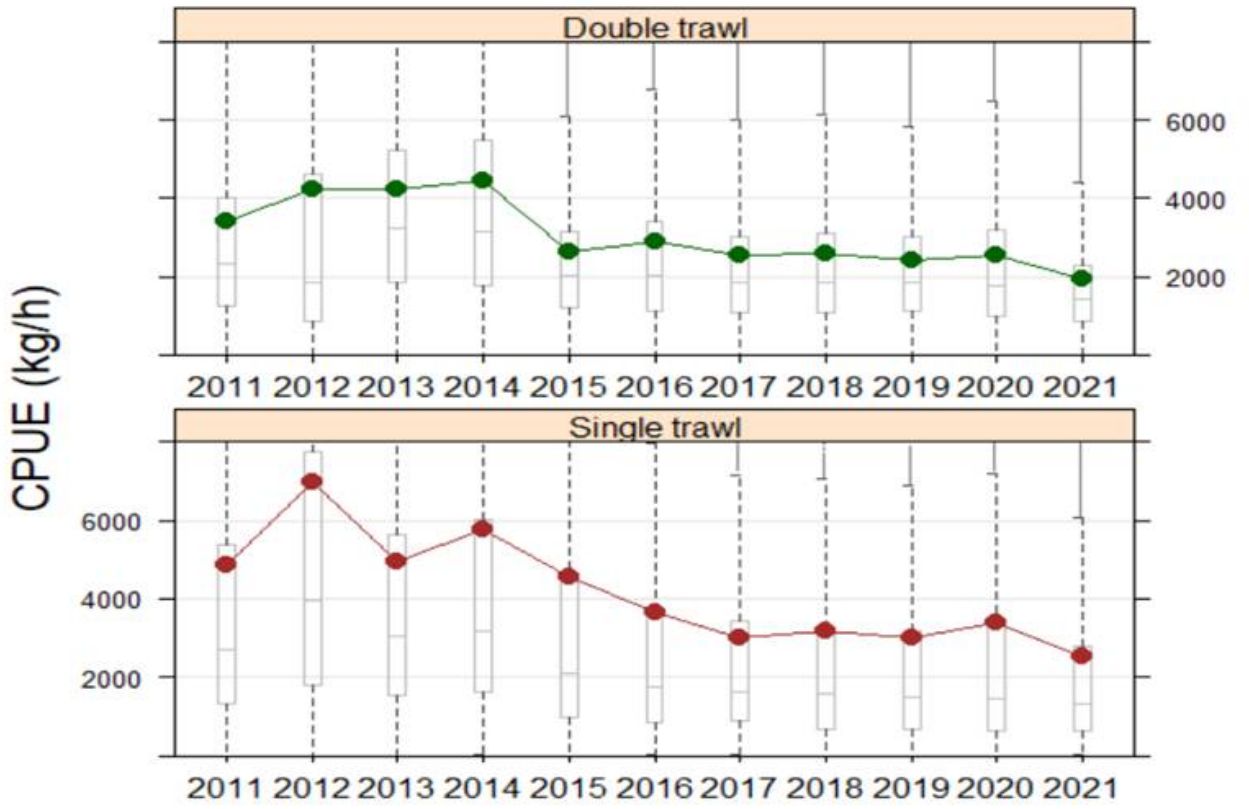


Figure 3. 5. Cod CPUE in Norwegian trawl catches where cod is the main species (double and single trawl). Connected line shows mean, line inside the box shows the median, and the box shows 25 and 75 percentiles.

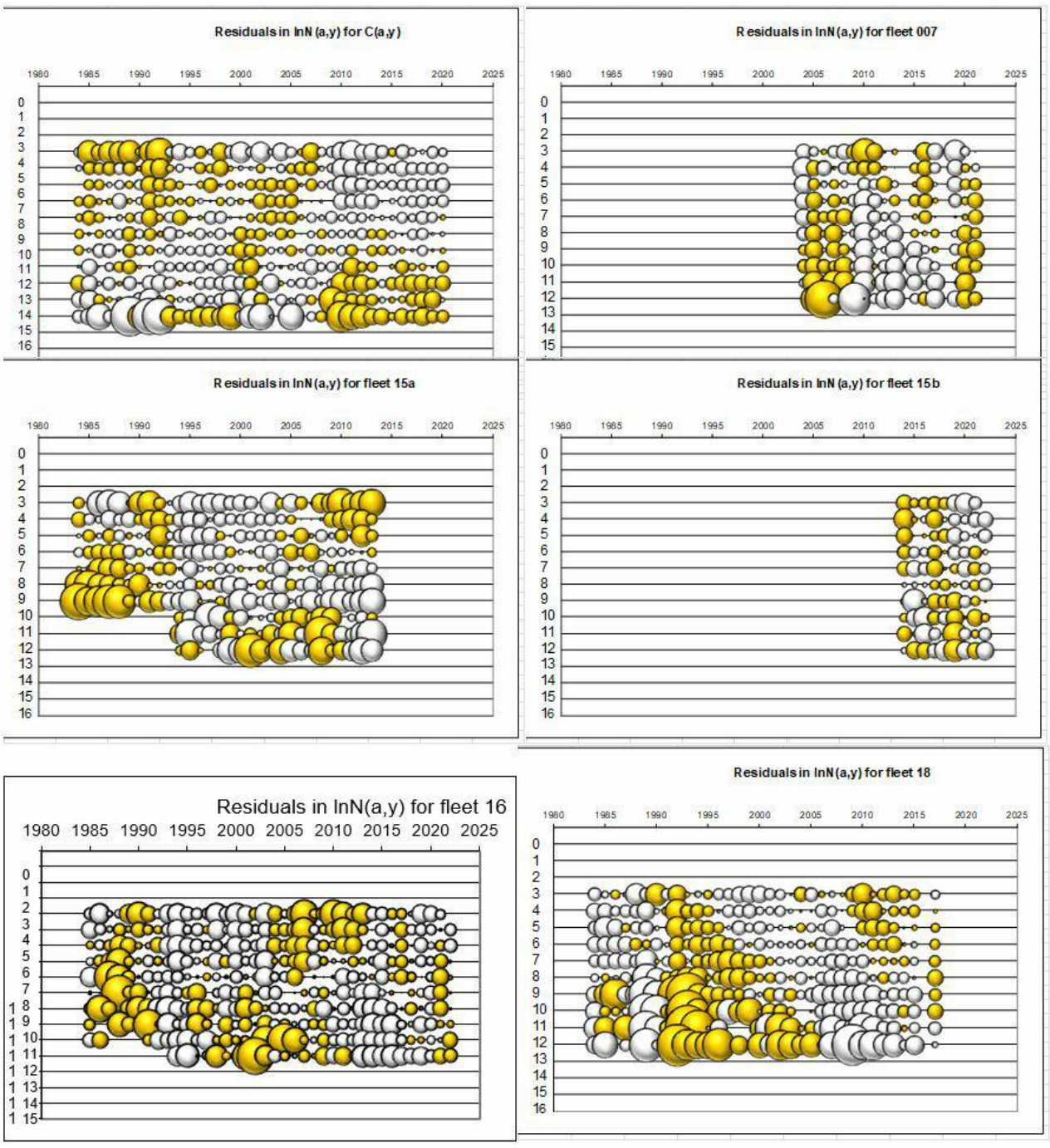


Figure 3.6a. Residuals of the TISVPA data approximation (yellow circles are positive residuals, white – negative, maximum bubble size corresponds to residual = 2.4).

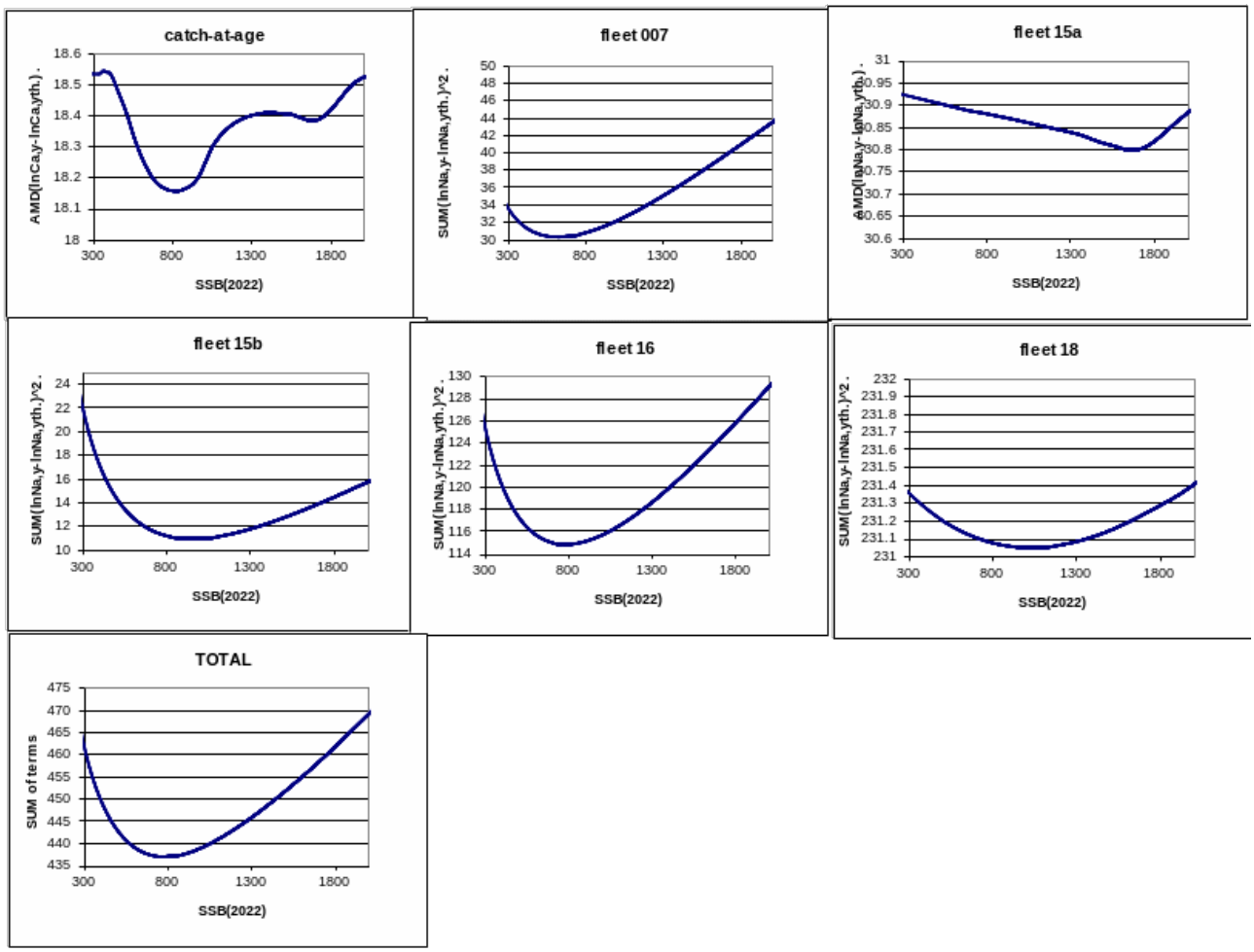
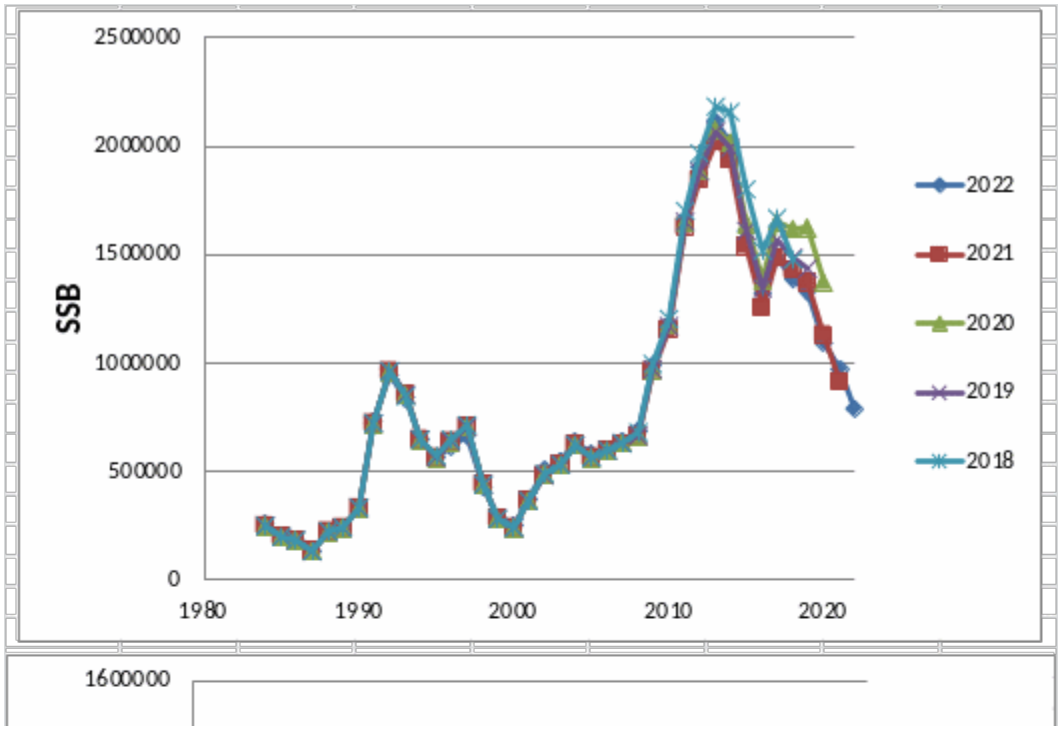


Figure 3.6b. Profiles of the components of the TISVPA objective function.



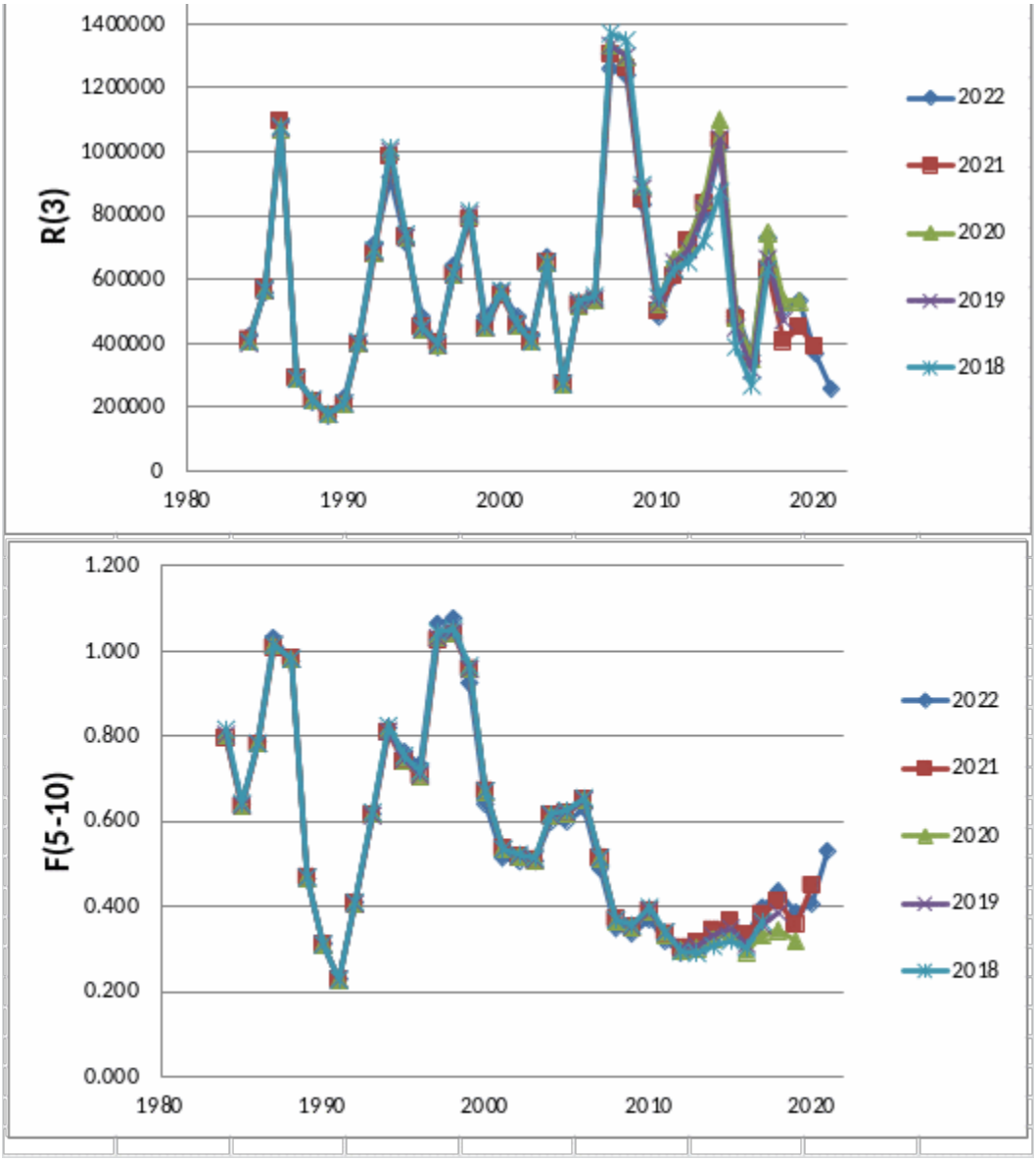


Figure 3.6c. TISVPA retrospective runs.

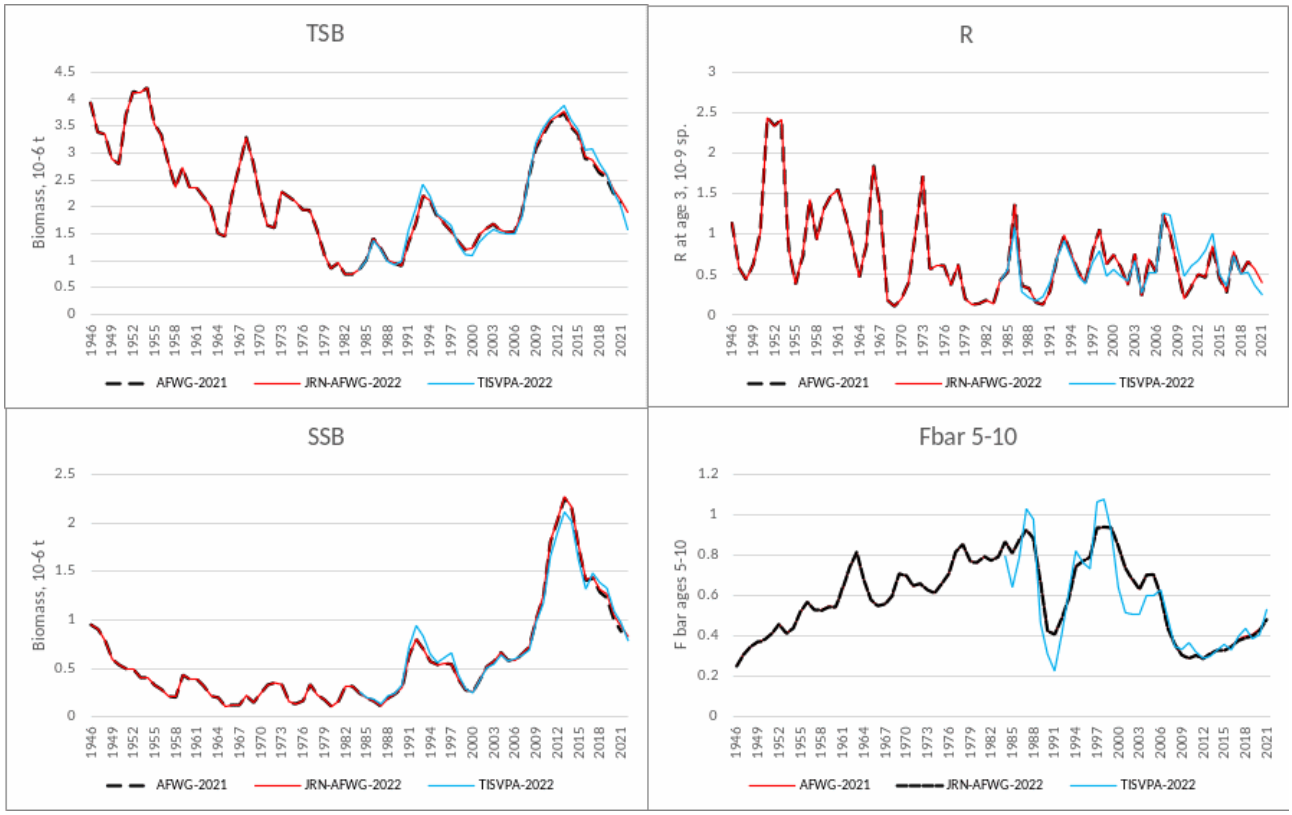


Figure 3.7. Model comparison. TSB (total stock biomass, age 3+), SSB recruitment and F in SAM and TISVPA.

Table A1. North-East Arctic COD. Catch per unit effort.

	Sub-area I			Division IIb			Division IIa		Total
Year	Norway [2]	UK [3]	Russia [4]	Norway [2]	UK [3]	Russia [4]	Norway [2]	UK [3]	Norway
1966	-	0.074	0.42	-	0.078	0.19	-	0.067	
1967	-	0.081	0.53	-	0.106	0.87	-	0.052	
1968	-	0.110	1.09	-	0.173	1.21	-	0.056	
1969	-	0.113	1.00	-	0.135	1.17	-	0.094	
1970	-	0.100	0.80	-	0.100	0.80	-	0.066	
1971	-	0.056	0.43	-	0.071	0.16	-	0.062	
1972	0.90	0.047	0.34	0.59	0.051	0.18	1.08	0.055	
1973	1.05	0.057	0.56	0.43	0.054	0.57	0.71	0.043	
1974	1.75	0.079	0.86	1.94	0.106	0.77	0.19	0.028	
1975	1.82	0.077	0.94	1.67	0.100	0.43	1.36	0.033	
1976	1.69	0.060	0.84	1.20	0.081	0.30	1.69	0.035	
1977	1.54	0.052	0.63	0.91	0.056	0.25	1.16	0.044	1.17
1978	1.37	0.062	0.52	0.56	0.044	0.08	1.12	0.037	0.94
1979	0.85	0.046	0.43	0.62	-	0.06	1.06	0.042	0.85
1980	1.47	-	0.49	0.41	-	0.16	1.27	-	1.23
					Spain [5]			**Russia** [4]	
1981	1.42	-	0.41	(0.96)	-	0.07	1.02	0.35	1.21

1982	1.30	-	0.35	-	0.86	0.26	1.01	0.34	1.09
1983	1.58	-	0.31	(1.31)	0.92	0.36	1.05	0.38	1.11
1984	1.40	-	0.45	1.20	0.78	0.35	0.73	0.27	0.96
1985	1.86	-	1.04	1.51	1.37	0.50	0.90	0.39	1.29
1986	1.97	-	1.00	2.39	1.73	0.84	1.36	1.14	1.70
1987	1.77	-	0.97	2.00	1.82	1.05	1.73	0.67	1.77
1988	1.58	-	0.66	1.61	(1.36)	0.54	0.97	0.55	1.03
1989	1.49	-	0.71	0.41	2.70	0.45	0.78	0.43	0.76
1990	1.35	-	0.70	0.39	2.69	0.80	0.38	0.60	0.49
1991	1.38	-	0.67	0.29	4.96	0.76	0.50	0.90	0.44
1992	2.19	-	0.79	3.06	2.47	0.23	0.98	0.65	1.29
1993	2.33	-	0.85	2.98	3.38	1.00	1.74	1.03	1.87
1994	2.50	-	1.01	2.82	1.44	1.14	1.27	0.86	1.59
1995	1.57	-	0.59	2.73	1.65	1.10	1.00	1.01	1.92
1996			0.74		1.11	0.85		0.99	1.81
1997			0.61			0.57		0.74	1.36
1998			0.37			0.29		0.40	0.83
1999			0.29			0.34		0.39	0.74
2000			0.34			0.37		0.53	0.92
2001			0.46			0.46		0.69	1.21
2002			0.58			0.66		0.57	1.35
2003			0.70			1.22		0.73	1.67
2004			0.48			0.78		0.84	1.67
2005			0.45			0.62		0.81	1.23
2006			0.49			0.54		0.84	0.88
2007			0.71			0.51		0.88	1.16
200 8			0.93			0.79		1.21	
2009			1.33			1.16		0.83	
2010			1.47			1.18		1.16	
2011			1.77			1.69		2.46	4.87 [6]
2012			2.25			1.44		2.11	6.97 [6]
201 3			2.30			1.46		2.60	4.96 [6]
201 4			2.07			1.54		2.38	5.75 [6]
2015			1.06			1.38		1.93	4.54 [6]
2016			1.15			1.06		1.39	3.64 [6]
201 7			1.00			1.0 0		1.0 5	3.01 [6]
2018			1.0 6			1. 40		1. 31	3.20 [6]
2019			1 .01			0.89		1.16	3.02 [6]
2020			0.78			0.68		1.42	3.38 [6]
2021 [1]			0.70			0.89		0.86	2.51 [6]

[1] Preliminary figures.

[2] Norwegian data - t per 1,000 tonnage*hrs fishing.

[3] United Kingdom data - t per 100 tonnage*hrs fishing.

[4] Russian data - t per hr fishing.

[5] Spanish data - t per hr fishing.

[6] 2011-2020 Norwegian data on t per hr fishing are from single-trawl only, not comparable to data from previous years

Table A2. North-east Arctic COD. Abundance indices (millions) from the Norwegian acoustic survey in the Barents Sea in January-March. New TS and rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl. Data from 1994 onwards corrected for three northern areas and the method of filling in gaps (WD 1, WKBarFar 2021).

Period	Sub-area I	Divisions IIa and IIb
1960–1973	RT	RT
1974–1980	PST	RT
1981–	PST	PST

Vessel type: RT = side trawlers, 800–1000 HP, PST = stern trawlers, up to 2000 HP.

Year			Age															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	10+	12+
1981	8.00	82.00	40.00	63.00	106.00	103.00	16.00	3.00	1.00							422.0	1.00	
1982	4.00	5.00	49.00	43.00	40.00	26.00	28.00	2.00	+							197.0	0.00	
1983	60.49	2.78	5.34	14.27	17.37	11.13	5.58	2.98	0.45							120.4	0.06	
1984	745.44	146.11	39.13	13.59	11.26	7.44	2.81	0.19	0.02							966.0	0.00	
1985	69.06	446.29	153.04	141.59	19.66	7.58	3.32	0.22	0.09							840.9	0.04	
1986	353.63	243.90	499.61	134.27	65.90	8.28	2.15	0.37	0.06							1308.2	0.02	
1987	1.62	34.07	62.80	204.93	41.41	10.40	1.22	0.19	0.66							357.3	0.00	
1988	1.98	26.25	50.42	35.53	56.20	6.48	1.35	0.15	0.01							178.4	0.00	
1989	7.53	7.98	17.00	34.39	21.38	53.82	6.88	0.97	0.10							150.1	0.05	
1990	81.13	24.92	14.82	20.63	26.08	24.30	39.78	2.37	0.06							234.1	0.03	
1991	181.04	219.51	50.23	34.64	29.33	28.87	16.89	17.33	0.86							578.7	0.03	
1992	241.38	562.13	176.48	65.79	18.84	13.23	7.58	4.50	2.78							1092.7	0.21	
1993	1074.04	494.68	357.24	191.05	108.24	20.84	8.12	4.98	2.25							2261.4	2.51	
1994	902.64	624.38	323.88	374.47	205.53	70.24	13	3.59	2.6	0.71	1.15	0.11	0.13	NA	0	2522.4		0.24
1995	2175.25	212.29	137.74	139.49	197.08	66.38	15.73	2.43	0.91	0.32	0.48	0.17	NA	NA	0	2948.3		0.17
1996	1826.33	271.71	99.4	89.62	111.34	82.96	22.17	2.22	0.3	0.1	0.07	0.05	0.1	0.01	0	2506.4		0.16
1997	1698.49	565.31	158.57	44.22	49.91	40.91	23.48	5.02	0.84	0.27	0.09	NA	NA	0.01	0	2587.1		0.01
1998	2523.56	475.15	391.16	189.79	44.87	41.22	27.85	16.06	1.81	0.5	0.04	NA	NA	NA	0.06	3712.1		0.06
1999	364.84	231.51	147.62	130.29	52.03	11.93	6.94	4.13	1.47	0.24	0.01	0.03	0.01	NA	0	951.1		0.04
2000	153.42	262.81	294.83	167.25	145.55	50.75	11.33	4.7	2.75	0.85	0.18	0.11	0.03	NA	0	1094.6		0.14
2001	363.55	51.45	177.44	160.63	80.8	44.47	11.1	1.73	0.46	0.19	0.08	NA	NA	NA	0.01	891.9		0.01
2002	19.22	209.1	61.37	106.23	98.78	52.18	20.07	2.9	0.32	0.52	0.09	NA	NA	NA	0.02	570.8		0.02
2003	1505	52.53	306.71	116.8	124.62	116.52	37.69	10.05	1.93	0.31	0.07	NA	0.08	0.07	0	2272.4		0.15
2004	161.2	117.19	33.41	85.21	32.96	28.03	18.14	5.33	1.16	0.31	0.08	0	0.01	NA	0	483.0		0.01
2005	499.71	138.66	125.03	33.28	65.94	21.21	15.02	4.95	1.01	0.25	0.05	0.07	0.05	0.03	0	905.3		0.15
2006	411.21	157.95	64.77	53.82	18.35	29.52	9.5	4.9	1.28	0.2	0.13	0.3	NA	NA	0	751.9		0.3
2007	85.13	47.09	58.49	30.4	29.35	9.04	18.07	6.41	2.67	0.53	0.24	0.07	NA	NA	0	287.5		0.07
2008	50.87	94.2	199.85	288.71	116.17	72.91	21.82	14.43	2.8	0.81	0.04	0.01	0.01	NA	0	862.6		0.02
2009	204.9	25.46	107.83	182.54	138.08	41.48	13.87	4.69	4.32	0.5	0.14	0.02	0.01	NA	0	723.8		0.03
2010	620.25	43.56	22.82	87.98	160.16	154.39	44.56	14.57	3.9	2.89	0.94	0.11	0.12	0.09	0.01	1156.4		0.33
2011	266	91	40.36	28.32	65.2	106.97	101.8	19.76	6.11	1.7	0.92	0.25	0.15	0.09	0.02	728.7		0.51
2012	496.49	40.23	82.79	49.38	33.77	72.53	132.3	65.59	8.37	4.39	1.21	0.66	0.47	0.04	0.1	988.3		1.27
2013	313.11	89.17	60.55	84.49	72.18	47.75	98.41	130.5	55.32	5.41	4.02	1.3	0.73	0.2	0.07	963.3		2.3
2014	1758.58	211.04	286.89	124.18	111.14	74.47	39.41	89.89	61.31	22.64	2.56	1.31	0.16	0.05	0.19	2783.8		1.71
2015	1903.54	211.41	138.71	235.58	128.8	140.36	80.55	35.07	53.8	24.38	7.91	0.8	0.13	0.05	0.01	2961.1		0.99
2016	240.8	201.89	56.29	76.91	119.38	64.84	50.17	25.8	13.49	17.83	7.35	2.15	0.72	0.22	0.1	877.9		3.19
2017	439.4	73.3	111.54	42.35	44.25	65.3	35.75	24.31	11.97	4	2.88	3.15	0.67	0.19	0.11	859.2		4.12
2018	2057.6	280.29	109.03	149.94	53.4	54.93	66.09	34.35	10.78	6.27	1.73	2.25	1.5	0.15	0.23	2828.5		4.13
2019	1437.21	362.38	203.63	125.42	144.06	60.98	34.99	37.86	9.64	3.47	0.55	0.32	0.18	0.28	0.24	2421.2		1.02
2020	92.68	157.92	117.32	117.32	81.36	90.6	42.35	26.57	21.41	6.23	1.75	0.67	0.66	0.51	0.89	758.2		2.73
2021*	45.92	28.51	64.86	59.08	55.48	38.54	30.80	12.41	6.32	4.67	2.17	0.29	0.18	0	0.21	349.4		0.68
2022	524.71	43.42	29.42	52.98	56.69	47.05	42.94	27.77	7.85	2.44	1.51	0.94	0.18	0	0.28	838.2		1.40
*revised																		

Table A3. North-East Arctic COD. Abundance indices (millions) from the Norwegian bottom trawl survey in the Barents Sea in January-March. Rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl. Data from 1994 and onwards corrected - WD 1, WKBarFar 2021

			Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	10+	12+
1981	4.60	34.30	16.40	23.30	40.00	38.40	4.80	1.00	0.30							163.1	0.00	
1982	0.80	2.90	28.30	27.70	23.60	15.50	16.00	1.40	0.20							116.4	0.00	
1983	152.90	13.40	24.95	52.34	43.33	16.96	5.82	3.21	0.97							313.9	0.05	
1984	2755.04	379.11	97.49	28.28	21.44	11.74	4.07	0.40	0.08							3297.7	0.08	
1985	49.49	660.04	166.79	125.98	19.92	7.67	3.34	0.21	0.07							1033.5	0.05	
1986	665.79	399.61	805.00	143.93	64.14	8.30	1.91	0.34	0.04							2089.1	0.03	
1987	30.72	444.98	240.38	391.15	54.35	15.70	2.00	0.45	0.03							1179.8	0.00	
1988	3.21	72.83	148.03	80.49	173.31	20.48	3.58	0.53	0.03							502.5	0.00	
1989	8.24	15.62	46.36	75.86	37.79	90.19	9.82	0.94	0.10							284.9	0.07	
1990	207.17	56.72	28.35	34.87	34.59	20.56	27.23	1.61	0.38							411.5	0.03	
1991	460.45	220.14	45.85	33.67	25.65	21.49	12.15	12.67	0.61							832.7	0.02	
1992	126.56	570.92	158.26	57.71	17.82	12.83	7.67	4.29	2.72							958.8	0.22	
1993	534.48	420.40	273.89	140.13	72.48	15.83	6.24	3.89	2.23							1469.6	2.36	
1994	1043.8	556.7	293.9	307	153.3	45.72	7.95	2.61	1.48	0.55	0.55	0.08	0.05	NA	0	2413.7		0.13
1995	5356.4	541.3	282.8	242.4	251	76.42	17.98	2.42	1.07	0.5	0.61	0.19	NA	NA	0	6773.1		0.19
1996	5899.2	791.6	163.1	117.4	138.6	108.9	24.43	2.64	0.37	0.17	0.12	0.07	0.07	0.02	0	7246.7		0.16
1997	5044.1	1423	318	68.44	74.26	59.99	26.67	4.85	0.64	0.91	0.08	NA	NA	NA	0	7020.8		0.00
1998	2490.5	496.5	355.1	166.9	31.67	26.15	17.52	8.16	0.79	0.52	0.04	NA	NA	NA	0.04	3594.0		0.04
1999	473.04	350.2	188.5	180.8	61.39	12.71	6.81	5.14	1.01	0.26	0.02	0.04	0.02	NA	0	1279.9		0.06
2000	128.57	242.3	245.8	130	111.7	26.75	4.56	1.84	1.21	0.33	0.1	0.03	0.02	NA	0	893.3		0.05
2001	712.77	78.03	182.8	195.1	82.9	37.96	9.45	1.17	0.44	0.19	0.04	NA	NA	NA	0.01	1300.9		0.01
2002	34.11	418.7	118.4	137.6	109	45.79	14.4	2.2	0.32	0.18	0.05	NA	NA	NA	0.02	880.7		0.02
2003	3022.2	65.78	376.7	126.3	93.93	66.88	17.5	4.67	1.02	0.17	0.04	NA	0.02	0.02	0	3775.3		0.04
2004	322.87	242.9	63.88	184.6	53.46	43.24	30.59	6.85	1.65	0.28	0.07	0.01	0.01	NA	0	950.5		0.02
2005	853.43	216.7	248.9	55.06	103	22.38	16.36	3.81	0.92	0.3	0.04	0.02	0.04	0.04	0	1520.9		0.10
2006	674.21	289.4	116.5	115.4	28.32	43.42	13.72	5.24	1.36	0.24	0.18	0.18	NA	NA	0	1288.1		0.18
2007	594.69	369.7	361.1	127.7	68.51	13.65	23.6	6.82	2.3	0.41	0.11	0.1	NA	NA	0	1568.8		0.10
2008	68.83	102	194.4	300.6	111.9	40.24	17.34	8.11	1.79	0.36	0.03	0.02	0.01	NA	0	845.6		0.03
2009	389.48	35.59	126.3	196.7	220.2	60.69	17.9	9.02	5.24	0.51	0.17	0.03	0.04	NA	0	1061.9		0.07
2010	1027.59	95.14	36.81	114.25	154.80	144.50	39.56	11.24	3.67	1.60	0.58	0.04	0.02	0.04	0.02	1629.9		0.12
2011	617.18	225.81	85.40	50.37	129.70	138.66	103.51	16.37	4.36	1.20	0.82	0.19	0.14	0.04	0.02	1373.8		0.39
2012	702.97	100.30	75.72	64.59	33.71	90.69	132.58	48.61	9.02	2.26	0.88	0.55	0.44	0.07	0.05	1262.4		1.11
2013	435.72	142.96	68.84	114.09	63.18	40.43	64.54	76.38	33.52	2.22	2.87	0.40	0.35	0.06	0.03	1045.6		0.84
2014	1245.71	191.48	226.85	93.79	88.59	56.39	32.74	53.05	36.19	9.81	1.01	0.95	0.15	0.02	0.08	2036.8		1.20
2015	1642.00	342.76	144.07	228.25	147.29	113.53	74.43	29.22	53.51	18.08	3.38	0.75	0.12	0.07	0.04	2797.5		0.98
2016	312.16	305.57	99.37	135.48	188.31	113.47	72.33	28.56	13.17	16.06	6.77	0.97	0.52	0.17	0.14	1293.1		1.80
2017	644.51	128.92	179.25	62.15	84.54	90.16	37.82	26.33	8.18	3.26	2.61	3.70	0.58	0.17	0.06	1272.2		4.51
2018	2714.35	500.69	139.41	184.78	61.81	64.17	73.88	25.88	9.28	5.87	1.29	2.46	1.23	0.13	0.37	3785.6		4.19
2019	1790.57	559.44	281.57	179.15	221.90	79.65	32.96	38.31	8.15	2.62	0.54	0.24	0.16	0.18	0.12	3195.6		0.70
2020	164.75	273.82	237.73	160.24	131.56	114.88	49.83	24.26	20.44	4.53	1.66	0.93	0.51	0.26	0.73	1186.1		2.43
2021*	80.88	34.87	111.50	119.35	112.31	54.28	37.98	13.57	7.27	3.53	1.25	0.42	0.25	0.04	0.32	577.8		1.03
2022	667.82	65.64	51.98	88.68	86.60	66.51	44.60	30.42	5.70	2.29	2.08	1.49	0.16	0.00	0.90	1114.9		2.55
*revised																		

Table A4. North East Arctic COD. Abundance at age (millions) from the Norwegian acoustic survey on the spawning grounds off Lofoten in March-April.

Year	5	6	7	8	9	10	11	12+	Sum
1985	0.68	7.45	12.36	3.11	1.15	1.01	0.45		26.21
1986	2.49	3.30	5.54	2.71	0.16		0.40	0.08	14.68
1987	8.77	7.04	0.23	2.83	0.04		0.03	0.03	18.97
1988	1.57	4.43	2.56	0.05	0.01	0.05			8.67
1989	0.04	13.20	9.73	2.20	0.38	0.12		0.06	25.73
1990	0.13	2.60	27.02	4.85	0.49	0.32			35.41
1991	0.00	5.00	19.83	32.67	2.75	0.19	0.17		60.61
1992	2.74	5.23	20.80	20.87	79.60	4.17	1.61	0.22	135.24
1993	4.87	14.58	17.35	20.22	25.44	41.95	4.74	0.71	129.86
1994	23.78	25.85	10.36	8.21	7.68	3.49	17.53	2.61	99.51
1995	6.49	35.24	12.34	2.27	3.60	2.56	2.15	7.96	72.61
1996	1.41	14.43	24.00	3.65	0.79	0.25	0.80	1.30	46.63
1997	0.40	4.95	27.56	16.50	1.50	0.42		0.75	52.08
1998	0.05	0.30	7.06	11.05	3.24	0.51	0.18	0.02	22.41
1999	0.25	1.92	4.84	14.58	8.42	0.75	0.19	0.10	31.05
2000	3.61	3.85	3.25	2.15	2.23	0.45	0.39	0.05	15.98
2001	4.33	17.61	8.03	0.96	0.33	0.36	0.26	0.09	31.97
2002	2.30	19.11	16.50	6.49	0.83	0.31	0.47	0.01	46.02
2003	2.49	29.56	30.01	13.46	1.90	0.11	0.04	0.02	77.59
2004	1.96	17.52	29.82	16.34	7.67	2.04	0.15	0.68	76.18
2005	3.33	12.93	28.75	13.06	6.51	1.55	0.06	0.16	66.35
2006	0.20	12.50	8.11	10.98	7.42	2.12	0.16	0.66	42.14
2007	1.46	3.88	28.52	8.69	5.35	2.80	0.68	0.36	51.72
2008	0.45	5.96	2.95	20.72	2.70	2.02	1.66	0.71	37.17
2009	3.42	14.48	27.64	8.10	22.31	3.07	1.56	0.37	80.95
2010	0.96	20.06	16.98	16.84	6.89	9.61	3.05	2.60	76.96
2011	2.01	51.73	170.09	44.72	17.16	5.12	6.54	0.40	297.76
2012	0.46	12.56	91.58	67.75	17.30	5.98	2.59	1.53	199.76
2013	0.22	5.89	33.69	101.76	106.39	16.08	7.05	6.48	277.56
2014	0.25	2.82	15.49	58.75	112.10	75.33	12.07	8.82	285.62
2015	0.87	1.40	15.42	14.73	42.98	44.20	24.62	11.75	155.97
2016	0.24	1.46	9.05	14.53	22.06	38.65	27.06	25.45	138.51
2017	0.17	7.51	12.84	21.94	14.79	12.70	11.67	18.84	100.46
2018	0.61	3.28	11.11	11.21	8.44	7.82	4.42	9.60	56.50
2019	0.25	2.35	13.34	36.00	17.68	18.35	5.96	9.93	103.87
2020	0.58	3.17	7.75	24.37	28.05	13.28	6.66	5.29	89.15
2021*	0.34	1.68	6.13	3.90	5.04	9.68	5.99	2.77	35.53
2022	0.31	3.34	4.58	6.70	3.77	4.39	3.75	2.53	29.37
*revised									

Table A5. North East Arctic COD. Length (cm) at-age in the Barents Sea from the investigations winter survey in February. Data for ages 1-11 from 1994 and onwards - WD 1, WKBarFar 2021.

	Age													
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1981	17.0	26.1	35.5	44.7	52.0	61.3	69.6	77.9						
1982	14.8	25.8	37.6	46.3	54.7	63.1	70.8	82.9						
1983	12.8	27.6	34.8	45.9	54.5	62.7	73.1	78.6						
1984	14.2	28.4	35.8	48.6	56.6	66.2	74.1	79.7						
1985	16.5	23.7	40.3	48.7	61.3	71.1	81.2	85.7						
1986	11.9	21.6	34.4	49.9	59.8	69.4	80.3	93.8						
1987	13.9	21.0	31.8	41.3	56.3	66.3	77.6	87.9						
1988	15.3	23.3	29.7	38.7	47.6	56.8	71.7	79.4						
1989	12.5	25.4	34.7	39.9	46.8	56.2	67.0	83.3						
1990	14.4	27.9	39.4	47.1	53.8	60.6	68.2	79.2						
1991	13.6	27.2	41.6	51.7	59.5	67.1	72.3	77.6						
1992	13.2	23.9	41.3	49.9	60.2	68.4	76.1	82.8						
1993	11.3	20.3	35.9	50.8	59.0	68.2	76.8	85.8						
1994	11.3	17.9	30.2	44.6	55.2	65.7	73.9	78.9	87.4	97.2	97.6	104.7	122.4	
1995	12.2	18.1	29.0	42.2	53.9	63.9	75.4	80.4	85.9	99.1	90.1	109.0		
1996	12.1	18.8	28.8	40.5	49.4	60.9	71.8	85.1	92.4	94.9	96.1	104.2	103.9	121.0
1997	10.8	16.9	29.7	41.0	50.6	59.4	69.6	81.2	92.3	80.4	103.2			
1998	10.5	17.8	30.8	40.9	50.9	58.5	67.7	76.7	87.2	103.0	111.4		105.9	
1999	12.0	18.4	29.0	40.0	50.4	59.4	70.4	78.4	88.5	87.6	117.0	62.0	108.0	
2000	12.8	20.7	28.4	39.7	51.5	61.4	70.4	76.3	84.9	84.3	100.0	116.2	90.0	
2001	11.6	22.6	33.0	41.2	52.2	63.3	70.4	78.3	86.0	95.7	104.7			
2002	12.0	19.6	28.9	43.6	52.1	61.9	71.4	79.5	91.2	89.7	103.7			
2003	11.4	18.1	29.1	39.7	53.4	61.7	70.6	80.8	89.1	90.1	105.4		104.3	110.5
2004	10.6	18.4	31.7	40.6	51.7	61.6	68.6	79.7	90.9	90.4	92.2	116.0	112.0	
2005	11.2	18.3	29.5	43.4	51.1	60.4	71.0	79.6	89.0	96.4	109.3	113.7	129.6	107.0
2006	12.0	19.4	30.9	42.1	53.8	60.3	66.7	76.7	84.9	98.9	95.4	84.9		
2007	13.2	20.7	29.6	41.1	52.8	62.5	70.4	78.2	87.5	92.7	101.8	121.6	110.0	
2008	12.1	22.3	33.0	43.2	51.8	64.0	69.9	81.3	88.7	95.3	108.9	103.0	102.0	
2009	11.2	21.1	32.1	42.6	53.2	61.9	76.6	81.8	89.5	97.8	99.5	94.2	110.0	
2010	11.2	18.4	31.4	42.7	52.4	60.7	70.5	80.4	88.8	96.3	102.2	99.8	100.8	126.0
2011	11.9	19.5	29.4	41.9	51.0	60.7	68.1	78.3	86.1	95.4	102.2	110.4	114.3	116.9
2012	10.6	18.4	29.7	41.0	52.4	58.1	66.5	75.6	86.0	91.8	105.9	114.0	119.0	115.5
2013	11.2	19.3	31.1	41.1	51.7	62.0	69.7	76.5	81.2	95.3	93.7	110.7	110.8	145.0
2014	9.7	17.1	29.5	40.5	52.0	59.6	70.2	76.8	81.8	87.1	97.4	98.9	107.8	91.1
2015	10.5	15.9	30.0	40.3	51.1	60.2	68.8	77.5	81.2	88.7	94.0	101.9	127.5	121.1
2016	12.2	18.3	27.7	40.6	49.8	60.5	68.3	76.6	85.5	86.5	90.5	94.1	112.0	122.5
2017	12.3	22.2	31.2	42.5	51.2	60.5	69.6	75.5	85.2	90.9	96.0	92.6	108.6	108.7
2018	11.2	19.1	32.7	42.4	51.2	61.6	69.0	77.5	83.4	87.6	97.0	99.3	101.8	106.8
2019	11.7	17.5	31.2	42.4	51.0	59.6	69.7	77.0	84.1	87.1	99.3	103.4	104.6	109.8
2020	12.0	17.5	25.5	39.5	50.2	58.6	66.7	74.8	83.0	90.0	93.9	92.4	111.2	113.9
2021*	11.6	19.9	26.5	37.4	48.0	58.5	66.7	74.9	84.0	91.7	97.7	102.1	105.8	115.0
2022	10.8	20.4	32.4	39.1	49.3	58.4	68.7	75.3	84.1	92.5	98.2	102.6	113.2	
revised														

Table A6. North East Arctic COD. Weight (g) at-age in the Barents Sea from the investigations winter survey in February. Data for ages 1-11 from 1994 and onwards - WD 1, WKBarFar 2021.

Year \ Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1983	20	190	372	923	1597	2442	3821	4758						
1984	23	219	421	1155	1806	2793	3777	4566						
1985	20	171	576	1003	2019	3353	5015	6154						
1986	20	119	377	997	1623	2926	3838	7385						
1987	21	65	230	490	1380	2300	3970	6000						
1988	24	114	241	492	892	1635	3040	4373						
1989	16	158	374	604	947	1535	2582	4906	10943	5226				
1990	26	217	580	1009	1435	1977	2829	4435	10772	11045	9615			
1991	18	196	805	1364	2067	2806	3557	4502	7404	13447				
1992	20	136	619	1118	1912	2792	3933	5127	6420	8103	17705	22060		
1993	9	71	415	1179	1743	2742	3977	5758	7068	7515	7521	10744		
1994	13	56	262	796	1470	2386	3481	4603	6777	8195	8516	13972		
1995	15	54	240	658	1336	2207	3570	4715	5712	8816	6817	12331		
1996	15	62	232	627	1084	1980	3343	5514	7722	8873	9613	12865	12556	
1997	13	52	230	638	1175	1797	2931	4875	7529	5739	10194			
1998	11	52	280	635	1182	1728	2588	4026	6076	11257	14391			
1999	14	59	231	592	1178	1829	2991	4128	6321	7342				
2000	16	74	210	558	1210	1963	3036	3867	5401	6154	10023			
2001	14	106	336	646	1288	2233	3088	4439	5732	8442	11429			
2002	14	67	238	747	1229	2063	3199	4578	7525	6598	12292			
2003	13	61	234	597	1316	2014	2989	4715	6517	7500	12812			
2004	11	59	275	608	1143	1947	2623	4137	6673	7368	8109			
2005	13	61	246	723	1146	1866	2949	4226	6436	8646	12537		24221	11640
2006	13	69	280	669	1420	1970	2641	4260	5914	10179	9439	8328		
2007	19	73	235	639	1302	2190	3039	4411	6394	8056	10826	20104		
2008	15	90	335	798	1399	2442	3235	5210	6981	9641				
2009	13	83	294	704	1302	2065	4067	5087	6874	9460	9511			
2010	12	64	304	700	1296	2033	3162	4743	6562	8984	10315			22766
2011	15	66	246	668	1131	1940	2726	4013	5969	8275	10309	13159	14868	
2012	13	62	252	609	1276	1681	2489	3764	5920	7809	12199	15006	17582	
2013	11	65	269	602	1208	2055	2809	3843	4822	8447	9101	15108	14743	
2014	8	50	246	603	1226	1780	2866	3930	4927	6203	8570	9566	12239	
2015	10	44	242	602	1221	1929	2741	4043	4804	6817	7759	11544	21652	
2016	13	53	200	593	1049	1928	2674	3830	5540	6129	7110	8272	15256	21945
2017	15	102	292	720	1178	1972	3056	3962	5901	7429	9301	8599	12958	14894
2018	12	69	320	688	1228	2062	2803	4154	5409	6632	9156	10510	11810	12443
2019	12	48	273	685	1164	1870	2916	3974	5394	6068	9637	11507	12371	13993
2020	14	44	153	548	1077	1692	2476	3625	5074	6758	8040	8107	14892	15793
2021*	14	68	164	462	910	1682	2484	3620	5379	7160	9313	10923	12410	
2022	11	77	311	535	1052	1716	2885	3855	5321	7751	9538	11432	14940	

*revised

Table A7. Northeast Arctic COD. Length at age in cm in the Lofoten survey.

Year/age	5	6	7	8	9	10	11	12	13	14	12+
1985	59.6	71.1	79.0	88.2	97.3	105.2	114.0				
1986	62.7	70.0	80.0	89.4	86.6		105.8				115.0
1987	58.2	64.5	76.7	86.2	88.0		118.5				116.0
1988	53.1	67.1	71.6	94.0	97.0	119.6					
1989	54.0	59.0	69.8	80.8	96.6	103.0					125.0
1990	56.9	65.1	69.2	79.5	83.7	100.1					
1991	59.0	67.3	74.4	81.0	91.3	99.8	85.0				
1992	66.3	68.7	78.3	83.9	89.2	92.2	101.9				127.0
1993	58.3	66.1	72.8	83.6	87.4	92.7	95.4				111.2
1994	64.3	70.6	82.0	87.3	90.0	95.3	92.4				101.4
1995	61.5	69.7	77.8	84.4	92.6	96.7	100.3				99.5
1996	62.2	67.1	75.9	81.0	93.6	100.9	97.4				104.1
1997	63.7	68.6	74.2	83.8	99.9	108.4					109.0
1998	55.0	62.6	70.2	80.0	92.0	98.0	96.7				115.0
1999	52.7	67.0	69.4	78.6	85.8	100.3	102.0				125.0
2000	58.4	66.5	72.6	77.0	83.9	90.6	93.7				112.4
2001	59.3	66.9	73.2	87.1	88.7	102.8	98.5				128.2
2002	58.6	66.0	73.2	80.8	88.2	101.8	91.0				101.4
2003	62.3	65.0	73.2	80.9	88.9	86.4	120.0				122.0
2004	58.8	64.7	71.2	80.1	85.6	97.0	102.6				115.8
2005	56.3	65.4	72.3	76.0	85.3	95.5	110.5				117.8
2006	56.2	63.7	72.6	77.5	82.9	88.3	89.2				116.3
2007	63.0	66.4	72.4	82.5	88.2	99.8	103.7				115.0
2008	63.8	69.1	73.6	80.9	90.0	94.9	94.9				96.5
2009	60.5	69.3	76.5	82.7	88.7	98.8	92.9				111.6
2010	59.9	64.9	73.6	83.3	89.2	96.3	100.8	103.1	118.2	123.0	
2011	57.1	64.3	70.0	79.9	91.2	98.3	101.6	103.6	110.0	102.0	
2012	65.3	65.1	69.9	76.6	85.3	98.7	104.6	103.9	116.2	89.0	
2013	63.6	68.7	73.0	78.4	83.5	90.9	99.1	96.6	103.0	116.8	
2014	55.9	66.0	74.5	77.9	82.8	86.8	93.4	99.1	109.2	116.0	
2015	61.0	66.5	72.9	78.6	83.4	89.0	95.4	99.5	106.1	114.5	
2016	64.0	63.0	74.3	81.1	88.8	93.2	95.5	97.1	103.2	117.1	
2017	58.0	64.8	70.7	81.6	87.3	94.8	98.7	99.4	102.7	106.1	
2018	67.9	67.3	72.9	79.5	89.4	93.6	99.3	104.9	104.3	107.9	
2019	59.9	69.4	74.7	81.4	87.9	93.9	98.1	106.2	111.1	109.8	
2020	66.1	68.3	75.1	81.8	88.9	95.1	96.3	106.0	109.5	109.1	
2021*	63.3	66.3	74.3	78.6	89.4	93.3	96.9	103.7	103.1	108.4	
2022	61.4	67.9	72.9	81.0	88.4	96.5	100.1	98.3	99.3	104.0	

*revised

Table A8. Northeast Arctic COD. Mean weight-at-age (kg) in the Lofoten survey.

Year	5	6	7	8	9	10	11	12	13	14+	12+
1985	2.00	3.42	4.61	6.67	8.89	10.73	14.29				
1986	2.22	3.22	4.74	6.40	5.80		10.84				13.48
1987	1.44	1.94	3.61	5.40	5.64		13.15				12.55
1988	1.46	2.82	3.39	6.63	7.27	13.64					
1989	1.30	1.77	2.89	4.74	8.28	9.98					26.00
1990	1.54	2.32	2.55	3.78	4.77	8.80					
1991	2.21	2.52	3.51	5.18	7.40	11.36	5.35				
1992	2.56	2.85	3.99	5.43	6.35	8.03	9.50				17.80
1993	1.79	2.58	3.55	5.31	6.21	7.69	9.28				14.71
1994	2.31	3.27	5.06	6.39	6.64	7.92	7.73				10.10
1995	2.20	3.24	4.83	5.98	7.80	10.03	10.39				10.68
1996	2.22	2.75	4.11	5.63	7.92	10.53	10.58				12.08
1997	2.42	2.92	3.86	5.71	9.65	13.41					12.67
1998	1.88	2.09	2.98	4.85	7.92	9.91	11.05				18.34
1999	1.51	2.80	2.96	4.22	5.92	9.33	9.17				16.00
2000	1.71	2.50	3.16	3.85	5.32	7.07	7.62				12.84
2001	1.90	2.72	3.49	6.23	6.82	10.95	10.29				28.58
2002	1.87	2.57	3.52	4.71	6.18	10.56	8.70				10.48
2003	2.30	2.34	3.48	4.59	5.89	8.07	24.50				27.70
2004	1.74	2.30	3.02	4.50	5.77	7.81	9.95				13.25
2005	1.56	2.40	3.20	3.71	5.79	8.52	16.27				18.63
2006	1.54	2.35	3.44	4.19	5.43	6.57	6.19				18.15
2007	2.34	2.67	3.53	5.30	6.70	9.95	11.24				16.62
2008	2.21	2.97	3.63	4.88	6.74	8.18	7.70				9.07
2009	2.04	2.98	4.10	5.19	6.56	9.38	8.58				15.67
2010	1.90	2.46	3.47	5.13	6.26	7.83	9.59	10.77	18.31	20.84	
2011	1.66	2.28	2.89	4.52	6.82	8.82	9.55	9.08	13.38	10.70	
2012	3.07	2.47	2.93	3.89	5.37	8.79	11.53	12.28	15.04	5.41	
2013	2.49	3.05	3.52	4.46	5.54	7.56	10.26	10.23	11.49	16.61	
2014	1.90	2.52	3.80	4.04	5.06	5.96	7.36	9.01	12.20	16.95	
2015	2.16	2.62	3.42	3.95	5.21	6.53	8.32	9.95	12.45	14.21	
2016	2.53	2.31	3.72	5.05	6.79	8.03	8.93	9.02	12.12	18.46	
2017	2.01	2.52	2.94	4.91	5.75	7.16	8.18	9.10	10.49	11.59	
2018	3.25	2.77	3.41	4.53	6.51	7.94	9.65	12.05	12.04	12.85	
2019	2.12	3.02	3.76	4.81	6.07	7.44	8.71	11.06	13.86	13.40	
2020	2.75	2.79	3.64	4.69	6.06	7.78	8.70	10.86	12.93	13.95	
2021*	2.30	2.62	3.76	4.40	6.59	7.39	8.56	10.15	11.82	14.79	
2022	2.61	3.00	3.59	5.01	7.15	8.34	9.34	9.35	9.41	11.63	

*revised

Table A9. Northeast Arctic COD. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent waters in the autumn. Stock number in millions.

Year					Age							Total
		1	2	3	4	5	6	7	8	9	10+	1941
1985	[1]	77	569	400	568	244	51	20	8	1	3	1998
1986	[1]	25	129	899	612	238	69	20	3	2	1	1323
1987	[2]	2	58	103	855	198	82	19	4	1	1	602
1988	[2]	3	23	96	100	305	54	16	3	1	1	332
1989	[1]	1	3	17	45	57	91	75	25	13	5	377
1990	[1]	36	27	8	27	62	74	91	39	10	3	494
1991	[1]	63	65	96	45	50	54	66	49	5	1	1222
1992	[1]	133	399	380	121	56	58	33	29	11	2	783
1993	[1]	20	44	220	234	164	51	19	13	8	10	1335
1994	[1]	105	38	147	275	303	314	100	35	10	8	971
1995	[1]	242	42	111	219	229	97	21	6	2	2	2127
1996	[1,3,5]	424	275	189	316	449	314	126	27	3	4	900
1997	[4,5]	72	160	263	198	112	57	27	9	1	1	672
1998	[1]	26	86	279	186	57	23	10	4	1	0	658
1999	[1]	19	79	166	260	98	20	8	5	2	1	642
2000	[1, rev]	24	82	191	159	127	48	6	3	1	1	656
2001	[1]	38	59	148	204	120	70	14	2	1		672
2002	[1,5,6]	83	2	106	85	140	151	67	30	7	1	908
2003		69	36	25	218	142	167	163	60	23	4	1669
2004		375	35	170	85	345	194	229	167	49	19	803
2005		112	48	65	154	70	214	68	47	17	8	341
2006	[7]	12	20	39	49	78	32	64	23	13	8	1221
2007		13	35	165	372	208	189	74	113	32	20	
[1]	October-December											
[2]	September-October											
[3]	Area IIb not covered											
[4]	Areas IIa, IIb covered in October-December, part of Area I covered in February-March 1998											
[5]	Adjusted for incomplete area coverage											
[6]	Area IIa not covered											
[7]	Area I not fully covered											

Table A10. Northeast Arctic COD. Abundance indices (millions) from the Russian bottom trawl survey in the Barents Sea.

Year				Age												
		0	1	2	3	4	5	6	7	8	9	10	11	12	13+	Sum
				Total (Sub-area I and Division IIa and IIb)												
1982		849.3	1905.3	33.2	141.3	152.5	72.1	19.8	55.1	17.4	3.7	1.9	1.5	0.1	0.0	3253.3
1983		1872.2	2003.4	73.2	52.0	64.2	50.6	35.8	17.9	25.2	9.4	0	0	0	0	4203.9
1984		363.3	180.5	104.4	118.9	70.0	48.9	35.7	15.4	6.9	6.1	1.7	1.5	0.6	0.2	954.0
1985		284.6	15.6	129.0	118.8	159.2	106.8	36.5	16.5	3.7	0.8	1.6	0.1	2.1	0.0	875.3
1986		329.9	7.6	31.7	162.2	153.2	149.3	48.1	18.9	4.2	0.2	0.6	0.0	0.0	0.0	905.9
1987		7.7	1.3	46.9	55.7	307.6	90.0	70.1	18.4	6.0	2.5	0.4	0.1	0.3	0.0	607.0
1988		92.5	2.9	31.3	99.3	93.8	287.9	58.3	26.0	4.7	2.4	0.1	0.0	0.0	0.0	699.2
1989		355.8	3.0	14.7	49.0	97.8	106.2	145.4	116.7	29.9	11.2	4.7	1.8	0.7	0.5	937.4
1990		1248.4	31.1	51.0	16.7	48.7	62.7	97.2	153.8	67.3	15.3	4.9	0.9	0.2	0.0	1798.2
1991		974.0	64.0	91.1	107.7	48.4	53.2	58.3	68.5	74.7	9.8	1.4	0.3	0.0	0.0	1551.4
1992		1204.8	157.7	151.1	67.5	30.8	23.9	27.3	21.8	17.5	2.5	2.5	0.4	0.0	0.0	1707.8
1993		484.8	38.0	158.6	160.4	113.5	68.1	41.6	35.4	8.7	0.3	0.7	0.1	0.1	0.0	1110.3
1994		1606.6	833.2	69.9	136.3	130.9	101.9	35.4	12.8	4.9	2.1	1.1	0.6	0.2	0.0	2935.9
1995		5703.5	471.9	36.9	58.9	106.5	139.5	84.9	25.1	8.3	1.9	1.8	0.9	0.6	0.0	6640.8
1996		2660.3	396.5	128.5	73.3	78.4	103.5	77.3	34.8	13.2	1.9	0.5	1.2	0.2	0.0	3569.6
1997		1371.4	353.9	135.3	134.2	83.5	61.3	60.2	34.8	11.6	3.2	3.0	0.0	0.0	0.0	2252.4
1998		304.8	276.8	89.6	202.8	136.3	78.8	47.0	25.9	13.0	4.8	0.5	0.0	0.1	0.0	1180.4
1999		266.9	40.1	118.4	158.7	207.2	98.0	30.1	12.3	9.4	4.2	0.4	0.0	0.0	0.0	945.7
2000		1436.5	37.7	103.6	183.9	128.6	178.6	77.3	11.4	5.2	2.3	0.9	0.4	0.0	0.0	2166.4
2001		321.6	233.8	77.3	122.4	155.7	129.0	106.1	30.4	5.0	1.4	0.5	2.5	1.3	0.0	1187.1
2002		1797.9	26.7	135.6	98.0	147.3	147.3	89.6	60.0	18.2	2.9	0.8	0.1	0.1	0.0	2524.4
2003		489.5	517.5	26.8	124.6	105.7	116.6	120.3	53.5	24.1	4.0	0.9	0.3	0.0	0.1	1583.9
2004		1770.4	158.4	87.5	32.9	157.6	88.0	111.1	77.6	27.9	9.3	2.3	0.4	0.2	0.0	2523.6
2005		2298.0	323.9	61.7	140.8	63.1	183.2	74.4	60.5	24.4	8.8	2.8	0.6	0.1	0.0	3242.4
2006		427.4	52.4	63.2	92.7	161.3	77.7	180.1	66.2	34.2	16.1	4.3	1.7	0.7	0.0	1178.1
2007		177.5	37.0	148.6	257.9	161.7	190.3	84.6	152.5	55.3	22.6	8.6	4.9	1.1	0.7	1303.3
2008		1468.6	45.2	86.3	220.3	308.8	163.5	147.2	83.0	86.3	29.1	11.5	3.3	1.7	0.2	2654.9
2009		1877.7	287.8	21.9	97.4	231.7	368.7	201.6	117.5	62.0	41.3	20.5	6.5	3.2	0.9	3338.7
2010		2210.4	214.9	47.0	33.4	107.0	250.5	371.5	181.7	78.9	39.5	29.9	15.6	5.5	2.0	3587.7
2011		2296.1	125.9	80.0	88.2	50.8	143.2	306.5	330.0	91.7	43.9	17.6	17.5	7.0	3.5	3602.1
2012		1096.0	196.2	45.1	81.5	111.4	83.9	212.2	335.8	187.8	43.2	19.5	4.6	5.7	1.9	2424.8
2013		297.1	654.0	107.6	74.7	117.4	117.7	88.4	234.9	313.2	136.7	30.6	9.2	5.4	4.5	2191.5
2014		909.7	211.0	72.1	139.9	136.8	172.5	148.3	111.1	192.9	129.7	38.3	9.3	3.5	2.0	2277.1
2015		572.9	465.4	51.5	65.7	158.3	174.2	193.2	161.0	92.5	115.8	76.1	24.2	6.5	4.9	2162.0
2016		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
2017		4325.9	5257.4	94.5	145.6	88.4	106.3	195.2	123.1	56.7	26.6	12.0	12.0	7.5	2.8	10454.0
2018		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
2019		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
2020		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

Table A11. Northeast Arctic COD. Length-at-age (cm) from Russian surveys in November-December.

Year	Age												
	0	1	2	3	4	5	6	7	8	9	10	11	12
1984	15.7	22.3	30.7	44.3	51.7	63.6	73.4	82.5	88.4	97.0	-	-	-
1985	15.0	21.1	30.6	43.2	53.7	61.2	72.8	83.0	92.8	101.3	-	-	-
1986	15.2	19.7	28.3	39.0	51.8	62.2	70.9	83.0	91.3	104.0	-	-	-
1987	-	19.2	27.9	33.4	41.4	59.1	69.2	80.1	95.7	102.6	-	-	-
1988	11.3	21.3	28.7	36.2	43.9	53.3	65.3	79.5	85.0	-	-	-	-
1989	-	20.8	28.8	34.8	46.0	53.9	61.8	69.8	78.7	88.6	-	-	-
1990	16.0	24.0	30.4	46.5	54.9	62.5	69.7	77.6	87.8	102.0	-	-	-
1991	11.5	22.4	30.6	43.0	55.9	64.6	72.8	78.5	87.9	101.8	-	-	-
1992	11.3	21.3	31.9	50.1	59.8	69.1	78.6	84.0	90.8	97.5	-	-	-
1993	12.1	17.4	29.1	43.4	52.7	64.3	73.9	81.2	89.1	91.8	-	-	-
1994	12.2	20.3	26.3	33.7	47.4	58.7	70.6	80.8	90.1	96.1	-	-	-
1995	11.6	19.8	27.6	33.8	45.2	60.5	71.1	83.5	92.9	99.1	-	-	-
1996	10.2	20.0	28.1	36.7	48.7	58.9	70.5	80.0	93.6	102.7	-	-	-
1997	9.6	18.5	28.8	38.2	50.8	62.0	70.5	80.1	88.9	103.5	-	-	-
1998	11.4	19.0	28.0	36.4	50.5	61.0	70.7	80.3	91.1	102.5	-	-	-
1999	11.7	19.7	27.9	35.3	51.6	60.6	70.6	78.9	86.8	94.3	-	-	-
2000	10.7	20.8	30.1	34.7	49.8	61.1	71.6	82.0	88.3	85.7	104,2	-	-
2001	10.6	19.4	29.8	37.3	50.4	61.9	71.9	81.4	91.0	98.7	103,8	-	-
2002	10.7	19.2	29.9	38.2	52.5	60.4	70.6	82.2	91.3	97.2	104.1	-	-
2003	9.8	18.9	28.3	34.9	49.2	62.2	71.0	81.5	92.3	100.9	104.3	-	-
2004	9.8	19.6	29.3	38.4	49.1	60.0	70.5	80.0	91.0	98.0	106.0	-	-
2005	11.2	19.4	29.7	38.5	48.7	59.3	69.3	79.2	87.7	96.1	104.4	-	-
2006	13.0	21.9	31.6	42.7	53.2	60.1	70.2	79.1	88.3	95.2	107.7	-	-
2007	10.7	21.5	30.8	42.2	53.6	63.7	71.0	79.6	87.3	95.9	-	-	-
2008	10.2	20.0	30.3	40.2	53.7	64.5	74.6	82.7	89.5	98.2	102.3	110.2	111.9
2009	12.9	19.3	29.5	38.4	50.7	61.5	70.7	81.7	89.9	94.7	101.8	105.9	109.4
2010	11.1	19.3	28.7	38.5	48.9	59.1	68.0	78.4	88.2	97.3	102.5	108.4	117.7
2011	11.2	20.3	29.2	38.5	49.5	58.6	68.7	78.2	90.0	97.9	106.9	109.3	116.0
2012	11.0	20.3	31.1	40.8	50.8	60.7	68.4	77.6	87.4	97.7	105.2	111.7	116.6
2013	9.5	19.5	29.0	40.3	50.4	59.3	67.3	75.3	84.4	95.3	104.5	111.9	119.4
2014	10.1	20.1	29.8	39.2	50.7	60.9	69.4	77.9	85.1	93.6	102.7	113.3	122.8
2015	11.5	19.0	28.5	37.5	48.0	58.4	67.4	76.3	83.5	91.0	98,8	107,1	117,9
2016	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	14.6	20.6	30.6	40.2	51.5	59.3	67.1	76.2	84.9	92.6	97.9	104	110.1
2018	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A12. Northeast Arctic COD. Weight (g) at age from Russian surveys in November-December.

Year	Age												
	0	1	2	3	4	5	6	7	8	9	10	11	12
1984	26	90	250	746	1187	2234	3422	5027	6479	9503	-	-	-
1985	26	80	245	762	1296	1924	3346	5094	7360	6833	11167	-	-
1986	25	63	191	506	1117	1940	2949	4942	7406	9300	-	-	-
1987	-	54	182	316	672	1691	2688	3959	8353	10583	13107	-	-
1988	15	78	223	435	789	1373	2609	4465	5816	-	-	-	-
1989	-	73	216	401	928	1427	2200	3133	4649	6801	8956	-	-
1990	28	106	230	908	1418	2092	2897	4131	6359	10078	13540	-	-
1991	26	93	260	743	1629	2623	3816	4975	7198	11165	15353	-	-
1992	10	76	273	1165	1896	2971	4377	5596	7319	9452	12414	-	-
1993	11	46	211	717	1280	2293	3509	4902	6621	7339	8494	-	-
1994	12	69	153	316	919	1670	2884	4505	6520	8207	9812	-	-
1995	11	61	180	337	861	1987	3298	5427	7614	9787	10757	-	-
1996	7	64	191	436	1035	1834	3329	5001	8203	10898	11358	-	-
1997	6	48	203	487	1176	2142	3220	4805	6925	10823	12426	-	-
1998	11	55	187	435	1186	2050	3096	4759	7044	11207	12593	-	-
1999	10	58	177	371	1214	1925	3064	4378	6128	7843	11543	-	-
2000	8	74	232	379	1101	2128	3341	5054	6560	8497	12353	-	-
2001	9	58	221	459	1125	2078	3329	4950	7270	9541	11672	-	-
2002	8	65	232	505	1299	1964	3271	5325	7249	9195	11389	-	-
2003	6	49	205	492	972	1993	2953	4393	6638	9319	11085	-	-
2004	6	55	231	543	1079	1798	2977	4110	5822	8061	12442	-	-
2005	10	59	223	521	1034	1910	3036	4619	6580	9106	12006	-	-
2006	13	72	270	707	1332	1953	2969	4340	6410	8622	12436	-	-
2007	10	96	252	669	1344	2277	3140	4691	6178	8567	10014	-	-
2008	7	58	228	558	1332	2305	3527	5001	6519	8848	10339	13276	15196
2009	15	54	214	495	1116	2024	3090	4876	6592	8087	10262	11472	13268
2010	9	54	191	794	989	1784	2719	4246	6384	8747	10499	12117	14199
2011	10	63	206	486	1037	1691	2827	4312	6698	8979	11557	12915	15694
2012	9	62	237	561	1087	1877	2688	3974	5930	8496	11000	13377	14826
2013	5	55	202	546	1062	1718	2541	3667	5258	7821	10509	13161	16581
2014	7	64	221	508	1079	1849	2734	3994	5418	7480	10100	14163	18404
2015	11	55	198	452	947	1735	2588	3728	5081	6827	8877	11623	15626
2016	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	22	69	248	571	1150	1771	2539	3819	5426	7554	9236	11220	13536
2018	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A13. Northeast Arctic COD. Sum of acoustic abundance estimates (millions) in the Joint winter Barents Sea survey (Table A2) and the Norwegian Lofoten acoustic survey (Table A4).

						Age							
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	12+
1985	69.1	446.3	153.0	141.6	20.4	15.1	15.7	3.3	1.3	1.0	0.5	na	na	0.0
1986	353.6	243.9	499.6	134.3	68.4	11.6	7.7	3.1	0.3	0.0	0.4	na	na	0.1
1987	1.6	34.1	62.8	204.9	50.2	17.4	1.4	3.0	0.7	0.0	0.0	na	na	0.0
1988	2.0	26.3	50.4	35.5	57.8	10.9	4.0	0.3	0.0	0.1	0.0	na	na	0.0
1989	7.5	8.0	17.0	34.4	21.4	67.0	16.6	3.2	0.5	0.2	0.0	na	na	0.1
1990	81.1	24.9	14.8	20.6	26.2	26.9	66.8	7.3	0.6	0.3	0.0	na	na	0.0
1991	181.0	219.5	50.2	34.6	29.3	33.9	36.7	50.0	3.7	0.2	0.2	na	na	0.0
1992	241.4	562.1	176.5	65.8	21.5	18.4	28.4	25.4	82.4	4.3	1.7	na	na	0.2
1993	1074.0	494.7	357.2	191.1	113.1	35.4	25.5	25.2	27.7	44.2	4.9	na	na	0.8
1994	902.6	624.4	323.9	374.5	229.3	96.1	23.4	11.8	10.3	4.2	18.7	na	na	2.9
1995	2175.3	212.3	137.7	139.5	203.6	101.6	28.1	4.7	4.5	2.9	2.6	na	na	8.1
1996	1826.3	271.7	99.4	89.6	112.8	97.4	46.2	5.9	1.1	0.4	0.9	na	na	1.5
1997	1698.5	565.3	158.6	44.2	50.3	45.9	51.0	21.5	2.3	0.7	0.1	na	na	0.8
1998	2523.6	475.2	391.2	189.8	44.9	41.5	34.9	27.1	5.1	1.0	0.2	na	na	0.1
1999	364.8	231.5	147.6	130.3	52.3	13.9	11.8	18.7	9.9	1.0	0.2	na	na	0.1
2000	153.4	262.8	294.8	167.3	149.2	54.6	14.6	6.9	5.0	1.3	0.6	na	na	0.2
2001	363.6	51.5	177.4	160.6	85.1	62.1	19.1	2.7	0.8	0.6	0.3	na	na	0.1
2002	19.2	209.1	61.4	106.2	101.1	71.3	36.6	9.4	1.2	0.8	0.6	na	na	0.0
2003	1505.0	52.5	306.7	116.8	127.1	146.1	67.7	23.5	3.8	0.4	0.1	na	na	0.2
2004	161.2	117.2	33.4	85.2	34.9	45.6	48.0	21.7	8.8	2.4	0.2	na	na	0.7
2005	499.7	138.7	125.0	33.3	69.3	34.1	43.8	18.0	7.5	1.8	0.1	na	na	0.3
2006	411.2	158.0	64.8	53.8	18.6	42.0	17.6	15.9	8.7	2.3	0.3	na	na	1.0
2007	85.1	47.1	58.5	30.4	30.8	12.9	46.6	15.1	8.0	3.3	0.9	na	na	0.4
2008	50.9	94.2	199.9	288.7	116.6	78.9	24.8	35.2	5.5	2.8	1.7	na	na	0.7
2009	204.9	25.5	107.8	182.5	141.5	56.0	41.5	12.8	26.6	3.6	1.7	na	na	0.4
2010	620.3	43.6	22.8	88.0	161.4	175.0	61.8	31.4	10.8	12.5	4.0	2.0	0.9	2.9
2011	266.0	91.0	40.4	28.3	67.4	159.5	272.7	64.5	23.3	6.8	7.5	0.4	0.5	0.9
2012	496.5	40.2	82.8	49.4	34.4	89.5	226.6	133.5	25.7	10.4	3.8	1.8	1.0	2.8
2013	313.1	89.2	60.6	84.5	72.4	54.1	133.6	233.8	161.7	21.5	11.1	5.5	3.2	8.8
2014	1758.6	211.0	286.9	124.2	111.5	77.7	55.3	149.0	173.9	98.0	14.6	6.8	3.8	10.5
2015	1903.5	211.4	138.7	235.6	130.0	144.2	96.4	49.8	96.9	68.6	32.5	6.6	6.1	12.7
2016	240.8	201.9	56.3	76.9	119.9	66.4	59.4	40.9	35.6	56.5	34.4	17.6	11.0	28.6
2017	439.4	73.3	111.5	42.4	44.4	74.2	48.6	48.4	26.8	16.7	14.6	15.1	7.8	23.0
2018	2057.6	280.3	109.0	149.9	54.0	58.4	77.5	45.6	19.3	14.1	6.1	6.0	7.8	13.7
2019	1437.2	362.4	203.6	125.4	144.6	63.9	49.3	73.9	27.3	21.8	6.5	2.9	8.1	11.1
2020	92.7	157.9	117.3	117.3	81.9	94.3	50.6	50.9	49.5	19.5	8.4	2.6	5.4	8.0
2021*	45.9	28.5	64.9	59.1	55.8	40.2	36.9	16.3	11.4	14.3	8.2	1.9	1.6	3.4
2022	524.7	43.4	29.4	53.0	57.0	50.4	47.5	34.5	11.6	6.8	5.3	2.2	1.8	3.9
*revised														

Table A14. Swept area estimates (millions) of Northeast Arctic Cod from the Joint Norwegian- Russian ecosystem survey in August-September (2020 data are taken from WD 01 AFWG 2021).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	13+
2004	543.0	330.6	329.7	147.7	421.5	150.2	79.8	40.2	10.1	2.2	0.5	0.1	0.1	0.1
2005	180.2	440.7	146.6	216.6	55.8	100.9	28.0	15.6	5.7	1.2	0.5	0.1	0.0	0.1
2006	276.0	479.0	509.7	186.1	205.6	59.9	69.8	17.6	8.1	2.6	0.6	0.2	0.0	0.0
2007	101.0	333.3	505.4	586.2	159.2	79.1	24.6	26.9	6.0	2.2	0.9	0.1	0.2	0.0
2008	483.4	130.9	372.6	652.6	483.4	132.3	51.1	12.8	17.5	3.3	0.9	0.2	0.2	0.2
2009	903.3	569.7	93.5	202.3	280.6	289.6	101.7	31.9	12.7	7.3	2.6	0.8	0.3	0.2
2010	652.6	310.3	84.2	56.8	177.0	397.2	424.9	142.7	38.5	10.5	6.8	1.6	0.3	0.3
2011	2083.0	509.8	160.0	123.6	101.5	240.2	300.4	178.4	32.3	7.7	1.8	1.3	0.6	0.3
2012	1412.7	1454.3	255.9	229.1	146.4	70.0	150.8	165.2	84.5	12.7	4.4	1.6	1.4	0.6
2013	2281.8	914.2	659.0	249.1	183.6	125.7	63.2	118.2	130.2	53.8	9.1	3.3	1.5	0.9
2014	2445.2	308.2	155.1	190.0	108.6	93.9	52.8	30.4	50.2	36.3	12.1	3.4	1.0	1.4
2014 *	***2445.2***	***339.0***	***184.0***	***226.3***	***122.2***	***103.4***	***67.7***	***42.1***	***81.3***	***78.9***	***28.1***	***4.7***	***1.3***	***1.5***
2015	350.9	725.3	154.0	174.4	225.2	141.3	72.6	48.6	26.2	35.3	26.6	7.9	1.7	1.0
2016	1164.8	350.8	341.3	77.2	93.7	121.6	70.1	44.4	27.2	13.8	13.2	5.4	1.7	1.4
2017	2316.3	757.5	260.6	375.0	141.5	104.9	120.9	62.6	28.0	11.2	6.4	4.4	4.5	2.7
2018 *	***1841.2***	***2100.3***	***413.8***	***183.6***	***148.9***	***60.0***	***37.6***	***57.1***	***20.2***	***14.4***	***5.8***	***3.6***	***3.5***	***2.8***
2019	313.4	560.2	475.2	416.6	232.3	215.1	76.6	42.2	44.4	16.1	4.9	2.2	1.1	1.8
2020**	115.6	63.5	106.3	139.5	135.6	93.4	82.9	30.8	14.2	10.7	3.1	1.0	0.5	1.0
2021	749.1	62.1	51.2	84.7	99.8	81.1	45.7	33.6	12.4	4.7	5.0	2.4	1.0	0.7
*data adjusted taking into account not complete area coverage														
** revised														

Table A15. Mean weight at age of cod (g), data from bottom trawls Barents Sea Ecosystem survey. StoX calculations.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2004		30	127	415	823	1464	2448	3266	4608	6323	9444	18331	13830	-	15924			
2005		37	162	428	985	1723	2553	3697	4808	5958	8583	7662	-	8799	-			
2006		39	155	473	1068	1759	2723	3725	5220	6798	10769	8904	9520	-	-			
2007		52	173	523	1237	2078	3004	4163	5860	7638	11251	-	12683	-	15529			
2008		39	193	511	1154	1958	3187	4262	5793	7741	9563	12039	11149	16320	-			
2009		29	164	462	989	1614	2453	4034	5313	6334	7595	8221	12001	12040	-			
2010		37	152	470	946	1634	2551	3801	5381	6921	7986	9063	8868	13406	19217			
2011		35	143	419	991	1672	2523	3500	4812	6826	9403	12623	10379	10945	-			
2012		34	149	418	904	1634	2388	3276	4344	6466	8459	9798	11181	14621	10895			
2013		28	129	429	918	1553	2249	3230	4443	5805	8454	9817	12531	14308	17723			
2014		28	148	374	897	1684	2244	3501	4511	5933	7183	7894	11979	7602	13250			
2015		28	149	414	823	1483	2297	3219	4490	5635	6962	8478	12148	10385	15370			
2016		45	162	527	914	1563	2308	3324	4492	6472	7476	8689	10939	7485	16645			
2017		37	185	441	953	1660	2414	3398	4821	5876	7173	8345	9968	12765	12445			
2018		-	-	-	-	-	-	-	-	-	-	-	-	-	-			
2019		28	103	386	899	1458	2208	3369	4508	6355	7734	9351	9147	11394	11403			
2020*		38	125	343	864	1514	2311	3204	4609	6020	7589	8685	10474	12242	13537	10724	14504	19800
2021		41	200	359	714	1278	2224	3196	4482	6355	7527	9165	10910	12089		15930	17193	

*revised

4 - Haddock in subareas 1 and 2 (Northeast Arctic)

4.1 – Introductory note

On 30th March 2022 all Russian participation in ICES was suspended. The AFWG report 2022 chapter on haddock was therefore not been updated except tables of total catch (Tables 4.1-4.5.).

In the present report, we have kept the main structure of the NEA haddock chapters in AFWG reports from the last years.

4.2 – Status of the fisheries

4.2.1 - Historical development of the fisheries

Haddock is mainly fished by trawl as bycatch in the fishery for cod. Also, a directed trawl fishery for haddock is conducted. The proportion of the total catches taken by direct fishery varies between years. On average approximately 30% of the catch is with conventional gears, mostly longline, which in the past was used almost exclusively by Norway. Some of the longline catches are from a directed fishery, which is restricted by national quotas. In the Norwegian management, the quotas are set separately for trawl and other gears. The fishery is also regulated by a minimum landing size (40 cm), a minimum mesh size in trawls and Danish seine, a maximum bycatch of undersized fish, closure of areas with high density/catches of juveniles and other seasonal and area restrictions.

The exploitation rate of haddock has been variable. The highest fishing mortalities for haddock have occurred at low to intermediate stock levels and historically show little relationship with the exploitation rate of cod, despite haddock being primarily caught as bycatch in the cod fishery. However, the more restrictive quota regulations introduced around 1990 have resulted in a more stable pattern in the exploitation rate.

The exceptionally strong year classes 2005–2006 contributed to the strong increase to all-time high stock levels and high catch levels in the last decade. Their importance in the catches is currently minimal. Currently, the 2016 year-class is dominating the catches.

4.2.2 - Catches prior to 2022 (Table 4.1–Table 4.3, Figure 4.1)

The highest landings of haddock historically were 322 kt in 1973. Since 1973 the highest catches observed was 316 kt in 2012. The landings in 2018, 2019 and 2020 were below 200 kt (Figure 4.1).

Provisional official landings for 2021 are about 205 kt, which is 12% below agreed TAC (233 kt).

In 2006 it was decided to include reported Norwegian landings of haddock from the Norwegian statistical areas 06 and 07 (i.e. between 62°N and Lofoten Islands). These areas were not previously included in the total landings of NEA haddock as input for this stock assessment (ICES CM 2006/ACFM:19; ICES CM 2006/ACFM:25).

Estimates of unreported catches (IUU catches) of haddock have been added to reported landings for the years from 2002 to 2008. Two estimates of IUU catches were available, one Norwegian and one Russian. At the benchmark in 2011 it was decided to base the final assessment on the Norwegian IUU estimates (ICES CM 2011/ACOM:38; Table 4.1).

We continue to include the estimates of IUU catches 2002–2008. The IUU catches are assumed to be negligible for the period 2009–2021 and therefore set to zero.

4.2.3 - Catch advice and TAC for 2022

The catch advice for 2022 was 179 kt and the Joint Norwegian-Russian Fisheries Commission set the TAC in accordance with the HCR. Furthermore, Russia and Norway can transfer the unused part of their own quota, restricted to a maximum of 10% of own quotas from 2021 to 2022.

4.3 - Status of research

4.3.1 - Survey results

Russia provided indices for 1982–2015 and 2017 for the Barents Sea trawl and acoustic survey (TAS) which was carried out in October–December (FLT01, RU-BTr-Q4). The survey was discontinued in 2018.

The Joint Barents Sea winter survey provides two index series used for tuning and recruitment forecast (bottom trawl: FLT02, NoRu-BTr-Q1 and acoustics: FLT04, NoRu-Aco-Q1). The survey area has been extended from 2014 with additional northern areas (N) covered. The extended area is now included in total and standard survey index calculations for haddock (WKDEM 2020). Overall, this survey tracks both strong and poor year classes well. The indices from the Joint winter survey of cod and haddock in the Barents Sea are provided in the annual survey reports from this survey (e.g., Fall et al 2022). The spatial survey coverage in 2022 was good. Note that since the AFWG 2021 was conducted, minor errors were discovered in the winter survey indices for 2021 (both acoustic and bottom trawl). The current assessment uses the corrected indices. The report from the 2022 survey (Fall et al in prep) will provide the correct indices back in time.

The Joint Barents Sea ecosystem survey provides indices by age from bottom trawl data (FLT007, Eco-NoRu-Q3 Btr) used for tuning and recruitment forecast. At the benchmark in 2011 it was decided to include this survey as tuning series. Tuning indices by age from the Joint ecosystem survey is calculated using the BIOFOX programme (Prozorkevich and Gjøsæter 2014). The survey coverage of the haddock distribution in 2022 was relatively good.

The survey indices for ages used in tuning can be found in Table 4.9, and the survey indices used in recruitment forecast can be found in Table 4.16.

4.4 - Data used in the assessment

4.4.1 - Catch-at-age (Table 4.4)

Age and length composition of the landings in 2021 were available from Norway and Russia in Subarea 1 and Division 2.b, and from Norway, Russia, and Germany in Division 2.a. The biological sampling of NEA haddock catches is considered good for the most important ages in the fisheries.

Relevant data of estimated catch-at-age was obtained from InterCatch for the period 2008–2020 and is presented together with historical values from 1950–2007 in Table 4.4. For the 2021 catch data allocation, instead of InterCatch, the same algoritm was realized in Excel. Excel was used for comparison with InterCatch in 2008-2002, and no differences between InterCatch and Excel allocations were detected.

4.4.2 - Catch-weight-at-age (Table 4.5)

The mean weight-at-age in the catch was obtained as a weighted average of the weight-at-age in the catch from Norway, Russia and Germany.

4.4.3 - Stock-weight-at-age (Table 4.6)

Since 1983 the stock weights-at-age (Table 4.6) are calculated using the average of the weight-at-age estimate from the Joint Barents Sea winter survey and the Russian bottom trawl survey. These averages are assumed to give representative values for the beginning of the year (see stock annex for details). However, the Russian bottom trawl survey has been discontinued and therefor stock weights-at-age were calculated using a correction factor (WKDEM 2020). Since the benchmark in 2006 stock weight at age has been smoothed (ICES 2006, see stock annex for details).

4.4.4 - Maturity-at-age (Table 4.7)

Since the benchmark 2006, smoothed estimates were produced separately for the Russian autumn survey and the Joint winter survey and then combined using arithmetic average. These averages are assumed to give representative values for the beginning of the year. However, the Russian bottom trawl survey has been discontinued and therefore stock weights-at-age were calculated using a correction factor (see WKDEM 2020 and stock annex).

4.4.5 - Natural mortality (Table 4.8)

Natural mortality used in the assessment was 0.2. For ages 3–6 mortality predation by cod is added (see stock annex). For the period from 1984 and onwards actual estimates of predation by cod was used. For the years 1950–1983 the average natural mortality for 1984–2020 was used (age groups 3–6). Estimated mortality from predation by cod in this year's assessment is based on the 'final run' cod assessment. The proportion of F and M before spawning was set to zero.

4.4.6 - Data for tuning (Table 4.9)

The following survey series are included in the data for tuning, the last age for all surveys is the plus group. Data are lacking (no survey) for FLT01 in 2016, and for FLT007 in 2018 (not included due to poor coverage).

Name	Acronym	Place	Season	Age	Year	prior weight
FLT01: Russian bottom trawl	RU-BTr-Q4	Barents Sea	October–December	3–8+	1991–2017	1
FLT02: Joint Barents Sea survey–acoustic	BS-NoRU-Q1(Aco)	Barents Sea	February–March	3–9+	1993–2022	1
FLT04: Joint Barents Sea survey–bottom trawl	BS-NoRu-Q1 (BTr)	Barents Sea	February–March	3–10+	1994–2022	1
FLT007: Joint Russian-Norwegian ecosystem autumn survey in the Barents Sea–bottom trawl	Eco-NoRu-Q3 (Btr)	Barents Sea	August–September	3–9+	2004–2021	1

4.4.7 - Changes in data from last year (Table 4.6–Table 4.7, Table 4.9)

At the benchmark (WKDEM 2020) it was decided that historic values (1950–1993) of stock weight and maturity should not be updated in the following years. Due to the smoothing procedure (see stock annex) the stock weight and maturity at age back to 1994 are updated every year.

Natural mortality includes cod predation for the ages 3–6. The data from 1984 and onwards are updated every year after the update of the cod assessment. The averages used for the historic period (1950–1983) were updated and used in the assessment.

4.5 - Assessment models and settings (Table 4.10)

At the benchmark in 2020 it was decided to continue using the SAM model as the main model.

The SAM configuration was revised during the benchmark in 2020. The main changes to the configuration were to include:

1) age group 3 in the winter survey indices (Fleet 02 and 04),

2) plus group in all survey series (new option in SAM),

3) prediction variance link for the observation variances (new option in SAM, Breivik *et al.,* 2021) 4) correlation structure in observation variance for the surveys (Berg and Nielsen, 2016).

The configuration, settings and tuning of SAM that were decided on during the benchmark (WKDEM 2020) were used in the current assessment. The configuration file is given in Table 4.10 and in the stock annex.

XSA, with revised settings, will be used as additional model for comparison. This year the TISVPA model is also used as an additional model for comparison.

4.6 - Results of the assessment (Table 4.11–Table 4.14 and Figure 4.1–Figure 4.3)

The dominating feature of the assessment is that the stock reached an all-time high level around 2011 due to the strong

2004–2006 year-classes, and since declined (Table 4.11; Figure 4.1)

Fishing mortality has increased since 2013 (Table 4.12), and the estimate of fishing mortality of main ages (4–7) has been above F_{MSY} = 0.35 since 2018.

The SSB has decreased since the peak in 2013. The estimate for 2022 is 217kt and well above MSY $B_{trigger}$ = 80 kt (Figure 4.1).

The residuals and retrospective patterns are shown in Figure 4.2 and 4.3.

4.7 - Comparison with last year's assessment (Figure 4.4)

The text table below compares this year's estimates with last year's estimates. Compared to last year the current estimates of the total stock (TSB) in 2021 is 3% higher , whereas the spawning stock (SSB) estimate is almost the same. The Fbar in 2020 is estimated as the same as the Fbar for 2020 estimated last year. Estimates for all ages except ages 7, 8 and 10 were higher or identical to last year's assessment. Ratios are calculated on original numbers (not rounded as shown in table)

Assessment year, model	F (2020)	Numbers 2021 (ages)											SSB (2021)	TSB (2021)
		3	4	5	6	7	8	9	10	11	12	13+		
2021 SAM	0.44	158	265	350	67	22	10	4	4	1	1	2	199	644
2022 SAM	0.44	164	280	364	73	21	9	4	3	2	2	2	199	661
Ratio 2022/2021	1.0	1.0	1.1	1.0	1.1	0.9	0.9	1.1	0.8	1.7	1.6	1.2	1.0	1.0

4.8 - Additional assessment methods (Table 4.15, Figure 4.5–Figure 4.6)

4.8.1 - XSA (Figure 4.5)

The Extended Survivors Analysis (XSA) was used to tune the VPA by available index series. As last years, FLR was used for the assessment of haddock (see stock annex), and thus all results concerning XSA are obtained using FLR. The settings used were the same as set in the benchmark in 2015 (WKARCT 2015). At this meeting the comparison confirmed that usage XSA with survivor estimate shrinkage 0.5 gave similar result to the estimates from SAM.

The estimated consumption of NEA haddock by NEA cod is incorporated into the XSA analysis by first constructing a catch number-at-age matrix, adding the numbers of haddock eaten by cod to the catches for the years where such data are available (1984–2021). The summary of XSA stock estimates with shrinkage value 0.5 are presented in Table 4.15. A retrospective estimate for XSA gave same signals as for main model SAM (Figure 4.5).

4.8.2 - TISVPA (Figure 4.5)

The TISVPA (Triple Instantaneous Separable VPA) model (Vasilyev, 2005; 2006) represents fishing mortality coefficients (more precisely – exploitation rates) as a product of three parameters: f(year)*s(age)*g(cohort). The generation-dependent parameters, which are estimated within the model, are intended to adapt traditional separable representation of fishing mortality to situations when several year classes may have peculiarities in their interaction with fishing fleets caused by different spatial distribution, higher attractiveness of more abundant schools to fishers, or by some other reasons. The TISVPA model was presented at benchmark group for arctic stocks (WKARCT) in 2015 and it was decided to apply to NEA haddock using the same data as SAM except that natural mortality values from cannibalism were taken from the SAM runs. All the input data, including catch-at-age, weight-at-age in stock and in catches, maturity-at-age were the same as used in SAM. Generally, the biomass estimates of this model were higher than SAM estimates, which can be explained by different assumptions about catchability of indices. The retrospective pattern for TISVPA shows the same trends as both the SAM and XSA models (Figure 4.5).

4.8.3 - Model comparisons (Figure 4.6)

Results from SAM, XSA and TISVPA are compared in Figure 4.6. Comparison of results of SAM, TISVPA and XSA with previous year settings shows that the models estimate similar trends. The TSVPA model is more flexible for settings than the others and taking into account a possible decrease in survey data consistency, it was attempted to do tuning of surveys not at abundance but to age proportions because the probable change in effective survey catchability.

4.9 - Predictions, reference points and harvest control rules (Table 4.16–Table 4.21)

4.9.1 - Recruitment (Table 4.16–Table 4.17)

SAM was used to estimate the recruitment at age 3 of the 2019 year-class in 2022. The RCT3 program translation in R was used to estimate the recruiting year classes 2020–2021 in 2023 and 2024 with survey data from the ecosystem survey and winter survey (acoustics and bottom trawl). Input data and results are shown in Tables 4.16 and 4.17, respectively.

The text table below shows the recruitment estimates for the year classes 2004–2021 from assessments and RCT3 forecasts (shaded cells). Overall, there is good agreement with the year-class strength estimates from RCT3 and the assessments (r=0.96), and the estimate the first year the year-class was assessed was on average 84% of the initial RCT3 estimate (year-classes 2005-2019. In the most recent years, it is noticeable that the 2018 year-class was less than 50% of the initial RCT3 estimate.

Year Class	Year of assessment, base model															
	2008 XSA	2009 XSA	2010 XSA	2011 XSA	2012 XSA	2013 XSA	2014 XSA	2015 XSA	2015 SAM	2016 SAM	2017 SAM	2018 SAM	2019 SAM	2020 SAM	2021 SAM	2022 SAM
2004	665	668	610	765	743	725	698	768	687	930	898	869	879	557	543	546
2005	943	975	1029	1193	1301	1317	1303	1415	996	1456	1330	1241	1251	1149	1113	1118
2006	832	1036	811	1057	1187	1264	1267	1366	827	1254	1083	1027	1030	1063	1025	1032
2007	202	208	212	284	330	370	384	411	211	355	307	305	308	249	241	242
2008		149	101	120	151	155	169	178	89	157	107	109	110	122	117	119
2009			303	315	320	345	357	363	230	351	294	291	293	356	340	344
2010				188	146	137	146	150	100	133	105	105	106	124	119	120
2011					483	513	482	398	298	397	340	329	332	425	411	415
2012						124	145	104	78	73	79	70	68	75	72	73
2013							394	290	197	235	184	174	177	219	213	215
2014								279	198	247	189	146	148	202	194	198
2015										422	398	333	336	384	368	370
2016											1067	933	930	875	822	831
2017												577	629	497	442	449
2018													344	294	154	164
2019														39	31	38
2020															95	89
2021																303

4.9.2 - Prediction data (Table 4.18, Figure 4.7)

The input data for the prediction are presented in Table 4.18.

Stock numbers for 2022–2023 at age 3 are taken from RCT3, and abundance-at-ages 3–13+ in 2021 from the SAM assessment. The average fishing pattern observed in 2019–2021 scaled to F in 2021 was used for distribution of fishing mortality-at-age for 2022–2024 (Figure 4.7). The proportion of M and F before spawning was set to 0.

Input data to projection of weight at age in the stock, weight at age in the catch, maturity and mortality followed the stock annex.

4.9.3 - Biomass reference points (Figure 4.1)

Biological and fisheries reference points for NEA haddock were last set following a thorough analysis as part of the WKNEAMP-2 (ICES, 2016) Harvest Control Rule evaluation in 2016. The revised model developed during the 2020 benchmark produced better fits to the data but only a small change in the reconstructed stock (WKDEM 2020). A brief analysis at WKDEM 2020 indicated that the reference points from the current model are very similar to the previously estimated values. Given the more thorough analysis at WKNEAMP-2 (ICES, 2016), this is taken as indicating that there was no evidence to deviate from the reference points set in 2016.

At the last benchmark (WKDEM 2020) it was proposed to keep B_{lim} = 50 000 t and B_{pa} = 80 000 t with the rationale that B_{lim} is equal to B_{loss}, and $B_{pa} = B_{lim}*\exp(1.645*\sigma)$, where $\sigma = 0.3$. This gives a 95% probability of maintaining SSB above B_{lim} taking into account the uncertainty in the assessments and stock dynamics. B_{MSY} trigger was proposed equal B_{pa}, $B_{trigger}$ was then selected as a biomass that is encountered with low probability if F_{MSY} is implemented, as recommended by WKFRAME2 (ICES CM 2011/ACOM:33). Values of reference points compared with current stock values are reflected in Figure 4.1.

4.9.4 - Fishing mortality reference points (Figure 4.1)

Biological and fisheries reference points for NEA haddock were last set following a thorough analysis as part of the WKNEAMP-2 (ICES, 2016) Harvest Control Rule evaluation in 2016. The revised model developed during the 2020 benchmark produced better fits to the data but only a small change in the reconstructed stock (WKDEM 2020). A brief analysis at WKDEM 2020 indicated that the reference points from the current model are very similar to the previously estimated values. Given the more thorough analysis at WKNEAMP-2 (ICES, 2016), this is taken as indicating that there was no evidence to deviate from the reference points set in 2016.

There is no standard method of estimating F_{lim} nor F_{pa}, and ACOM accepted to use geometric mean recruitment (146 million) and B_{lim} as basis for the F_{lim} estimate. F_{lim} is then based on the slope of line from origin at SSB = 0 to the geometric mean recruitment (146 million) and SSB = B_{lim}. The SPR value of this slope give F_{lim} value on SPR curve; F_{lim} = 0.77 (found using Pasoft). Using the same approach as for B_{pa}; $F_{pa} = F_{lim}*\exp(-1.645*\sigma)$ = 0.47.

F_{MSY} = 0.35 has been estimated by long-term stochastic simulations. Values of reference points compared with current stock values are reflected in Figure 4.1.

The estimates of cod's consumption of haddock were revised following the cod benchmark in early 2021. At the AFWG 2021 meeting, the haddock F_{MSY} was checked with the new updated mortality estimates and found to still be valid and precautionary.

4.9.5 - Harvest control rule

The harvest control rule (HCR) was evaluated by ICES in 2007 (ICES CM 2007/ACFM:16) and found to be in agreement with the precautionary approach. The agreed HCR for haddock with last modifications is as follows (Protocol of the 40th Session of The Joint Norwegian Russian Fisheries Commission (JNRFC), 14 October 2011):

- TAC for the next year will be set at level corresponding to F_{MSY}.
- The TAC should not be changed by more than +/- 25% compared with the previous year TAC.
- If the spawning stock falls below B_{pa}, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from F_{MSY} at B_{pa} to F = 0 at SSB equal to zero. At SSB-levels below B_{pa} in any of the operational years (current year and a year ahead) there should be no limitations on the year-to-year variations in TAC.

As mentioned above F_{lim} and F_{pa} were revised in 2011. The new values of F_{lim} = 0.77 and F_{pa} = 0.47 are higher than the previous values (0.49 and 0.35, respectively). In the 2012 meeting of the JNRFC the proposals of ICES were accepted, and the current HCR management is based on F_{MSY} instead of $F_{pa.}$ This corresponds to the goal of the

management strategy for this stock and should provide maximum sustainable yield.

In 2014, JNRFC decided that from 2015 onwards, Norway and Russia can transfer to next year or borrow from last year maximum 10% of the country's quota. At its 45th session in October 2015, the Joint Norwegian-Russian Fisheries Commission (JNRFC) decided that a number of alternative harvest control rules (HCRs) for Northeast Arctic haddock should be evaluated by ICES. This was done by WKNEAMP (ICES 2015b/ACOM:60, ICES C. M. 2016/ACOM:47). Six HCRs for NEA haddock including the existing one were tested. At its 46th session in October 2016, the JNRFC decided not to change the HCR.

4.9.6 - Prediction results and catch options for 2021 (Table 4.19–Table 4.21)

The projection shows a slight increase in SSB from 216 kt in 2022 to 232 kt in 2023 (Table 4.19). TAC constraint F is used for 2022. The TAC for 2023 is established using the current one-year HCR, in accordance to the management plan. F_{MSY} = 0.35 would give a quota for 2023 of 170 kt, this is a 5% decrease from the TAC and advice for 2022.

Catch options for 2023 are shown in the text table below (weights in tonnes).

Basis	Total catch (2023)	F ages 4–7 (2023)	SSB (2024)	% SSB change *	% TAC change **	% Advice change ***
Advice basis						
Management plan	170 067	0	205 549	-11	-5	-5
Other scenarios						
MSY approach: F_{MSY}	170 067	0.35	205 549	-11	-5	-5
F = 0	0	0.00	321 974	39	-100	-100
F = F2022	151 269	0.30	218 188	-6	-15	-15
F_{pa}	213 495	0.47	176 638	-24	20	20
F_{lim}	298 284	0.77	121 687	-48	67	67

*** SSB 2024 relative to SSB 2023.**

**** Catch in 2023 relative to TAC in 2022 (178532 t)**

***** Catch value for 2023 relative to advice value for 2022 (178532 t)**

Detailed information about expected catches by following HCR in 2023 and 2024 is given in Table 4.20. The forecast covers all catches. It is then implied that all types of catches are to be counted against this TAC.

4.9.7 - Comments to the assessment and predictions (Figure 4.2–Figure 4.4)

Haddock was benchmarked in 2020 (WKDEM 2020). The motivation for the benchmark was the poor retrospective (text table below). The retrospective biases were greatly improved after the benchmark. The retrospective biases from this year's assessment for SSB, TSB and F were reduced compared to AFWG 2021.

Retrospective bias (Mohn's Rho), 5-year peel	R	SSB	F	TSB
AFWG 2018	−3%	24%	−7%	14%
AFWG 2019	−5%	18%	−7%	7%
WKDEM 2020	−2%	3%	−3%	1%
AFWG 2020	−4%	−3%	0%	−5%
AFWG 2021	1%	6%	−7%	3%
AFWG 2022	-2%	5%	-6%	1%

A jitter analysis performed to verify that the SAM model is not sensitive to starting values ,, revealed no problems (see Breivik et al 2021 for details on jitter analysis). The one step ahead residuals showed no clear pattern (Figure 4.2). The

retrospective The retrospective biases for F, SSB, RSB and R (absolute values) are <7% (Figure 4.3). Overall, adding a year of data confirmed the trend from last year's assessment. To conclude, no obvious problems with the 2022 assessment were detected.

According to this year's assessment, the 2016 year-class is the sixth strongest year class in the time-series back to 1950. The 2017 year-class is close to average, whereas the 2018 year-class is weak, and the 2019 year-class is the weakest since the 1987 year-class. The 2020 year-class is predicted to be well below average, whereas the 2021 year-class is predicted to be above average.

The strong 2016 year-class is now dominating the spawning stock and catches (48% of the catches in biomass in 2021) and will continue to do so for the coming years. The stock is declining and expected to continue to decline in the next years, since the incoming year-classes are weak.

Fbar(4-7) has been above Fmsy from 2018 and onwards, meaning that the quotas for 2018-2021 have been set too high. The assessments from 2017 to 2019 on which the TAC advice for 2018-2020 were based, had large positive retrospective biases for TSB and SSB (see text table above), implying that the stock sizes were overestimated. The retrospective bias was reduced after the revision at the 2020 benchmark (WKDEM 2020).

Only 88% of 2021 TAC was taken. One possible reason is that the advice and quota was set too high, due to lower catch weights of ages 3-7 compared to the forecast, e.g. the catch weight at age 5 (2016 year-class) was 16% lower than predicted by AFWG in 2020. The 2016 year-class accounted for more than half of the individuals caught in 2021 (54%) and thus the weight of this year-class in the catches had the greatest impact on the yield. As a result, a given catch in tons required more individuals had to be caught, and hence a higher effort from the fishing fleet. The discrepancy between forecast and catch statistics can be explained by a larger proportion of the catches being taken in ICES Area I in 2021 compared to earlier years (Table 4.2). This eastern area is colder compared to the western Barents Sea and here size at age tends to be smaller.

As most of the 2016 year-class will be spawning in 2022 and 2023, moving into warmer waters in western Barents Sea, we expect the fishing fleet to follow, and that the catch weight at age in the forecast and in the catch statistics will be more similar in the coming years.

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Table 4.1. Northeast Arctic haddock. Total nominal catch (t) by fishing areas.

Year	Subarea 1	Division 2.a	Division 2.b	un-reported[2)]	Total[3)]	Norw. stat.areas 06 and 07[4)]
1960	125026	27781	1844	-	154651	6000
1961	165156	25641	2427	-	193224	4000
1962	160561	25125	1723	-	187409	3000
1963	124332	20956	936	-	146224	4000
1964	79262	18784	1112	-	99158	6000
1965	98921	18719	943	-	118583	6000
1966	125009	35143	1626	-	161778	5000
1967	107996	27962	440	-	136398	3000
1968	140970	40031	725	-	181726	3000
1969	89948	40306	566	-	130820	2000
1970	60631	27120	507	-	88258	-
1971	56989	21453	463	-	78905	-
1972	221880	42111	2162	-	266153	-
1973	285644	23506	13077	-	322227	-
1974	159051	47037	15069	-	221157	10000
1975	121692	44337	9729	-	175758	6000
1976	94054	37562	5648	-	137264	2000
1977	72159	28452	9547	-	110158	2000
1978	63965	30478	979	-	95422	2000
1979	63841	39167	615	-	103623	6000
1980	54205	33616	68	-	87889	5098
1981	36834	39864	455	-	77153	4767
1982	17948	29005	2	-	46955	3335
1983	5837	16859	1904	-	24600	3112
1984	2934	16683	1328	-	20945	3803
1985	27982	14340	2730	-	45052	3583

Year	Subarea 1	Division 2.a	Division 2.b	un-reported	Total	Norw. stat.areas 06 and 07
1986	61729	29771	9063	-	100563	4021
1987	97091	41084	16741	-	154916	3194
1988	45060	49564	631	-	95255	3756
1989	29723	28478	317	-	58518	4701
1990	13306	13275	601	-	27182	2912
1991	17985	17801	430	-	36216	3045
1992	30884	28064	974	-	59922	5634
1993	46918	32433	3028	-	82379	5559
1994	76748	50388	8050	-	135186	6311
1995	75860	53460	13128	-	142448	5444
1996	112749	61722	3657	-	178128	5126
1997	78128	73475	2756	-	154359	5987
1998	45640	53936	1054	-	100630	6338
1999	38291	40819	4085	-	83195	5743
2000	25931	39169	3844	-	68944	4536
2001	35072	47245	7323	-	89640	4542
2002	40721	42774	12567	18736/5310	114798/101372	6898
2003	53653	43564	8483	33226/9417	138926/115117	4279
2004	64873	47483	12146	33777/8661	158279/133163	3743
2005	53518	48081	16416	40283/9949	158298/127964	5538
2006	51124	47291	33291	21451/8949	153157/140655	5410
2007	62904	58141	25927	14553/3102	161525/150074	7110
2008	58379	60178	31219	5828/-	155604/149776	6629
2009	57723	66045	76293	0	200061	4498
2010	62604	86279	100318	0	249200	3661
2011	86931	99307	123546	0	309785	4169
2012	90141	96807	128679	0	315627	3869
2013	68416	64810	60520	0	193744	4000
2014	61537	58320	57665	0	177522	3433
2015	75195	61567	57993	0	194756	3902
2016	78714	95140	59561	0	233416	3233
2017	94772	75455	57362	0	227589	2987
2018	80902	58522	51853	0	191276	4437
2019	87446	50967	36989	0	175402	2812
2020[1)]	98341	57397	26730	0	182468	3196
2021[1)]	109914	5800 6	36823	0	204743	2363

1) Provisional figures

2) Figures based on Norwegian/Russian IUU estimates. From 2009, IUU estimates are made by a Joint Russian-Norwegian analysis group under the Russian-Norwegian Fisheries Commission.

3) In 2002–2008, the Norwegian IUU estimates were used in final assessment.

4) Included in total landings and in landings in region 2.a.

Table 4.2. Northeast Arctic haddock. Total nominal catch ('000 t) by trawl and other gear for each area.

	Subarea 1		Division 2.a		Division 2.b		Unreported[2]
Year	Trawl	Others	Trawl	Others	Trawl	Others	
1967	73.7	34.3	20.5	7.5	0.4	-	-
1968	98.1	42.9	31.4	8.6	0.7	-	-
1969	41.4	47.8	33.2	7.1	1.3	-	-
1970	37.4	23.2	20.6	6.5	0.5	-	-
1971	27.5	29.2	15.1	6.7	0.4	-	-
1972	193.9	27.9	34.5	7.6	2.2	-	-
1973	242.9	42.8	14	9.5	13.1	-	-
1974	133.1	25.9	39.9	7.1	15.1	-	-
1975	103.5	18.2	34.6	9.7	9.7	-	-
1976	77.7	16.4	28.1	9.5	5.6	-	-
1977	57.6	14.6	19.9	8.6	9.5	-	-
1978	53.9	10.1	15.7	14.8	1	-	-
1979	47.8	16	20.3	18.9	0.6	-	-
1980	30.5	23.7	14.8	18.9	0.1	-	-
1981	18.8	17.7	21.6	18.5	0.5	-	-
1982	11.6	11.5	23.9	13.5	-	-	-
1983	3.6	2.2	8.7	8.2	0.2	1.7	-
1984	1.6	1.3	7.6	9.1	0.1	1.2	-
1985	24.4	3.5	6.2	8.1	0.1	2.6	-
1986	51.7	10.1	14	15.8	0.8	8.3	-
1987	79	18.1	23	18.1	3	13.8	-
1988	28.7	16.4	34.3	15.3	0.6	0	-
1989	20	9.7	13.5	15	0.3	0	-
1990	4.4	8.9	5.1	8.2	0.6	0	-
1991	9	8.9	8.9	8.9	0.2	0.2	-
1992	21.3	9.6	11.9	16.1	1	0	-
1993	35.3	11.6	14.5	17.9	3	0	-
1994	58.6	18.2	26.1	24.3	7.9	0.2	-
1995	63.9	12	29.6	23.8	12.1	1	-
1996	98.3	14.4	36.5	25.2	3.4	0.3	-
1997	57.4	20.7	44.9	28.6	2.5	0.3	-
1998	26	19.6	27.1	26.9	0.7	0.3	-
1999	29.4	8.9	19.1	21.8	4	0.1	-
2000	20.1	5.9	18.8	20.4	3.7	0.1	-
2001	28.4	6.7	23.4	23.8	7	0.3	-

	Subarea 1		Division 2.a		Division 2.b		Unreported
2002	30.5	10.2	19.5	23.3	12.5	0.1	18.7/5.3
2003	42.7	10.9	21.9	21.7	8.1	0.4	33.2/9.4
2004	52.4	12.5	27	20.5	11.5	0.6	33.8/8.7
2005	38.5	15	24.9	20.9	13	1.6	40.3/9.9
2006	40.1	11	22	25.3	30.1	3.2	21.5/8.9
2007	51.8	11.1	30.5	27.7	20.4	5.5	14.6/3.1
2008	46.8	11.6	30.9	29.3	24.9	6.3	5.8/-
2009	49	8.8	40.1	25.3	67.1	7.8	0
2010	43.6	19	50	35.7	87	10.4	0
2011	55.8	31.1	61.1	38.9	107.7	14.3	0
2012	58.8	31.3	57.5	39.2	103.2	24.8	0
2013	40.1	28.3	37.7	26.9	52.1	8.1	0
2014	35.2	26.3	32.5	25.8	49	8.6	0
2015	49.1	26.1	34.6	27	48.5	9.4	0
2016	56.4	22.3	62.5	32.5	45.4	14.1	0
2017	65	29.8	50.7	24.7	47.1	10.3	0
2018	51.7	29.2	36.9	21.6	43.2	8.6	0
2019	53.9	33.5	30.4	20.4	31.0	5.9	0
2020	66.7	31.6	35.1	22.3	23.2	3.5	0
2021[1)]	81.4	28.5	41.0	17.0	31.0	5.8	0

1) Provisional

2) Figures based on Norwegian/Russian IUU estimates.

Table 4.3 Northeast Arctic haddock. Nominal catch (t) by countries. Subarea 1 and divisions 2.a and 2.b combined. (Data provided by Working Group members).

Year	Faroe Islands	France	GDR (–1990) & Greenland (1992–)	Germany	Norway[4]	Poland	UK	Russia[2]	Others	Total[3]
1960	172	-	-	5597	46263	-	45469	57025	125	154651
1961	285	220	-	6304	60862	-	39650	85345	558	193224
1962	83	409	-	2895	54567	-	37486	91910	58	187408
1963	17	363	-	2554	59955	-	19809	63526	-	146224
1964	-	208	-	1482	38695	-	14653	43870	250	99158
1965	-	226	-	1568	60447	-	14345	41750	242	118578
1966	-	1072	11	2098	82090	-	27723	48710	74	161778
1967	-	1208	3	1705	51954	-	24158	57346	23	136397
1968	-	-	-	1867	64076	-	40129	75654	-	181726
1969	2	-	309	1490	67549	-	37234	24211	25	130820
1970	541	-	656	2119	37716	-	20423	26802	-	88257
1971	81	-	16	896	45715	43	16373	15778	3	78905
1972	137	-	829	1433	46700	1433	17166	196224	2231	266153
1973	1212	3214	22	9534	86767	34	32408	186534	2501	322226

Year	Faroe Islands	France	GDR (–1990) & Greenland (1992–)	Germany	Norway	Poland	UK	Russia	Others	Total
1974	925	3601	454	23409	66164	3045	37663	78548	7348	221157
1975	299	5191	437	15930	55966	1080	28677	65015	3163	175758
1976	536	4459	348	16660	49492	986	16940	42485	5358	137264
1977	213	1510	144	4798	40118	-	10878	52210	287	110158
1978	466	1411	369	1521	39955	1	5766	45895	38	95422
1979	343	1198	10	1948	66849	2	6454	26365	454	103623
1980	497	226	15	1365	66501	-	2948	20706	246	92504
1981	381	414	22	2402	63435	Spain	1682	13400	-	81736
1982	496	53	-	1258	43702	-	827	2900	-	49236
1983	428	-	1	729	22364	139	259	680	-	24600
1984	297	15	4	400	18813	37	276	1103	-	20945
1985	424	21	20	395	21272	77	153	22690	-	45052
1986	893	12	75	1079	52313	22	431	45738	-	100563
1987	464	7	83	3105	72419	59	563	78211	5	154916
1988	1113	116	78	1323	60823	72	435	31293	2	95255
1989	1217	-	26	171	36451	1	590	20062	-	58518
1990	705	-	5	167	20621	-	494	5190	-	27182
1991	1117	-	**Greenland**	213	22178	-	514	12177	17	36216
1992	1093	151	1719	387	36238	38	596	19699	1	59922
1993	546	1215	880	1165	40978	76	1802	35071	646	82379
1994	2761	678	770	2412	71171	22	4673	51822	877	135186
1995	2833	598	1097	2675	76886	14	3111	54516	718	142448
1996	3743	6	1510	942	94527	669	2275	74239	217	178128
1997	3327	540	1877	972	103407	364	2340	41228	304	154359
1998	1903	241	854	385	75108	257	1229	20559	94	100630
1999	1913	64	437	641	48182	652	694	30520	92	83195
2000	631	178	432	880	42009	502	747	22738	827	68944
2001	1210	324	553	554	49067	1497	1068	34307	1060	89640
2002	1564	297	858	627	52247	1505	1125	37157	682	114798
2003	1959	382	1363	918	56485	1330	1018	41142	1103	138926
2004	2484	103	1680	823	62192	54	1250	54347	1569	158279
2005	2138	333	15	996	60850	963	1899	50012	1262	158298
2006	2390	883	1830	989	69272	703	1164	53313	1162	153157
2007	2307	277	1464	1123	71244	125	1351	66569	2511	161525
2008	2687	311	1659	535	72779	283	971	68792	1759	155604
2009	2820	529	1410	1957	104354	317	1315	85514	1845	200061
2010	3173	764	1970	3539	123384	379	1758	111372	2862	249201
2011	1759	268	2110	1724	158202	502	1379	139912	4763	310619
2012	2055	322	3984	1111	159602	441	833	143886	3393	315627
2013	1886	342	1795	500	99215	439	639	85668	3260	193744

Year	Faroe Islands	France	GDR (–1990) & Greenland (1992–)	Germany	Norway	Poland	UK	Russia	Others	Total
2014	1470	198	1150	340	91306	187	355	78725	3791	177522
2015	2459	145	1047	124	95094	246	450	91864	3327	194756
2016	2460	340	1401	170	108718	200	575	115710	3838	233412
2017	2776	108	1810	170	113132	228	372	106714	2279	227588
2018	2333	183	1317	385	93839	169	453	90486	2111	191276
2019	1515	143	1208	204	93860	280	456	76125	1611	175402
2020	1392	96	910	282	88108	45	320	89030	2286	182468
2021[1)]	1722	105	1101	365	100673	13	78	98296	2390	204743

1) Provisional figures., 2) USSR prior to 1991. , 3) Figures based on Norwegian IUU estimates in 2002–2008 (see table 4.1), 4) Included landings in Norwegian statistical areas 06 and 07 (from 1983)

Table 4.4. Northeast Arctic haddock. Catch numbers-at-age (numbers, ´000).

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
1950	0	4446	3189	37949	35344	18849	28868	9199	1979	1093	853	867	1257
1951	4069	222	65643	9178	18014	13551	6808	6850	3322	1182	734	178	436
1952	0	13674	6012	151996	13634	9850	4693	3237	2434	606	534	185	161
1953	392	8031	64528	13013	70781	5431	2867	1080	424	315	393	202	410
1954	1726	493	6563	154696	5885	27590	3233	1302	712	319	126	68	349
1955	0	989	1154	10689	176678	4993	28273	1445	271	100	50	30	20
1956	97	3012	16437	5922	14713	127879	3182	8003	450	200	80	60	45
1957	828	243	2074	24704	7942	12535	46619	1087	1971	356	17	40	119
1958	153	2312	1727	5914	31438	5820	12748	17565	822	1072	226	79	296
1959	169	2425	20318	7826	7243	14040	3154	2237	5918	285	316	71	113
1960	2319	3613	39910	70912	13647	7101	6236	1579	2340	2005	497	70	42
1961	362	5531	15429	56855	63351	8706	3578	4407	788	527	1287	67	80
1962	0	4524	39503	30868	48903	33836	3201	1341	1773	242	247	483	28
1963	3	2143	28466	72736	18969	13579	9257	1239	559	409	80	84	212
1964	149	834	22363	49290	30672	5815	3527	2716	833	104	206	235	190
1965	0	3498	5936	46356	40201	12631	1679	974	897	123	204	123	471
1966	0	2577	26345	22631	63176	29048	5752	582	438	189	186	25	30
1967	0	53	15907	41346	13496	25719	8872	1616	218	175	155	75	41
1968	0	33	657	67632	41267	7748	15599	5292	655	182	101	115	70
1969	0	1061	1524	1968	44634	19002	3620	4937	1628	316	43	43	23
1970	480	281	23444	2454	1906	22417	8100	2012	2016	740	166	26	96
1971	15	3535	1978	24358	1257	918	9279	3056	826	1043	369	130	35
1972	133	9399	230942	22315	42981	3206	1611	6758	2638	900	989	538	120
1973	0	5956	70679	260520	24180	6919	422	426	1692	529	147	339	95
1974	281	3713	9685	41706	88120	5829	4138	382	618	2043	935	276	659
1975	1321	4355	10037	14088	33871	49711	2135	1236	92	131	500	147	287

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
1976	3475	7499	13994	13454	6810	20796	40057	1247	1350	193	280	652	671
1977	184	18456	55967	22043	7368	2586	7781	11043	311	388	96	101	182
1978	46	2033	47311	18812	4076	1389	1626	2596	6215	162	258	3	139
1979	0	48	17540	35290	10645	1429	812	546	1466	2310	181	87	55
1980	0	0	627	22878	21794	2971	250	504	230	842	1299	111	50
1981	1	68	486	2561	22124	10685	1034	162	162	72	330	564	69
1982	2	29	883	900	3372	12203	2625	344	75	80	91	321	238
1983	3	351	1173	2636	1360	2394	2506	1799	267	37	60	100	132
1984	7	754	1271	1019	1899	657	950	2619	352	87	2	22	53
1985	4	2952	29624	1695	564	1009	943	886	1763	588	124	64	93
1986	506	650	23113	68429	1565	783	896	393	702	1144	443	130	414
1987	9	83	5031	87170	64556	960	597	376	212	230	419	245	73
1988	7	139	1439	12478	47890	20429	397	178	74	88	168	198	80
1989	611	221	2157	4986	16071	25313	3198	147	1	28	28	53	96
1990	2	446	1015	2580	2142	4046	6221	840	134	42	14	13	44
1991	23	533	4421	3564	2416	3299	4633	3953	461	83	9	18	27
1992	49	2793	11571	11567	4099	2642	2894	3327	3498	486	35	32	18
1993	498	272	13487	19457	13704	4103	1747	1886	2105	1965	201	96	25
1994	95	187	3374	47821	36333	13264	2057	903	1453	2769	1802	259	49
1995	2	85	2003	16109	72644	19145	6417	746	361	770	655	804	116
1996	35	478	1662	6818	36473	73579	13426	2944	573	365	533	598	767
1997	70	94	2280	5633	12603	32832	49478	5636	778	245	126	158	463
1998	547	1476	1701	11304	9258	8633	13801	19469	2113	330	59	54	377
1999	104	568	16839	8039	15365	6073	4466	6355	6204	647	117	109	220
2000	46	692	1520	29986	6496	5149	2406	1657	1570	1744	183	70	184
2001	374	1758	12971	5230	32049	5279	2941	1137	1161	1169	747	169	288
2002	59	603	7132	46335	11084	21985	2602	1602	482	448	581	349	98
2003	123	611	6803	31448	56480	11736	14541	1637	2178	858	411	413	395
2004	58	1295	7993	21116	41310	41226	4939	4914	598	1252	296	139	465
2005	102	865	11452	19369	22887	37067	24461	2393	2997	990	201	263	1059
2006	271	2496	4539	35040	27571	15033	16023	8567	1259	1298	222	175	321
2007	575	3914	30707	15213	45992	18516	10642	7889	2570	678	605	197	185
2008	440	2089	14536	44192	15926	31173	9145	4520	2846	1181	274	214	166
2009	483	1364	15379	55013	52498	13679	15382	3800	1669	887	285	353	321
2010	457	620	6545	52006	80622	50306	9273	5324	1954	1114	533	242	621
2011	909	806	1277	8501	90394	100522	39496	4397	2340	668	437	269	708
2012	268	611	7814	4206	18007	93055	82721	14445	1325	448	217	216	568
2013	402	904	1778	12780	3805	12297	58024	29930	4976	957	331	212	535
2014	528	649	6948	4503	14563	6833	16304	39620	16439	2431	619	440	545
2015	303	1334	1645	27317	8526	16624	7950	20538	25534	6677	1556	295	312

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
2016	294	655	5774	3482	33177	9563	18045	12030	21875	13492	4757	876	248
2017	724	1898	30744	46463	16895	48927	10518	14992	9 485	8447	6640	1872	317
2018	679	1438	9424	16291	34060	8466	18882	5123	8902	4125	3564	4504	1040
2019	797	968	13908	28572	24171	32555	6278	6803	2601	3618	1225	1715	1400
2020	122	1298	10797	62206	46715	18137	10773	3051	2839	1445	996	915	1092
2021	263	641	2882	31573	99086	31202	7412	3595	1985	1161	814	802	966

Table 4.5. Northeast Arctic haddock. Catch weights-at-age (kg).

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
1950	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1951	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1952	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1953	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1954	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1955	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1956	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1957	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1958	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1959	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1960	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1961	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1962	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1963	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1964	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1965	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1966	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1967	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1968	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1969	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1970	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1971	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1972	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1973	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1974	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1975	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1976	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1977	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1978	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1979	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
1980	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1981	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1982	0.299	0.519	0.75	1.038	1.321	1.617	1.873	2.147	2.418	2.698	2.931	3.094	3.461
1983	0.188	0.689	1.033	1.408	1.71	2.149	2.469	2.748	3.069	3.687	4.516	3.094	3.461
1984	0.408	0.805	1.218	1.632	2.038	2.852	2.845	3.218	3.605	4.065	4.407	4.734	5.099
1985	0.319	0.383	0.835	1.29	1.816	2.174	2.301	2.835	3.253	3.721	4.084	4.137	4.926
1986	0.218	0.325	0.612	1.064	1.539	1.944	2.362	2.794	3.25	3.643	4.14	4.559	5.927
1987	0.143	0.221	0.497	0.765	1.179	1.724	2.135	2.551	3.009	3.414	3.84	4.415	5.195
1988	0.279	0.551	0.55	0.908	1.097	1.357	1.537	1.704	2.403	2.403	2.486	2.531	2.834
1989	0.258	0.55	0.684	0.84	0.998	1.176	1.546	1.713	1.949	2.14	2.389	2.522	2.797
1990	0.319	0.601	0.793	1.172	1.397	1.624	1.885	2.112	2.653	3.102	3.18	3.438	3.319
1991	0.216	0.616	0.941	1.281	1.556	1.797	2.044	2.079	2.311	2.788	3.408	2.896	3.274
1992	0.055	0.458	0.906	1.263	1.535	1.747	2.043	2.2	2.298	2.494	2.49	2.673	2.923
1993	0.381	0.64	0.94	1.204	1.487	1.748	1.994	2.237	2.417	2.654	2.906	3.184	3.363
1994	0.278	0.521	0.614	0.906	1.287	1.602	1.968	2.059	2.39	2.545	2.881	2.918	3.222
1995	0.258	0.446	0.739	0.808	1.107	1.556	1.838	2.234	2.416	2.602	2.965	3.163	3.786
1996	0.287	0.427	0.683	0.868	1.045	1.363	1.71	1.886	2.214	2.37	2.438	2.707	2.896
1997	0.408	0.575	0.682	1.028	1.151	1.369	1.637	1.856	2.073	2.5	2.279	2.532	2.609
1998	0.409	0.593	0.748	0.974	1.262	1.433	1.641	1.863	2.069	2.335	2.511	2.8	2.849
1999	0.435	0.695	0.826	1.079	1.261	1.485	1.634	1.798	2.032	2.237	2.339	2.611	2.865
2000	0.378	0.577	0.853	1.186	1.395	1.588	1.808	1.989	2.264	2.415	2.587	2.647	3.098
2001	0.391	0.647	0.751	1.104	1.459	1.709	1.921	2.182	2.331	2.609	2.757	3.376	3.338
2002	0.159	0.407	0.687	1.001	1.363	1.643	1.975	2.086	2.294	2.487	2.612	2.847	3.501
2003	0.198	0.384	0.594	0.875	1.113	1.364	1.361	1.972	1.636	1.877	2.088	2.351	2.842
2004	0.328	0.429	0.636	0.886	1.183	1.508	1.821	2.075	2.339	2.58	2.527	3.153	3.197
2005	0.285	0.492	0.722	0.906	1.121	1.343	1.619	2.036	2.177	2.382	2.527	2.496	2.81
2006	0.311	0.567	0.745	1.041	1.287	1.504	1.72	2.082	2.377	2.738	3.082	3.02	3.43
2007	0.329	0.431	0.652	0.899	1.197	1.435	1.722	1.99	2.309	2.715	2.987	2.947	3.591
2008	0.383	0.484	0.658	0.901	1.242	1.515	1.781	2.18	2.33	2.664	3.019	3.326	3.829
2009	0.378	0.508	0.707	1.024	1.28	1.538	1.806	2.107	2.398	2.531	2.606	3.089	3.541
2010	0.317	0.499	0.642	0.887	1.137	1.396	1.702	1.907	2.095	2.404	2.534	3.064	3.249
2011	0.423	0.513	0.811	0.953	1.093	1.254	1.462	1.715	1.978	2.328	2.305	2.55	2.76
2012	0.271	0.506	0.756	1.004	1.174	1.371	1.514	1.715	2.051	2.444	2.414	2.615	2.932
2013	0.469	0.542	0.821	1.014	1.217	1.401	1.571	1.714	1.914	2.168	2.24	2.516	2.807
2014	0.469	0.645	0.792	1.033	1.253	1.417	1.625	1.793	1.941	2.081	2.479	2.703	3.011
2015	0.473	0.647	0.876	1.054	1.327	1.571	1.777	1.934	2.025	2.216	2.481	2.99	3.455
2016	0.497	0.743	0.882	1.115	1.369	1.662	1.917	2.089	2.301	2.567	3.076	3.286	3.331
2017	0.449	0.608	0.874	1.088	1.378	1.666	1.879	2.146	2.258	2.476	2.72	2.98	3.713
2018	0.443	0.663	0.820	1.051	1.339	1.629	1.927	2.156	2.372	2.588	2.728	2.773	3.175
2019	0.341	0.508	0.729	0.955	1.275	1.581	1.834	2.151	2.378	2.607	2.868	2.934	3.382

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
2020	0.364	0.523	0.629	0.788	1.131	1.489	1.821	2.126	2.426	2.651	2.771	3.147	3.359
2021	0.257	0.445	0.570	0.773	0.997	1.351	1.716	2.150	2.388	2.682	3.073	3.201	4.139

Table 4.6a. Northeast Arctic haddock. Stock weights-at-age (kg). The data from 1950–1993 is unchanged AFWG 2019, the data from 1994 and onward have been updated this year.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
1950-1979	0.031	0.145	0.354	0.653	1.016	1.427	1.867	2.327	2.771	3.195	3.597	3.597	3.597
1980	0.063	0.262	0.454	0.878	1.159	1.675	2.292	3.134	3.31	3.553	3.792	3.792	3.792
1981	0.051	0.274	0.603	0.805	1.315	1.582	2.118	2.728	3.51	3.679	3.904	3.904	3.904
1982	0.036	0.224	0.631	1.049	1.217	1.782	2.017	2.553	3.14	3.853	4.016	4.016	4.016
1983	0.035	0.164	0.524	1.098	1.558	1.663	2.255	2.448	2.97	3.524	4.165	4.165	4.165
1984	0.028	0.158	0.391	0.926	1.632	2.093	2.121	2.718	2.865	3.363	3.878	3.878	3.878
1985	0.03	0.127	0.379	0.700	1.394	2.195	2.626	2.572	3.158	3.261	3.728	3.728	3.728
1986	0.035	0.136	0.311	0.682	1.069	1.898	2.761	3.138	3.005	3.568	3.632	3.632	3.632
1987	0.042	0.161	0.331	0.569	1.047	1.473	2.411	3.307	3.616	3.412	3.946	3.946	3.946
1988	0.039	0.189	0.383	0.603	0.887	1.452	1.895	2.915	3.822	4.054	3.787	3.787	3.787
1989	0.037	0.175	0.445	0.689	0.936	1.248	1.878	2.317	3.395	4.297	4.449	4.449	4.449
1990	0.031	0.169	0.413	0.789	1.054	1.312	1.635	2.308	2.728	3.844	4.73	4.73	4.73
1991	0.025	0.141	0.402	0.737	1.193	1.458	1.714	2.035	2.732	3.122	4.256	4.256	4.256
1992	0.023	0.114	0.34	0.721	1.119	1.63	1.881	2.127	2.437	3.142	3.491	3.491	3.491
1993	0.025	0.107	0.279	0.616	1.100	1.537	2.08	2.308	2.54	2.831	3.531	3.531	3.531

Table 4.6b Northeast Arctic haddock. Stock weights-at-age (kg), updated from 1994 and onwards this year.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13
1994	0.025	0.106	0.251	0.504	0.938	1.648	2.172	2.7	2.852	2.818	2.979	3.624	4.181
1995	0.032	0.113	0.262	0.471	0.796	1.312	2.115	2.634	3.166	3.296	3.213	3.164	3.938
1996	0.032	0.141	0.279	0.487	0.745	1.134	1.716	2.57	3.093	3.61	3.72	3.404	3.482
1997	0.034	0.141	0.344	0.513	0.768	1.061	1.492	2.124	3.022	3.53	4.026	3.871	3.721
1998	0.026	0.151	0.344	0.623	0.814	1.098	1.414	1.875	2.535	3.467	3.957	4.181	4.181
1999	0.027	0.12	0.364	0.628	0.971	1.156	1.448	1.774	2.265	2.957	3.888	4.111	4.471
2000	0.025	0.124	0.294	0.659	0.978	1.362	1.519	1.823	2.149	2.656	3.366	4.041	4.415
2001	0.021	0.111	0.306	0.539	1.025	1.362	1.765	1.906	2.206	2.54	3.051	3.545	4.342
2002	0.026	0.101	0.273	0.557	0.851	1.429	1.776	2.192	2.289	2.592	2.922	3.238	3.871
2003	0.026	0.118	0.248	0.504	0.875	1.202	1.846	2.192	2.611	2.697	2.979	3.12	3.56
2004	0.027	0.116	0.288	0.462	0.796	1.24	1.574	2.274	2.611	3.029	3.08	3.179	3.435
2005	0.019	0.121	0.284	0.529	0.735	1.134	1.62	1.97	2.703	3.044	3.444	3.282	3.497
2006	0.019	0.088	0.294	0.525	0.832	1.054	1.492	2.024	2.372	3.131	3.444	3.624	3.592
2007	0.021	0.088	0.22	0.543	0.832	1.179	1.397	1.875	2.422	2.777	3.539	3.624	3.938
2008	0.026	0.101	0.22	0.416	0.856	1.179	1.555	1.763	2.265	2.831	3.169	3.721	3.938
2009	0.027	0.118	0.248	0.412	0.666	1.209	1.546	1.938	2.138	2.656	3.243	3.358	4.041

2010	0.035	0.121	0.288	0.462	0.666	0.959	1.583	1.938	2.336	2.527	3.051	3.419	3.673
2011	0.032	0.152	0.296	0.535	0.735	0.953	1.281	1.98	2.336	2.736	2.909	3.253	3.738
2012	0.037	0.141	0.367	0.543	0.838	1.054	1.273	1.628	2.385	2.736	3.139	3.091	3.56
2013	0.033	0.162	0.34	0.669	0.856	1.186	1.397	1.619	1.982	2.791	3.124	3.328	3.404
2014	0.035	0.147	0.392	0.623	1.032	1.209	1.565	1.763	1.972	2.353	3.184	3.328	3.64
2015	0.033	0.152	0.354	0.706	0.964	1.439	1.593	1.948	2.138	2.341	2.717	3.373	3.64
2016	0.026	0.145	0.367	0.643	1.089	1.353	1.867	1.992	2.349	2.515	2.717	2.922	3.689
2017	0.025	0.118	0.35	0.669	0.998	1.509	1.765	2.298	2.385	2.75	2.909	2.908	3.223
2018	0.024	0.11	0.288	0.638	1.032	1.395	1.94	2.181	2.73	2.791	3.154	3.091	3.223
2019	0.024	0.108	0.271	0.529	0.991	1.439	1.806	2.382	2.599	3.16	3.198	3.343	3.404
2020	0.024	0.11	0.267	0.504	0.838	1.387	1.867	2.239	2.825	3.029	3.572	3.389	3.656
2021	NA	0.107	0.271	0.496	0.796	1.186	1.795	2.298	2.65	3.266	3.428	3.738	3.705
2022	NA	NA	0.262	0.5	0.785	1.134	1.555	2.227	2.73	3.086	3.669	3.608	4.058

Table 4.7a. Northeast Arctic haddock. Proportion mature at age. The data from 1950-1993 is unchanged since AFWG 2019. Age 1-2 are 0, and ages 11-13+ set to 1 (not shown)

Year	3	4	5	6	7	8	9	10
1950-1979	0.027	0.101	0.311	0.622	0.845	0.944	0.982	0.994
1980	0.026	0.076	0.243	0.649	0.86	0.95	0.984	0.995
1981	0.056	0.104	0.303	0.549	0.857	0.948	0.984	0.995
1982	0.053	0.161	0.332	0.577	0.77	0.947	0.983	0.995
1983	0.057	0.183	0.472	0.665	0.8	0.906	0.983	0.995
1984	0.044	0.196	0.51	0.801	0.862	0.921	0.967	0.995
1985	0.027	0.149	0.522	0.796	0.928	0.953	0.973	0.989
1986	0.021	0.103	0.454	0.758	0.928	0.977	0.984	0.991
1987	0.021	0.076	0.294	0.713	0.918	0.976	0.993	0.994
1988	0.025	0.074	0.24	0.576	0.898	0.975	0.993	0.998
1989	0.032	0.09	0.25	0.534	0.822	0.966	0.993	0.998
1990	0.046	0.127	0.305	0.578	0.798	0.937	0.99	0.997
1991	0.041	0.164	0.358	0.623	0.82	0.925	0.98	0.997
1992	0.03	0.147	0.449	0.704	0.855	0.936	0.976	0.994
1993	0.018	0.113	0.396	0.741	0.878	0.95	0.979	0.992

Table 4.7b. Northeast Arctic haddock. Proportion mature at age. Data 1994-2022, Age 1-2 set to 0, and ages 11-13+ set to 1 (not shown)

Year	3	4	5	6	7	8	9	10
1994	0.028	0.085	0.266	0.63	0.839	0.939	0.957	0.956
1995	0.03	0.077	0.207	0.493	0.826	0.933	0.975	0.98
1996	0.032	0.081	0.187	0.411	0.718	0.926	0.972	0.989
1997	0.043	0.088	0.196	0.377	0.637	0.858	0.968	0.987
1998	0.043	0.12	0.214	0.394	0.605	0.804	0.93	0.985
1999	0.047	0.121	0.28	0.422	0.618	0.777	0.898	0.964

2000	0.035	0.13	0.283	0.516	0.648	0.79	0.88	0.945
2001	0.037	0.095	0.304	0.516	0.734	0.811	0.889	0.936
2002	0.031	0.101	0.229	0.545	0.737	0.871	0.901	0.941
2003	0.028	0.085	0.239	0.443	0.758	0.871	0.937	0.948
2004	0.033	0.075	0.207	0.461	0.668	0.885	0.937	0.968
2005	0.033	0.092	0.182	0.411	0.686	0.827	0.945	0.968
2006	0.035	0.091	0.221	0.374	0.637	0.838	0.911	0.972
2007	0.023	0.096	0.221	0.433	0.597	0.804	0.918	0.954
2008	0.023	0.064	0.231	0.433	0.661	0.773	0.898	0.957
2009	0.028	0.063	0.157	0.447	0.658	0.818	0.878	0.945
2010	0.033	0.075	0.157	0.328	0.672	0.818	0.907	0.935
2011	0.036	0.093	0.182	0.325	0.546	0.829	0.907	0.951
2012	0.048	0.096	0.224	0.374	0.542	0.732	0.913	0.951
2013	0.042	0.134	0.231	0.436	0.597	0.729	0.851	0.955
2014	0.052	0.12	0.307	0.447	0.665	0.773	0.848	0.918
2015	0.045	0.145	0.278	0.549	0.675	0.822	0.878	0.916
2016	0.048	0.126	0.331	0.512	0.764	0.831	0.908	0.934
2017	0.045	0.134	0.292	0.578	0.734	0.888	0.913	0.952
2018	0.033	0.124	0.307	0.53	0.784	0.868	0.947	0.955
2019	0.031	0.092	0.289	0.549	0.746	0.901	0.936	0.974
2020	0.031	0.085	0.224	0.526	0.764	0.879	0.955	0.968
2021	0.031	0.083	0.207	0.436	0.743	0.888	0.941	0.979
2022	0.03	0.084	0.202	0.411	0.661	0.877	0.947	0.97

Table 4.8. Northeast Arctic haddock. Consumption of Haddock by NEA Cod (mln. spec) age 0–6, and total biomass ages 0–6 consumed.

Age	0	1	2	3	4	5	6	Biomass
1984	2228.8	1022.2	15.3	0.1	0.0	0.0	0.0	55.7
1985	2019.2	1372.8	5.1	0.0	0.0	0.0	0.0	53.3
1986	92.7	598.9	224.1	168.3	0.0	0.0	0.0	109.2
1987	0.0	1061.3	0.0	0.0	0.0	0.0	0.0	5.8
1988	0.0	16.7	0.5	8.7	0.0	0.2	0.0	2.5
1989	21.2	221.2	0.0	0.0	0.0	0.0	0.0	9.9
1990	48.2	136.9	34.1	3.3	0.0	0.0	0.0	14.0
1991	0.0	354.3	12.9	0.0	0.0	0.0	0.0	15.6
1992	132.4	1743.6	123.5	0.9	0.0	0.0	0.0	88.1
1993	826.2	1444.1	143.8	32.2	3.1	2.6	0.0	69.5
1994	1350.6	1486.9	73.6	23.9	6.9	0.8	0.0	48.4
1995	182.1	2875.9	167.5	12.4	28.2	27.9	0.3	113.8
1996	359.9	1546.3	154.5	38.2	5.2	2.5	3.2	66.6
1997	0	946	39	26	2	1	1	44

Age	0	1	2	3	4	5	6	Biomass
1998	0	1736	28	2	3	0	0	36
1999	0	1041	25	0	0	0	0	30
2000	814	1413	72	2	1	0	0	58
2001	1051	595	53	5	0	0	0	51
2002	457	2444	241	40	2	0	0	127
2003	1145	3580	215	39	13	1	0	166
2004	5407	2871	305	40	10	2	0	199
2005	7738	6703	277	56	9	2	1	326
2006	12843	8447	377	6	4	1	0	362
2007	1216	10226	663	72	4	2	0	380
2008	1370	973	900	229	45	6	3	295
2009	5673	1875	277	264	70	22	2	255
2010	1991	5747	181	67	69	63	12	269
2011	2339	2648	455	56	76	87	19	281
2012	235	7193	135	108	15	7	4	221
2013	2175	1595	380	32	23	6	4	202
2014	1196	2010	141	28	2	1	0	88
2015	4985	2599	132	14	45	1	0	179
2016	8177	2688	281	23	2	8	2	225
2017	4702	7782	234	23	13	6	14	279
2018	2382	7129	597	67	7	1	0	281
2019	556	4621	421	125	9	0	0	218
2020	1979	522	81	61	77	4	0	92
2021	1084	323	86	6	5	1	0	28
Av.1984–2021	2020.4	2673.4	198.7	44.2	14.4	6.8	1.8	140.7

Table 4.9. Northeast Arctic haddock. Survey indices for SAM tuning (see section 4.4.6). The last age is a plus group.

North-East Arctic haddock

104

RU-BTr-Q4

1991 2021

1 1 0.9 1.00

3 8

1 62 9 3 6 18 17

1 346 50 4 6 9 9

1 1985 356 48 8 4 4

1 442 1014 116 15 1 6

1 31 123 370 40 5 4

1 28 49 362 334 29 6

1 32 32 10 27 10 8

1 38 46 8 5 15 5

1 196 39 37 8 3 14

1 60 109 26 11 2 5

1 334 40 65 11 4 4

1 399 450 47 24 4 3

1 221 299 231 34 16 3

1 113 94 107 87 5 6

1 240 86 48 57 24 3

1 113 119 57 26 24 13

1 838 73 137 38 14 15

1 2557 1051 124 111 17 11

1 1647 1704 631 57 32 9

1 299 1697 1589 466 34 17

1 47 268 1087 783 165 13

1 209 49 160 720 480 70

1 61 175 50 104 374 272

1 250 46 175 56 142 416

1 22 199 40 74 28 171

1 -1 -1 -1 -1 -1 -1

1 71 99 9 38 6 27

1 -1 -1 -1 -1 -1 -1

1 -1 -1 -1 -1 -1 -1

1 -1 -1 -1 -1 -1 -1

1 -1 -1 -1 -1 -1 -1

BS-NoRU-Q1(Aco)

1994 2022

1 1 0.077 0.189

3 9

1 348.73 626.65 121.38 8.55 0.7 0.33 2.71

1 41.47 121.49 395.37 47.61 2.8 0.05 0.83

1 29.97 22.09 68.65 143.69 5.67 0.93 0.07

1 57.27 22.22 15.47 56.13 62.77 4.68 0.19

1 33.78 58.79 24.2 7.7 14.06 20.69 1.62

1 83.67 21.64 22.1 6.17 1.55 3.88 2.77

1 36.39 75.53 14.01 12.61 1.57 0.53 3.02

1 233.45 40.2 41.38 2.2 1.61 0.15 0.71

1 255.2 201.84 18.47 11.7 1.59 0.29 0.56

1 203.68 184.57 136.04 12.26 6.01 0.26 0.9

1 151.01 101.85 107.82 57.68 7.61 1.15 0.55

1 221.33 115.67 57.43 56.71 12.69 0.38 0.33

1 56.32 123.84 47.37 19.26 13.64 3.23 0.35

1 209.28 46.14 80.57 28.92 10 5.05 2.79

1 812.41 303.04 90.02 74.12 7.41 12.77 2.11

1 883.68 629.98 266.65 38.87 14.57 1.26 1.05

1 128.07 631.03 603.99 166.96 12.07 2.94 2.11

1 54.16 84.23 313.02 292.21 54.91 1.71 1.46

1 191.63 48.84 88.12 310.6 172.52 30.09 1.01

1 67.29 146.77 35.41 53.03 223.77 102.68 14.37

1 334.82 39.12 108.72 23.18 34.77 86.36 38.82

1 24.35 189.4 26.63 46.13 9.22 22.45 31.99

1 71.81 12.08 59.62 12.52 17.28 7.48 33.24

1 81.15 65.05 4.81 34.81 6.24 7.93 17.72

1 171.03 62.74 64.4 6.77 15.57 2.75 14.69

1 507.61 146.22 31.73 21.88 4.72 3.46 4.19

1 286.32 306.38 79.18 22.38 11.59 1.84 6.33

1 50.76 130.37 181.8 19.35 5.44 0.94 1.77

1 11.35 63.40 95.30 101.24 11.79 0.82 1.08

BS-NoRu-Q1 (BTr)

1994 2022

1 1 0.077 0.189

3 10

1 314.533 436.251 46.176 3.54 0.163 0.13 0.2 0.651

1 54.857 167.104 343.38 29.623 1.441 0.025 0.043 0.404

1 55.843 31.334 150.768 238.108 16.131 1.15 0 0.069

1 79.632 39.855 18.255 61.566 88.411 3.277 0.082 0.043

1 21.681 36.749 11.844 1.294 9.203 7.212 0.648 0.092

1 56.92 15.874 9.418 2.831 0.807 1.282 0.771 0.034

1 24.08 35.241 6.789 4.134 0.684 0.083 0.802 0.288

1 293.996 26.252 22.997 1.634 0.752 0.058 0.06 0.329

1 312.87 185.453 12.417 8.04 0.846 0.218 0.009 0.325

1 352.236 174.452 72.708 5.104 1.682 0.119 0.104 0.217

1 173.132 100.516 77.021 51.281 7.409 0.912 0.133 0.228

1 317.889 141.058 50.664 61.191 10.082 0.249 0.08 0.009

1 78.798 130.76 46.048 20.874 16.208 3.184 0.094 0.265

1 443.266 81.784 84.667 26.279 5.411 2.197 1.376 0.896

1 1591.031 583.606 53.079 54.732 6.794 10.248 0.23 0.167

1 1230.426 751.012 368.33 25.414 12.437 0.851 0.09 0.363

1 102.451 510.449 443.759 139.316 7.988 1.016 0.386 0.574

1 52.883 123.634 469.482 290.036 65.236 1.416 1.121 0.184

1 316.077 28.785 74.714 267.945 154.601 24.766 3.115 0.391

1 57.444 143.984 22.019 33.624 191.145 69.385 6.114 0.076

1 381.173 32.729 104.397 23.257 50.035 97.536 38.692 2.425

1 30.615 187.035 43.601 39.44 14.668 18.735 30.744 10.2

1 163.385 34.342 115.597 22.406 41.948 12.437 32.396 33.161

1 134.9 105.5 7.553 55.338 9.692 15.6 2.527 23.861

1 336.307 86.656 65.764 7.771 15.59 3.621 2.564 11.931

1 1075.552 187.224 49.399 16.996 4.038 2.948 0.736 1.91

1 424.225 586.985 99.123 22.08 6.057 2.605 1.042 2.827

1 111.35 176.57 265.49 19.32 3.57 0.68 0.19 0.72

1 12.226 86.540 121.699 113.566 9.099 0.617 0.113 0.44

FLT007: Eco-NoRu-Q3 (Btr)

2004 2021

1 1 0.65 0.75

3 9

1 123.368 70.303 69.118 31.482 2.989 1.721 0.220

1 324.560 89.531 30.440 32.246 15.035 0.472 1.116

1 107.467 124.640 41.597 18.980 17.482 7.289 1.384

1 1282.940 88.498 90.369 19.227 5.881 7.102 3.209

1 1154.869 405.999 43.133 35.517 4.940 2.514 2.539

1 650.742 619.088 305.883 21.045 6.549 0.870 0.576

1 184.001 865.318 666.439 147.720 15.840 2.730 0.589

1 40.446 73.802 392.930 301.368 37.357 2.972 0.514

1 92.468 20.348 67.607 214.052 152.030 12.739 2.003

1 25.779 65.228 19.575 50.846 150.131 76.427 7.561

1 261.631 40.768 70.161 25.781 60.452 85.771 19.646

1 42.148 213.636 25.132 37.111 20.577 47.868 42.903

1 209.303 34.430 184.090 47.965 56.787 40.367 125.907

1 70.313 70.306 11.470 20.537 3.963 4.025 15.265

1 -1 -1 -1 -1 -1 -1 -1

1 896.982 160.736 38.067 15.133 5.303 5.037 11.560

1 204.059 341.372 58.813 4.918 1.959 0.802 1.483

1 129.533 345.768 330.627 32.250 5.446 0.885 1.410

Table 4.10 Northeast Arctic haddock. SAM model configuration used. Updated at WKDEM 2020

#Configuration saved: Wed Feb 12 12:57:09 2020

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

$minAge

The minimum age class in the assessment

3

$maxAge

The maximum age class in the assessment

13

$maxAgePlusGroup

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

1 1 1 1 1

$keyLogFsta

Coupling of the fishing mortality states (nomally only first row is used).

0 1 2 3 4 5 5 5 5 5

-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1

-1 -1 -1 -1 -1 -1 -1 -1 -1 -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).

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 -1 -1 -1 -1

0 1 1 1 1 1 -1 -1 -1 -1 -1

2 3 3 3 3 4 4 -1 -1 -1 -1

5 6 6 6 6 7 7 7 -1 -1 -1

8 9 9 9 9 9 9 -1 -1 -1 -1

$keyQpow

Density dependent catchability power parameters (if any).

-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1

0 0 0 0 0 0 -1 -1 -1 -1 -1

1 1 1 1 1 2 2 -1 -1 -1 -1

3 3 3 3 3 4 4 4 -1 -1 -1

5 5 5 5 5 5 5 -1 -1 -1 -1

$keyVarF

Coupling of process variance parameters for log(F)-process (nomally only first row is used)

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

$keyVarLogN

Coupling of process variance parameters for log(N)-process

0 1 1 1 1 1 1 1 1 1 1

$keyVarObs

Coupling of the variance parameters for the observations.

0 1 2 2 2 2 2 2 2 2 2

3 3 3 3 3 3 -1 -1 -1 -1 -1

4 4 4 4 4 4 4 -1 -1 -1 -1

5 5 5 5 5 5 5 5 -1 -1 -1

6 6 6 6 6 6 6 -1 -1 -1 -1

$obsCorStruct

Covariance structure for each fleet ("ID" independent, "AR" AR(1), or "US" for unstructured). | Possible values are: "ID" "AR" "US"

"ID" "AR" "AR" "AR" "AR"

$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).

#V1 V2 V3 V4 V5 V6 V7 V8 V9 V10

NA NA NA NA NA NA NA NA NA NA

0 1 1 1 2 -1 -1 -1 -1 -1

3 3 3 3 3 4 -1 -1 -1 -1

5 5 5 5 5 6 6 -1 -1 -1

7 7 7 7 7 7 -1 -1 -1 -1

$stockRecruitmentModelCode

Stock recruitment code (0 for plain random walk, 1 for Ricker, 2 for Beverton–Holt, and 3 piece-wise constant).

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

4 7

$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 and 5 TSB index).

-1 -1 -1 -1 -1

$obsLikelihoodFlag

Option for observational likelihood | Possible values are: "LN" "ALN"

"LN" "LN" "LN" "LN" "LN"

$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

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

$constRecBreaks

This option is only used in combination with stock-recruitment code 3)

$predVarObsLink

Coupling of parameters used in a mean-variance link for observations.

0 1 2 2 2 2 2 2 2 2 2

3 3 3 3 3 3 -1 -1 -1 -1 -1

4 4 4 4 4 4 4 -1 -1 -1 -1

5 5 5 5 5 5 5 5 -1 -1 -1

6 6 6 6 6 6 6 -1 -1 -1 -1

Table 4.11. Northeast Arctic haddock. SAM model. Estimated recruitment, spawning-stock biomass (SSB), and average fishing mortality (Fbar ages 4.-7).

Year	R(age 3)	Low	High	SSB	Low	High	Fbar	Low	High	TSB	Low	High
1950	71954	46160	112161	214279	192049	239082	0.757	0.640	0.895	387448	347900	431491
1951	662668	429436	1022572	126110	112047	141939	0.683	0.576	0.811	434923	341406	554056
1952	87684	56210	136781	101799	88941	116517	0.713	0.597	0.852	426462	340536	534068
1953	1236112	814474	1876024	120561	104157	139550	0.536	0.443	0.648	733249	561653	957269
1954	132692	85171	206726	174538	148014	205816	0.430	0.354	0.522	826604	653951	1044841
1955	58481	37134	92100	313360	267430	367179	0.447	0.371	0.539	847418	714270	1005387
1956	229412	146973	358093	367219	312961	430885	0.472	0.392	0.569	688366	591608	800948
1957	60191	38357	94452	253094	217114	295035	0.426	0.355	0.512	434424	377495	499938
1958	72727	46696	113271	181736	157983	209059	0.517	0.430	0.622	314993	277299	357810
1959	388917	256300	590152	125293	108818	144263	0.444	0.366	0.538	333079	274384	404329
1960	319617	209398	487852	112867	99564	127948	0.540	0.450	0.646	418492	349162	501588
1961	144191	94743	219445	124747	111163	139991	0.663	0.561	0.785	401510	349516	461237
1962	294721	194343	446943	125047	111195	140626	0.793	0.674	0.934	376236	324272	436527
1963	313728	208414	472257	94205	82955	106980	0.761	0.638	0.907	352837	295662	421068
1964	352219	232640	533263	84357	74141	95980	0.632	0.525	0.762	385078	319073	464736
1965	126309	82135	194241	103060	89956	118073	0.524	0.433	0.633	385804	326369	456061
1966	313027	205139	477656	145581	126799	167144	0.559	0.465	0.671	450542	385007	527232

1967	341917	223471	523142	151115	130284	175276	0.441	0.364	0.534	464355	390615	552016
1968	18033	11181	29084	168049	145535	194044	0.483	0.398	0.585	427102	362441	503298
1969	20492	12780	32859	167756	144118	195271	0.412	0.336	0.504	316603	271150	369674
1970	209907	135812	324426	155327	131740	183137	0.383	0.310	0.473	286808	241814	340175
1971	108513	69785	168732	127578	107522	151376	0.326	0.261	0.407	263234	223953	309405
1972	1066297	686314	1656659	128558	111671	147997	0.655	0.536	0.800	606115	458740	800835
1973	309863	204061	470519	125538	107980	145951	0.537	0.439	0.657	640625	514095	798295
1974	65777	42815	101054	153803	134044	176476	0.502	0.414	0.609	462914	399648	536194
1975	59215	38571	90908	195116	167179	227722	0.497	0.415	0.595	379238	329211	436866
1976	61657	39505	96230	196497	168938	228551	0.720	0.606	0.854	296463	259812	338284
1977	120878	76578	190806	118927	100298	141017	0.738	0.609	0.894	201470	172925	234726
1978	214299	141229	325173	81230	67275	98081	0.625	0.507	0.769	199293	164652	241223
1979	161196	105893	245381	62550	52626	74344	0.582	0.468	0.722	206358	171758	247928
1980	22214	13770	35836	62876	53385	74055	0.472	0.378	0.588	213181	178172	255069
1981	10373	6182	17404	72926	61649	86267	0.433	0.347	0.540	168442	142141	199610
1982	16685	10270	27106	68721	56827	83105	0.380	0.302	0.478	122845	102836	146747
1983	8517	5013	14472	58413	47945	71166	0.350	0.274	0.448	87912	73614	104988
1984	13170	8117	21369	53238	43378	65339	0.315	0.244	0.406	71782	59894	86028
1985	360421	236188	550001	49175	40893	59134	0.395	0.310	0.504	192100	141398	260982
1986	480423	315598	731331	54932	46581	64781	0.535	0.425	0.673	375571	295920	476661
1987	90168	58164	139782	77886	66612	91068	0.630	0.506	0.784	356991	298457	427006
1988	39086	24572	62172	79981	67314	95032	0.510	0.408	0.637	253784	215181	299311
1989	28690	17838	46145	84497	69604	102576	0.373	0.296	0.470	192911	161527	230393
1990	36995	23783	57547	85921	69888	105632	0.211	0.165	0.269	153556	128235	183876
1991	111064	78155	157832	100599	84419	119880	0.239	0.191	0.300	186577	159220	218635
1992	328345	233437	461840	111029	95914	128527	0.295	0.238	0.365	291072	244156	347003
1993	847060	614155	1168288	125586	110671	142511	0.317	0.258	0.390	525266	434289	635301
1994	398541	321655	493805	154808	138283	173307	0.372	0.307	0.451	651807	569635	745834
1995	101169	79053	129473	188058	167539	211090	0.298	0.250	0.355	646393	570710	732114
1996	100698	79043	128284	217720	194150	244150	0.365	0.310	0.429	559665	498603	628206
1997	120498	94753	153239	188657	168178	211630	0.444	0.376	0.525	402551	361525	448233
1998	63525	49193	82032	131664	116654	148606	0.451	0.378	0.539	267336	239682	298182
1999	151800	121599	189502	95277	84396	107561	0.463	0.384	0.557	234447	209286	262633
2000	83531	65493	106537	78591	69508	88860	0.341	0.280	0.417	215167	190291	243294
2001	369908	302935	451687	92000	82049	103159	0.367	0.305	0.442	320514	283381	362512
2002	397842	324975	487048	109706	97927	122903	0.353	0.294	0.425	437375	386388	495090
2003	342420	275510	425581	137919	123784	153669	0.425	0.359	0.503	508138	452684	570385
2004	262688	214934	321052	156548	140497	174432	0.388	0.330	0.457	495469	444528	552248
2005	369114	303533	448865	168006	150852	187110	0.404	0.344	0.475	512134	460213	569914
2006	158484	128452	195538	152111	136464	169553	0.369	0.313	0.436	439733	395317	489139
2007	546307	446462	668482	154138	138541	171491	0.385	0.326	0.456	505369	452460	564466

2008	1118238	923680	1353778	163581	145927	183371	0.316	0.264	0.379	739975	651077	841011
2009	1032328	855199	1246143	184743	164860	207025	0.261	0.218	0.312	998392	876484	1137257
2010	242169	197117	297516	250124	222925	280640	0.245	0.207	0.291	1130728	994342	1285821
2011	118630	94061	149618	358639	319475	402603	0.256	0.218	0.301	1180978	1046214	1333101
2012	343696	280562	421036	477985	422713	540483	0.221	0.187	0.260	1175395	1043301	1324215
2013	120201	95747	150901	525035	462748	595705	0.148	0.124	0.176	1005103	892555	1131843
2014	415161	340548	506123	524516	465653	590819	0.154	0.128	0.184	985764	884448	1098686
2015	73229	57412	93404	499511	448301	556572	0.189	0.158	0.225	877036	792009	971192
2016	214907	173580	266072	492548	442909	547750	0.259	0.219	0.307	807191	729705	892904
2017	197724	160085	244212	412857	373794	456002	0.349	0.296	0.412	707465	642413	779104
2018	370008	299579	456994	306676	276535	340103	0.402	0.340	0.475	620407	560008	687321
2019	831409	682866	1012264	237709	213456	264719	0.432	0.362	0.515	691820	616267	776635
2020	449467	366822	550732	204215	181387	229916	0.435	0.360	0.525	718196	633884	813723
2021	164246	128805	209438	199550	173606	229372	0.420	0.340	0.518	661365	575999	759381
2022	38431	25191	58630	216456	176604	265300				566427	466593	687622

Table 4.12. Northeast Arctic haddock. SAM model estimated fishing mortality-at-age. SAM model.

Year Age	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1950	0.097	0.416	0.708	0.850	1.053	0.886	0.886	0.886	0.886	0.886	0.886
1951	0.086	0.361	0.618	0.773	0.981	0.886	0.886	0.886	0.886	0.886	0.886
1952	0.093	0.384	0.643	0.797	1.029	0.935	0.935	0.935	0.935	0.935	0.935
1953	0.067	0.284	0.473	0.586	0.801	0.738	0.738	0.738	0.738	0.738	0.738
1954	0.048	0.208	0.356	0.466	0.690	0.651	0.651	0.651	0.651	0.651	0.651
1955	0.046	0.200	0.368	0.503	0.716	0.603	0.603	0.603	0.603	0.603	0.603
1956	0.050	0.210	0.390	0.552	0.738	0.624	0.624	0.624	0.624	0.624	0.624
1957	0.047	0.198	0.367	0.493	0.646	0.549	0.549	0.549	0.549	0.549	0.549
1958	0.057	0.235	0.450	0.600	0.784	0.692	0.692	0.692	0.692	0.692	0.692
1959	0.059	0.229	0.408	0.520	0.619	0.567	0.567	0.567	0.567	0.567	0.567
1960	0.091	0.320	0.537	0.632	0.669	0.616	0.616	0.616	0.616	0.616	0.616
1961	0.119	0.409	0.683	0.782	0.780	0.694	0.694	0.694	0.694	0.694	0.694
1962	0.149	0.506	0.859	0.944	0.864	0.721	0.721	0.721	0.721	0.721	0.721
1963	0.134	0.474	0.810	0.914	0.845	0.681	0.681	0.681	0.681	0.681	0.681
1964	0.096	0.360	0.634	0.771	0.765	0.648	0.648	0.648	0.648	0.648	0.648
1965	0.076	0.291	0.511	0.636	0.656	0.567	0.567	0.567	0.567	0.567	0.567
1966	0.090	0.330	0.565	0.669	0.671	0.555	0.555	0.555	0.555	0.555	0.555
1967	0.072	0.268	0.446	0.515	0.536	0.465	0.465	0.465	0.465	0.465	0.465
1968	0.083	0.298	0.491	0.554	0.589	0.515	0.515	0.515	0.515	0.515	0.515
1969	0.079	0.268	0.428	0.469	0.482	0.416	0.416	0.416	0.416	0.416	0.416

1970	0.082	0.262	0.402	0.428	0.440	0.381	0.381	0.381	0.381	0.381	0.381
1971	0.073	0.233	0.350	0.354	0.366	0.324	0.324	0.324	0.324	0.324	0.324
1972	0.197	0.504	0.764	0.696	0.654	0.544	0.544	0.544	0.544	0.544	0.544
1973	0.206	0.493	0.649	0.531	0.477	0.380	0.380	0.380	0.380	0.380	0.380
1974	0.181	0.431	0.544	0.512	0.522	0.461	0.461	0.461	0.461	0.461	0.461
1975	0.200	0.462	0.547	0.493	0.487	0.417	0.417	0.417	0.417	0.417	0.417
1976	0.297	0.649	0.782	0.720	0.728	0.641	0.641	0.641	0.641	0.641	0.641
1977	0.335	0.722	0.856	0.717	0.657	0.557	0.557	0.557	0.557	0.557	0.557
1978	0.228	0.551	0.729	0.643	0.576	0.504	0.504	0.504	0.504	0.504	0.504
1979	0.161	0.443	0.673	0.653	0.556	0.502	0.502	0.502	0.502	0.502	0.502
1980	0.100	0.315	0.526	0.565	0.480	0.460	0.460	0.460	0.460	0.460	0.460
1981	0.084	0.273	0.473	0.542	0.444	0.429	0.429	0.429	0.429	0.429	0.429
1982	0.075	0.244	0.412	0.479	0.385	0.381	0.381	0.381	0.381	0.381	0.381
1983	0.078	0.247	0.388	0.427	0.339	0.340	0.340	0.340	0.340	0.340	0.340
1984	0.069	0.228	0.348	0.377	0.307	0.292	0.292	0.292	0.292	0.292	0.292
1985	0.075	0.258	0.412	0.481	0.429	0.412	0.412	0.412	0.412	0.412	0.412
1986	0.087	0.315	0.540	0.666	0.619	0.588	0.588	0.588	0.588	0.588	0.588
1987	0.097	0.360	0.646	0.789	0.725	0.658	0.658	0.658	0.658	0.658	0.658
1988	0.071	0.278	0.511	0.658	0.592	0.537	0.537	0.537	0.537	0.537	0.537
1989	0.055	0.220	0.389	0.468	0.414	0.361	0.361	0.361	0.361	0.361	0.361
1990	0.029	0.127	0.214	0.255	0.247	0.231	0.231	0.231	0.231	0.231	0.231
1991	0.031	0.136	0.243	0.291	0.285	0.261	0.261	0.261	0.261	0.261	0.261
1992	0.032	0.146	0.293	0.368	0.372	0.340	0.340	0.340	0.340	0.340	0.340
1993	0.025	0.128	0.292	0.410	0.440	0.398	0.398	0.398	0.398	0.398	0.398
1994	0.023	0.123	0.305	0.479	0.583	0.546	0.546	0.546	0.546	0.546	0.546
1995	0.018	0.098	0.230	0.366	0.499	0.492	0.492	0.492	0.492	0.492	0.492
1996	0.024	0.122	0.285	0.437	0.615	0.623	0.623	0.623	0.623	0.623	0.623
1997	0.032	0.157	0.374	0.532	0.715	0.682	0.682	0.682	0.682	0.682	0.682
1998	0.037	0.178	0.402	0.551	0.675	0.677	0.677	0.677	0.677	0.677	0.677
1999	0.045	0.204	0.434	0.561	0.651	0.624	0.624	0.624	0.624	0.624	0.624
2000	0.033	0.160	0.326	0.413	0.467	0.438	0.438	0.438	0.438	0.438	0.438
2001	0.034	0.163	0.357	0.458	0.491	0.449	0.449	0.449	0.449	0.449	0.449
2002	0.031	0.151	0.322	0.457	0.483	0.423	0.423	0.423	0.423	0.423	0.423
2003	0.035	0.169	0.366	0.534	0.632	0.572	0.572	0.572	0.572	0.572	0.572
2004	0.034	0.158	0.329	0.484	0.580	0.549	0.549	0.549	0.549	0.549	0.549
2005	0.036	0.163	0.335	0.495	0.625	0.605	0.605	0.605	0.605	0.605	0.605
2006	0.036	0.159	0.317	0.443	0.558	0.551	0.551	0.551	0.551	0.551	0.551
2007	0.037	0.159	0.321	0.467	0.595	0.577	0.577	0.577	0.577	0.577	0.577
2008	0.025	0.112	0.230	0.385	0.538	0.532	0.532	0.532	0.532	0.532	0.532
2009	0.020	0.089	0.178	0.308	0.469	0.485	0.485	0.485	0.485	0.485	0.485
2010	0.020	0.084	0.169	0.288	0.441	0.494	0.494	0.494	0.494	0.494	0.494

2011	0.021	0.088	0.185	0.304	0.449	0.492	0.492	0.492	0.492	0.492	0.492
2012	0.020	0.082	0.159	0.266	0.376	0.401	0.401	0.401	0.401	0.401	0.401
2013	0.015	0.062	0.107	0.170	0.252	0.313	0.313	0.313	0.313	0.313	0.313
2014	0.017	0.069	0.120	0.177	0.248	0.347	0.347	0.347	0.347	0.347	0.347
2015	0.022	0.090	0.159	0.222	0.285	0.397	0.397	0.397	0.397	0.397	0.397
2016	0.028	0.115	0.223	0.312	0.387	0.510	0.510	0.510	0.510	0.510	0.510
2017	0.036	0.149	0.304	0.441	0.502	0.586	0.586	0.586	0.586	0.586	0.586
2018	0.035	0.154	0.347	0.529	0.578	0.633	0.633	0.633	0.633	0.633	0.633
2019	0.032	0.152	0.374	0.613	0.587	0.589	0.589	0.589	0.589	0.589	0.589
2020	0.031	0.149	0.379	0.617	0.594	0.571	0.571	0.571	0.571	0.571	0.571
2021	0.028	0.138	0.359	0.600	0.581	0.588	0.588	0.588	0.588	0.588	0.588

Table 4.13. Northeast Arctic haddock. SAM model. Estimated stock numbers-at-age.

Year Age	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1950	71954	100948	75803	37104	46922	16672	4878	2687	1380	1457	2055
1951	662668	47596	45982	27423	12794	12505	5438	1937	1010	446	1092
1952	87684	441709	30601	19171	9000	4342	3846	1638	734	356	506
1953	1236112	51854	209514	13984	6355	2641	1332	1053	532	251	306
1954	132692	913814	26007	91482	6873	2332	1088	548	387	198	225
1955	58481	84380	629858	14587	52314	3085	919	453	236	160	167
1956	229412	40721	55799	323834	7228	17743	1435	401	213	112	152
1957	60191	151658	27702	35983	110731	3090	6141	698	167	98	128
1958	72727	39863	92948	15487	20858	40057	1633	2510	350	84	118
1959	388917	51327	26067	40083	7338	7281	14858	723	901	146	87
1960	319617	266424	35703	15675	17032	3483	3666	6151	360	371	107
1961	144191	192337	144960	17670	6984	8060	1597	1508	2792	156	204
1962	294721	86152	92056	59648	6749	2715	3289	659	610	1159	139
1963	313728	177883	37775	26324	17552	2650	1091	1230	273	244	536
1964	352219	199197	75457	12227	7658	5839	1225	441	510	122	345
1965	126309	239697	114967	30319	4161	2786	2266	535	199	219	210
1966	313027	82587	158862	62233	12369	1705	1276	944	271	92	187
1967	341917	200993	43550	72547	24793	4865	791	602	451	132	132
1968	18033	248789	118244	21868	36167	12509	2350	410	314	233	138
1969	20492	11753	142282	55303	10688	15769	5749	1163	197	156	175
1970	209907	12595	7457	70546	25170	5916	8044	3009	644	106	186
1971	108513	135135	7126	4488	33462	12298	3362	4541	1695	371	163
1972	1066297	79576	82209	4547	3103	17586	6743	2018	2775	1030	316

1973	309863	617024	46426	23183	1700	1546	7651	2907	927	1381	613
1974	65777	168110	250735	16514	10662	885	1013	4476	1688	549	1229
1975	59215	37393	90307	140730	6802	4949	449	560	2148	817	937
1976	61657	33714	16473	44334	79265	3152	2773	247	332	1150	972
1977	120878	31792	13734	6439	17673	30352	1284	1183	103	148	810
1978	214299	55235	9743	4423	2904	7752	15135	629	564	45	432
1979	161196	117773	23260	3249	2034	1407	4104	7093	337	274	227
1980	22214	102951	58664	8302	1153	1047	717	2165	3493	174	241
1981	10373	15666	63657	26356	3451	552	557	380	1140	1720	214
1982	16685	6813	11084	31844	10538	1721	278	307	217	623	960
1983	8517	11374	4651	6829	13553	5614	983	147	177	126	805
1984	13170	5094	6707	2749	3894	8842	2882	577	80	104	519
1985	360421	8905	2884	3607	1785	2573	5373	1842	369	51	398
1986	480423	277897	5187	1593	1851	994	1474	2796	1027	206	261
1987	90168	252499	156719	2536	653	793	470	679	1207	471	208
1988	39086	69528	135666	46610	1065	233	320	205	301	508	280
1989	28690	25847	49114	70932	12183	549	95	152	99	145	366
1990	36995	20973	17122	26053	32813	5487	355	59	87	57	278
1991	111064	25066	13652	14104	20210	20303	3141	249	40	57	206
1992	328345	83998	16040	10097	10403	12631	12669	1890	165	26	159
1993	847060	223767	57624	10695	5917	6244	7670	7284	1052	101	108
1994	398541	586581	154943	31769	4684	3141	3758	4796	4334	596	116
1995	101169	227631	436642	78224	14686	2097	1428	1871	2202	2146	340
1996	100698	62296	170360	249488	32110	7281	1087	710	938	1104	1266
1997	120498	55757	38426	96597	103534	13995	2517	494	313	416	1096
1998	63525	80689	35130	18194	36780	39226	5240	994	211	132	711
1999	151800	48591	47748	17443	8917	15900	13962	1921	412	93	389
2000	83531	120835	30886	21383	6882	4345	6596	5481	816	189	232
2001	369908	68769	94812	16790	10168	3527	2611	3530	2691	441	239
2002	397842	300355	51914	48421	9123	5526	1906	1463	1939	1413	358
2003	342420	261719	196392	34361	24969	4595	3509	1235	839	1098	1006
2004	262688	172605	166134	112529	16305	11043	2147	1666	620	397	1075
2005	369114	172023	95010	110263	51403	6645	5628	1150	739	312	798
2006	158484	219791	109769	52144	45046	21018	3222	2853	561	348	541
2007	546307	121683	167892	61580	26788	19474	8222	1758	1492	287	447
2008	1118238	467328	98324	104726	22042	14103	7244	3321	897	726	362
2009	1032328	727573	382754	62874	40565	10455	5359	3171	1463	496	599
2010	242169	689310	609912	236370	32550	15363	4868	2751	1623	785	649
2011	118630	194392	562233	431733	123576	14436	6265	2153	1357	838	828
2012	343696	74135	139336	402923	272118	55421	6244	2608	1055	710	954
2013	120201	202416	58533	96203	277646	129788	24047	3239	1437	605	1004

2014	415161	74430	147429	50354	89089	148484	62741	11002	1912	904	1022
2015	73229	290572	66276	93516	40951	70860	75335	26084	5431	1042	1055
2016	214907	49671	171111	46462	62421	33999	50637	38639	13024	2607	1026
2017	197724	179071	34226	111248	28352	36992	19184	22229	18250	5693	1505
2018	370008	137595	127037	24887	44354	14746	18241	9104	9411	8688	3192
2019	831409	244589	89230	64256	16774	17916	6986	7847	3791	3980	4369
2020	449467	536349	162423	46595	23457	9104	7543	3462	3388	1841	3506
2021	164246	279776	363859	73157	20670	9211	4391	3305	1677	1642	2457
2022	38431	137815	192967	201210	35275	8936	4027	2003	1507	763	1870

Table 4.14. Northeast Arctic haddock. SAM model. Natural mortality estimated.

Year	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1950	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1951	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1952	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1953	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1954	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1955	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1956	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1957	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1958	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1959	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1960	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1961	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1962	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1963	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1964	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1965	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1966	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1967	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1968	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1969	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1970	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1971	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1972	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1973	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1974	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1975	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200

1976	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1977	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1978	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1979	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1980	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1981	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1982	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1983	0.345	0.258	0.243	0.241	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1984	0.216	0.223	0.214	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1985	0.209	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1986	0.639	0.263	0.200	0.210	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1987	0.200	0.208	0.419	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1988	0.380	0.200	0.200	0.391	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1989	0.200	0.200	0.200	0.231	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1990	0.329	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1991	0.202	0.216	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1992	0.216	0.205	0.203	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1993	0.253	0.248	0.275	0.260	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1994	0.289	0.215	0.296	0.226	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1995	0.380	0.342	0.319	0.292	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1996	0.725	0.321	0.254	0.284	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1997	0.503	0.267	0.258	0.285	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1998	0.231	0.291	0.267	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1999	0.200	0.208	0.278	0.262	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2000	0.214	0.200	0.215	0.245	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2001	0.210	0.200	0.225	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2002	0.323	0.213	0.200	0.203	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2003	0.418	0.251	0.208	0.201	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2004	0.415	0.302	0.201	0.227	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2005	0.397	0.303	0.233	0.271	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2006	0.223	0.215	0.276	0.212	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2007	0.297	0.200	0.238	0.320	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2008	0.372	0.279	0.266	0.338	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2009	0.404	0.248	0.285	0.256	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2010	0.359	0.249	0.274	0.286	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2011	0.530	0.469	0.311	0.228	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2012	0.595	0.314	0.204	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2013	0.461	0.341	0.249	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2014	0.283	0.206	0.219	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2015	0.344	0.402	0.210	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2016	0.306	0.200	0.247	0.229	0.200	0.200	0.200	0.200	0.200	0.200	0.200

2017	0.341	0.297	0.234	0.411	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2018	0.432	0.266	0.264	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2019	0.371	0.255	0.213	0.273	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2020	0.388	0.358	0.270	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2021	0.238	0.227	0.214	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200

Table 4.15. Northeast Arctic haddock. Summary XSA (p-shrinkage not applied, F shrinkage= 0.5). Thu Aug 18 19:55:38 2022

YEAR	RECR_a3	TOTBIO	TOTSPB	LANDINGS	YIELDSSB	SOPCOFAC	FBAR 4–7
1950	82322	242608	134590	132125	0.9817	1.5897	0.8308
1951	668176	355757	101109	120077	1.1876	1.2272	0.6238
1952	76818	235584	57514	127660	2.2196	1.7404	0.7243
1953	1273827	511706	82577	123920	1.5007	1.4279	0.516
1954	152533	538363	117419	156788	1.3353	1.474	0.3802
1955	68620	485903	178882	202286	1.1308	1.536	0.5115
1956	208519	475076	243748	213924	0.8776	1.2623	0.4328
1957	66143	326445	186311	123583	0.6633	1.2455	0.4325
1958	87000	277063	156999	112672	0.7177	1.1252	0.5185
1959	398046	364914	133327	88211	0.6616	0.9405	0.3672
1960	289305	401199	114679	154651	1.3486	1.0411	0.484
1961	130618	391535	130034	193224	1.4859	0.9942	0.6362
1962	290545	346475	118923	187408	1.5759	1.0518	0.8
1963	340707	310767	82677	146224	1.7686	1.1458	0.8645
1964	397921	301963	63878	99158	1.5523	1.3572	0.6522
1965	124218	358201	95514	118578	1.2415	1.1507	0.4935
1966	293588	387773	127618	161778	1.2677	1.1621	0.583
1967	361942	468013	154613	136397	0.8822	0.9984	0.4147
1968	23929	421571	169561	181726	1.0717	0.9976	0.503
1969	21420	342673	184198	130820	0.7102	0.882	0.3972
1970	202213	286658	156137	88257	0.5653	0.9762	0.3578
1971	122366	345655	168600	78905	0.468	0.7638	0.2465
1972	1250282	618953	123034	266153	2.1632	1.0883	0.6918
1973	341562	603856	114751	322226	2.808	1.1656	0.5365
1974	69144	604062	200865	221157	1.101	0.8946	0.4315
1975	60105	493288	256399	175758	0.6855	0.8957	0.427
1976	66788	307418	206745	137264	0.6639	1.12	0.571
1977	134214	228959	141822	110158	0.7767	1.09	0.6838
1978	213205	255959	130594	95422	0.7307	0.9219	0.5112
1979	175893	318319	129550	103623	0.7999	0.7684	0.5515
1980	34738	343357	133248	87889	0.6596	0.7568	0.3978
1981	13409	293031	148285	77153	0.5203	0.7174	0.4012
1982	17361	211963	127271	46955	0.3689	0.7224	0.3093

YEAR	RECR_a3	TOTBIO	TOTSPB	LANDINGS	YIELDSSB	SOPCOFAC	FBAR 4–7
1983	9547	104375	71486	24600	0.3441	1.0373	0.2715
1984	13434	83502	64118	20945	0.3267	1.0547	0.2498
1985	288301	182799	62012	45052	0.7265	0.9761	0.32
1986	529639	343729	62307	100563	1.614	1.0484	0.4388
1987	109761	333920	75055	154916	2.064	0.992	0.5958
1988	54831	260035	78423	95255	1.2146	0.9955	0.499
1989	26591	212726	91989	58518	0.6361	0.9774	0.3892
1990	36913	170792	95306	27182	0.2852	1.0159	0.1562
1991	104304	195381	110525	36216	0.3277	1.0374	0.2082
1992	207592	269195	125750	59922	0.4765	0.9797	0.2838
1993	661997	442259	130420	82379	0.6316	1.0031	0.359
1994	292328	544195	145929	135186	0.9264	1.0056	0.425
1995	97829	540315	160502	142448	0.8875	1.0247	0.3825
1996	102157	472986	185986	178128	0.9577	1.0175	0.4235
1997	115574	349747	163846	154359	0.9421	1.0519	0.4862
1998	58300	250014	124862	100630	0.8059	1.0113	0.4235
1999	230885	253171	93537	83195	0.8894	1.021	0.4212
2000	89390	251208	85968	68944	0.802	1.026	0.2802
2001	366156	358759	111533	89640	0.8037	0.9903	0.2792
2002	342698	443732	129987	114798	0.8831	1.011	0.3173
2003	224164	474912	152014	138926	0.9139	1.019	0.4295
2004	225179	456111	158774	158279	0.9969	1.0192	0.3802
2005	347338	471600	169083	158298	0.9362	1.0029	0.491
2006	156884	415058	143388	153157	1.0681	0.9938	0.4062
2007	669958	496939	140637	161525	1.1485	0.9916	0.4245
2008	1343753	741065	146716	155604	1.0606	0.9928	0.3915
2009	1461294	1079206	169829	200061	1.178	1.0019	0.3535
2010	529864	1260008	235707	249200	1.0572	0.9994	0.2935
2011	247471	1284238	340210	309785	0.9106	0.9978	0.3172
2012	389760	1164978	423313	315627	0.7456	0.9994	0.265
2013	157017	997100	470593	193744	0.4117	0.9967	0.1328
2014	388029	1003241	517888	177522	0.3428	0.9968	0.109
2015	106410	946411	533846	194756	0.3648	0.9953	0.1535
2016	259863	858367	507122	233183	0.4598	1.0006	0.2162
2017	187245	736267	426678	227588	0.5334	0.994	0.3318
2018	359770	616476	315843	191276	0.6056	0.9943	0.3988
2019	890210	698113	241945	175402	0.725	0.9963	0.463
2020	442477	745989	210739	182468	0.8658	0.9962	0.478
2021	202490	698772	213623	204743	0.9584	0.9981	0.3925

Table 4.16. Northeast Arctic haddock. Input data for recruitment prediction (RCT3)- recruits as 3 year-olds. Recr: recruitment estimate from SAM 2021 NT1: Norwegian Russian winter bottom trawl survey age 1 NT2: Norwegian Russian winter bottom trawl survey age 2 NT3: Norwegian Russian winter bottom trawl survey age 3 NAK1: Norwegian Russian winter acoustic survey age 1 NAK2: Norwegian Russian winter acoustic survey age 2 NAK3: Norwegian Russian winter acoustic survey age 3 ECO1: Ecosystem survey age 1. ECO2: Ecosystem survey age 2. The Russian survey (RT) was discontinued in 2017 and has not been used for recruitment.

Year class	Recr.	NT1	NT2	NT3	NAK1	NAK2	NAK3	EC01	ECO2
1990	847060	NA	NA	NA	NA	NA	NA	NA	NA
1991	398541	NA	NA	314.5	NA	NA	348.73	NA	NA
1992	101169	NA	224.785	54.9	NA	187.96	41.47	NA	NA
1993	100698	604.198	199.523	55.8	887.82	88.59	29.97	NA	NA
1994	120498	1429.036	265.083	79.6	1198.18	94.52	57.27	NA	NA
1995	63525	300.778	90.806	21.7	132.6	26.51	33.78	NA	NA
1996	151800	1117.83	196.698	56.9	508.87	150.99	83.67	NA	NA
1997	83531	248.274	83.201	24.1	210.96	30.11	36.39	NA	NA
1998	369908	1207.984	437.224	294	653.4	404.77	233.45	NA	NA
1999	397842	832.297	446.843	312.9	1063.01	266.12	255.2	NA	NA
2000	342420	1230.979	475.308	352.2	753.01	267.9	203.68	NA	NA
2001	262688	1700.188	471.677	173.1	1315.15	362.35	151.01	NA	NA
2002	369114	3327.315	706.61	317.9	2743.74	466.54	221.33	NA	268.462
2003	158484	700.861	386.388	78.8	528.97	143.98	56.32	188.987	114.244
2004	546307	4473.159	1310.216	443.3	2276.46	624.78	209.28	603.787	929.118
2005	1118238	4944.605	1684.829	1591	2091.11	953.5	812.41	2270.189	1818.927
2006	1032328	3731.194	2042.009	1230.4	2015.71	1753.54	883.68	988.391	1291.864
2007	242169	853.093	317.051	102.5	778.39	209.05	128.07	322.015	143.819
2008	118630	562.606	79.895	52.9	443.93	86.03	54.16	134.833	65.087
2009	343696	1634.823	353.866	316.1	1559.42	288.27	191.63	274.353	113.561
2010	120201	676.315	137.384	57.4	428.46	94.54	67.29	105.263	41.529
2011	415161	1866.965	490.28	381.2	1583.44	407.16	334.82	591.096	222.994
2012	73229	344.585	123.954	30.6	292.71	109.92	24.35	155.943	75.054
2013	214907	1281.405	342.024	163.4	1838.71	246.59	71.81	264.813	145.248
2014	197724	1133.967	561.956	134.9	1593.12	107.18	81.15	319.963	144.86
2015	370008	2299.365	770	336.3	1276	331.42	171.03	793.772	189.253
2016	831409	5065.427	1675.638	1075.6	3343.93	810.16	507.61	935.791	NA
2017	449467	3823.293	1125.267	424.2	2925.9	687.8	286.32	NA	585.3
2018	164246	1898.2	267.785	111.35	1544.96	260.72	48.99	379.389	57.781
2019	38431	110.624	24.99	NA	272.94	15.69	NA	26.825	35.878
2020	NA	405.82	110.312	NA	431.68	70.15	NA	107.622	NA
2021	NA	1662.107	NA	NA	1797.09	NA	NA	NA	NA

Table 4.17. Northeast Arctic haddock Analysis by RCT3 ver3.1 - R translation

Analysis by RCT3 ver3.1 - R translation

Data for 6 surveys over 32 year classes : 1990 - 2021

Regression type = C

Tapered time weighting applied

power = 3 over 20 years

Survey weighting not applied

Final estimates shrunk towards mean

Estimates with S.E.'S greater than that of mean included

Minimum S.E. for any survey taken as 0.2

Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

yearclass:2019

index slope intercept se rsquare n indices prediction se.pred WAP.weights

NT1 1.0215 4.995 0.3434 0.8510 20 4.715 9.811 0.5359 0.16848

NT2 0.8741 7.181 0.3303 0.8624 20 3.258 10.029 0.4979 0.19522

NAK1 1.2559 3.538 0.5677 0.6762 20 5.613 10.587 0.7527 0.08540

NAK2 0.9759 7.017 0.3423 0.8537 20 2.815 9.764 0.5387 0.16674

EC01 1.1117 5.905 0.4086 0.8127 15 3.326 9.603 0.6636 0.10987

ECO2 0.7930 8.384 0.3955 0.7948 16 3.608 11.245 0.4988 0.19446

VPA Mean NA NA NA NA 29 NA 12.533 0.7786 0.07983

yearclass:2020

index slope intercept se rsquare n indices prediction se.pred WAP.weights

NT1 0.8911 5.978 0.3260 0.8988 20 6.008 11.33 0.3881 0.23212

NT2 0.7932 7.693 0.3079 0.9088 20 4.712 11.43 0.3639 0.26399

NAK1 1.2459 3.582 0.5368 0.7660 20 6.070 11.14 0.6443 0.08422

NAK2 0.8523 7.749 0.3360 0.8933 20 4.265 11.38 0.3983 0.22040

EC01 0.9432 6.939 0.3918 0.8702 16 4.688 11.36 0.4696 0.15854

ECO2 NA NA NA NA NA NA NA NA NA

VPA Mean NA NA NA NA 30 NA 12.36 0.9267 0.04071

yearclass:2021

index slope intercept se rsquare n indices prediction se.pred WAP.weights

NT1 0.8786 6.056 0.3251 0.9013 19 7.416 12.57 0.3760 0.6516

NT2 NA NA NA NA NA NA NA NA NA

NAK1 1.2274 3.684 0.5275 0.7762 19 7.494 12.88 0.6160 0.2428

NAK2 NA NA NA NA NA NA NA NA NA

EC01 NA NA NA NA NA NA NA NA NA

ECO2 NA NA NA NA NA NA NA NA NA

VPA Mean NA NA NA NA 30 NA 12.33 0.9337 0.1057

WAP logWAP int.se

yearclass:2019 32378 10.39 0.2200

yearclass:2020 89327 11.40 0.1870

yearclass:2021 303267 12.62 0.3035

From R estimates

Table 4.18. Northeast Arctic haddock. Prediction with management option table: Input data (based on SAM estimates

2022								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	38431	0.332	0.03	0	0	0.262	0.030	0.690
4	137815	0.28	0.084	0	0	0.5	0.143	0.918
5	192967	0.232	0.202	0	0	0.785	0.363	1.147
6	201210	0.224	0.411	0	0	1.134	0.597	1.391
7	35275	0.2	0.661	0	0	1.555	0.575	1.709
8	8936	0.2	0.877	0	0	2.227	0.570	1.980
9	4027	0.2	0.947	0	0	2.73	0.570	2.381
10	2003	0.2	0.97	0	0	3.086	0.570	2.635
11	1507	0.2	1.000	0	0	3.669	0.570	2.859
12	763	0.2	1.000	0	0	3.608	0.570	3.190
13	1870	0.2	1.000	0	0	4.058	0.570	3.559
2023								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	89327	0.332	0.031	0	0	0.361	0.03	0.8
4		0.28	0.081	0	0	0.487	0.143	0.904
5		0.232	0.205	0	0	0.791	0.363	1.153
6		0.224	0.405	0	0	1.12	0.597	1.378
7		0.2	0.637	0	0	1.492	0.575	1.672
8		0.2	0.822	0	0	1.948	0.57	1.974
9		0.2	0.941	0	0	2.65	0.57	2.223
10		0.2	0.974	0	0	3.16	0.57	2.629
11		0.2	1.000	0	0	3.492	0.57	2.819

12		0.2	1.000	0	0	3.837	0.57	3.048
13		0.2	1.000	0	0	3.921	0.57	3.55
2024								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	303267	0.332	0.031	0	0	0.338	0.03	0.774
4		0.28	0.083	0	0	0.494	0.143	0.912
5		0.232	0.198	0	0	0.773	0.363	1.136
6		0.224	0.408	0	0	1.127	0.597	1.384
7		0.2	0.63	0	0	1.475	0.575	1.661
8		0.2	0.804	0	0	1.875	0.57	1.943
9		0.2	0.908	0	0	2.349	0.57	2.218
10		0.2	0.97	0	0	3.072	0.57	2.505
11		0.2	1.000	0	0	3.572	0.57	2.815
12		0.2	1.000	0	0	3.673	0.57	3.021
13		0.2	1.000	0	0	4.146	0.57	3.437

Table 4.19. Northeast Arctic haddock. Prediction with management option table for 2022-2024

(TAC constraint applied for intermediate year)

MFDP R version

Run22 data from file fhcr_fmgmt.xls

2022						
Biomass	SSB	FMult	FBar	Landings		
566426	216456	0.7224	0.303	178532		
2023					2024	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
476850	231868	0	0	0	599203	321974
.	231868	0.1	0.042	24477	575221	304970
.	231868	0.2	0.0839	47708	552519	288898
.	231868	0.3	0.1259	69759	531028	273707
.	231868	0.4	0.1678	90695	510680	259347
.	231868	0.5	0.2098	110573	491413	245773
.	231868	0.6	0.2517	129452	473169	232941
.	231868	0.7	0.2936	147383	455891	220809
.	231868	0.8	0.3356	164418	439527	209340
.	231868	0.9	0.3776	180603	424027	198496
.	231868	1	0.4195	195985	409343	188243
.	231868	1.1	0.4615	210605	395433	178548
.	231868	1.2	0.5034	224504	382252	169381
.	231868	1.3	0.5454	237720	369762	160712

.	231868	1.4	0.5873	250289	357926	152514
.	231868	1.5	0.6292	262244	346708	144760
.	231868	1.6	0.6712	273619	336074	137427
.	231868	1.7	0.7132	284443	325993	130491
.	231868	1.8	0.7551	294746	316434	123930
.	231868	1.9	0.797	304554	307371	117724
.	231868	2	0.839	313893	298776	111853

Input units are thousands and kg - output in tonnes

MFDP R version Run22 data from file fhcr_fmgmt.xls Fbar age range: 4-7

Table 4.20. Northeast Arctic haddock. Prediction single option table for 2024-2024 based on HCR

Year:	2022	F multiplier:	0.7224	Fbar:	0.303	
age	CatchN	CatchYield	F	SSB (Jan)	StockBiomass (Jan)	StockN (Jan)
3	701	484	0.0217	302	10069	38431
4	11825	10856	0.1033	5788	68908	137815
5	39924	45793	0.2622	30599	151479	192967
6	63655	88545	0.4313	93779	228172	201210
7	10942	18700	0.4154	36258	54853	35275
8	2752	5449	0.4117	17453	19900	8936
9	1240	2953	0.4117	10411	10994	4027
10	617	1626	0.4117	5996	6181.3	2003
11	464	1327	0.4117	5529	5529.2	1507
12	235	750	0.4117	2753	2752.9	763
13	576	2050	0.4117	7588	7588.5	1870
TOTAL	132933	178532		216456	566426	624804
Year:	2023	F multiplier:	0.8343	Fbar:	0.35	
age	CatchN	CatchYield	F	SSB (Jan)	StockBiomass (Jan)	StockN (Jan)
3	1880	1504	0.025	1000	32247	89327
4	2654	2399	0.1193	1064	13141	26983
5	22034	25405	0.3029	15232	74303	93936
6	41759	57544	0.4981	53397	131845	117719
7	36375	60820	0.4797	99308	155900	104491
8	6591	13011	0.4756	30527	37137	19064
9	1676	3725	0.4756	12086	12844	4846.9
10	755	1985	0.4756	6723	6902.2	2184.3
11	376	1059	0.4756	3794	3793.8	1086.4
12	283	861	0.4756	3136	3136.4	817.4
13	494	1753	0.4756	5600	5599.8	1428.1
TOTAL	114877	170067		231868	476850	461883
Year:	2024	F multiplier:	0.8343	Fbar:	0.35	

age	CatchN	CatchYield	F	SSB (Jan)	StockBiomass (Jan)	StockN (Jan)
3	6383	4941	0.025	3178	102504	303267
4	6149	5607	0.1193	2563	30878	62507
5	4246	4823	0.3029	2770	13991	18100
6	19519	27014	0.4981	25301	62011	55023
7	19906	33063	0.4797	53135	84341	57180
8	18307	35570	0.4756	79823	99283	52951
9	3354	7439	0.4756	20692	22788	9701.2
10	853	2136	0.4756	7350	7577	2466.4
11	384	1082	0.4756	3970	3970	1111.5
12	191	577	0.4756	2031	2031	552.85
13	395	1358	0.4756	4738	4738	1142.7
TOTAL	79686	123611		205549	434112	564002

Input units are thousands and kg - output in tonnes

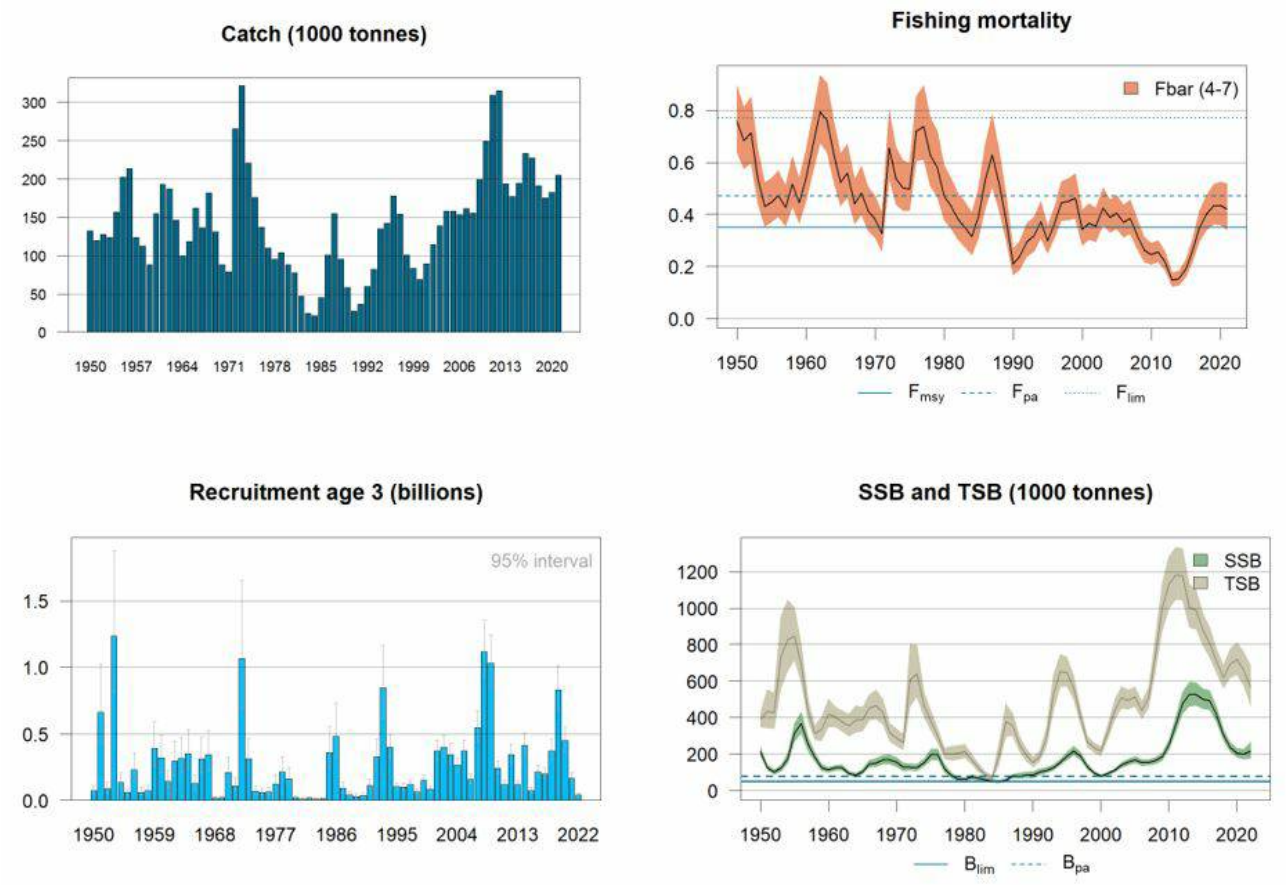

Figure 4.1 Northeast Arctic haddock landings (top left 1950-2021), fishing mortality (top right 1950-2021), recruitment (bottom left 1950-2022), and total stock biomass for ages 3+ (TSB) and spawning-stock biomass (SSB) (bottom right 1950–2022). The reference points in the SSB and TSB plot refers to the spawning stocks biomass. Fishing mortality and total and spawning stock biomass are given with point wise 95% confidence intervals (shaded areas), recruitment is given with upper 95% confidence interval (bar).

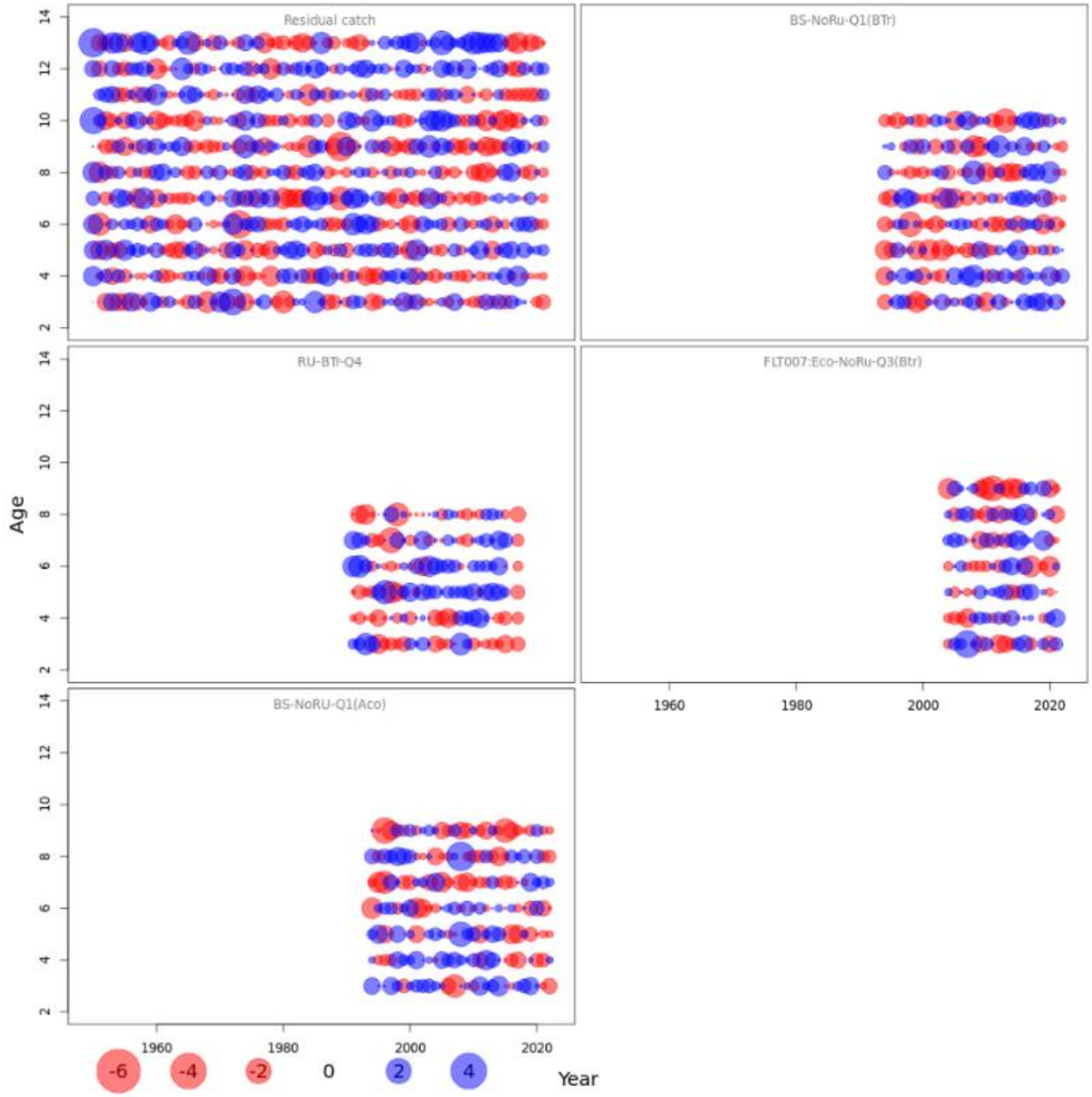

Figure 4.2. Northeast Arctic haddock; on step ahead residuals for the final SAM run 2022. Blue circles indicate positive residuals (observations larger than predicted) and red circles indicate negative residuals.

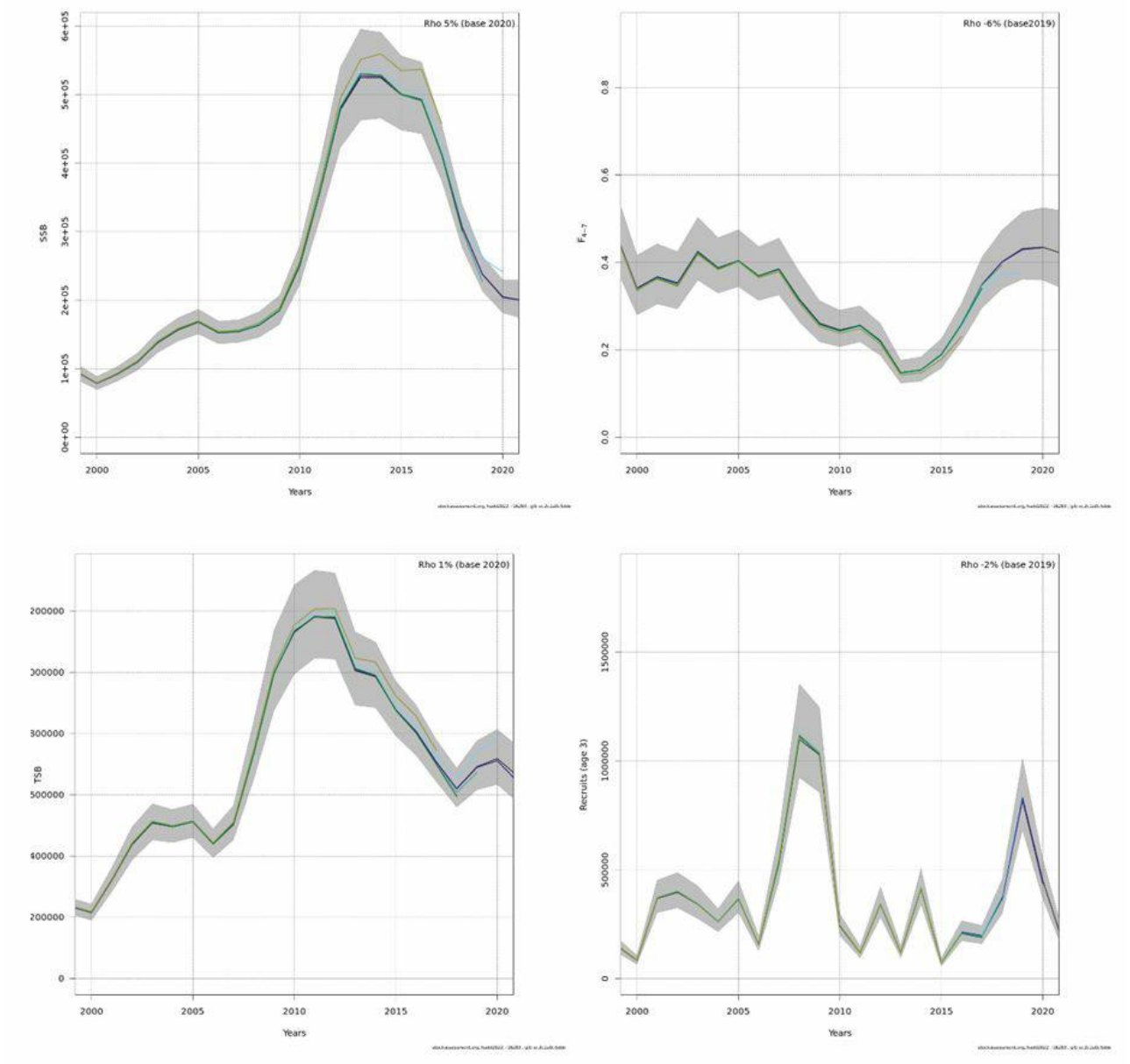

Figure 4.3. Northeast Arctic haddock. 5 year retrospective plots of SSB (top right), fishing mortality (top left), TSB (bottom left), and recruitment (bottom right) for years 2000–2022 (SAM with 95% confidence intervals).

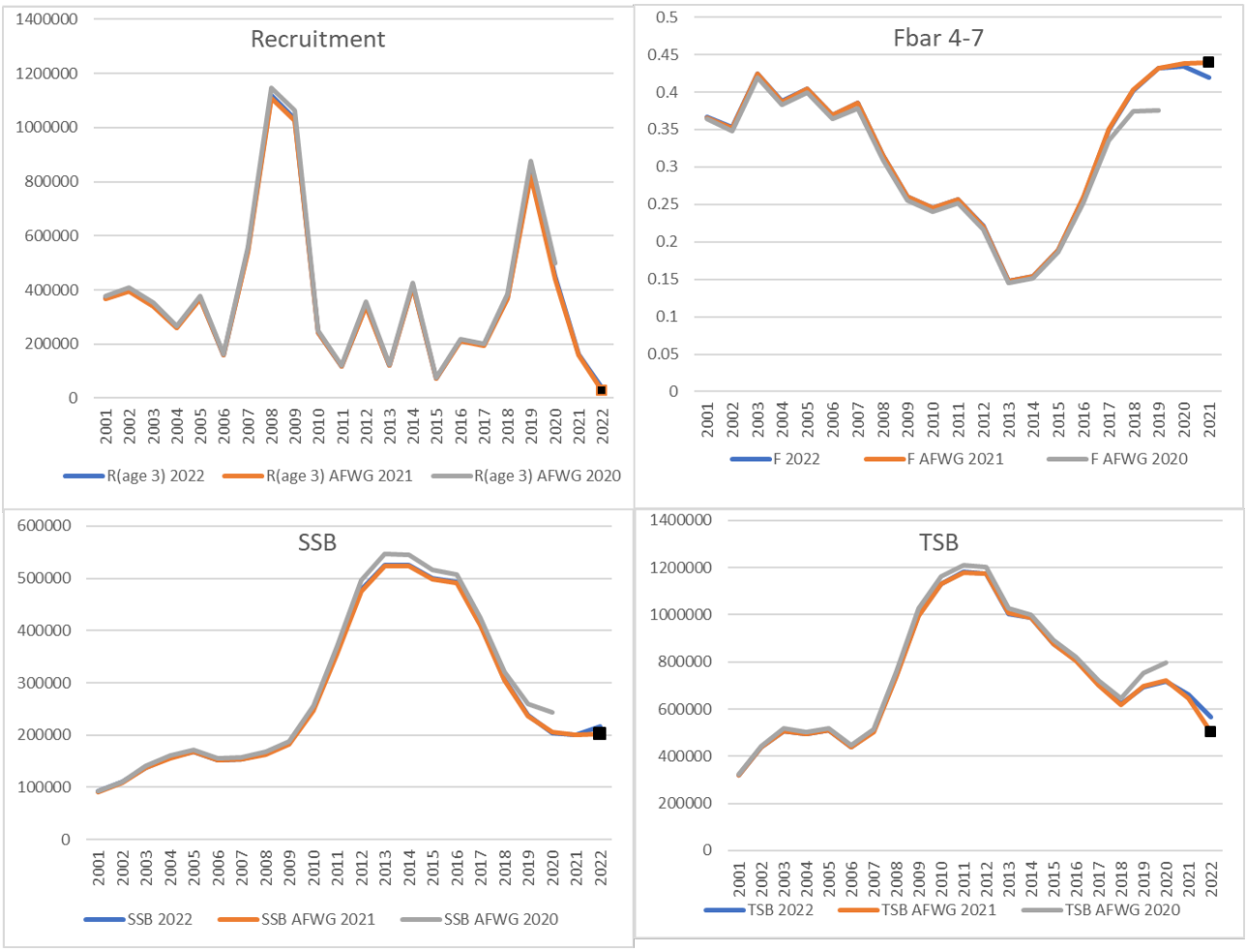

Figure 4.4. Results of assessment of NEA haddock. Fbar(4-7), TSB, recruits and SSB from AFWG 2020 (grey), AFWG 2021 (orange) and this year's (2022) assessment (blue) from 2001 and onwards. The last black squares on the lines for AFWG 2021 (orange) are forecasts for 2022 made last year. .

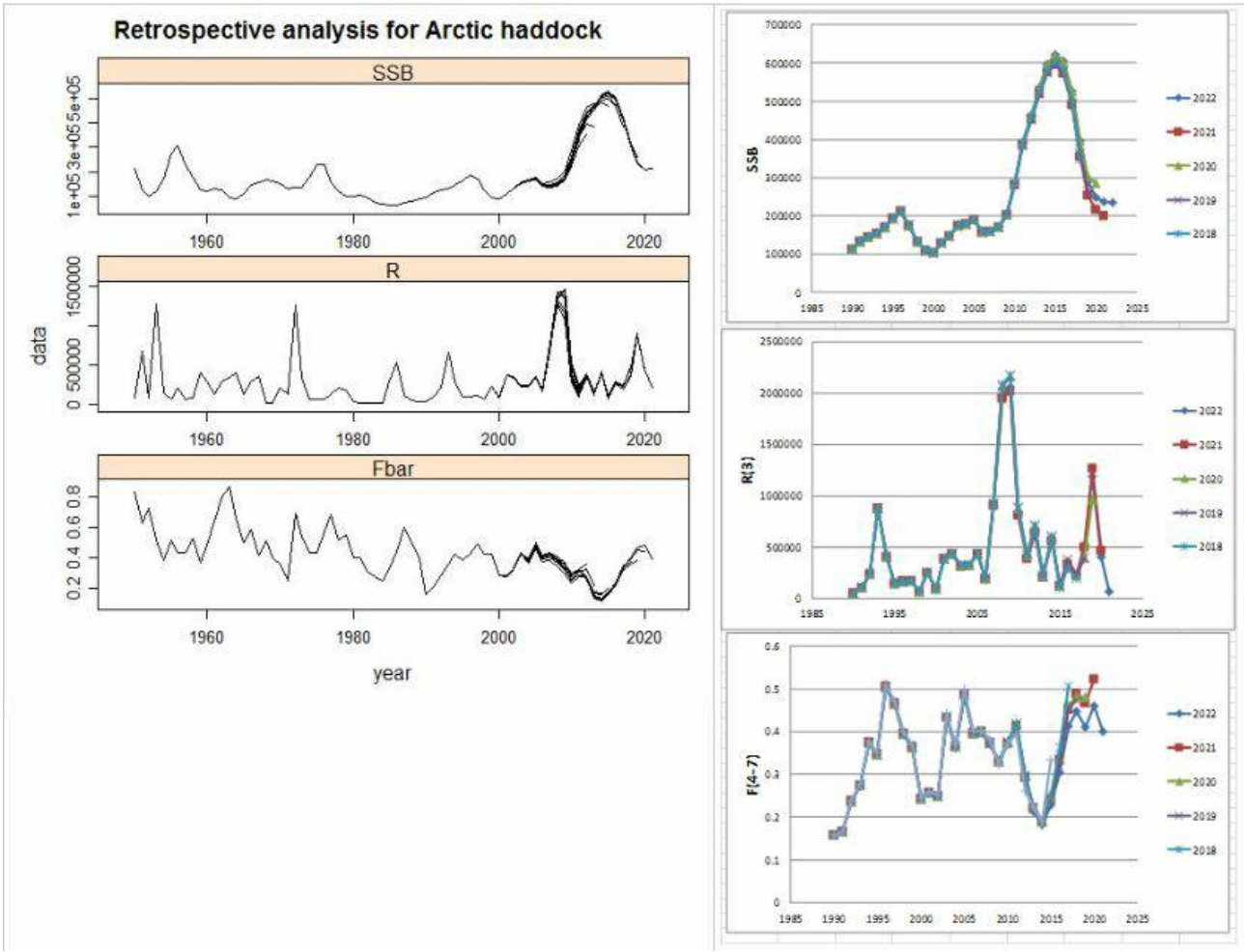

Figure 4.5. Northeast Arctic haddock. Retrospective plots of SSB, fishing mortality and recruitment for assessment years 1950–2021 (left - XSA without P shrinkage, F shrinkage= 0.5) and right - for assessment years 1990–2021 from the TSVPA model.

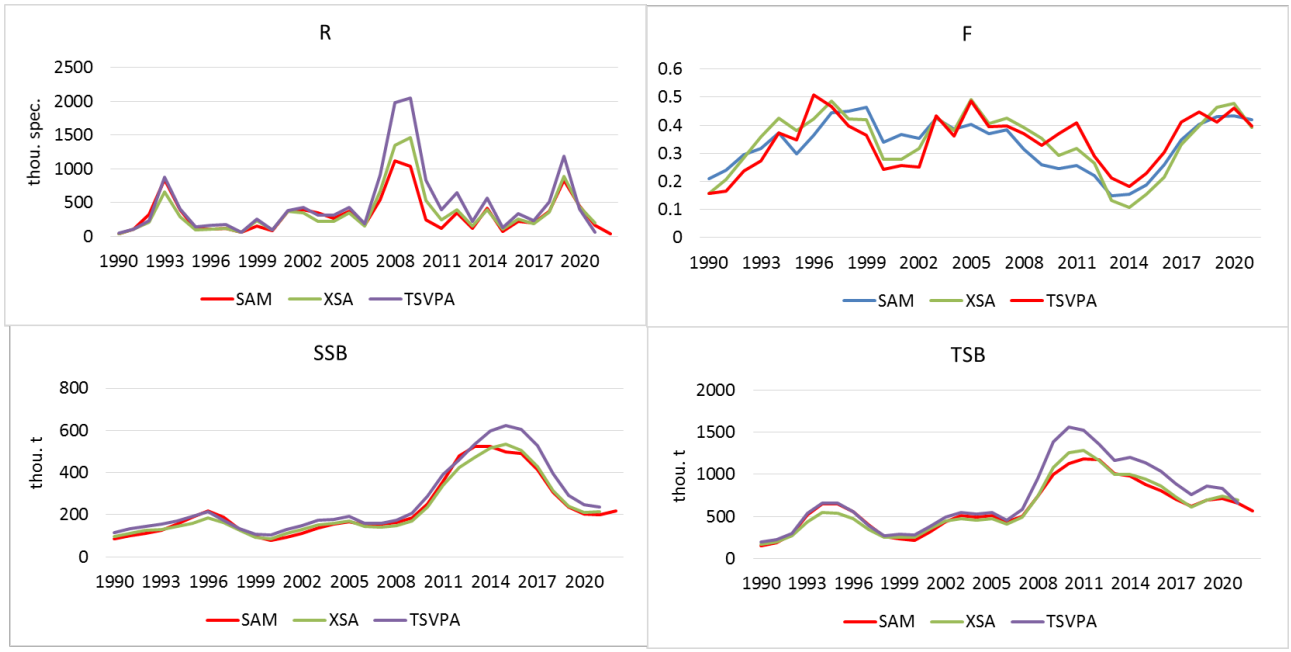

Figure 4.6. Comparison of results of assessment of NEA haddock. Recruits, biomass, spawning biomass and F in 1990–2021 by different models: medium SAM estimates, XSA with setting mentioned at section 4.9 and TISVPA with settings as mentioned at WDXX.

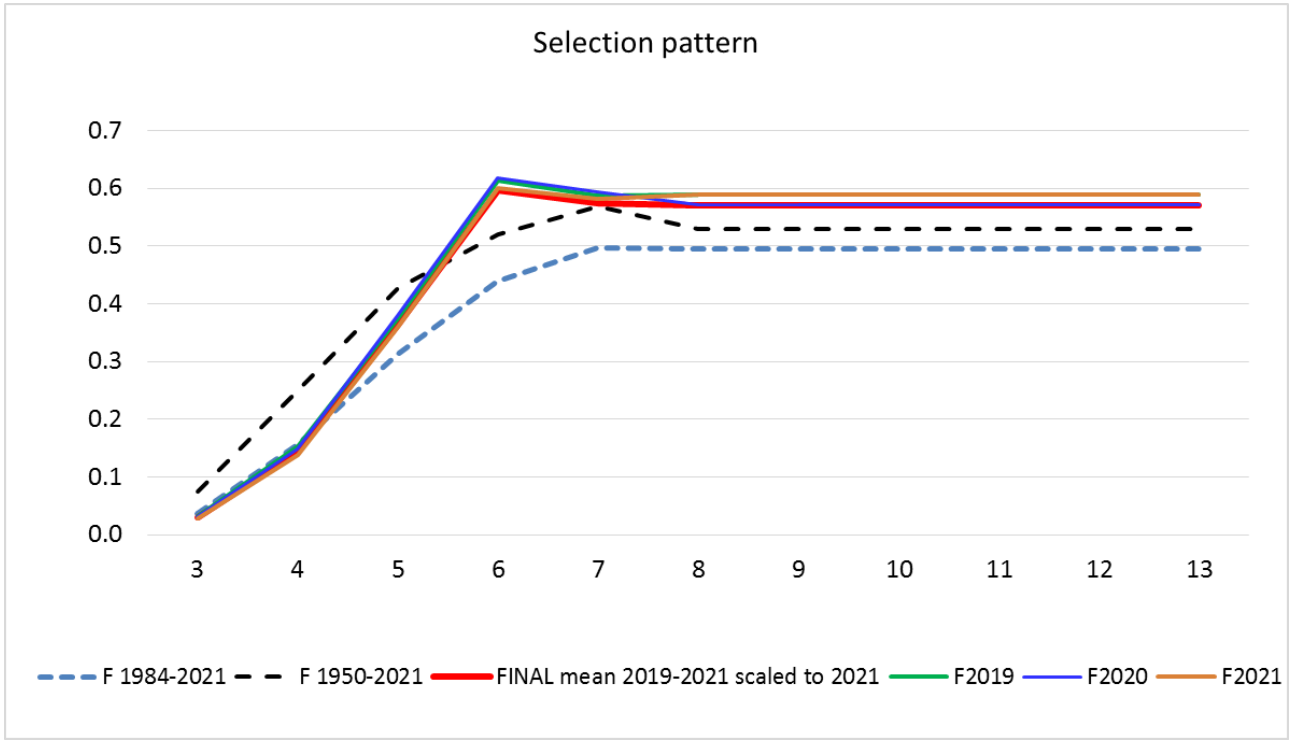

Figure 4.7 Standard selection pattern model (red) used for short-term forecasts at the current meeting

Beaked redfish in subareas 1 and 2 (Northeast Arctic)

4.11 - Status of the fisheries

4.11.1 - Development of the fishery

A description of the historical development of the fishery in subareas 1 and 2 is found in the stock annex for this stock.

An international pelagic fishery for *S. mentella* in the Norwegian Sea outside EEZs has developed since 2004 (Figure 6.1). This pelagic fishery, which is further described in the stock annex, is managed by the Northeast Atlantic Fisheries Commission (NEAFC). Since 2014 the directed demersal and pelagic fisheries are reopened in the Norwegian Economic Zone, the Fisheries Protection Zone around Svalbard and, for pelagic fisheries only, in the Fishing Zone around Jan Mayen. The spatial regulation for this fishery is illustrated in Figures 6.2 and 6.3. In 2021, most of the catches of *S. mentella* from the Russian and Norwegian fisheries were taken in the Norwegian Exclusive Economic Zone or as bycatch in the Fisheries Protection Zone around Svalbard. Catches in international waters were mainly taken by EU nations.

Figure 6.2 shows the distribution of catch among national fishing fleets for 2018 to 2021 and the location of Norwegian *S. mentella* catches in the Norwegian EEZ in 2021 as well as bycatch in other areas. The 44th Session of the Joint Norwegian-Russian Fisheries Commission decided to split the total TAC among countries as follows: Norway: 72%, Russia: 18%, Third countries: 10% (as bycatch in the fishery protection zone at Svalbard (Spitsbergen): 4.1%, and international waters of the Norwegian Sea (NEAFC-area): 5.9%). This split was reconducted at the 51st session of the commission in 2021.

4.11.2 - Bycatch in other fisheries

During 2003–2013, all catches of *S. mentella*, except the pelagic fishery in the Norwegian Sea outside EEZ, were taken as bycatches in other fisheries. Some of the pelagic catches are taken as bycatches in the blue whiting and herring fisheries. From 2014 onwards most of the catch is taken as targeted catch and no longer as bycatch, following the opening of a targeted fishery in the Norwegian EEZ, Svalbard Fisheries Protection Zone and around Jan Mayen. When fishing for other species it has since 2013 been allowed to have up to 20% redfish (both species together) in round weight as bycatch outside 12 nautical miles and only 10% bycatch inside 12 nautical miles to better protect *S. norvegicus*.

4.11.3 - Landings prior to 2021 (Tables 6.1–6.7, Figure 6.1)

Nominal catches of *S. mentella* by country for subareas 1 and 2 combined are presented in Table 6.1, while they are presented for Subarea 1 and divisions 2.a and 2.b in Tables 6.2–6.4. The pelagic catch of *S. mentella* in the Norwegian Sea outside EEZs reported to NEAFC and/or ICES amounted to 7 739 t in 2018, 6060 t in 2019, 5469 t in 2020 and 2 872 t in 2021, and is shown by country in Table 6.5. Nominal catches for both redfish species combined (i.e. *S. mentella* and *S. norvegicus*) by country are presented in Table 6.6. The sources of information used are catches reported to ICES, NEAFC, Norwegian and Russian authorities (foreign vessels fishing in the Norwegian and Russian economic zones) or direct reporting to the AFWG. Where catches are reported as *Sebastes sp*., they are split into *S. norvegicus* and *S. mentella* by AFWG experts based on available correlation between official catches of these two species in the considered areas. All tables have been updated for 2020, and new figures presented for 2021. Total international landings in 1952–2021 are also shown in Figure 6.1.

In 2014, ICES advised that the annual catch in 2015, 2016, and 2017 should be set at no more than 30 000 t and in 2017, ICES advised that the annual catch in 2018 should not exceed 32 658 t. Following the benchmark (WKREDFISH, ICES 2018a) and the subsequent evaluation of a management plan for the stock (WKREBMSE, ICES 2018b) ICES advised an annual catch of no more than 53 757 t for 2019 and 55 860 t in 2020, corresponding to a fishing mortality of F = 0.06. This was continued in 2020, when ICES advised an annual catch of no more than 66 158 t in 2021 and 67 210 t in 2022, still corresponding to F = 0.06.

Because of the novelty of the situation, related with reopening fisheries after 10 years of its ban, the total landings of *S. mentella* in subareas 1 and 2 in 2014, demersal and pelagic catches, amounted to only 18 426 t. The total landings of the demersal and pelagic fishery increased to 34 754 t in 2016, 30 783 t in 2017, 38 046 t in 2018, 45 640 t in 2019, 53 631 t in 2020 and 63 482 t in 2021. Of this, 2 872 t were reported from the pelagic fishery in international waters of the Norwegian Sea. The total landings in 2017 and 2018 were respectively 783 t and 5 388 t above the TAC advised by ICES, but were 8 117 t, 2 229 t and 2 676 t below TAC in 2019, 2020 and 2021, respectively. Norway caught the major share of the demersal catches, but Russian demersal catches increased substantially after 2017, particularly in ICES Division 2.b.

The redfish population in Subarea 4 (North Sea) is believed to belong to the Northeast Arctic stock. Since this area is outside the traditional areas handled by this Working Group, the catches are not included in the assessment. The total redfish landings (golden and beaked redfish combined) from Subarea 4 have up to 2003 been 1000–3000 t per year. Since 2005 the annual landings from this area have varied between 89 and 341 t (Table 6.7).

4.11.4 - Expected landings in 2022

ICES has advised on the basis of precautionary considerations that the annual catch should be set at no more than 67 210 t in 2022. The 51st sessions of the Joint Norwegian-Russian Fisheries Commission decided to follow this advice.

In 2022 Norwegian fishing vessels, can catch and land up to 44 291 t of redfish in the Norwegian economic zone (NEZ) in a limited area north of 65°20'N (see map in Figure 6.3), in international waters and the fisheries zone around Jan Mayen. Of this quantity, 100 t are allocated to cover bycatch in other fisheries and 52 t for research/surveillance and education purposes, while the remaining 43 139 t can be taken in a directed fishery. Only vessels with cod and saithe trawl permits can participate in the directed fishery for redfish. Each vessel which has the right to participate is assigned a maximum quota, which can be adjusted during the year, per how much of the national quota is exploited. The fishery may be stopped if the total quota is reached. This quota must also cover catches of redfish (both species) in other fisheries. It is prohibited to fish for redfish with bottom trawls in the period from 1 March until 10 May. Investigations were conducted in 2015–2016 to see if the protection of females during the main time of larvae release should be improved by extending the period of prohibited fishing until later in May, and to see if the area south of Bear Island (Area 20 in Figure 6.3) can be opened for directed fishing, either with or without sorting grid, and permissions were granted to a small number of vessels of the Norwegian reference fleet for an earlier onset of fishing to gain further data. The hitherto conclusion is that males dominated the catches (more than 70%) in the main fishing areas south and southwest of Bear Island during the investigations from late April until the directed fishery started on 10 May, and that the area south of Bear Island should stay closed during January-February due to smaller *S. mentella* inhabiting this area at the beginning of the year.

Since 2015, Russia has had access to the NEZ when fishing their quota share. In 2022 Russia may fish 12 098 t (18%) plus 2000 t transferred from Norway to Russia. Apart from this an additional 2100 t were transferred from Norway to Russia and the EU to cover bycatch of redfish (both species) in their fisheries targeting other species. The remaining 6721 t are divided between third countries in the NEZ and Svalbard Zone (2755 t) and the NEAFC areas (3966 t). Catch in the NEAFC areas in 2021 amounted to 2872 t while the catch in the national economic zones of Norway and Russia as well as the fisheries protection zone around Svalbard was 60 610 t. The total catch in 2021 was 2676 t lower than the advised TAC. Norwegian catches up to week 33 were 32 295 t, which is about 9 000 tonnes less than at the same time of 2021. This indicates that the Norwegian quota is unlikely to be exhausted as there is usually little redfish catch in autumn.

4.12 - Data used in the assessment

Analytical assessment was conducted for this stock following recommendation from the benchmark assessment working group (WKREDFISH, ICES 2018a). Input datasets were updated with the most recently available data. The analytical assessment, based on a statistical catch-at-age model (SCAA), covers the period 1992–2020. The input data consists

of the following tables:

- Total catch in tonnes (Table 6.1)
- Catch in tonnes in the pelagic fishery Norwegian Sea outside EEZs (Table 6.5)
- Total catch numbers-at-age 6–19+ (Table 6.8)
- Catch numbers-at-age 7–19+ in the pelagic fishery (Table 6.9)
- Weight-at-age 2–19+ in the population (Table 6.12)
- Maturity-at-age 2–19+ in the population (Table 6.14)
- Russian autumn survey numbers-at-age 0–11 (Table 6.15)
- Ecosystem survey numbers-at-age 2–15 (Table 6.17)
- Winter survey numbers-at-age 2–15 (Table 6.18b)
- Deep pelagic ecosystem survey proportions-at-age (Table 6.19)

There was no direct observation of catch numbers-at-age for the pelagic fishery in the Norwegian Sea outside EEZs in 2012–2021. Instead, numbers-at-age were estimated based on catch-at-age from previous or following year, and weight-at-age and fleet selectivities (section 6.2.2 in AFWG report 2013). In 2013, 2016 and 2019, observations from the scientific survey in the Norwegian Sea were used to derive numbers-at-age in the pelagic fishery. This was considered appropriate given that the survey operates in the area of the fishery, with a commercial pelagic trawl and at the time of the start of the fishery.

4.12.1 - Length- composition from the fishery (Figure 6.4)

Comparison of length distributions of the Norwegian and Russian catches of *S. mentella* in 2019–2021 are shown in Figure 6.4. In 2020, the Russian and Norwegian fleets fished smaller fish than in 2019, reflecting good year classes due to enter the fishable stock. After 2019 length of beaked redfish in Norwegian catches was larger than in Russian catches. This is probably due to differences in the fishing areas. The Russian fleet largely operated in area 2b, and the Norwegian fleet in area 2a.

4.12.2 - Catch-at-age (Tables 6.8–6.11, Figure 6.5)

Catch-at-age in the Norwegian fishery was estimated using ECA for 2014 and 2020. For 2015, 2016 and 2018, it was not possible to run ECA and the catch-at-age for the Norwegian Fishery was estimated using the older Biomass program in SAS (Table 6.8). Not enough age readings were available to estimate catch-at-age in 2017, 2019 and 2021. For the pelagic fisheries 2017, 2018, 2020 and 2021 (Table 6.9) proportions-at-age in the catch were derived from proportions at-age in earlier years, weight-at-age and fleet selectivity (section 6.2.2 in AFWG report 2013).

This procedure for estimating catch-at-age for recent years in which age data are not available is somewhat problematic. This is because the last year of observation has a large effect on the estimated catch-at-age for several years. At the assessment working group in 2017 and at the benchmark assessment in January 2018, the last year of observations for the catch-at-age was 2014 and the values for the years 2015 and 2016 were extrapolated. Once available, the data for 2015 (demersal) and 2016 (pelagic) were substantially different from these earlier extrapolations. In the 2022 assessment the catch-at-age observations in 2018, had a large effect on the years around it, producing a very large proportion of the 19+ class in the catch and a correspondingly high F_{19+}. As the age structure in 2018 was based on less than 1000 aged fish it was decided to use a time-averaged age-length-key (ALK) to convert the length distribution in 2017-2019 and in 2021 to an age distribution. The time-averaged ALK is based on the Norwegian age-length data back to 2009, excluding the years 2017, 2019 and 2021 and on commercial catches with demersal gears. The conversion still produced a fraction of the 19+-group of >60% but F_{19+} was lower than in the standard method.

Several other options were considered. Firstly, extrapolation as in the standard method but extrapolating also the 19+-group and then rescaling to sum up to 100%, rather than calculating the 19+ as the difference between other ages and 100%. Secondly, calculating the fraction of each age-class as an average of the same cohort's fraction in the year before and after. Thirdly, as an average of the fraction of the same age-class in the last 3 years with data or last 3 calendar years. Finally, using a combined Russian-Norwegian ALK for individual years. Whilst some of these options

produced lower fishing mortalities for the 19+-group, the change in observed selectivity for the demersal catches since 2017 remained largely the same. Therefore, the option of a common ALK across years was chosen because a as the option with the most sensible underlying reasoning.

Age composition of the Russian and Norwegian catches in 2021 was calculated using the age–length key, based on Russian age readings. The joint age–length key for the last three years (2019–2021) was applied. In general, the age distribution in the Norwegian fishery was shifted towards older fish compared to the Russian fishery. In the Russian catches fish at age 15–16 dominated, while in the Norwegian catches 16–17 years old made up the majority of the catches. (Figure 6.5). The proportion (by numbers) of individuals at age 18 and older in the Norwegian catches was almost twice as large as in the Russian ones.

Age–length-keys for *S. mentella* are uncertain because of the slow growth rate of individuals and therefore these data should be used with caution. Given that age is difficult to derive from length it is important that age readings are available for the most recent years, at the time of the working group.

4.12.3 - Weight-at-age (Tables 6.12, 6.13, Figures 6.6, 6.7)

In earlier assessment, weight-at-age in the stock was set equal to the weight-at-age in the catch. This turned out to be problematic because of important fluctuations in reported weight-at-age in the catch that cannot be explained biologically (i.e. these are noisy data). In 2015, it was advised to either use a fixed weight-at-age for the 19+ group, or use a modelled weight-at-age based on catch and survey records (Planque, 2015). The second option was chosen. Weight-at-age in the population was modelled for each year using mixed-effect models of a von Bertalanffy growth function (in weight). In 2018 an attempt was made to model weight-at-age for each cohort (rather than each year of observation). This showed that the growth function is nearly invariant between cohorts. Therefore, it was decided to use a fixed (i.e. common to all years) weight-at-age as input to the Statistical Catch-at-age model. The observed and modelled weight-at-age are presented in Table 6.12 as well as Figures 6.6 and 6.7.

4.12.4 - Maturity-at-age (Table 6.14, Figure 6.8)

The proportion maturity-at-age was estimated for individual years using a mixed-effect statistical model (Table 6.14, Figure 6.8). The modelled values of maturity-at-age for individual years are used in the analytical assessment models, except in 2008, 2011 and 2017–2021 when the fixed effects only were considered, at least in the two latest years due to a lack of age data.

4.12.5 - Natural mortality

In previous years, natural mortality for *S. mentella* was set to 0.05 for all ages and all years. This was based on life-history correlates presented in Hoenig (1983). Thirty-nine alternative mortality estimates were explored during the benchmark workshop, based on the review work by Kenchington (2014) and several additional recent papers (Then *et al*., 2014; Hamel, 2014; Charnov *et al*., 2013). Overall, the mode of these natural mortality estimates is 0.058 which departs only slightly from the original estimate of 0.050 (Figure 6.9). WKREDFISH (ICES, 2018a) decided to continue using 0.050 as the value of M in the assessment model. These estimates were updated for a peer-reviewed paper submitted in 2022 (Höffle and Planque, in revision) with 44 estimators resulting in a mode of the distribution of 0.07.

Figure 6.10 shows cod's predation on juvenile (5–14 cm) redfish during 1984–2020. This time-series confirms the presence of redfish juveniles and may be used as an indicator of redfish abundance. A clear difference is seen between the abundance/consumption ratio in the 1980s and at present. A change in survey trawl catchability (smaller meshes) from 1993 onwards (Jakobsen *et al*., 1997) and/or a change in the cod's prey preference may cause this difference. As long as the trawl survey time-series has not been corrected for the change in catchability, the abundance index of juvenile redfish less than 15 cm during the 1980s might have been considerably higher, if this change in catchability had been corrected for. The decrease in the abundance of young redfish in the surveys during the 1990s is consistent with the decline in the consumption of redfish by cod. It is important that the estimation of the consumption of redfish by cod is being continued.

4.12.6 - Scientific surveys

Following a dedicated review, AFWG approved the use of the new SToX versions of winter and ecosystem surveys for use in the *S.s mentella* assessment (WD 17 and WD 18 in AFWG 2020). The group recommended that the data be monitored annually to identify if a significant portion of the mentella stock moves east of the strata system. The group further recommended that work continues to investigate redfish-specific strata systems for the winter survey.

The results from the following research vessel survey series were evaluated by the Working Group:

4.12.6.1 - Surveys in the Barents Sea and Svalbard area (Tables 1.1, 1.2, 6.15–6.18, Figures 6.11, 6.12)

Russian bottom-trawl survey in the Svalbard and Barents Sea areas in October-December for 1978–2015 in fishing depths of 100–900 m (Table 6.15, Figure 6.11). ICES acronym: RU-BTr-Q4.

Russian-Norwegian Barents Sea 'Ecosystem survey' (bottom-trawl survey, August-September) from 1986–2019 in fishing depths of 100–500 m (Figures 6.11–6.12). Data disaggregated by age for the period 1992–2019 (Tables 6.16b-6.17). ICES acronym: Since 2003 part of Eco-NoRu-Q3 (BTr), survey code: A5216.

Winter Barents Seabed-trawl survey (February) from 1986–2014 (jointly with Russia since 2000, except 2006 and 2007) in fishing depths of 100–500 m (Figures 6.11–6.12). Data disaggregated by age for the period 1992–2011 and 2013 (Table 6.18b). ICES acronym: BS-NoRu-Q1 (BTr), survey code: A6996.

The Norwegian survey initially designed for redfish and Greenland halibut is now part of the ecosystem survey and covers the Norwegian Economic Zone (NEZ) and Svalbard Fisheries Protection Zone incl. north and east of Spitsbergen during August 1996–2012 from less than 100 m to 800 m depth. This survey includes survey no. 2 above, and has been a joint survey with Russia since 2003, and since then called the Ecosystem survey. ICES acronym: Eco-NoRu-Q3 (Btr), survey code: A5216.

4.12.6.2 - Pelagic survey in the Norwegian Sea (Table 6.19, Figures 6.13, 6.14)

The international deep pelagic ecosystem survey in the Norwegian Sea (WGIDEEPS, ICES 2016, survey code: A3357) monitors deep pelagic ecosystems, focusing on beaked redfish (*S. mentella*). The latest survey was conducted in the open Norwegian Sea from 22 July until 12 August 2022, following similar surveys in 2008, 2009, 2013, 2016 and 2019. The spatial coverage of the 2022 survey and the catch rates of beaked redfish in the 2019 survey are presented in Figure 6.13. The survey is scheduled every third year. Estimated numbers-at-age from this survey were presented at the benchmark assessment in 2018 and used in the SCAA model. Data for 2016 was updated in 2019, using additional age readings and numbers-at-age for the 2019 survey were presented during AFWG 2020, used in the assessment and updated for AFWG 2021. The details of the data preparation, using StoX, are available from WD7 of AFWG 2018 (Planque *et al.,* 2018). The data used as input to the analytical assessment consists of proportions-at-age from age 2 to 75 years (Figure 6.14).

4.12.6.3 - Additional surveys (Figures 6.15–6.17)

The international 0-group survey in the Svalbard and Barents Sea areas in August-September 1980–2021, is now part of the Ecosystem survey (Figures 6.15 and 6.16). ICES acronym: Eco-NoRu-Q3 (Btr), survey code: A5216.

A slope survey, "Egga-sør survey" was carried out by IMR from 25 March to 20 April 2022, following similar surveys in 2009, 2012, 2014, 2016, 2018 and 2020. The spatial coverage of the 2022 survey and the distribution of beaked redfish registered by acoustic is presented in Figure 6.17. Egga-Sør and Egga-Nord surveys operate on a biennial basis. The length and age distributions of beaked redfish from these surveys show consistent ageing in the population and gradual incoming of new cohorts after the recruitment failure period. These surveys are considered as candidates for data input to the analytical assessment of *S. mentella* (see also Planque, 2016).

4.13 - Assessment

The group performed the analytical assessment using the statistical catch-at-age (SCAA) model reviewed at the

benchmark in January 2018 (WKREDFISH, ICES 2018a). The model was configured as the benchmark baseline model which includes 53 parameters to be estimated and the model converged correctly.

4.13.1 - Results of the assessment (Tables 6.20, 6.21, Figures 6.18–6.24)

4.13.1.1 - Stock trends

The temporal patterns in recruitment-at-age 2 (Figures 6.18, 6.21) confirm the previously reported recruitment failure for the year classes 1996 to 2003 and indicate a return to high levels of recruitment. The estimates of year-class strength for recent years are uncertain due to limited age data from the winter and ecosystem surveys. Modelled spawning-stock biomass (SSB) has increased from 1992 to 2007 (Table 6.21). In the late 2000s the total-stock biomass (TSB) consisted of a larger proportion of mature fish than in the 1990s. This is reversing as individuals from new successful year classes, but still immature, are growing. TSB has increased from about 1.0 to slightly below 1.5 million tonnes in the last 10 years (Table 6.21 and Figures 6.21–6.22). The concurrent decline in SSB from 2007 to 2014 can be attributed to the weak year classes (1996–2003) entering the mature stock. This trend has levelled off and SSB increases again. SSB at the start of 2022 is estimated at 996 124 t.

4.13.1.2 - Fishing mortality (Tables 6.20a,b–6.21, Figure 6.19)

The patterns of fleet selectivity-at-age indicate that most of the fish captured by the demersal fleet as well as the pelagic fleet in 2021 are of age 16 and older (Tables 6.20a,b and Figure 6.19). Model results at the benchmark workshop did show a gradual shift in the demersal selectivity towards older ages, a shift that was not observed after the 2015 catch-at-age data were incorporated in the model. This shift towards older ages is now again visible in the data from 2017 onwards, similar to what was observed in 2014. In 2021 F_{19+} is estimated at 0.01 (Table 6.21), with 0.091 for the demersal and 0.006 for the pelagic fleets (Table 6.20a), respectively.

4.13.1.3 - Survey selectivity patterns (Figure 6.20)

Winter and ecosystem surveys selectivity at age are very similar and show reduced selectivity for age 8 years and older, which is consistent with the known geographical distribution of different life stages of *S. mentella* (Figure 6.20). Conversely, the Russian survey shows a reduced selectivity for age 7 years and younger. This is believed to result from gear selectivity.

4.13.1.4 - Residual patterns (Figure 6.23)

Residual patterns in catch and survey indices are presented in Figure 6.23a-e. There is generally no visible trend in the residuals for the Russian groundfish survey neither by age nor by year. Trends in residuals are visible in recent years for winter and ecosystem surveys and will need to be investigated further. Alternative methods for the estimation of the survey selectivity patterns will be investigated in the benchmark assessment planned for 2024 and could resolve the issue. Residual patterns for the demersal fleet indicate a similar fit of the model compared to AFWG 2018, when a time varying selectivity-at-age for this fleet was introduced.

4.13.1.5 - Retrospective patterns (Figure 6.24)

The historical and analytical retrospective patterns for the years 2007 to 2016 are presented in Figures 6.24 and 6.25. All model parameters were estimated in each individual run. The most recent model run (last year of data 2021) is consistent with previous runs. Estimated SSB is increased As in 2018 the SSB time-series is smoother than before, due to fixed weight-at-age for every year. The new estimates for winter and Ecosystem surveys in 2020 led to an increase in estimated SSB, up to 19% in the early years and around 7% to 9% in later years. Contrarily, the 2021 update revised SSB moderately down, by about 5% to 6%. SSB in 2021 is again revised upwards by about 10% across the assessment period. The benchmark run stands out and this is due to the unavailability of recent catch-at-age data during the benchmark assessment (see section 6.2.2). The analytical retrospectives back to 2018 showed likewise a higher SSB but with a lesser increase, ranging around 3% for much of the assessment period and dropping to the 1% range in the later years. The analytical retrospectives showed a consistent pattern for $F_{12\text{-}18}$ until 2017 when it started to deviate. Likewise, the pattern for F_{19+} was very similar in the analytical retrospectives. Retrospective bias (Mohn's rho) over the last 5 assessments was -0.3% for recruitment, -24% for F(19+) and -7% for SSB.

4.13.1.6 - Projections

F_{MSY} at age 19+ is approximated using $F_{0.1}$ and estimated at 0.084 (section 1.4 of the WKREBMSE report 2018b).

The estimated fishing mortality in 2021 is: F_{19+} = 0.01.

If the fishing mortality is maintained, this is expected to lead to a catch of 64 159 t in 2022, about 3000 tonnes below the advised TAC of 67 210 t. This would lead to a SSB of 1 018 117 t in early 2023, catches of 66 779 t in 2023 and a SSB of 1 040 323 t in 2024.

Lowering F_{19+} to the precautionary approach (F_{19+} = 0.06) advice, in 2023–2025 would lead to average catches of 45 150 t during that period and a SSB of 1 131 595 t by 2026 (SSB at the start of 2021 is estimated at 976 956 t).

These projections assume that the selectivity patterns of the demersal and pelagic fleets are identical with those estimated for 2021. It is also assumed that the ratio of fishing mortality between these two fleets remains unchanged.

4.13.1.7 - Additional considerations

Historical fluctuations in the recruitment-at-age 2 (Figures 6.18 and 6.21) are consistent with the 0-group survey index (Figure 6.16), although the 0-group survey index is not used as an input to the SCAA.

The population age structure derived from the model outputs for the old individuals (beyond 19+, Figure 6.22) is consistent with the age structure reported from the slope surveys although these are not yet used as input to the model.

Recent recruitment levels estimated with SCAA are highly uncertain since they rely on only a few years of observations and since the age readings from winter survey were not available for years 2014–2022. The use of the autoregressive model for recruitment (random effects in the SCAA) which was introduced in 2018 allows for a projection of the recruitment in recent years, despite the current lack of age data.

4.13.1.8 - Assessment summary (Table 6.21, Figure 6.21)

The history of the stock as described by the SCAA model for the period 1992–2021 is summarized in Table 6.21 and Figure 6.21. The key elements are as follows:

- upward trend in Total-stock biomass from 1992 to 2006 followed by stabilization until 2011 and a new upward trend until the present,
- upward trend in spawning-stock biomass from 1992 to 2007 followed by stabilization (or slight decline) until 2014 and subsequent increase,
- recruitment failure for year classes 1996–2003 (2y old fish in 1998–2005),
- good (although uncertain) recruitment for year classes born after 2005. Age data for recruits (at age 2y) after 2014 is limited.
- Annual fishing mortality for the 19+ group throughout the assessment period varied between 0.003 and 0.097.

4.14 - Comments to the assessment

Currently, the survey series used in the SCAA do not appropriately cover the geographical distribution of the adult population. Data from the pelagic survey in the Norwegian Sea has been reviewed in the last benchmark and is now included in the assessment model. Priority should be given to including additional data from the slope surveys that include older age groups, in the analytical assessment in future (WD 5 in 2016).

The SCAA model relies on the availability of reliable age data in surveys and in the catch. Although additional age reading since the last assessment has improved reliability, it requires a continuous effort to keep these data at an appropriate level.

4.15 - Biological reference points

The proposed reference points estimated during the workshop on the management plan for *S. mentella* in (ICES 2018b) were:

Reference point	Value
B_{lim}	227 000 t
B_{pa}	315 000 t
F_{MSY19+}= $F_{0.1}$	0.084

Which are revised from those set during the benchmark in the same year (ICES 2018a) which were B_{pa} = 450 kt, B_{lim} = 324 kt and F_{MSY19+} = $F_{0.1}$ = 0.08.

4.16 - Management advice

The present report updates the assessment and advises that when the status quo approach is applied, catches in 2023 should be no more than 66 779 tonnes, and catches in 2024 should be no more than 70 164 tonnes. This would correspond to a fishing mortality of F_{19+} = 0.097, whilst fishing pressure across the fishable age-classes would remain nearly constant.

4.17 - Possible future development of the assessment

Many developments suggested in earlier years were presented and evaluated at the benchmark in January 2018. These include integrating a stochastic process model i) for recruitment-at-age 2, ii) for the annual component of fishing mortalities, and iii) to account for annual changes in fleet selectivities-at-age. In addition, iv) a right trapezoid population matrix, v) coding of older ages into flexible predefined age-blocks, and vi) integrating of data from pelagic surveys in the Norwegian Sea were implemented. The purpose of these new features was to reduce the number of parameters to estimate (i, ii), include new data on the older age fraction of the population (iv, v, vi) and account for possible temporal changes in selectivity linked to changes in the national and international fisheries and their regulations (iii).

Recommendations that have been followed since comprise:

- An increase in the number of age readings from surveys and from the fishery, particularly for recent years.
- Use of a standardized method (StoX) for the determination of numbers-at-age in the surveys. The use of StoX for survey indices was evaluated at the beginning of AFWG 2020.

Future developments for the assessment of *S. mentella* may possibly include:

- Use of a standardized method (ECA) for the determination of numbers-at-age in the catch.
- A genetic-based method for rapidly identifying Sebastes species (*S. norvegicus*, *S. mentella*, *S. viviparus*);
- Direct use of length information (as in GADGET);
- Development of a joint age–length key for calculation of age composition of all *S. mentella* catches.
- Development of a joint model for *S. mentella* and *S. norvegicus* which can include uncertainty in species identification and reporting of catch of *Sebastes sp*.

Implementing the current model in a more generic framework (SAM or XSAM) would provide a set of diagnostic tools and the wider expertise shared by the groups developing these models. The new version of GADGET, running the currently used TMB-package in the background, may provide an opportunity to put both species on the same platform.

Further studies of redfish mortality at young age, including a scientific publication, should be carried out. These studies should also take account of historic estimates of bycatch. Variable M by age and possibly time period could then be incorporated in the assessment.

4.18 – References

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4.19 – Tables and figures

Table 6. 1 . S. mentella in subareas 1 and 2. Nominal catch (t) by countries in Subarea 1, divisions 2.a and 2.b combined.

Year		Estonia	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Latvia	Lithuania	Netherlands	Norway	Poland

Year		Estonia	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Latvia	Lithuania	Netherlands	Norway	Poland
1998		-	20	73	100	14	-	9	-	-	-	9733	13
1999		-	73	26	202	50	-	3	-	-	-	7884	6
2000		-	50	12	62	29	48	1	-	-	-	6020	2
2001		-	74	16	198	17	3	4	-	-	-	13 937	5
2002		15	75	58	99	18	41	4	-	-	-	2152	8
2003		-	64	22	32	8	5	5	-	-	-	1210	7
2004	**Sweden** - 1	-	588	13	10	4	10	3	-	-	-	1375	42
2005		5	1147	46	33	39	4	4	-	-	7	1760	-
2006	**Canada** - 433	396	3808	215	2483	63	2513	4	341	845	-	4710	2496
2007		684	2197	234	520	29	1587	17	349	785	-	3209	1081
2008		-	1849	187	16	25	9	9	267	117	13	2220	8
2009	**EU** - 889	-	1343	15	42	-	33	-	-	-	3	2677	338
2010		-	979	175	21	12	2	-	243	457	-	2065	-
2011		-	984	175	835	-	2	-	536	565	-	2471	11
2012		-	259	-	517	-	36	-	447	449	-	2114	318
2013		-	697	-	80	21	1	-	280	262	-	1750	84
2014		-	743	215	446	15	-	-	215	167	3	13 149	103
2015		-	657	49	242	48	3	-	537	192	3	19 433	5
2016		-	502	134	493	74	24	0	1243	1065	-	18 191	208
2017		4	443	45	763	66	3	-	562	790	-	17 077	102
2018		-	425	67	2473	82	10	-	1020	1010	374	18 594	275
2019		-	156	370	1599	615	10	-	-	653	244	23 844	471
2020		-	149	163	1807	62	5	-	2	1081	1483	32 950	4
2021[1]		-	290	218	1166	85	6	-	-	1379	-	43797	2

1 - Provisional figures.

Table 6. 2 . S. mentella in subareas 1 and 2. Nominal catch (t) by countries in Subarea 1.

Year	Faroe Islands	France	Germany	Greenland	Iceland	Lithuania	Norway	Poland	Portugal	Russia	Spain	UK	Total
1998	20	-	-	-	-	-	26	-	-	378	-	-	**424**
1999	69	-	-	-	-	-	69	-	-	489	-	-	**627**
2000	-	-	-	-	48	-	47	-	-	406	-	-	**501**
2001	-	-	-	-	3	-	8	-	-	296	-	-	**307**

Year	Faroe Islands	France	Germany	Greenland	Iceland	Lithuania	Norway	Poland	Portugal	Russia	Spain	UK	Total
2002	-	-	-	-	-	-	4	-	-	587	-	-	**591**
2003	-	-	-	-	-	-	6	-	-	292	-	-	**298**
2004	-	-	-	-	-	-	2	-	-	355	-	-	**357**
2005	-	-	-	-	-	-	3	-	-	327	-	-	**330**
2006	2	-	-	-	-	-	12	-	-	460	-	2	**476**
2007	-	-	-	-	8	-	11	-	-	210	-	20	**249**
2008	-	-	-	-	-	-	5	-	-	155	-	2	**162**
2009	-	-	-	-	8	-	3	-	-	80	-	-	**91**
2010	-	-	-	-	-	-	20	-	-	10	-	-	**30**
2011	-	-	-	-	-	-	48	-	-	13	-	-	**61**
2012	-	-	-	-	-	-	34	-	-	17	-	-	**51**
2013	-	-	-	-	-	-	64	-	-	27	-	-	**91**
2014	-	-	-	-	-	-	159	-	-	63	-	-	**222**
2015	-	-	-	18	-	-	138	1	-	125	-	-	**282**
2016	-	-	-	-	-	-	225	1	-	229	342	-	**797**
2017	-	-	-	12	-	-	207	3	-	196	-	-	**418**
2018	-	-	19	26	3	-	255	-	-	376	-	-	**679**
2019	83	4	-	13	-	1	369	16	1	206	19	4	**715**
2020	35	12	6	18	1	-	335	3	2	118	1	-	**532**
2021[1]	87	31	-	14	-	-	195	-	4	367	1	-	**699**

1 - Provisional figures.

Table 6. 3 . S. mentella in subareas 1 and 2. Nominal catch (t) by countries in Division 2.a (including landings from the pelagic trawl fishery in the international waters).

Year		Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Lithuania	Latvia	Norway	Portugal	Poland	Russia
1998		-	73	58	14	-	6	-	-	9186	118	-	2626
1999		-	16	160	50	-	3	-	-	7358	56	-	1340
2000		50	11	35	29	-	-	-	-	5892	98	-	2167
2001		63	12	161	17	-	4	-	-	13 636	105	-	2716
2002		37	54	59	18	41	4	-	-	1937	124	-	2615
2003		58	18	17	8	5	5	-	-	1014	17	-	448
2004	**Sweden** - 1	555	8	4	4	10	3	-	-	987	86	-	2081
2005		1101	36	17	38	2	4	-	-	1083	71	-	3307
2006	**Estonia** - 396 **Canada** – 433	3793	199	2475	52	2513	3	845	-	4010	1731	2467	10 110
2007	**Estonia** - 684	2157	226	519	29	1579	16	785	349	3043	1395	1079	5061
2008	**Netherlands** - 13	1821	179	9	24	9	9	117	267	1952	666	1	6442
2009	**EU** – 889	1316	7	23	-	25	-	-	-	2208	764	338	3305

Year		Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Lithuania	Latvia	Norway	Portugal	Poland	Russia
2010		961	175	13	12	2	-	457	243	1705	246	-	5903
2011		932	175	697	-	2	-	561	536	1682	599	-	4326
2012		259	-	469	-	32	-	449	447	1500	1038	311	3478
2013	**NL**	675	-	24	21	1	-	262	280	871	1055	68	3293
2014	2	728	209	411	15	-	-	167	215	4089	505	100	1334
2015	3	657	49	236	25	3	-	192	537	11 410	678	3	480
2016		495	107	493	61	-	24	1065	1243	8887	1052	183	3949
2017		425	38	763	44	3	-	790	562	7348	1059	94	3922
2018	374	400	47	2440	51	7	-	1010	876	14 057	699	272	4721
2019	244	73	363	1599	59	10	-	652	-	17741	1421	455	7366
2020	1483	112	146	1797	41	4	-	1081	-	22 854	868	-	6085
2021[1]	-	151	182	1128	70	6	-	1379	-	35 799	377	-	6008

1 - Provisional figures.

Table 6. 4 . S. mentella in subareas 1 and 2. Nominal catch (t) by countries in Division 2.b.

Year		Netherlands	Faroe Islands	France	Germany	Greenland	Ireland	Norway	Poland	Portugal	Russia	Spain	Denmark
1998		-	-	-	42	-	3	521	13	7	642	122	-
1999		-	4	10	42	-	-	457	6	9	902	15	-
2000		-	-	1	27	-	1	82	2	17	946	69	-
2001		-	11	4	37	-	-	293	5	74	763	72	**Estonia**
2002		-	38	4	40	-	-	210	8	118	702	182	15
2003		-	6	4	15	-	-	190	7	27	212	39	-
2004		-	33	5	6	-	-	386	42	149	443	250	-
2005	**Iceland** - 2	7	46	10	17	1	-	673	-	69	1389	143	5
2006		-	13	16	8	11	1	688	29	73	843	121	-
2007		-	40	8	1	-	1	155	2	88	389	22	-
2008		-	28	8	7	1	-	263	6	47	520	33	-
2009	**Canada** - 3	3	27	8	19	-	-	466	1	42	458	41	-
2010		-	18	-	8	-	-	339	-	47	501	1	-
2011	**LT -** 4	-	52	-	139	-	-	741	11	14	698	23	-
2012	**Iceland** - 4	-	-	-	48	-	-	581	7	-	606	10	-
2013		-	22	-	56	-	-	815	16	23	357	23	-
2014		1	15	6	34	-	-	8901	3	-	307	3	-
2015		-	-	-	6	5	-	7885	1	-	536	21	-
2016		-	7	27	-	14	-	9078	24	14	4241	9	-
2017		-	18	7	1	10	-	9522	5	1	2476	25	4

Year		Netherlands	Faroe Islands	France	Germany	Greenland	Ireland	Norway	Poland	Portugal	Russia	Spain	Denmark
2018	**LT** - 144	-	25	20	14	6	-	4281	3	-	5400	22	-
2019		-	-	4	-	543	-	5734	-	-	5873	19	-
2020[1]	**LV** - 2	-	2	5	4	2	-	9760	-	-	7671	6	-
2021[1]		-	52	6	38	1		7803	2	-	8512	79	1

1 - Provisional figures.

Table 6. 5 . S. mentella in subareas 1 and 2. Nominal catch (t) by countries of the pelagic fishery in international waters of the Norwegian Sea (see text for further details).

Year		Estonia	Faroe Islands	France	Germany	Iceland	Latvia	Lithuania	Norway	Poland	Portugal	Russia	Spain	UK	To
2002		-	-	-	9	-	-	-	-	-	-	-	-	-	
2003		-	-	-	40	-	-	-	-	-	-	-	-	-	
2004		-	500	-	2	-	-	-	-	-	-	1510	-	-	2
2005		-	1083	-	20	-	-	-	-	-	-	3299	-	-	4
2006	**CAN** - 433	396	3766	192	2475	2510	341	845	2862	2447	1697	9390	575	841	**28**
2007		684	1968	226	497	1579	349	785	1813	1079	1377	3645	2155	-	**16**
2008		-	1797	-	-	-	267	117	330	-	641	4901	390	-	
2009	**EU** - 889	-	1253	-	-	-	-	-	-	337	701	1975	135	-	
2010		-	912	-	-	-	243	457	450	-	244	5103	820	-	
2011		-	740	175	693	-	536	561	342	-	595	3621	1648	-	
2012		-	259	-	469	31	447	449	-	311	1038	2714	1768	-	
2013		8	675	-	-	-	280	262	1	68	1078	2720	1435	-	
2014		-	697	-	409	-	215	167	-	100	505	795	1146	-	
2015		-	606	-	231	-	537	192	-	-	678	-	2508	-	
2016		-	393	-	493	-	1243	1065	9	-	821	512	2862	-	
2017	**NL**	-	296	-	761	-	562	790	-	14	791	1014	2624	-	
2018	374	-	400	-	2192	-	876	1010	-	116	372	-	2399	-	
2019	244	**Greenland**	-	298	1157	-	-	652	1	364	1096	117	1908	223	
2020	1366	3	-	73	1380	-	-	1081	-	-	480	25	737	324	
2021[1]	-	-	-	117	514	-	-	1379	-	-	84	498	280	-	

1 - Provisional figures.

Table 6. 6 . REDFISH in subareas 1 and 2. Nominal catch (t) by countries in Subarea 1, divisions 2.a and 2.b combined for both S. mentella and S. norvegicus.

Year	Latvia	Lithuania	Estonia	Faroe Islands	France	Germany[4]	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portug
1984	-	-	-	-	2970	7457	-	-	-	-	18 650	-	18
1985	-	-	-	-	3326	6566	-	-	-	-	20 456	-	20
1986	-	**DK**	-	29	2719	4884	-	-	-	-	23 255	-	15

Year	Latvia	Lithuania	Estonia	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portug
1987	-	+	-	450[3]	1611	5829	-	-	-	-	18 051	-	117
1988	-	-	-	973	3349	2355	-	-	-	-	24 662	-	50
1989	-	-	-	338	1849	4245	-	-	-	-	25 295	-	34
1990	-	37[3]	-	386	1821	6741	-	-	-	-	34 090	-	83
1991	-	23	-	639	791	981	-	-	-	-	49 463	-	16
1992	CAN	9	-	58	1301	530	614	-	-	-	23 451	-	97
1993	8[3]	4	-	152	921	685	15	-	-	-	18 319	-	104
1994	-	28	-	26	771	1026	6	4	3	-	21 466	-	98
1995	-	-	-	30	748	693	7	1	5	1	16 162	-	93
1996	-	-	-	42[3]	746	618	37	-	2	-	21 675	-	52
1997	-	-	-	7	1011	538	39[2]	-	11	-	18 839	1	53
1998	-	-	-	98	567	231	47[3]	-	28	-	26 273	13	13
1999	-	-	-	108	61[3]	430	97	14	10	-	24 634	6	6
2000	-	-	-	67[3]	25	222	51	65	1	-	19 052	2	13
2001	-	-	-	111[3]	46	436	34	3	5	-	23 071	5	18
2002	-	-	15	135[3]	89	141	49	44	4	-	10 713	8[3]	27
2003	S	-	-	173[3]	30	154	44[3]	9	5[3]	89	8063	7	5
2004	1	-	-	607	17[3]	78	24[3]	40	3	33	7608[12]	42	24
2005	CAN	LT	5	1194	56	105	75[3]	12[2]	4[3]	55[2]	7845[12]	-	19
2006	433	845	396	3919	223	2518	107[3]	2544[3]	12[3]	21	11 015	2496[2]	187
2007	LV	785	684	2343	249	587	84[3]	1655[2]	7[3]	20	8993[2]	1081[2]	170
2008	267	117	-	2123[3]	250	46	96[3]	36[3]	15[3]	15	7436[1]	8	78
2009	-	-	-	1413	16	100	81	99	-	4	8128	338	83
2010	243[3]	457[3]	-	1150	226	52	84[3]	24[3]	-	-	8059	1[3]	32
2011	536	565	-	1008[2]	228	844	51	24	-	1	7152	59	63
2012	447	449	-	346	182	588	58	59	12	5	6361	352	105
2013	280	262	-	780	353	81	66	9	1	-	5606	103	111
2014	215	167	-	810	434	452	35	29	-	4	16 556	124	51
2015	537	192	-	733	102	266	259	38	-	3	22 208	22	67
2016	1243	1065	-	685	164	497	161	79	-	-	22 322	234	106
2017	562	790	4	566	62	782	127	68	-	2	20 581	129	115
2018	1020	1010	-	571	104	2539	159	77	-	374	23 563	311	76
2019	-	656	-	392	395	1692	671	93	-	244	29 795	491	149
2020	2	1081	-	315	164	1895	161	57	-	1483	39 453	13	95
2021[1]	-	1379	-	613	224	1242	177	78	-	-	51 498	22	44

1 - Provisional figures.

2 - Working Group figure.

3 - As reported to Norwegian authorities or NEAFC.

4 - Includes former GDR prior to 1991.

5 - USSR prior to 1991.

6 - UK(E&W) + UK(Scot.)

7 - EU not split on countries.

Table 6. 7 . REDFISH in Subarea 4 (North Sea). Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment.

Year	Belgium	Denmark	Faroe Islands	France	Germany	Ireland	Netherlands	Norway	Poland	Portugal	Sweden	UK (Scot.)	Total
1998	2	27	12	570	370	4	21	1113		-	-	749	**2868**
1999	3	52	1	-	58	39	16	862		-	-	532	**1563**
2000	5	41	-	224	19	28	19	443		-	-	618	**1397**
2001	4	96	-	272	13	19	+	421		-	-	538	**1363**
2002	2	40	2	98	11	7	+	241		-	-	524	**925**
2003	1	71	2	26	2	-	-	474		-	-	463	**1039**
2004	+	42	3	26	1	-	-	287		-	-	214	**578**
2005	2	34	-	10	1	-	-	84		-	-	28	**159**
2006	1	49	1	12	3	-	-	163	-	33	-	79	**341**
2007	+	27	-	8	1	-	-	116	1	-	-	77	**230**
2008	+	3	-	8	1	-	-	77	-	-	1	54	**144**
2009	+	4	1	38	+	-	-	119	-	-	+	86	**248**
2010	-	5	-	3	-	-	-	62	-	-	+	150	**220**
2011	-	9	-	90	1	-	-	66	-	-	+	71	**237**
2012	-	10	-	19	+	-	-	71	-	-	+	87	**187**
2013	-	7	-	40	+	-	-	54	-	-	-	176	**277**
2014	-	-	-	32	1	-	-	146	-	-	+	93	**272**
2015	+	1	-	14	1	-	-	157	-	-	+	61	**234**
2016	-	3	-	11	+	-	-	180	-	-	+	22	**216**
2017	-	3	-	10	+	-	-	168	-	-	+	38	**21**
2018	-	10	-	4	-	-	-	71	-	-	+	29	**114**
2019[1]	-	7	+	10	+	-	+	62	-	-	+	10	**89**
2020	-	10	-	4	+	-	+	54	-	-	+	27	**95**
2021[1]	-	4	-	11	+	-	+	30	-	-	+	123	**168**

1 - Provisional figures.

+ denotes less than 0.5 tonnes.

Table 6. 8 . S. mentella in subareas 1 and 2. Catch numbers-at-age 6 to 18 and 19+ (in thousands) and total landings (in tonnes). For the periods 2014–2015, 2017-2018 and 2020-2021, age data are missing from the pelagic fishery. For the years 2017, 2019 and 2021, age data are missing from the demersal fishery fisheries. The numbers-at-age have been estimated following the method outlined in section 6.2.2.

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	+gp	Total No.	Tonnes Land.
1992	1 873	2 498	1 898	1 622	1 780	1 531	2 108	2 288	2 258	2 506	2 137	1 512	677	9 258	33 946	15 590
1993	159	159	174	512	2 094	3 139	2 631	2 308	2 987	1 875	1 514	1 053	527	6 022	25 154	12 814
1994	738	730	722	992	2 561	2 734	3 060	1 535	2 253	2 182	3 336	1 284	734	3 257	26 118	12 721
1995	662	941	1 279	719	740	1 230	2 013	4 297	3 300	2 162	1 454	757	794	2 404	22 752	10 284
1996	223	634	1 699	1 554	1 236	1 078	1 146	1 413	1 865	880	621	498	700	2 247	15 794	8075
1997	125	533	1 287	1 247	1 297	1 244	876	1 416	1 784	1 217	537	1 177	342	3 568	16 650	8598
1998	37	882	2 904	4 236	3 995	2 741	1 877	1 373	1 277	1 595	1 117	784	786	6 241	29 845	14 045
1999	9	83	441	1 511	2 250	3 262	1 867	1 454	1 447	1 557	1 418	1 317	658	3 919	21 193	11 209
2000	1	24	390	1 235	2 460	2 149	1 816	1 205	1 001	993	932	505	596	5 705	19 012	10 075
2001	117	372	542	976	925	1 712	2 651	2 660	1 911	1 773	1 220	714	814	16 234	32 621	18 418
2002	2	40	252	572	709	532	1 382	1 893	1 617	855	629	163	237	4 082	12 965	6993
2003	6	37	103	93	132	220	384	391	434	466	513	199	231	1 193	4 402	2520
2004	7	16	70	96	278	429	611	433	1 063	813	830	841	607	3 076	9 170	5493
2005	2	20	57	155	244	262	295	754	783	1 896	817	1 087	1 023	6 065	13 460	8465
2006	0	4	3	38	64	121	423	1 461	1 356	2 835	4 271	3 487	3 969	32 084	50 116	33 261
2007	0	1	3	22	33	86	235	631	2 194	2 825	3 657	4 359	3 540	15 824	33 410	20 219
2008	0	0	1	10	46	100	197	469	612	1 502	1 384	894	1 886	11 906	19 007	13 096
2009	0	1	16	22	42	39	254	258	577	364	823	692	1 856	11 706	16 650	10 246
2010	10	4	6	19	34	55	61	241	267	390	566	655	667	13 879	16 854	11 924
2011	4	4	4	25	55	114	11	103	286	394	408	479	567	15 223	17 677	12 962
2012	4	24	29	24	26	66	69	78	80	279	387	365	409	13 332	15 172	11 056
2013	0	3	19	101	90	44	41	42	9	177	146	185	317	12 826	14 000	9389
2014	14	27	338	95	114	92	147	54	108	68	248	287	193	23 101	24 886	18 426
2015	43	41	134	565	843	1 355	1 245	717	385	945	289	595	871	29 441	37 469	25 570
2016	40	0	977	667	3 350	2 579	2 983	1 995	1 964	1 269	1 342	1 256	1 108	36 719	56 249	34 754
2017	36	187	403	461	1 042	1 431	1 226	1 370	1 222	1 648	1 462	1 272	1 786	32 989	46 535	30 783
2018	50	319	611	822	1 363	2 481	2 663	2 825	2 816	2 872	2 623	1 804	2 353	41 030	64 632	38 046
2019	129	447	809	1 257	2 122	2 225	2 024	2 238	2 394	3 141	2 814	1 982	2 511	45 497	69 590	45 640

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	+gp	Total No.	Tonnes Land.
2020	5	14	571	231	2 023	1 277	1 732	3 179	2 592	2 537	3 768	3 291	3 000	47 712	71 932	53 631
2021	79	470	1 007	1 280	2 286	2 825	2 247	2 827	3 127	4 297	4 038	2 879	3 656	60 437	91 455	63 482

Table 6. 9 . Pelagic S. mentella in the Norwegian Sea (outside the EEZ). Catch numbers-at-age.

	Numbers 10^3								Age				
YEAR	7	8	9	10	11	12	13	14	15	16	17	18	19+
2006	0	0	0	0	23	93	1 083	323	1 563	3 628	2 514	3 756	29 704
2007	0	0	9	18	25	154	444	1 642	2 302	3 021	3 394	3 156	12 684
2008	0	0	0	0	28	146	115	143	214	594	752	753	13 258
2009	0	0	0	0	9	1 314	294	471	889	999	869	1 150	2 981
2010	0	0	0	0	0	0	155	74	135	224	356	458	12 497
2011	0	0	0	0	0	223	83	83	168	136	166	136	13 182
2012[1]	0	0	0	0	0	0	0	0	227	90	139	206	10 087
2013[2]	0	0	78	27	28	0	0	0	94	28	104	168	9 473
2014[3]	0	0	0	74	24	25	0	0	0	58	16	57	4 920
2015[3]	0	0	0	0	170	54	51	0	0	0	84	22	6 343
2016[3]	0	0	154	307	271	276	134	90	107	239	445	229	10 499
2017[3]	0	0	0	238	462	390	370	165	100	109	226	402	8 349
2018[3]	0	0	0	0	691	1 281	1 008	874	352	195	198	393	12 659
2019	25	5	200	400	220	242	197	279	183	155	135	161	6 696
2020[4]	0	44	8	345	672	353	362	270	345	206	163	136	5 496
2021[4]	0	0	45	8	339	631	309	290	195	228	127	96	2 380

1 - No age data in 2012, catch numbers-at-age are estimated from proportions at age in 2011 and in 2013.

2 - No age data from the catches in 2013. Age readings from the research survey conducted in September 2013 are used to derive catch numbers-at-age.

3 - No age data in 2014 – 2018, catch numbers-at-age are estimated from previous year according to protocol described in section 6.2.2.

4 - No age data in 2020-2021, catch numbers-at-age are estimated from previous year according to protocol described in section 6.2.2.

Table 6. 10 . S. mentella in subareas 1 and 2. Total catch numbers-at-length, in thousands, for 2011–2021.

Year	Length group																
	18–20	20–22	22–24	24–26	26–28	28–30	30–32	32–34	34–36	36–38	38–40	40–42	42–44	44–46	46–48	48–50	50–52
2011	0	12	0	0	1	8	249	2544	6481	6528	3620	829	95	18	1	0	0
2012	0	0	23	19	26	28	41	287	1898	5030	5385	1911	451	197	43	23	0
2013	0	0	4	32	154	137	90	69	1382	4214	4480	1633	497	197	0	0	0
2014	0	5	0	25	29	235	660	697	3358	7667	8544	3808	787	34	0	0	0

Year	Length group															
	18–20	20–22	22–24	24–26	26–28	28–30	30–32	32–34	34–36	36–38	38–40	40–42	42–44	44–46	46–48	48–50	50–52
2015	*Data not available at the time of the working group*																
2016	*Data not available at the time of the working group*																
2017	*Data not available at the time of the working group*																
2018	*Data not available at the time of the working group*																
2019	*Data not available at the time of the working group*																
2020	*Data not available at the time of the working group*																
2021	*Data not available at the time of the working group*																

Table 6. 11 . S. mentella in subareas 1 and 2. Catch numbers-at-length, in thousands, in the pelagic fishery for 2011–2021.

									Length group								
Year	18–20	20–22	22–24	24–26	26–28	28–30	30–32	32–34	34–36	36–38	38–40	40–42	42–44	44–46	46–48	48–50	50–52
2011	0	0	0	0	1	8	244	2562	5887	4425	1537	287	13	0	1	0	0
2012	0	0	0	0	0	0	106	2014	5092	3681	952	48	0	0	0	0	0
2013	0	0	0	0	0	0	75	1352	4791	2967	730	87	6	0	0	0	0
2014	0	0	0	0	0	3	14	349	2408	2454	827	80	6	1	0	0	0
2015	*Data not available at the time of the working group*																
2016	*Data not available at the time of the working group*																
2017	*Data not available at the time of the working group*																
2018	*Data not available at the time of the working group*																
2019	*Data not available at the time of the working group*																
2020	*Data not available at the time of the working group*																
2021	*Data not available at the time of the working group*																

Table 6. 12 . S. mentella in subareas 1 and 2. Observed mean weights-at-age (kg) from the Norwegian data (Catches and surveys combined). Weights-at-age used in the statistical catch-at-age model are identical for every year and given at the bottom line of the table.

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1992	0.167	0.164	0.211	0.241	0.309	0.324	0.378	0.366	0.428	0.454	0.487	0.529	0.571	0.805
1993	0.141	0.181	0.217	0.254	0.306	0.357	0.349	0.4	0.45	0.436	0.46	0.499	0.462	0.846
1994	0.174	0.188	0.235	0.298	0.361	0.396	0.415	0.48	0.492	0.562	0.642	0.636	0.72	0.846
1995	0.158	0.185	0.226	0.261	0.324	0.36	0.432	0.468	0.496	0.519	0.566	0.573	0.621	0.758
1996	0.175	0.189	0.224	0.272	0.323	0.337	0.377	0.518	0.536	0.603	0.69	0.8	0.683	0.958
1997	0.152	0.191	0.228	0.28	0.324	0.367	0.435	0.492	0.521	0.615	0.601	0.611	0.671	0.911
1998	0.12	0.148	0.192	0.261	0.326	0.373	0.427	0.496	0.537	0.566	0.587	0.625	0.658	0.809
1999	0.133	0.17	0.226	0.286	0.343	0.382	0.441	0.483	0.537	0.565	0.62	0.644	0.672	0.757
2000	0.109	0.144	0.199	0.276	0.332	0.392	0.437	0.49	0.54	0.585	0.631	0.65	0.671	0.872
2001	0.115	0.137	0.183	0.262	0.31	0.356	0.4	0.434	0.484	0.534	0.581	0.615	0.624	0.819
2002	0.114	0.139	0.182	0.253	0.329	0.372	0.392	0.434	0.476	0.52	0.545	0.587	0.601	0.833
2003	0.109	0.124	0.196	0.245	0.312	0.371	0.422	0.434	0.477	0.516	0.551	0.591	0.623	0.817

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
2004	0.104	0.129	0.18	0.264	0.308	0.376	0.413	0.444	0.478	0.521	0.579	0.614	0.688	0.835
2005	0.104	0.136	0.196	0.263	0.322	0.37	0.408	0.451	0.478	0.523	0.55	0.551	0.64	0.797
2006	0.107	0.143	0.2	0.266	0.314	0.374	0.419	0.462	0.489	0.527	0.57	0.602	0.59	0.796
2007	0.115	0.131	0.18	0.252	0.305	0.364	0.409	0.449	0.485	0.513	0.523	0.554	0.569	0.737
2008	0	0.158	0.177	0.242	0.304	0.402	0.465	0.486	0.511	0.546	0.6	0.596	0.635	0.803
2009	0.129	0.179	0.206	0.249	0.326	0.394	0.51	0.55	0.542	0.583	0.609	0.594	0.595	0.809
2010	0.129	0.128	0.175	0.263	0.375	0.447	0.501	0.541	0.582	0.602	0.593	0.608	0.592	0.706
2011	0.136	0.156	0.183	0.261	0.316	0.435	0.512	0.604	0.655	0.609	0.671	0.647	0.677	0.795
2012	0.135	0.178	0.225	0.246	0.249	0.356	0.474	0.582	0.53	0.626	0.654	0.73	0.699	0.833
2013	0.129	0.145	0.189	0.23	0.27	0.282	0.345	0.384	0.534	0.559	0.634	0.627	0.661	0.72
2014	0.193	0.172	0.221	0.167	0.192	0.239	0.333	0.277	0.364	0.516	0.713	0.78	0.797	0.882
2015	0.167	0.168	0.232	0.294	0.346	0.383	0.457	0.436	0.474	0.538	0.665	0.69	0.724	0.824
2016[1]	0.11	0	0.331	0.356	0.401	0.392	0.434	0.486	0.543	0.579	0.74	0.591	0.598	0.776
2017	0.154	0.196	0.254	0.27	0.306	0.413	0.425	0.458	0.533	0.472	0.562	0.65	0.692	0.796
2018[1]	0	0.233	0.135	0.371	0.323	0.28	0.379	0.452	0.524	0.633	0.483	0.589	0.457	0.821
2019[1]	0.118	0.38	0.341	0.47	0.538	0.523	0.539	0.565	0.572	0.62	0.656	0.601	0.633	0.744
Modelled	0.141	0.188	0.237	0.286	0.334	0.381	0.424	0.465	0.503	0.537	0.569	0.597	0.623	0.755

1 - Provisional figures.

Table 6. 13 . Pelagic S. mentella in the Norwegian Sea (outside the EEZ). Catch weights-at-age (kg).

Year/ Age	11	12	13	14	15	16	17	18	19+
2006	0.44	0.44	0.52	0.44	0.49	0.55	0.53	0.56	0.61
2007	0.39	0.43	0.41	0.48	0.50	0.52	0.55	0.57	0.64
2008	0.36	0.47	0.56	0.50	0.56	0.54	0.56	0.55	0.64
2009	0.38	0.44	0.45	0.48	0.54	0.59	0.64	0.58	0.69
2010	-	-	0.62	0.56	0.54	0.59	0.59	0.56	0.61
2011	-	0.48	0.54	0.54	0.64	0.59	0.54	0.59	0.59
2012	*No data*	-	-	-	-	-	-	-	-
2013[2]	0.31	-	-	-	0.56	0.62	0.60	0.62	0.68
2014	*No data*	-	-	-	-	-	-	-	-
2015	*No data*	-	-	-	-	-	-	-	-
2016	*No data*	-	-	-	-	-	-	-	-
2017	*No data*	-	-	-	-	-	-	-	-
2018	*No data*	-	-	-	-	-	-	-	-
2019	*No data*	-	-	-	-	-	-	-	-
2020	*No data*	-	-	-	-	-	-	-	-
2021[1]	*No data*	-	-	-	-	-	-	-	-

1 - Provisional figures.

2 - As observed in the research survey in the Norwegian Sea in September 2013.

Table 6. 14 . Proportion of maturity-at-age 6–19+ in S. mentella in subareas 1 and 2 derived from Norwegian commercial and survey data. The proportions were derived from samples with at least 5 individuals. a50 w1 and w2 are the annual coefficients for modelled maturity ogives using a double half sigmoid of the form 0.5 ((1+tanh(age- a50)/w1)) for age < a50 and 0.5 (1+tanh((age- a50)/w2) for age > a50. a50 equals the age at 50% maturity.

year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1992	0.00	0.01	0.02	0.04	0.07	0.14	0.26	0.42	0.53	0.59	0.65	0.70	0.75	1.00
1993	0.01	0.02	0.04	0.08	0.15	0.28	0.44	0.55	0.61	0.67	0.72	0.77	0.82	1.00
1994	0.02	0.04	0.08	0.15	0.28	0.44	0.59	0.72	0.81	0.88	0.93	0.96	0.98	1.00
1995	0.03	0.07	0.13	0.24	0.39	0.57	0.71	0.83	0.90	0.95	0.97	0.98	0.99	1.00
1996	0.01	0.01	0.02	0.05	0.10	0.19	0.33	0.50	0.59	0.66	0.73	0.79	0.84	1.00
1997	0.02	0.04	0.08	0.16	0.29	0.46	0.55	0.61	0.66	0.71	0.76	0.80	0.84	1.00
1998	0.02	0.04	0.08	0.15	0.26	0.43	0.56	0.65	0.73	0.80	0.85	0.90	0.93	1.00
1999	0.03	0.05	0.10	0.20	0.34	0.51	0.57	0.64	0.70	0.75	0.80	0.84	0.87	1.00
2000	0.03	0.06	0.11	0.21	0.36	0.52	0.63	0.73	0.81	0.87	0.91	0.94	0.96	1.00
2001	0.01	0.02	0.04	0.09	0.17	0.30	0.47	0.56	0.62	0.68	0.74	0.79	0.83	1.00
2002	0.02	0.05	0.10	0.19	0.33	0.50	0.54	0.59	0.63	0.67	0.70	0.74	0.77	1.00
2003	0.03	0.06	0.12	0.21	0.36	0.51	0.57	0.63	0.69	0.73	0.78	0.82	0.85	1.00
2004	0.03	0.06	0.12	0.22	0.37	0.51	0.55	0.59	0.63	0.67	0.70	0.73	0.76	1.00
2005	0.02	0.05	0.09	0.18	0.31	0.49	0.55	0.61	0.66	0.71	0.75	0.79	0.83	1.00
2006	0.01	0.02	0.03	0.07	0.13	0.24	0.39	0.53	0.59	0.64	0.70	0.75	0.79	1.00
2007	0.02	0.04	0.09	0.17	0.30	0.47	0.64	0.77	0.87	0.93	0.96	0.98	0.99	1.00
2008[1]	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00
2009	0.02	0.04	0.09	0.17	0.30	0.47	0.60	0.71	0.80	0.87	0.92	0.95	0.97	1.00
2010	0.02	0.04	0.08	0.16	0.28	0.45	0.54	0.60	0.66	0.71	0.76	0.80	0.83	1.00
2011[1]	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00
2012	0.02	0.05	0.10	0.19	0.32	0.50	0.59	0.68	0.75	0.81	0.86	0.90	0.93	1.00
2013	0.00	0.01	0.02	0.04	0.08	0.15	0.28	0.45	0.62	0.77	0.87	0.93	0.97	1.00
2014	0.00	0.00	0.01	0.02	0.03	0.06	0.12	0.23	0.38	0.53	0.61	0.68	0.74	1.00
2015	0.01	0.02	0.05	0.09	0.17	0.31	0.48	0.54	0.58	0.63	0.67	0.71	0.74	1.00
2016	0.03	0.06	0.12	0.22	0.38	0.52	0.56	0.61	0.66	0.70	0.74	0.77	0.81	1.00
2017[1]	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00
2018[1]	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00
2019[1]	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00
2020[1]	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00
2021[1]	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00

1 - Model parameter estimates were unrealistic and replaced by average parameter values.

Table 6. 15 . S. mentella. Average catch (numbers of specimens) per hour trawling of different ages of S. mentella in the Russian groundfish survey in the Barents Sea and Svalbard areas (1976–1983 published in Annales Biologiques). The survey was not conducted in 2016 took place in 2017 with insufficient coverage and was terminated after that year.

Year class	0	1	2	3	4	5	6	7	8	9	10	11
1974	-	-	4.8	-	4.9	22.8	4.8	4.8	-	-	-	3
1975	-	7.4	-	1.7	6.4	2.4	3.5	5	-	-	4	-

Year class	0	1	2	3	4	5	6	7	8	9	10	11
1976	7	-	8.1	1.2	2.5	6.8	4.9	5	1	13	-	-
1977	-	0.2	0.2	0.2	0.9	5.1	3.7	1	19	2	-	-
1978	0.8	0.02	0.9	1	5	3.8	2	20	6	-	-	-
1979	-	1.9	1.4	3.6	2.3	9	11	16	1	-	-	0.1
1980	0.3	0.4	2	2.5	16	6	11	25	2	-	1.5	2
1981	-	2.2	3.9	20	6	12	47	18	6.3	1.6	0.5	1
1982	19.8	13.2	13	15	34	44	39	32.6	4.3	3.1	4.9	+
1983	12.5	3	5	6	31	34	32.3	13.3	4	4.2	0.6	1.1
1984	-	10	2	-	5	18.3	19	2.2	2.4	0.2	1.7	2.4
1985	107	7	-	1	5.2	16.2	1.7	1.7	0.6	2.8	3.8	0.3
1986	2	-	1	1.8	8.4	3.6	2.1	1.2	5.6	8.2	0.9	0.7
1987	-	3	37.9	1.3	8	4.1	2	10.6	9.6	1.4	2	1.3
1988	4	58.1	4.3	13.3	25.8	3.9	8.6	11.2	2.8	4.2	3	4.7
1989	8.7	9	17	23.4	4.6	5.4	4	6.6	6.6	4.1	7.7	5.3
1990	2.5	6.3	6.1	1	4.3	1.7	11.5	6.5	5.5	6.7	7.4	3.6
1991	0.3	1	0.5	1.5	1.2	11.3	3.9	3.3	4.6	5.8	2.7	1.9
1992	0.6	+	0.2	0.1	4.3	1.3	2	2.3	4.9	2.3	1	4.1
1993[1]	-	+	1.5	1.8	1	1.2	3	4.2	2.6	2	3.2	2.1
1994	0.3	3.5	1.7	1.7	0.9	3.6	5.2	4.3	3.1	3.3	1.8	1.2
1995	2.8	1	1.1	0.4	2.2	2.6	3.5	3.4	2.9	1.2	1	8.5
1996[2]	+	0.1	0.1	0.4	0.7	1.1	1	1.4	1	0.8	3.7	0.6
1997	-	-	+	0.4	0.5	0.3	0.9	0.6	1	1.1	0.5	0.4
1998	-	0.1	0.2	0.3	0.2	1.1	0.5	0.7	1	0.4	0.4	0.7
1999	0.1	-	0.1	+	0.1	0.3	0.5	0.8	0.5	0.2	0.4	0.6
2000	-	0.6	0.1	0.5	0.3	0.3	0.6	0.4	0.1	0.1	0.7	0.3
2001	-	0.1	0.4	-	0.1	0.2	0.2	0.3	0.2	0.8	0.1	1
2002[3]	0.1	0.5	0.1	-	-	0.1	0.5	0.4	1.5	0.5	1	1.1
2003	-	-	0.1	-	0.3	1.0	0.5	4.8	2.1	3.7	1.3	1.9
2004	-	0.2	0.3	0.5	1.5	0.9	4.4	3.7	7.5	4.1	3.1	3.3
2005	-	-	1.4	1.9	1.4	2.3	3.9	7.2	6.1	6.8	3.1	
2006[4]	0.1	1.8	1.2	1.1	0.8	2.1	4.1	3.0	6.1	5.9		
2007	2.5	0.4	0.1	1.2	1.7	2.4	3.6	4.3	7.4			
2008	0.1	0.1	1.6	1.8	4.1	2.9	5.8	5.5				
2009	1.6	1.9	1.1	4.4	4.8	2.9	4.8					
2010	7.5	0.7	1.2	1.5	1.9	1.6						
2011	0.1	0.3	0.6	1.6	1.6							
2012	0.2	0.7	0.5	0.3								
2013	0.1	0.1	0.4									
2014	3.6	1.0										

Year class	0	1	2	3	4	5	6	7	8	9	10	11
2015	6.6											

1 - Not complete area coverage of Division 2.b.

2 - Area surveyed restricted to Subarea 1 and Division 2.a only.

3 - Area surveyed restricted to Subarea 1 and Division 2.b only.

4 - Area surveyed restricted to divisions 2.a and 2.b only.

Table 6.16a. S. mentella1 in Division 2.b. Abundance indices (on length) from the bottom-trawl survey in the Svalbard area (Division 2.b) in summer/fall 1986–2021 (numbers in millions).

Year	Length group (cm)									
	5.0–9.9	10.0–14.9	15.0–19.9	20.0–24.9	25.0–29.9	30.0–34.9	35.0–39.9	40.0–44.9	> 45.0	Total
1986[2]	6	101	192	17	10	5	2	4	0	**337**
1987[2]	20	14	140	19	6	2	1	2	0	**204**
1988[2]	33	23	82	77	7	3	2	2	0	**229**
1989	556	225	24	72	17	2	2	8	4	**910**
1990	184	820	59	65	111	23	15	7	3	**1287**
1991	1533	1426	563	55	138	38	30	7	1	**3791**
1992	149	446	268	43	22	15	4	7	4	**958**
1993	9	320	272	89	16	13	3	1	0	**723**
1994	4	284	613	242	10	9	2	2	1	**1167**
1995	33	33	417	349	77	18	5	1	0	**933**
1996	56	69	139	310	97	8	4	1	1	**685**
1997	3	44	13	65	57	9	5	0	0	**195**
1998	0	37	35	28	132	73	45	2	0	**352**
1999	3	3	124	62	260	169	42	1	0	**664**
2000	0	10	30	59	126	143	21	1	0	**391**
2001	1	5	3	32	57	227	50	3	0	**378**
2002	1	4	6	21	62	266	47	4	0	**410**
2003	1	5	7	11	51	244	45	1	0	**364**
2004	0	2	8	6	14	78	49	2	0	**160**
2005	22	1	4	4	10	70	47	1	0	**158**
2006	85	6	5	7	43	200	108	3	0	**457**
2007	97	68	1	5	11	102	119	3	0	**406**
2008	124	47	22	3	8	22	70	3	0	**299**
2009	9	122	88	14	3	27	219	5	0	**486**
2010	96	18	44	37	2	20	91	7	0	**315**
2011	126	91	81	48	10	7	67	5	1	**436**
2012	29	71	65	77	47	8	94	10	0	**400**
2013	33	43	127	106	67	19	89	13	0	**497**
2014[3]	3	10	59	49	38	24	66	20	0	**268**

Year	Length group (cm)									
	5.0–9.9	10.0–14.9	15.0–19.9	20.0–24.9	25.0–29.9	30.0–34.9	35.0–39.9	40.0–44.9	> 45.0	Total
2015	85	7	28	157	115	65	69	25	0	**552**
2016	244	33	44	205	138	139	142	48	0	**993**
2017	41	39	8	20	59	76	57	17	0	**317**
2018	66	62	55	35	100	65	80	26	0	**489**
2019	3	25	84	31	59	82	72	25	1	**381**
2020	97	8	57	39	40	115	97	16	0	**470**
2021	492	135	15	39	16	58	88	18	0	**860**

1 - Includes some unidentified Sebastes specimens mostly less than 15 cm.

2 - Old trawl equipment (bobbins gear and 80 m sweep length).

3 - Poor survey coverage in 2014.

Table 6.16b. S. mentella 1 in Division 2.b. Norwegian bottom-trawl survey indices (on age) in the Svalbard area (Division 2.b) in summer/fall 1992–2021 (numbers in millions).

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	283	419	484	131	58	45	14	8	5	2	7	2	1	3	**1462**
1993	2	527	117	202	142	8	23	6	13	1	7	1	1	0	**1050**
1994	7	280	290	202	235	42	94	1	1	3	4	1	1	0	**1161**
1995	4	50	365	237	132	61	19	17	11	0	1	3	0	0	**900**
1996	13	32	10	36	103	135	78	16	50	28	32	8	21	2	**565**
1997	8	43	6	7	38	18	29	19	6	2	0	2	1	1	**181**
1998	0	25	27	13	10	12	61	52	41	15	0	5	13	0	**276**
1999	3	16	108	25	28	39	106	59	54	26	35	14	18	12	**543**
2000	4	6	5	13	30	21	28	44	66	48	21	19	9	6	**321**
2001	1	4	2	0	12	15	18	36	28	46	45	80	53	14	**354**
2002	3	2	4	1	5	22	34	23	90	35	54	65	17	22	**377**
2003	0	4	3	3	5	3	29	25	25	25	11	164	55	23	**376**
2004	1	1	4	4	1	4	2	9	4	15	14	17	15	15	**108**
2005	15	1	1	3	1	2	2	8	4	5	14	7	30	21	**115**
2006	35	1	3	3	2	6	5	37	3	20	46	69	8	22	**258**
2007	28	39	0	0	4	1	5	5	7	5	3	7	28	17	**150**
2008	6	24	19	11	3	2	2	4	3	3	3	3	6	8	**96**
2009	9	69	50	29	26	25	7	1	1	1	4	20	11	8	**260**
2010	*No age readings available*														
2011	125	42	61	42	12	49	31	4	1	0	2	0	0	1	**369**
2012	27	54	32	27	34	43	26	34	18	9	0	1	0	0	**305**
2013	30	4	29	36	7	93	72	43	40	7	8	3	3	3	**377**
2014[2,3]	0	3	2	7	21	40	13	27	5	30	13	11	3	2	**176**
2015	63	1	10	56	36	54	33	95	28	21	12	4	5	3	**421**

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
2016	*No age readings available*														
2017	39	26	10	13	14	20	39	16	29	8	6	19	1	28	**269**
2018	*No age readings available*														
2019	0	32	53	0	24	21	21	46	52	76	0	0	0	0	**324**
2020	No age readings available														
2021	No age readings available														

1 - Includes some unidentified *Sebastes* specimens mostly less than 15 cm.

2 - Old trawl equipment (bobbins gear and 80 m sweep length).

3 - Poor survey coverage in 2014.

Table 6.17. S. mentella in subareas 1 and 2. Abundance indices (on age) from the Ecosystem survey in August-September 1996–2021 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (numbers in thousands and total biomass in thousand tonnes) and the continental slope down to 1000 m.

Year/ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total N	Total B
1996	146 198	112 742	22 353	53 507	165 531	181 980	108 738	43 328	65 310	40 546	38 254	19 843	29 446	10 931	17 414	**1 056 120**	**171**
1997	62 682	130 816	12 492	23 452	74 342	55 880	76 607	82 503	17 640	14 274	675	2238	1723	633	8765	**564 723**	**73**
1998	313	78 767	85 715	39 849	25 805	23 413	84 825	100 332	54 287	24 329	11 334	7457	15 250	576	25 212	**577 464**	**105**
1999	5359	23 240	117 170	47 851	41 608	76 797	128 677	73 306	58 018	64 781	49 890	13 565	18 458	12 171	24 672	**755 562**	**155**
2000	5964	23 169	14 336	19 960	52 666	68 081	83 857	77 513	100 442	72 294	71 148	36 599	17 183	20 590	26 501	**690 304**	**178**
2001	5026	6541	10 957	1093	19 766	25 591	36 594	51 644	44 407	61 704	50 083	86 122	53 952	15 699	31 877	**501 057**	**162**
2002	9112	6646	7379	3821	8635	28 215	47 456	63 903	103 368	49 964	76 133	71 970	25 241	36 765	34 957	**573 565**	**181**
2003	4086	8218	7368	3140	7885	7983	43 821	62 360	52 015	34 782	61 735	168 703	107 298	39 760	26 882	**636 036**	**257[2]**
2004	8554	15793	11 443	7399	3554	7560	6164	11 686	8566	22 973	25 920	23 199	20 392	19 472	50 960	**243 635**	**91[2]**
2005	32 526	6856	5546	5616	3772	5980	6985	13 151	5803	5700	16 554	34 393	34 987	34 336	53 165	**265 370**	**101[2]**
2006	125 437	4833	6844	6602	4255	8486	7424	38 309	3983	24 756	48 733	71 491	13 957	37 991	159 909	**563 010**	**199[2]**
2007	411 738	213 851	15 844	5121	11 830	3234	8884	10 298	14 652	7217	4200	7925	53 657	19 308	237 861	**1 025 620**	**199[2]**
2008	58 894	206 727	14 2254	29386	7745	3182	2895	6352	6132	3538	3445	5380	7018	9717	95 279	**587 944**	**84[2]**
2009	122 459	176 405	231 265	82701	109 509	45 607	15 812	2775	5807	2950	3929	22 097	12 431	9299	331 974	**1 175 019**	**260[2]**
2010	*No age reading*																
2011	422 533	390 888	227 693	61575	56 025	78 022	47 213	12 153	3176	2049	2607	856	85	2948	103 653	**1 411 479**	**120[2]**

Year/ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total N	Total B
2012	353 610	256 305	351 327	173183	130 446	70 403	58 164	40 645	21 408	12 671	3553	1044	1568	3374	139 887	**1 617 588**	**184[2]**
2013	299 841	203 094	189 851	194068	164 206	178 236	112 427	103 262	92 160	13 848	13 956	8579	2784	2857	144 033	**1 723 202**	**271[2]**
2014[1]	2247	20 884	33 295	82052	52 428	94 324	93 771	68 765	35 193	56 728	40 647	19 047	16 518	3335	163 869	**783 104**	**239[2]**
2015	404 973	86 648	53 046	95737	53 022	109 686	46 714	126 156	73 141	25 441	19 583	6569	5284	3335	119 261	**1 228 596**	**207[2]**
2016	*No age reading*																
2017	534 647	244 469	213 984	215852	33 595	45 809	61 428	62 449	37 597	33 901	39 670	37 492	10 364	40 052	85 250	**1 696 557**	**213[2]**
2018	*No age reading*																
2019[3]	93 518	77 195	125 457	81499	62 447	38 668	61 615	91672	178887	124876	0	0	0	0	60 931	**996 765**	**211[2]**
2020	*No age reading*																
2021	*No age reading*																

1 - Poor survey coverage in 2014.

2 – Calculated using modelled weight-at-age.

3 – Provisional figures.

Table 6.18a. S. mentella1. Abundance indices (on length) from the bottom-trawl survey in the Barents Sea in winter 1986–2022 (numbers in millions). The area coverage was extended from 1993 onwards. Numbers from 1994 onwards were recalculated while numbers for 1986–1993 are as in previous reports.

Year	Length group (cm)									
	5.0–9.9	10.0–14.9	15.0–19.9	20.0–24.9	25.0–29.9	30.0–34.9	35.0–39.9	40.0–44.9	> 45.0	Total
1986	81	152	205	88	169	130	88	24	14	**950**
1987	72	25	227	56	35	11	5	1	0	**433**
1988	587	25	133	182	40	50	48	4	0	**1068**
1989	623	55	28	177	58	9	8	2	0	**961**
1990	324	305	36	56	80	13	13	2	0	**828**
1991	395	449	86	39	96	35	24	3	0	**1127**
1992	139	367	227	35	55	34	8	2	1	**867**
1993	31	593	320	116	24	25	6	1	0	**1117**
1994	8	296	479	488	74	74	17	3	0	**1440**
1995	310	84	571	390	83	58	24	3	0	**1522**
1996	215	101	198	343	136	42	17	1	0	**1054**
1997[2]	38	83	19	198	266	82	39	3	0	**728**
1998[2]	1	87	62	101	202	40	13	2	0	**507**
1999	2	7	70	37	172	73	22	3	0	**386**
2000	9	13	40	78	143	97	27	7	2	**415**
2001	10	23	7	57	79	75	10	1	0	**260**
2002	17	7	19	36	96	116	24	1	0	**317**

Year	Length group (cm)									
	5.0–9.9	10.0–14.9	15.0–19.9	20.0–24.9	25.0–29.9	30.0–34.9	35.0–39.9	40.0–44.9	> 45.0	Total
2003	4	4	10	13	70	198	46	6	0	**351**
2004	2	3	7	19	33	86	32	2	0	**183**
2005	0	6	7	11	28	154	86	4	0	**296**
2006	100	2	10	15	23	104	83	3	1	**339**
2007	382	121	3	7	12	121	121	7	0	**773**
2008	858	359	27	5	12	104	165	5	0	**1533**
2009	95	325	136	5	9	67	163	6	0	**806**
2010	652	276	215	64	7	74	191	6	0	**1485**
2011	501	230	212	149	14	47	157	5	0	**1315**
2012	129	280	86	125	47	14	154	18	0	**855**
2013	249	227	245	159	143	35	193	27	0	**1279**
2014	91	174	250	114	125	51	115	14	0	**933**
2015	175	110	215	302	290	215	171	18	0	**1495**
2016	615	105	149	332	213	163	124	14	1	**1714**
2017	568	185	68	197	286	310	231	11	0	**1855**
2018	189	250	83	109	192	270	214	22	1	**1329**
2019	42	288	263	92	158	255	211	20	0	**1330**
2020	196	122	207	92	118	231	209	25	1	**1200**
2021	887	132	142	124	81	186	172	23	1	**1749**
2022[3]	640	1025	45	104	76	87	153	20	0	**2149**

1 - Includes some unidentified *Sebastes* specimens mostly less than 15 cm.

2 - Adjusted indices to account for not covering the Russian EEZ in Subarea 1.

3- Norwegian numbers only

Table 6.18b. S. mentella 1 in subareas 1 and 2. Preliminary Norwegian bottom-trawl indices (on age) from the annual Barents Sea survey in February 1992–2022 (numbers in millions). The area coverage was extended from 1993 onwards. Numbers recalculated.

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	351	252	132	56	14	11	3	9	18	16	12	11	2	5	**892**
1993	38	473	192	242	62	45	19	22	13	11	10	4	2	3	**1136**
1994	5	96	315	160	342	269	97	55	4	28	13	14	26	5	**1430**
1995	315	49	148	251	343	238	67	25	7	19	21	9	11	10	**1512**
1996	189	107	85	111	140	132	128	60	21	24	14	6	9	4	**1029**
1997[2]	41	65	30	33	92	83	103	100	30	67	29	13	7	3	**697**
1998[2]	1	72	45	25	11	50	108	112	36	17	7	6	3	2	**496**
1999	0	1	38	40	29	28	52	62	55	32	16	4	7	1	**364**
2000	19	1	4	33	37	21	30	69	72	49	22	14	10	4	**385**
2001	1	17	8	2	7	25	36	30	41	18	22	28	5	3	**243**
2002	18	4	11	8	2	9	43	56	23	14	34	19	38	14	**293**

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
2003	0	3	2	4	6	6	15	36	24	24	43	36	62	33	**293**
2004	2	1	4	2	4	10	11	16	14	12	14	25	24	13	**152**
2005	0	4	3	2	6	6	7	14	18	8	18	27	40	57	**208**
2006	74	26	4	4	6	8	9	12	6	14	16	10	41	28	**259**
2007	237	75	4	1	2	2	5	8	9	6	8	21	33	72	**485**
2008	699	166	101	14	0	2	4	6	4	6	4	20	22	30	**1079**
2009	104	108	100	87	64	32	19	14	4	6	21	1	22	7	**589**
2010	160	264	176	166	93	72	24	23	3	11	5	8	10	17	**1031**
2011	348	228	128	127	99	67	42	20	2	6	1	1	2	25	**1095**
2012	*No age readings*														
2013	0	179	268	136	154	108	126	14	31	8	7	20	41	12	**1105**
2014	*No age readings*														
2015	*No age readings*														
2016	*No age readings*														
2017	*No age readings*														
2018	*No age readings*														
2019	*No age readings*														
2020	*No age readings*														
2021	*No age reading*														
2022	*No age reading*														

1 - Includes some unidentified *Sebastes* specimens mostly less than 15 cm.

2 - Adjusted indices to account for not covering the Russian EEZ in Subarea 1.

Table 6.19. Comparison of results on S. mentella from the Norwegian Sea pelagic surveys in 2008, 2009, 2013, 2016, and 2019. Acoustic results for the 2019 survey were not available at the time of AFWG 2021.

	2008	2009	2013	2016	2019
mean length (cm) All/M/F[1]	37.0/36.4/37.5	36.6/36.0/37.1	37.5/37.0/38.1	37.7/37.0/38.3	37.6/37.2/38.0
mean length (cm) S/DSL/D[2]	37.2/36.8/39.1	37.2/36.5/38.3	37.1/37.4/38.9	38.1/37.6/38.4	37.4/37.6/37.7
mean weight (g) All/M/F	619/585/648	625/609/666	659/625/706	656/619/694	683/644/724
Mean age (y) All/M/F	25 / 25 / 25	25 / 25 / 24	28 / 29 / 28	27 / 27 / 26	- / - / -
Sex ratio (M/F)	45% / 55%	45% / 55%	59% / 41%	50% / 50%	51% / 49%
Occurrence	96%	100%	95%	80%	99%
Catch rates	3.80 t/NM2	3.94 t/NM2	3.47 t/NM2	1.01 t/NM2	3.40 t/NM2
mean s_A	33 m^2/NM2	34 m^2/NM2	19 m^2/NM2	5.2 m^2/NM2	-
Total Area	53 720 NM2	69 520 NM2	69 520 NM2	67 150 NM2	73 364 NM2
Abundance (Acoustics)[3]	395 000 t	532 000 t	297 000 t	136 000 t	-
Abundance (Trawl)[4]	406 000 t	548 000 t	482 000 t	116 000 t	499 000 t

1 - M = males only, F = females only.

2 - S = shallower than DSL, DSL = deep scattering layer, D = deeper than DSL.

3 - The abundance derived from hydroacoustics is calculated assuming a Length-dependent target strength equation of TS=20log(L)-68.0. In 2016 the TS equation used was TS=20log(L)-69.6 following recommendation from ICES-WKTAR (2010).

4 - Trawls: Gloria 2048 in 2008 and 2009 Gloria 2560 HO helix in 2013 and Gloria 1024 in 2016. Trawl catchability for redfish set to 0.5 for all trawls based on results from Bethke *et al.* (2010).

Table 6.20a. S. mentella in subareas 1 and 2. Population matrix with numbers-at-age (in thousands) for each year and separable fishing mortality coefficients for the demersal and pelagic fleet by year (Fy) and selectivity at age for the pelagic fleet (Sa). Numbers are estimated from the statistical catch-at-age model.

sa (demersal)	Varies over time																		
sa (pelagic)	0.000	0.000	0.000	0.000	0.000	0.014	0.024	0.039	0.063	0.100	0.155	0.234	0.337	0.458	0.584	0.699	0.795	1.0	

Fy (demseral)	Fy (pelagic)	Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.042	0	1992	429 977	415 175	375 788	242 932	149 082	102 443	97 930	107 160	130 282	91 119	102 382	75 533	77 953	65 441	46 307	30 041	19 657	207 239
0.031	0	1993	289 490	409 094	395 010	357 537	229 100	140 310	96 194	91 724	100 097	121 356	84 641	94 849	69 802	71 879	60 224	42 545	27 562	207 147
0.027	0	1994	209 655	275 430	389 225	375 825	340 094	217 847	133 302	91 205	86 611	93 909	113 067	78 467	87 700	64 464	66 350	55 581	39 262	216 588
0.020	0	1995	200 014	199 472	262 053	370 321	357 293	323 028	206 534	125 963	85 766	81 007	87 447	104 994	72 756	81 258	59 709	61 447	51 470	236 914
0.014	0	1996	159 840	190 300	189 784	249 325	352 084	339 424	306 393	195 374	118 715	80 518	75 820	81 695	97 990	67 870	75 784	55 681	57 298	268 907
0.013	0	1997	111 468	152 077	181 057	180 567	237 151	334 736	322 328	290 270	184 453	111 726	75 637	71 165	76 655	91 934	63 673	71 096	52 236	306 023
0.019	0	1998	57 486	106 055	144 691	172 264	171 764	225 507	317 976	305 482	274 120	173 637	104 993	71 029	66 814	71 962	86 303	59 772	66 741	336 313
0.014	0	1999	46 459	54 694	100 904	137 664	163 884	163 356	214 155	300 527	286 693	256 314	162 197	98 055	66 333	62 395	67 203	80 596	55 820	376 399
0.011	0	2000	36 893	44 203	52 037	96 003	130 976	155 913	155 358	203 324	283 878	269 463	240 519	152 154	91 978	62 221	58 528	63 037	75 600	405 428
0.020	0	2001	35 692	35 101	42 056	49 510	91 340	124 613	148 320	147 606	192 108	267 188	253 477	226 238	143 119	86 516	58 527	55 052	59 294	452 464
0.007	0	2002	42 423	33 958	33 397	40 014	47 087	86 817	118 273	140 366	139 075	180 187	249 838	236 648	211 076	133 491	80 688	54 582	51 341	477 252
0.003	0	2003	45 546	40 363	32 309	31 775	38 069	44 796	82 571	112 379	133 073	131 549	170 266	236 016	223 541	199 383	126 095	76 217	51 558	499 306
0.006	0	2004	61 313	43 334	38 402	30 740	30 228	36 213	42 602	78 502	106 794	126 400	124 904	161 623	224 002	212 145	189 211	119 660	72 327	522 741
0.008	0	2005	117 600	58 335	41 229	36 537	29 244	28 753	34 436	40 491	74 546	101 302	119 777	118 275	152 984	211 986	200 748	179 037	113 224	563 055
0.005	0.037	2006	228 265	111 888	55 502	39 227	34 760	27 819	27 345	32 730	38 440	70 642	95 818	113 149	111 658	144 385	200 048	189 434	168 944	638 148
0.004	0.020	2007	341 155	217 179	106 454	52 806	37 321	33 071	26 451	25 987	31 075	36 434	66 788	90 308	106 262	104 428	134 410	185 341	174 743	737 346
0.005	0.013	2008	379 932	324 586	206 631	101 284	50 241	35 508	31 454	25 151	24 698	29 505	34 537	63 174	85 222	100 031	98 049	125 870	173 152	847 570
0.003	0.009	2009	381 522	361 480	308 821	196 595	96 365	47 801	33 776	29 915	23 910	23 452	27 954	32 655	59 643	80 340	94 145	92 123	118 077	954 101

Fy (demseral)	Fy (pelagic)	Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.004	0.010	2010	484 675	362 993	343 923	293 822	187 046	91 683	45 471	32 123	28 436	22 703	22 238	26 479	30 904	56 389	75 871	88 806	86 806	1 007 725
0.005	0.010	2011	585 041	461 135	345 363	327 220	279 549	177 957	87 211	43 244	30 535	27 005	21 532	21 063	25 050	29 202	53 217	71 514	83 612	1 027 695
0.005	0.008	2012	514 156	556 626	438 739	328 589	311 326	265 970	169 284	82 947	41 112	29 000	25 602	20 376	19 904	23 642	27 526	50 100	67 248	1 042 065
0.004	0.007	2013	277 390	489 184	529 592	417 430	312 628	296 200	253 008	161 008	78 865	39 063	27 523	24 261	19 278	18 805	22 309	25 944	47 172	1 041 939
0.015	0.008	2014	301 447	263 918	465 425	503 871	397 155	297 441	281 777	240 664	153 125	74 979	37 115	26 125	22 997	18 245	17 771	21 056	24 461	1 024 513
0.025	0.008	2015	287 730	286 806	251 100	442 821	479 386	377 845	282 934	267 988	228 814	145 502	71 175	35 174	24 697	21 669	17 132	16 636	19 665	975 718
0.035	0.009	2016	261 768	273 756	272 876	238 905	421 301	456 067	359 382	269 005	254 567	216 926	137 410	66 825	32 823	22 941	20 072	15 841	15 363	916 904
0.033	0.010	2017	267 611	249 055	260 460	259 623	227 286	400 768	433 666	341 476	255 168	240 609	203 731	127 978	61 766	30 181	21 027	18 359	14 468	848 894
0.044	0.010	2018	273 985	254 614	236 958	247 810	246 992	216 208	381 114	412 212	324 304	241 952	227 513	191 794	119 756	57 411	27 883	19 337	16 829	787 387
0.058	0.008	2019	277 225	260 678	242 247	225 450	235 726	234 909	205 540	362 080	391 193	307 191	228 487	213 861	179 152	111 032	52 830	25 493	17 593	725 368
0.078	0.007	2020	271 416	263 761	248 017	230 482	214 406	224 115	223 212	195 148	343 330	370 190	289 814	214 617	199 691	166 063	102 091	48 193	23 095	662 166
0.091	0.006	2021	265 735	258 234	250 951	235 971	219 279	203 975	213 173	212 261	185 485	326 027	350 907	273 802	201 556	185 740	152 417	92 321	43 018	599 005

Table 6.20b. S. mentella in subareas 1 and 2. Fisheries selectivity at age for the demersal fleet by age (Sa). Numbers are estimated from the statistical catch-at-age model.

Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1992	0.000	0.000	0.000	0.212	0.261	0.316	0.377	0.442	0.509	0.576	0.640	0.699	0.753	0.799	0.839	0.872	0.899	1.000
1993	0.000	0.000	0.000	0.007	0.019	0.047	0.114	0.248	0.459	0.686	0.849	0.935	0.974	0.990	0.996	0.998	0.999	1.000
1994	0.000	0.000	0.000	0.029	0.063	0.131	0.252	0.432	0.631	0.793	0.896	0.951	0.978	0.990	0.995	0.998	0.999	1.000
1995	0.000	0.000	0.000	0.035	0.075	0.153	0.286	0.470	0.663	0.814	0.906	0.955	0.979	0.991	0.996	0.998	0.999	1.000
1996	0.000	0.000	0.000	0.019	0.053	0.135	0.303	0.549	0.773	0.905	0.964	0.987	0.995	0.998	0.999	1.000	1.000	1.000
1997	0.000	0.000	0.000	0.014	0.042	0.118	0.290	0.555	0.793	0.921	0.973	0.991	0.997	0.999	1.000	1.000	1.000	1.000
1998	0.000	0.000	0.000	0.004	0.022	0.100	0.357	0.735	0.933	0.986	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.000	0.000	0.001	0.005	0.029	0.149	0.507	0.859	0.973	0.995	0.999	1.000	1.000	1.000	1.000	1.000	1.000
2000	0.000	0.000	0.000	0.000	0.001	0.012	0.123	0.609	0.945	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2001	0.000	0.000	0.000	0.020	0.050	0.122	0.266	0.487	0.713	0.867	0.945	0.978	0.992	0.997	0.999	1.000	1.000	1.000
2002	0.000	0.000	0.000	0.003	0.012	0.049	0.184	0.495	0.810	0.949	0.988	0.997	0.999	1.000	1.000	1.000	1.000	1.000
2003	0.000	0.000	0.000	0.042	0.084	0.161	0.286	0.455	0.635	0.784	0.883	0.940	0.970	0.986	0.993	0.997	0.998	1.000
2004	0.000	0.000	0.000	0.020	0.044	0.094	0.190	0.348	0.547	0.732	0.861	0.934	0.970	0.986	0.994	0.997	0.999	1.000
2005	0.000	0.000	0.000	0.008	0.020	0.051	0.123	0.267	0.486	0.711	0.865	0.943	0.977	0.991	0.997	0.999	0.999	1.000

Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2006	0.000	0.000	0.000	0.003	0.008	0.022	0.057	0.140	0.306	0.543	0.763	0.897	0.959	0.985	0.994	0.998	0.999	1.000
2007	0.000	0.000	0.000	0.001	0.003	0.010	0.027	0.076	0.194	0.414	0.674	0.858	0.946	0.981	0.993	0.998	0.999	1.000
2008	0.000	0.000	0.000	0.000	0.001	0.003	0.013	0.060	0.241	0.613	0.887	0.975	0.995	0.999	1.000	1.000	1.000	1.000
2009	0.000	0.000	0.000	0.001	0.004	0.015	0.055	0.180	0.452	0.756	0.921	0.978	0.994	0.998	1.000	1.000	1.000	1.000
2010	0.000	0.000	0.000	0.003	0.007	0.020	0.056	0.146	0.328	0.582	0.800	0.919	0.970	0.989	0.996	0.999	1.000	1.000
2011	0.000	0.000	0.000	0.001	0.002	0.007	0.024	0.082	0.242	0.535	0.805	0.937	0.982	0.995	0.999	1.000	1.000	1.000
2012	0.000	0.000	0.000	0.002	0.005	0.012	0.031	0.076	0.178	0.363	0.599	0.797	0.911	0.964	0.986	0.995	0.998	1.000
2013	0.000	0.000	0.000	0.001	0.003	0.006	0.014	0.032	0.071	0.151	0.294	0.493	0.694	0.841	0.925	0.967	0.985	1.000
2014	0.000	0.000	0.000	0.002	0.004	0.007	0.014	0.027	0.053	0.101	0.183	0.308	0.471	0.639	0.780	0.876	0.934	1.000
2015	0.000	0.000	0.000	0.001	0.003	0.008	0.021	0.052	0.125	0.270	0.489	0.712	0.865	0.943	0.977	0.991	0.997	1.000
2016	0.000	0.000	0.000	0.002	0.005	0.013	0.032	0.077	0.174	0.348	0.575	0.774	0.897	0.956	0.982	0.993	0.997	1.000
2017	0.000	0.000	0.000	0.003	0.005	0.011	0.022	0.044	0.085	0.159	0.278	0.439	0.614	0.764	0.868	0.930	0.964	1.000
2018	0.000	0.000	0.000	0.005	0.008	0.015	0.028	0.050	0.087	0.149	0.242	0.368	0.516	0.661	0.781	0.867	0.922	1.000
2019	0.000	0.000	0.000	0.008	0.012	0.020	0.033	0.053	0.085	0.132	0.201	0.293	0.405	0.529	0.649	0.753	0.834	1.000
2020	0.000	0.000	0.000	0.001	0.001	0.002	0.005	0.009	0.019	0.039	0.077	0.146	0.260	0.419	0.598	0.754	0.863	1.000
2021	0.000	0.000	0.000	0.007	0.010	0.016	0.025	0.040	0.062	0.094	0.141	0.207	0.293	0.396	0.509	0.622	0.723	1.000

Table 6.21. Stock summary for S. mentella in subareas 1 and 2 as estimated by the statistical catch-at-age model. Stock biomass is for age 2 y+.

Year	Rec (age 2) in millions	Rec (age 6) in millions	Stock Biomass (tonnes)	SSB (tonnes)	F (12–18)	F(19+)
1992	430	149	578 519	272 832	0.033	0.042
1993	289	229	625 410	323 633	0.029	0.031
1994	210	340	683 984	408 052	0.026	0.027
1995	200	357	749 346	469 927	0.020	0.020
1996	160	352	815 427	388 973	0.014	0.014
1997	111	237	879 903	478 373	0.013	0.013
1998	57	172	939 166	540 768	0.019	0.019
1999	46	164	987 329	608 797	0.014	0.014
2000	37	131	1 028 157	705 479	0.011	0.011
2001	36	91	1 061 896	655 042	0.020	0.020
2002	42	47	1 076 158	738 944	0.007	0.007
2003	46	38	1 092 380	815 196	0.003	0.003
2004	61	30	1 105 589	821 177	0.005	0.006
2005	118	29	1 111 783	876 777	0.008	0.008
2006	228	35	1 114 129	863 053	0.022	0.042
2007	341	37	1 093 928	1 006 505	0.013	0.024
2008	380	50	1 087 883	943 961	0.011	0.018
2009	382	96	1 091 599	981 572	0.007	0.012
2010	485	187	1 104 151	934 873	0.008	0.013
2011	585	280	1 123 427	924 087	0.009	0.015

Year	Rec (age 2) in millions	Rec (age 6) in millions	Stock Biomass (tonnes)	SSB (tonnes)	F (12–18)	F(19+)
2012	514	311	1 151 950	918 287	0.008	0.013
2013	277	313	1 194 986	870 554	0.006	0.011
2014	301	397	1 253 060	818 776	0.013	0.023
2015	288	479	1 307 703	839 740	0.025	0.032
2016	262	421	1 350 509	896 320	0.035	0.044
2017	268	227	1 386 933	872 141	0.027	0.042
2018	274	247	1 427 869	892 107	0.032	0.054
2019	277	236	1 459 921	919 610	0.034	0.066
2020	271	214	1 483 445	950 770	0.038	0.085
2021	266	219	1 498 423	976 956	0.041	0.097

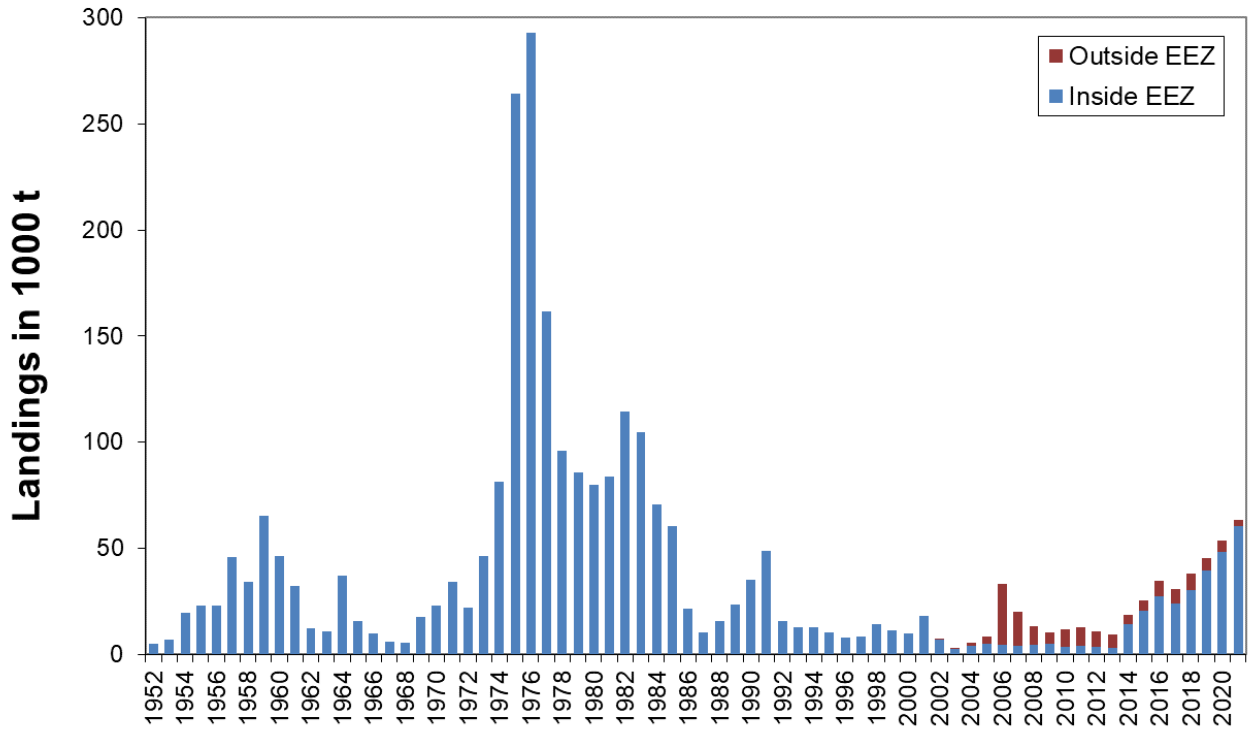


Figure 6.1. S. mentella in subareas 1 and 2. Total international landings 1952–2020 (thousand tonnes).

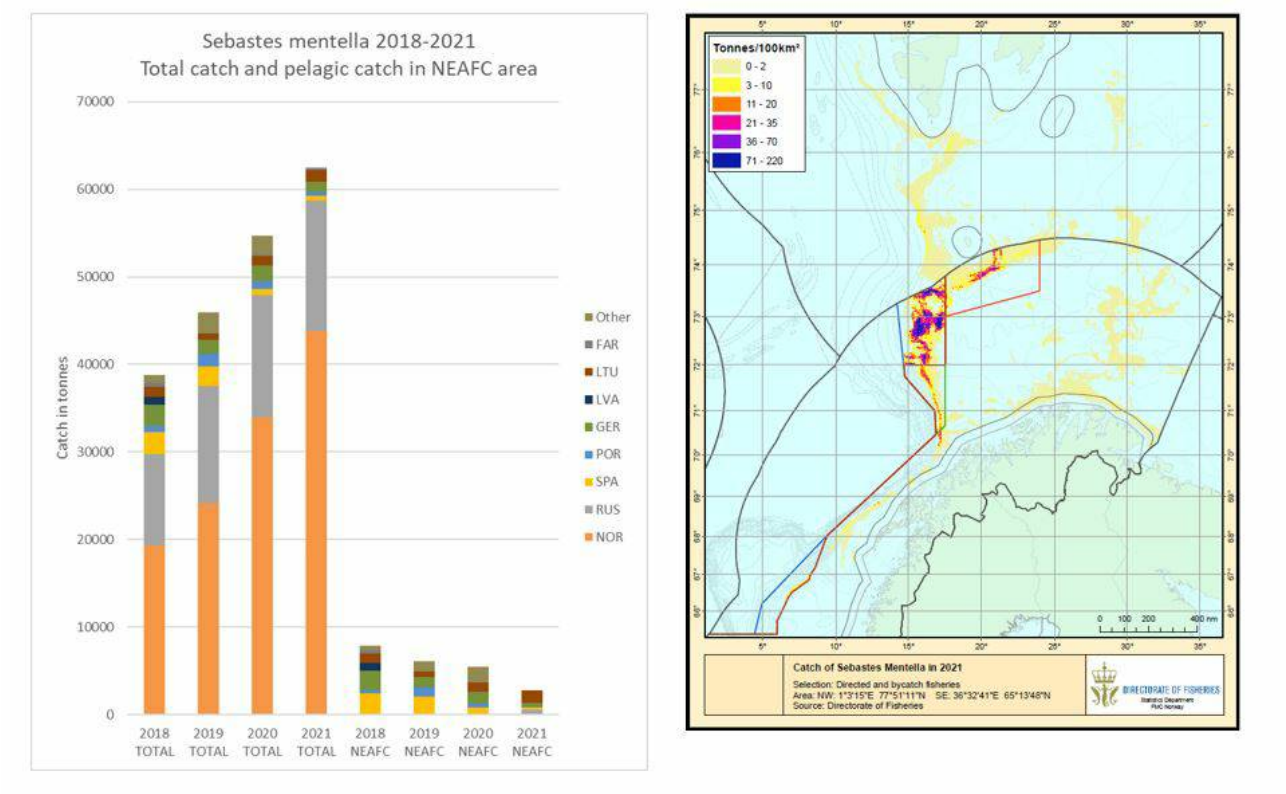


Figure 6.2. S. mentella in subareas 1 and 2. Left panel: Catch in tonnes reported by national fleets for the subareas 27.1 and 27.2 and in the NEACF regulatory area. Right panel: Geographical location of the directed Norwegian fishery in 2021 within the Norwegian Exclusive Economic Zone and bycatches by Norwegian vessels in all areas. Directed fishing with bottom trawl is not permitted to the east of the red line. Directed fishing with pelagic trawl is not permitted to the east of the blue line. Directed fishing is not permitted in the Fishery Protection Zone around Svalbard.

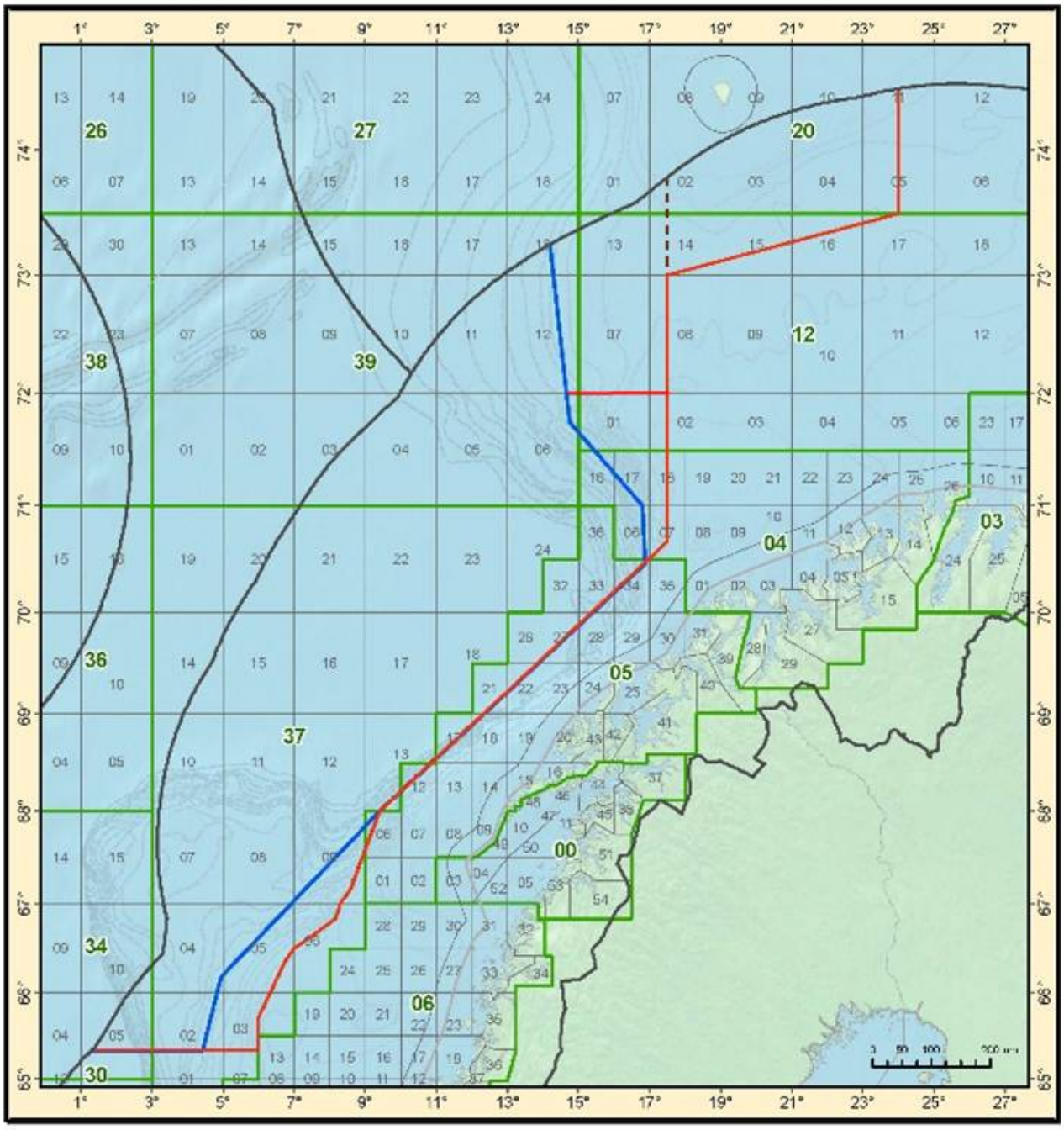
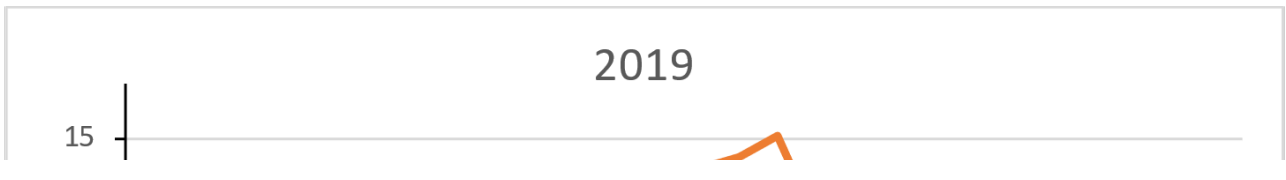
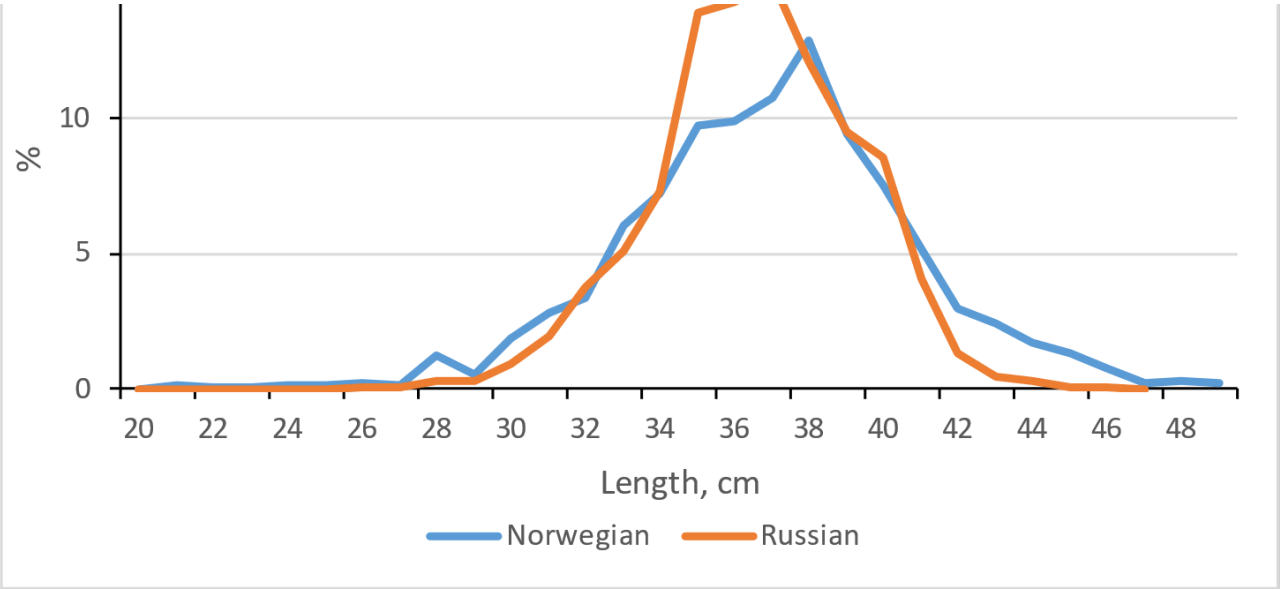
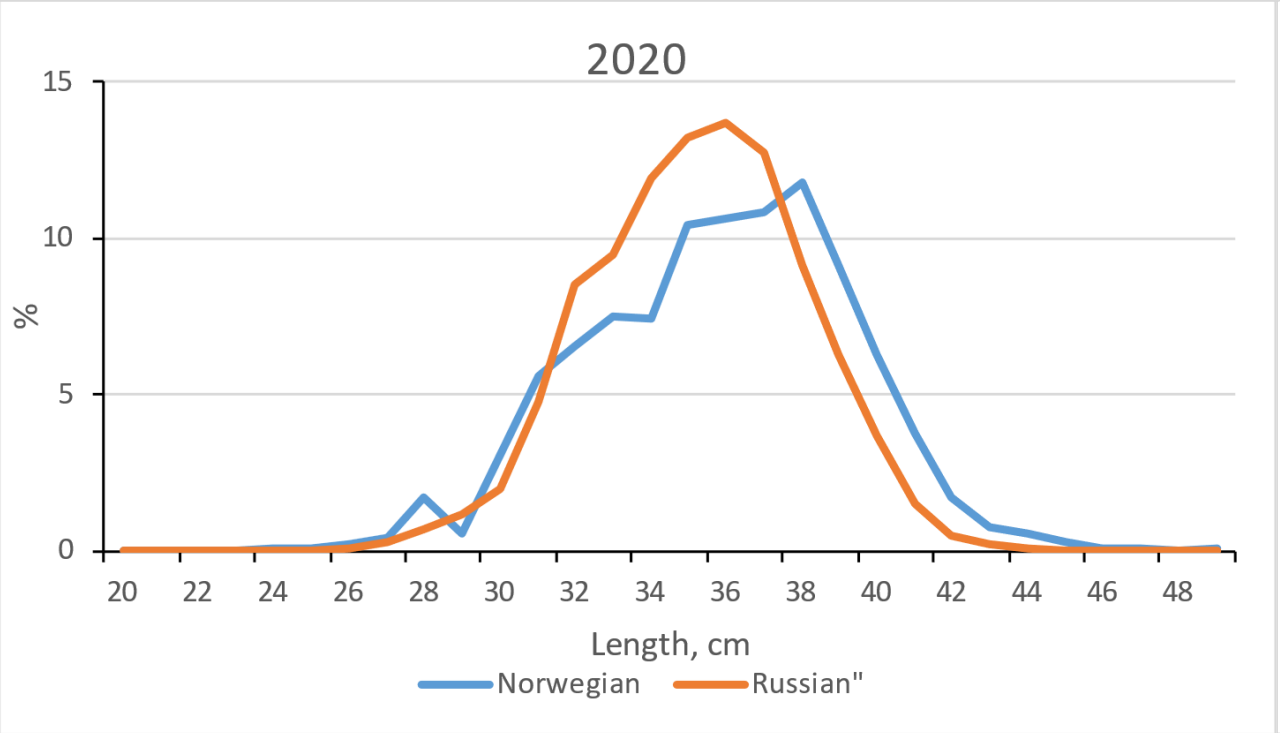
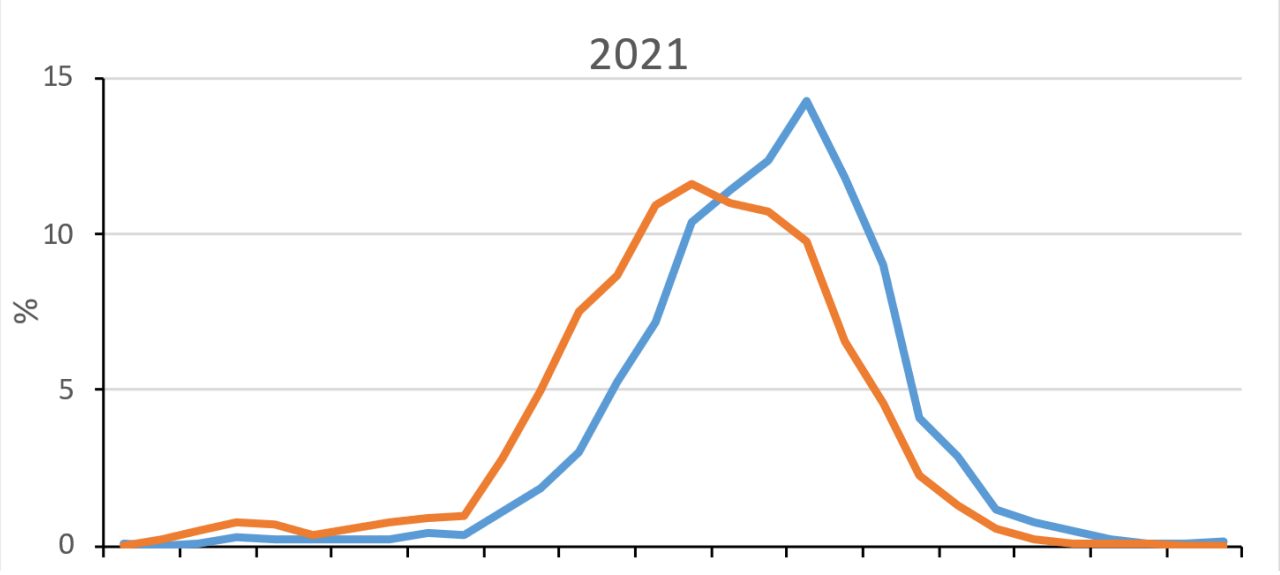


Figure 6.3. Delineation of the geographical limits for directed fishing in the Norwegian Economic Zone in 2014–2021. Directed pelagic trawling is only allowed west of the blue line. Directed demersal trawling is only allowed between the blue and the red line. The area east of the stippled line inside NEZ south of Bear Island is only open for directed demersal trawling after 10 May. The other areas for directed fishing are also open during 1 January to last February. Due to high bycatch ratios of golden redfish 72°N was suggested as southern limit for directed demersal fishing marked by the red line along that latitude to the Norwegian directorate of fisheries in November 2018.




%
10
5
0
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Length, cm
Norwegian
Russian


2020
15
10
5
0
%
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Length, cm
Norwegian
Russian"


2021
15
10
5
0
%

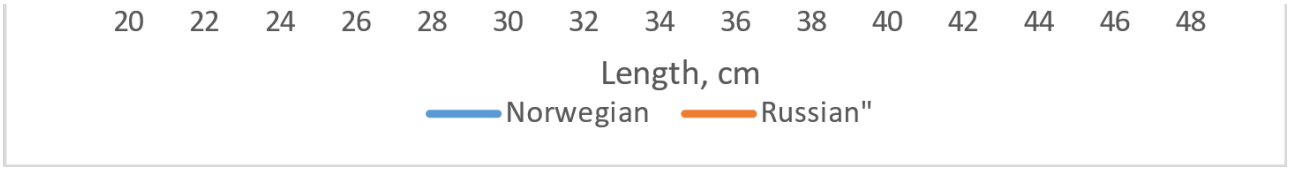
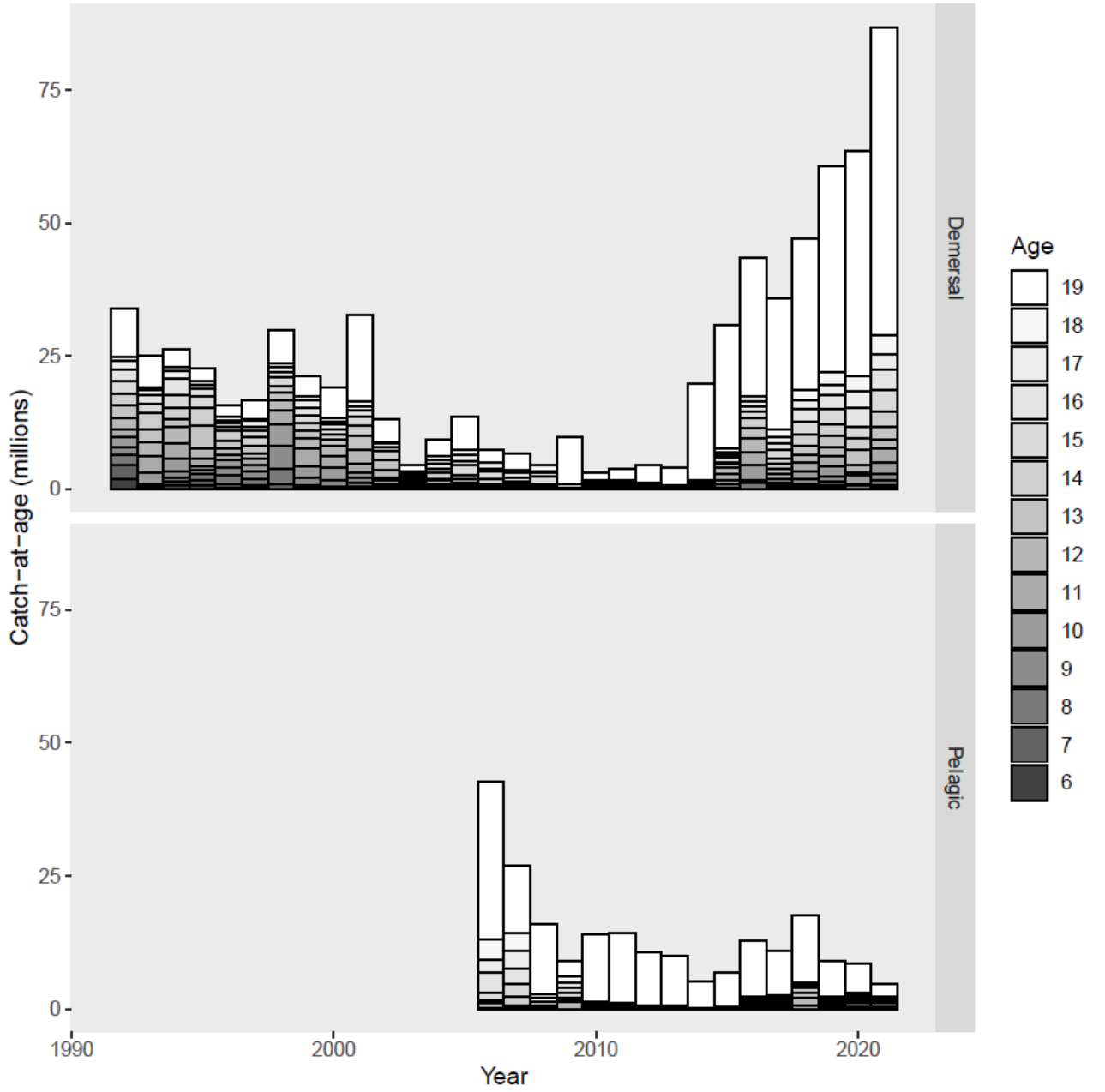


Figure 6.4. S. mentella in subareas 1 and 2. Length-distributions of the commercial demersal catches by Norway and Russia in 2019–2021.



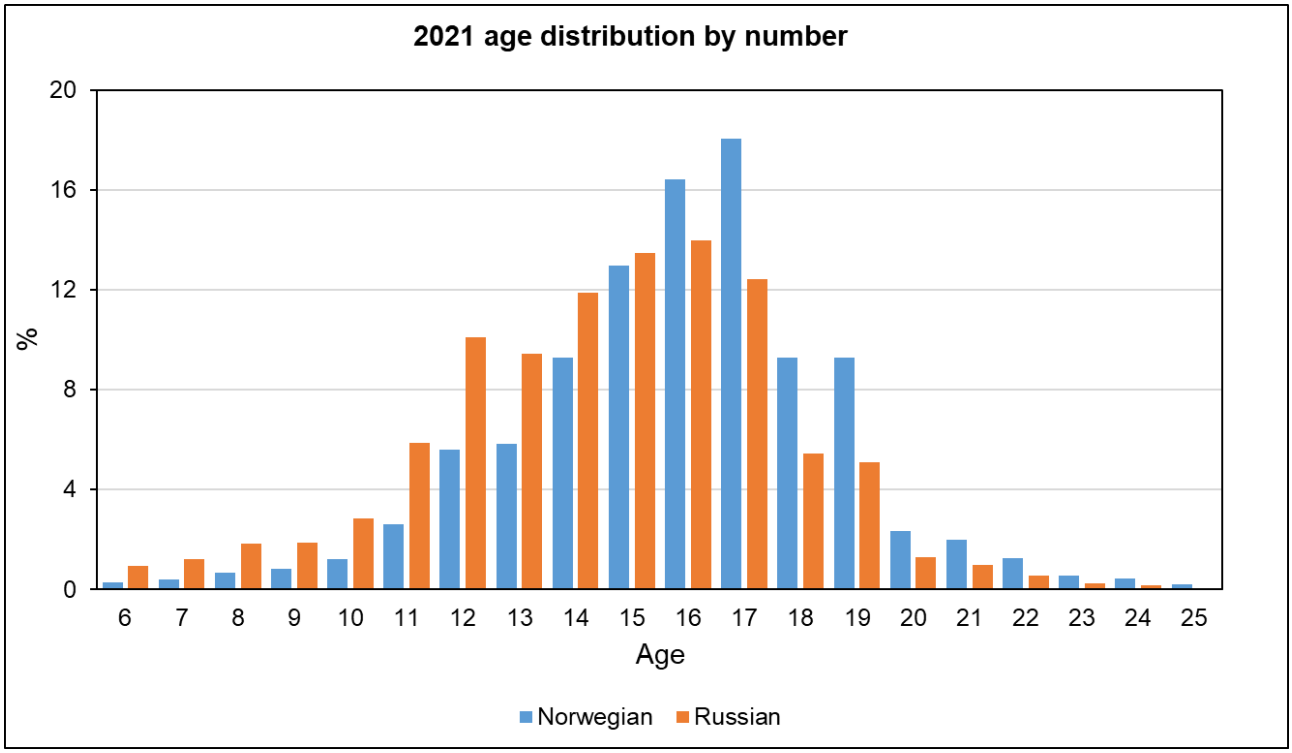


Figure 6.5. S. mentella in subareas 1 and 2. Upper panels: Catch numbers-at-age for the demersal and pelagic fleets 1992–2020. Lower panel: Age composition of the commercial demersal catches by Norway and Russia in 2021 (calculated using ALK).

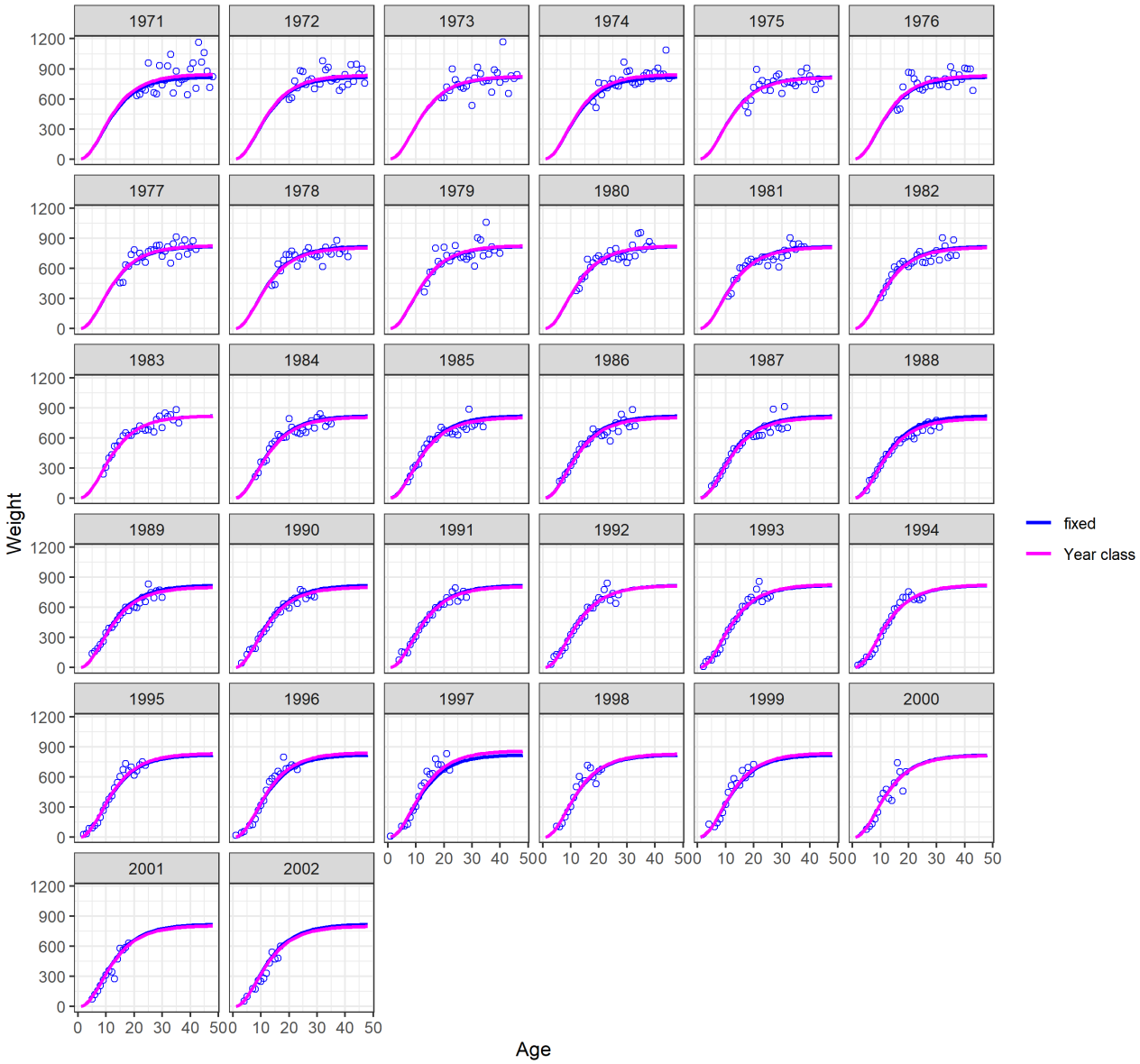


Figure 6.6. Weight-at-age of S. mentella per year class in subareas 1 and 2 derived from Norwegian commercial and survey data (Table 6.7). The weights were derived from samples with at least five individuals and are expressed in grammes. The blue and purple lines show the fitted mixed-effect models.

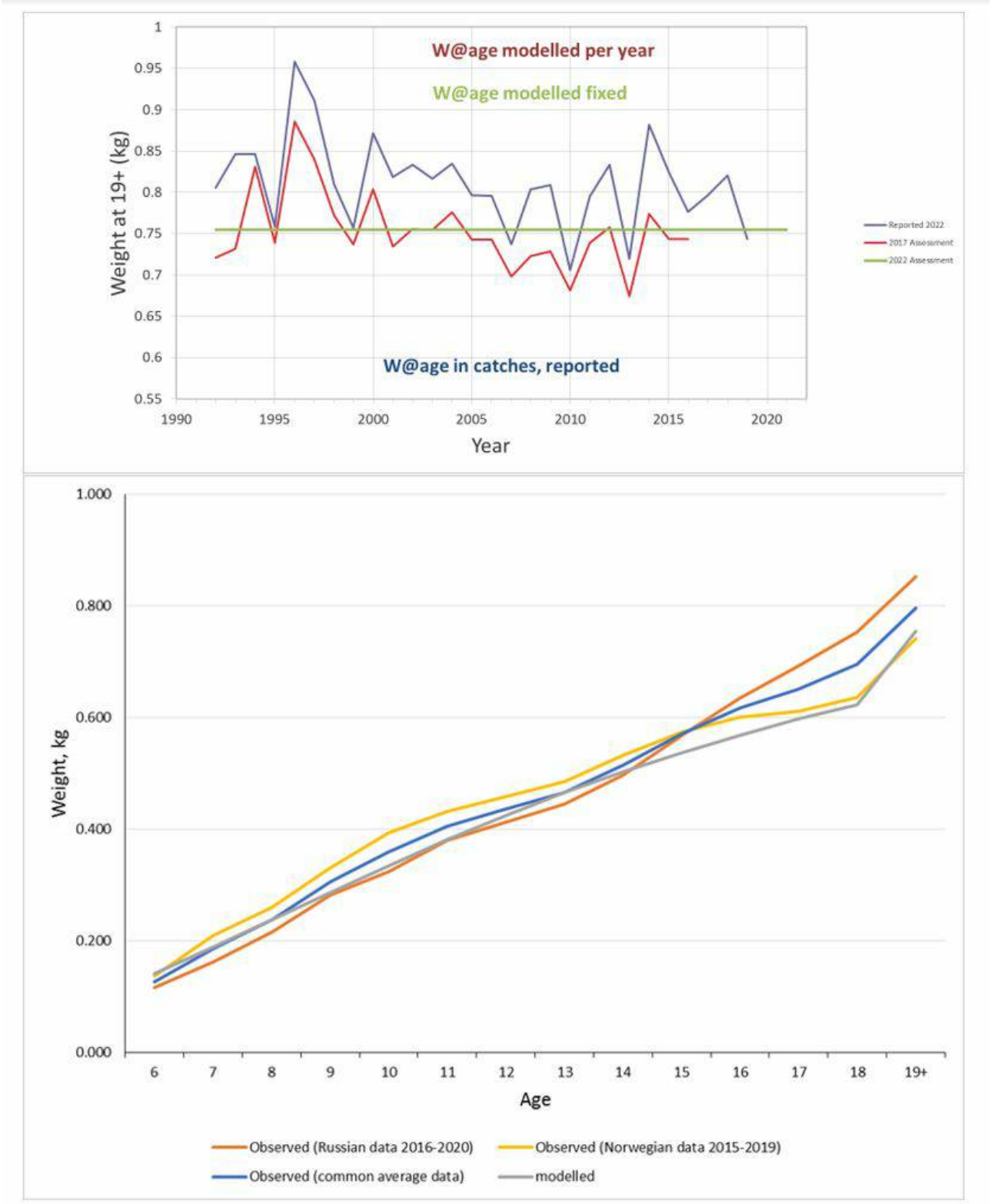


Figure 6.7. S. mentella in subareas 1 and 2. The upper panel shows weight-at-age 19+ as reported from catches (blue) or modelled from catches and survey observations (red) using a mixed effect model (Figure 6.5). AFWG 2017 was the last working group using the annual mixed effect model. The weights-at-age used in the assessment were based on the fixed effects model and are therefore the same for every year. These weights were updated in 2022 and differ only slightly from those estimated in the assessments since 2018. The bottom panel shows comparison of the observed Norwegian and Russian weight by age with the modelled one up to 2020.

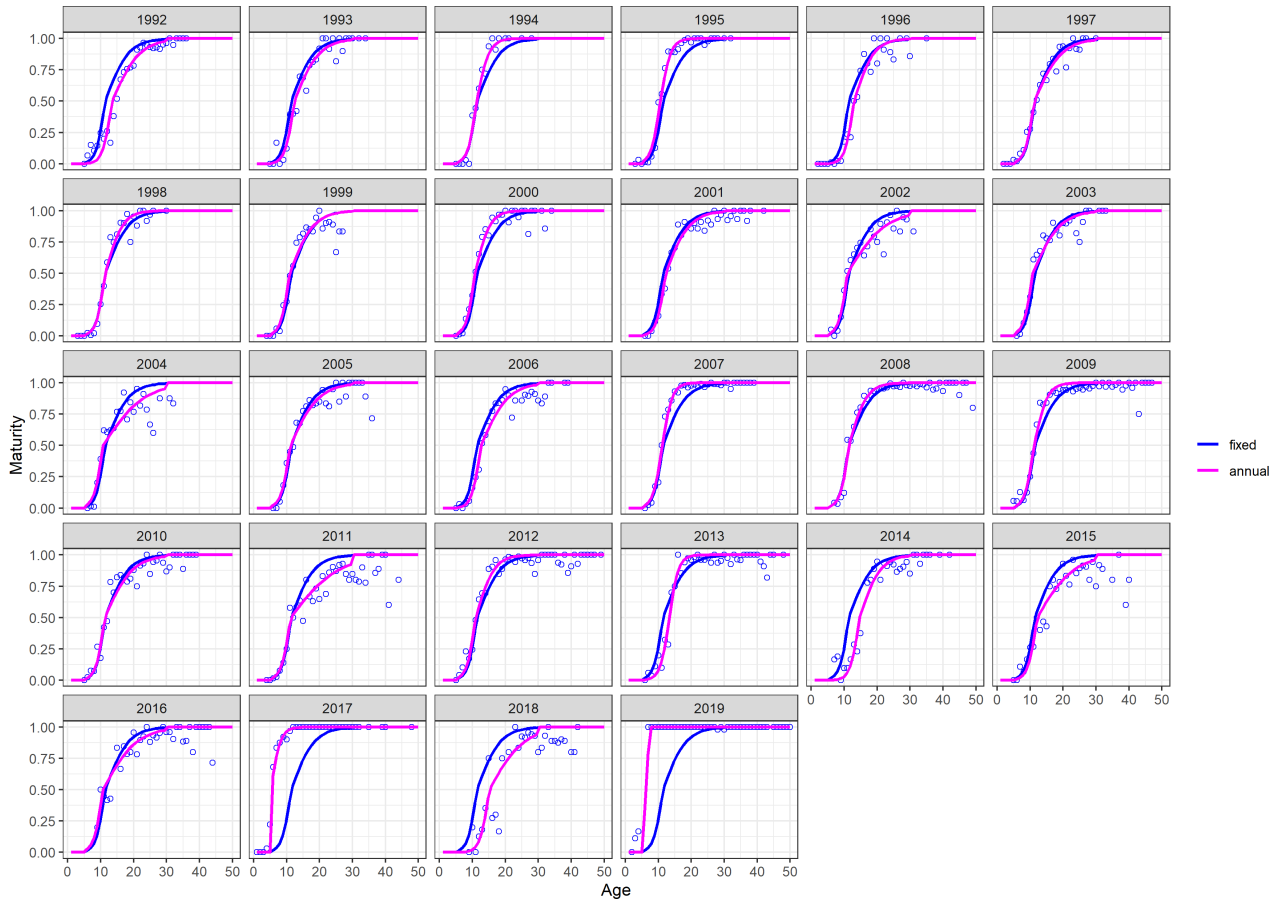


Figure 6.8. Proportion maturity-at-age of S. mentella in subareas 1 and 2 derived from Norwegian commercial and survey data (Table D7). The proportions were derived from samples with at least five individuals. The blue and purple lines show the fitted mixed-effect models. For 2008, 2011 and 2016–2019 the common model (fixed effects blue) was used for other years the annual models (random effects purple) were used. Available data for 2019 was insufficient at the time of the meeting and the fixed effect model was used and there was no age data available for 2020 or 2021.

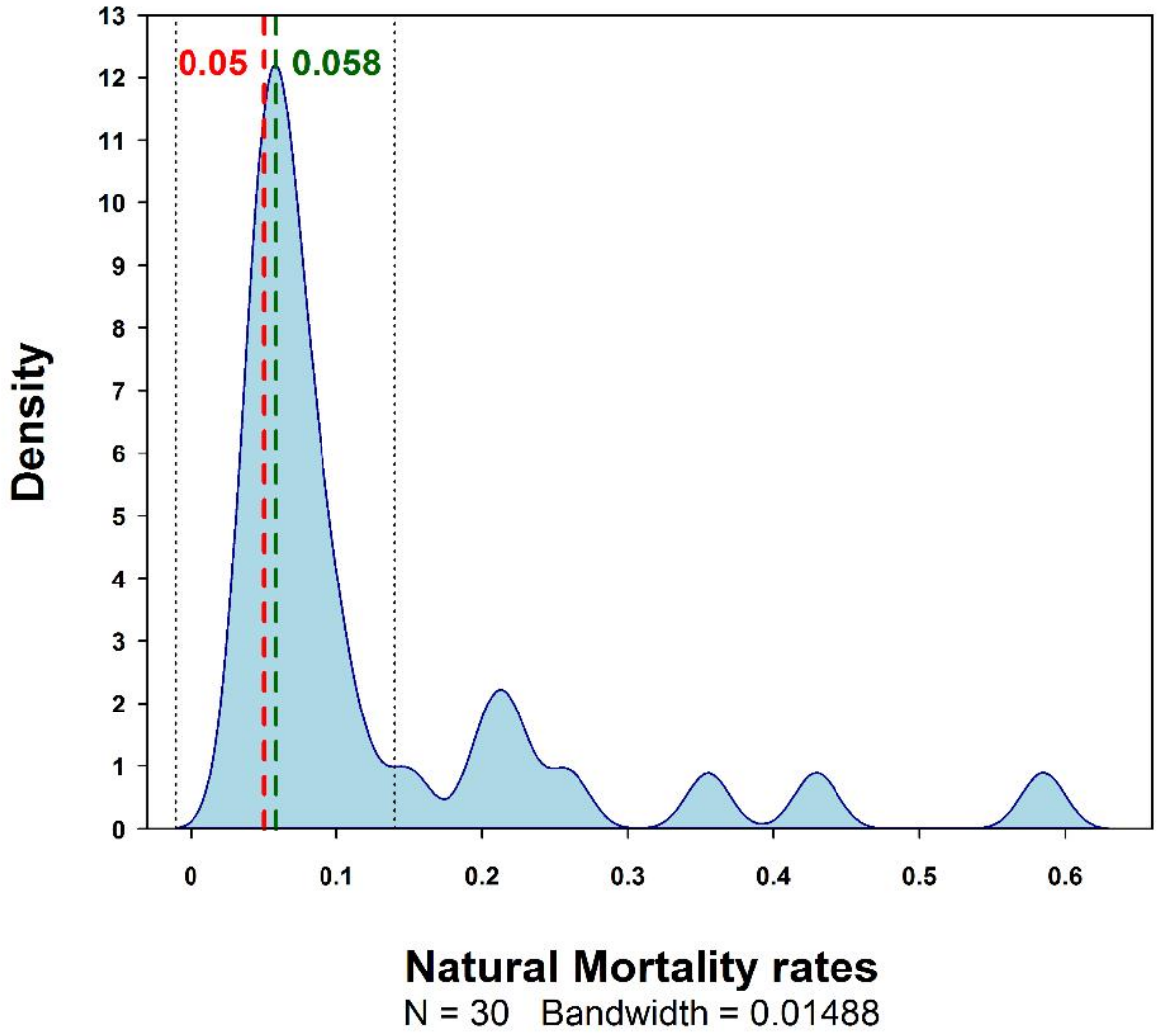


Figure 6.9. Density distribution of natural mortality rates calculated with 30 of the 39 compared methods. The excluded methods are those based on certain taxa or areas. The broken red line indicates the currently used value; the broken green line the most frequent one and the black dotted lines indicate the beginning and end of the distribution's peak.

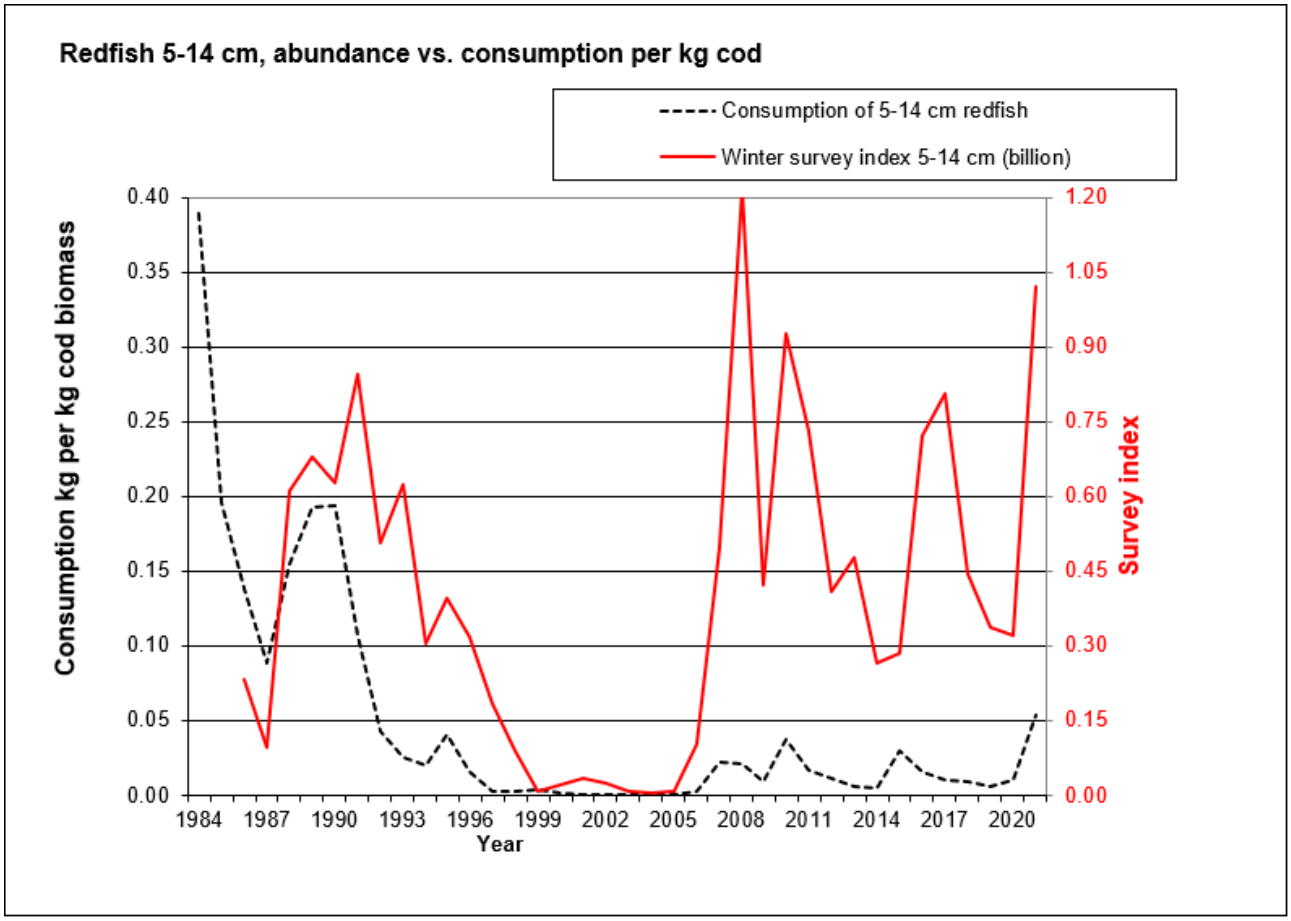


Figure 6.10. Abundance of S. mentella (5–14 cm) during the winter survey (February) in the Barents Sea compared with the consumption of redfish (mainly S. mentella) by cod (See Section 1 Table 1.1).

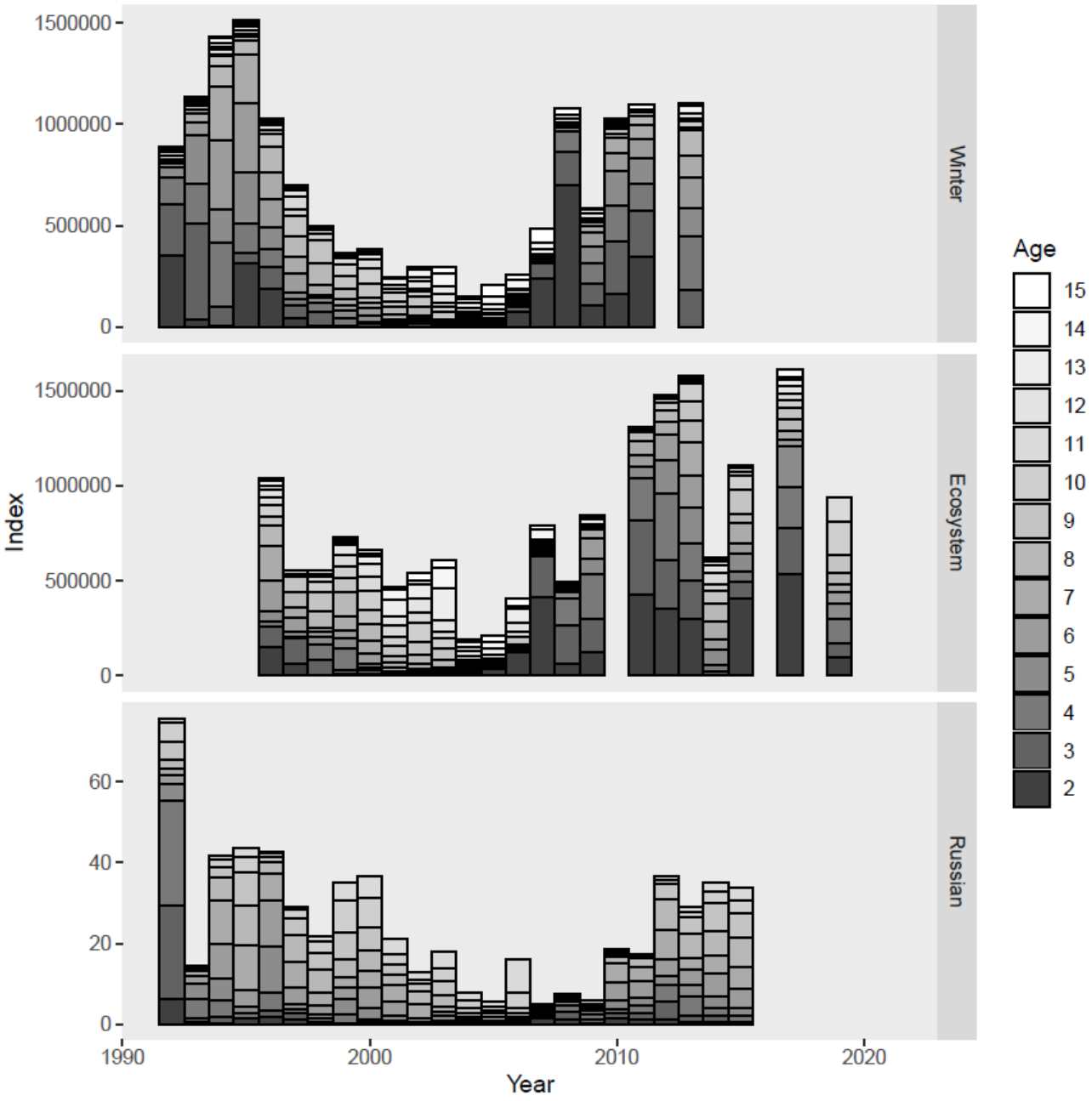
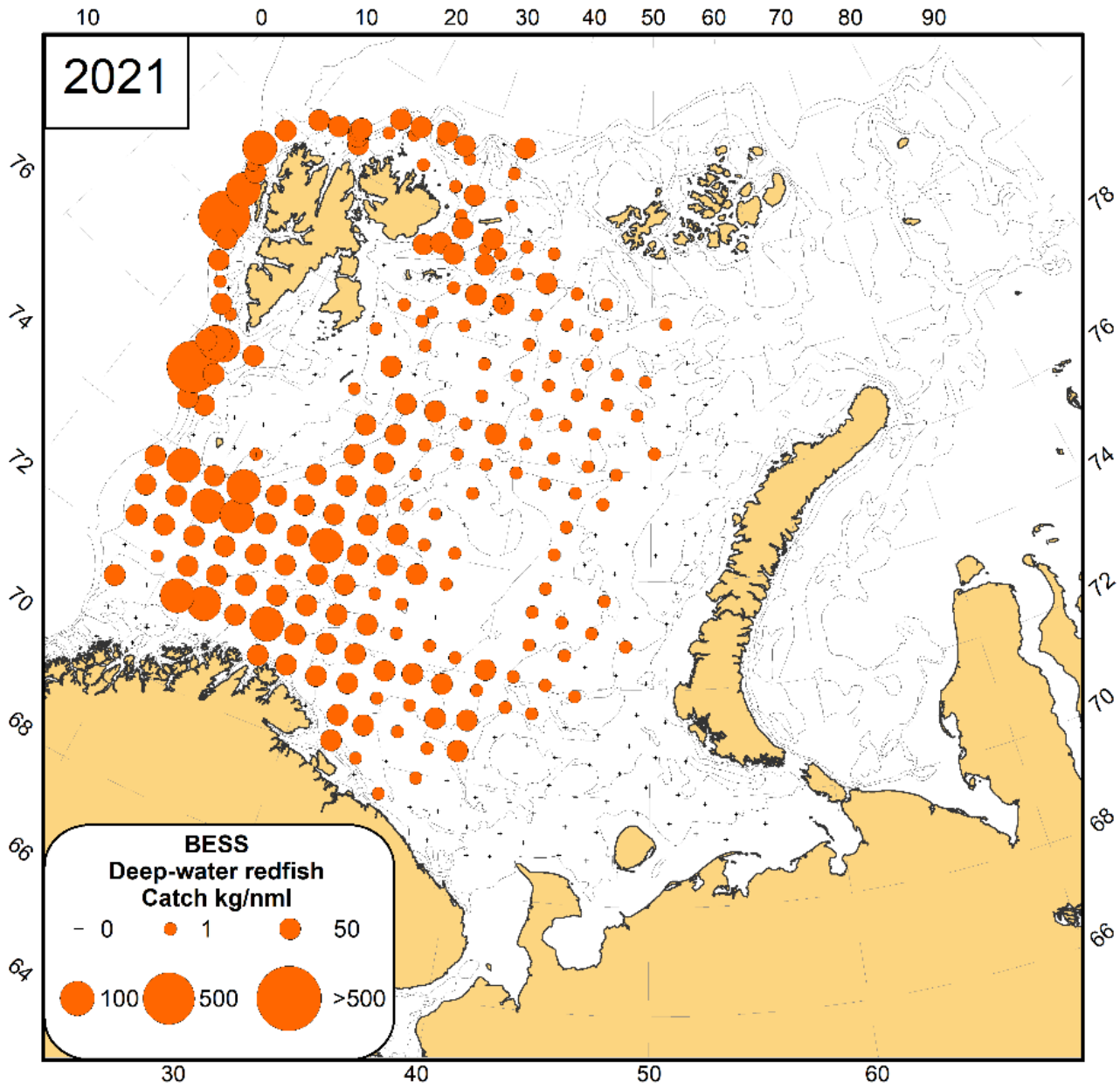


Figure 6.11. S. mentella in subareas 1 and 2. Age disaggregated abundance indices for bottom-trawl surveys 1992–2021 in the Barents Sea in winter (winter survey top) in summer (Ecosystem survey middle) and in autumn (Russian groundfish survey bottom).


2021
BESS
Deep-water redfish
Catch kg/nml
0
1
50
100
500
>500
10
0
10
20
30
40
50
60
70
80
90
76
74
72
70
68
66
64
78
76
74
72
70
68
66
30
40
50
60

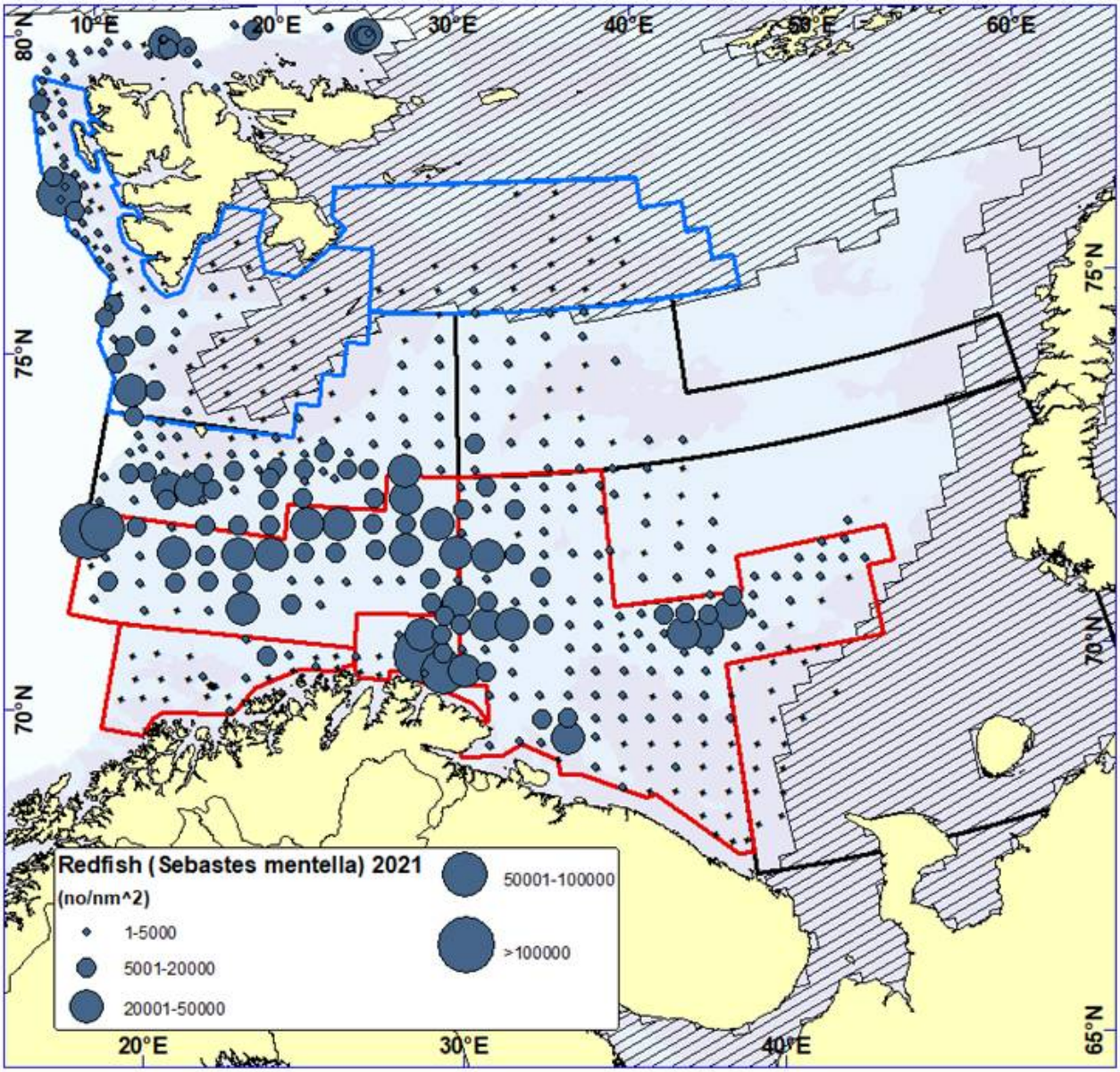


Figure 6.12. S. mentella in subareas 1 and 2. Abundance indices for individual trawl stations during the ecosystem survey in autumn 2021 (top) and winter survey 2021 (bottom).

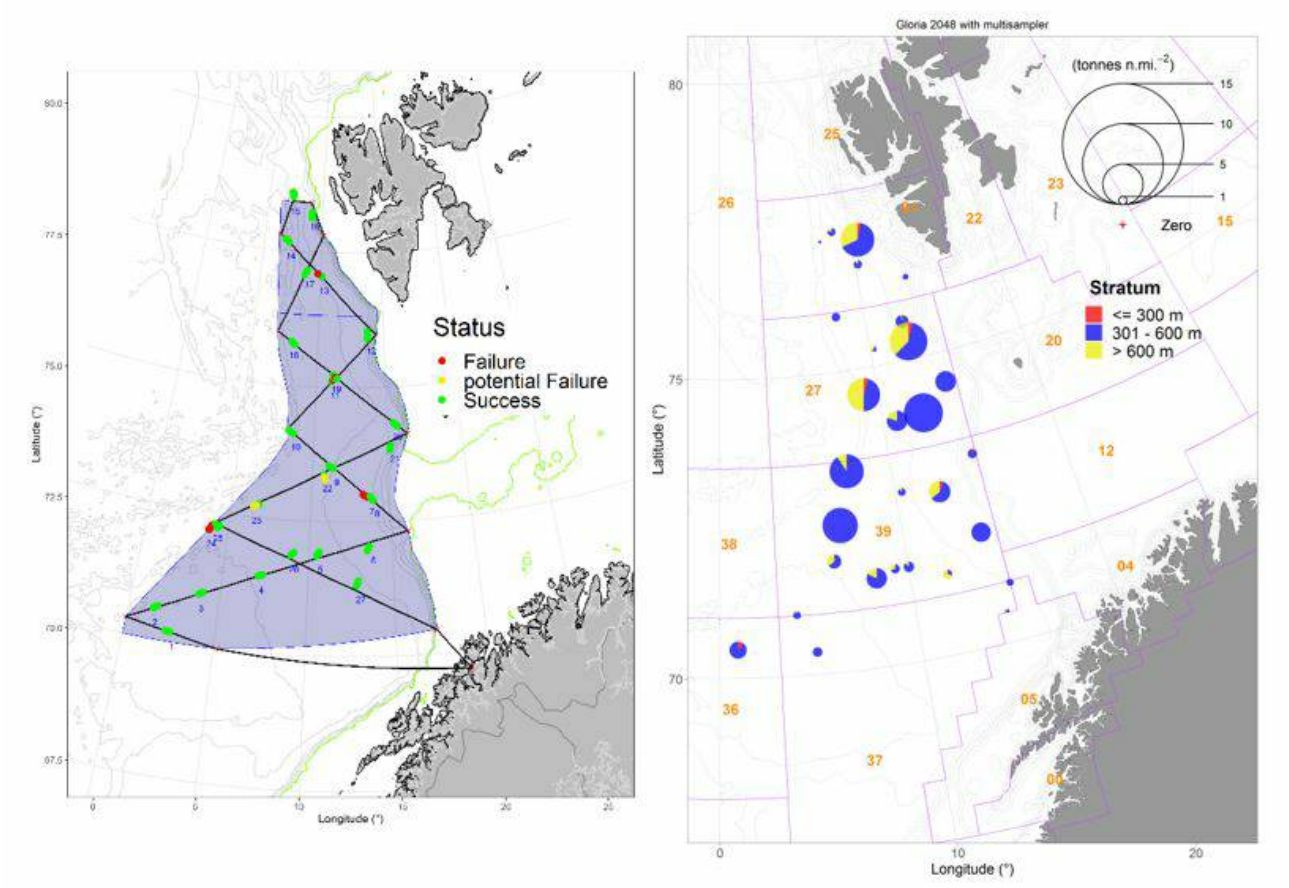


Figure 6.13. S. mentella in subareas 1 and 2. Left panel: Survey track of the Deep Pelagic Ecosystem Survey in 2022 and categorized trawls. Potential failures need further examination to determine their usability, whilst successful trawls can be used for the survey index without further consideration. Right panel: Catch rates in tonnes per square nautical mile for the surveyed depth layers (< = 300 m, 301–600 m and > 600 m) from the 2019 survey. The corresponding results for the 2022 survey were not available at the time of the working group.

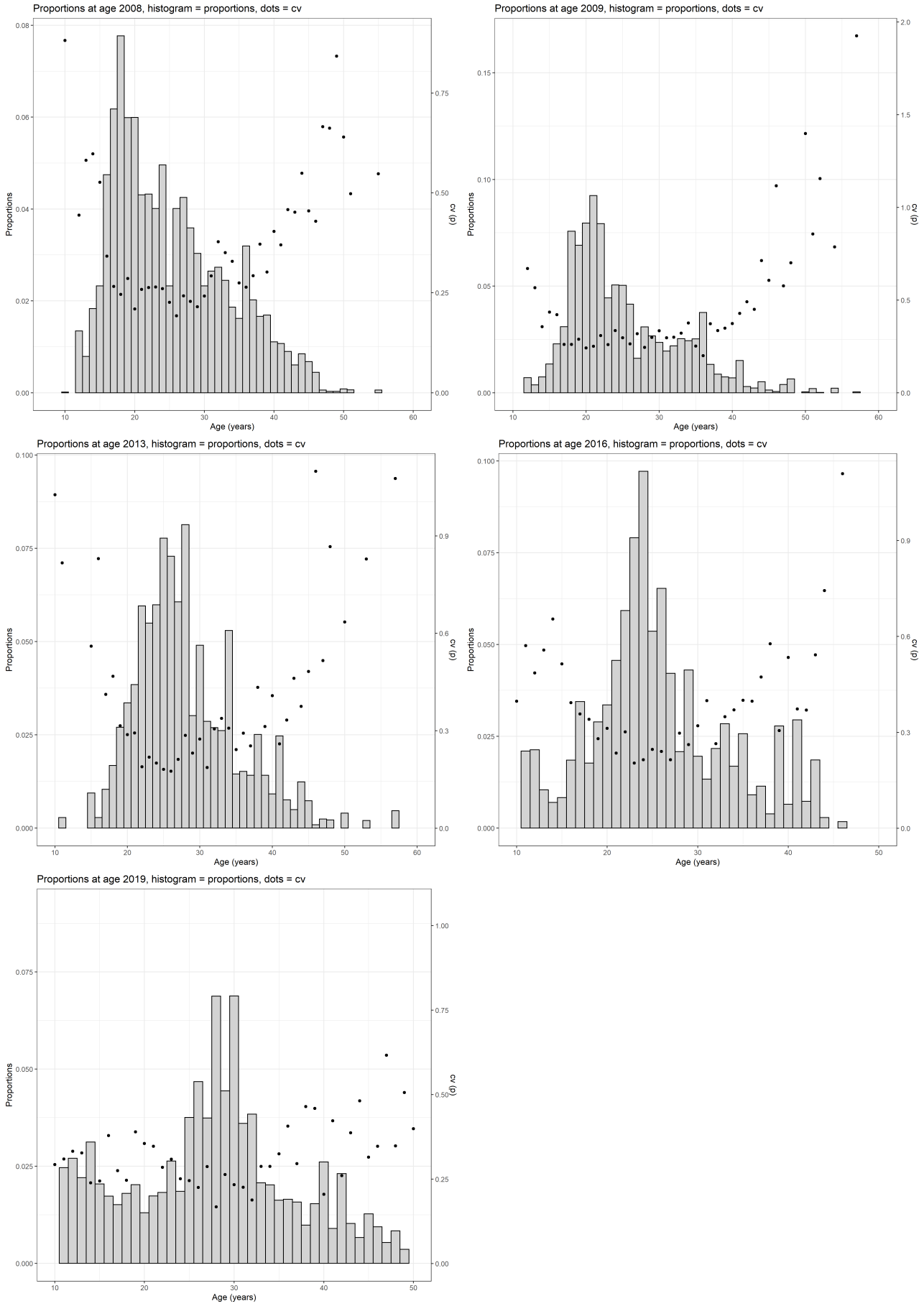


Figure 6.14. S. mentella in subareas 1 and 2. Proportions at age during the International Deep Pelagic Ecosystem Survey

(WGIDEEPS) in the Norwegian Sea. Bars show proportions at age and dots shows the coefficient of variation for each age. Estimated with RStoX.

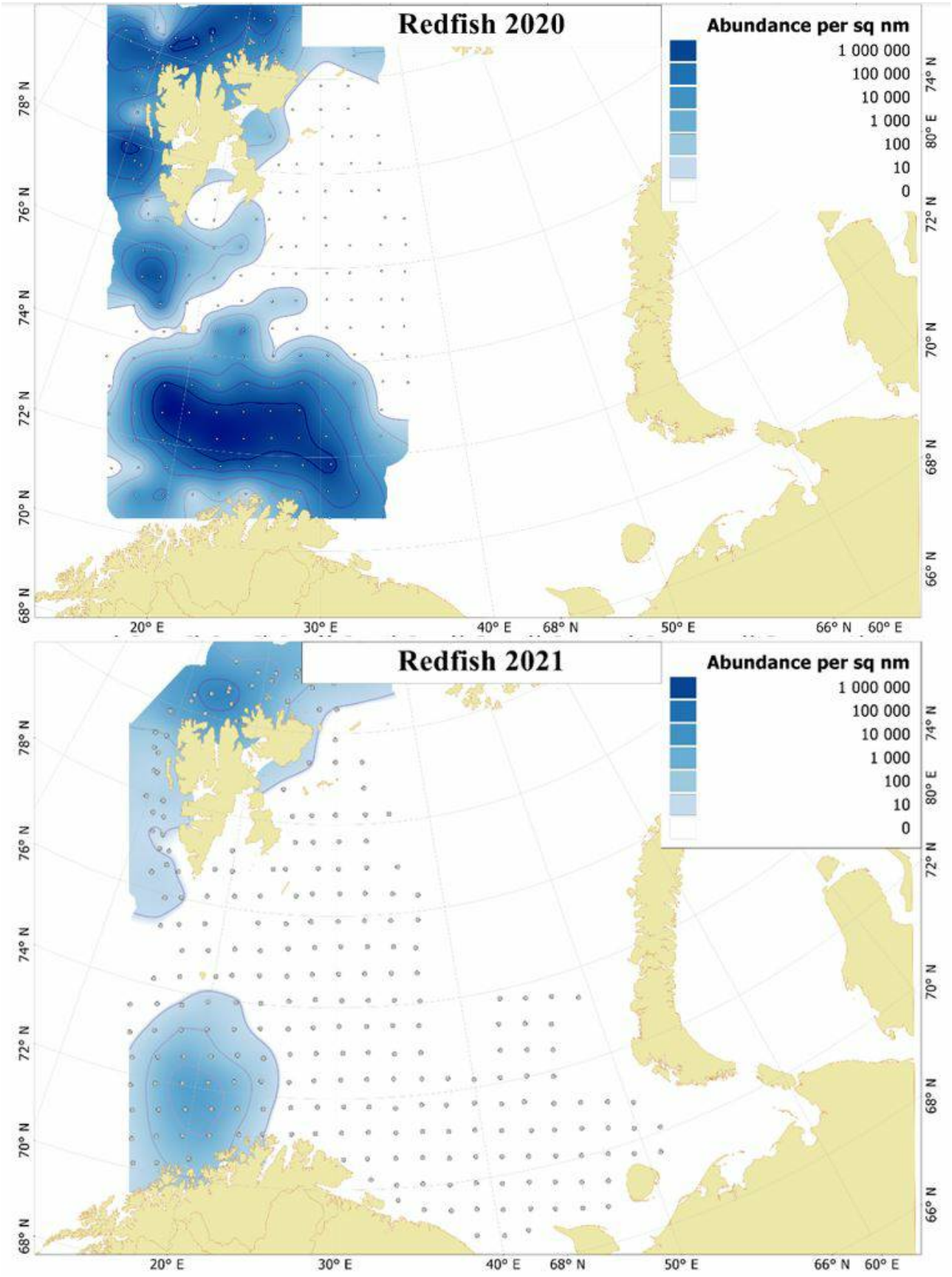


Figure 6.15. Map showing the specific pelagic 0-group trawl stations and the abundance of 0-group S. mentella during the joint Norwegian-Russian Ecosystem survey in the Barents Sea and Svalbard in 2020 (upper panel) and 2021 (lower panel).

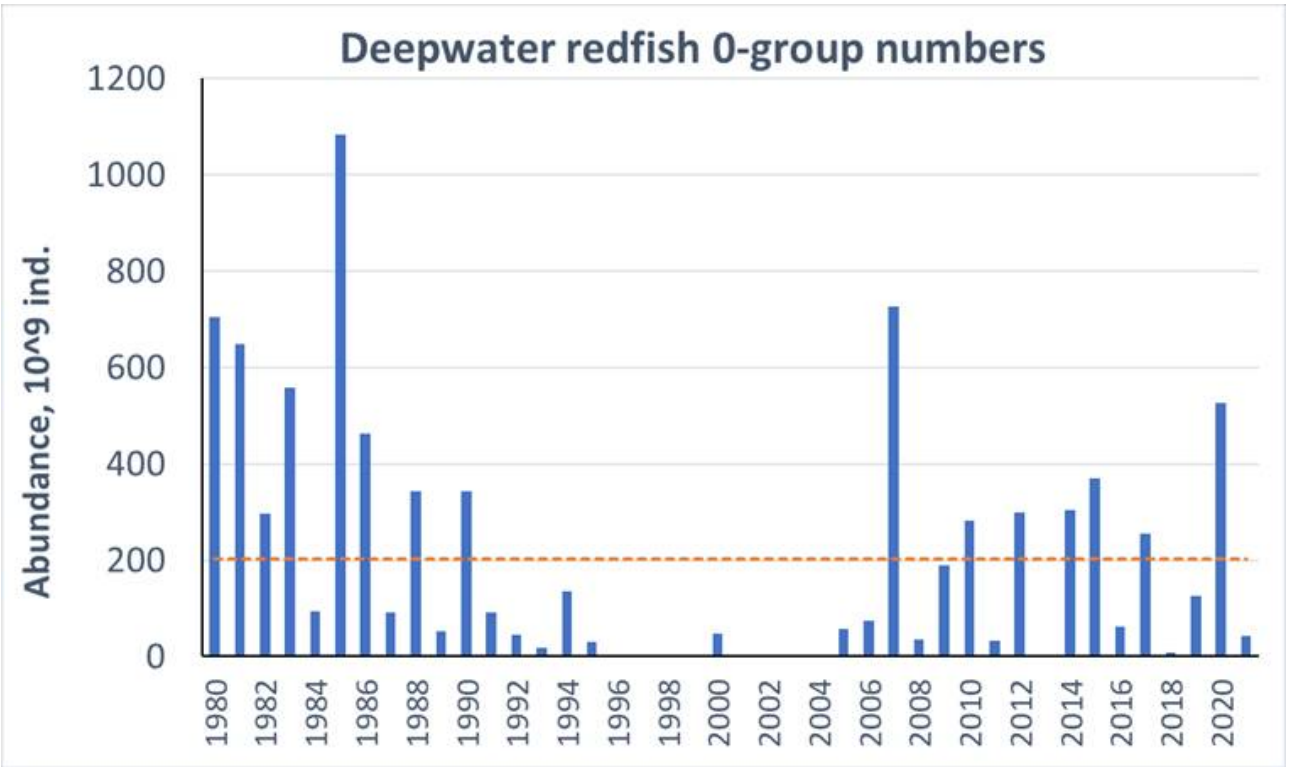


Figure 6.16. S. mentella in subareas 1 and 2. Abundance indices (in billions) of 0-group redfish (believed to be mostly S. mentella) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980–2021.

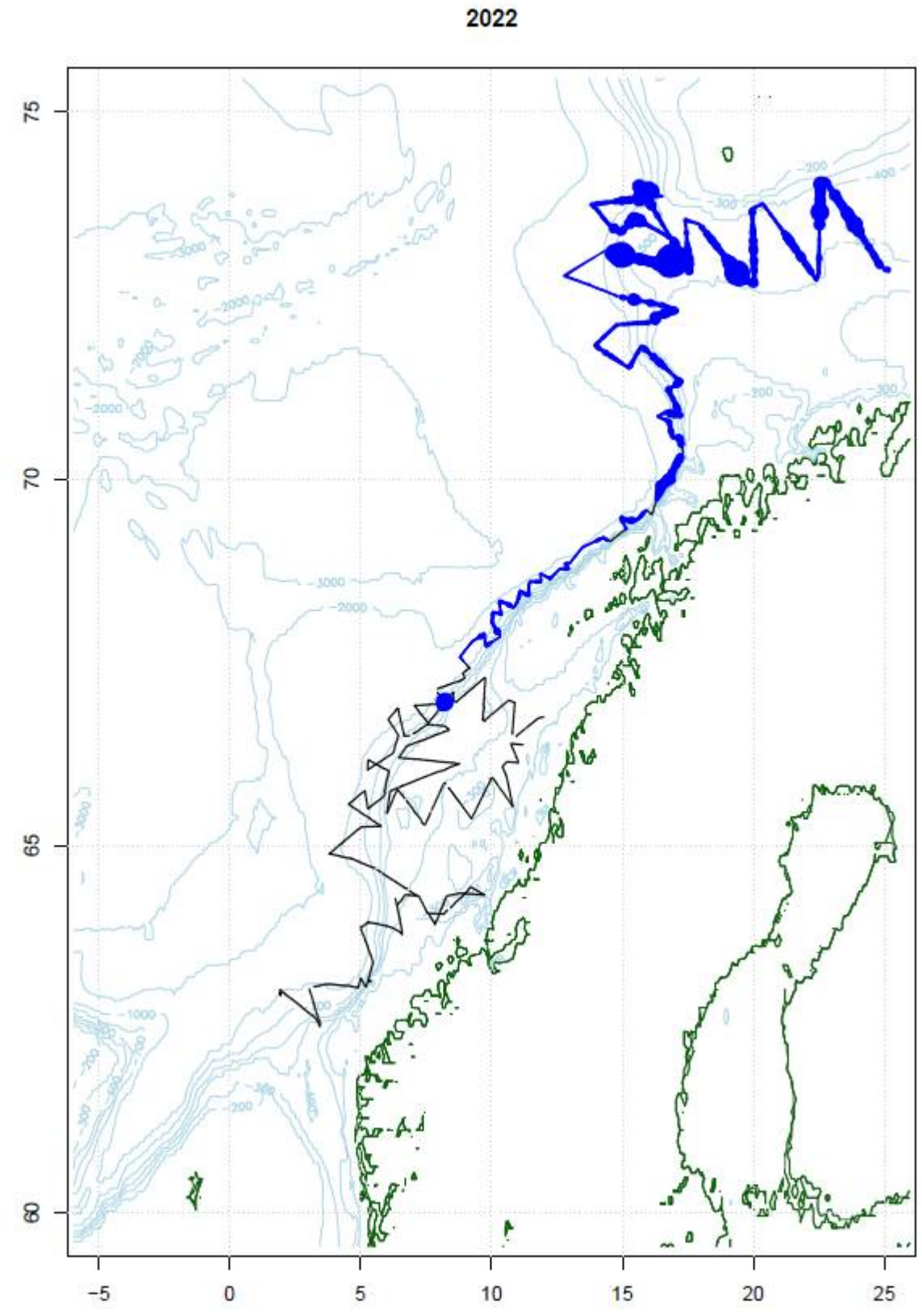


Figure 6.17. S. mentella in subareas 1 and 2. Horizontal distribution of S. mentella hydroacoustic backscattering (sA) during the Norwegian slope survey in spring 2022. The circles are proportional to the sA assigned to redfish along the vessel track.

Recruitment-at-age 2	Spawning-stock biomass

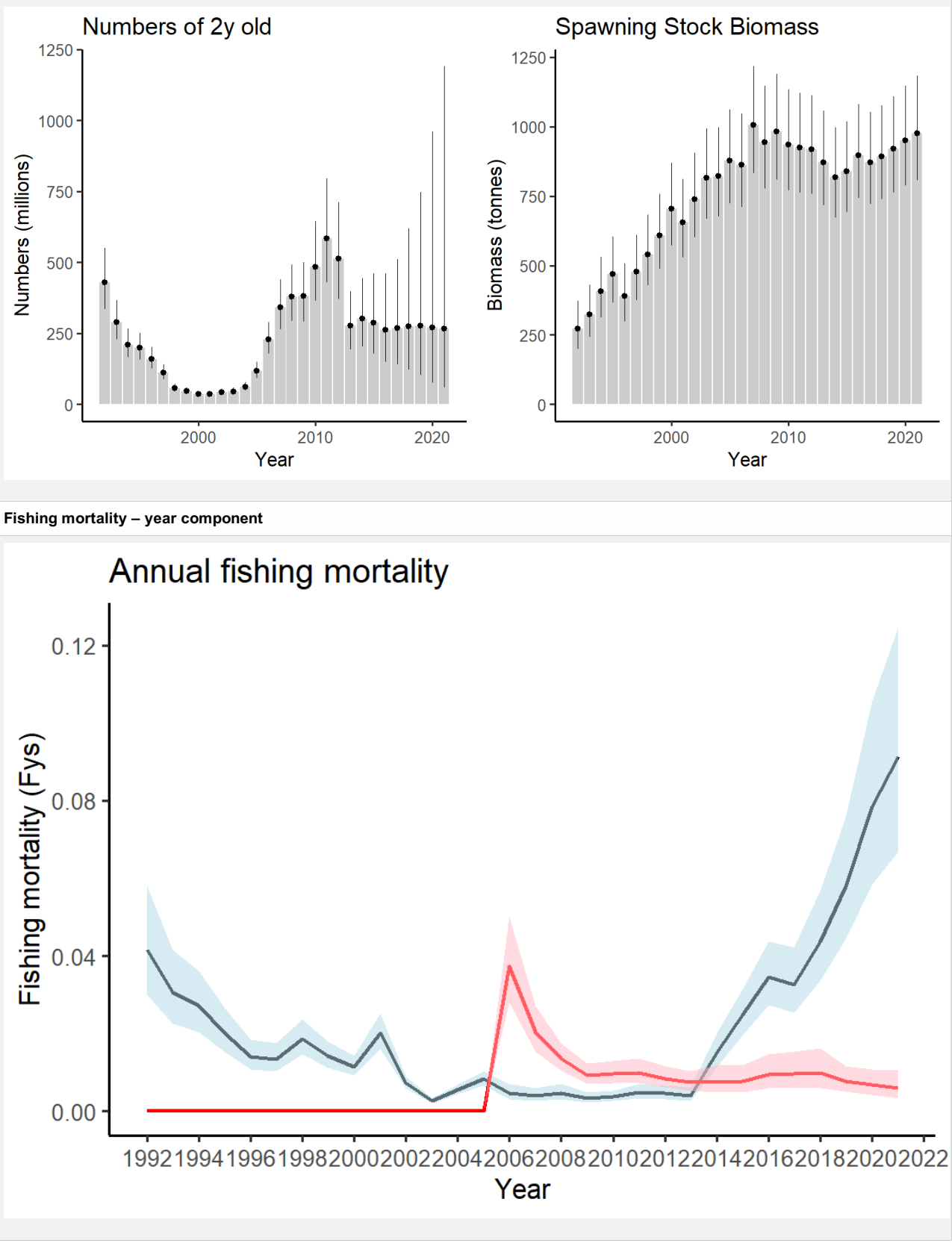
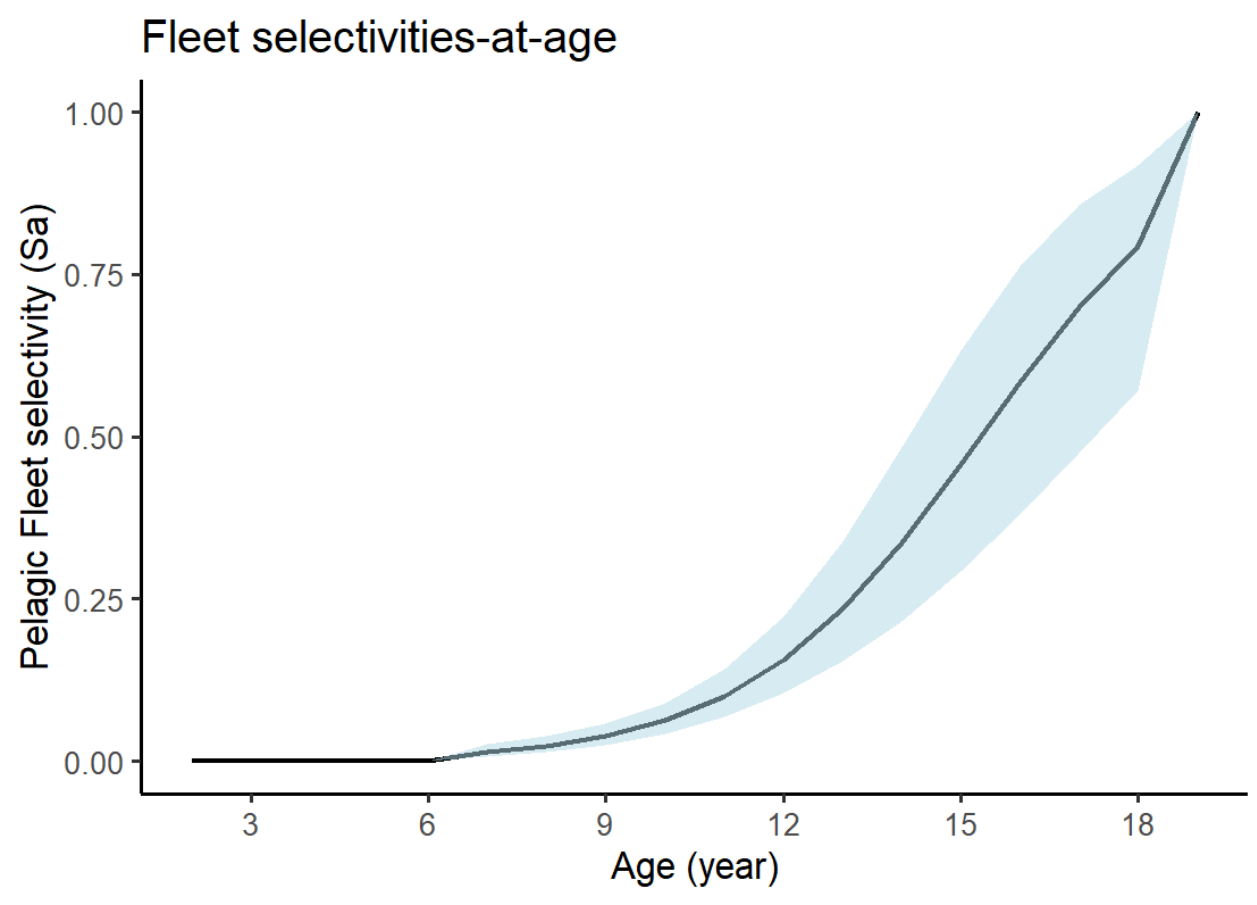


Figure 6.18. ***S. mentella*** **in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the estimated recruitment-at-age 2 spawning-stock biomass from 1992 to 2021 and annual fishing mortality coefficients by year (Fy) from the demersal (blue) and pelagic (red) fleets. Error bars (top) and the colored envelope (bottom) indicate 95% confidence limits.**

Fleet selectivity – age component



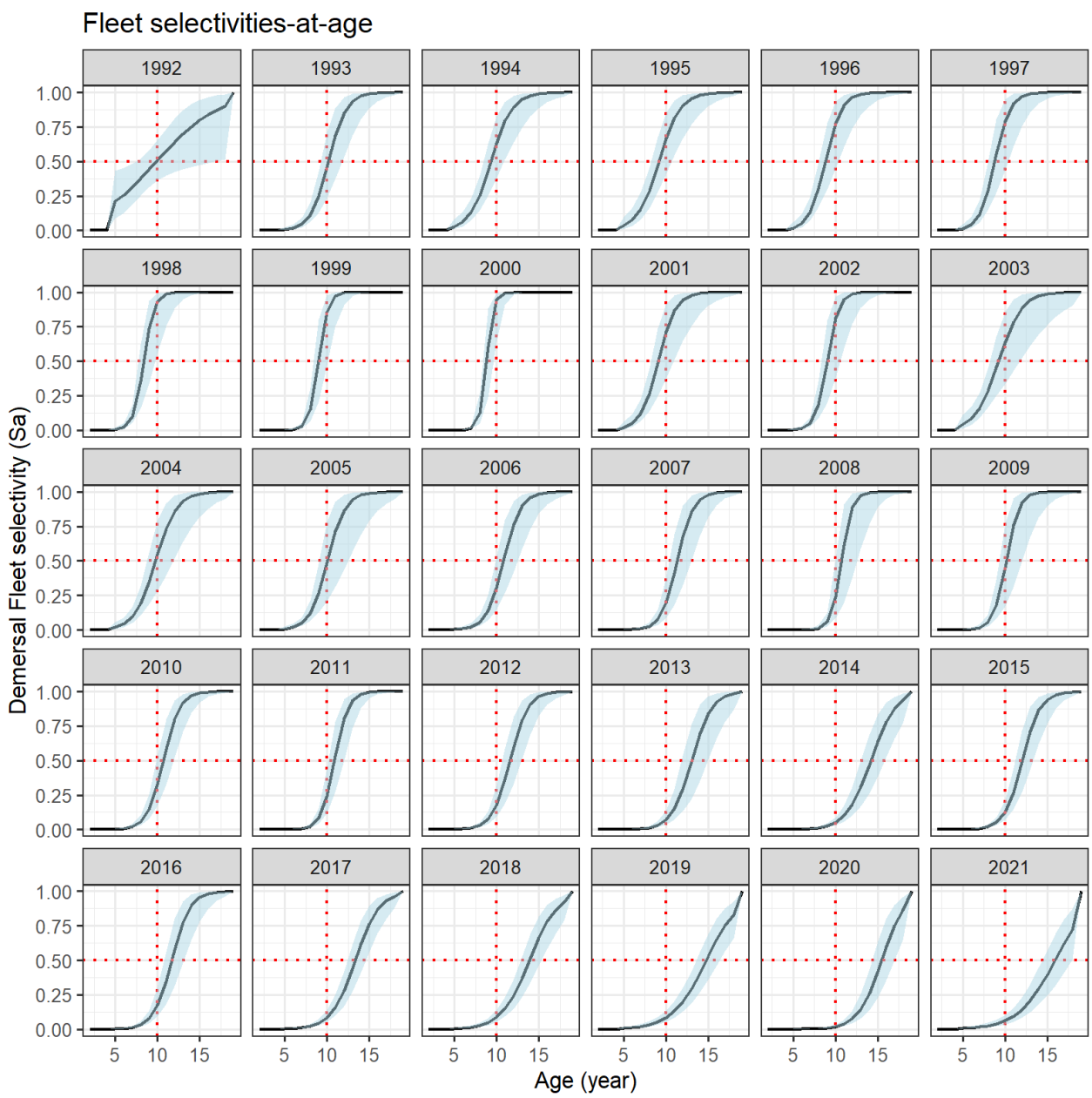


Figure 6.19. S. mentella in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the estimated annual fleet selectivity by age (Fa) from the pelagic (top panel) and demersal (lower panels) fleets. Colored envelopes indicate 95% confidence limits.

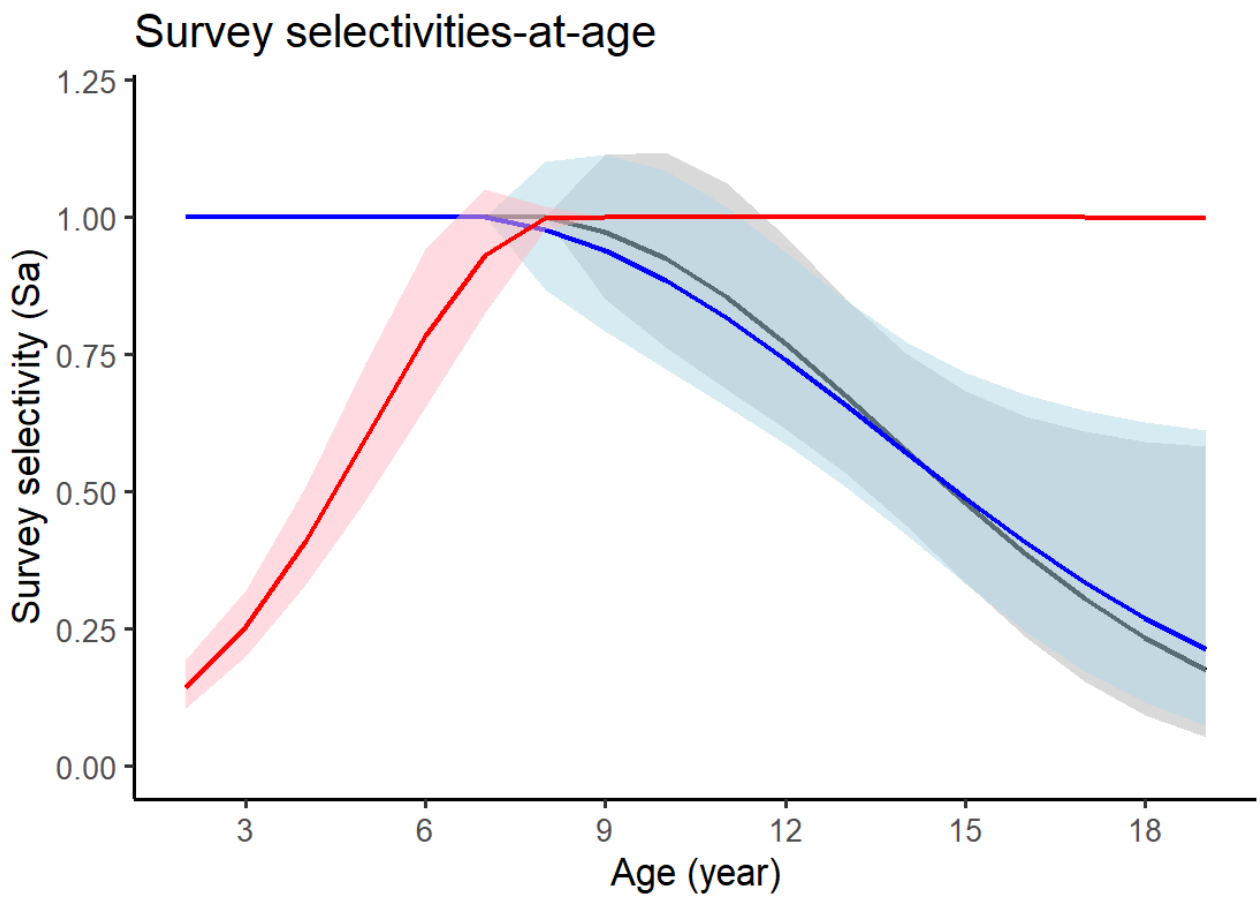


Figure 6.20. S. mentella in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the selectivity-at-age for winter (blue) ecosystem (grey) and Russian groundfish (red) surveys.

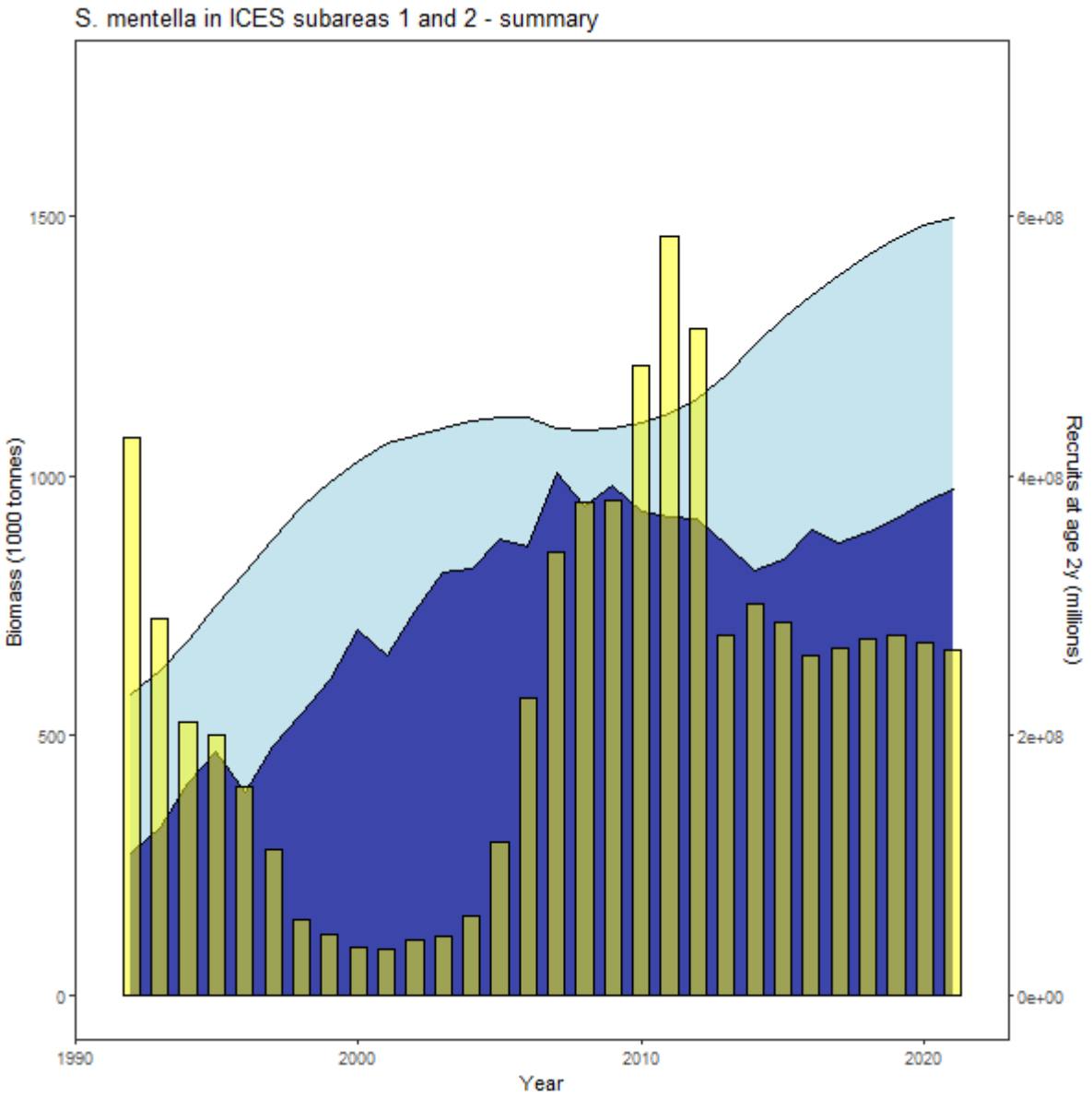


Figure 6.21. S. mentella in subareas 1 and 2. Results from the statistical catch-at-age model showing the evolution of total biomass (in tonnes light blue left axis) spawning-stock-biomass (in tonnes dark blue, left axis) and recruitment-at-age 2 (in numbers yellow, right axis) for the period 1992–2021 for S. mentella in subareas 1 and 2.

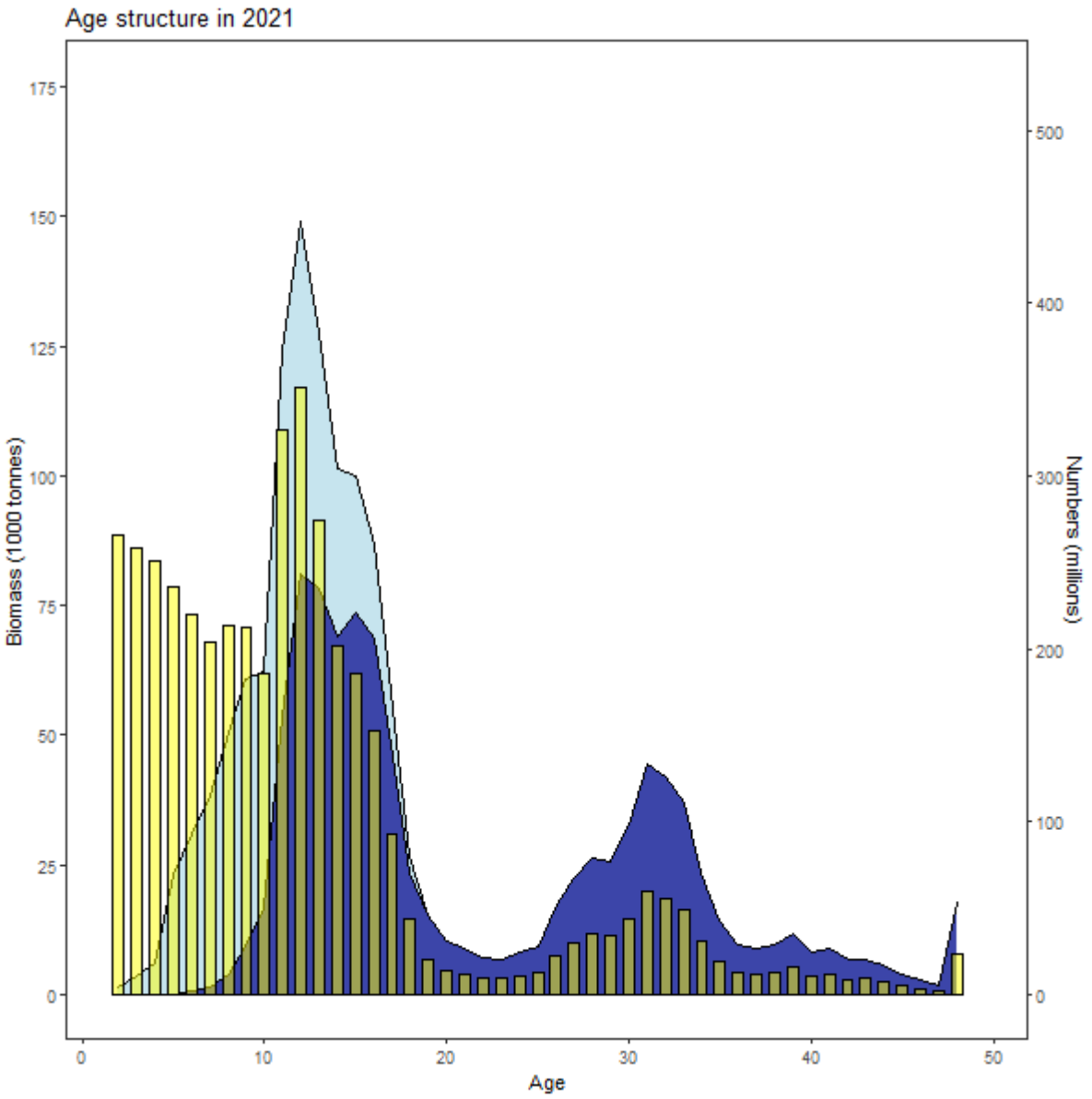


Figure 6.22. S. mentella in subareas 1 and 2. Modelled distribution of numbers (yellow bars right y-axis) biomass (light blue left y-axis) and spawning-stock-biomass (dark blue left y-axis) at age 2–45+ in 2021.

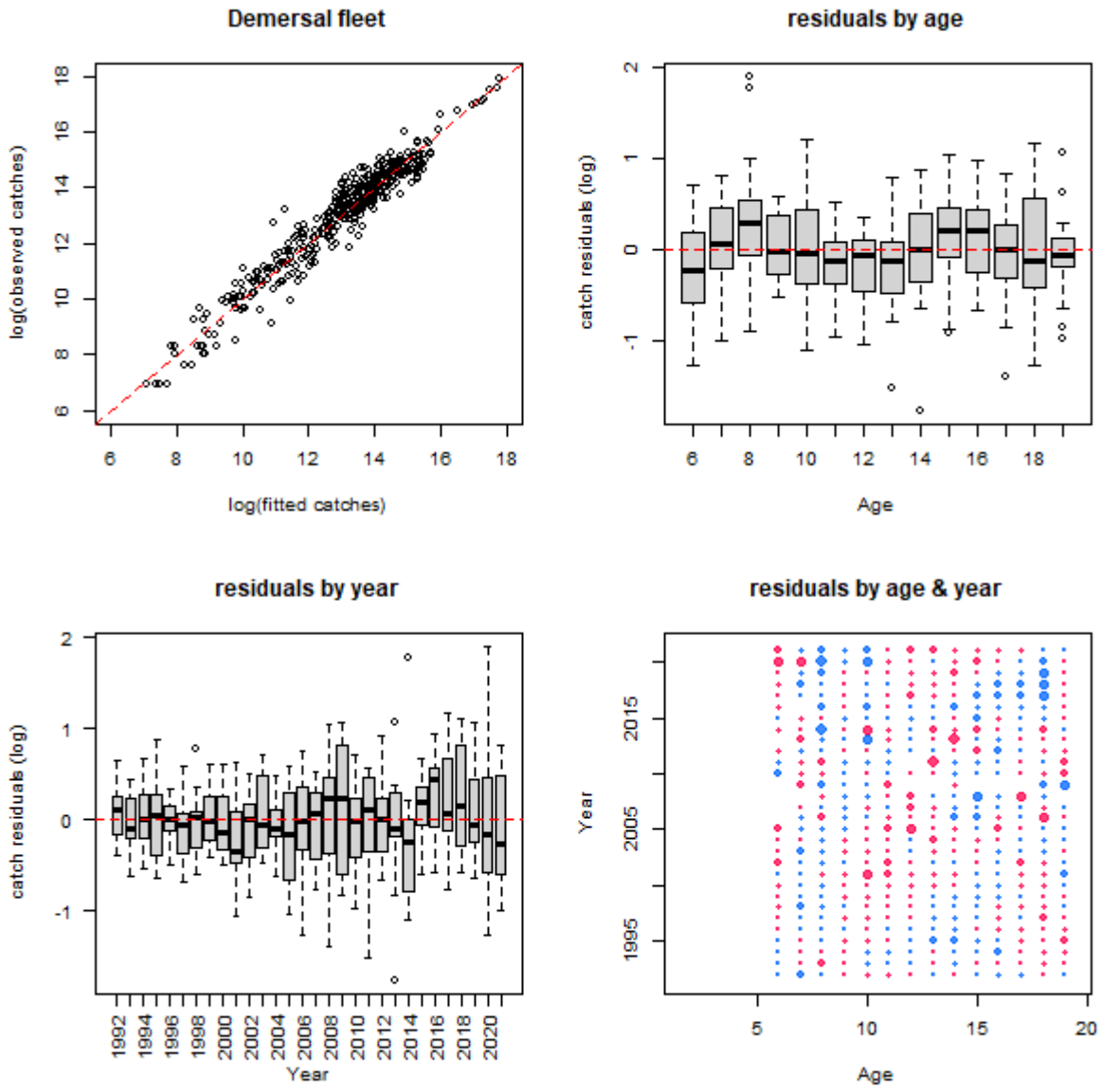


Figure 6.23a. Diagnostic plots for the demersal fleet catch-at-age data. Top-left: scatterplot of observed vs. fitted indices the dotted red line indicates 1:1 relationship. Top right: boxplot of residuals (observed-fitted) for each age. Bottom left: boxplot of residuals for each year. Bottom right: bubble plot of residuals for each age/year combination bubble size is proportional to mean residuals blue are positive and red are negative residuals.

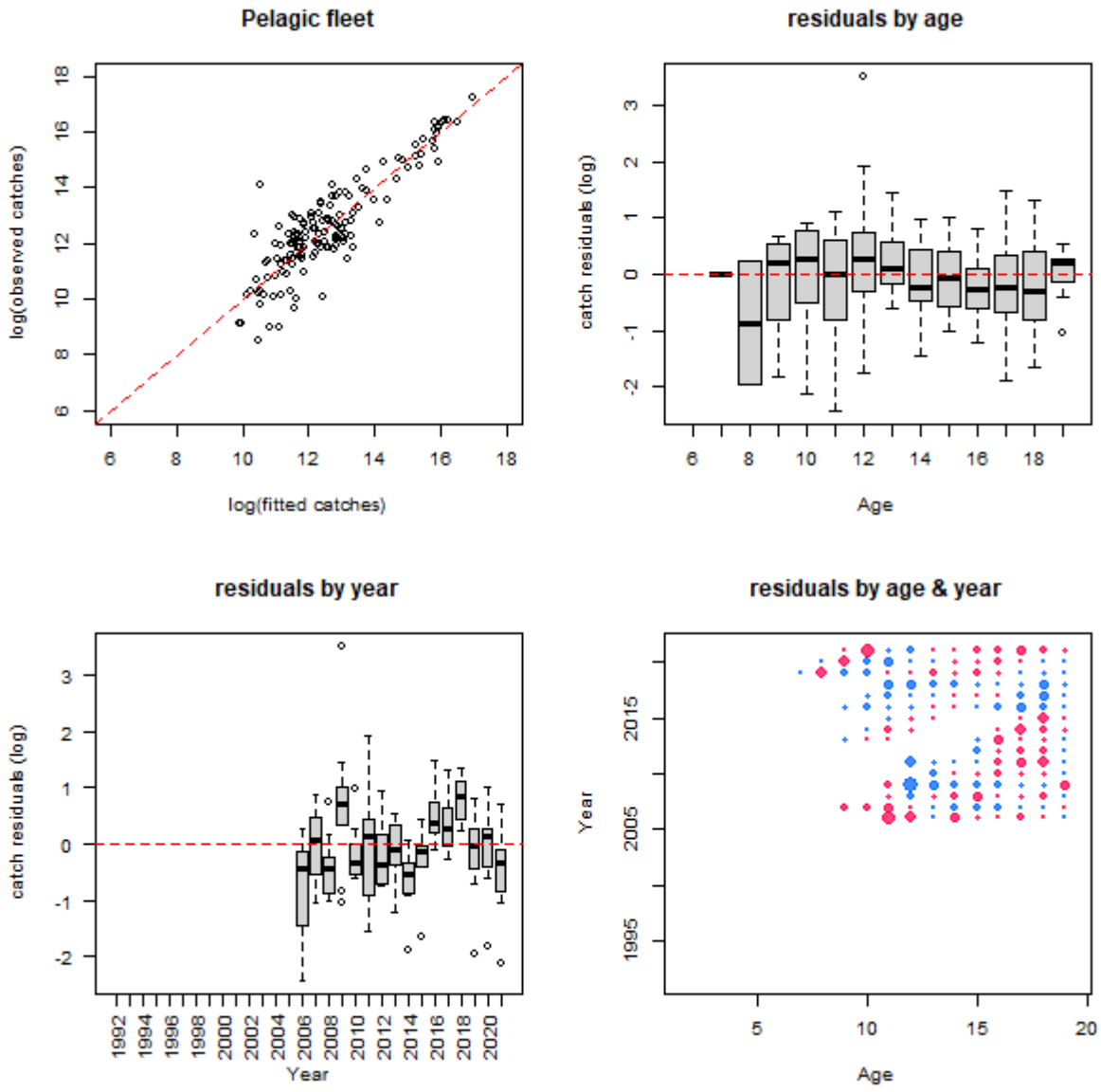


Figure 6.23b. Diagnostic plots for the pelagic fleet catch-at-age data. See legend from Figure 6.23a.

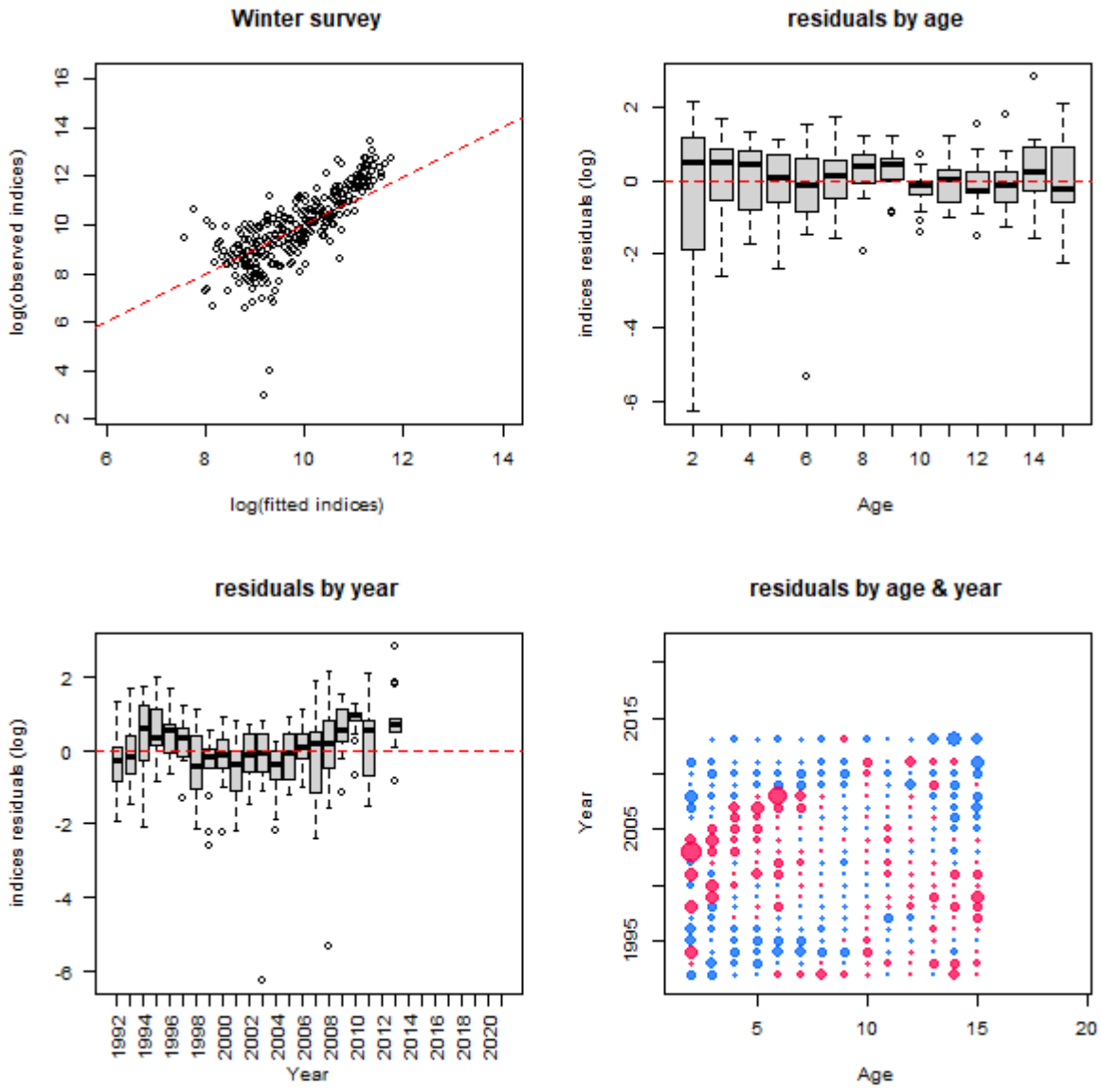


Figure 6.23c. Diagnostic plots for winter survey data. See legend from Figure 6.23a.

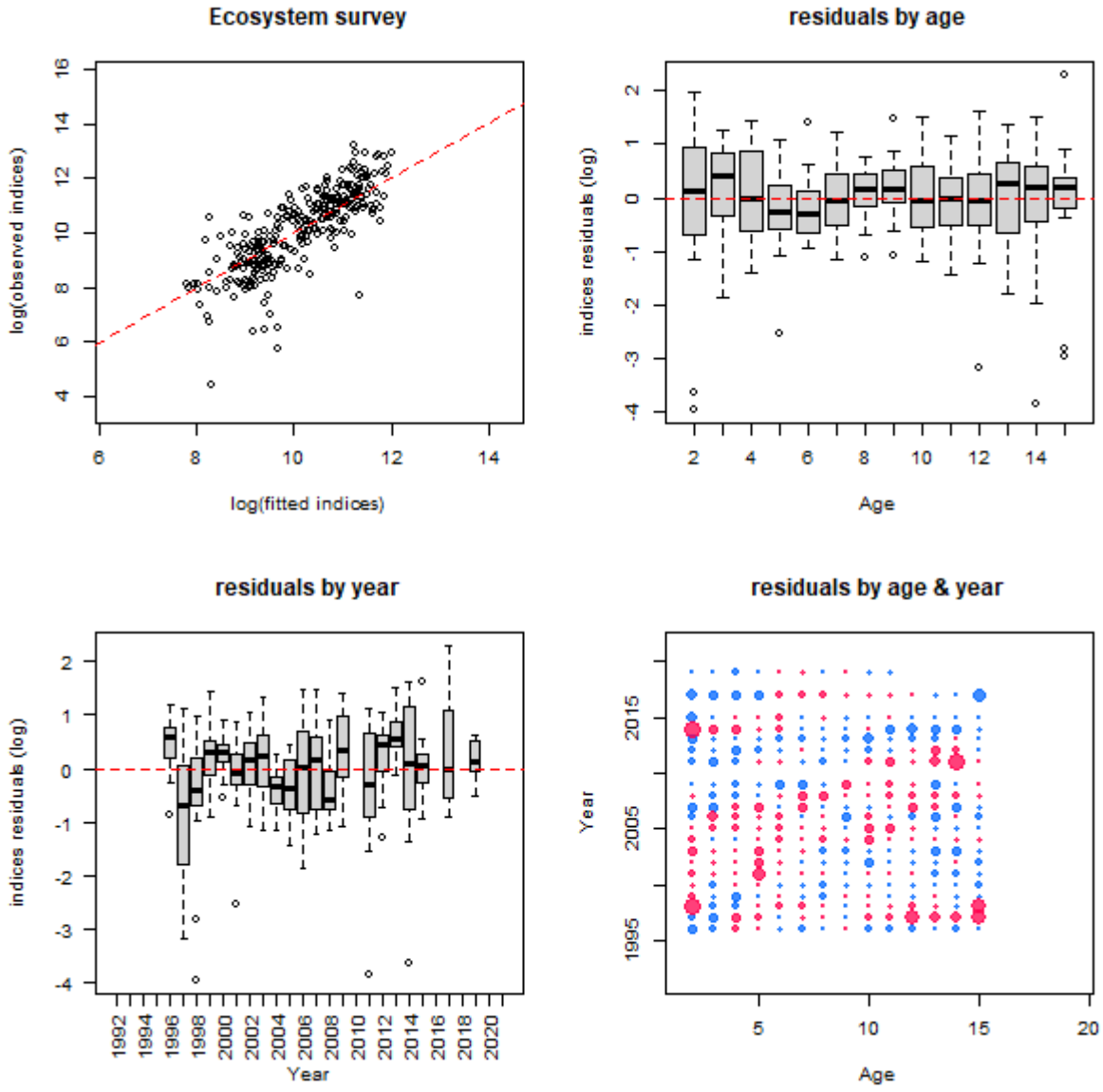


Figure 6.23d. Diagnostic plots for Ecosystem survey data. See legend from Figure 6.23a.

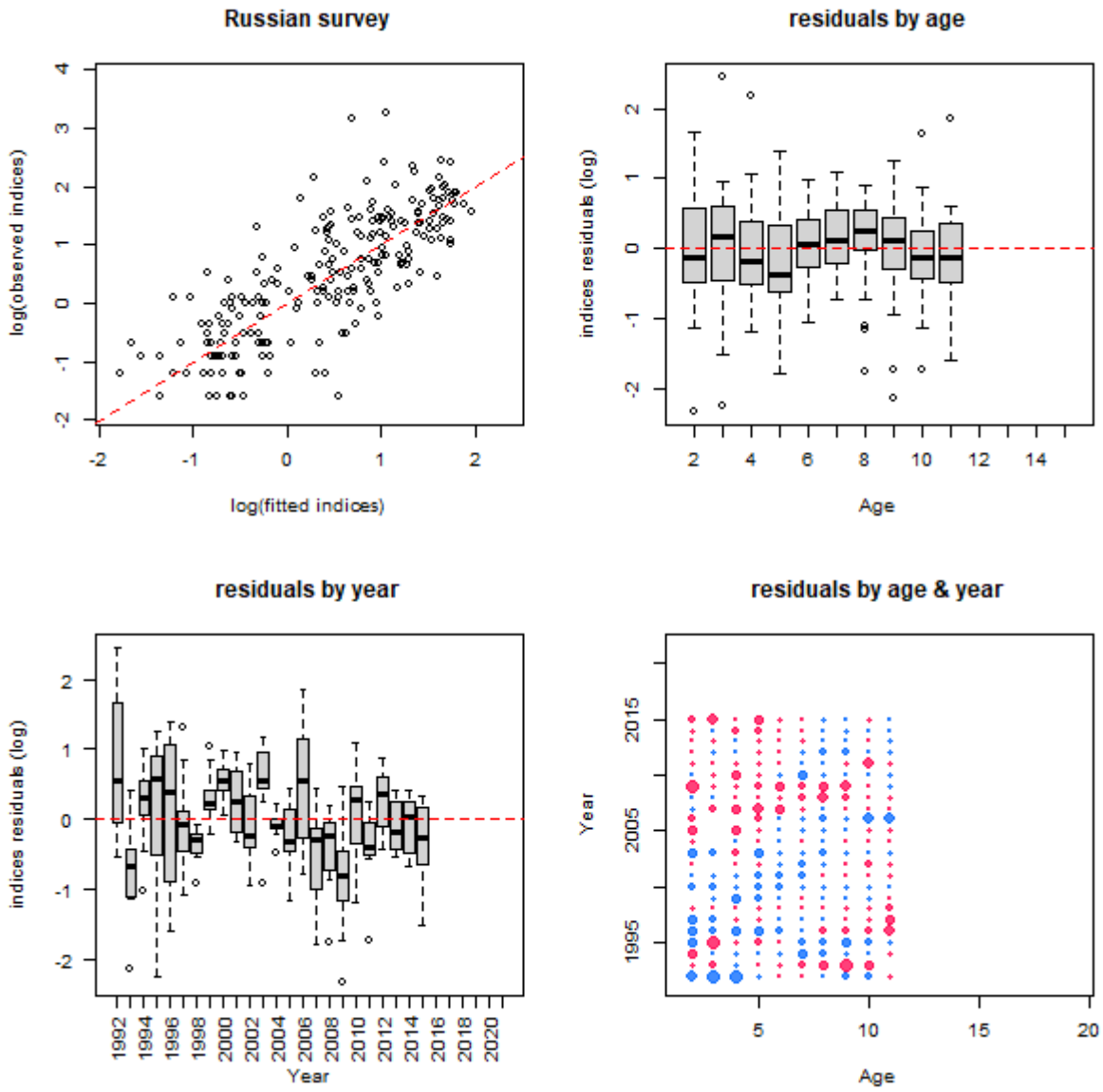


Figure 6.23e. Diagnostic plots for the Russian groundfish survey data. See legend from Figure 6.23a.

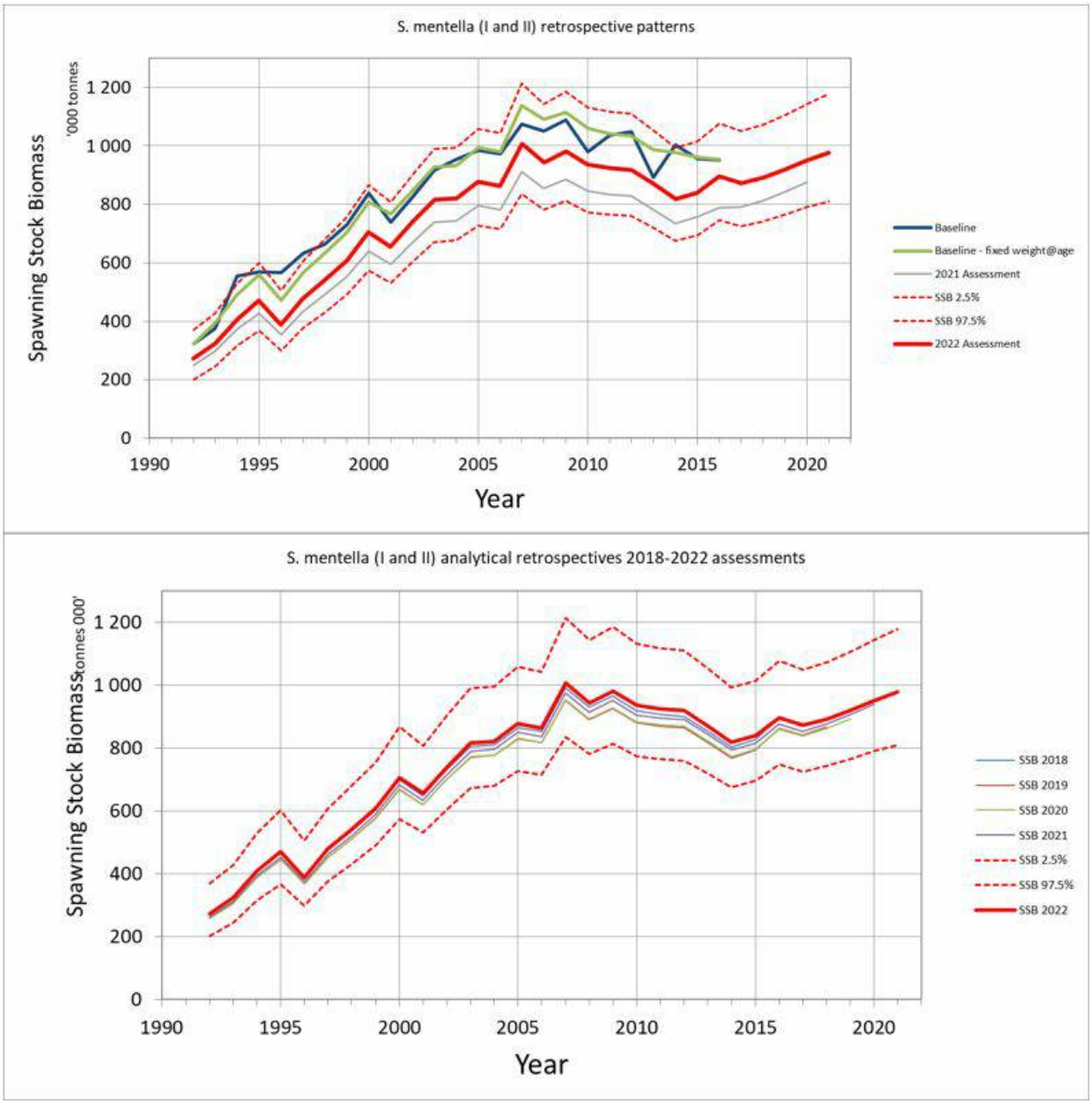


Figure 6.24. The upper panel shows the retrospective patterns of the spawning-stock biomass of S. mentella estimated by the SCAA model for runs up to years 2007–2017 and the baseline model of the 2018 benchmark. The lower panel presents the analytical retrospectives for the current assessment and back to 2018. Confidence Intervals are shown for the latest assessment.

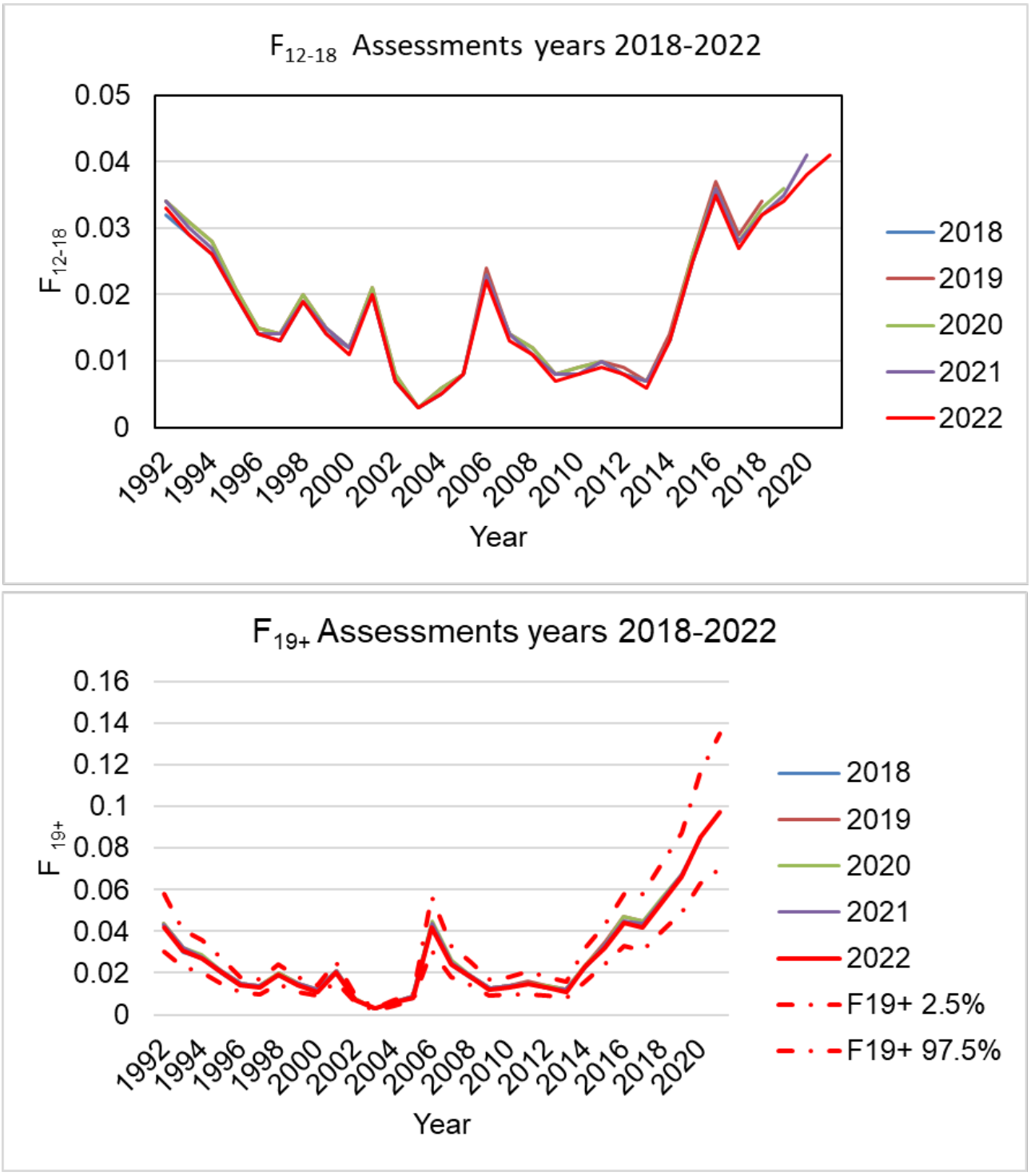


Figure 6.25. The upper panel shows the retrospective patterns of the fishing mortality for the age classes 12-18, estimated by the SCAA model for runs up to years 2018-2022. The lower panel presents fishing mortality for the age-19+ group for the same time period. Broken lines indicate the confidence intervals for the 2022 assessments.

5 - Beaked redfish in subareas 1 and 2 (Northeast Arctic)

5.1 - Status of the fisheries

5.1.1 - Development of the fishery

A description of the historical development of the fishery in subareas 1 and 2 is found in the stock annex for this stock.

An international pelagic fishery for *S. mentella* in the Norwegian Sea outside EEZs has developed since 2004 (Figure 6.1). This pelagic fishery, which is further described in the stock annex, is managed by the Northeast Atlantic Fisheries Commission (NEAFC). Since 2014 the directed demersal and pelagic fisheries are reopened in the Norwegian Economic Zone, the Fisheries Protection Zone around Svalbard and, for pelagic fisheries only, in the Fishing Zone around Jan Mayen. The spatial regulation for this fishery is illustrated in Figures 6.2 and 6.3. In 2021, most of the catches of *S. mentella* from the Russian and Norwegian fisheries were taken in the Norwegian Exclusive Economic Zone or as bycatch in the Fisheries Protection Zone around Svalbard. Catches in international waters were mainly taken by EU nations.

Figure 6.2 shows the distribution of catch among national fishing fleets for 2018 to 2021 and the location of Norwegian *S. mentella* catches in the Norwegian EEZ in 2021 as well as bycatch in other areas. The 44th Session of the Joint Norwegian-Russian Fisheries Commission decided to split the total TAC among countries as follows: Norway: 72%, Russia: 18%, Third countries: 10% (as bycatch in the fishery protection zone at Svalbard (Spitsbergen): 4.1%, and international waters of the Norwegian Sea (NEAFC-area): 5.9%). This split was reconducted at the 51st session of the commission in 2021.

5.1.2 - Bycatch in other fisheries

During 2003–2013, all catches of *S. mentella*, except the pelagic fishery in the Norwegian Sea outside EEZ, were taken as bycatches in other fisheries. Some of the pelagic catches are taken as bycatches in the blue whiting and herring fisheries. From 2014 onwards most of the catch is taken as targeted catch and no longer as bycatch, following the opening of a targeted fishery in the Norwegian EEZ, Svalbard Fisheries Protection Zone and around Jan Mayen. When fishing for other species it has since 2013 been allowed to have up to 20% redfish (both species together) in round weight as bycatch outside 12 nautical miles and only 10% bycatch inside 12 nautical miles to better protect *S. norvegicus*.

5.1.3 - Landings prior to 2021 (Tables 6.1–6.7, Figure 6.1)

Nominal catches of *S. mentella* by country for subareas 1 and 2 combined are presented in Table 6.1, while they are presented for Subarea 1 and divisions 2.a and 2.b in Tables 6.2–6.4. The pelagic catch of *S. mentella* in the Norwegian Sea outside EEZs reported to NEAFC and/or ICES amounted to 7 739 t in 2018, 6060 t in 2019, 5469 t in 2020 and 2 872 t in 2021, and is shown by country in Table 6.5. Nominal catches for both redfish species combined (i.e. *S. mentella* and *S. norvegicus*) by country are presented in Table 6.6. The sources of information used are catches reported to ICES, NEAFC, Norwegian and Russian authorities (foreign vessels fishing in the Norwegian and Russian economic zones) or direct reporting to the AFWG. Where catches are reported as *Sebastes sp*., they are split into *S. norvegicus* and *S. mentella* by AFWG experts based on available correlation between official catches of these two species in the considered areas. All tables have been updated for 2020, and new figures presented for 2021. Total international landings in 1952–2021 are also shown in Figure 6.1.

In 2014, ICES advised that the annual catch in 2015, 2016, and 2017 should be set at no more than 30 000 t and in 2017, ICES advised that the annual catch in 2018 should not exceed 32 658 t. Following the benchmark (WKREDFISH, ICES 2018a) and the subsequent evaluation of a management plan for the stock (WKREBMSE, ICES 2018b) ICES advised an annual catch of no more than 53 757 t for 2019 and 55 860 t in 2020, corresponding to a fishing mortality of F = 0.06. This was continued in 2020, when ICES advised an annual catch of no more than 66 158 t

in 2021 and 67 210 t in 2022, still corresponding to F = 0.06.

Because of the novelty of the situation, related with reopening fisheries after 10 years of its ban, the total landings of *S. mentella* in subareas 1 and 2 in 2014, demersal and pelagic catches, amounted to only 18 426 t. The total landings of the demersal and pelagic fishery increased to 34 754 t in 2016, 30 783 t in 2017, 38 046 t in 2018, 45 640 t in 2019, 53 631 t in 2020 and 63 482 t in 2021. Of this, 2 872 t were reported from the pelagic fishery in international waters of the Norwegian Sea. The total landings in 2017 and 2018 were respectively 783 t and 5 388 t above the TAC advised by ICES, but were 8 117 t, 2 229 t and 2 676 t below TAC in 2019, 2020 and 2021, respectively. Norway caught the major share of the demersal catches, but Russian demersal catches increased substantially after 2017, particularly in ICES Division 2.b.

The redfish population in Subarea 4 (North Sea) is believed to belong to the Northeast Arctic stock. Since this area is outside the traditional areas handled by this Working Group, the catches are not included in the assessment. The total redfish landings (golden and beaked redfish combined) from Subarea 4 have up to 2003 been 1000–3000 t per year. Since 2005 the annual landings from this area have varied between 89 and 341 t (Table 6.7).

5.1.4 - Expected landings in 2022

ICES has advised on the basis of precautionary considerations that the annual catch should be set at no more than 67 210 t in 2022. The 51st sessions of the Joint Norwegian-Russian Fisheries Commission decided to follow this advice.

In 2022 Norwegian fishing vessels, can catch and land up to 44 291 t of redfish in the Norwegian economic zone (NEZ) in a limited area north of 65°20’N (see map in Figure 6.3), in international waters and the fisheries zone around Jan Mayen. Of this quantity, 100 t are allocated to cover bycatch in other fisheries and 52 t for research/surveillance and education purposes, while the remaining 43 139 t can be taken in a directed fishery. Only vessels with cod and saithe trawl permits can participate in the directed fishery for redfish. Each vessel which has the right to participate is assigned a maximum quota, which can be adjusted during the year, per how much of the national quota is exploited. The fishery may be stopped if the total quota is reached. This quota must also cover catches of redfish (both species) in other fisheries. It is prohibited to fish for redfish with bottom trawls in the period from 1 March until 10 May. Investigations were conducted in 2015–2016 to see if the protection of females during the main time of larvae release should be improved by extending the period of prohibited fishing until later in May, and to see if the area south of Bear Island (Area 20 in Figure 6.3) can be opened for directed fishing, either with or without sorting grid, and permissions were granted to a small number of vessels of the Norwegian reference fleet for an earlier onset of fishing to gain further data. The hitherto conclusion is that males dominated the catches (more than 70%) in the main fishing areas south and southwest of Bear Island during the investigations from late April until the directed fishery started on 10 May, and that the area south of Bear Island should stay closed during January-February due to smaller *S. mentella* inhabiting this area at the beginning of the year.

Since 2015, Russia has had access to the NEZ when fishing their quota share. In 2022 Russia may fish 12 098 t (18%) plus 2000 t transferred from Norway to Russia. Apart from this an additional 2100 t were transferred from Norway to Russia and the EU to cover bycatch of redfish (both species) in their fisheries targeting other species. The remaining 6721 t are divided between third countries in the NEZ and Svalbard Zone (2755 t) and the NEAFC areas (3966 t). Catch in the NEAFC areas in 2021 amounted to 2872 t while the catch in the national economic zones of Norway and Russia as well as the fisheries protection zone around Svalbard was 60 610 t. The total catch in 2021 was 2676 t lower than the advised TAC. Norwegian catches up to week 33 were 32 295 t, which is about 9 000 tonnes less than at the same time of 2021. This indicates that the Norwegian quota is unlikely to be exhausted as there is usually little redfish catch in autumn.

5.2 - Data used in the assessment

Analytical assessment was conducted for this stock following recommendation from the benchmark assessment working

group (WKREDFISH, ICES 2018a). Input datasets were updated with the most recently available data. The analytical assessment, based on a statistical catch-at-age model (SCAA), covers the period 1992–2020. The input data consists of the following tables:

- Total catch in tonnes (Table 6.1)
- Catch in tonnes in the pelagic fishery Norwegian Sea outside EEZs (Table 6.5)
- Total catch numbers-at-age 6–19+ (Table 6.8)
- Catch numbers-at-age 7–19+ in the pelagic fishery (Table 6.9)
- Weight-at-age 2–19+ in the population (Table 6.12)
- Maturity-at-age 2–19+ in the population (Table 6.14)
- Russian autumn survey numbers-at-age 0–11 (Table 6.15)
- Ecosystem survey numbers-at-age 2–15 (Table 6.17)
- Winter survey numbers-at-age 2–15 (Table 6.18b)
- Deep pelagic ecosystem survey proportions-at-age (Table 6.19)

There was no direct observation of catch numbers-at-age for the pelagic fishery in the Norwegian Sea outside EEZs in 2012–2021. Instead, numbers-at-age were estimated based on catch-at-age from previous or following year, and weight-at-age and fleet selectivities (section 6.2.2 in AFWG report 2013). In 2013, 2016 and 2019, observations from the scientific survey in the Norwegian Sea were used to derive numbers-at-age in the pelagic fishery. This was considered appropriate given that the survey operates in the area of the fishery, with a commercial pelagic trawl and at the time of the start of the fishery.

5.2.1 - Length- composition from the fishery (Figure 6.4)

Comparison of length distributions of the Norwegian and Russian catches of *S. mentella* in 2019–2021 are shown in Figure 6.4. In 2020, the Russian and Norwegian fleets fished smaller fish than in 2019, reflecting good year classes due to enter the fishable stock. After 2019 length of beaked redfish in Norwegian catches was larger than in Russian catches. This is probably due to differences in the fishing areas. The Russian fleet largely operated in area 2b, and the Norwegian fleet in area 2a.

5.2.2 - Catch-at-age (Tables 6.8–6.11, Figure 6.5)

Catch-at-age in the Norwegian fishery was estimated using ECA for 2014 and 2020. For 2015, 2016 and 2018, it was not possible to run ECA and the catch-at-age for the Norwegian Fishery was estimated using the older Biomass program in SAS (Table 6.8). Not enough age readings were available to estimate catch-at-age in 2017, 2019 and 2021. For the pelagic fisheries 2017, 2018, 2020 and 2021 (Table 6.9) proportions-at-age in the catch were derived from proportions at-age in earlier years, weight-at-age and fleet selectivity (section 6.2.2 in AFWG report 2013).

This procedure for estimating catch-at-age for recent years in which age data are not available is somewhat problematic. This is because the last year of observation has a large effect on the estimated catch-at-age for several years. At the assessment working group in 2017 and at the benchmark assessment in January 2018, the last year of observations for the catch-at-age was 2014 and the values for the years 2015 and 2016 were extrapolated. Once available, the data for 2015 (demersal) and 2016 (pelagic) were substantially different from these earlier extrapolations. In the 2022 assessment the catch-at-age observations in 2018, had a large effect on the years around it, producing a very large proportion of the 19+ class in the catch and a correspondingly high F_{19+}. As the age structure in 2018 was based on less than 1000 aged fish it was decided to use a time-averaged age-length-key (ALK) to convert the length distribution in 2017-2019 and in 2021 to an age distribution. The time-averaged ALK is based on the Norwegian age-length data back to 2009, excluding the years 2017, 2019 and 2021 and on commercial catches with demersal gears. The conversion still produced a fraction of the 19+-group of >60% but F_{19+} was lower than in the standard method.

Several other options were considered. Firstly, extrapolation as in the standard method but extrapolating also the 19+-group and then rescaling to sum up to 100%, rather than calculating the 19+ as the difference between other ages and 100%. Secondly, calculating the fraction of each age-class as an average of the same cohort's fraction in the year

before and after. Thirdly, as an average of the fraction of the same age-class in the last 3 years with data or last 3 calendar years. Finally, using a combined Russian-Norwegian ALK for individual years. Whilst some of these options produced lower fishing mortalities for the 19+-group, the change in observed selectivity for the demersal catches since 2017 remained largely the same. Therefore, the option of a common ALK across years was chosen because a as the option with the most sensible underlying reasoning.

Age composition of the Russian and Norwegian catches in 2021 was calculated using the age–length key, based on Russian age readings. The joint age–length key for the last three years (2019–2021) was applied. In general, the age distribution in the Norwegian fishery was shifted towards older fish compared to the Russian fishery. In the Russian catches fish at age 15–16 dominated, while in the Norwegian catches 16–17 years old made up the majority of the catches. (Figure 6.5). The proportion (by numbers) of individuals at age 18 and older in the Norwegian catches was almost twice as large as in the Russian ones.

Age–length-keys for *S. mentella* are uncertain because of the slow growth rate of individuals and therefore these data should be used with caution. Given that age is difficult to derive from length it is important that age readings are available for the most recent years, at the time of the working group.

5.2.3 - Weight-at-age (Tables 6.12, 6.13, Figures 6.6, 6.7)

In earlier assessment, weight-at-age in the stock was set equal to the weight-at-age in the catch. This turned out to be problematic because of important fluctuations in reported weight-at-age in the catch that cannot be explained biologically (i.e. these are noisy data). In 2015, it was advised to either use a fixed weight-at-age for the 19+ group, or use a modelled weight-at-age based on catch and survey records (Planque, 2015). The second option was chosen. Weight-at-age in the population was modelled for each year using mixed-effect models of a von Bertalanffy growth function (in weight). In 2018 an attempt was made to model weight-at-age for each cohort (rather than each year of observation). This showed that the growth function is nearly invariant between cohorts. Therefore, it was decided to use a fixed (i.e. common to all years) weight-at-age as input to the Statistical Catch-at-age model. The observed and modelled weight-at-age are presented in Table 6.12 as well as Figures 6.6 and 6.7.

5.2.4 - Maturity-at-age (Table 6.14, Figure 6.8)

The proportion maturity-at-age was estimated for individual years using a mixed-effect statistical model (Table 6.14, Figure 6.8). The modelled values of maturity-at-age for individual years are used in the analytical assessment models, except in 2008, 2011 and 2017–2021 when the fixed effects only were considered, at least in the two latest years due to a lack of age data.

5.2.5 - Natural mortality

In previous years, natural mortality for *S. mentella* was set to 0.05 for all ages and all years. This was based on life-history correlates presented in Hoenig (1983). Thirty-nine alternative mortality estimates were explored during the benchmark workshop, based on the review work by Kenchington (2014) and several additional recent papers (Then *et al*., 2014; Hamel, 2014; Charnov *et al*., 2013). Overall, the mode of these natural mortality estimates is 0.058 which departs only slightly from the original estimate of 0.050 (Figure 6.9). WKREDFISH (ICES, 2018a) decided to continue using 0.050 as the value of M in the assessment model. These estimates were updated for a peer-reviewed paper submitted in 2022 (Höffle and Planque, in revision) with 44 estimators resulting in a mode of the distribution of 0.07.

Figure 6.10 shows cod's predation on juvenile (5–14 cm) redfish during 1984–2020. This time-series confirms the presence of redfish juveniles and may be used as an indicator of redfish abundance. A clear difference is seen between the abundance/consumption ratio in the 1980s and at present. A change in survey trawl catchability (smaller meshes) from 1993 onwards (Jakobsen *et al*., 1997) and/or a change in the cod's prey preference may cause this difference. As long as the trawl survey time-series has not been corrected for the change in catchability, the abundance index of juvenile redfish less than 15 cm during the 1980s might have been considerably higher, if this change in catchability had been corrected for. The decrease in the abundance of young redfish in the surveys during the 1990s is consistent with the decline in the consumption of redfish by cod. It is important that the estimation of the consumption of redfish by

cod is being continued.

5.2.6 - Scientific surveys

Following a dedicated review, AFWG approved the use of the new SToX versions of winter and ecosystem surveys for use in the *S.s mentella* assessment (WD 17 and WD 18 in AFWG 2020). The group recommended that the data be monitored annually to identify if a significant portion of the mentella stock moves east of the strata system. The group further recommended that work continues to investigate redfish-specific strata systems for the winter survey.

The results from the following research vessel survey series were evaluated by the Working Group:

5.2.6.1 - Surveys in the Barents Sea and Svalbard area (Tables 1.1, 1.2, 6.15–6.18, Figures 6.11, 6.12)

Russian bottom-trawl survey in the Svalbard and Barents Sea areas in October-December for 1978–2015 in fishing depths of 100–900 m (Table 6.15, Figure 6.11). ICES acronym: RU-BTr-Q4.

Russian-Norwegian Barents Sea 'Ecosystem survey' (bottom-trawl survey, August-September) from 1986–2019 in fishing depths of 100–500 m (Figures 6.11–6.12). Data disaggregated by age for the period 1992–2019 (Tables 6.16b-6.17). ICES acronym: Since 2003 part of Eco-NoRu-Q3 (BTr), survey code: A5216.

Winter Barents Seabed-trawl survey (February) from 1986–2014 (jointly with Russia since 2000, except 2006 and 2007) in fishing depths of 100–500 m (Figures 6.11–6.12). Data disaggregated by age for the period 1992–2011 and 2013 (Table 6.18b). ICES acronym: BS-NoRu-Q1 (BTr), survey code: A6996.

The Norwegian survey initially designed for redfish and Greenland halibut is now part of the ecosystem survey and covers the Norwegian Economic Zone (NEZ) and Svalbard Fisheries Protection Zone incl. north and east of Spitsbergen during August 1996–2012 from less than 100 m to 800 m depth. This survey includes survey no. 2 above, and has been a joint survey with Russia since 2003, and since then called the Ecosystem survey. ICES acronym: Eco-NoRu-Q3 (Btr), survey code: A5216.

5.2.6.2 - Pelagic survey in the Norwegian Sea (Table 6.19, Figures 6.13, 6.14)

The international deep pelagic ecosystem survey in the Norwegian Sea (WGIDEEPS, ICES 2016, survey code: A3357) monitors deep pelagic ecosystems, focusing on beaked redfish (*S. mentella*). The latest survey was conducted in the open Norwegian Sea from 22 July until 12 August 2022, following similar surveys in 2008, 2009, 2013, 2016 and 2019. The spatial coverage of the 2022 survey and the catch rates of beaked redfish in the 2019 survey are presented in Figure 6.13. The survey is scheduled every third year. Estimated numbers-at-age from this survey were presented at the benchmark assessment in 2018 and used in the SCAA model. Data for 2016 was updated in 2019, using additional age readings and numbers-at-age for the 2019 survey were presented during AFWG 2020, used in the assessment and updated for AFWG 2021. The details of the data preparation, using StoX, are available from WD7 of AFWG 2018 (Planque *et al.,* 2018). The data used as input to the analytical assessment consists of proportions-at-age from age 2 to 75 years (Figure 6.14).

5.2.6.3 - Additional surveys (Figures 6.15–6.17)

The international 0-group survey in the Svalbard and Barents Sea areas in August-September 1980–2021, is now part of the Ecosystem survey (Figures 6.15 and 6.16). ICES acronym: Eco-NoRu-Q3 (Btr), survey code: A5216.

A slope survey, "Egga-sør survey" was carried out by IMR from 25 March to 20 April 2022, following similar surveys in 2009, 2012, 2014, 2016, 2018 and 2020. The spatial coverage of the 2022 survey and the distribution of beaked redfish registered by acoustic is presented in Figure 6.17. Egga-Sør and Egga-Nord surveys operate on a biennial basis. The length and age distributions of beaked redfish from these surveys show consistent ageing in the population and gradual incoming of new cohorts after the recruitment failure period. These surveys are considered as candidates for data input to the analytical assessment of *S. mentella* (see also Planque, 2016).

5.3 - Assessment

The group performed the analytical assessment using the statistical catch-at-age (SCAA) model reviewed at the benchmark in January 2018 (WKREDFISH, ICES 2018a). The model was configured as the benchmark baseline model which includes 53 parameters to be estimated and the model converged correctly.

5.3.1 - Results of the assessment (Tables 6.20, 6.21, Figures 6.18–6.24)

5.3.1.1 - Stock trends

The temporal patterns in recruitment-at-age 2 (Figures 6.18, 6.21) confirm the previously reported recruitment failure for the year classes 1996 to 2003 and indicate a return to high levels of recruitment. The estimates of year-class strength for recent years are uncertain due to limited age data from the winter and ecosystem surveys. Modelled spawning-stock biomass (SSB) has increased from 1992 to 2007 (Table 6.21). In the late 2000s the total-stock biomass (TSB) consisted of a larger proportion of mature fish than in the 1990s. This is reversing as individuals from new successful year classes, but still immature, are growing. TSB has increased from about 1.0 to slightly below 1.5 million tonnes in the last 10 years (Table 6.21 and Figures 6.21–6.22). The concurrent decline in SSB from 2007 to 2014 can be attributed to the weak year classes (1996–2003) entering the mature stock. This trend has levelled off and SSB increases again. SSB at the start of 2022 is estimated at 996 124 t.

5.3.1.2 - Fishing mortality (Tables 6.20a,b–6.21, Figure 6.19)

The patterns of fleet selectivity-at-age indicate that most of the fish captured by the demersal fleet as well as the pelagic fleet in 2021 are of age 16 and older (Tables 6.20a,b and Figure 6.19). Model results at the benchmark workshop did show a gradual shift in the demersal selectivity towards older ages, a shift that was not observed after the 2015 catch-at-age data were incorporated in the model. This shift towards older ages is now again visible in the data from 2017 onwards, similar to what was observed in 2014. In 2021 F_{19+} is estimated at 0.01 (Table 6.21), with 0.091 for the demersal and 0.006 for the pelagic fleets (Table 6.20a), respectively.

5.3.1.3 - Survey selectivity patterns (Figure 6.20)

Winter and ecosystem surveys selectivity at age are very similar and show reduced selectivity for age 8 years and older, which is consistent with the known geographical distribution of different life stages of *S. mentella* (Figure 6.20). Conversely, the Russian survey shows a reduced selectivity for age 7 years and younger. This is believed to result from gear selectivity.

5.3.1.4 - Residual patterns (Figure 6.23)

Residual patterns in catch and survey indices are presented in Figure 6.23a-e. There is generally no visible trend in the residuals for the Russian groundfish survey neither by age nor by year. Trends in residuals are visible in recent years for winter and ecosystem surveys and will need to be investigated further. Alternative methods for the estimation of the survey selectivity patterns will be investigated in the benchmark assessment planned for 2024 and could resolve the issue. Residual patterns for the demersal fleet indicate a similar fit of the model compared to AFWG 2018, when a time varying selectivity-at-age for this fleet was introduced.

5.3.1.5 - Retrospective patterns (Figure 6.24)

The historical and analytical retrospective patterns for the years 2007 to 2016 are presented in Figures 6.24 and 6.25. All model parameters were estimated in each individual run. The most recent model run (last year of data 2021) is consistent with previous runs. Estimated SSB is increased As in 2018 the SSB time-series is smoother than before, due to fixed weight-at-age for every year. The new estimates for winter and Ecosystem surveys in 2020 led to an increase in estimated SSB, up to 19% in the early years and around 7% to 9% in later years. Contrarily, the 2021 update revised SSB moderately down, by about 5% to 6%. SSB in 2021 is again revised upwards by about 10% across the assessment period. The benchmark run stands out and this is due to the unavailability of recent catch-at-age data during the benchmark assessment (see section 6.2.2). The analytical retrospectives back to 2018 showed likewise a higher SSB but with a lesser increase, ranging around 3% for much of the assessment period and dropping to the 1% range in the later years. The analytical retrospectives showed a consistent pattern for $F_{12\text{-}18}$ until 2017 when it started

to deviate. Likewise, the pattern for F_{19+} was very similar in the analytical retrospectives. Retrospective bias (Mohn's rho) over the last 5 assessments was -0.3% for recruitment, -24% for F(19+) and -7% for SSB.

5.3.1.6 - Projections

F_{MSY} at age 19+ is approximated using $F_{0.1}$ and estimated at 0.084 (section 1.4 of the WKREBMSE report 2018b).

The estimated fishing mortality in 2021 is: F_{19+} = 0.01.

If the fishing mortality is maintained, this is expected to lead to a catch of 64 159 t in 2022, about 3000 tonnes below the advised TAC of 67 210 t. This would lead to a SSB of 1 018 117 t in early 2023, catches of 66 779 t in 2023 and a SSB of 1 040 323 t in 2024.

Lowering F_{19+} to the precautionary approach (F_{19+} = 0.06) advice, in 2023–2025 would lead to average catches of 45 150 t during that period and a SSB of 1 131 595 t by 2026 (SSB at the start of 2021 is estimated at 976 956 t).

These projections assume that the selectivity patterns of the demersal and pelagic fleets are identical with those estimated for 2021. It is also assumed that the ratio of fishing mortality between these two fleets remains unchanged.

5.3.1.7 - Additional considerations

Historical fluctuations in the recruitment-at-age 2 (Figures 6.18 and 6.21) are consistent with the 0-group survey index (Figure 6.16), although the 0-group survey index is not used as an input to the SCAA.

The population age structure derived from the model outputs for the old individuals (beyond 19+, Figure 6.22) is consistent with the age structure reported from the slope surveys although these are not yet used as input to the model.

Recent recruitment levels estimated with SCAA are highly uncertain since they rely on only a few years of observations and since the age readings from winter survey were not available for years 2014–2022. The use of the autoregressive model for recruitment (random effects in the SCAA) which was introduced in 2018 allows for a projection of the recruitment in recent years, despite the current lack of age data.

5.3.1.8 - Assessment summary (Table 6.21, Figure 6.21)

The history of the stock as described by the SCAA model for the period 1992–2021 is summarized in Table 6.21 and Figure 6.21. The key elements are as follows:

- upward trend in Total-stock biomass from 1992 to 2006 followed by stabilization until 2011 and a new upward trend until the present,
- upward trend in spawning-stock biomass from 1992 to 2007 followed by stabilization (or slight decline) until 2014 and subsequent increase,
- recruitment failure for year classes 1996–2003 (2y old fish in 1998–2005),
- good (although uncertain) recruitment for year classes born after 2005. Age data for recruits (at age 2y) after 2014 is limited.
- Annual fishing mortality for the 19+ group throughout the assessment period varied between 0.003 and 0.097.

5.4 - Comments to the assessment

Currently, the survey series used in the SCAA do not appropriately cover the geographical distribution of the adult population. Data from the pelagic survey in the Norwegian Sea has been reviewed in the last benchmark and is now included in the assessment model. Priority should be given to including additional data from the slope surveys that include older age groups, in the analytical assessment in future (WD 5 in 2016).

The SCAA model relies on the availability of reliable age data in surveys and in the catch. Although additional age reading since the last assessment has improved reliability, it requires a continuous effort to keep these data at an appropriate level.

5.5 - Biological reference points

The proposed reference points estimated during the workshop on the management plan for *S. mentella* in (ICES 2018b) were:

Reference point	Value
B_{lim}	227 000 t
B_{pa}	315 000 t
F_{MSY19+}= $F_{0.1}$	0.084

Which are revised from those set during the benchmark in the same year (ICES 2018a) which were B_{pa} = 450 kt, B_{lim} = 324 kt and F_{MSY19+} = $F_{0.1}$ = 0.08.

5.6 - Management advice

The present report updates the assessment and advises that when the status quo approach is applied, catches in 2023 should be no more than 66 779 tonnes, and catches in 2024 should be no more than 70 164 tonnes. This would correspond to a fishing mortality of F_{19+} = 0.097, whilst fishing pressure across the fishable age-classes would remain nearly constant.

5.7 - Possible future development of the assessment

Many developments suggested in earlier years were presented and evaluated at the benchmark in January 2018. These include integrating a stochastic process model i) for recruitment-at-age 2, ii) for the annual component of fishing mortalities, and iii) to account for annual changes in fleet selectivities-at-age. In addition, iv) a right trapezoid population matrix, v) coding of older ages into flexible predefined age-blocks, and vi) integrating of data from pelagic surveys in the Norwegian Sea were implemented. The purpose of these new features was to reduce the number of parameters to estimate (i, ii), include new data on the older age fraction of the population (iv, v, vi) and account for possible temporal changes in selectivity linked to changes in the national and international fisheries and their regulations (iii).

Recommendations that have been followed since comprise:

- An increase in the number of age readings from surveys and from the fishery, particularly for recent years.
- Use of a standardized method (StoX) for the determination of numbers-at-age in the surveys. The use of StoX for survey indices was evaluated at the beginning of AFWG 2020.

Future developments for the assessment of *S. mentella* may possibly include:

- Use of a standardized method (ECA) for the determination of numbers-at-age in the catch.
- A genetic-based method for rapidly identifying Sebastes species (*S. norvegicus*, *S. mentella*, *S. viviparus*);
- Direct use of length information (as in GADGET);
- Development of a joint age–length key for calculation of age composition of all *S. mentella* catches.
- Development of a joint model for *S. mentella* and *S. norvegicus* which can include uncertainty in species identification and reporting of catch of *Sebastes sp*.

Implementing the current model in a more generic framework (SAM or XSAM) would provide a set of diagnostic tools and the wider expertise shared by the groups developing these models. The new version of GADGET, running the currently used TMB-package in the background, may provide an opportunity to put both species on the same platform.

Further studies of redfish mortality at young age, including a scientific publication, should be carried out. These studies should also take account of historic estimates of bycatch. Variable M by age and possibly time period could then be incorporated in the assessment.

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