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Summary (English):

On 30th 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 Greenland halibut 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.

In 2024 we are giving 2-year advice for both Greenland halibut and beaked redfish. The beaked redfish model is planned for a method revision prior to the next advice.

Advice on fishing opportunities for NEA cod

The NEA cod stock is continuing to decline following a period of moderate to poor recruitment. Following the agreed HCR, the advice for 2025 is that catches should be no more than 311 587 tonnes. This is down from 453 427 because the stock is projected to fall below Bpa, and therefore the stability constraint on interannual catch variation does not apply. Provided that this advice is followed, then projections indicate that at current recruitment levels the stock should stabilize and start to rise after 2027.

Advice on fishing opportunities for NEA haddock

Advice is that catches in 2025 should not exceed 106 912 tonnes, down from 127 550 tonnes, from the advice in 2023. A relatively good yearclass in 2021 should enter the fishery in 2026- Provided that this yearclass is not heavily caught at small sizes then then should lead to an increase in stock and catches thereafter. In recent years there has been a rise in the catch of small haddock, and if this is not curtailed then there is a risk that a large part of the incoming yearclass could be fished before reaching a size to give optimum yield.

Advice on fishing opportunities for Greenland halibut

The Greenland halibut stock is projected to fall below Bpa in the course of 2024, which has resulted in lowered advice. The advice is that catches in 2025 should be no more than 12 431 tonnes, and catches in 2016 should be no more than 14 891. This stock has a history of quota and catches being set above advice, which has led to the decline of the stock. There is good yearclass in 2019 which offers a prospect of an increase in stock and advice – provided the advice is followed and the stock is not further reduced.

Advice on fishing opportunities for beaked redfish

The stock is at a high level, with SSB rising slowly and total fishable biomass relatively stable. The catch advice is no more than 67 191 tonnes in 2025 and 69 177 tonnes in 2026, compared to an advice of 70 164 tonnes for 2024. There has been a high retrospective pattern for this stock assessment, and a method revision is planned before the next advice is due (for the 2027 fishing season).

Content

Chapter 1. Ecosystem considerations

The aim of this chapter is to identify important ecosystem information influencing the fish stocks. Ecosystem and climate changes, along with fishery, determine the stock dynamics of commercial species. Water temperature and ice conditions influence on distribution of the commercial fishes in the Barents Sea. Apart from this, temperature impacts on growth rate and mortality at the early stages (larvae, juveniles). Currents affect the strength of year-classes by providing transport of eggs, larvae and 0-group of commercial species from the spawning areas into the Barents Sea. Food availability is another important ecosystem driver that influence on the rate of growth and maturation of commercial fishes. It depends not only on the prey availability, but also on feeding competition. Mortality due to predation, including cannibalism, can greatly affect population abundance of commercial species. The impact of ecosystem changes on the dynamics of bycatches of juveniles and non-target species in mixed fisheries should also be taken into account.

Specification of the ecosystem impact on the assessed species :

Cod

The cod stock has been decreasing, but predictions indicate that it will stabilize on a low level. The main effect of the ecosystem impact on cod stock dynamics is manifested in the change in the abundance of its recruitment. There have not been any strong year-classes of cod since 2005 despite high cod SSB and above average sea temperatures. Recruitment has previously been shown to be positively correlated with both those factors, but in recent years this is no longer the case. Meso-zooplankton is important for survival of larvae and 0-group cod, so their distribution must overlap with areas of relatively high plankton biomasses. Despite a large number of studies (see e.g. summary in Ottersen et al., 2014), the underlying mechanism of the impact of the Barents Sea ecosystem on cod recruitment is still not well understood.

Haddock

Warm conditions are necessary, but not sufficient conditions to ensure good recruitment and growth. Plankton bloom (timing and strength) and influx are important for recruitment and feeding conditions are important for growth and reproduction. In 2019-2020 feeding conditions of haddock in the Barents Sea were poor, which reduced its condition. Older haddock includes a high proportion of benthic invertebrates in their diet, the availability of this prey group is not known. Reduction of cod stock and intermediate to high abundance of capelin could lead to less predation on haddock by cod, and therefore lower mortality on both pre-recruits and younger haddock recruited into the fishery.

Greenland halibut

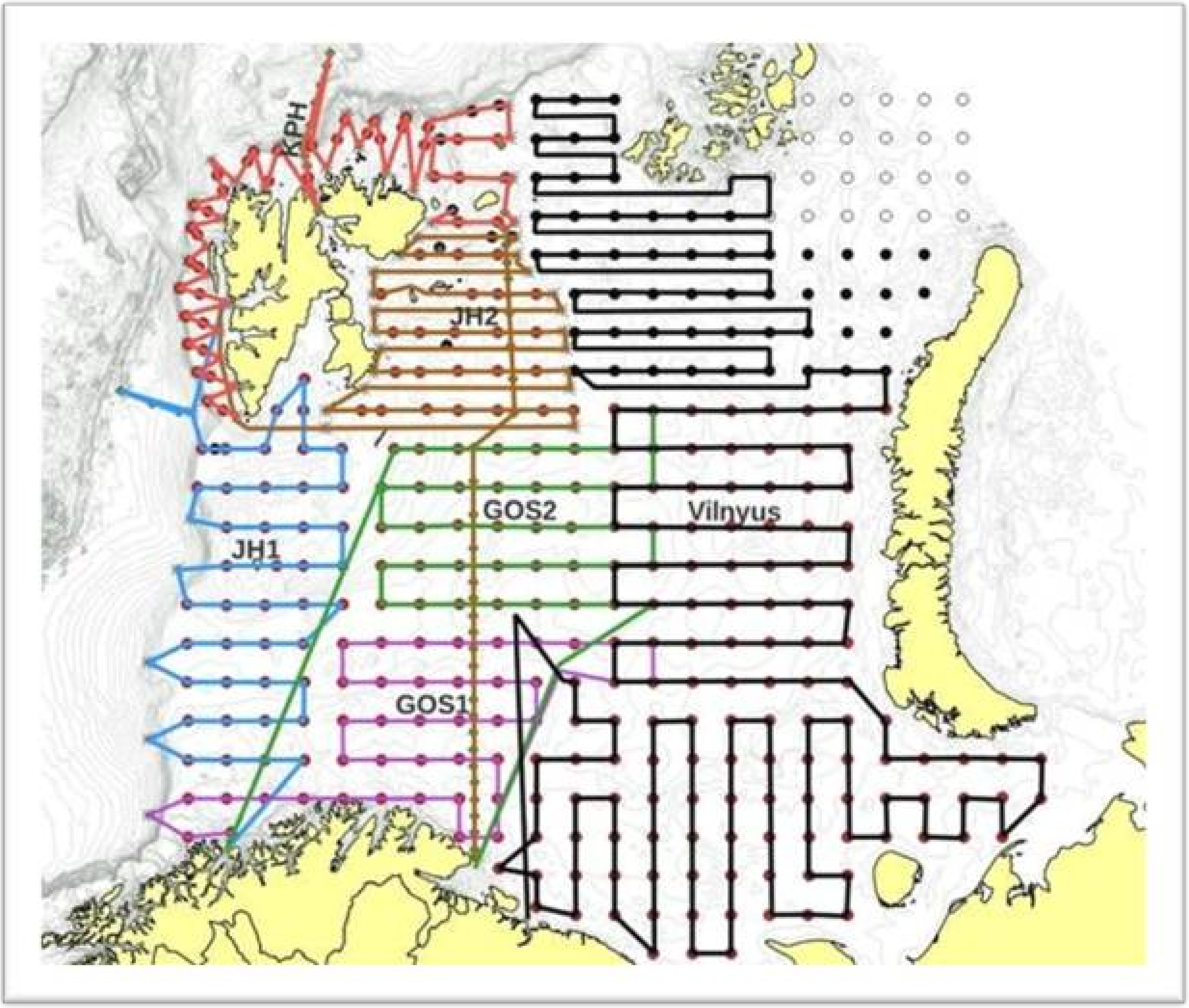
The distribution of the Greenland halibut stock is very uneven in the Barents Sea and adjacent waters and strongly depends on the migrations that it makes throughout its life. The highest densities of adult fish are observed in spawning grounds on the slope of the continental shelf. Juveniles are widely distributed along the northern part of the shelf and their abundance in the Barents Sea may be affected by water temperature and currents, although the effect of these factors is not fully understood and uncertain. Growth and maturation of the Greenland halibut depend on prey abundance. Greenland halibut feeds on zooplankton, capelin, herring, polar cod and other small fishes. Cod can be both predator and food competitor for Greenland halibut. Cannibalism can also be observed in areas with overlapping of adults and juveniles. Mammals can consume Greenland halibut in the spawning areas.

Beaked redfish

As a boreal species, it is benefiting from the warming in the Barents Sea. Its stock has increased in recent years, but its stock assessment is characterized by high uncertainty. Feeding condition for beaked redfish in 2022-2023 were likely to be relatively stable. Cod and Greenland halibut are main predators for the beaked redfish. However, as abundance of these species is declining and abundance of capelin, herring and polar cod is increased, the predation pressure on redfish probably is relatively low. In recent years, the mortality rate of young beaked redfish has been high due to bycatches in the shrimp fishery (ICES AFWG, 2023). This strongly depends on the overlap between the distribution areas of redfish juveniles and shrimp fishery areas. The stock size and distribution of shrimp as well as currents and temperature affect this.

Current situation :

In the last six years, the Barents Sea coverage during the ecosystem survey (BESS) was incomplete in 2020 and 2022, making the evaluation of the ecosystem status more uncertain. The 20-th BESS was carried out during the period from 10-th August 2023 to 7th October 2023 by three Norwegian and one Russian research vessels. The temporal and spatial progression during the survey was good (Figure 1a,b).



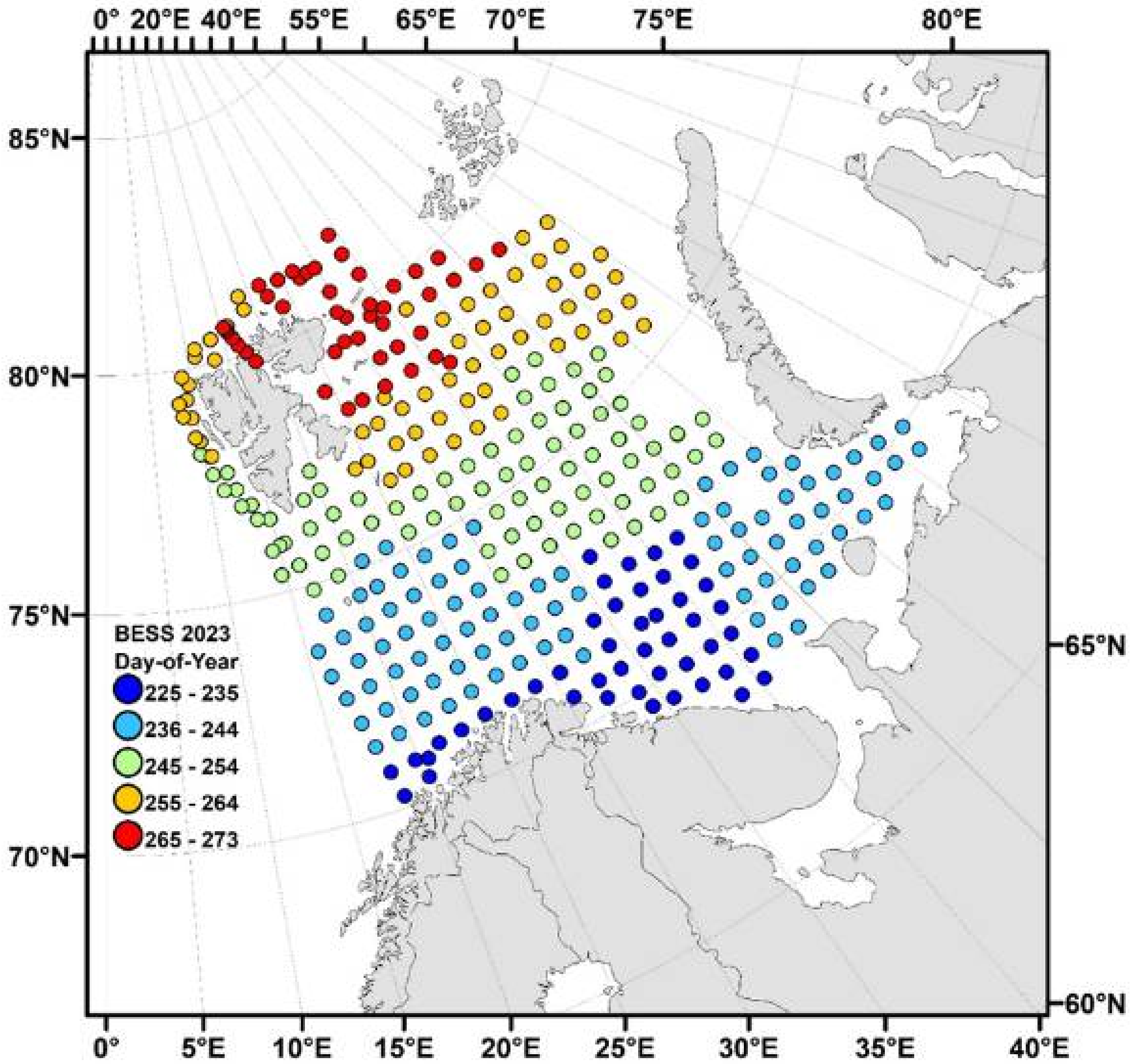


Figure 1. Cruise lines and sample sites (top), day of year of sampling (bottom)

Abiotic conditions

A warming was evident in most of the central Barents Sea in 2023, with temperatures well above the long-term mean (1981-2010). However, the northwestern and southwestern parts were colder than both the long-term mean and the year before (2022). Ice coverage of the Barents Sea in 2023 was below both the long-term mean and that of 2022. The area of the Barents Sea occupied by bottom waters with a temperature < 0°C amounted to 17% and was substantially lower compared to the level of the previous four years (Fig. 1). According to the expert evaluation, Atlantic water temperature in the Murman Current in 202 4 is expected to decline slightly but remain typical of warm years. Due to high temperatures and low sea-ice extent in recent years, the ice coverage of the Barents Sea is expected to remain below normal. Lower than average ice coverage and longer duration of ice-free season, increase primary productivity of the Barents Sea.

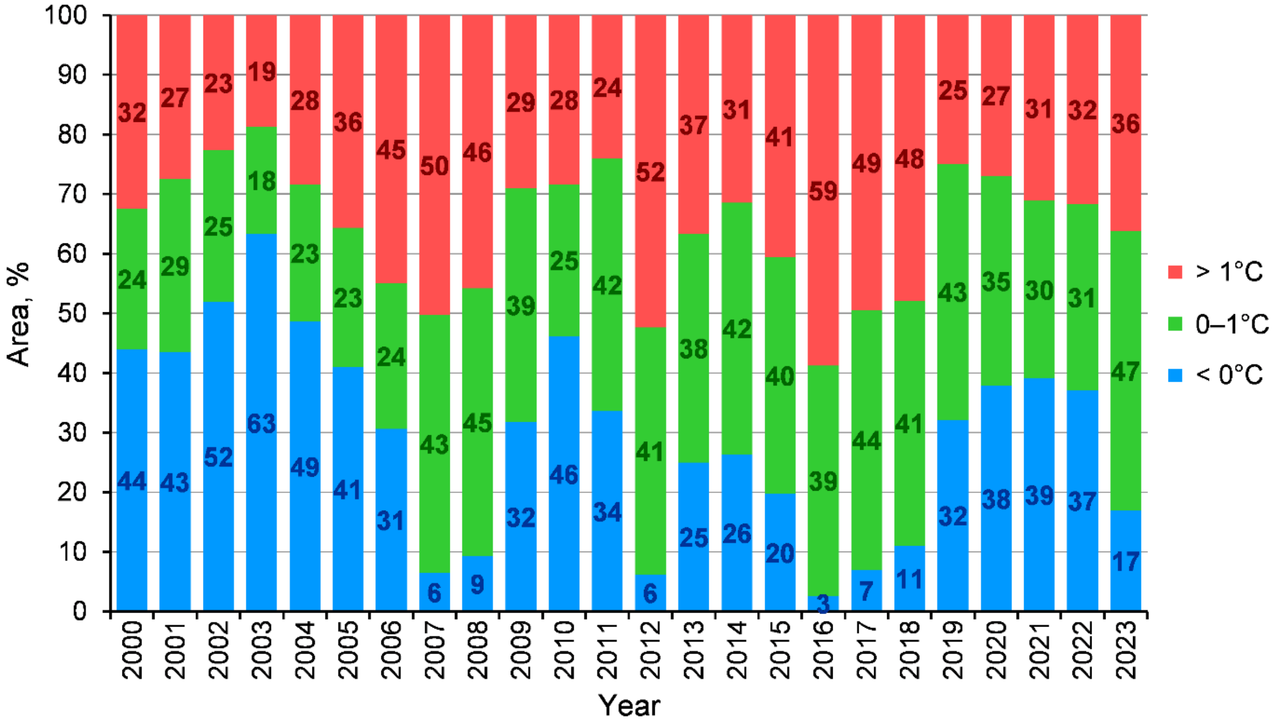


Figure 1. Area of bottom waters with different temperature ranges in the Barents Sea in September-October 2000-2023.

Mesozooplankton

The results from the joint Norwegian-Russian Barents Sea ecosystem cruise in autumn 2023 show the typical pattern of comparatively high mesozooplankton biomasses in the southwestern and northerly regions, and in the deeper part of the southeastern area. Biomasses were much lower on the banks in central regions, and particularly low in the southeastern corner of the Barents Sea. Considering the overall mesozooplankton biomass in 2023, the levels in western areas influenced by inflowing Atlantic water were comparable to earlier years when considering year-to-year variability. This was also the case for the bank regions in the central Barents Sea, as well as in the easternmost subareas. However, when studying size-fractioned biomass which is available for the Norwegian sector of the Barents Sea, the mid-size biomass fraction stands out with conspicuously low levels during the last four years. This size-fraction typically represents older stages of relatively large copepods such as *Calanus* and *Metridia* . In contrast, the smallest biomass size-fraction which generally represents small species or young stages of copepods, has shown comparatively high levels in the last two years. The low level of the mid-size biomass fraction (primarily representing large copepods) in later years is worth noting when considering the feeding conditions for fish and other predators in the ecosystem.

Prey stocks

Euphausiids, amphipods and shrimp are important prey for most commercial fish in the Barents Sea. In 2023 the total biomass of euphausiids was slightly less than long term mean (2015-2021). In recent years, the northern shrimp stock has remained stable, showing fluctuations but without a clear trend.

Capelin, polar cod and young herring are the main forage pelagic fish in the Barents Sea, which are important prey for most predators in the area, including commercial demersal species. These species are very sensitive to various changes in the ecosystem, the influence of predators, fishing, or the plankton availability. Historically, their stocks change rapidly depending on year-classes strength. Capelin abundance is still around average level now and will likely have a negative trend in 2024-2025 due to lack of strong year classes in 2021-2022 and probably insufficient feeding conditions. The average length and weight of capelin remains very low most likely due to the low biomass of plankton in the feeding areas. The recent strong herring year classes may have a negative impact on capelin recruitment also. The 2022-2023 year- classes of herring were very abundant at 0-group stage and confirmed by other recent observations. This gives a probable increase in the herring stock in the next 4-5 years. Polar cod biomass very uncertain since in recent years the area of polar cod distribution was not covered well in the ecosystem surveys. The polar cod stock is likely increasing since the consumption of cod has been much lower in recent years. In 2023, abundant polar cod at age 0 were mainly found around the Svalbard (Spitsbergen) in 2023 and for the first time since the observations started in 1980, the record strong year class came from this area.

Fish diets

Cod is a main predator in the Barents Sea. Its diet was relatively stable in recent years; capelin was the main prey. The diet composition of cod in 2023 was similar to that in 2022 (Fig. 2). Since 2013 the importance of snow crab considerably increased in cod diet and consisted of 3-7 % by weight (Fig. 3). It should be noted that in 2022-2023 an unexpected increase of red king crab up to 3-5 % by weight in the diet was observed (Fig.3), but cod consume only crab legs, empty carapaces after molting or individuals with soft carapace immediately after molting. Fig. 4 shows the consumption by cod in the period 1984-2023. Consumption of most prey decreased from 2022 to 2023 due to decrease in cod abundance.

Fig. 5 and 6 show the proportion of cod and haddock in the diet of cod. Predation of cod on juvenile cod and haddock was relatively low in recent years, but the proportion of haddock in cod diet is increasing, which is consistent with the increased abundance of young haddock in recent years.

Individual growth of cod has increased somewhat in recent years, but now seems to have stabilized. Feeding conditions for cod are expected to be adequate in the near future, as the cod likely will be able to feed on other prey if the capelin stock decreases (see Gjøsæter et al. 2009 for a discussion of ecosystem effects of capelin collapses). Also, the cod stock is decreasing so there will be less competition for food.

The diet composition of haddock is presented in Fig. 7. Haddock is benthivorous species and feed mainly on polychaets, echinoderms and molluscs (on average up to 43 % by weight). However, euphausiids and fish (including capelin and herring) can be important prey items (on average up to 13 % and 17 % by weight respectively).

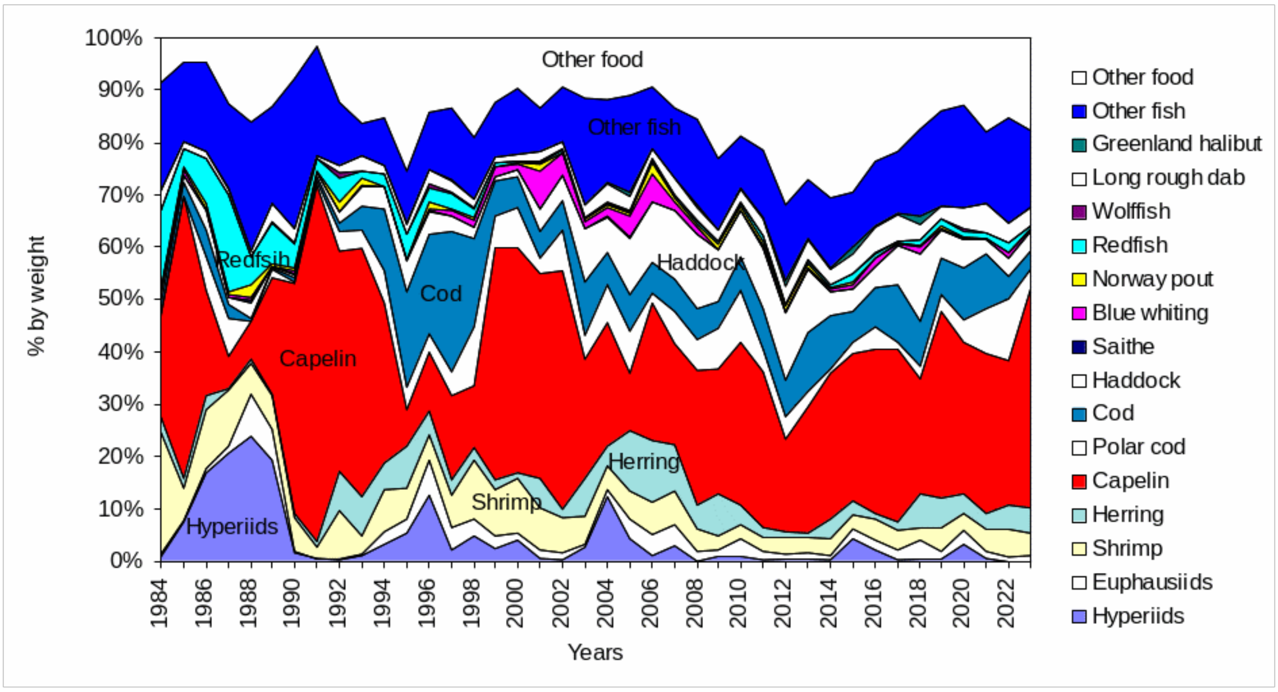


Figure 2. Diet composition of cod in 1984-2023, % by weight (The state …, 2024).

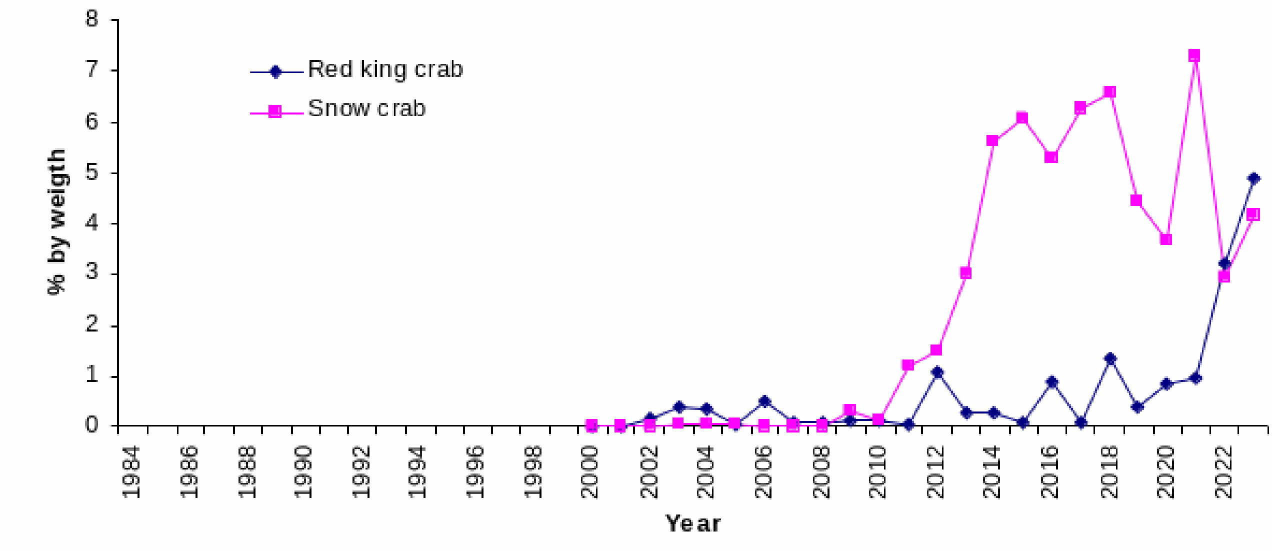


Figure 3. Importance of snow crab and red king crab in diet of cod in 1984-2023, % by weight

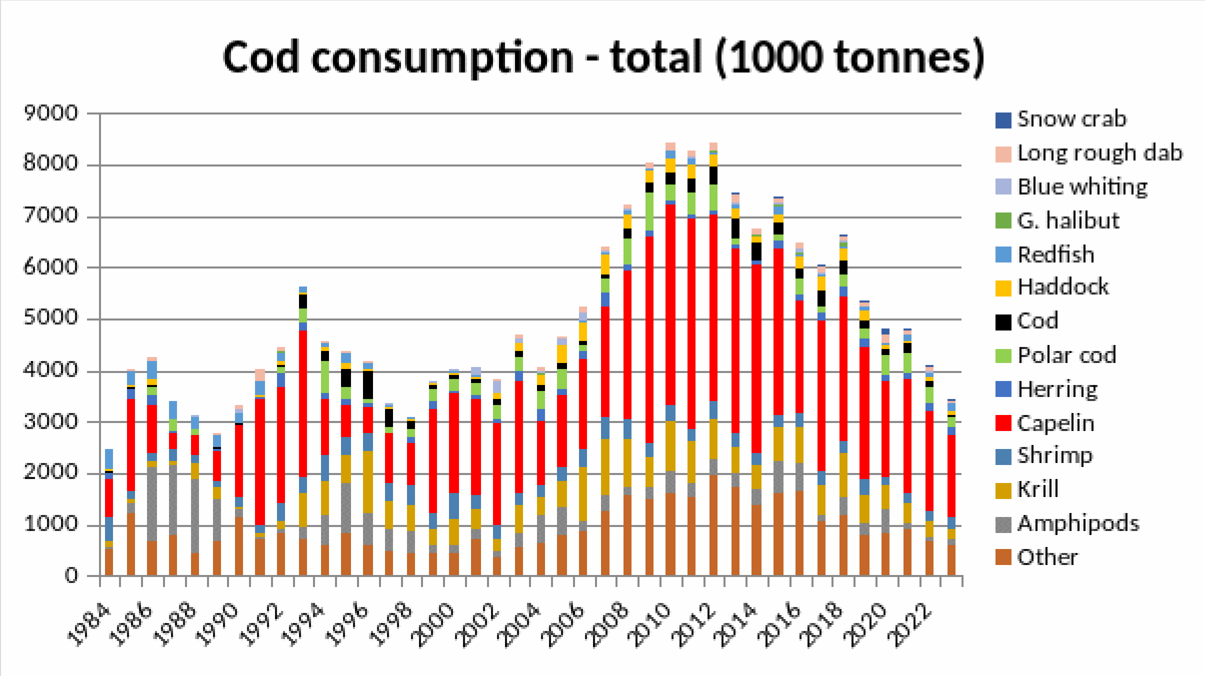


Figure 4. Consumption of various prey items by cod in 1984-2023. Norwegian calculations.

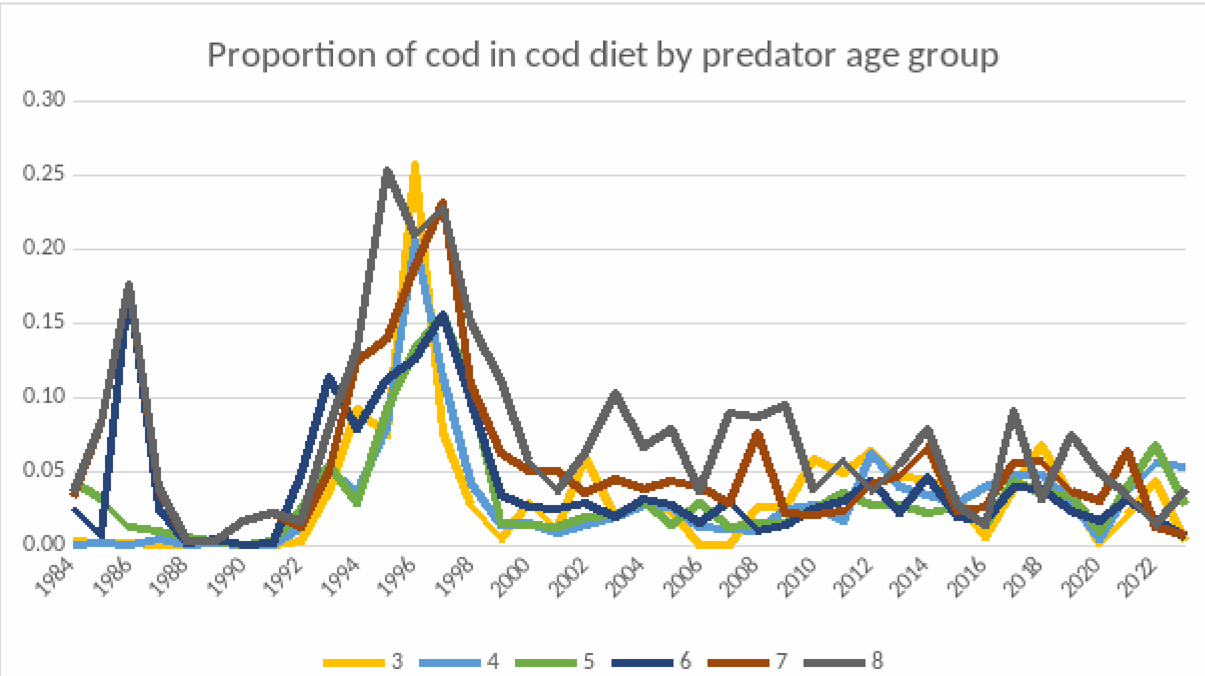


Figure 5. Proportion of cod in cod diet by predator age group.

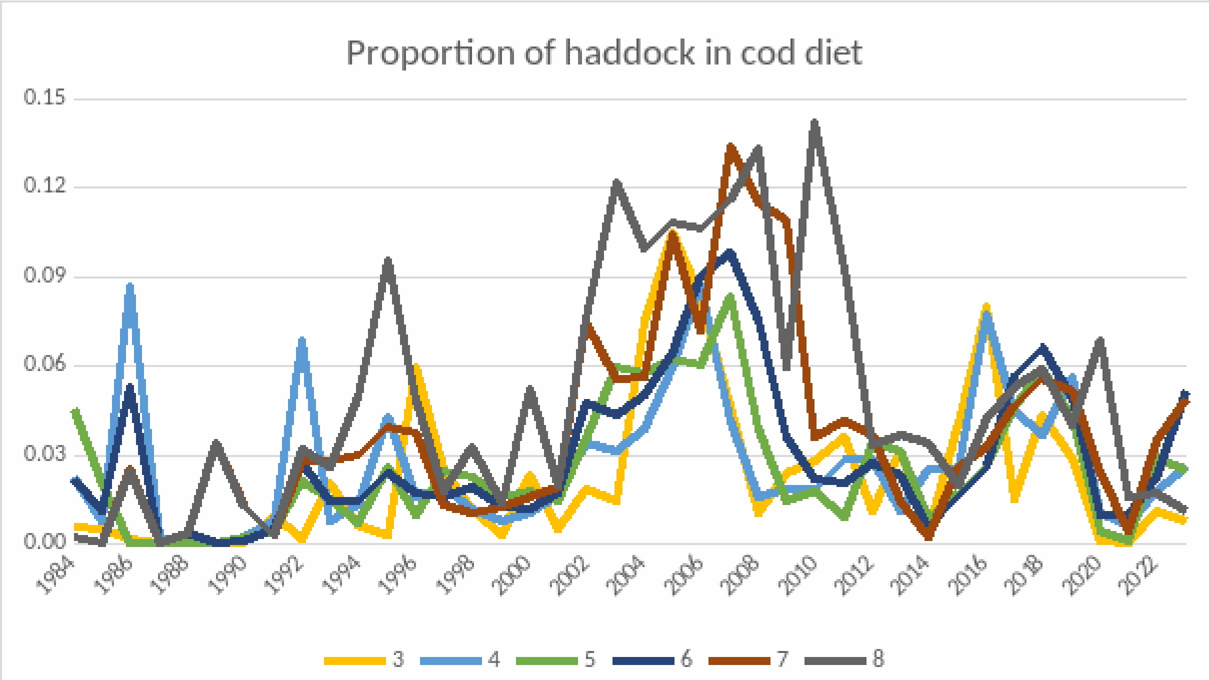


Figure 6. Proportion of haddock in cod diet by predator age group.

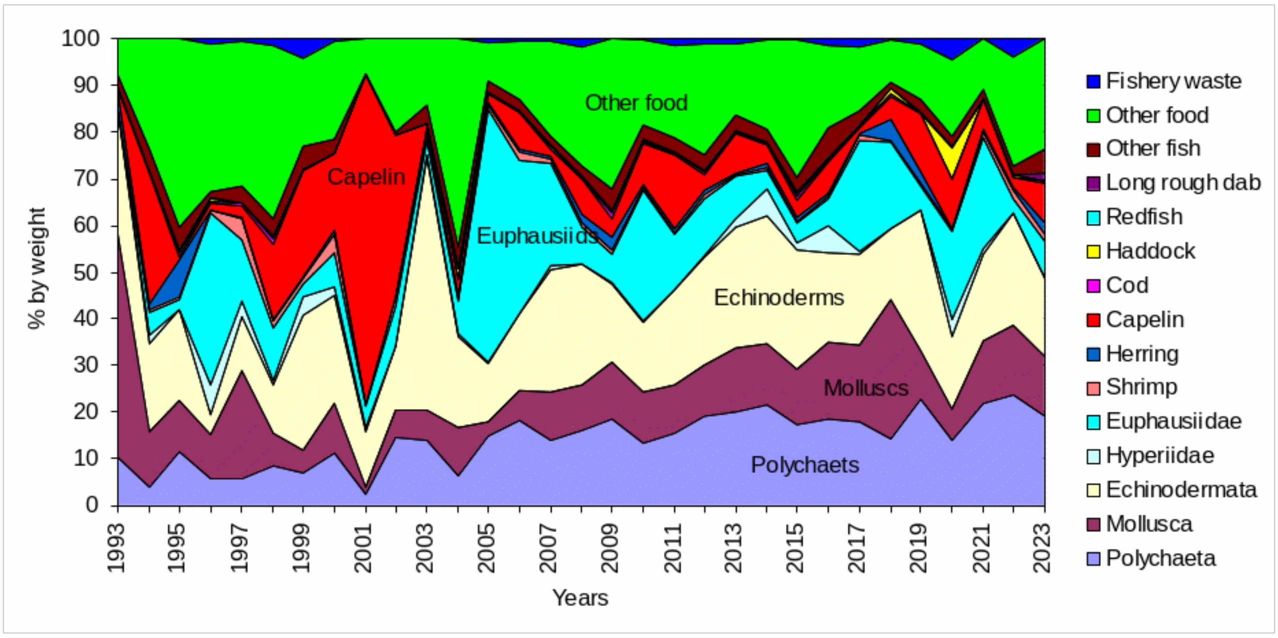


Figure 7. Diet composition of haddock in 1993-2023, % by weight (The state …, 2024).

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Gjøsæter, H., Bogstad, B., and Tjelmeland, S. 2009. Ecosystem effects of three capelin stock collapses in the Barents Sea. In Haug, T., Røttingen, I., Gjøsæter, H., and Misund, O. A. (Guest Editors). 2009. Fifty Years of Norwegian-Russian Collaboration in Marine Research. Thematic issue No. 2, Marine Biology Research 5(1):40-

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Survey report (Part 1) from the joint Norwegian/Russian Ecosystem Survey in the Barents Sea and the adjacent waters August-October 2023 Report series: IMR-PINRO Year - No.: 2024-2 Date: 20.11.2023 DOI: 10.13140/RG.2.2.19519.07842

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Chapter 3. Northeast Arctic Cod (Subareas 1 and 2)

Status of the fisheries

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 986 000 tonnes in 2014 to 693 000 tonnes in 2019-2020 before increasing to 767 000 tonnes in 2021 and decreasing again to 582 552 tonnes in 2023. 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.

Reported catches prior to 2024 (Tables 3.1-3.4, Figure 3.1)

The provisional catch of cod in Subarea 1 and divisions 2.a and 2.b for 2023 reported to the working group is 630 662 t (including both NEA cod and NCC catches).

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—2023 are given in Table 3.2. For 2012–2023 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 2023 for the southern and northern area combined were 48 110 tonnes 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 time series for coastal cod catches are now inconsistent with the coastal cod catches presented in ICES AFWG 2024 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 gears in 2023 was similar to 2022, while the proportion of catches taken in area 2b decreased markedly. 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. A description of this fishery as well as a historic overview of cod observations around Jan Mayen is given in Bogstad (2023).

Quotas, catches and advice for the period 2019-2024 for cod in the Jan Mayen area are given in Table 3.1a. These catches are not included in the catch statistics for Northeast Arctic cod.

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.

TACs and advised catches for 2023 and 2024

The Joint Norwegian-Russian Fisheries Commission (JNRFC) agreed on a cod TAC of 566 784 t for 2023, and in addition 21 000 t Norwegian coastal cod. The total reported catch of 630 662 t in 2023 was 42 878 t above 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, but thereafter the maximum transfer was reset back to the agreed 10%.

The advice for 2024 given by JRN-AFWG in 2023 was 453 427 t based on the agreed harvest control rule. The quota established by JNRFC for 2024 was set equal to the advice. In addition, the TAC for Norwegian Coastal Cod was set to the same value for 2024 as for 2023: 21 000 t.

Status of research

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 2011–2023 are not compatible with data for 2007 and previous years. Norwegian CPUE declined from 2020 to 2023 and reached the lowest level in the 2011-2023 time series (Figure 3.5). Note that double trawl is now the dominant gear in the Norwegian trawl fishery (Nedreaas and Otterå WD02), but trends are the same for single and double trawl. Russian CPUE in area 2a in 2022-2023 was the lowest since 1999 and in area 1 in 2023 it was the lowest since 2006, while in area 2b it increased somewhat from 2022 to 2023.

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

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 relatively good spatial coverage, although bad weather and ice limited the coverage somewhat.

Before 2000 this survey was made without participation from Russian vessels, while in 2001—2005, 2008—2016 and 2018-2024 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, and 2021-2024 the Norwegian vessels did not cover any part of the Russian EEZ. The methods for adjustment for incomplete area coverage are described in detail in Fall et al. (2024) and references therein. 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.

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. Changes in the survey methodology through time are described in Appendix 2 in Fall et al. (2024). 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.

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 2014–2024 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 2014-2024 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 2024 survey results in biomass terms was 108 thousand tonnes, this is 16 % below the 2023 level and the lowest since 2001.

A pilot survey on spawning grounds north of the area covered by the Lofoten survey was carried out in 2023 (Korsbrekke 2024), at about the same time and in the same way as the Lofoten survey. The total abundance in that area was about 17% of that in the Lofoten area. The area covered by this pilot survey is mostly covered also by the winter survey, but with much larger distance between transects at that time. Such a survey was not carried out in 2024.

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 2004–2023 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, but it was decided to keep the results in the assessment. The 2021 and 2023 coverage was adequate.

In 2022 the coverage of the Russian EEZ was done much later than the coverage of the Norwegian EEZ, with the entire survey period being from 15 August to 3 December (van der Meeren and Prozorkevitch, 2023). Also some areas were not covered. Indices based on the combined data have been calculated (Table A14), but due to the poor synopticity and incomplete coverage it was decided not to use the index for that year in the assessment.

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.

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 2018-2023 and is discontinued.

Survey results - length and weight-at-age (Tables A5-A8, A11-A12, A15, A16)

Length-at-age is shown in Table A5 for the Joint 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). Table A16 presents combined data on Weight-at-age from winter survey and Lofoten survey.

Length and weight at age in the Joint winter survey in the Barents Sea was fairly stable from 2023 to 2024, with some increase noted for ages 4 and 7. Weight at age in the Lofoten survey decreased for ages 6-9. The size at age in the BESS survey showed little change from 2022 to 2023.

Age reading

The joint Norwegian-Russian work on cod otolith reading has for many years included 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 somewhat younger (from -0.6 years for the 1940-1950s to -0.28-0 years for the 1970-1980s) 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% (Zuykova et al. 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 age groups 7 years and older. 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 for younger fish (1-5 years), underestimating for older fish (>10 years) and reading without significant difference for ages 6-9 years.

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.

Cod otoliths from 2019-2023 have not yet been exchanged between the parties. A system for transferring otoliths between IMR and Polar Branch of VNIRO needs to be set up to resume regular calibration of age readings. Images of otoliths are intended to be temporarily used instead of a physical exchange of otoliths until a system for exchange is in place.

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.

Catch-at-age (Table 3.6)

For 2023, age compositions from all areas were available from Norway, Russia, Spain and Germany.

There is a concern about the biological sampling from parts of both the Norwegian and Russian fishery that may be too low or missing. Also the split between NEA cod and coastal cod may be affected by the sampling coverage. Data from Norwegian Coast Guard vessels' length measurements onboard Russian vessels in some quarters of 2023 were used for calculation of age composition of Russian catches in Division 1, 2a and 2b.

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

The following survey data series were available:

Surveys used in assessment

Fleet code	Name	Place	Season	Age	Years

Fleet 15*	Joint bottom trawl survey	Barents Sea	Feb-Mar	3–12+	1981–2013, 2014-2024
Fleet 16	Joint acoustic survey	Barents Sea+Lofoten	Feb-Mar	3–12+	1985–2024
Fleet 18	Russian bottom trawl surv.	Barents Sea	Oct-Dec	3–12+	1982–2017
Fleet 007	Ecosystem surv.	Barents Sea	Aug-Sep	3–12+	2004–2023**

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

**2014, 2018 and 2022 data not used in the assessment

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.

Weight-at-age (Tables 3.7-3.9, A2, A4, A6, A8, A12, A16).

Catch weights

For 2023, 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—2024 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.

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.

2023 data are available and 2022 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—2023.

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 2015, 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).

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—2024, 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 WD15, 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 2020-2024.

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 years, particularly for ages 6–9. According to the combined data, maturity at age increased from 2023 to 2024 for age groups 6 and 9 and decreased for ages 7 and 8 (Table 3.11).

Assessment using SAM

SAM settings (Table 3.14)

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

SAM diagnostics (Figure 3.2 a-e)

Residuals for the SAM run are shown in Figure 3.2a, while model retrospective plots of F, SSB and recruitment are shown in Figure 3.2b. Historical retrospective pattern for final SAM run are shown in Figure 3.2c. Figure

3.2d compares observed and modelled catches in tonnes and Figure 3.2e shows the catchability by survey and age group.

The retrospective pattern is generally good (Figure 3.2b), with absolute values of Mohn's rho $< 13\%$ for SSB, R and F.

Results of assessment (Tables 3.15-3.18, 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 2023 is 0.589, which is above F_{pa} and within the F_{msy} range (Table 3.18). Fishing mortality has been increasing steadily in recent years, but now seems to have levelled off. The spawning stock biomass in 2024 is estimated to be 552 kt (Table 3.20), which is the lowest since 2002, and much lower than the peak in 2013 (2,211 kt). When comparing farther back in time, 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 2024 is estimated to 1,289 kt, which is somewhat below the long-term mean and well below the highest level observed after 1955 (3,695 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 as 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 cannibalism mortality since the benchmark meeting in 2015 (WKARCT 2015).

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 JNRFC a new version of the management rule was adopted (see section 3.5.3) . The TAC advice for 2025 is based on the agreed harvest control rule.

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).

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.

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 2015, 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* $F_{tr} = SSB / B_{pa} \times F_{msy}$ *;*

- if $B_{pa} \leq SSB \leq 2 \times B_{pa}$*, then* $F_{tr} = F_{msy}$ *;*

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

- if $SSB \geq 3 \times B_{pa}$*, then* $F_{tr} = 1.5 \times F_{msy}$ *;*

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.*

Prediction

Prediction input (Tables 3.19a)

The input data to the short-term prediction with management option table (2024—2027) are given in Table 3.19a. For 2024 stock weights and maturity were calculated from surveys as described in Sections 3.3.2 and 3.3.4.

Catch weights in 2024 onwards and stock weights in 2025 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 the 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 2021 benchmark).

The maturity ogive for the years 2025—2027 was predicted by using the 2022-2024 average. The fishing pattern in 2024 and later years was set equal to the previous 3 years. The stock annex prescribes average over 5 years, but as there has been a clear shift in the fishing pattern in recent years towards exploiting younger fish, a 3-year average was considered to be more appropriate. A 3-year average was also used in last year's assessment.

The stock number-at-age in 2024 was taken from the final SAM run (Table 3.16) for ages 4 and older. The recruitment at age 3 in the years 2024—2027 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—2023. There was no clear trend in natural mortality, but the average M values for the last 3 years are used to predict natural mortality of age groups 3—6 for years 2024—2027 (based on benchmark decision, WKARCT 2015 and unchanged at WKBaRFar 2021).

The assessment shows an increasing F from 2012 to 2023. 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 2023 (*status quo*) is used for F in the intermediate year (2024). Table 3.19 shows input data to the predictions. The results of prediction show that the catch in 2024 predicted using F_{sq} is close to the agreed TAC.

Recruitment prediction (Table 3.19b-c)

At the 2008 AFWG meeting it was decided to use a hybrid model, which is a weighted arithmetic mean of different recruitment models. This model has not performed well in recent years (as shown e.g. in Fig. 3.2c for the prediction of age 3 abundance in the assessment (intermediate) year. Also, the 2023 JRN-AFWG concluded a review of recruitment models was needed. Additionally, some of the oceanographic time series used in the hybrid model are no longer updated. Thus, a thorough analysis of existing recruitment models and five proposed new models, as well as using recent averages of recruitment values was carried out (Kovalev and Chetyrkin, WD6).

First, an analysis was carried out based on the results of the 2023 assessment, and models were evaluated based on how well they performed over the period 2010-2022. For the models which performed best, the analysis was repeated based on the 2024 assessment and their performance for the period 2014-2023. The input data for the RCT3 model, which is one of those considered in this final analysis, is given in Table 3.19b and the results in Table 3.19c. A summary of the results of the models considered for use in the prediction is given in Table 3.19d. Based on the model performance, the RCT3 model was chosen for predicting 1-3 years ahead (i. e. the recruitment at age 3 in 2024, 2025 and 2026), and an average of the recent 4 years was chosen to predict 4 years ahead (i.e. the recruitment at age 3 for 2027 being calculated as the 2021-2024 average). This gave recruitment values of 587 million for 2024, 450 million for 2025, 375 million for 2026 and 340 million for 2027. For the age 3 recruitment in 2024, the results of running RCT3 with/without the ecosystem survey and SAM were all very similar.

It is suggested to rerun an analysis of various recruitment models each year.

Issues to be considered for the future:

Including the ecosystem survey in the RCT3 analysis.

Evaluate the performance of the SAM model for the 1-year-ahead prediction. The Mohn's rho for SAM is currently quite good (12% for the last 5 years), but the retrospective performance of SAM has not been compared to the models proposed in WD6.

Prediction results (Tables 3.20-3.21)

The catch corresponding to F_{sq} in 2024 is 477 185 tonnes (Table 3.20), which is close to the agreed TAC of 453 427 tonnes. The resulting SSB in 2025 is 451 kt, which is 18 % lower than the SSB in 2024. Table 3.20 shows the short-term consequences over a range of F-values in 2025. The detailed outputs corresponding to F_{sq} in 2024 and the F corresponding to the HCR and F_{pa} in 2025 is given in Table 3.21. Summarised results are shown in the text table below.

Since SSB in 2025 is below B_{pa} =460 000 t, F = 0.40*SSB(2025)/B_{pa} =0.3918 is used in the 3-year prediction, giving catches of 287 330, 309 101 and 338 329 tonnes in 2025, 2026 and 2027, respectively. The average of this is 311 587 tonnes. As SSB is below B_{pa} in 2025, the 20% limit on annual change in TAC does not apply.

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

Basis	Total catch (2025)	F (2025)	SSB(2026)	% SSB change *	% TAC change **	% Advice change ***
Management plan^	311 587	0.43	410 740	-9	-31	-31
Other options						
F_{MSY} ****	292 245	0.40	425 617	-6	-36	-36
F = 0	0	0	664 770	48	-100	-100
$F = F_{2023}$	395 821	0.589	347 651	-23	-13	-13
F_{pa}	292 245	0.40	425 617	-6	-36	-36
F_{lim}	466 835	0.74	296 859	-34	3	3

* SSB 2026 relative to SSB 2025.

** Advice for 2025 relative to TAC for 2024 (453 427 tonnes).

*** Advice for 2025 relative to advice for 2024.

**** F = 0.40 corresponds to the lower bound of the F_{MSY} range (0.40-0.60), F not reduced for SSB being below B_{pa}.

^ Since SSB in 2025 is below B_{pa} =460 000 t, F = 0.40*SSB(2025)/B_{pa} =0.3918 is used in the 3-year prediction, giving catches of 287 330, 309 101 and 338 329 tonnes in 2025, 2026 and 2027, respectively. The average of this is 311 587 tonnes. As SSB is below B_{pa} in 2025, the 20% limit on annual change in TAC does not apply.

The advice for 2025 is 31% lower than the advice for 2024. The downward adjustment of stock size since last year's assessment and the declining stock trend both contribute to the reduction in advice. In addition, the 20% TAC change constraint was applied in the advice for 2024, resulting in higher advice than that resulting from the F_{target}. The stability constraint does not apply for 2025 because SSB has dropped below B_{pa}, and therefore advice for 2025 corresponds to F_{target} , and is considerably lower than the advice for 2024.

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.

Medium-term predictions (Figure 3.8)

The inputs for medium-term prediction are the same as for short-term ones. For years after terminal year in short-term prediction the same value as for this year are used for all parameters except target fishing mortality which is according to the HCR.

The stock size has been decreasing in recent years due to low incoming recruitment, downward adjustment of the stock size (due to model modifications at the benchmark in 2021) and increasing fishing mortality. The increase in fishing mortality is partly due to the 20% limit on annual reduction of TAC. Recruitment in coming years (2022-2025 year classes) is also estimated to be below average. The reason for low recent recruitment is not known. Previous periods of low recruitment have mainly occurred when temperature is below average, which is not the case at present.

The predictions for 2025 and following years indicate that catches and total stock biomass will increase slightly after 2025 while SSB will reach its lowest level in 2027 and then increase slightly. (Figure 3.8).

Comparison to 2023 assessment

The text table below compare this year's estimates with the 2023 JRN-AFWG estimates for numbers at age (millions), total biomass, spawning biomass (thousand tonnes) in 2023, as well as reference F for the year 2022.

		N(2023)															
Assessment year	F(2022)	age3	age4	age5	age6	age7	age8	age9	age10	age11	age12	age13	age14	age15	TSB (2023)	SSB (2023)	F (2023)
2023	0.574	446.0*	150.6	185.0	159.7	104.4	54.4	35.1	9.1	3.6	2.8	1.3	0.5	1.2	1610	719	0.574**
2024	0.582	231.0	138.4	160.9	141.4	111.5	62.9	33.9	9.2	3.2	1.8	0.6	0.3	0.6	1501	710	0.589
Ratio 2024/2023	1.01	0.52	0.92	0.87	0.89	1.07	1.16	0.97	1.01	0.88	0.64	0.47	0.51	0.50	0.93	0.99	1.03

Number at age

In the current assessment, the number of age 7, 8 and 10 in 2023 was adjusted upwards compared to the 2023 JRN-AFWG assessment, while the other age groups was adjusted downwards. The largest downwards adjustments were seen for age 3 (recruitment) and ages 12 and older.

Comparison to prediction

The change in the advice is large compared to last year. The advice for 2025 is 311 587 tonnes, while the advice for 2024 given by JRN-AFWG was 453 427 tonnes. The 2024 assessment adjusted the stock size in recent years slightly downwards. The main tendency for stock decrease in recent years was similar to last year's assessment.

Concerns with the assessment and management advice

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.

In recent years stock size has been overestimated (particularly before the 2021 benchmark) and the stock is declining due to recruitment being below average. In this situation, the 20% limit on annual TAC change has led to fishing pressure well above the target in the HCR for several years, and this may pose a danger to the stock. The SSB has now fallen below B_{pa} , and to continue to apply the stability constraint would no longer be precautionary. The allowed 10% quota transfer between years compounds this issue in such a situation and this allowance should be reduced at low stock sizes.

Additional assessment methods

All models use the same tuning data.

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 (Tables 3.22-3.24) 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.

Model comparisons (Figures 3.2a, 3.6c, 3.7)

Figure 3.7 compares the results of SAM and TISVPA, showing F, SSB, TSB and recruitment. Trends are similar in all models, but TISVPA gives higher F in 2023 and lower biomass in 2024 than SAM. However, recruitment in 2023 is higher in TISVPA than in SAM. Both models show a reasonable retrospective pattern (Figures 3.2a, 3.6c).

New and revised data sources

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

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).

Discard and bycatch data

Work on updating discard and bycatch data series is ongoing. Revised bycatch estimates in numbers for the period 2005-2023 are shown in ICES AFWG-2024 Fig. 0.1. 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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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

Year	Subarea 1	Division 2.a	Division 2.b	Unreported catches	Total catch
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
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

Year	Subarea 1	Division 2.a	Division 2.b	Unreported catches	Total catch
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
2018	249397	321548	207681		778627
2019	234985	318539	139084		692609
2020	234029	298707	160166		692903
2021	281198	268942	217144		767284
2022	236173	256394	226644		719211
2023 [1]	260853	202358	119341		582552

Data provided by Working Group members

1 Provisional figure

Table 3.1a Advice, quota and official Norwegian catches (tonnes) in the fishery zone around Jan Mayen (part of ICES area 2a).

Year	Advice		TAC	CATCH
2018	-		-	441
2019	-		800	628
2020	-		800	522
2021	600		600	146
2022	347		347	276
2023	315		315	181
2024	0		0	

Table 3.2. Catches of Norwegian Coastal Cod in subareas 1 and 2, 1000 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

Year	Norwegian catches of cod removed from the NEAC cod -assessment
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
2022	40.3
2023	48.1

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

		Subarea 1		Division 2.a		Division 2.b	
Year		**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
2018		204.7	44.7	156.7	164.9	192.0	15.6
2019		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		220.8	60.4	120.2	148.7	202.1	15.1
2022		192.9	43.3	108.9	147.4	212.9	13.7
2023	[1]	218.5	42.4	90.9	111.5	112.6	6.8

Data provided by Working Group members

1 Provisional figures

Table 3.4. Northeast Arctic COD. Nominal catch(t) by countries. (Subarea 1 and divisions 2a and 2b combined, data provided by Working group members

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep.Germany	Greenland	Iceland	Norway	Poland	United Kingdom	Russia**	Spain	(
1961	3934	13755	3921	8129			268377	-	158113	325780		
1962	3109	20482	1532	6503			225615	-	175020	476760		
1963	-	18318	129	4223			205056	108	129779	417964		
1964	-	8634	297	3202			149878	-	94549	180550		
1965	-	526	91	3670			197085	-	89962	152780		
1966	-	2967	228	4284			203792	-	103012	169300		
1967	-	664	45	3632			218910	-	87008	262340		
1968	-	-	225	1073			255611	-	140387	676758		

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep.Germany	Greenland	Iceland	Norway	Poland	United Kingdom	Russia**	Spain
1969	29374	-	5907	5543			305241	7856	231066	612215	
1970	26265	44245	12413	9451			377606	5153	181481	276632	
1971	5877	34772	4998	9726			407044	1512	80102	144802	
1972	1393	8915	1300	3405			394181	892	58382	96653	
1973	1916	17028	4684	16751			285184	843	78808	387196	
1974	5717	46028	4860	78507			287276	9898	90894	540801	
1975	11309	28734	9981	30037			277099	7435	101843	343580	
1976	11511	20941	8946	24369			344502	6986	89061	343057	
1977	9167	15414	3463	12763			388982	1084	86781	369876	
1978	9092	9394	3029	5434			363088	566	35449	267138	
1979	6320	3046	547	2513			294821	15	17991	105846	
1980	9981	1705	233	1921			232242	3	10366	115194	
1981	12825	3106	298	2228			277818		5262	83000	14500
1982	11998	761	302	1717			287525		6601	40311	14515
1983	11106	126	473	1243			234000		5840	22975	14229
1984	10674	11	686	1010			230743		3663	22256	8608
1985	13418	23	1019	4395			211065		3335	62489	7846
1986	18667	591	1543	10092			232096		7581	150541	5497
1987	15036	1	986	7035			268004		10957	202314	16223
1988	15329	2551	605	2803			223412		8107	169365	10905
1989	15625	3231	326	3291			158684		7056	134593	7802
1990	9584	592	169	1437			88737		3412	74609	7950
1991	8981	975		2613			126226		3981	119427***	3677
1992	11663	2		3911	3337		168460		6120	182315	6217
1993	17435	3572		5887	5389	9374	221051		11336	244860	8800
1994	22826	1962		8283	6882	36737	318395		15579	291925	14929
1995	22262	4912		7428	7462	34214	319987		16329	296158	15505
1996	17758	5352		8326	6529	23005	319158		16061	305317	15871
1997	20076	5353		6680	6426	4200	357825		18066	313344	17130
1998	14290	1197		3841	6388	1423	284647		14294	244115	14212
1999	13700	2137		3019	4093	1985	223390		11315	210379	8994
2000	13350	2621		3513	5787	7562	192860		9165	166202	8695
2001	12500	2681		4524	5727	5917	188431		8698	183572	9196
2002	15693	2934		4517	6419	5975	202559		8977	184072	8414
2003	19427	2921		4732	7026	5963	191977		8711	182160	7924

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep.Germany	Greenland	Iceland	Norway	Poland	United Kingdom	Russia**	Spain	(
2004	19226	3621		6187	8196	7201	212117		14004	201525	11285	
2005	16273	3491		5848	8135	5874	207825		10744	200077	9349	
2006	16327	4376		3837	8164	5972	201987		10594	203782	9219	
2007	14788	3190		4619	5951	7316	199809		9298	186229	9496	
2008	15812	3149		4955	5617	7535	196598		8287	190225	9658	
2009	16905	3908		8585	4977	7380	224298		8632	229291	12013	
2010	15977	4499		8442	6584	11299	264701		9091	267547	12657	
2011	13429	1173		4621	7155	12734	331535		8210	310326	13291	1
2012	17523	2841		8500	8520	9536	315739		11166	329943	12814	
2013	13833	7858		8010	7885	14734	438734		12536	432314	15042	
2014	33298	8149		6225	10864	18205	431846		14762	433479	16378	
2015	26568	7480		6427	7055	16120	377983		11778	381778	19905	
2016	24084	7946		6336	8607	16031	348949		13583	394107	14640	
2017	28637	9554		5977	13638	11925	357419		16731	396180	14414	
2018	26152	6605		9768	12743	10708	333539		11533	340364	13143	
2019	22270	6371		8470	7553	12294	282120		11214	316813	13939	
2020	21679	5796		9725	7391	9734	289472		12113	312683	11403	
2021	21767	4459		6190	8246	8933	337931		5426	352064	11080	
2022	21530	4988		7134	7688	6214	310145		7024	333697	12214	
2023*	17556	4632		5630	3994	5157	242117		5972	276923	8030	

* Provisional figures

** USSR prior to 1991.

*** Includes Baltic countries.

^ Includes unspecified EU catches.

^^ In 2022-2024 assessment and advice was carried out by the Joint Russian-Norwegian working group on Arctic Fisheries (JRN-AFWG) which compiled catches for 2021-2023 and gave advice for 2023-2025.

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 (REZ). "Index ratio by age" 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		
1995	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	203.6		
2014	266.8		
2015	243.3		
2016	228.0		
2017	184.4	37.5	Index ratio by age
2018	236.3		
2019	241.2		
2020	203.2	25.1	Index ratio by age
2021	232.0	10.9	Index ratio by age
2022	232.7		
2023	253.3		
2024	263.1		

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Table 3.6. Northeast Arctic cod. Catch numbers-at-age (Thous)

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

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
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	NA
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

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
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	NA	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	NA	NA	2
1992	21835	36015	27494	23392	18351	13541	18321	2529	264	82	3	9	NA
1993	10094	46182	63578	33623	14866	9449	6571	12593	1749	377	63	22	NA
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	NA
1996	7655	28782	80711	100509	54590	10545	2023	930	462	230	809	84	NA
1997	12827	36491	69633	83017	65768	28392	4651	1151	373	213	144	238	NA
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	NA	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	NA
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	3	4	5	6	7	8	9	10	11	12	13	14	+gp	
2022	5725	23486	53467	68112	47067	30569	11776	6046	3797	1489	575	164	107	
2023	11046	15493	30653	37250	38616	28163	16233	5885	1995	984	195	56	94	

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

Norway													
Year			Age										
	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
2022	0.32	0.71	1.15	1.73	2.42	3.36	4.47	5.79	7.18	8.65	10.09	11.45	12.93	16.43
2023	0.38	0.80	1.23	1.79	2.51	3.39	4.47	5.80	7.23	8.74	9.86	11.79	13.66	15.78

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

Russia (trawl only)															
Year				Age											
		2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
2022		0.39	0.62	0.91	1.42	2.21	3.22	4.45	6.15	8.16	9.91	10.83	11.96		10.33
2023		0.36	0.63	1.03	1.55	2.29	3.27	4.49	5.81	7.05	8.92	9.99	10.77		

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

Germany (Division IIa and IIb)															
Year				Age											
		2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
2022	1		0.59	0.82	1.40	2.20	3.04	4.13	5.54	7.36	8.56	10.79	13.12	14.96	15.18
2023	2		0.74	0.94	1.25	1.89	2.97	4.36	5.7	5.55	8.4	10.06	9.86	22.68	
1	Division IIa only														
2	IIa and IIb combined														
3	I,IIa and IIb combined														
4	Division IIb only														
5	I and IIa combined														

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

Spain (Division IIb)															
Year				Age											
		2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
2022	2		0.49	0.80	1.25	1.83	2.77	4.06	5.52	7.71	8.87	12.18			
2023	2		0.54	1.15	1.56	2.28	3.27	4.24	5.56	6.62	8.62	7.00	12.98	16.92	
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													

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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	0.350	0.590	1.110	1.690	2.370	3.170	3.980	5.050	5.920	7.200	8.150	8.130	9.250
1947	0.320	0.560	0.950	1.500	2.140	2.920	3.650	4.560	5.840	7.420	8.850	8.790	10.000
1948	0.340	0.530	1.260	1.930	2.460	3.360	4.220	5.310	5.920	7.090	8.430	8.180	9.430
1949	0.370	0.670	1.110	1.660	2.500	3.230	4.070	5.270	5.990	7.080	8.220	8.260	8.700
1950	0.390	0.640	1.290	1.700	2.360	3.480	4.520	5.620	6.400	7.960	8.890	9.070	10.270
1951	0.400	0.830	1.390	1.880	2.540	3.460	4.880	5.200	7.140	8.220	9.390	9.500	9.520
1952	0.440	0.800	1.330	1.920	2.640	3.710	5.060	6.050	7.420	8.430	10.190	10.130	10.560
1953	0.400	0.760	1.280	1.930	2.810	3.720	5.060	6.340	7.400	8.670	10.240	11.410	11.930
1954	0.440	0.770	1.260	1.970	3.030	4.330	5.400	6.750	7.790	10.670	9.680	9.560	11.110
1955	0.320	0.570	1.130	1.730	2.750	3.940	4.900	7.040	7.200	8.780	10.080	11.020	12.110
1956	0.330	0.580	1.070	1.830	2.890	4.250	5.550	7.280	8.000	8.350	9.940	10.250	11.560
1957	0.330	0.590	1.020	1.820	2.890	4.280	5.490	7.510	8.240	9.250	10.610	10.820	12.070
1958	0.340	0.520	0.950	1.920	2.940	4.210	5.610	7.350	8.670	9.580	11.630	11.000	13.830
1959	0.350	0.720	1.470	2.680	3.590	4.320	5.450	6.440	7.170	8.630	11.620	11.950	13.000
1960	0.340	0.510	1.090	2.130	3.380	4.870	6.120	8.490	7.790	8.300	11.420	11.720	13.420
1961	0.310	0.550	1.050	2.200	3.230	5.110	6.150	8.150	8.680	9.600	11.950	13.180	13.420
1962	0.320	0.550	0.930	1.700	3.030	5.030	6.550	7.700	9.270	10.560	12.720	13.480	14.440
1963	0.320	0.610	0.960	1.730	3.040	4.960	6.440	7.910	9.620	11.310	12.740	13.190	14.290
1964	0.330	0.550	0.950	1.860	3.250	4.970	6.410	8.070	9.340	10.160	12.890	13.250	14.000
1965	0.380	0.680	1.030	1.490	2.410	3.520	5.730	7.540	8.470	11.170	13.720	13.460	14.120
1966	0.440	0.740	1.180	1.780	2.460	3.820	5.360	7.270	8.630	10.660	14.150	14.000	15.000
1967	0.290	0.810	1.350	2.040	2.810	3.480	4.890	7.110	9.030	10.590	13.830	14.150	16.760
1968	0.330	0.700	1.480	2.120	3.140	4.210	5.270	6.650	9.010	9.660	14.850	16.300	17.000

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
1969	0.440	0.790	1.230	2.030	2.900	3.810	5.020	6.430	8.330	10.710	14.210	15.000	17.000
1970	0.370	0.910	1.340	2.000	3.000	4.150	5.590	7.600	8.970	10.990	14.070	14.610	16.000
1971	0.450	0.880	1.380	2.160	3.070	4.220	5.810	7.130	8.620	10.830	12.950	14.250	15.970
1972	0.380	0.770	1.430	2.120	3.230	4.380	5.830	7.620	9.520	12.090	13.670	13.850	16.000
1973	0.380	0.910	1.540	2.260	3.290	4.610	6.570	8.370	10.540	11.620	13.900	14.000	15.840
1974	0.320	0.660	1.170	2.220	3.210	4.390	5.520	7.860	9.820	11.410	13.240	13.700	14.290
1975	0.410	0.640	1.110	1.900	2.950	4.370	5.740	8.770	9.920	11.810	13.110	14.000	14.290
1976	0.350	0.730	1.190	2.010	2.760	4.220	5.880	9.300	10.280	11.860	13.540	14.310	14.280
1977	0.490	0.900	1.430	2.050	3.300	4.560	6.460	8.630	9.930	10.900	13.670	14.260	14.910
1978	0.490	0.810	1.450	2.150	3.040	4.460	6.540	7.980	10.150	10.850	13.180	14.000	15.000
1979	0.350	0.700	1.240	2.140	3.150	4.290	6.580	8.610	9.220	10.890	14.340	14.500	15.310
1980	0.270	0.560	1.020	1.720	3.020	4.200	5.840	7.260	8.840	9.280	14.450	15.000	15.500
1981	0.490	0.980	1.440	2.090	2.980	4.850	6.570	9.160	10.820	10.770	13.930	15.000	16.000
1982	0.370	0.660	1.350	1.990	2.930	4.240	6.460	8.510	12.240	10.780	14.040	15.000	16.000
1983	0.840	1.370	2.090	2.860	3.990	5.580	7.770	9.290	11.550	11.420	12.800	14.180	15.550
1984	1.420	1.930	2.490	3.140	3.910	4.910	6.020	7.400	8.130	11.420	12.800	14.180	15.550
1985	0.940	1.370	2.020	3.220	4.630	6.040	7.660	9.810	11.800	11.420	12.800	14.180	15.550
1986	0.640	1.270	1.880	2.790	4.490	5.840	6.830	7.690	9.810	11.420	12.800	14.180	15.550
1987	0.490	0.880	1.550	2.330	3.440	5.920	8.600	9.600	12.170	11.420	12.800	14.180	15.550
1988	0.540	0.850	1.320	2.240	3.520	5.350	8.060	9.510	11.360	11.420	12.800	14.180	15.550
1989	0.740	0.960	1.310	1.920	2.930	4.640	7.520	9.120	11.080	11.420	12.800	14.180	15.550
1990	0.810	1.220	1.640	2.220	3.240	4.680	7.300	9.840	13.250	11.420	12.800	14.180	15.550
1991	1.050	1.450	2.150	2.890	3.750	4.710	6.080	8.820	11.800	11.420	12.800	14.180	15.550
1992	1.160	1.570	2.210	3.100	4.270	5.190	6.140	7.770	10.120	11.420	12.800	14.180	15.550
1993	0.810	1.520	2.160	2.790	4.070	5.530	6.470	7.190	7.980	11.457	12.800	14.180	15.550
1994	0.820	1.300	2.060	2.890	3.210	5.200	6.800	7.570	8.010	9.955	13.012	14.180	15.550
1995	0.770	1.200	1.780	2.590	3.810	4.990	6.230	8.050	8.740	9.774	11.388	14.546	15.550
1996	0.790	1.110	1.610	2.460	3.820	5.720	6.740	8.040	9.280	10.451	11.190	12.819	16.045
1997	0.670	1.040	1.530	2.220	3.420	5.200	7.190	7.730	8.610	11.145	11.926	12.608	14.234
1998	0.680	1.050	1.620	2.300	3.300	4.860	6.870	9.300	10.300	10.754	12.676	13.394	14.011
1999	0.630	1.010	1.540	2.340	3.210	4.290	6.000	6.730	10.080	11.151	12.255	14.191	14.839
2000	0.570	1.040	1.610	2.340	3.340	4.480	5.720	7.520	8.020	11.930	12.682	13.743	15.675
2001	0.660	1.050	1.620	2.510	3.510	4.780	6.040	7.540	9.000	10.230	13.519	14.197	15.206
2002	0.720	1.130	1.560	2.310	3.520	4.780	6.200	7.660	9.140	10.379	11.687	15.081	15.681
2003	0.670	1.120	1.830	2.500	3.580	5.040	6.360	8.200	10.710	10.167	11.848	13.138	16.602
2004	0.720	1.130	1.610	2.430	3.270	4.720	6.710	7.980	9.190	10.840	11.619	13.310	14.571

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
2005	0.690	1.080	1.570	2.210	3.260	4.440	6.230	8.190	9.720	10.626	12.347	13.066	14.752
2006	0.720	1.160	1.600	2.390	3.320	4.540	5.470	6.780	7.700	10.800	12.116	13.842	14.494
2007	0.740	1.210	1.830	2.510	3.820	5.040	6.580	8.080	8.940	10.349	12.304	13.596	15.309
2008	0.770	1.270	1.870	2.820	3.790	5.120	6.220	7.750	8.400	10.139	11.816	13.795	15.052
2009	0.750	1.170	1.740	2.420	3.860	5.350	6.430	8.010	8.670	10.055	11.588	13.276	15.261
2010	0.780	1.200	1.740	2.440	3.400	5.040	6.250	7.320	8.530	10.378	11.496	13.033	14.715
2011	0.780	1.310	1.720	2.370	3.200	4.620	6.180	7.470	8.570	10.387	11.847	12.935	14.459
2012	0.670	1.140	1.730	2.340	3.120	4.400	6.280	8.240	10.350	10.367	11.857	13.309	14.356
2013	0.710	1.170	1.670	2.360	3.190	4.220	5.580	7.310	9.080	11.029	11.835	13.320	14.750
2014	0.790	1.200	1.730	2.340	3.280	4.210	5.490	6.980	8.670	10.823	12.551	13.297	14.761
2015	0.780	1.090	1.550	2.180	3.140	4.460	5.610	6.620	7.340	10.215	12.328	14.058	14.737
2016	0.780	1.140	1.660	2.260	3.250	4.500	5.980	7.310	8.540	9.372	11.670	13.822	15.536
2017	0.710	1.150	1.660	2.320	3.320	4.670	6.130	7.150	8.140	9.597	10.752	13.121	15.288
2018	0.860	1.170	1.710	2.500	3.310	4.610	6.030	7.320	8.060	9.707	10.998	12.137	14.552
2019	0.680	1.150	1.660	2.390	3.330	4.450	6.110	7.290	8.410	9.806	11.117	12.401	13.513
2020	0.709	1.084	1.604	2.195	3.092	4.390	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
2022	0.623	0.956	1.478	2.245	3.247	4.441	5.877	7.328	8.738	10.122	11.427	12.858	14.051
2023	0.638	1.056	1.617	2.346	3.310	4.470	5.794	7.141	8.777	9.988	11.519	12.792	14.184

* values starting from 1993, ages 12-15, have been updated by the VB model using the most recent actual data for ages 3-11

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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

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
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
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

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
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	16.971	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	11.361	13.279	15.613	17.706
2023	0.272	0.645	1.022	1.71	2.876	4.352	5.925	7.879	9.79	11.36	13.478	15.46	17.876
2024	0.246	0.706	1.075	1.803	2.667	3.995	5.95	7.011	9.436	11.714	13.477	15.683	17.707

2023 data updated,

values starting from 1993, ages 12-15, have been updated by the VB model using the most recent actual data for ages 3-11

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
2023**	0	0	0.3	12.3	50.9	84.3	92.6	97.5
2024**	0	0	1.4	10.2	32.5	74.8	97.4	100
***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	68.6	93.2	96.7	99.8
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
2023	0.80	2.10	2.29	8.89	49.84	80.60	94.93	94.05
2024	0.00	0.30	1.08	10.98	37.92	73.88	96.51	99.23

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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

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
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
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

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
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
2023	0.007	0.02	0.019	0.074	0.454	0.774	0.93	0.931	1	1	1	1	1

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp
2024	0	0.003	0.009	0.091	0.345	0.709	0.946	0.982	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	444.692	22.438	0.216	0.000	0.000	0.000
1985	1627.802	354.039	71.711	0.198	0.000	0.000	0.000
1986	69.080	1114.780	343.699	87.608	0.000	0.000	0.000
1987	649.421	194.012	325.201	14.392	0.000	0.000	0.000
1988	32.172	485.301	26.482	1.791	0.000	0.000	0.000
1989	953.718	142.813	0.000	0.000	0.000	0.000	0.000
1990	0.000	110.169	23.524	0.000	0.000	0.000	0.000
1991	118.095	138.911	182.399	1.621	0.000	0.000	0.000
1992	3148.272	894.249	143.699	4.190	0.000	0.000	0.000
1993	3860.477	18251.786	479.661	46.391	1.306	0.420	0.000
1994	7963.520	7018.563	648.501	129.613	49.590	7.864	0.409
1995	8174.708	14866.757	759.039	211.213	67.018	3.730	0.222
1996	10170.629	21688.051	1473.363	136.550	52.811	18.502	1.070
1997	3069.149	17614.488	1897.232	165.961	15.751	1.218	0.220
1998	92.182	5690.457	577.717	204.732	23.508	1.459	0.467
1999	635.509	2104.161	303.649	50.828	4.193	0.004	0.000
2000	1912.370	2547.861	188.046	38.319	13.963	3.834	0.042
2001	94.476	2395.845	114.635	23.795	11.590	1.786	0.909
2002	7560.920	456.443	404.266	41.245	5.290	0.801	0.017
2003	5396.707	4104.542	107.603	24.088	0.000	0.000	0.000
2004	6482.152	2399.712	566.564	20.340	10.338	1.294	0.221
2005	2473.242	3030.902	133.121	79.648	4.494	5.462	0.509
2006	3312.722	2121.951	150.212	6.219	2.007	0.074	0.000
2007	2298.412	1150.968	187.898	73.386	3.354	0.123	0.000
2008	14416.448	704.125	84.869	95.674	31.459	4.145	0.000
2009	9627.376	7323.184	142.831	65.586	20.246	5.023	0.214
2010	4171.341	7153.213	300.278	53.225	27.346	16.245	2.153
2011	12528.280	4410.681	449.948	171.817	39.717	10.334	4.959
2012	21032.804	11923.910	1014.296	100.801	30.171	4.260	0.000
2013	26235.707	4758.523	1539.876	170.857	16.368	7.232	1.090
2014	35801.890	6042.223	721.071	189.971	51.590	4.999	0.061

2015	1524.789	10457.642	303.122	66.519	37.821	15.951	1.571
2016	11812.914	2514.074	497.623	11.528	17.665	25.755	6.078
2017	21105.989	1559.950	380.932	114.241	7.800	4.153	2.843
2018	7183.336	13321.450	272.179	35.096	2.189	0.263	0.000
2019	826.561	8344.350	824.307	52.598	5.557	0.018	0.000
2020	3143.143	2501.133	335.946	146.024	42.186	10.364	0.537
2021	23357.280	1560.840	233.110	71.256	22.308	11.927	1.408
2022	9582.112	4408.346	281.233	12.490	1.273	0.058	0.000
2023	1878.393	1732.112	192.755	43.173	0.706	0.017	0.000

Table 3.13. Northeast Arctic COD. Tuning data

104

FLT15_I: NorBarTrSur_I

1981 2024

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

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 2024

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

1 4121 3982 4652 4317 3224 1426 749 158 34 35

1 19871 6331 3621 2996 2822 1615 890 268 37 20

FLT16: NorBarLofAcSur

1985 2024

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

1 649 591 558 402 369 163 114 143 82 34

1 294 530 570 504 476 345 116 68 53 39

1 287 265 336 346 278 183 135 32 17 15

1 1507 510 299 286 304 265 185 59 11 2

FLT18: RusSweptArea

1982 2024

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 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 12.0 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 49.0 18.5

1 2203 3088 1635 1472 830 863 291 115 33.0 19.0

1 974 2317 3687 2016 1175 620 413 205 65.0 41.0

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

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 2023

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

1 NA NA NA NA NA NA NA NA NA NA

1 699 401 571 527 450 233 93 22 8.0 8.9

Table 3.14. Parameters settings used in SAM run

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

$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 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

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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	0.069	0.137	0.270	0.248	0.379	0.396	0.572	0.563	0.626	0.648	0.648	0.250
1947	0.002	0.021	0.090	0.187	0.387	0.294	0.450	0.446	0.692	0.635	0.689	0.781	0.781	0.309
1948	0.001	0.021	0.095	0.220	0.464	0.346	0.512	0.450	0.713	0.695	0.741	0.922	0.922	0.348
1949	0.002	0.030	0.138	0.301	0.473	0.367	0.459	0.476	0.771	0.752	0.788	1.028	1.028	0.369
1950	0.002	0.043	0.163	0.314	0.436	0.363	0.481	0.538	0.838	0.855	0.816	1.149	1.149	0.382

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	FBAR5-10
1951	0.010	0.078	0.231	0.343	0.445	0.392	0.496	0.567	0.781	0.866	0.841	1.197	1.197	0.413
1952	0.014	0.103	0.277	0.430	0.475	0.408	0.523	0.639	0.843	0.920	0.844	1.199	1.199	0.459
1953	0.021	0.112	0.251	0.360	0.402	0.373	0.473	0.612	0.813	0.823	0.799	1.021	1.021	0.412
1954	0.017	0.116	0.268	0.384	0.424	0.357	0.489	0.707	0.831	0.823	0.790	0.929	0.929	0.438
1955	0.015	0.108	0.295	0.494	0.497	0.509	0.565	0.751	0.895	0.866	0.790	0.862	0.862	0.518
1956	0.018	0.122	0.349	0.581	0.559	0.598	0.589	0.740	0.892	0.986	0.824	0.804	0.804	0.570
1957	0.020	0.137	0.291	0.529	0.548	0.588	0.536	0.674	0.880	0.914	0.821	0.719	0.719	0.528
1958	0.036	0.181	0.359	0.543	0.540	0.511	0.508	0.692	0.829	0.879	0.721	0.630	0.630	0.526
1959	0.036	0.203	0.425	0.524	0.526	0.527	0.552	0.721	0.786	0.801	0.708	0.644	0.644	0.546
1960	0.037	0.212	0.406	0.510	0.495	0.546	0.523	0.755	0.854	0.802	0.698	0.711	0.711	0.539
1961	0.039	0.225	0.491	0.576	0.546	0.644	0.696	0.849	0.897	0.863	0.742	0.748	0.748	0.634
1962	0.037	0.224	0.584	0.750	0.633	0.683	0.796	1.009	0.935	0.845	0.775	0.738	0.738	0.743
1963	0.023	0.194	0.584	0.800	0.759	0.773	0.893	1.083	1.080	0.851	0.802	0.735	0.735	0.815
1964	0.018	0.159	0.412	0.554	0.585	0.700	0.934	0.883	0.978	0.802	0.881	0.755	0.755	0.678
1965	0.023	0.143	0.364	0.459	0.472	0.589	0.785	0.798	0.805	0.670	0.891	0.758	0.758	0.578
1966	0.031	0.140	0.286	0.388	0.469	0.600	0.752	0.790	0.713	0.655	0.799	0.675	0.675	0.548
1967	0.029	0.155	0.265	0.329	0.463	0.639	0.828	0.811	0.771	0.665	0.792	0.610	0.610	0.556
1968	0.025	0.176	0.356	0.433	0.495	0.633	0.847	0.832	0.747	0.600	0.799	0.631	0.631	0.599
1969	0.026	0.182	0.404	0.482	0.630	0.811	1.006	0.922	0.835	0.631	0.757	0.620	0.620	0.709
1970	0.034	0.164	0.376	0.468	0.589	0.824	0.996	0.933	0.796	0.577	0.713	0.631	0.631	0.698
1971	0.029	0.155	0.306	0.355	0.505	0.810	0.981	0.920	0.801	0.604	0.691	0.617	0.617	0.646
1972	0.049	0.183	0.333	0.402	0.427	0.719	1.058	1.013	0.895	0.652	0.745	0.636	0.636	0.659
1973	0.139	0.226	0.386	0.439	0.459	0.698	0.921	0.861	0.845	0.673	0.757	0.621	0.621	0.627
1974	0.165	0.296	0.481	0.520	0.509	0.622	0.667	0.870	0.910	0.714	0.892	0.629	0.629	0.611
1975	0.113	0.277	0.507	0.622	0.641	0.729	0.721	0.728	0.937	0.778	0.952	0.599	0.599	0.658
1976	0.146	0.307	0.530	0.615	0.687	0.852	0.874	0.672	0.796	0.821	0.942	0.676	0.676	0.705
1977	0.131	0.335	0.634	0.678	0.707	0.901	1.128	0.857	0.894	0.811	1.052	0.810	0.810	0.818
1978	0.114	0.253	0.571	0.737	0.767	0.893	1.219	0.946	1.303	1.008	1.198	0.916	0.916	0.856
1979	0.055	0.202	0.410	0.622	0.711	0.804	1.094	0.992	1.295	1.095	1.124	1.009	1.009	0.772
1980	0.037	0.158	0.345	0.628	0.723	0.809	0.998	1.057	1.230	0.997	1.161	0.907	0.907	0.760
1981	0.031	0.141	0.283	0.581	0.784	0.973	1.159	0.976	1.071	0.937	1.044	0.836	0.836	0.793
1982	0.041	0.158	0.286	0.641	0.841	0.919	1.132	0.827	0.823	0.925	0.866	0.823	0.823	0.774
1983	0.027	0.164	0.300	0.549	0.903	1.080	1.068	0.848	0.714	0.726	0.802	0.866	0.866	0.791
1984	0.023	0.156	0.331	0.582	1.063	1.167	1.167	0.899	0.747	0.702	0.671	0.892	0.892	0.868
1985	0.039	0.162	0.390	0.667	0.945	1.149	0.930	0.779	0.758	0.655	0.594	0.950	0.950	0.810
1986	0.031	0.171	0.456	0.766	0.907	1.144	0.926	1.042	0.887	0.852	0.587	1.072	1.072	0.874

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	FBAR5-10
1987	0.039	0.155	0.470	0.828	1.013	1.117	0.893	1.249	0.976	1.002	0.636	1.255	1.255	0.928
1988	0.035	0.128	0.335	0.637	0.937	1.018	1.027	1.354	0.960	0.916	0.730	1.214	1.214	0.885
1989	0.031	0.107	0.252	0.457	0.644	0.835	0.818	1.001	0.755	0.710	0.697	1.430	1.430	0.668
1990	0.019	0.093	0.178	0.308	0.416	0.500	0.550	0.590	0.654	0.611	0.626	1.311	1.311	0.424
1991	0.020	0.101	0.212	0.343	0.435	0.471	0.505	0.483	0.496	0.593	0.571	1.264	1.264	0.408
1992	0.025	0.114	0.279	0.429	0.528	0.556	0.565	0.562	0.517	0.701	0.541	1.254	1.254	0.487
1993	0.014	0.110	0.315	0.522	0.618	0.658	0.694	0.715	0.690	0.828	0.677	1.226	1.226	0.587
1994	0.012	0.110	0.322	0.596	0.924	0.916	0.875	0.855	0.915	0.935	0.776	1.213	1.213	0.748
1995	0.014	0.117	0.323	0.605	0.932	0.895	0.950	0.924	1.010	0.963	0.854	1.125	1.125	0.772
1996	0.021	0.134	0.353	0.617	0.883	0.939	0.853	1.102	0.961	0.960	0.922	1.032	1.032	0.791
1997	0.022	0.169	0.447	0.684	0.895	1.202	1.128	1.271	1.029	1.018	0.921	0.936	0.936	0.938
1998	0.027	0.182	0.474	0.712	0.852	1.161	1.136	1.317	1.052	0.897	0.830	0.787	0.787	0.942
1999	0.015	0.150	0.464	0.682	0.869	1.101	1.224	1.299	0.956	0.883	0.693	0.697	0.697	0.940
2000	0.009	0.115	0.364	0.587	0.831	1.019	1.109	1.185	0.848	0.902	0.555	0.680	0.680	0.849
2001	0.009	0.096	0.294	0.532	0.755	0.926	0.890	1.051	0.736	0.770	0.444	0.716	0.716	0.741
2002	0.008	0.091	0.276	0.520	0.775	0.887	0.840	0.794	0.628	0.731	0.391	0.679	0.679	0.682
2003	0.010	0.089	0.284	0.473	0.729	0.812	0.776	0.748	0.572	0.633	0.364	0.647	0.647	0.637
2004	0.010	0.090	0.293	0.499	0.770	0.857	0.897	0.952	0.642	0.676	0.345	0.544	0.544	0.711
2005	0.011	0.102	0.318	0.516	0.742	0.869	0.956	0.897	0.677	0.747	0.348	0.491	0.491	0.716
2006	0.016	0.102	0.281	0.441	0.621	0.742	0.811	0.796	0.678	0.773	0.377	0.580	0.580	0.615
2007	0.018	0.091	0.241	0.348	0.451	0.545	0.566	0.542	0.646	0.751	0.389	0.507	0.507	0.449
2008	0.011	0.069	0.162	0.276	0.371	0.450	0.491	0.448	0.593	0.702	0.406	0.422	0.422	0.366
2009	0.010	0.058	0.132	0.221	0.320	0.357	0.464	0.378	0.541	0.757	0.449	0.365	0.365	0.312
2010	0.009	0.049	0.106	0.178	0.284	0.381	0.399	0.429	0.611	0.623	0.516	0.340	0.340	0.296
2011	0.006	0.048	0.105	0.161	0.257	0.356	0.454	0.545	0.577	0.527	0.504	0.282	0.282	0.313
2012	0.006	0.047	0.118	0.161	0.243	0.329	0.426	0.495	0.564	0.490	0.480	0.275	0.275	0.295
2013	0.007	0.048	0.122	0.189	0.271	0.366	0.454	0.530	0.577	0.500	0.466	0.306	0.306	0.322
2014	0.008	0.054	0.142	0.228	0.315	0.396	0.428	0.529	0.613	0.548	0.487	0.333	0.333	0.340
2015	0.010	0.056	0.150	0.269	0.327	0.398	0.371	0.517	0.761	0.624	0.523	0.368	0.368	0.339
2016	0.009	0.053	0.149	0.258	0.344	0.422	0.414	0.568	0.844	0.690	0.584	0.420	0.420	0.359
2017	0.010	0.058	0.154	0.274	0.361	0.483	0.481	0.605	0.920	0.776	0.653	0.464	0.464	0.393
2018	0.012	0.062	0.161	0.271	0.374	0.468	0.529	0.661	0.895	0.865	0.726	0.491	0.491	0.411
2019	0.009	0.066	0.163	0.261	0.385	0.511	0.537	0.717	0.863	0.882	0.744	0.487	0.487	0.429
2020	0.010	0.069	0.176	0.290	0.420	0.541	0.632	0.813	0.930	0.914	0.785	0.480	0.480	0.479
2021	0.013	0.077	0.214	0.358	0.492	0.586	0.756	0.959	0.961	1.047	0.840	0.482	0.482	0.561
2022	0.030	0.098	0.253	0.400	0.491	0.593	0.759	0.998	1.113	1.222	0.899	0.428	0.428	0.582

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	FBAR5-10
2023	0.047	0.111	0.250	0.380	0.467	0.608	0.757	1.070	1.125	1.275	0.874	0.386	0.386	0.589
Mean 2021-2023	0.030	0.095	0.239	0.379	0.483	0.596	0.757	1.009	1.066	1.181	0.871	0.432		

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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	1130233	675382	371790	171846	78290	84492	227481	80771	36055	30512	18876	8117	1995	291583
1947	591326	677104	497853	298121	133484	53539	56348	132793	45806	17357	14614	8429	4506	253128
1948	451445	339052	462772	346442	206762	75339	34926	29934	69636	18419	7644	6064	4961	205339
1949	632170	292487	264623	354130	229166	103977	42971	16913	15969	28223	7444	2996	3599	199466
1950	1020622	398481	231051	187664	208610	114842	57067	22806	8657	6118	11057	2743	1937	227165
1951	2411969	774897	311756	177887	114891	111007	65972	28226	10910	2984	2094	4025	1197	401781
1952	2316011	1130311	460653	190153	115837	61780	61037	33217	13121	4216	1025	730	1279	438936
1953	2400790	1111650	638922	245352	91156	60037	33175	28535	13943	4525	1348	356	480	463026
1954	832049	1380660	708239	387849	137883	49039	34631	17302	12915	5054	1646	496	245	356800
1955	384305	551413	920908	434179	223694	74977	30566	18096	6941	4691	1835	616	240	265246
1956	752521	246808	395197	550374	211780	112681	35638	14597	7021	2283	1654	690	298	233154
1957	1430781	408080	151546	209100	238296	94860	49100	15408	5683	2355	668	595	362	260683
1958	929342	715310	250138	95854	100423	109358	40982	23275	6428	1912	779	230	380	227441
1959	1310632	486619	428363	141352	47129	47674	54762	20184	9516	2300	640	318	268	254975
1960	1473685	625097	253662	208007	69473	23057	22998	25334	8046	3641	862	257	261	271437
1961	1541584	705041	347642	134399	102625	36293	11320	12024	9808	2789	1371	360	209	290546
1962	1249285	808614	390760	168465	64340	49249	15627	4559	4397	3278	943	540	221	276027
1963	909205	702558	455313	165603	62671	28803	20757	5755	1329	1465	1159	352	300	235527
1964	473764	412416	370078	179363	54823	21598	10559	6925	1519	351	514	432	257	153259
1965	880243	251325	259326	200200	83134	23795	8204	3221	2387	451	123	172	266	171284
1966	1844090	567763	167141	144903	106293	44082	10959	3046	1180	894	192	40	163	289074
1967	1310906	1270917	397018	106400	80587	55322	20421	4379	1136	491	388	72	82	324812
1968	182428	1012822	889592	279539	72348	42283	23745	7295	1619	422	206	145	70	251251
1969	110961	137641	702719	495089	154408	41021	19619	8554	2638	651	194	75	95	167366
1970	207795	86264	88130	368846	238187	64448	15100	5827	2766	915	281	75	75	107870
1971	406859	146547	58079	45523	174417	103303	22561	4581	1862	1030	428	113	65	965367
1972	1052424	314048	105485	37358	27304	81802	36135	6969	1528	696	465	181	80	166447
1973	1711725	752849	212662	63977	21252	15868	32375	9744	1982	500	297	180	114	282352
1974	566788	1197630	515780	123095	35423	11342	6628	10170	3411	701	207	117	130	247142
1975	607022	366386	669223	258194	61541	18466	5371	3069	3313	1120	283	68	109	199416

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	TOTAL
1976	600127	444290	227174	311819	108450	26025	7500	2269	1297	1004	418	89	82	1730544
1977	371249	412546	272840	112792	137091	43303	8835	2625	1046	522	348	136	73	1363400
1978	625497	247351	218075	112306	47537	55754	14036	2250	896	383	206	99	77	1324466
1979	204057	448135	155349	90795	40819	17643	18406	3268	697	187	115	51	57	979579
1980	131441	156405	301972	87124	39225	16113	6538	5038	981	154	48	31	31	745103
1981	144740	103354	113159	174665	38014	15649	6030	2070	1396	231	47	12	20	599387
1982	182264	125716	83686	63945	81819	15217	4644	1520	640	380	74	13	11	559928
1983	140731	136554	92251	51912	28867	28244	4899	1236	567	229	119	26	9	485643
1984	441833	114911	83614	54196	24638	10635	7704	1353	438	241	94	42	12	739712
1985	528650	384971	82056	45025	24333	6372	2799	1913	438	165	100	41	18	1076888
1986	1361054	402065	243536	46408	19154	7440	1602	1006	751	176	73	46	19	2083333
1987	355144	997896	255127	109493	16420	6841	1792	573	287	255	61	35	19	1743944
1988	331994	237875	592196	118968	32991	5002	1734	627	134	90	73	27	12	1321722
1989	158526	228126	147935	305205	54954	9880	1479	486	126	40	29	27	10	906821
1990	132617	129135	130038	95741	142094	22824	2913	534	137	48	16	11	7	656113
1991	299280	126888	98052	86360	61750	81977	11416	1376	248	55	22	7	4	767434
1992	714113	271783	101122	69263	48817	33853	46269	6025	799	132	25	10	3	1292213
1993	986989	503101	240654	72783	36783	23574	15460	23776	2997	429	57	13	3	1906620
1994	749130	732747	398885	146928	39011	15934	10622	6347	9677	1301	158	24	4	2110768
1995	536724	491918	523726	232006	63182	12460	5307	3422	2194	3172	416	60	7	1874594
1996	400745	302670	335880	283629	104290	19826	4291	1582	1110	615	1001	144	18	1455801
1997	772850	207462	203965	182951	120264	37543	6295	1646	436	337	192	328	47	1534316
1998	1043689	471407	126205	97679	71065	41752	9494	1624	356	130	95	61	119	1863676
1999	622788	597860	262948	62284	32933	26114	11603	2516	343	98	45	33	68	1619633
2000	745072	408625	375066	122272	24448	11238	7407	2640	578	108	33	19	41	1697547
2001	590310	533117	290991	184957	52005	8982	3401	1929	662	198	35	15	25	1666627
2002	374816	429975	368283	186265	82224	20322	3088	1174	561	248	77	18	16	1467067
2003	758231	287940	288182	235679	84483	30267	6729	1123	438	260	95	44	14	1693485
2004	242815	577192	214954	183065	116213	33870	10909	2612	467	219	123	54	25	1382518
2005	692086	186024	407216	136528	94257	39126	11189	3909	812	201	94	76	37	1571555
2006	538831	468194	141276	232695	68654	33902	13517	3337	1298	354	78	57	63	1502256
2007	1255333	439298	305131	89157	119919	30244	12551	4455	1165	544	137	43	57	2258034
2008	1015424	975699	337003	168673	53003	62620	15383	5635	1915	524	206	77	49	2636211
2009	591345	795862	744298	249723	89506	33524	28863	7765	3004	915	218	111	68	2545202
2010	206731	461588	654037	551757	167652	54247	18913	14606	4550	1567	338	117	103	2136206
2011	365681	183969	382561	537521	388162	86085	31244	10587	8000	1981	723	156	128	1996798

Year_age	3	4	5	6	7	8	9	10	11	12	13	14	+gp	TOTAL
2012	510602	279003	148245	317904	405897	220336	44905	15967	5184	3745	963	366	173	195329
2013	469476	373162	227977	129922	242135	264468	135519	23139	8382	2397	1895	489	349	187930
2014	849995	356579	299576	183518	102243	169767	146198	65255	11113	3763	1173	974	512	219066
2015	449183	569220	300617	215625	132543	68126	97324	74461	30171	5100	1749	586	879	194558
2016	283071	312961	418760	217056	136472	76691	43897	53386	34522	11444	2233	842	834	159216
2017	760664	236388	227647	288518	146702	79104	41303	24244	23053	12569	4702	1019	892	184680
2018	486272	528617	187164	160041	186504	86193	40178	21784	10862	7353	4652	1975	960	172255
2019	622063	361216	384899	149354	91769	107377	46062	19572	9154	3703	2444	1786	1408	180080
2020	529571	419747	276166	250300	100971	53890	54483	22319	8196	3236	1262	936	1521	172259
2021	368238	337201	311798	194154	147400	53501	26777	23392	8684	2705	1082	471	1184	147658
2022	182355	242396	241576	197622	121961	75017	23881	10445	7018	2647	780	384	784	110686
2023	231028	138420	160897	141401	111521	62875	33940	9225	3171	1805	615	254	595	895748
2024	577881	167206	101584	91913	80106	55649	29258	12898	2596	817	406	208	463	112098

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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	0.490	0.304	0.226	0.200	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	0.200	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	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1950	0.316	0.236	0.210	0.200	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	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1953	0.537	0.322	0.230	0.200	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	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1956	0.590	0.343	0.235	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1958	0.562	0.332	0.233	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1959	0.713	0.390	0.246	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1961	0.609	0.350	0.237	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1962	0.520	0.315	0.229	0.200	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	0.200	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	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1966	0.353	0.251	0.214	0.200	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	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1969	0.206	0.200	0.200	0.200	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	0.200	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	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1973	0.217	0.200	0.201	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1974	0.217	0.200	0.201	0.200	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	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1976	0.224	0.200	0.202	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1977	0.249	0.210	0.204	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1978	0.234	0.205	0.203	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1979	0.208	0.200	0.201	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1980	0.200	0.200	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1981	0.200	0.200	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1982	0.200	0.200	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1983	0.203	0.200	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1984	0.201	0.200	0.219	0.210	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1985	0.204	0.224	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1986	0.270	0.216	0.252	0.231	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1987	0.256	0.236	0.219	0.271	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1988	0.222	0.211	0.242	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1989	0.200	0.230	0.200	0.233	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1990	0.200	0.200	0.207	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1991	0.200	0.200	0.200	0.208	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1992	0.207	0.200	0.200	0.203	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1993	0.241	0.200	0.200	0.200	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	0.220	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1995	0.530	0.314	0.227	0.202	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1996	0.524	0.327	0.243	0.217	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1997	0.421	0.269	0.241	0.226	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1998	0.428	0.273	0.218	0.267	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999	0.264	0.233	0.237	0.223	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2000	0.248	0.212	0.243	0.226	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2001	0.236	0.220	0.200	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	0.200	0.224	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2003	0.239	0.200	0.200	0.212	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2004	0.250	0.215	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2005	0.297	0.212	0.215	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2006	0.203	0.228	0.200	0.207	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2007	0.247	0.200	0.247	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2008	0.258	0.213	0.200	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	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2010	0.297	0.234	0.207	0.201	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2011	0.424	0.310	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2012	0.378	0.298	0.200	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2013	0.392	0.234	0.204	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2014	0.369	0.292	0.212	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2015	0.355	0.259	0.233	0.206	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2016	0.216	0.253	0.261	0.216	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2017	0.390	0.217	0.214	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2018	0.268	0.212	0.200	0.218	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2019	0.293	0.211	0.213	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2020	0.440	0.229	0.200	0.210	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2021	0.430	0.266	0.230	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2022	0.265	0.223	0.215	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2023	0.332	0.202	0.222	0.200	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

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Table 3.18. Northeast Arctic COD. Summary table

Year	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-10
1946	1130233	3935180	952985	706000	0.741	0.250
1947	591326	3386475	902641	882017	0.977	0.309
1948	451445	3356715	784654	774295	0.987	0.348
1949	632170	2896946	594887	800122	1.345	0.369
1950	1020622	2795419	535869	731982	1.366	0.382
1951	2411969	3692064	495077	827180	1.671	0.413
1952	2316011	4110119	488765	876795	1.794	0.459
1953	2400790	4090773	412395	695546	1.687	0.412
1954	832049	4197512	408300	826021	2.023	0.438
1955	384305	3536136	327878	1147841	3.501	0.518
1956	752521	3318710	281174	1343068	4.777	0.570

Year	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-10
1957	1430781	2814511	212263	792557	3.734	0.528
1958	929342	2357116	205421	769313	3.745	0.526
1959	1310632	2723988	434410	744607	1.714	0.546
1960	1473685	2351587	384829	622042	1.616	0.539
1961	1541584	2346756	386500	783221	2.026	0.634
1962	1249285	2172259	315322	909266	2.884	0.743
1963	909205	2008725	215906	776337	3.596	0.815
1964	473764	1511142	200247	437695	2.186	0.678
1965	880243	1459212	108045	444930	4.118	0.578
1966	1844090	2222881	121054	483711	3.996	0.548
1967	1310906	2735822	128761	572605	4.447	0.556
1968	182428	3282513	222997	1074084	4.817	0.599
1969	110961	2818930	148877	1197226	8.042	0.709
1970	207795	2163000	242004	933246	3.856	0.698
1971	406859	1661055	330344	689048	2.086	0.646
1972	1052424	1615131	353349	565254	1.600	0.659
1973	1711725	2280108	334153	792685	2.372	0.627
1974	566788	2176277	159026	1102433	6.932	0.611
1975	607022	2089076	133536	829377	6.211	0.658
1976	600127	1939165	167187	867463	5.189	0.705
1977	371249	1928027	335946	905301	2.695	0.818
1978	625497	1585938	227795	698715	3.067	0.856
1979	204057	1137294	180383	440538	2.442	0.772
1980	131441	853590	108436	380434	3.508	0.760
1981	144740	966706	161279	399038	2.474	0.793
1982	182264	751168	321325	363730	1.132	0.774
1983	140731	746879	311431	289992	0.931	0.791
1984	441833	830482	243534	277651	1.140	0.868
1985	528650	1000841	195541	307920	1.575	0.810
1986	1361054	1397885	163901	430113	2.624	0.874
1987	355144	1233243	114908	523071	4.552	0.928
1988	331994	1006657	191457	434939	2.272	0.885
1989	158526	956535	237314	332481	1.401	0.668
1990	132617	913000	303355	212000	0.699	0.424
1991	299280	1347064	635806	319158	0.502	0.408
1992	714113	1687381	801872	513234	0.640	0.487

Year	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-10
1993	986989	2197863	698491	581611	0.833	0.587
1994	749130	2112773	568725	771086	1.356	0.748
1995	536724	1849957	532870	739999	1.389	0.772
1996	400745	1697388	551369	732228	1.328	0.791
1997	772850	1537459	546260	762403	1.396	0.938
1998	1043689	1350918	386165	592624	1.535	0.942
1999	622788	1199169	280597	484910	1.728	0.940
2000	745072	1223157	255138	414868	1.626	0.849
2001	590310	1477707	383239	426471	1.113	0.741
2002	374816	1594411	520404	535045	1.028	0.682
2003	758231	1682627	570813	551990	0.967	0.637
2004	242815	1568423	664368	606445	0.913	0.711
2005	692086	1516694	576671	641276	1.112	0.716
2006	538831	1539716	579579	537642	0.928	0.615
2007	1255333	1865207	644011	486883	0.756	0.449
2008	1015424	2553066	712366	464171	0.652	0.366
2009	591345	3091745	1001388	523430	0.523	0.312
2010	206731	3328980	1229135	609983	0.496	0.296
2011	365681	3552449	1782709	719830	0.404	0.313
2012	510602	3625094	1997429	727663	0.364	0.295
2013	469476	3695151	2211080	966209	0.437	0.322
2014	849995	3416507	2089429	986449	0.472	0.340
2015	449183	3243403	1676734	864384	0.516	0.339
2016	283071	2822461	1335743	849422	0.636	0.359
2017	760664	2754263	1363003	868276	0.637	0.393
2018	486272	2543558	1226591	778627	0.635	0.411
2019	622063	2421489	1161583	692609	0.596	0.429
2020	529571	2131600	923962	692903	0.750	0.479
2021	368238	1920246	792317	767284	0.968	0.561
2022	182355	1691782	674790	719211	1.066	0.582
2023	231028	1500905	709740	582552	0.821	0.589
Arith. Mean	718954	2193515	566280	673138	2.000	0.596

Table 3.19a. Northeast Arctic COD. Input for the short term prediction

2024								
Age	N	M	Mat	PF	PM	SWT	Sel	CWT
3	587000	0.342	0	0	0	0.246	0.030	0.571
4	167206	0.230	0.003	0	0	0.706	0.095	0.987
5	101584	0.222	0.009	0	0	1.075	0.239	1.573
6	91913	0.200	0.091	0	0	1.803	0.379	2.296
7	80106	0.2	0.345	0	0	2.667	0.483	3.240
8	55649	0.2	0.709	0	0	3.995	0.596	4.541
9	29258	0.2	0.946	0	0	5.950	0.757	5.931
10	12898	0.2	0.982	0	0	7.011	1.009	7.100
11	2596	0.2	1	0	0	9.436	1.066	8.466
12	817	0.2	1	0	0	11.714	1.181	10.249
13	406	0.2	1	0	0	13.477	0.871	11.400
14	208	0.2	1	0	0	15.683	0.432	12.920
15	463	0.2	1	0	0	17.707	0.432	14.168
2025								
Age	N	M	Mat	PF	PM	SWT	Sel	CWT
3	450000	0.342	0.007	0	0	0.263	0.030	0.563
4		0.230	0.008	0	0	0.611	0.095	0.920
5		0.222	0.013	0	0	1.194	0.239	1.505
6		0.200	0.081	0	0	1.816	0.379	2.252
7		0.2	0.400	0	0	2.883	0.483	3.190
8		0.2	0.719	0	0	3.998	0.596	4.471
9		0.2	0.877	0	0	5.838	0.757	6.002
10		0.2	0.963	0	0	7.754	1.009	7.237
11		0.2	1.000	0	0	8.873	1.066	8.424
12		0.2	1	0	0	11.324	1.181	9.938
13		0.2	1	0	0	13.823	0.871	11.662
14		0.2	1	0	0	15.672	0.432	12.801
15		0.2	1	0	0	17.936	0.432	14.296
2026								
Age	N	M	Mat	PF	PM	SWT	Sel	CWT
3	375000	0.342	0.007	0	0	0.268	0.030	0.563
4		0.230	0.008	0	0	0.628	0.095	0.920
5		0.222	0.013	0	0	1.099	0.239	1.505

6		0.200	0.081	0	0	1.935	0.379	2.252
7		0.2	0.400	0	0	2.896	0.483	3.190
8		0.2	0.719	0	0	4.214	0.596	4.471
9		0.2	0.877	0	0	5.841	0.757	6.002
10		0.2	0.963	0	0	7.642	1.009	7.237
11		0.2	1.000	0	0	9.616	1.066	8.424
12		0.2	1	0	0	10.761	1.181	9.938
13		0.2	1	0	0	13.433	0.871	11.662
14		0.2	1	0	0	16.018	0.432	12.801
15		0.2	1	0	0	17.924	0.432	14.296

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

Table 3.19 d. Results of various recruitment models (million individuals age 3) . Values used in the predictions are shown in green. RCT3+Eco: Including the recruitment indices for ages 0,1, 2 for the ecosystem survey (Table A14). Iner: averages over 4 years or all years. M2: A model based on storm activity, length of thermal front zones and storm activity in the year the year class was spawned

Yearclass	recruitment	BST1	BST2	BST3	BSA1	BSA2	BSA3
1982	529	NA	NA	NA	NA	NA	NA
1983	1361	NA	NA	NA	NA	NA	NA
1984	355	NA	NA	NA	NA	NA	NA
1985	332	NA	NA	NA	NA	NA	NA
1986	159	NA	NA	NA	NA	NA	NA
1987	133	NA	NA	NA	NA	NA	NA
1988	299	NA	NA	NA	NA	NA	NA
1989	714	NA	NA	NA	NA	NA	NA
1990	987	NA	NA	NA	NA	NA	NA
1991	749	NA	NA	294	NA	NA	324
1992	537	NA	557	283	NA	624	138
1993	401	1044	541	163	903	212	99
1994	773	5356	792	318	2175	272	159
1995	1044	5899	1423	355	1826	565	391
1996	623	5044	496	188	1698	475	148
1997	745	2491	350	246	2524	232	295
1998	590	473	242	183	365	263	177
1999	375	129	78	118	153	51	61
2000	758	713	419	377	364	209	307
2001	243	34	66	64	19	53	33
2002	692	3022	243	249	1505	117	125

2003	539	323	217	116	161	139	65
2004	1255	853	289	361	500	158	58
2005	1015	674	370	194	411	47	200
2006	591	595	102	126	85	94	108
2007	207	69	36	37	51	25	23
2008	366	389	95	85	205	44	40
2009	511	1028	226	76	620	91	83
2010	469	617	100	69	266	40	61
2011	850	703	143	227	496	89	287
2012	449	436	191	144	313	211	139
2013	283	1246	343	99	1759	211	56
2014	761	1642	306	179	1904	202	112
2015	486	312	129	139	241	73	109
2016	622	645	501	282	439	280	204
2017	530	2714	559	238	2058	362	117
2018	368	1791	274	112	1437	158	65
2019	182	165	35	52	93	29	29
2020	231	81	66	41	46	43	29
2021	NA	668	163	199	525	103	151
2022	NA	305	307	NA	244	201	NA
2023	NA	378	NA	NA	328	NA	NA

Table 3.19c. Results of RCT3 prediction of NEA cod recruitment (in million individuals of age 3).

prediction

	WAP	logWAP	int.se
yearclass:2018	507.6	6.23	0.24
yearclass:2019	242.8	5.49	0.25
yearclass:2020	196.7	5.28	0.24
yearclass:2021	587.3	6.38	0.20
yearclass:2022	449.7	6.11	0.32

NEA cod recruitment at age 3				
Year	**2024**	**2025**	**2026**	**2027+**
Yearclass	**2021**	**2022**	**2023**	
RCT3+Eco	**530**	**401**	**340**	
RCT3	**587**	**450**	**375**	
M2	**252**	**444**		
SAM	**578**			

Iner4 (2021-2024)		**340**	**340**	**340**
InerAll 1946-2024	**717**	**717**	**717**	**717**

Table 3.20. Northeast Arctic COD. Management option table.

2024					
Biomass (t)	SSB (t)	FMult	FBar	Landings (t)	
1288843	552231	1	0.589	477185	
2025				2026	
Biomass	SSB	FBar	Landings	Biomass	SSB
1216106	450572	0.00	0	1653519	664770
		0.05	43268	1603233	627886
		0.10	84365	1555582	593280
		0.15	123424	1510399	560798
		0.20	160572	1467531	530298
		0.25	195923	1426835	501648
		0.30	229586	1388176	474726
		0.35	261662	1351431	449417
		0.40	292245	1316483	425617
		0.45	321423	1283225	403227
		0.50	349278	1251555	382156
		0.55	375887	1221379	362319
		0.60	401320	1192610	343636
		0.65	425645	1165166	326034
		0.70	448925	1138969	309445
		0.75	471217	1113950	293804
		0.80	492578	1090039	279052
		0.85	513057	1067176	265134
		0.90	532704	1045301	251998
		0.95	551562	1024359	239595

Table 3.21. Northeast Arctic COD. Detailed prediction output assuming Fsq in 2024 and HCR in 2025.

Fbar age range: 5-10 Year: 2024 F multiplier: 1 Fbar: 0.5890

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0.031	15003	8567	587000	144402	0	0
4	0.097	13827	13647	167206	118047	502	354
5	0.244	19806	31154	101584	109203	914	983
6	0.387	26892	61745	91913	165719	8364	15080
7	0.493	28485	92292	80106	213643	27637	73707
8	0.608	23215	105420	55649	222318	39455	157623
9	0.773	14453	85720	29258	174085	27678	164685
10	1.030	7642	54261	12898	90428	12666	88800
11	1.088	1588	13443	2596	24496	2596	24496
12	1.205	529	5420	817	9570	817	9570
13	0.889	220	2506	406	5472	406	5472
14	0.441	68	875	208	3262	208	3262
15+	0.441	151	2135	463	8198	463	8198
Total	NA	151878	477185	1130104	1288843	121706	552231
		Thous	Tonnes	Thous	Tonnes	Thous	Tonnes
Fbar age range: 5-10 Year: 2025 F multiplier: 0.73 Fbar: 0.4329							
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0.023	8485	4777	450000	118350	3150	828
4	0.071	24879	22889	404402	247090	3235	1977
5	0.179	17803	26794	120576	143968	1567	1872
6	0.284	14364	32348	63751	115772	5164	9378
7	0.362	14164	45182	51115	147364	20446	58946
8	0.447	13186	58954	40063	160171	28805	115163
9	0.568	9829	58994	24800	144783	21750	126974
10	0.757	5389	39002	11063	85785	10654	82611
11	0.800	1906	16059	3771	33462	3771	33462
12	0.886	387	3846	716	8110	716	8110
13	0.653	88	1027	200	2770	200	2770
14	0.324	34	441	137	2142	137	2142
15+	0.324	89	1274	354	6341	354	6341
Total	NA	110604	311587	1170948	1216106	99949	450572
		Thous	Tonnes	Thous	Tonnes	Thous	Tonnes

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

Year	B(3+)	SSB	R(3)	F(5-10)
1984	828204	255437	420073	0.783
1985	990841	200745	558031	0.638
1986	1362387	180925	1082847	0.787
1987	1209661	131818	287852	1.029
1988	984363	217416	215685	0.978
1989	917455	241556	173082	0.467
1990	985687	330844	227234	0.311
1991	1571223	725212	405026	0.226
1992	1946335	940452	702429	0.405
1993	2403035	830676	908137	0.610
1994	2186120	645238	706368	0.809
1995	1846433	557946	480284	0.752
1996	1751926	606083	385573	0.722
1997	1634823	652796	640375	1.049
1998	1297640	426387	789087	1.067
1999	1105679	288440	481116	0.916
2000	1086894	247768	563234	0.642
2001	1335214	373529	480654	0.516
2002	1471385	504831	419248	0.507
2003	1571230	542927	667532	0.506
2004	1514211	637185	272724	0.598
2005	1478463	575655	527240	0.601
2006	1501672	594175	526419	0.626
2007	1793000	631970	1251152	0.490
2008	2513266	684648	1223669	0.350
2009	3149887	974513	823929	0.335
2010	3412030	1160876	472059	0.367
2011	3588390	1637235	587136	0.320
2012	3695258	1874908	666213	0.288
2013	3813565	2082410	783764	0.296
2014	3534082	1981719	971160	0.329
2015	3338684	1574729	484153	0.363
2016	2958860	1275153	379497	0.346
2017	2968773	1409319	749813	0.433
2018	2703258	1281947	545770	0.497
2019	2489928	1181640	520694	0.442

2020	2174101	937587	409689	0.475
2021	1936444	822577	289634	0.583
2022	1588998	674366	211523	0.755
2023	1390816	614038	731123.8	0.733
2024	1102102	369741		

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

	3	4	5	6	7	8	9	10	11	12	13	14	15
1984	420073	134704	77103	45256	24066	12585	9010	1429	635	404	186	33	22
1985	558031	336985	97147	45038	19552	6726	3327	2360	459	332	158	102	25
1986	1082847	436091	231422	55654	20716	6821	2177	1293	1089	225	231	96	39
1987	287852	803454	291941	114569	22468	7047	2091	739	402	377	70	147	50
1988	215685	212676	522295	145135	35711	6004	2090	727	156	132	107	36	13
1989	173082	165132	150336	284687	60441	9610	1617	597	164	34	43	49	71
1990	227234	137787	116909	94901	154504	25631	3437	644	252	93	16	32	13
1991	405026	184362	106089	82742	61115	97286	14515	2021	367	153	61	9	17
1992	702429	327695	142131	73535	50879	34433	58370	8518	1265	250	111	47	5
1993	908137	554960	239624	93509	40505	25696	16310	30853	4433	743	132	83	4
1994	706368	705077	413714	142612	47877	18834	11206	6757	13097	1825	281	60	13
1995	480284	493057	489970	244928	62734	13617	5966	3309	1951	4015	549	130	3
1996	385573	278494	323854	288502	115852	22982	4674	1970	1009	539	1478	264	3
1997	640375	222531	177710	184961	140512	46709	8423	1838	661	344	198	582	2
1998	789087	409404	139752	84135	73648	47040	11986	1952	411	135	66	54	129
1999	481116	491368	242328	68613	30793	25555	11900	3327	463	121	33	21	79
2000	563234	362448	321996	113450	25818	10928	6820	2380	978	150	49	3	49
2001	480654	434405	263417	171978	49714	9661	3583	1856	641	469	58	30	93
2002	419248	374949	317477	162463	81664	20962	3467	1483	616	245	281	40	27
2003	667532	314983	276746	195080	75829	31248	7615	1315	738	304	103	200	5
2004	272724	519057	239085	172914	98463	32141	12780	3524	608	445	160	65	33
2005	527240	210262	383194	151621	84689	37945	11281	4598	1316	234	240	96	28
2006	526419	386490	153085	216620	73634	32738	13396	3958	1560	543	99	166	573
2007	1251152	422167	268498	95255	106331	32308	12702	4522	1538	538	232	57	154
2008	1223669	958184	308889	157368	54210	54091	15981	6368	2223	758	196	148	74
2009	823929	937693	726565	215117	93325	31454	26513	8343	3520	1163	413	124	118
2010	472059	622627	724617	515386	134069	55985	17897	13804	4925	2043	251	271	194
2011	587136	348931	475260	531257	342078	75699	29832	10053	7245	1756	936	72	0

2012	666213	382657	247957	354963	364337	208657	42357	14562	4275	3309	935	447	153
2013	783764	453984	274208	186485	249884	232502	124338	23572	7453	1980	1753	523	853
2014	971160	526785	345665	201641	131676	155219	126838	61991	11523	3604	1034	1069	799
2015	484153	666740	375559	243750	131672	80740	79786	63448	30336	5942	1864	593	1123
2016	379497	335985	485923	258307	151058	76548	45388	43053	30257	11626	2654	1116	1380
2017	749813	303761	249753	326766	166020	89361	41536	24361	18829	12135	5325	1462	1044
2018	545770	502757	231970	173795	202198	91326	45155	20069	11213	5985	4621	2755	889
2019	520694	412170	379839	163418	106168	109738	45802	20944	8026	3635	1936	1975	1128
2020	409689	384768	313418	261129	105218	60804	52961	21550	9106	2899	1332	986	884
2021	289634	260448	284445	218244	159740	57712	29981	22280	7787	2635	1084	609	918
2022	211523	185707	182193	175425	121659	75463	26584	11489	6705	2292	736	363	237
2023	731124	157534	127654	98874	80072	52202	29801	10557	3695	1911	592	170	285
2024		515216	114716	74808	47246	30617	17256	9711	3319	1220	675	308	88

Table 3.24. NEA cod TISVPA estimates of fishing mortality coefficients

	3	4	5	6	7	8	9	10	11	12	13	14	15	F(5-10)
1984	0.022	0.134	0.321	0.548	0.958	0.966	0.961	0.944	0.314	1.003	0.520	0.520	0.520	0.783
1985	0.021	0.122	0.308	0.455	0.622	0.895	0.769	0.781	0.709	0.249	0.427	0.427	0.427	0.638
1986	0.021	0.152	0.385	0.623	0.750	0.879	1.120	0.966	0.898	0.790	0.498	0.498	0.498	0.787
1987	0.026	0.152	0.501	0.825	1.118	1.106	1.107	1.520	1.140	1.023	0.588	0.588	0.588	1.029
1988	0.024	0.160	0.407	0.884	1.174	1.285	1.047	1.073	1.299	0.975	0.557	0.557	0.557	0.978
1989	0.014	0.089	0.237	0.358	0.573	0.595	0.551	0.486	0.462	0.514	0.285	0.285	0.285	0.467
1990	0.008	0.058	0.157	0.257	0.310	0.412	0.376	0.357	0.299	0.280	0.188	0.188	0.188	0.311
1991	0.007	0.038	0.111	0.184	0.245	0.252	0.294	0.274	0.245	0.203	0.137	0.137	0.137	0.226
1992	0.010	0.068	0.165	0.309	0.436	0.507	0.460	0.556	0.478	0.414	0.236	0.236	0.236	0.405
1993	0.015	0.086	0.257	0.399	0.642	0.798	0.818	0.744	0.856	0.701	0.345	0.345	0.345	0.610
1994	0.017	0.112	0.282	0.552	0.710	1.023	1.110	1.173	0.953	1.086	0.435	0.435	0.435	0.809
1995	0.016	0.106	0.299	0.473	0.768	0.825	1.017	1.131	1.080	0.863	0.428	0.428	0.428	0.752
1996	0.020	0.102	0.288	0.519	0.668	0.931	0.850	1.078	1.087	1.011	0.434	0.434	0.434	0.722
1997	0.026	0.171	0.367	0.690	1.094	1.204	1.539	1.397	1.718	1.668	0.601	0.601	0.601	1.049
1998	0.029	0.172	0.493	0.650	1.020	1.370	1.232	1.638	1.312	1.533	0.603	0.603	0.603	1.067
1999	0.023	0.178	0.449	0.819	0.837	1.086	1.196	1.113	1.283	1.036	0.544	0.544	0.544	0.916
2000	0.018	0.111	0.366	0.556	0.785	0.657	0.709	0.781	0.681	0.741	0.384	0.384	0.384	0.642
2001	0.014	0.095	0.240	0.496	0.596	0.694	0.511	0.558	0.566	0.490	0.304	0.304	0.304	0.516
2002	0.012	0.082	0.239	0.376	0.642	0.645	0.650	0.490	0.498	0.494	0.285	0.285	0.285	0.507
2003	0.013	0.075	0.207	0.380	0.486	0.710	0.617	0.634	0.446	0.444	0.272	0.272	0.272	0.506
2004	0.014	0.096	0.226	0.403	0.621	0.678	0.883	0.773	0.734	0.498	0.317	0.317	0.317	0.598

2005	0.016	0.092	0.262	0.385	0.565	0.748	0.705	0.943	0.756	0.701	0.324	0.324	0.324	0.601
2006	0.016	0.107	0.266	0.490	0.585	0.738	0.855	0.821	1.021	0.792	0.356	0.356	0.356	0.626
2007	0.013	0.087	0.237	0.363	0.538	0.537	0.584	0.681	0.607	0.717	0.289	0.289	0.289	0.490
2008	0.009	0.065	0.174	0.292	0.360	0.447	0.394	0.433	0.464	0.410	0.217	0.217	0.217	0.350
2009	0.008	0.054	0.161	0.270	0.372	0.391	0.429	0.384	0.394	0.414	0.207	0.207	0.207	0.335
2010	0.008	0.055	0.150	0.283	0.392	0.466	0.431	0.482	0.402	0.404	0.223	0.223	0.223	0.367
2011	0.007	0.044	0.128	0.221	0.342	0.405	0.423	0.398	0.415	0.342	0.202	0.202	0.000	0.320
2012	0.007	0.044	0.106	0.194	0.273	0.365	0.382	0.405	0.357	0.365	0.190	0.190	0.190	0.288
2013	0.008	0.051	0.122	0.186	0.281	0.343	0.409	0.435	0.432	0.373	0.208	0.208	0.208	0.296
2014	0.009	0.056	0.152	0.231	0.289	0.380	0.414	0.505	0.503	0.488	0.245	0.245	0.245	0.329
2015	0.009	0.064	0.167	0.289	0.362	0.391	0.458	0.510	0.584	0.568	0.288	0.288	0.288	0.363
2016	0.008	0.057	0.163	0.268	0.382	0.409	0.389	0.464	0.481	0.538	0.283	0.283	0.283	0.346
2017	0.011	0.062	0.183	0.336	0.459	0.569	0.535	0.517	0.579	0.589	0.359	0.359	0.359	0.433
2018	0.012	0.077	0.181	0.343	0.525	0.616	0.673	0.642	0.574	0.631	0.411	0.411	0.411	0.497
2019	0.013	0.073	0.188	0.275	0.427	0.558	0.571	0.634	0.562	0.494	0.379	0.379	0.379	0.442
2020	0.015	0.088	0.211	0.346	0.414	0.559	0.646	0.673	0.694	0.600	0.427	0.427	0.427	0.475
2021	0.019	0.117	0.285	0.433	0.591	0.600	0.724	0.867	0.833	0.841	0.534	0.534	0.534	0.583
2022	0.025	0.150	0.397	0.624	0.782	0.920	0.797	1.009	1.130	1.049	0.691	0.691	0.691	0.755
2023	0.018	0.115	0.312	0.538	0.761	0.907	0.921	0.957	0.908	0.842	0.453	0.453	0.453	0.733

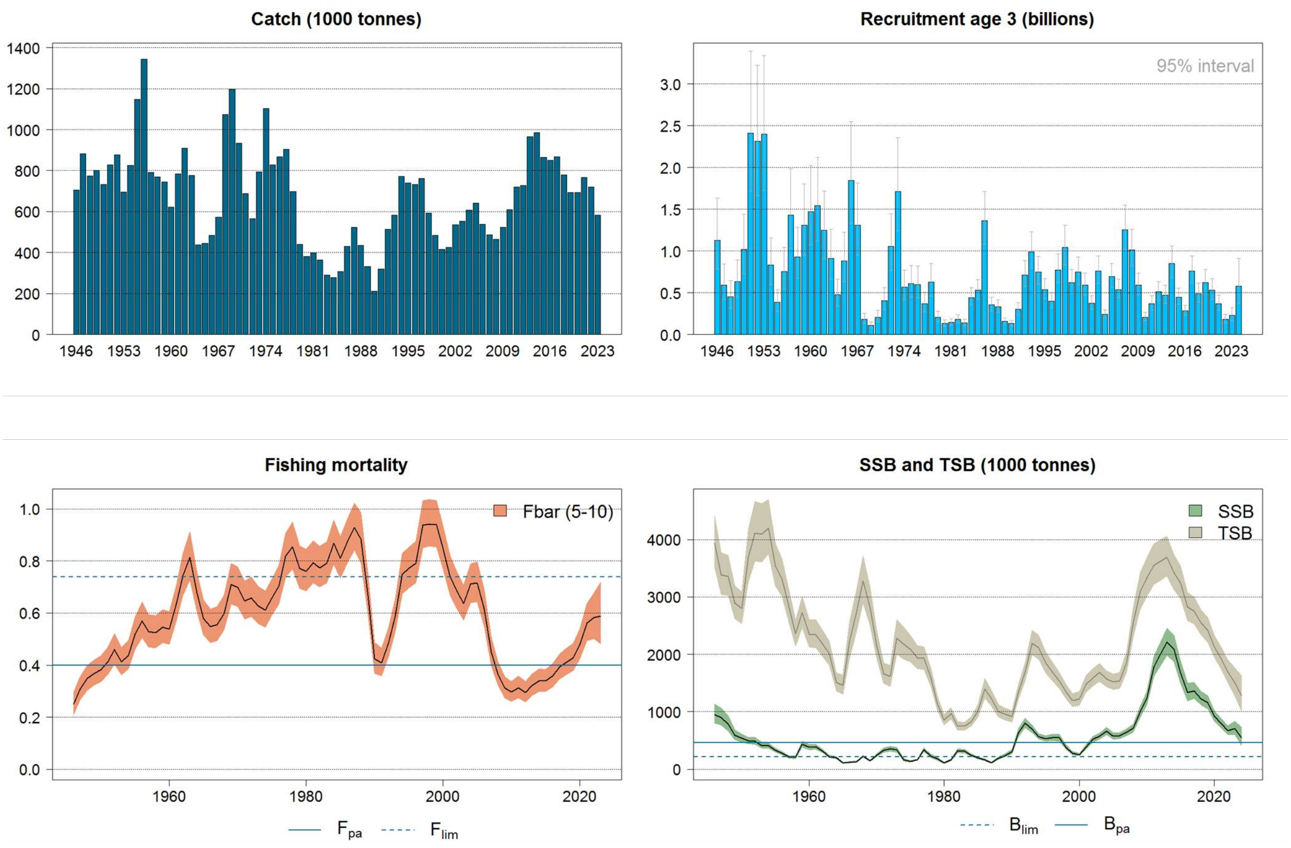


Figure 3.1. Standard plots for Northeast Arctic cod (ICES subareas 1 and 2)

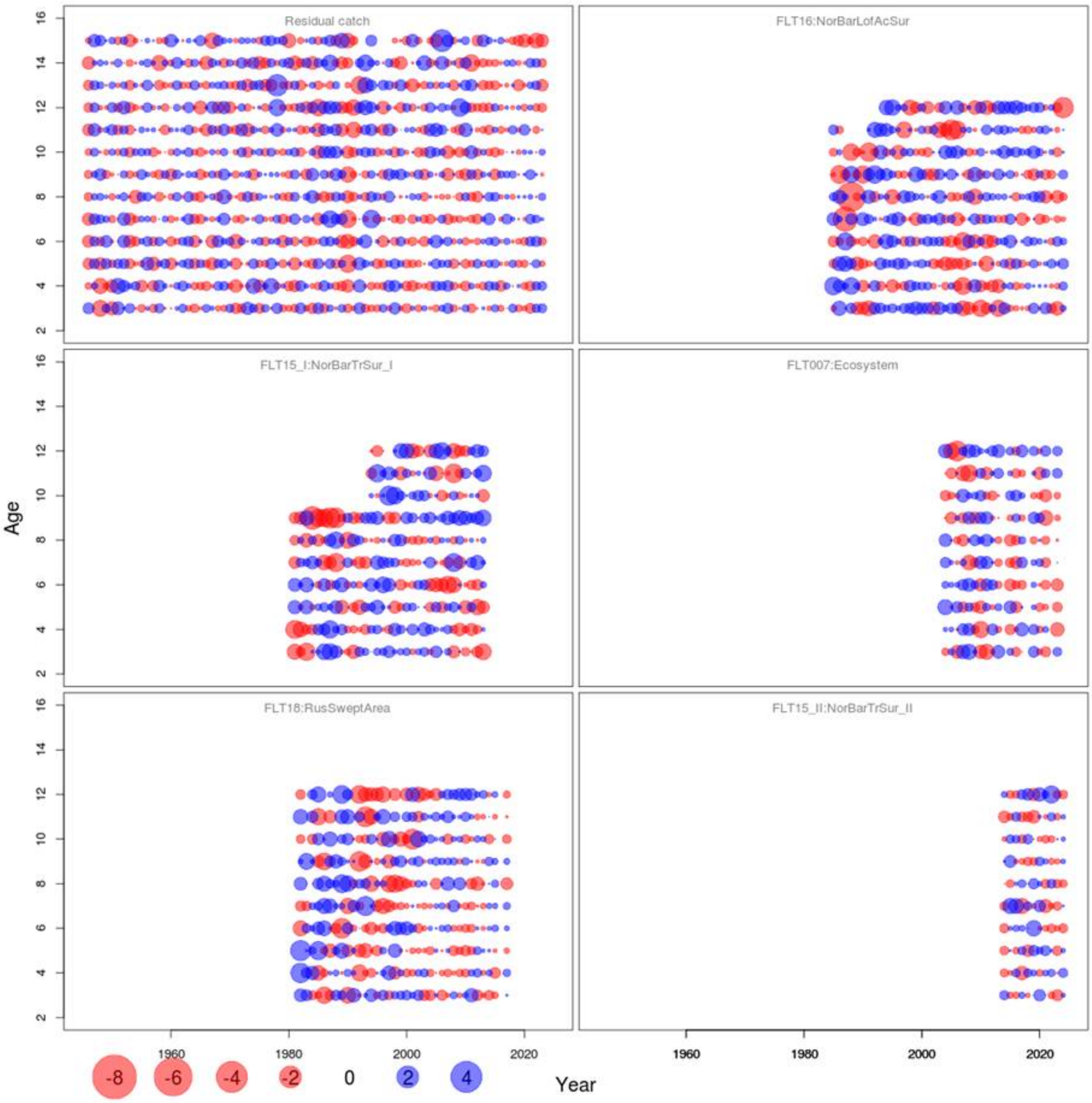
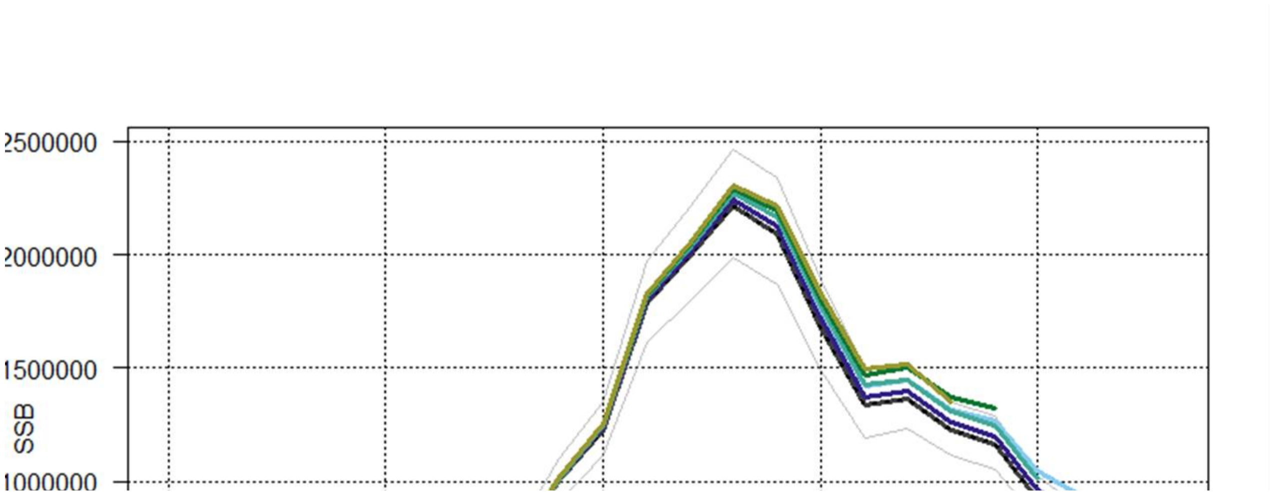
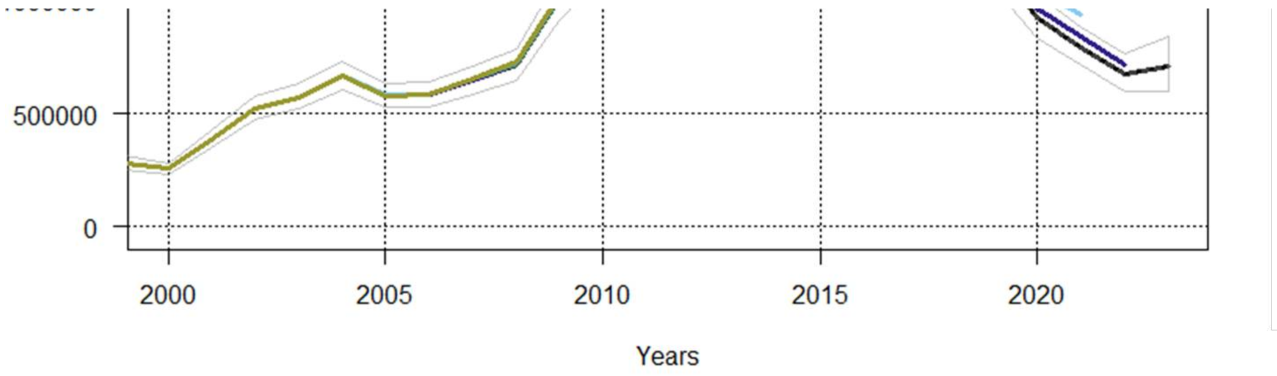
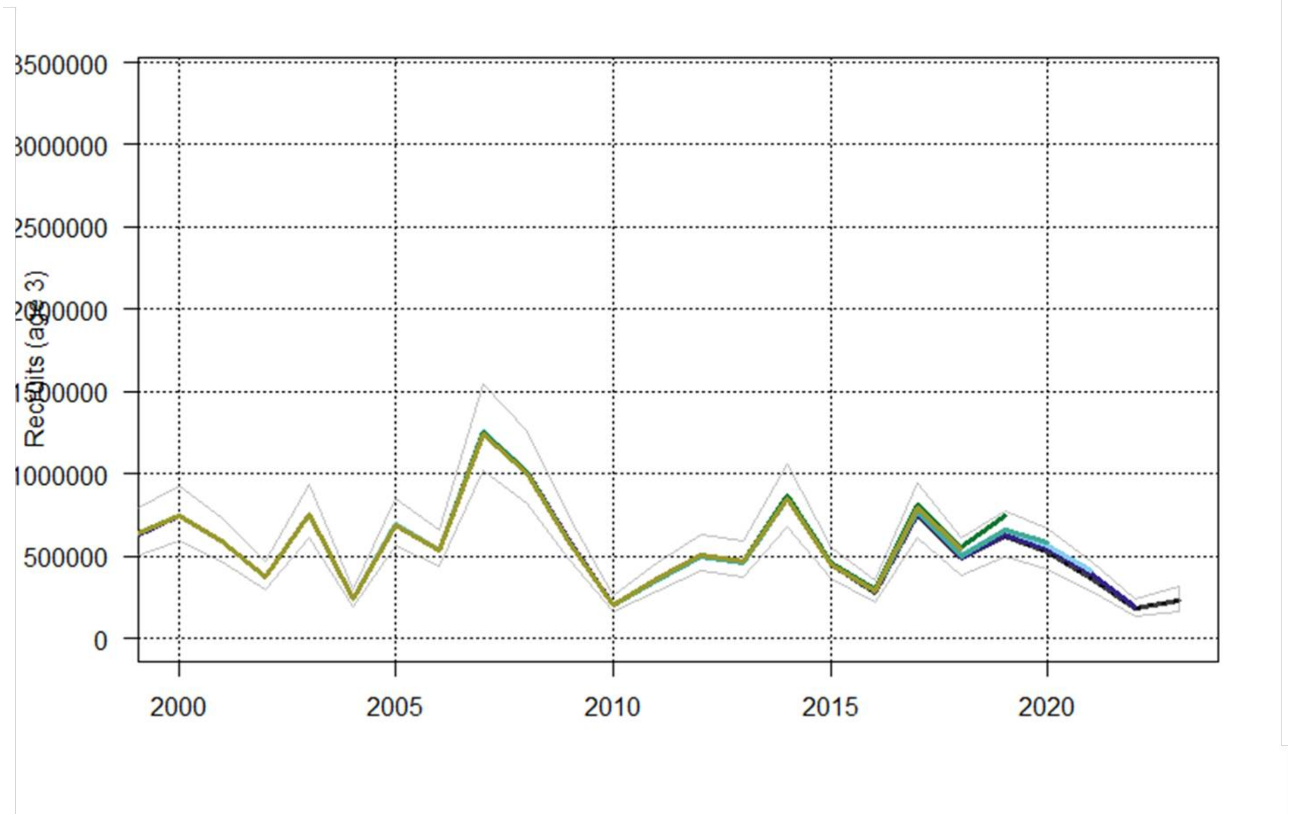


Figure 3.2a. Standardized one-observation-ahead residuals for log-catches and log-indices (Thygesen et al . 2017) in the final SAM run




500000
0
2000
2005
2010
2015
2020
Years


3500000
3000000
2500000
2000000
1500000
1000000
500000
0
Recruits (age 3)
2000
2005
2010
2015
2020

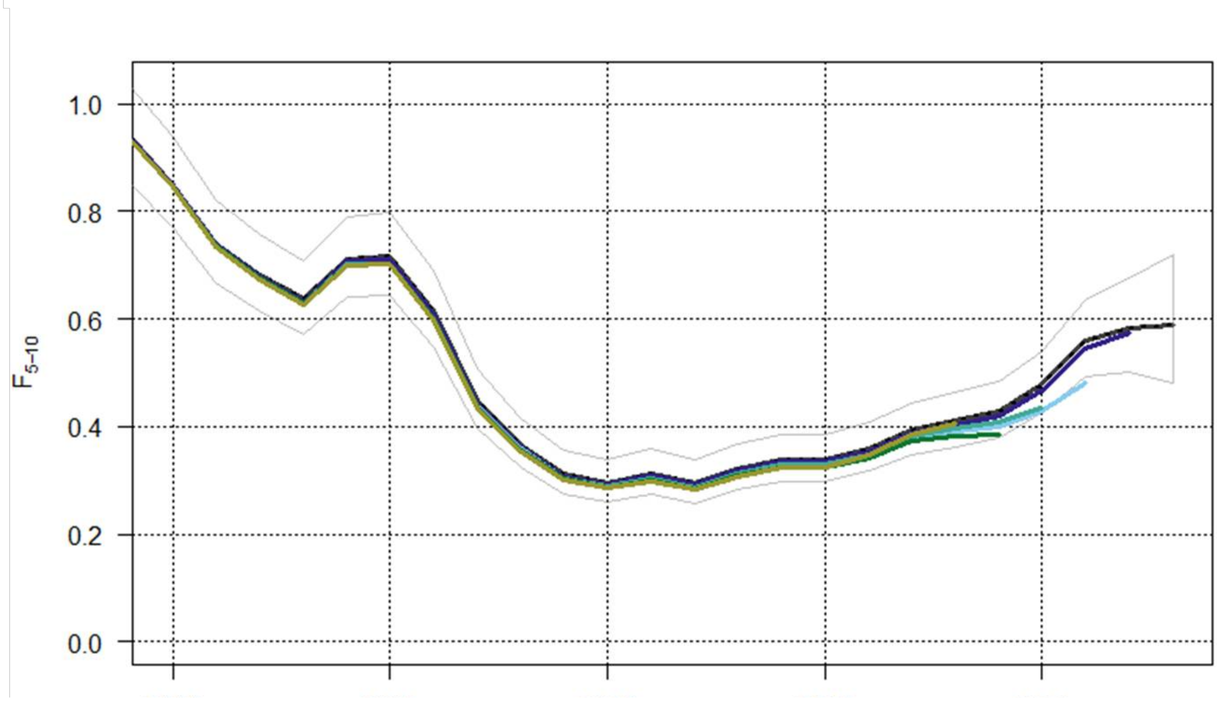

1.0
0.8
0.6
0.4
0.2
0.0
F_{5-10}

Figure 3.2b. SAM model retrospectives

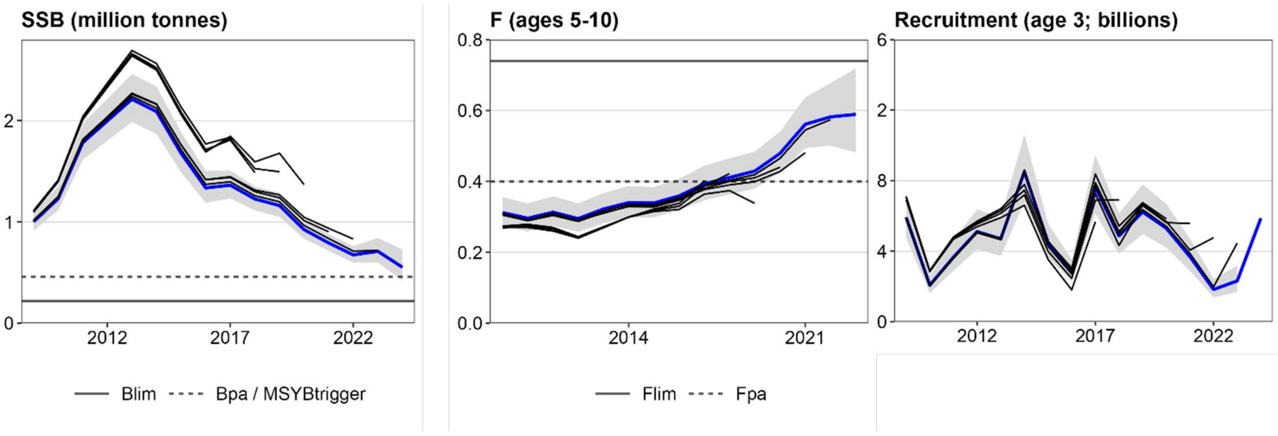


Figure 3.2c. Historical Retrospective

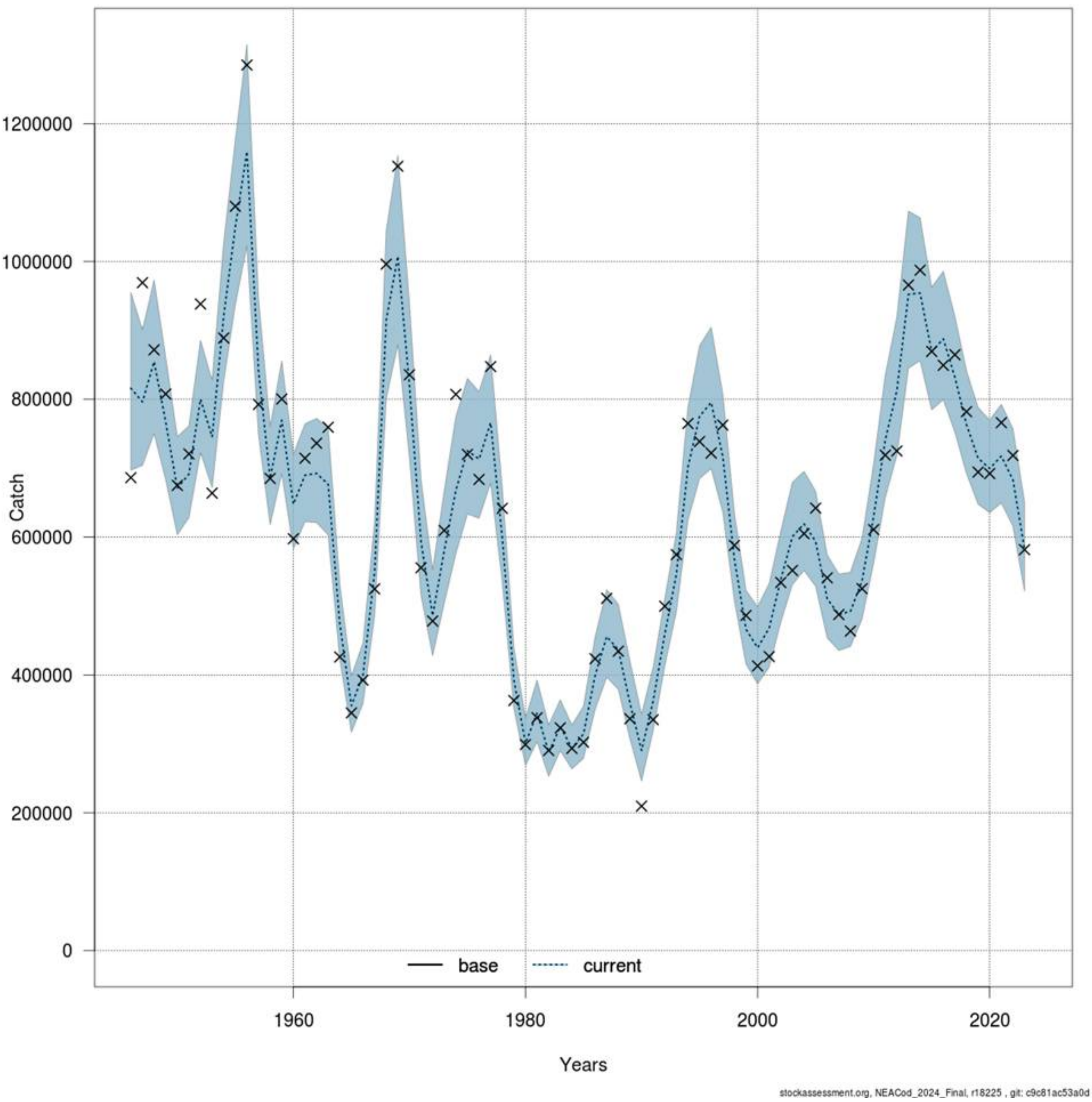


*Figure 3.2d. NEA cod final SAM run fit. Total catch in weight. Modelled catches from the final run and point wise 95% confidence intervals are shown by line and shaded area. The yearly observed total catch weight (crosses) are calculated as Catch(y)=sum(W(a,y)*C(a,y)).*

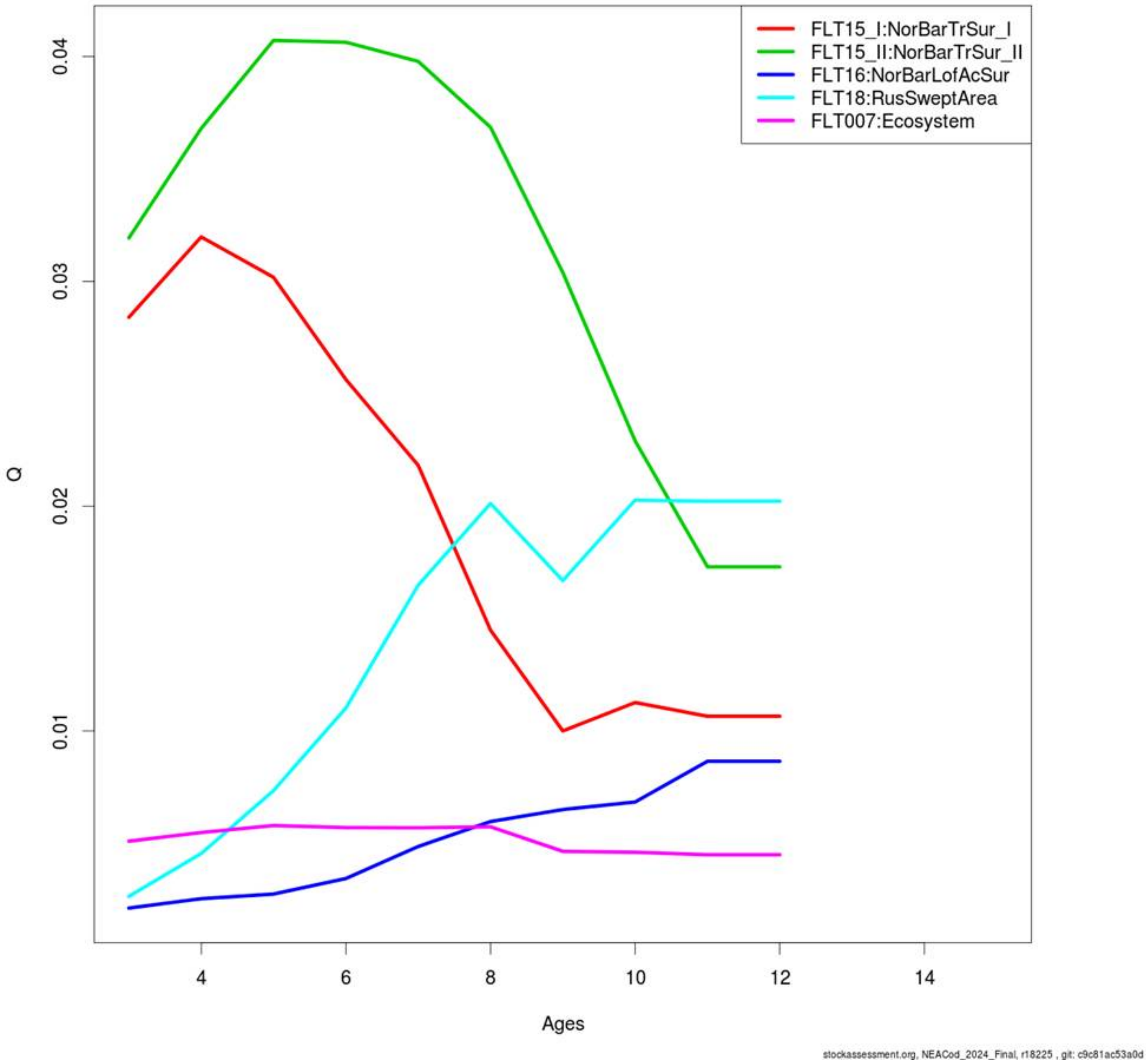


Figure 3.2e. NEA cod. Catchability of different fleets used for final SAM run fit.

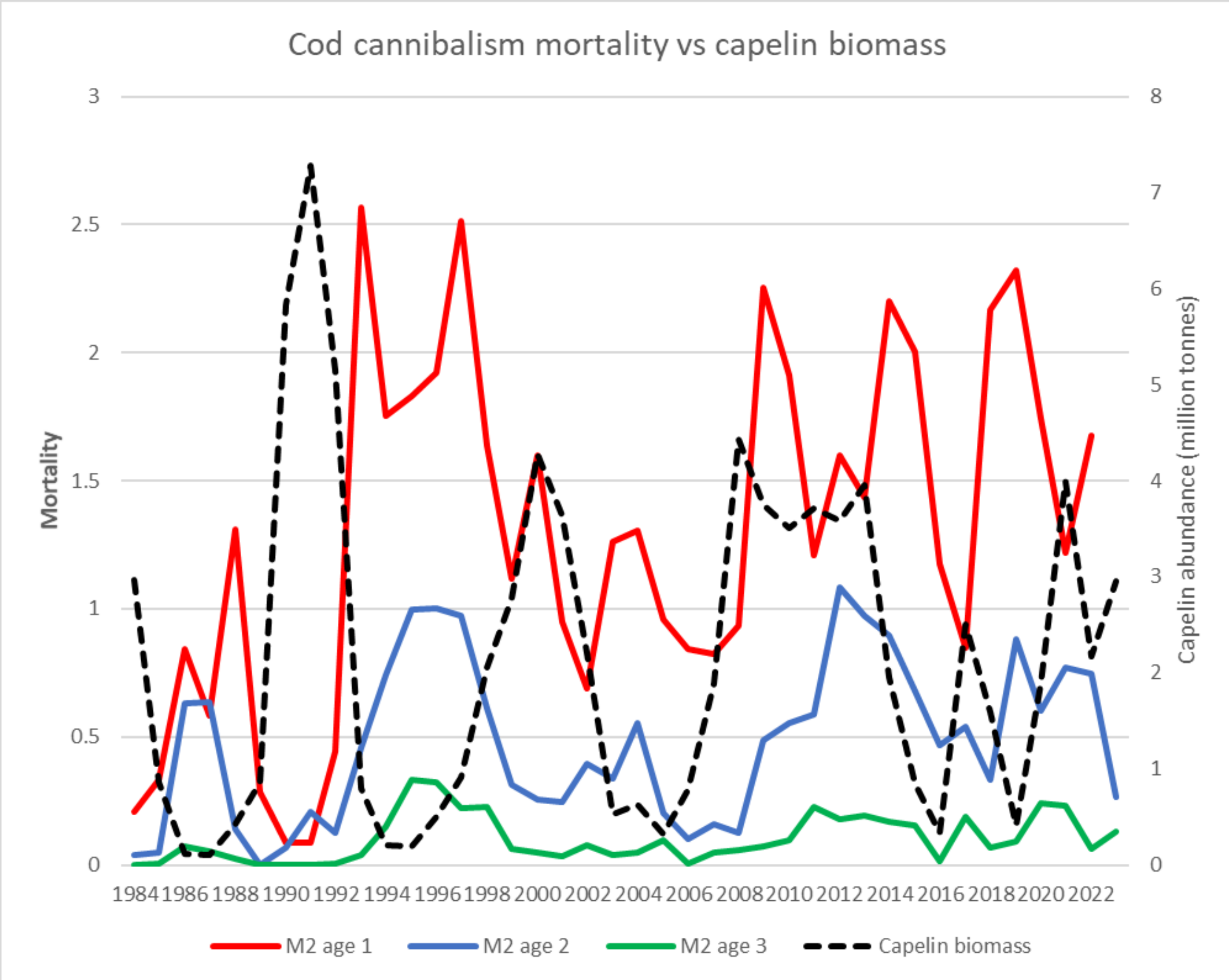
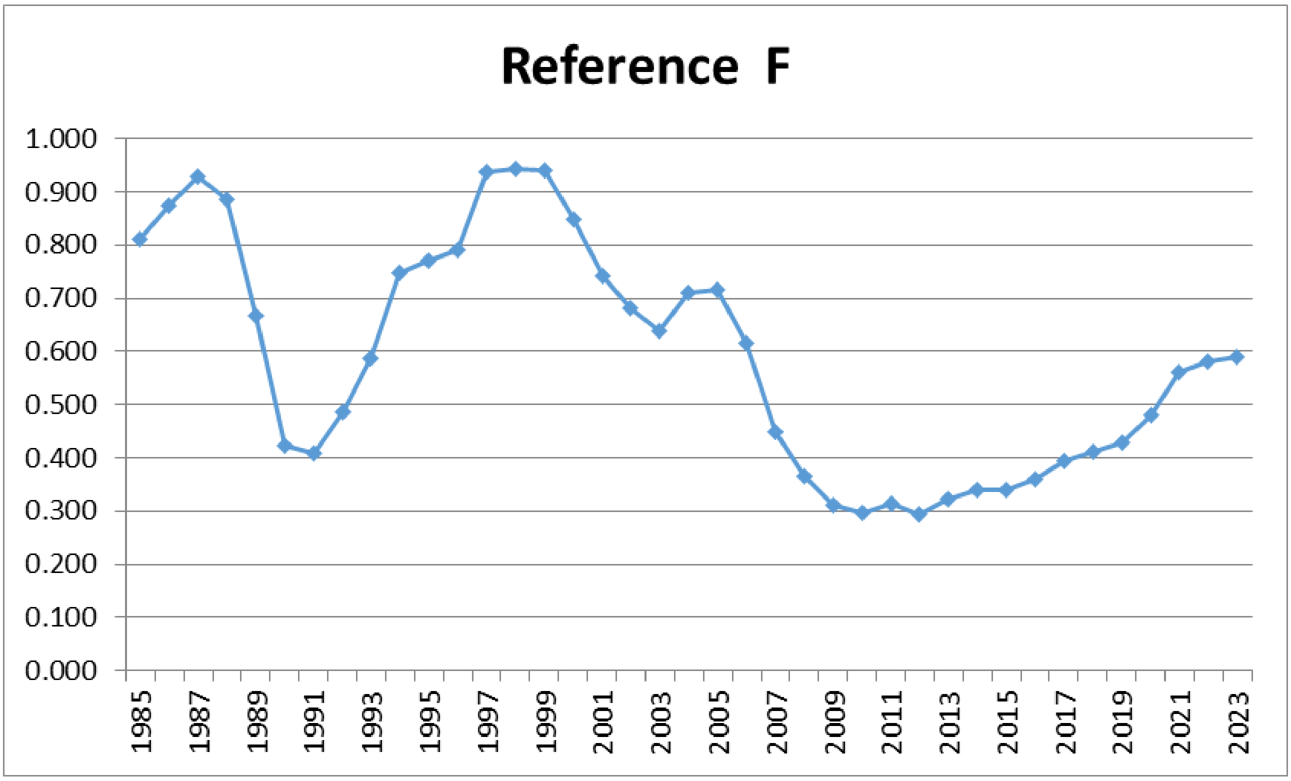


Figure 3.3. NEA cod cannibalism mortality vs. capelin abundance.


Reference F
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023

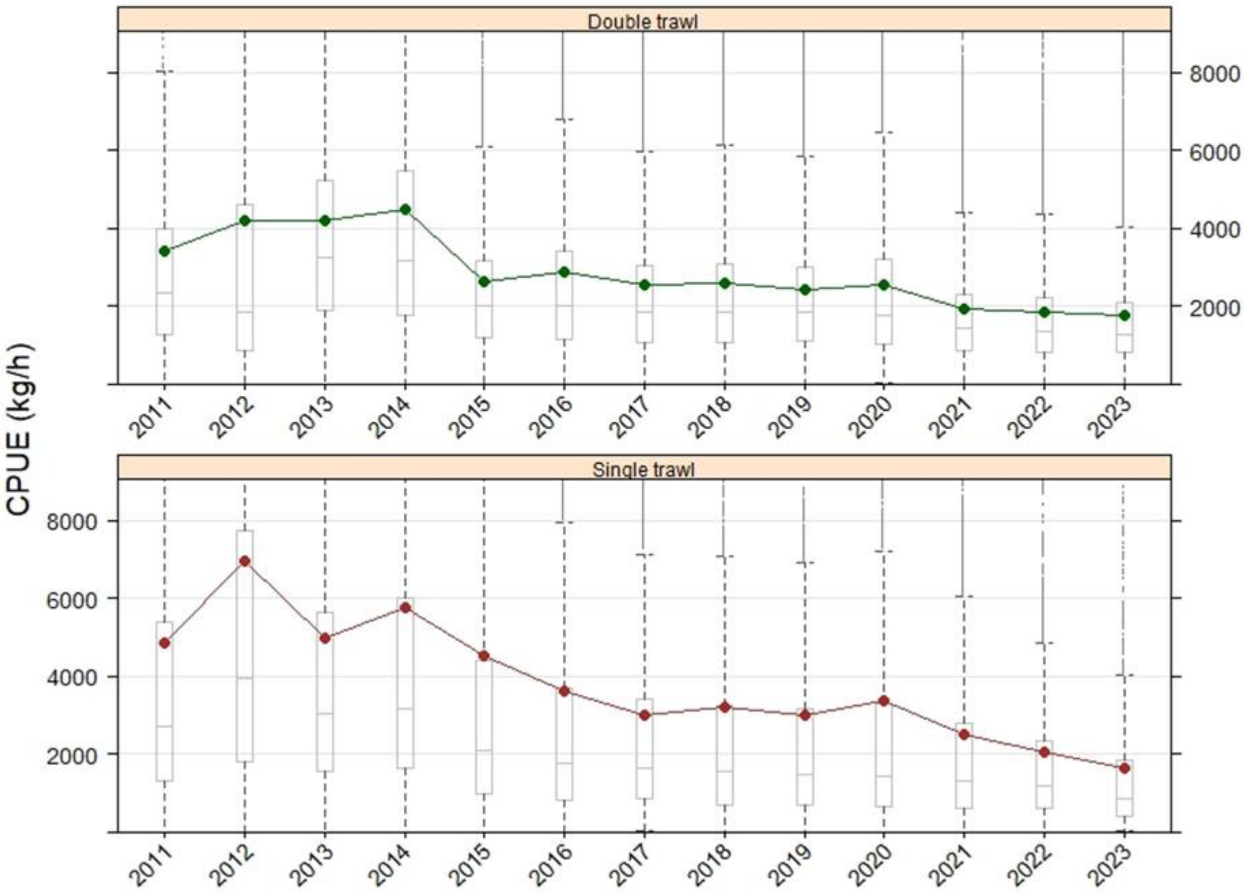


Figure 3. 5. Cod CPUE in Norwegian trawl catches where cod is the main species (double and single trawl, Nedreaas WD02). Connected line shows mean, line inside the box shows the median, and the box shows 25 and 75 percentiles.

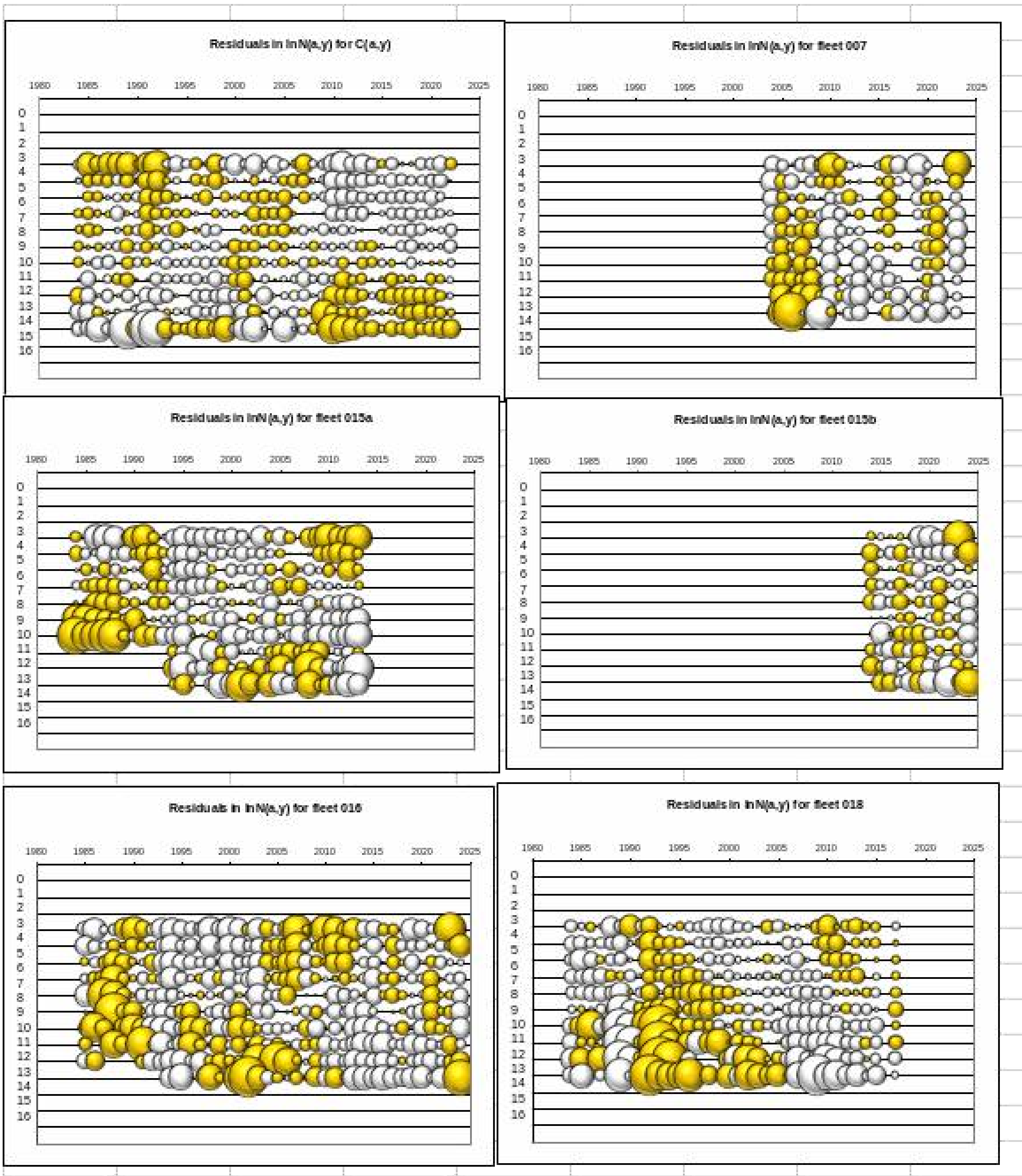


Figure 3.6a. Residuals of the TISVPA data approximation (yellow circles are positive residuals, white – negative).

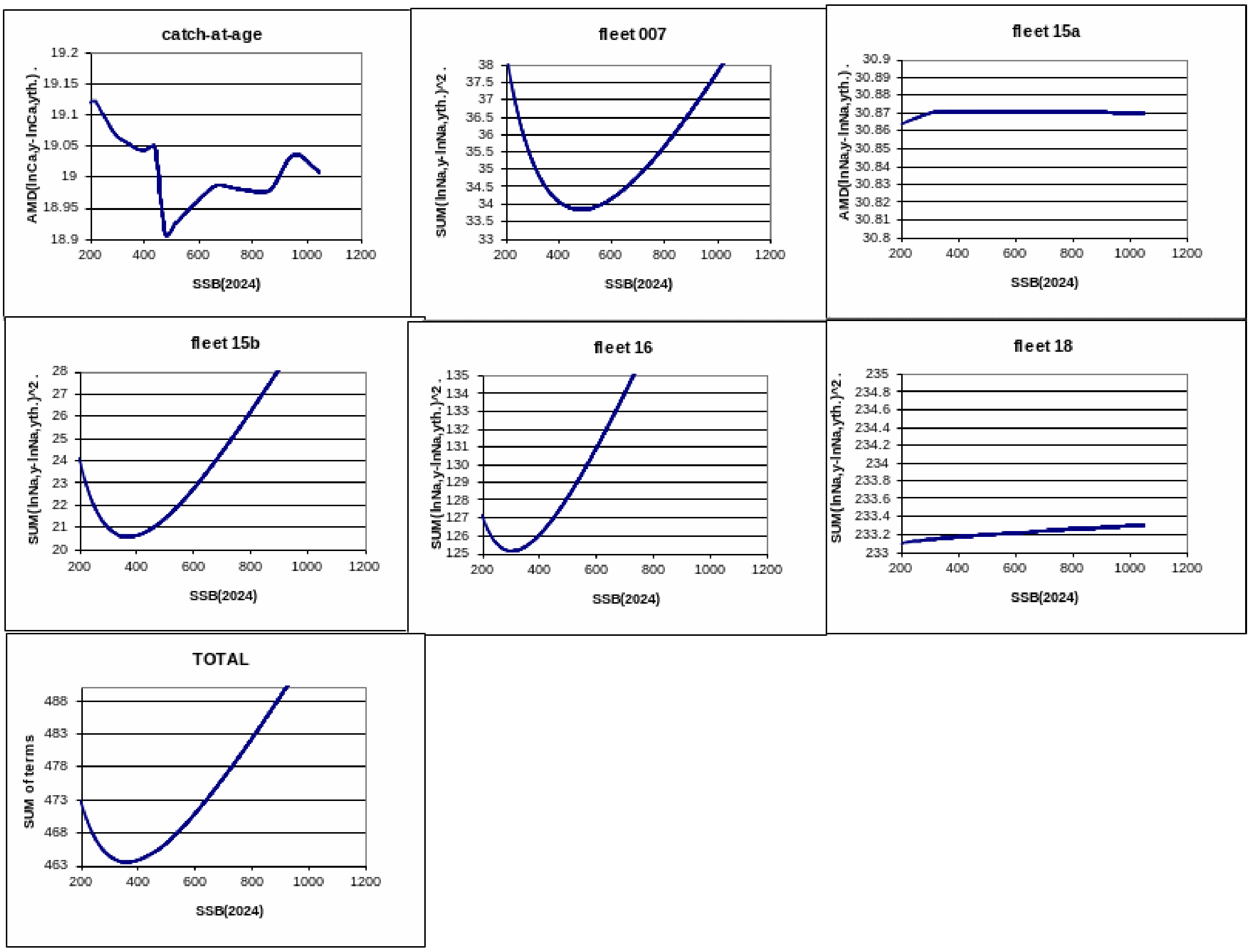
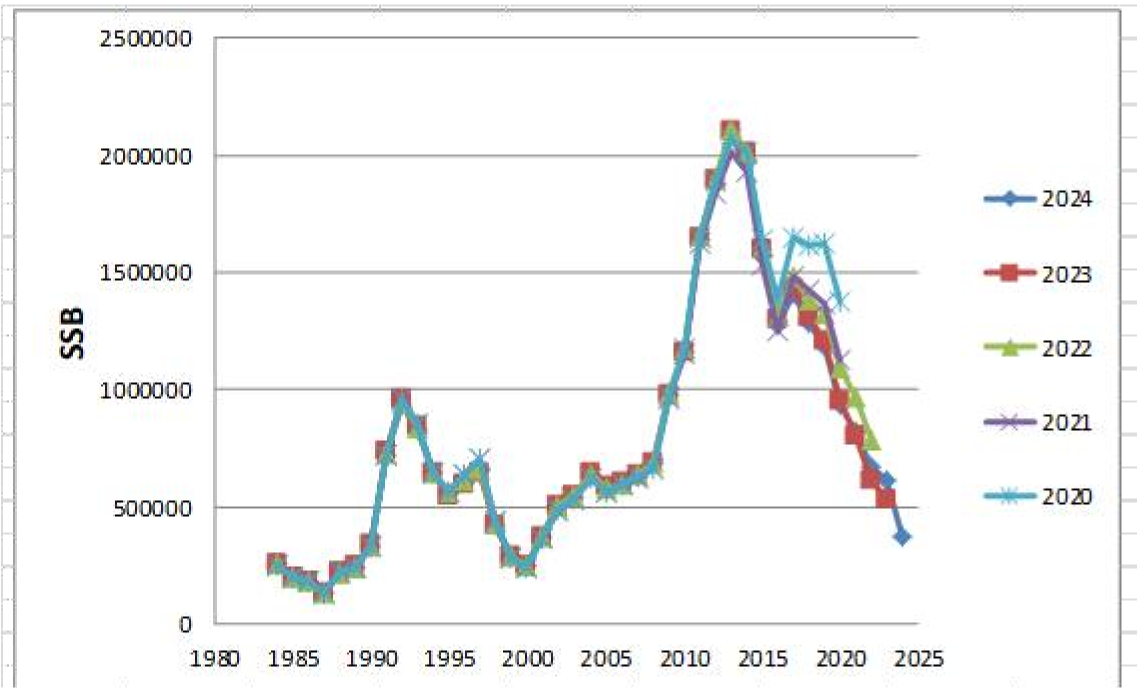


Figure 3.6b. Profiles of the components of the TISVPA objective function.



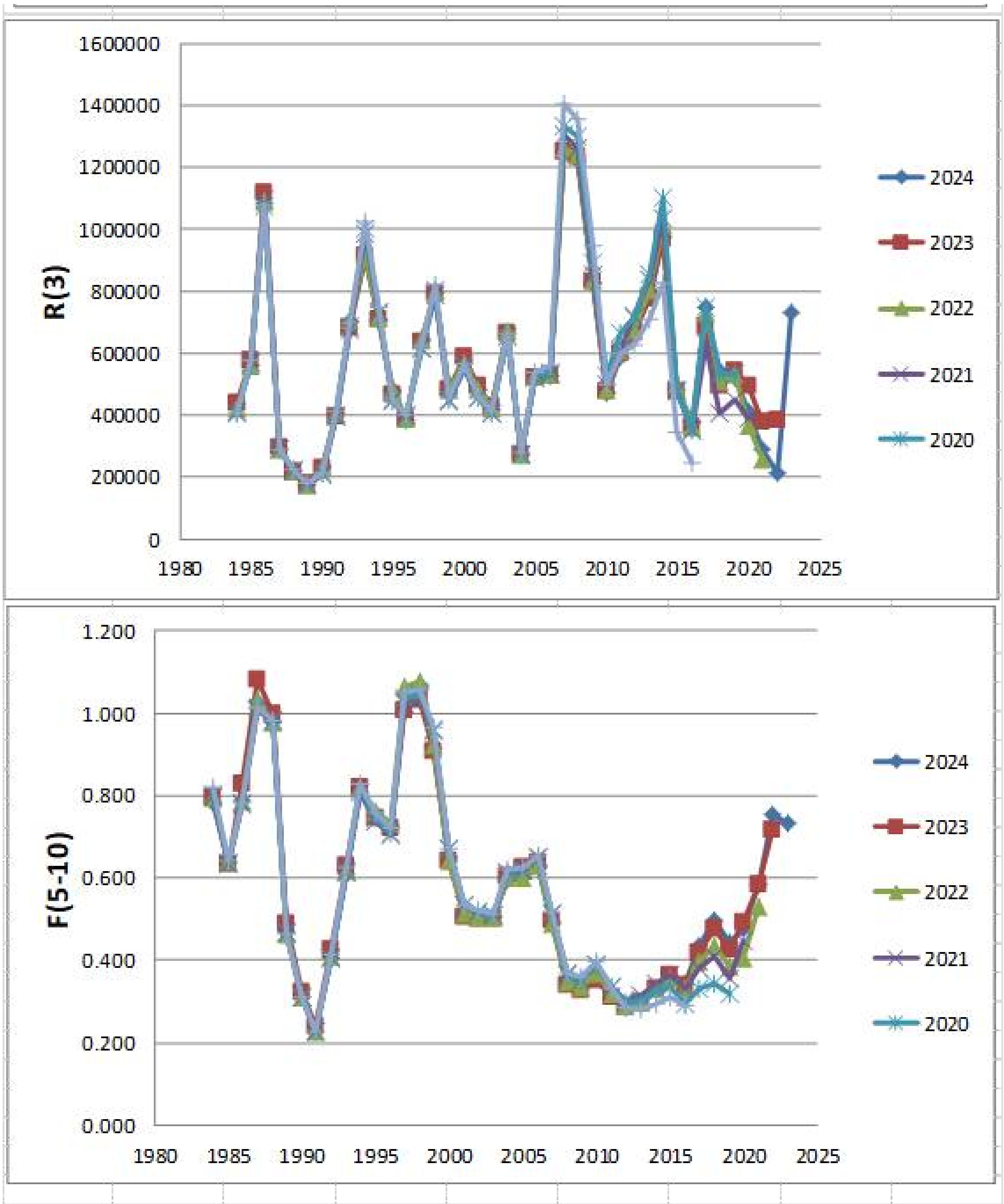


Figure 3.6c. TISVPA retrospective runs.

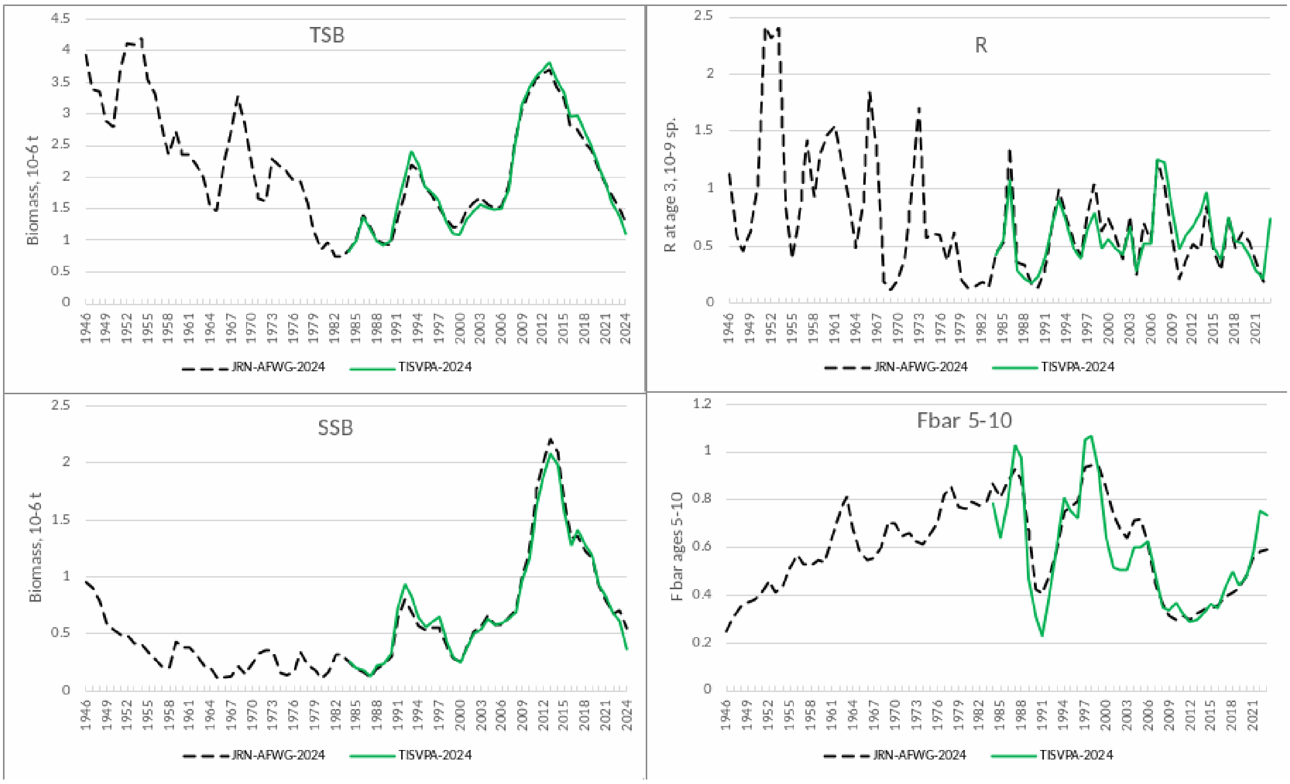
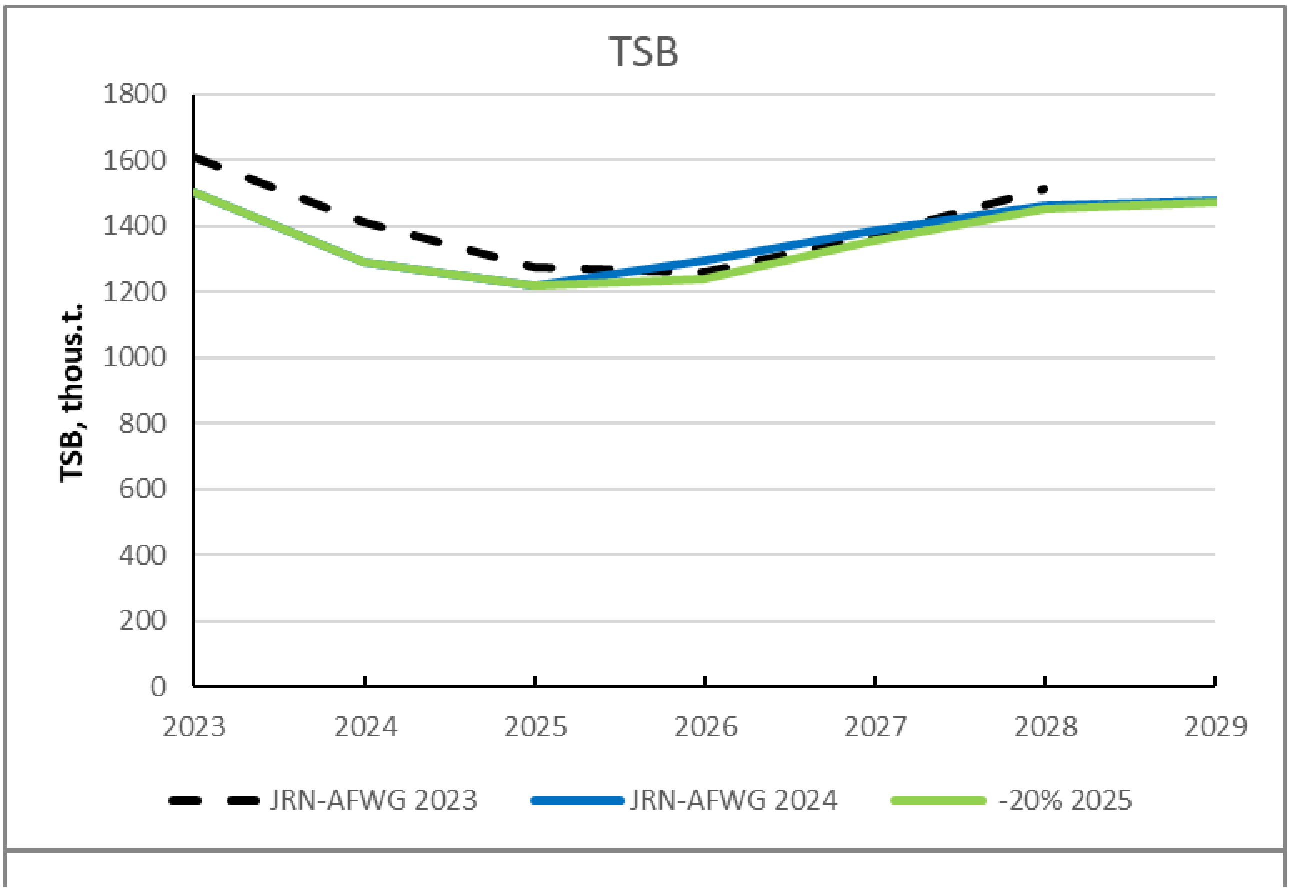


Figure 3.7. Model comparison. TSB (total stock biomass, age 3+), SSB recruitment and F in SAM and TISVPA.



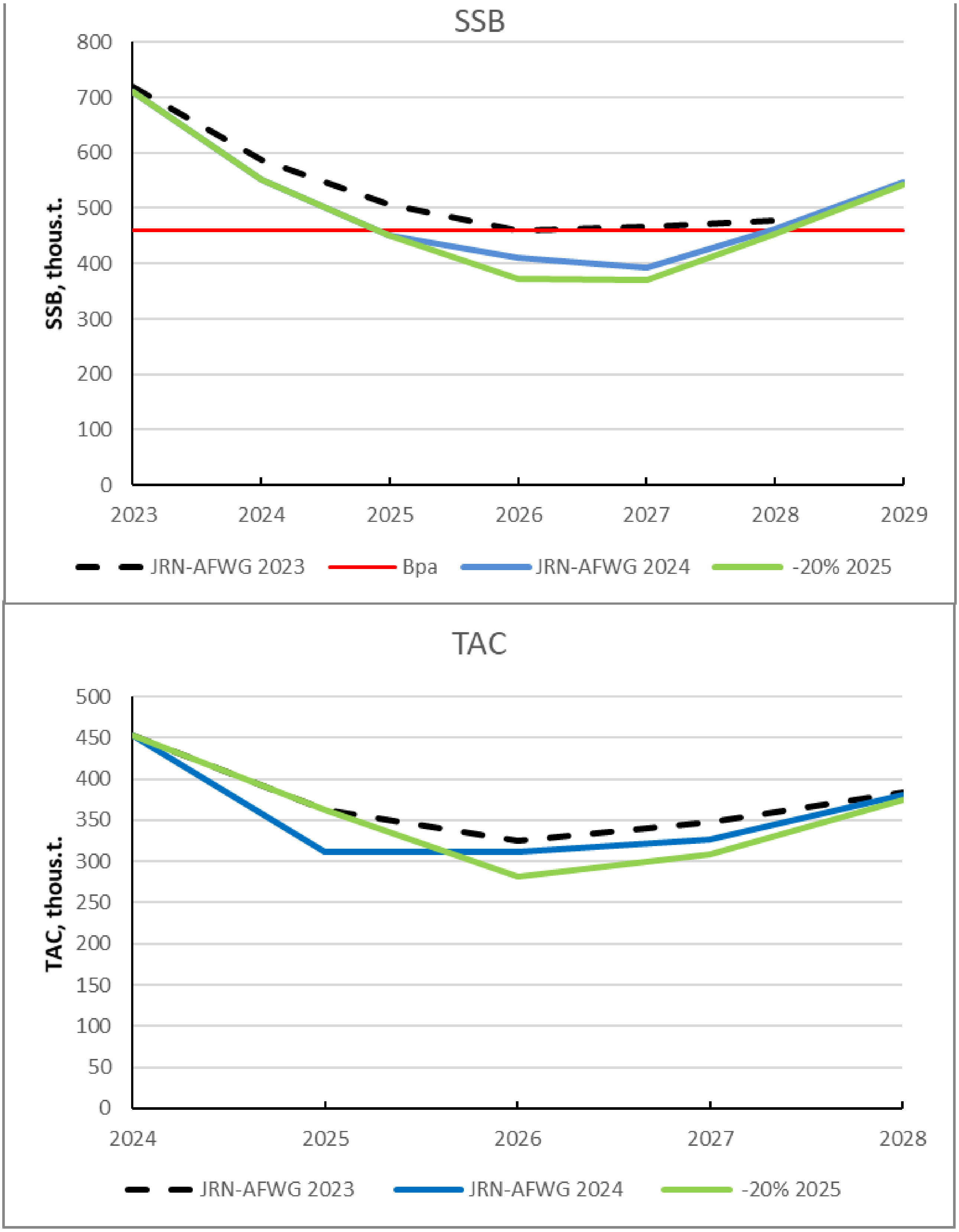


Figure 3.8. Medium term prediction of NEA cod stock dynamics and TAC according to HCR based on assessments of current year and previous year.

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

	Sub-area 1		Division 2b			Division 2a		Total	
Year	Norway [2]	Russia [3]	Norway [2]	Spain [4]	Russia [3]	Norway [2]	Russia [3]	Norway Single trawl	Norway double trawl
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	
2008		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 [5]	3.43
2012		2.25			1.44		2.11	6.97 [5]	4.21
2013		2.30			1.46		2.60	4.96 [5]	4.21
2014		2.07			1.54		2.38	5.75 [5]	4.47
2015		1.06			1.38		1.93	4.54 [5]	2.62

2016		1.15			1.06		1.39	3.64 [5]	2.90
2017		1.00			1.00		1.05	3.01 [5]	2.53
2018		1.06			1.40		1.31	3.20 [5]	2.57
2019		1.01			0.89		1.16	3.02 [5]	2.44
2020		0.78			0.68		1.42	3.38 [5]	2.56
2021		0.70			0.89		0.86	2.51 [5]	1.93
2022		0.60			0.72		0.49	2.04 [5]	1.87
2023 [1]		0.52			0.94		0.50	1.66 [5]	1.78

[1] Preliminary figures.

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

[3] USSR prior to 1991. Data are t per hour fishing.

[4] Spanish data - t per hour fishing.

[5] 2011-2023 Norwegian data on t per hour fishing are 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).

				Age														
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	10+	To
1981		8.00	82.00	40.00	63.00	106.00	103.00	16.00	3.00	1.00							1.00	4
1982		4.00	5.00	49.00	43.00	40.00	26.00	28.00	2.00	+							0.00	1
1983		60.49	2.78	5.34	14.27	17.37	11.13	5.58	2.98	0.45							0.06	1
1984		745.44	146.11	39.13	13.59	11.26	7.44	2.81	0.19	0.02							0.00	9
1985		69.06	446.29	153.04	141.59	19.66	7.58	3.32	0.22	0.09							0.04	8
1986		353.63	243.90	499.61	134.27	65.90	8.28	2.15	0.37	0.06							0.02	13
1987		1.62	34.07	62.80	204.93	41.41	10.40	1.22	0.19	0.66							0.00	3
1988		1.98	26.25	50.42	35.53	56.20	6.48	1.35	0.15	0.01							0.00	1
1989		7.53	7.98	17.00	34.39	21.38	53.82	6.88	0.97	0.10							0.05	1
1990		81.13	24.92	14.82	20.63	26.08	24.30	39.78	2.37	0.06							0.03	2
1991		181.04	219.51	50.23	34.64	29.33	28.87	16.89	17.33	0.86							0.03	5
1992		241.38	562.13	176.48	65.79	18.84	13.23	7.58	4.50	2.78							0.21	10
1993		1074.04	494.68	357.24	191.05	108.24	20.84	8.12	4.98	2.25							2.51	22
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		25
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		29
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		25
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		25
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		37

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		9
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		10
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		8
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		5
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		22
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		4
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		9
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		7
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		2
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		8
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		7
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		11
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		7
2012		496.49	40.23	82.79	49.38	33.77	72.53	132.31	65.59	8.37	4.39	1.21	0.66	0.47	0.04	0.1		9
2013		313.11	89.17	60.55	84.49	72.18	47.75	98.41	130.54	55.32	5.41	4.02	1.3	0.73	0.2	0.07		9
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		27
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		29
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		8
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		8
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		28
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		24
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		7
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		3
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		8
2023		244.43	103.24	28.66	26.54	33.54	33.83	23.81	12.62	7.08	1.58	0.33	0.11	0.04	0.00	0.08		5
2024		328.44	200.98	150.72	50.97	29.34	27.31	28.25	18.83	11.29	3.82	0.43	0.12	0.02	0.05	0.01		8

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+	10+	To
1981		4.60	34.30	16.40	23.30	40.00	38.40	4.80	1.00	0.30							0.00	
1982		0.80	2.90	28.30	27.70	23.60	15.50	16.00	1.40	0.20							0.00	
1983		152.90	13.40	24.95	52.34	43.33	16.96	5.82	3.21	0.97							0.05	
1984		2755.04	379.11	97.49	28.28	21.44	11.74	4.07	0.40	0.08							0.08	3
1985		49.49	660.04	166.79	125.98	19.92	7.67	3.34	0.21	0.07							0.05	1
1986		665.79	399.61	805.00	143.93	64.14	8.30	1.91	0.34	0.04							0.03	2

1987		30.72	444.98	240.38	391.15	54.35	15.70	2.00	0.45	0.03							0.00	1
1988		3.21	72.83	148.03	80.49	173.31	20.48	3.58	0.53	0.03							0.00	
1989		8.24	15.62	46.36	75.86	37.79	90.19	9.82	0.94	0.10							0.07	
1990		207.17	56.72	28.35	34.87	34.59	20.56	27.23	1.61	0.38							0.03	
1991		460.45	220.14	45.85	33.67	25.65	21.49	12.15	12.67	0.61							0.02	
1992		126.56	570.92	158.26	57.71	17.82	12.83	7.67	4.29	2.72							0.22	
1993		534.48	420.40	273.89	140.13	72.48	15.83	6.24	3.89	2.23							2.36	1
1994		1043.78	556.68	293.92	307.04	153.33	45.72	7.95	2.61	1.48	0.55	0.55	0.08	0.05	NA	0		2
1995		5356.43	541.25	282.84	242.36	251.01	76.42	17.98	2.42	1.07	0.5	0.61	0.19	NA	NA	0		6
1996		5899.23	791.62	163.08	117.43	138.59	108.88	24.43	2.64	0.37	0.17	0.12	0.07	0.07	0.02	0		7
1997		5044.09	1422.92	317.99	68.44	74.26	59.99	26.67	4.85	0.64	0.91	0.08	NA	NA	NA	0		7
1998		2490.54	496.48	355.1	166.94	31.67	26.15	17.52	8.16	0.79	0.52	0.04	NA	NA	NA	0.04		3
1999		473.04	350.21	188.48	180.75	61.39	12.71	6.81	5.14	1.01	0.26	0.02	0.04	0.02	NA	0		1
2000		128.57	242.33	245.81	130.03	111.73	26.75	4.56	1.84	1.21	0.33	0.1	0.03	0.02	NA	0		
2001		712.77	78.03	182.79	195.11	82.9	37.96	9.45	1.17	0.44	0.19	0.04	NA	NA	NA	0.01		1
2002		34.11	418.73	118.36	137.56	108.95	45.79	14.4	2.2	0.32	0.18	0.05	NA	NA	NA	0.02		
2003		3022.23	65.78	376.7	126.31	93.93	66.88	17.5	4.67	1.02	0.17	0.04	NA	0.02	0.02	0		3
2004		322.87	242.94	63.88	184.62	53.46	43.24	30.59	6.85	1.65	0.28	0.07	0.01	0.01	NA	0		
2005		853.43	216.67	248.88	55.06	102.97	22.38	16.36	3.81	0.92	0.3	0.04	0.02	0.04	0.04	0		1
2006		674.21	289.39	116.49	115.38	28.32	43.42	13.72	5.24	1.36	0.24	0.18	0.18	NA	NA	0		1
2007		594.69	369.74	361.13	127.73	68.51	13.65	23.6	6.82	2.3	0.41	0.11	0.1	NA	NA	0		1
2008		68.83	101.96	194.37	300.59	111.9	40.24	17.34	8.11	1.79	0.36	0.03	0.02	0.01	NA	0		
2009		389.48	35.59	126.28	196.7	220.23	60.69	17.9	9.02	5.24	0.51	0.17	0.03	0.04	NA	0		1
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		1
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		1
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		1
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		1
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		2
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		2
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		1
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		1
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		3
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		3
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		1
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		
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		1
2023		305.40	163.06	41.21	39.82	46.52	43.17	32.24	14.26	7.49	1.58	0.34	0.14	0.06	0.00	0.14		

2024		377.90	307.04	198.71	63.31	36.21	29.96	28.22	16.15	8.90	2.68	0.37	0.10	0.02	0.01	0.07		10

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
2023	0.08	0.72	4.01	5.73	6.45	1.66	1.40	1.28	21.34
2024	0.55	1.31	2.10	7.63	7.23	2.12	0.68	0.00	21.62

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.

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	
2023	11.4	19.7	32.3	42.2	50.0	59.1	67.6	75.9	81.7	86.8	104.2	104.1	115.6	
2024	11.3	18.1	30.9	42.2	50.7	59.6	66.7	76.0	80.4	85.9	96.6	99.5	117.0	117.0

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	
2023	12	71	316	694	1111	1757	2802	4097	5119	6443	10937	10668	14732	
2024	12	57	289	701	1133	1855	2571	3834	4994	5931	8809	10805	17000	

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	
2023	60.0	69.1	76.7	80.5	87.1	93.1	99.3	107.2	114.0	120.6	
2024	52.2	64.7	73.5	77.9	81.7	91.3	96.4				

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	11.821	14.79	
2022	2.61	3.00	3.59	5.01	7.15	8.34	9.34	9.35	9.41	11.63	
2023	1.86	2.94	4.16	4.84	6.00	7.19	9.36	11.88	15.31	17.69	
2024	1.13	2.32	3.95	4.38	5.68	7.16	9.72				

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								
		1	2	3	4	5	6	7	8	9	10+	Total	
1985	[1]	77	569	400	568	244	51	20	8	1	3	1941	
1986	[1]	25	129	899	612	238	69	20	3	2	1	1998	
1987	[2]	2	58	103	855	198	82	19	4	1	1	1323	
1988	[2]	3	23	96	100	305	54	16	3	1	1	602	
1989	[1]	1	3	17	45	57	91	75	25	13	5	332	
1990	[1]	36	27	8	27	62	74	91	39	10	3	377	
1991	[1]	63	65	96	45	50	54	66	49	5	1	494	
1992	[1]	133	399	380	121	56	58	33	29	11	2	1222	
1993	[1]	20	44	220	234	164	51	19	13	8	10	783	
1994	[1]	105	38	147	275	303	314	100	35	10	8	1335	
1995	[1]	242	42	111	219	229	97	21	6	2	2	971	
1996	[1,3,5]	424	275	189	316	449	314	126	27	3	4	2127	
1997	[4,5]	72	160	263	198	112	57	27	9	1	1	900	
1998	[1]	26	86	279	186	57	23	10	4	1	0	672	
1999	[1]	19	79	166	260	98	20	8	5	2	1	658	
2000	[1,rev]	24	82	191	159	127	48	6	3	1	1	642	
2001	[1]	38	59	148	204	120	70	14	2	1		656	
2002	[1,5,6]	83	2	106	85	140	151	67	30	7	1	672	
2003		69	36	25	218	142	167	163	60	23	4	908	
2004		375	35	170	85	345	194	229	167	49	19	1669	
2005		112	48	65	154	70	214	68	47	17	8	803	
2006	[7]	12	20	39	49	78	32	64	23	13	8	341	
2007		13	35	165	372	208	189	74	113	32	20	1221	
[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. Total (Sub-area I and Division IIa and IIb).

Year			Age											
	0	1	2	3	4	5	6	7	8	9	10	11	12	13+	Sum
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	

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	15	21	31	40	52	59	67	76	85	92.6	97.9	104	110.1

2018	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-	-	-	-	-	-	-

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	1895	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	8495	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	-	-	-	-	-	-	-	-	-	-	-	-	-

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
2023	244.4	103.2	28.7	26.5	33.6	34.6	27.8	18.3	13.5	3.2	1.7	0.8	0.7	1.5
2024	328.4	201.0	150.7	51.0	29.9	28.6	30.4	26.5	18.5	5.9	1.1	0.1	0.1	0.2

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
2022***	399.2	218.2	39.6	25.6	32.8	34.4	33.8	18.6	9.8	2.5	0.8	0.5	0.1	0.2
2023	359.7	322.1	275.2	69.9	40.1	57.1	52.7	45.0	23.3	9.3	2.2	0.8	0.6	0.3

*data adjusted taking into account not complete area coverage

** revised

*** incomplete and unsynoptic coverage

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

Year		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	
2022*		33	171	499	828	1451	2415	3688	5088	7208	7524	12754	9535	-	-	-	17880	
2023		37	152	584	899	1533	2331	3371	5354	6170	7201	9392	9284	8430	15030			

*revised

Table A16. Mean weight at age of cod (kg), combined data from winter survey and Lofoten survey.

Year/age	1	2	3	4	5	6	7	8	9	10	11
1985	0.02	0.171	0.576	1.003	2.018	3.386	4.696	6.636	8.245	10.321	14.290
1986	0.02	0.119	0.377	0.997	1.645	3.010	4.488	6.518			13.480
1987	0.021	0.065	0.23	0.49	1.390	2.155	3.913	5.438			12.550
1988	0.024	0.114	0.241	0.492	0.907	2.116	3.269	4.937		13.640	
1989	0.016	0.158	0.374	0.604	0.948	1.581	2.762	4.791	8.835	8.582	
1990	0.026	0.217	0.58	1.009	1.436	2.010	2.716	3.995	5.425	8.992	
1991	0.018	0.196	0.805	1.364	2.067	2.764	3.532	4.945	7.401	11.645	5.350
1992	0.02	0.136	0.619	1.118	1.994	2.808	3.975	5.376	6.352	8.034	9.500
1993	0.009	0.071	0.415	1.179	1.745	2.675	3.686	5.399	6.280	7.680	9.280

1994	0.013	0.056	0.262	0.796	1.557	2.624	4.181	5.846	6.675	7.966	7.778
1995	0.015	0.054	0.24	0.658	1.364	2.565	4.124	5.326	7.379	9.895	9.738
1996	0.015	0.062	0.232	0.627	1.098	2.094	3.742	5.586	7.866	10.057	10.502
1997	0.013	0.052	0.23	0.638	1.185	1.918	3.433	5.515	8.889	10.408	12.405
1998	0.011	0.052	0.28	0.635	1.183	1.731	2.667	4.362	7.259	10.577	11.657
1999	0.014	0.059	0.231	0.592	1.180	1.964	2.978	4.200	5.980	8.848	9.642
2000	0.016	0.074	0.21	0.558	1.222	2.001	3.064	3.862	5.365	6.471	8.379
2001	0.014	0.106	0.336	0.646	1.319	2.371	3.257	5.078	6.186	10.084	10.558
2002	0.014	0.067	0.238	0.747	1.244	2.199	3.344	4.669	6.554	8.078	9.277
2003	0.013	0.061	0.234	0.597	1.335	2.080	3.207	4.643	6.206	7.649	17.062
2004	0.011	0.059	0.275	0.608	1.177	2.083	2.870	4.411	5.889	7.752	9.310
2005	0.013	0.061	0.246	0.723	1.166	2.068	3.114	3.852	5.877	8.538	14.573
2006	0.013	0.069	0.28	0.669	1.421	2.083	3.009	4.212	5.501	6.881	7.646
2007	0.019	0.073	0.235	0.639	1.351	2.334	3.340	4.923	6.598	9.649	11.132
2008	0.015	0.09	0.335	0.798	1.402	2.482	3.282	5.015	6.863	8.598	7.822
2009	0.013	0.083	0.294	0.704	1.320	2.302	4.089	5.152	6.611	9.391	8.657
2010	0.012	0.064	0.304	0.7	1.300	2.082	3.251	4.951	6.366	8.095	9.757
2011	0.015	0.066	0.246	0.668	1.146	2.050	2.830	4.367	6.592	8.681	9.647
2012	0.013	0.062	0.252	0.609	1.295	1.792	2.664	3.827	5.551	8.373	11.741
2013	0.011	0.065	0.269	0.602	1.212	2.163	2.988	4.103	5.292	7.782	9.842
2014	0.008	0.05	0.246	0.603	1.228	1.804	3.121	3.975	5.015	6.018	7.575
2015	0.01	0.044	0.242	0.602	1.227	1.936	2.849	4.015	4.981	6.630	8.187
2016	0.013	0.053	0.2	0.593	1.051	1.936	2.835	4.240	6.315	7.431	8.541
2017	0.015	0.102	0.292	0.72	1.181	2.024	3.026	4.363	5.817	7.223	8.405
2018	0.012	0.069	0.32	0.688	1.251	2.099	2.890	4.246	5.893	7.356	9.512
2019	0.012	0.048	0.273	0.685	1.165	1.908	3.139	4.384	5.833	7.221	8.788
2020	0.014	0.044	0.153	0.548	1.089	1.729	2.650	4.133	5.633	7.455	8.566
2021	0.014	0.068	0.164	0.462	0.918	1.721	2.696	3.807	5.916	7.314	8.762
2022	0.011	0.077	0.311	0.535	1.061	1.801	2.953	4.079	5.915	8.126	9.399
2023	0.012	0.071	0.316	0.694	1.113	1.782	2.997	4.330	5.537	6.824	9.661
2024	0.012	0.057	0.289	0.701	1.133	1.876	2.666	3.991	5.262	6.370	9.367

Chapter 4. Haddock in subareas 1 and 2 (Northeast Arctic)

Introductory note

On 30th March 2022 all Russian participation in ICES was suspended. The AFWG report 2024 chapter on haddock was therefore not updated.

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

Status of the fisheries

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 70% of the catches are taken by trawl. Norway takes about half of the quota with other gear, in particular long line and Danish seine. Danish seine has become more important in the Norwegian fisheries the last 10 years. 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. Their importance in the catches is currently minimal. Currently, the 2017 and 2016 year-classes are dominating the catches.

Catches prior to 2024 (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 2018-2022 were below 200 kt (Figure 4.1).

Provisional official landings for 2023 are about 179 kt, which is 5% above the agreed TAC (170 kt). As for cod, there was a strong decrease in catches in area 2b from 2022 to 2023.

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 2009–2023 and therefore set to zero.

Catch advice and TAC for 2024

The catch advice for 2024 was 128 k t – a 25% reduction from the year before, following the Harvest Control Rule, and a F of 0.37. Fishing at F_{msy}==0.35 would have given a TAC of 123 kt. The Joint Norwegian-Russian Fisheries Commission set the TAC to 141 kt, which is 10% higher than the advice and not in accordance with the HCR. Russia and Norway can transfer the unused part of their own quota, restricted to a maximum of 10% of own quotas from 2023 to 2024. The catch in 2023 was 5% higher than the agreed TAC.

Status of research

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) and is done using the StoX software (Johnsen et al. 2019). 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. 2023). The spatial survey coverage in 2024 was good.

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 areas coverage with respect to the distribution of haddock was good in 2023. The estimates for cod and haddock are presented in WD 1.

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.

Data used in the assessment

Catch-at-age (Table 4.4)

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. Catch at age from For 2021 and 2022 catch data allocation, instead of using InterCatch, the same algorithm was realized in Excel. Excel was used for comparison with InterCatch in 2008-202 0 , and no differences between InterCatch and Excel allocations were detected.

Age and length composition of the landings in 2023 were available from Norway and Russia in Subarea 1 and Division 2.b, and from Norway, Russia, and Germany in Division 2.a. The German catches was obtained from Intercatch. Norwegian catch at age data was calculated using StoX-R Eca. International landings data were downloaded from https://data.ices.dk/ except for Belarus that reports directly to Russian authorities. Data was combined in Excel as for 2021 and 2022. The biological sampling of NEA haddock catches is considered good for the most important periods of the year and samples were taken from all types of gears in all areas. where the fisheries taken place

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.

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 and WD 4 for details).

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 maturity-at-age were calculated using a correction factor (see WKDEM 2020, stock annex and WD 4 for details).

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 1984–202 3 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.

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 and 2022 (not included due to poor/not synoptic coverage).

data tuning series

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+	1993–2024	1
FLT04: Joint Barents Sea survey–bottom trawl	BS-NoRu-Q1 (BTr)	Barents Sea	February–March	3–10+	1994–2024	1
FLT007: Joint Russian-Norwegian ecosystem autumn survey in the Barents Sea–bottom trawl	Eco-NoRu-Q3 (Btr)	Barents Sea	August–September	3–9+	2004–2023	1

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.

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, and TISVPA are both used as additional models for comparison.

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 combined with reduced fishing pressure. Since then, the stock has declined (Table 4.11; Figure 4.1).

The estimated SSB and TSB for 2024 is at the lowest levels since 2003 and 2001, respectively. The estimate of SSB for 2024 is 150 kt which is above MSY $B_{trigger}$ = 80kt (Figure 4.1). The residuals and retrospective patterns are shown in Figure 4.2 and 4.3.

Fbar increased from 2013 to 2019 and has fluctuated without a trend since then. It been above F_{msy} since 2016.

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 202 3 is 11 % lower, whereas the spawning stock (SSB) estimate is 19% lower. The Fbar in 2022 is estimated as higher compared to last year's assessment. Current estimates for 202 3 for all ages except ages 3 and 4 were lower compared to last year's assessment. Ratios are calculated on original numbers (not rounded as shown in table).

Number at age

Assessment year, model	F (202 2)	Numbers 2023 (ages)											SSB (202 3)	TSB (202)
		3	4	5	6	7	8	9	10	11	12	13+		
2023 SAM	0.35	157204	28014	107132	112780	88935	17075	3594	1770	908	624	1227	210340	4544

2024 SAM	0.42	164015	30160	97785	107760	70973	10278	2712	1283	670	531	969	170118	4044
Ratio 2024/2023	1.21	**1.04**	**1.08**	**0.91**	**0.96**	**0.80**	**0.60**	**0.75**	**0.72**	**0.74**	**0.85**	0.79	0.81	0.8

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

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 (1984–2023). 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 the main model SAM (Figure 4.5).

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 groups for haddock stock (WKARCT 2015, WKDEM, 2020) 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. All results of model run presented in WD #5. 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).

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 TISVPA model is more flexible for settings than the others and considering a possible decrease in survey data consistency, it was attempted to do tuning of surveys not at abundance but to age proportions because of the probable change in effective survey catchability.

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

Recruitment (Table 4.16–Table 4.17)

SAM was used to estimate the recruitment at age 3 of the 2021 year-class in 2024. The RCT3 program (R version) was used to estimate the recruiting year classes 2022–2023 in 2025 and 2026 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 2008–2023 from assessments and RCT3 forecasts (shaded cells). In the most recent years, it is noticeable that the 2018 year-class was less than 50% of the initial RCT3 estimate: The 2020 and 2021 year-classes were estimated by SAM to be more than 73% and 70% higher than the initial RCT3 estimate, respectively.

Recruitment estimates

Year Class	Year of assessment, base model														
	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	202 3 SAM	202 3 SAM
2008	120	151	155	169	178	89	157	107	109	110	122	117	119	118	117
2009	315	320	345	357	363	230	351	294	291	293	356	340	344	335	331
2010	188	146	137	146	150	100	133	105	105	106	124	119	120	118	117
2011		483	513	482	398	298	397	340	329	332	425	411	415	407	400
2012			124	145	104	78	73	79	70	68	75	72	73	73	72
2013				394	290	197	235	184	174	177	219	213	215	212	206
2014					279	198	247	189	146	148	202	194	198	195	191
2015							422	398	333	336	384	368	370	363	353
2016								1067	933	930	875	822	831	808	775
2017									577	629	497	442	449	432	414
2018										344	294	154	164	161	154
2019											39	31	38	47	45
2020												95	89	158	164
2021													303	372	514
2022														231	360
2023															387

Prediction data (Table 4.18, Figure 4.7)

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

Stock numbers for 2025–2026 at age 3 are taken from RCT3, and abundance-at-ages 3–13+ in 2024 from the SAM assessment.

The average fishing pattern observed in 2021–2023 scaled to F in 2023 was used for distribution of fishing mortality-at-age for 2024–2026 (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 (WKDEM, 2020).

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 σ = 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 to 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.

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 (ICES 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.

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 2015/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.

Prediction results and catch options for 2025 (Table 4.19–Table 4.20)

The projection shows a decrease in SSB from 150 kt in 2024 to 128 kt in 2025 (Table 4.19). F corresponding to TAC constraint is used for 2024. The TAC set by the Joint Norwegian-Russian Fisheries Commission was 141 kt, which is 10% higher than the advice and not in accordance with the HCR.

Catch options for 2025 are shown in the text table below (weights in tonnes).

Basis	Total catch (2025)	F ages 4–7 (2025)	SSB (2026)	% SSB change *	% TAC change **	% Advice change ***
Advice basis						
Management plan	106 912	0.35	148 477	16	-24	-16
Other scenarios						
MSY approach: F_{MSY}	106 912	0.35	148 477	16	-24	-16
F = 0	0	0.00	202 674	58	-100	-100
F = F2024	142 841	0.493	131 783	3	1	12
F_{pa}	137 261	0.47	134 320	5	-3	8
F_{lim}	202 346	0.77	106 114	-17	44	59

*** SSB 2026 relative to SSB 2025.**

**** Catch in 2025 relative to TAC in 2024 (141000 t)**

***** Catch value for 2025 relative to advice value for 2024 (127550 t)**

Detailed information about expected catches by following the HCR in 2025 and 2026 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.

Comments to the assessment and predictions (Figure 4.2-4.4 and Figure 4.7- Figure 4.10)

The one step ahead residuals did not show strong patterns. However, there were negative residuals in the last year for important ages for both catches and the ecosystem survey data (Fleet 007) (Figure 4.2). The leave one out analysis did not result in any large changes to the results (maximum change: 10% larger SSB 2024 leave out BS-NoRu-Q1 (Aco)). A jitter analysis did not reveal any problems with model optimization.

This year's assessment showed a downwards revision for the SSB and TSB and an upwards revision for $F_{bar4\text{-}7}$, most apparent back to 2018 (Figure 4.4). The estimates ages >4 years in 2023 was revised down from the 2023 assessment. Mohn's Rho increased compared to the years following the benchmark, especially for SSB.

Mohns rho

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 (Benchmark)	−2%	3%	−3%	1%
AFWG 2020	−4%	−3%	0%	−5%
AFWG 2021	1%	6%	−7%	3%
JRN_AFWG 2022	-2%	5%	-6%	1%
JRN_AFWG 2023	0%	7%	-6%	3%
JRN_AFWG 2024	4%	17%	-13%	12%

Fishing mortality (F_{bar4-7}) has been above F_{msy} since 2013. 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). In the current assessment, F in 2021 was revised upwards for most ages (Figure 4.7).

According to this year's assessment, the 2016 year-class is the sixth strongest year class in the time-series back to 1950. The 2015 and 2017 year-classes were above average (average 1950-2024, R3=258 million individuals). These year classes are soon going to be fished out of the stock, but we assume that they will contribute 47% to the catch in biomass in 2024 and 23% in 2025 (Figure 4.10). The 2018 -2020 year-classes are weak. The 2021 year-class is above average and will enter the fishery this year and was also in the catch data last year as 2-year-old (Figure 4.8). The 2022 and 2023 year-classes are predicted to be above average.

In both 2022 and 2023 the fishing pattern was distributed more towards younger fishes in the catches than what we predicted (Figure 4.8). If this trend continues this will lead to growth overfishing. Fishing out haddock before they reach their full growth potential and before they reach maturity will reduce yield and SSB in the coming years (Figure 4.9 and 4.10). Therefore, it is critical that area closures to avoid by-catch of under-sized fish are implemented. Caution should be raised since the stock size has been over-estimated in the recent assessments (Figure 4.3).

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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	-

Year	Subarea 1	Division 2.a	Division 2.b	un-reported	Total	Norw. stat.areas 06 and 07
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
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

Year	Subarea 1	Division 2.a	Division 2.b	un-reported	Total	Norw. stat.areas 06 and 07
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	98341	57397	26730	0	182468	3196
2021	109914	58006	36823	0	204743	2363
2022	85887	63415	27604	0	176906	2255
2023(1	92760	70916	15223	0	178899	2693

1) Provisional figures, preliminary catches estimated by JRN AFWG in May 2024

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	-	-

	Subarea 1		Division 2.a		Division 2.b		Unreported
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	-
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

Year	Subarea 1		Division 2.a		Division 2.b		Unreported
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	81.4	28.5	41.0	17.0	31.0	5.8	0
2022	63.4	22.5	44.7	18.7	22.1	5.5	0
2023 (1	69.6	23.2	51.7	19.2	11.1	4.1	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
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

Year	Faroe Islands	France	GDR (–1990) & Greenland (1992–)	Germany	Norway	Poland	UK	Russia	Others	Total
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	158751
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	249200
2011	1759	268	2110	1724	158202	502	1379	139912	4763	309785
2012	2055	322	3984	1111	159602	441	833	143886	3393	315627
2013	1886	342	1795	500	99215	439	639	85668	3260	193744
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	233416

Year	Faroe Islands	France	GDR (–1990) & Greenland (1992–)	Germany	Norway	Poland	UK	Russia	Others	Total
2017	2776	108	1810	170	113132	228	372	106714	2279	227588
2018	2333	183	1317	385	93839	169	453	90486	2173	191276
2019	1515	143	1208	204	93860	280	456	76125	1611	175402
2020	1392	96	910	282	88108	45	320	89030	2286	182468
2021	1722	105	1101	365	100673	131	78	98296	2390	204743
2022	1831	164	1101	268	89044	99	138	82364	1897	176906
2023 (1	1993	235	672	296	91325	139	112	81751	2376	178899

1) Provisional figures, preliminary catches estimated by JRN AFWG in May 2024., 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

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
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
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

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
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
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	6 640	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
2022	49	752	2836	18050	50522	55469	11172	2368	1016	544	285	335	479
2023	60	6615	10603	8935	29024	46726	27135	3052	888	337	175	222	313

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

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
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
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

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
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
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	0.57	0.773	0.997	1.351	1.716	2.15	2.388	2.682	3.073	3.201	4.139
2022	0.175	0.436	0.642	0.808	1.093	1.329	1.651	2.031	2.473	2.727	3.000	3.278	4.297
2023	0.248	0.394	0.684	1.02	1.203	1.458	1.673	1.98	2.334	2.676	3.122	3.223	3.849

Table 4.6a. Northeast Arctic haddock. Smoothed stock weights-at-age (kg). The data from 1950–1993 is unchanged since 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

Year	1	2	3	4	5	6	7	8	9	10	11	12	13+
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. Smoothed stock weights-at-age (kg), updated from 1994 and onwards this year.

Year	3	4	5	6	7	8	9	10	11	12	13
1994	0.251	0.505	0.94	1.651	2.164	2.707	2.858	2.81	2.972	3.616	4.155
1995	0.262	0.472	0.804	1.315	2.119	2.627	3.159	3.288	3.206	3.156	3.93
1996	0.279	0.487	0.747	1.136	1.72	2.575	3.086	3.602	3.695	3.396	3.474
1997	0.344	0.518	0.769	1.071	1.495	2.128	3.013	3.522	4.018	3.862	3.713
1998	0.344	0.624	0.816	1.1	1.417	1.879	2.54	3.458	3.931	4.155	4.155
1999	0.364	0.629	0.973	1.158	1.451	1.777	2.27	2.95	3.863	4.085	4.444
2000	0.294	0.665	0.979	1.365	1.522	1.827	2.153	2.663	3.358	4.016	4.37
2001	0.306	0.54	1.027	1.365	1.769	1.9	2.2	2.532	3.043	3.537	4.316
2002	0.274	0.562	0.852	1.432	1.779	2.186	2.294	2.597	2.915	3.23	3.846
2003	0.249	0.509	0.883	1.204	1.85	2.197	2.604	2.689	2.972	3.113	3.552
2004	0.288	0.463	0.804	1.243	1.577	2.279	2.617	3.021	3.072	3.171	3.412
2005	0.285	0.53	0.741	1.136	1.624	1.974	2.709	3.035	3.437	3.26	3.474
2006	0.294	0.53	0.84	1.057	1.505	2.028	2.365	3.123	3.437	3.6	3.584
2007	0.224	0.544	0.834	1.181	1.399	1.879	2.427	2.77	3.532	3.616	3.913
2008	0.22	0.42	0.858	1.181	1.558	1.768	2.27	2.838	3.161	3.713	3.93
2009	0.249	0.417	0.672	1.212	1.549	1.942	2.13	2.663	3.236	3.35	4.016
2010	0.291	0.467	0.667	0.962	1.586	1.942	2.341	2.52	3.043	3.412	3.665
2011	0.297	0.536	0.741	0.962	1.284	1.985	2.329	2.743	2.9	3.23	3.73
2012	0.372	0.548	0.845	1.057	1.284	1.631	2.377	2.729	3.131	3.084	3.552
2013	0.341	0.67	0.864	1.196	1.399	1.622	1.987	2.783	3.131	3.32	3.396
2014	0.393	0.624	1.041	1.219	1.568	1.768	1.976	2.358	3.175	3.305	3.632
2015	0.355	0.707	0.973	1.45	1.596	1.964	2.142	2.346	2.722	3.366	3.616
2016	0.361	0.644	1.091	1.357	1.871	1.996	2.354	2.52	2.708	2.914	3.665
2017	0.35	0.654	1	1.512	1.769	2.303	2.39	2.756	2.9	2.9	3.215
2018	0.277	0.64	1.014	1.398	1.944	2.186	2.723	2.797	3.146	3.098	3.215
2019	0.257	0.514	0.993	1.416	1.809	2.387	2.604	3.152	3.191	3.335	3.396
2020	0.268	0.48	0.81	1.39	1.829	2.232	2.817	3.021	3.563	3.381	3.648
2021	0.294	0.501	0.758	1.151	1.799	2.255	2.657	3.257	3.421	3.73	3.681
2022	0.328	0.54	0.792	1.085	1.513	2.22	2.683	3.079	3.661	3.6	4.033
2023	0.249	0.6	0.852	1.129	1.434	1.889	2.643	3.108	3.484	3.829	3.913

2024	0.294	0.463	0.94	1.204	1.486	1.798	2.281	3.065	3.515	3.648	4.137

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. Smoothed proportion mature at age. Data 1994-2024, 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	0.026	0.088	0.283	0.644	0.821	0.914	0.938	0.944
1995	0.027	0.079	0.221	0.507	0.812	0.907	0.954	0.965
1996	0.03	0.083	0.197	0.422	0.711	0.902	0.95	0.974
1997	0.04	0.092	0.206	0.39	0.632	0.841	0.947	0.972
1998	0.04	0.124	0.226	0.404	0.601	0.79	0.913	0.97
1999	0.044	0.126	0.298	0.433	0.615	0.764	0.884	0.951
2000	0.032	0.138	0.301	0.529	0.642	0.777	0.868	0.935
2001	0.034	0.098	0.323	0.529	0.726	0.795	0.874	0.925
2002	0.029	0.105	0.242	0.559	0.729	0.851	0.887	0.93
2003	0.025	0.089	0.256	0.455	0.749	0.852	0.919	0.937
2004	0.031	0.077	0.221	0.474	0.663	0.865	0.92	0.955
2005	0.03	0.096	0.194	0.422	0.679	0.811	0.928	0.955
2006	0.032	0.096	0.237	0.383	0.636	0.822	0.896	0.959
2007	0.022	0.099	0.234	0.444	0.593	0.79	0.902	0.942
2008	0.022	0.066	0.245	0.444	0.656	0.761	0.884	0.946

2009	0.025	0.065	0.166	0.459	0.653	0.804	0.864	0.935
2010	0.031	0.078	0.164	0.335	0.666	0.804	0.893	0.924
2011	0.032	0.097	0.194	0.335	0.542	0.813	0.891	0.94
2012	0.045	0.101	0.24	0.383	0.542	0.721	0.897	0.939
2013	0.039	0.14	0.248	0.451	0.593	0.718	0.84	0.942
2014	0.049	0.124	0.33	0.462	0.659	0.761	0.838	0.909
2015	0.042	0.153	0.298	0.566	0.669	0.809	0.866	0.908
2016	0.043	0.131	0.353	0.526	0.754	0.816	0.894	0.924
2017	0.041	0.135	0.311	0.591	0.726	0.868	0.898	0.941
2018	0.029	0.129	0.317	0.544	0.773	0.851	0.929	0.943
2019	0.026	0.091	0.307	0.551	0.737	0.88	0.919	0.96
2020	0.028	0.081	0.224	0.54	0.743	0.858	0.935	0.955
2021	0.032	0.087	0.201	0.429	0.734	0.862	0.923	0.964
2022	0.037	0.098	0.216	0.397	0.639	0.856	0.926	0.957
2023	0.025	0.117	0.242	0.419	0.608	0.792	0.922	0.958
2024	0.032	0.077	0.283	0.455	0.629	0.769	0.885	0.957

Table 4.8. Northeast Arctic haddock. Consumption of Haddock by NEA Cod (mln. spec) age 0–6, and total biomass ages 0–6 consumed (1000 tonnes)

Age	0	1	2	3	4	5	6	Biomass
1984	2211.03	1019.15	15.33	0.09	0.00	0.00	0.00	55.43
1985	2001.44	1361.72	5.06	0.00	0.00	0.00	0.00	52.90
1986	91.72	593.94	222.94	166.60	0.00	0.00	0.00	108.23
1987	0.00	1050.91	0.00	0.00	0.00	0.00	0.00	5.78
1988	0.00	16.69	0.48	8.68	0.00	0.20	0.00	2.50
1989	21.16	220.40	0.00	0.00	0.00	0.00	0.00	9.84
1990	48.39	137.35	34.29	3.33	0.00	0.00	0.00	14.09
1991	0.00	355.55	12.98	0.00	0.00	0.00	0.00	15.68
1992	132.13	1742.73	123.26	0.93	0.00	0.00	0.00	88.03
1993	824.28	1440.05	143.40	32.06	3.09	2.62	0.00	69.24
1994	1347.06	1482.72	73.28	23.84	6.89	0.81	0.01	48.24
1995	181.44	2866.91	167.12	12.38	28.14	27.77	0.32	113.44
1996	357.41	1531.75	154.59	38.26	5.19	2.46	3.19	66.30
1997	0.00	936.98	38.59	26.33	1.69	0.75	0.51	43.55
1998	0.00	1718.08	27.45	1.74	2.56	0.45	0.00	35.60
1999	0.00	1032.24	25.14	0.35	0.00	0.00	0.00	29.33
2000	809.13	1404.78	71.37	2.21	1.15	0.19	0.08	58.04
2001	1047.82	593.31	53.29	4.69	0.07	0.00	0.00	51.23

Age	0	1	2	3	4	5	6	Biomass
2002	455.83	2437.19	240.57	39.46	2.27	0.36	0.16	126.97
2003	1142.44	3574.05	214.12	39.25	12.68	1.21	0.00	165.96
2004	5389.73	2863.50	303.56	39.61	9.84	2.45	0.00	197.83
2005	7707.91	6679.54	275.70	54.87	9.25	2.24	0.87	324.23
2006	12794.26	8417.12	374.40	5.47	4.37	1.17	0.48	360.75
2007	1212.45	10184.39	657.29	71.27	3.80	2.18	0.21	377.29
2008	1368.08	966.98	894.26	227.17	43.30	5.56	3.16	291.38
2009	5641.94	1867.06	274.94	260.70	68.14	21.99	1.52	251.78
2010	1985.11	5719.13	179.00	65.90	67.01	60.68	11.30	264.61
2011	2324.69	2631.88	448.53	55.61	74.12	84.90	18.55	275.66
2012	234.85	7100.66	133.82	106.69	14.93	6.65	4.21	218.24
2013	2150.54	1581.86	373.20	30.96	21.76	5.40	4.08	197.25
2014	1154.90	1973.79	137.92	26.80	1.78	0.62	0.00	86.10
2015	4879.22	2534.35	127.69	13.11	42.54	1.40	0.22	174.16
2016	8003.64	2624.94	275.51	21.62	2.34	7.33	1.69	219.14
2017	4498.22	7607.64	227.18	22.45	12.34	6.10	13.21	269.40
2018	2272.80	6842.72	572.95	63.39	6.65	0.58	0.02	269.51
2019	523.60	4389.38	396.25	114.73	7.80	0.29	0.00	203.83
2020	1860.19	489.42	75.19	53.64	68.12	3.53	0.12	82.92
2021	1006.14	300.25	80.75	5.32	4.27	0.76	0.10	25.23
2022	4208.63	2123.94	217.82	8.34	1.24	0.06	0.00	77.59
2023	1595.50	829.28	192.13	8.27	1.91	0.07	0.00	69.55
Average 1984-202 3	2037.09	2581.11	196.03	41.40	13.23	6.27	1.60	134.92

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

Survey	Year\Age	3	4	5	6	7	8	9	10
RU-BTr-Q4	1991	62	9	3	6	18	17		
RU-BTr-Q4	1992	346	50	4	6	9	9		
RU-BTr-Q4	1993	1985	356	48	8	4	4		
RU-BTr-Q4	1994	442	1014	116	15	1	6		
RU-BTr-Q4	1995	31	123	370	40	5	4		
RU-BTr-Q4	1996	28	49	362	334	29	6		
RU-BTr-Q4	1997	32	32	10	27	10	8		
RU-BTr-Q4	1998	38	46	8	5	15	5		
RU-BTr-Q4	1999	196	39	37	8	3	14		
RU-BTr-Q4	2000	60	109	26	11	2	5		

RU-BTr-Q4	2001	334	40	65	11	4	4		
RU-BTr-Q4	2002	399	450	47	24	4	3		
RU-BTr-Q4	2003	221	299	231	34	16	3		
RU-BTr-Q4	2004	113	94	107	87	5	6		
RU-BTr-Q4	2005	240	86	48	57	24	3		
RU-BTr-Q4	2006	113	119	57	26	24	13		
RU-BTr-Q4	2007	838	73	137	38	14	15		
RU-BTr-Q4	2008	2557	1051	124	111	17	11		
RU-BTr-Q4	2009	1647	1704	631	57	32	9		
RU-BTr-Q4	2010	299	1697	1589	466	34	17		
RU-BTr-Q4	2011	47	268	1087	783	165	13		
RU-BTr-Q4	2012	209	49	160	720	480	70		
RU-BTr-Q4	2013	61	175	50	104	374	272		
RU-BTr-Q4	2014	250	46	175	56	142	416		
RU-BTr-Q4	2015	22	199	40	74	28	171		
RU-BTr-Q4	2016	-1	-1	-1	-1	-1	-1		
RU-BTr-Q4	2017	71	99	9	38	6	27		
RU-BTr-Q4	2018	-1	-1	-1	-1	-1	-1		
RU-BTr-Q4	2019	-1	-1	-1	-1	-1	-1		
RU-BTr-Q4	2020	-1	-1	-1	-1	-1	-1		
RU-BTr-Q4	2021	-1	-1	-1	-1	-1	-1		
RU-BTr-Q4	2022	-1	-1	-1	-1	-1	-1		
RU-BTr-Q4	2023	-1	-1	-1	-1	-1	-1		
BS-NoRU-Q1(Aco)	1994	348.73	626.65	121.38	8.55	0.7	0.33	2.71	
BS-NoRU-Q1(Aco)	1995	41.47	121.49	395.37	47.61	2.8	0.05	0.83	
BS-NoRU-Q1(Aco)	1996	29.97	22.09	68.65	143.69	5.67	0.93	0.07	
BS-NoRU-Q1(Aco)	1997	57.27	22.22	15.47	56.13	62.77	4.68	0.19	
BS-NoRU-Q1(Aco)	1998	33.78	58.79	24.2	7.7	14.06	20.69	1.62	
BS-NoRU-Q1(Aco)	1999	83.67	21.64	22.1	6.17	1.55	3.88	2.77	
BS-NoRU-Q1(Aco)	2000	36.39	75.53	14.01	12.61	1.57	0.53	3.02	
BS-NoRU-Q1(Aco)	2001	233.45	40.2	41.38	2.2	1.61	0.15	0.71	
BS-NoRU-Q1(Aco)	2002	255.2	201.84	18.47	11.7	1.59	0.29	0.56	
BS-NoRU-Q1(Aco)	2003	203.68	184.57	136.04	12.26	6.01	0.26	0.9	
BS-NoRU-Q1(Aco)	2004	151.01	101.85	107.82	57.68	7.61	1.15	0.55	
BS-NoRU-Q1(Aco)	2005	221.33	115.67	57.43	56.71	12.69	0.38	0.33	
BS-NoRU-Q1(Aco)	2006	56.32	123.84	47.37	19.26	13.64	3.23	0.35	
BS-NoRU-Q1(Aco)	2007	209.28	46.14	80.57	28.92	10	5.05	2.79	

BS-NoRU-Q1(Aco)	2008	812.41	303.04	90.02	74.12	7.41	12.77	2.11	
BS-NoRU-Q1(Aco)	2009	883.68	629.98	266.65	38.87	14.57	1.26	1.05	
BS-NoRU-Q1(Aco)	2010	128.07	631.03	603.99	166.96	12.07	2.94	2.11	
BS-NoRU-Q1(Aco)	2011	54.16	84.23	313.02	292.21	54.91	1.71	1.46	
BS-NoRU-Q1(Aco)	2012	191.63	48.84	88.12	310.6	172.52	30.09	1.01	
BS-NoRU-Q1(Aco)	2013	67.29	146.77	35.41	53.03	223.77	102.68	14.37	
BS-NoRU-Q1(Aco)	2014	334.82	39.12	108.72	23.18	34.77	86.36	38.82	
BS-NoRU-Q1(Aco)	2015	24.35	189.4	26.63	46.13	9.22	22.45	31.99	
BS-NoRU-Q1(Aco)	2016	71.81	12.08	59.62	12.52	17.28	7.48	33.24	
BS-NoRU-Q1(Aco)	2017	81.15	65.05	4.81	34.81	6.24	7.93	17.72	
BS-NoRU-Q1(Aco)	2018	171.03	62.74	64.4	6.77	15.57	2.75	14.69	
BS-NoRU-Q1(Aco)	2019	507.61	146.22	31.73	21.88	4.72	3.46	4.19	
BS-NoRU-Q1(Aco)	2020	286.32	306.38	79.18	22.38	11.59	1.84	6.33	
BS-NoRU-Q1(Aco)	2021	50.76	130.37	181.8	19.35	5.44	0.94	1.77	
BS-NoRU-Q1(Aco)	2022	11.35	63.4	95.3	101.24	11.79	0.82	1.08	
BS-NoRU-Q1(Aco)	2023	76.99	9.02	51.28	53.25	38.07	2.69	0.49	
BS-NoRU-Q1(Aco)	2024	337.4	44	3.7	14.9	12.5	7.8	0.33	
BS-NoRu-Q1 (BTr)	1994	314.533	436.251	46.176	3.54	0.163	0.13	0.2	0.651
BS-NoRu-Q1 (BTr)	1995	54.857	167.104	343.38	29.623	1.441	0.025	0.043	0.404
BS-NoRu-Q1 (BTr)	1996	55.843	31.334	150.768	238.108	16.131	1.15	0	0.069
BS-NoRu-Q1 (BTr)	1997	79.632	39.855	18.255	61.566	88.411	3.277	0.082	0.043
BS-NoRu-Q1 (BTr)	1998	21.681	36.749	11.844	1.294	9.203	7.212	0.648	0.092
BS-NoRu-Q1 (BTr)	1999	56.92	15.874	9.418	2.831	0.807	1.282	0.771	0.034
BS-NoRu-Q1 (BTr)	2000	24.08	35.241	6.789	4.134	0.684	0.083	0.802	0.288
BS-NoRu-Q1 (BTr)	2001	293.996	26.252	22.997	1.634	0.752	0.058	0.06	0.329
BS-NoRu-Q1 (BTr)	2002	312.87	185.453	12.417	8.04	0.846	0.218	0.009	0.325
BS-NoRu-Q1 (BTr)	2003	352.236	174.452	72.708	5.104	1.682	0.119	0.104	0.217
BS-NoRu-Q1 (BTr)	2004	173.132	100.516	77.021	51.281	7.409	0.912	0.133	0.228
BS-NoRu-Q1 (BTr)	2005	317.889	141.058	50.664	61.191	10.082	0.249	0.08	0.009
BS-NoRu-Q1 (BTr)	2006	78.798	130.76	46.048	20.874	16.208	3.184	0.094	0.265
BS-NoRu-Q1 (BTr)	2007	443.266	81.784	84.667	26.279	5.411	2.197	1.376	0.896
BS-NoRu-Q1 (BTr)	2008	1591.031	583.606	53.079	54.732	6.794	10.248	0.23	0.167
BS-NoRu-Q1 (BTr)	2009	1230.426	751.012	368.33	25.414	12.437	0.851	0.09	0.363
BS-NoRu-Q1 (BTr)	2010	102.451	510.449	443.759	139.316	7.988	1.016	0.386	0.574
BS-NoRu-Q1 (BTr)	2011	52.883	123.634	469.482	290.036	65.236	1.416	1.121	0.184
BS-NoRu-Q1 (BTr)	2012	316.077	28.785	74.714	267.945	154.601	24.766	3.115	0.391
BS-NoRu-Q1 (BTr)	2013	57.444	143.984	22.019	33.624	191.145	69.385	6.114	0.076

BS-NoRu-Q1 (BTr)	2014	381.173	32.729	104.397	23.257	50.035	97.536	38.692	2.425
BS-NoRu-Q1 (BTr)	2015	30.615	187.035	43.601	39.44	14.668	18.735	30.744	10.2
BS-NoRu-Q1 (BTr)	2016	163.385	34.342	115.597	22.406	41.948	12.437	32.396	33.161
BS-NoRu-Q1 (BTr)	2017	134.9	105.5	7.553	55.338	9.692	15.6	2.527	23.861
BS-NoRu-Q1 (BTr)	2018	336.307	86.656	65.764	7.771	15.59	3.621	2.564	11.931
BS-NoRu-Q1 (BTr)	2019	1075.552	187.224	49.399	16.996	4.038	2.948	0.736	1.91
BS-NoRu-Q1 (BTr)	2020	424.225	586.985	99.123	22.08	6.057	2.605	1.042	2.827
BS-NoRu-Q1 (BTr)	2021	111.35	176.57	265.49	19.32	3.57	0.68	0.19	0.72
BS-NoRu-Q1 (BTr)	2022	12.226	86.54	121.699	113.566	9.099	0.617	0.113	0.44
BS-NoRu-Q1 (BTr)	2023	82.055	8.058	50.201	49.022	33.313	2.168	0.096	0.318
BS-NoRu-Q1 (BTr)	2024	346.712	40.855	3.345	15.762	12.595	7.724	0.355	0.119
FLT007: Eco-NoRu-Q3 (Btr)	2004	123.368	70.303	69.118	31.482	2.989	1.721	0.22	
FLT007: Eco-NoRu-Q3 (Btr)	2005	324.56	89.531	30.44	32.246	15.035	0.472	1.116	
FLT007: Eco-NoRu-Q3 (Btr)	2006	107.467	124.64	41.597	18.98	17.482	7.289	1.384	
FLT007: Eco-NoRu-Q3 (Btr)	2007	1282.94	88.498	90.369	19.227	5.881	7.102	3.209	
FLT007: Eco-NoRu-Q3 (Btr)	2008	1154.869	405.999	43.133	35.517	4.94	2.514	2.539	
FLT007: Eco-NoRu-Q3 (Btr)	2009	650.742	619.088	305.883	21.045	6.549	0.87	0.576	
FLT007: Eco-NoRu-Q3 (Btr)	2010	184.001	865.318	666.439	147.72	15.84	2.73	0.589	
FLT007: Eco-NoRu-Q3 (Btr)	2011	40.446	73.802	392.93	301.368	37.357	2.972	0.514	
FLT007: Eco-NoRu-Q3 (Btr)	2012	92.468	20.348	67.607	214.052	152.03	12.739	2.003	
FLT007: Eco-NoRu-Q3 (Btr)	2013	25.779	65.228	19.575	50.846	150.131	76.427	7.561	
FLT007: Eco-NoRu-Q3 (Btr)	2014	261.631	40.768	70.161	25.781	60.452	85.771	19.646	
FLT007: Eco-NoRu-Q3 (Btr)	2015	42.148	213.636	25.132	37.111	20.577	47.868	42.903	
FLT007: Eco-NoRu-Q3 (Btr)	2016	209.303	34.43	184.09	47.965	56.787	40.367	125.907	
FLT007: Eco-NoRu-Q3 (Btr)	2017	70.313	70.306	11.47	20.537	3.963	4.025	15.265	
FLT007: Eco-NoRu-Q3 (Btr)	2018	-1	-1	-1	-1	-1	-1	-1	
FLT007: Eco-NoRu-Q3 (Btr)	2019	896.982	160.736	38.067	15.133	5.303	5.037	11.56	
FLT007: Eco-NoRu-Q3 (Btr)	2020	204.059	341.372	58.813	4.918	1.959	0.802	1.483	
FLT007: Eco-NoRu-Q3 (Btr)	2021	129.533	345.768	330.627	32.25	5.446	0.885	1.41	
FLT007: Eco-NoRu-Q3 (Btr)	2022	-1	-1	-1	-1	-1	-1	-1	
FLT007: Eco-NoRu-Q3 (Btr)	2023	182.62	13.345	37.289	36.344	12.06	0.456	0.341	

Table 4.10 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 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(4-7)	Low	High	TSB	Low	High
1950	110038	70318	172195	213098	190932	237837	0.794	0.673	0.935	396840	356254	442049
1951	633959	422176	951982	124868	110849	140660	0.684	0.577	0.811	428048	342682	534678
1952	83966	54059	130419	101012	88332	115513	0.704	0.59	0.84	416060	333540	518997
1953	1186876	792673	1777121	120410	104189	139155	0.532	0.441	0.643	714915	553832	922851
1954	131478	84861	203703	173385	147570	203715	0.431	0.356	0.523	810600	646087	1017004

1955	59255	37752	93006	309421	264756	361621	0.449	0.374	0.54	837088	708066	989619
1956	222228	142942	345493	364154	310799	426668	0.475	0.395	0.57	681368	586892	791054
1957	61053	38964	95667	253086	217226	294865	0.428	0.357	0.513	432656	376505	497182
1958	74378	48008	115231	181370	157654	208654	0.519	0.432	0.623	314705	277335	357112
1959	385153	255704	580136	125441	109041	144308	0.446	0.369	0.54	332489	275103	401846
1960	314280	207100	476930	112870	99616	127888	0.54	0.452	0.646	415474	347752	496383
1961	142446	93949	215978	124441	110920	139609	0.664	0.563	0.784	399311	348149	457992
1962	290162	192872	436527	124618	110750	140222	0.794	0.675	0.933	373352	322574	432124
1963	312272	209555	465339	93938	82704	106698	0.76	0.639	0.905	350259	294351	416786
1964	352016	234914	527494	84244	74116	95757	0.634	0.527	0.761	384346	319775	461955
1965	125910	82095	193108	102938	90003	117731	0.526	0.436	0.634	385196	326882	453913
1966	309997	204532	469842	144858	126330	166104	0.559	0.467	0.67	447607	383591	522308
1967	339255	223412	515165	150777	130228	174568	0.444	0.367	0.535	461966	389984	547235
1968	18922	11732	30517	167119	144992	192622	0.486	0.402	0.587	423781	360686	497914
1969	20435	12628	33068	166772	143621	193655	0.416	0.341	0.509	314469	270086	366146
1970	205947	133671	317302	154545	131368	181813	0.387	0.313	0.477	284409	240497	336338
1971	111639	72682	171479	127155	107395	150550	0.329	0.264	0.41	262792	224002	308298
1972	1073335	707532	1628262	128143	111460	147322	0.657	0.54	0.799	608117	466519	792693
1973	310663	206659	467007	125382	108183	145315	0.54	0.443	0.658	640283	517757	791805
1974	65039	42241	100139	153937	134375	176347	0.502	0.416	0.607	463910	401436	536107
1975	59149	38437	91022	194781	167105	227042	0.496	0.414	0.594	378394	328933	435293
1976	59157	37549	93200	195674	168190	227648	0.719	0.606	0.853	294661	258141	336346
1977	120692	76059	191516	118859	100310	140838	0.732	0.605	0.887	200270	171674	233629
1978	213186	141614	320929	80895	67101	97524	0.627	0.511	0.77	198221	164238	239234
1979	160795	106373	243060	62278	52461	73932	0.584	0.472	0.722	205202	171221	245926
1980	23618	14727	37876	62543	53210	73512	0.476	0.383	0.591	212423	177930	253603
1981	11101	6634	18576	72421	61374	85457	0.438	0.352	0.545	167972	142138	198501
1982	16377	9962	26924	68421	56732	82517	0.384	0.306	0.483	122621	102921	146092
1983	8039	4650	13898	58508	48149	71095	0.348	0.273	0.445	87685	73534	104558
1984	13082	7978	21453	53166	43434	65078	0.314	0.243	0.406	71488	59765	85509
1985	357657	235975	542084	49030	40833	58873	0.399	0.314	0.508	190947	141322	257997
1986	476527	315596	719523	54603	46371	64296	0.537	0.428	0.673	372645	294883	470914
1987	92051	59718	141890	77211	66119	90163	0.632	0.509	0.783	354417	297023	422900
1988	39771	24957	63379	79561	67118	94310	0.513	0.412	0.638	253833	215822	298538
1989	27846	17231	44999	84262	69611	101996	0.372	0.295	0.467	192287	161491	228957
1990	36089	23201	56137	86042	70285	105332	0.211	0.166	0.269	153279	128483	182861
1991	107694	75940	152726	100226	84352	119086	0.239	0.191	0.299	184411	157815	215489

1992	317850	227133	444801	110116	95315	127214	0.296	0.239	0.367	285199	240254	338553
1993	812363	593836	1111307	123913	109413	140334	0.321	0.262	0.393	510759	425088	613695
1994	389416	316627	478938	154765	138530	172902	0.376	0.311	0.454	634099	556863	722047
1995	99474	78314	126352	190437	170166	213122	0.305	0.257	0.363	632812	561467	713222
1996	98946	78328	124993	216671	193990	242004	0.374	0.319	0.438	546859	489670	610727
1997	118812	94279	149730	186707	166912	208851	0.454	0.385	0.535	397989	358577	441733
1998	63028	49180	80776	129431	114942	145745	0.457	0.384	0.544	264817	237962	294704
1999	147657	118952	183289	94302	83762	106169	0.465	0.387	0.56	231362	207007	258582
2000	83270	65838	105318	78990	70062	89054	0.342	0.281	0.417	212974	188845	240185
2001	359701	296740	436021	92264	82413	103292	0.371	0.309	0.446	315084	279574	355105
2002	386866	318438	469997	109407	97831	122354	0.355	0.296	0.426	428709	380290	483294
2003	332712	270243	409620	138630	124677	154143	0.43	0.364	0.507	499406	446671	558368
2004	255646	210593	310337	156676	140945	174163	0.396	0.337	0.465	486085	437656	539873
2005	354171	293454	427450	166277	149640	184763	0.412	0.351	0.482	501627	452493	556096
2006	153663	125409	188283	151767	136561	168666	0.376	0.319	0.443	432698	390438	479533
2007	514191	423913	623695	153081	138058	169738	0.394	0.334	0.465	492074	442738	546907
2008	1048186	874520	1256339	161015	144262	179714	0.325	0.273	0.387	706824	626814	797048
2009	982329	820791	1175658	181636	162878	202555	0.27	0.227	0.321	959547	849025	1084456
2010	235386	192881	287259	246977	221307	275624	0.254	0.215	0.3	1091313	966678	1232016
2011	117342	93736	146894	356055	319054	397348	0.267	0.228	0.311	1142998	1019581	1281354
2012	331422	272529	403041	467020	415602	524800	0.229	0.195	0.269	1139170	1017626	1275230
2013	117064	93785	146122	509013	451179	574260	0.153	0.129	0.182	976918	872153	1094267
2014	399947	330282	484305	510434	455625	571837	0.159	0.133	0.19	961198	866571	1066158
2015	71899	56805	91002	488941	440830	542304	0.194	0.163	0.231	855052	775536	942721
2016	206289	167949	253382	479940	433696	531114	0.267	0.226	0.315	784180	712300	863314
2017	191476	156175	234757	402555	365961	442809	0.356	0.303	0.419	686853	626497	753025
2018	353237	288706	432191	296733	269095	327210	0.414	0.353	0.487	595026	540450	655112
2019	774629	643003	933201	225698	204447	249158	0.452	0.382	0.535	641335	576832	713051
2020	414489	341742	502721	186017	168034	205924	0.479	0.405	0.567	649569	581535	725562
2021	153939	123568	191774	170620	153632	189487	0.495	0.419	0.584	584250	523338	652252
2022	44626	33640	59199	167259	147656	189465	0.424	0.353	0.509	476747	422112	538452
2023	164015	130651	205900	170118	146693	197283	0.45	0.365	0.556	404413	352397	464106
2024	469037	372117	591201	150433	120071	188471				415805	348356	496313

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	0.194	0.482	0.749	0.873	1.07	0.895	0.895	0.895	0.895	0.895	0.895
1951	0.131	0.375	0.616	0.767	0.977	0.881	0.881	0.881	0.881	0.881	0.881
1952	0.125	0.382	0.628	0.784	1.022	0.93	0.93	0.93	0.93	0.93	0.93
1953	0.08	0.281	0.468	0.582	0.799	0.737	0.737	0.737	0.737	0.737	0.737
1954	0.054	0.209	0.358	0.468	0.689	0.649	0.649	0.649	0.649	0.649	0.649
1955	0.051	0.203	0.372	0.506	0.715	0.605	0.605	0.605	0.605	0.605	0.605
1956	0.055	0.214	0.393	0.554	0.738	0.626	0.626	0.626	0.626	0.626	0.626
1957	0.05	0.201	0.369	0.494	0.646	0.551	0.551	0.551	0.551	0.551	0.551
1958	0.061	0.239	0.453	0.602	0.781	0.692	0.692	0.692	0.692	0.692	0.692
1959	0.061	0.232	0.411	0.522	0.62	0.568	0.568	0.568	0.568	0.568	0.568
1960	0.095	0.321	0.537	0.632	0.671	0.615	0.615	0.615	0.615	0.615	0.615
1961	0.127	0.409	0.684	0.782	0.782	0.693	0.693	0.693	0.693	0.693	0.693
1962	0.16	0.505	0.857	0.944	0.869	0.723	0.723	0.723	0.723	0.723	0.723
1963	0.14	0.472	0.809	0.912	0.848	0.683	0.683	0.683	0.683	0.683	0.683
1964	0.098	0.361	0.636	0.771	0.766	0.647	0.647	0.647	0.647	0.647	0.647
1965	0.076	0.294	0.515	0.637	0.657	0.567	0.567	0.567	0.567	0.567	0.567
1966	0.091	0.332	0.565	0.668	0.671	0.556	0.556	0.556	0.556	0.556	0.556
1967	0.071	0.272	0.449	0.517	0.537	0.465	0.465	0.465	0.465	0.465	0.465
1968	0.085	0.303	0.494	0.556	0.589	0.514	0.514	0.514	0.514	0.514	0.514
1969	0.08	0.275	0.434	0.473	0.484	0.418	0.418	0.418	0.418	0.418	0.418
1970	0.083	0.269	0.406	0.43	0.442	0.382	0.382	0.382	0.382	0.382	0.382
1971	0.072	0.238	0.353	0.356	0.367	0.324	0.324	0.324	0.324	0.324	0.324
1972	0.211	0.513	0.763	0.696	0.655	0.546	0.546	0.546	0.546	0.546	0.546
1973	0.218	0.496	0.647	0.534	0.481	0.385	0.385	0.385	0.385	0.385	0.385
1974	0.188	0.432	0.545	0.513	0.52	0.459	0.459	0.459	0.459	0.459	0.459
1975	0.206	0.458	0.546	0.493	0.487	0.418	0.418	0.418	0.418	0.418	0.418
1976	0.319	0.646	0.783	0.721	0.726	0.64	0.64	0.64	0.64	0.64	0.64
1977	0.357	0.708	0.849	0.716	0.656	0.559	0.559	0.559	0.559	0.559	0.559
1978	0.241	0.552	0.732	0.647	0.578	0.506	0.506	0.506	0.506	0.506	0.506
1979	0.167	0.448	0.675	0.654	0.558	0.503	0.503	0.503	0.503	0.503	0.503
1980	0.102	0.322	0.53	0.567	0.484	0.46	0.46	0.46	0.46	0.46	0.46
1981	0.085	0.282	0.479	0.543	0.448	0.43	0.43	0.43	0.43	0.43	0.43
1982	0.075	0.251	0.416	0.48	0.389	0.383	0.383	0.383	0.383	0.383	0.383
1983	0.075	0.246	0.384	0.423	0.34	0.339	0.339	0.339	0.339	0.339	0.339
1984	0.066	0.227	0.346	0.375	0.308	0.292	0.292	0.292	0.292	0.292	0.292
1985	0.075	0.262	0.417	0.485	0.433	0.414	0.414	0.414	0.414	0.414	0.414
1986	0.089	0.317	0.543	0.667	0.62	0.587	0.587	0.587	0.587	0.587	0.587

1987	0.1	0.361	0.648	0.79	0.727	0.66	0.66	0.66	0.66	0.66	0.66
1988	0.072	0.28	0.515	0.66	0.596	0.541	0.541	0.541	0.541	0.541	0.541
1989	0.054	0.218	0.386	0.467	0.415	0.364	0.364	0.364	0.364	0.364	0.364
1990	0.027	0.126	0.214	0.256	0.249	0.233	0.233	0.233	0.233	0.233	0.233
1991	0.029	0.136	0.243	0.291	0.286	0.263	0.263	0.263	0.263	0.263	0.263
1992	0.031	0.148	0.294	0.369	0.374	0.343	0.343	0.343	0.343	0.343	0.343
1993	0.025	0.132	0.297	0.412	0.442	0.402	0.402	0.402	0.402	0.402	0.402
1994	0.023	0.128	0.312	0.482	0.582	0.548	0.548	0.548	0.548	0.548	0.548
1995	0.018	0.103	0.239	0.375	0.503	0.496	0.496	0.496	0.496	0.496	0.496
1996	0.024	0.128	0.295	0.45	0.622	0.628	0.628	0.628	0.628	0.628	0.628
1997	0.033	0.163	0.382	0.545	0.724	0.693	0.693	0.693	0.693	0.693	0.693
1998	0.039	0.182	0.406	0.557	0.683	0.686	0.686	0.686	0.686	0.686	0.686
1999	0.047	0.206	0.435	0.564	0.656	0.631	0.631	0.631	0.631	0.631	0.631
2000	0.033	0.16	0.326	0.414	0.47	0.443	0.443	0.443	0.443	0.443	0.443
2001	0.035	0.168	0.361	0.46	0.496	0.455	0.455	0.455	0.455	0.455	0.455
2002	0.031	0.155	0.326	0.456	0.484	0.427	0.427	0.427	0.427	0.427	0.427
2003	0.037	0.175	0.373	0.537	0.633	0.574	0.574	0.574	0.574	0.574	0.574
2004	0.036	0.165	0.338	0.493	0.587	0.555	0.555	0.555	0.555	0.555	0.555
2005	0.038	0.169	0.343	0.504	0.63	0.608	0.608	0.608	0.608	0.608	0.608
2006	0.038	0.164	0.323	0.452	0.566	0.556	0.556	0.556	0.556	0.556	0.556
2007	0.04	0.165	0.329	0.478	0.604	0.586	0.586	0.586	0.586	0.586	0.586
2008	0.026	0.118	0.239	0.396	0.546	0.542	0.542	0.542	0.542	0.542	0.542
2009	0.021	0.094	0.187	0.319	0.478	0.495	0.495	0.495	0.495	0.495	0.495
2010	0.02	0.089	0.177	0.299	0.451	0.503	0.503	0.503	0.503	0.503	0.503
2011	0.022	0.094	0.193	0.317	0.462	0.506	0.506	0.506	0.506	0.506	0.506
2012	0.021	0.086	0.166	0.276	0.389	0.417	0.417	0.417	0.417	0.417	0.417
2013	0.014	0.064	0.111	0.176	0.261	0.324	0.324	0.324	0.324	0.324	0.324
2014	0.017	0.072	0.124	0.183	0.257	0.358	0.358	0.358	0.358	0.358	0.358
2015	0.022	0.092	0.162	0.227	0.294	0.407	0.407	0.407	0.407	0.407	0.407
2016	0.03	0.12	0.229	0.32	0.399	0.522	0.522	0.522	0.522	0.522	0.522
2017	0.039	0.154	0.308	0.447	0.516	0.599	0.599	0.599	0.599	0.599	0.599
2018	0.039	0.162	0.356	0.538	0.602	0.651	0.651	0.651	0.651	0.651	0.651
2019	0.037	0.165	0.389	0.627	0.627	0.619	0.619	0.619	0.619	0.619	0.619
2020	0.039	0.171	0.411	0.66	0.674	0.631	0.631	0.631	0.631	0.631	0.631
2021	0.041	0.176	0.416	0.676	0.711	0.692	0.692	0.692	0.692	0.692	0.692
2022	0.042	0.172	0.373	0.562	0.588	0.561	0.561	0.561	0.561	0.561	0.561
2023	0.054	0.203	0.414	0.602	0.581	0.531	0.531	0.531	0.531	0.531	0.531

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

Year	3	4	5	6	7	8	9	10	11	12	13 +
1950	110038	99320	73858	36888	46567	16586	4919	2700	1379	1453	2050
1951	633959	56570	45062	26846	12670	12358	5389	1920	1001	444	1089
1952	83966	425499	32389	19052	9007	4294	3831	1645	727	353	508
1953	1186876	49643	209247	14441	6401	2657	1332	1062	536	249	306
1954	131478	889106	25767	91865	6990	2341	1091	547	392	200	224
1955	59255	84625	620447	14535	51661	3108	926	455	236	162	168
1956	222228	41126	55834	320675	7224	17631	1440	403	213	112	153
1957	61053	148240	27684	35782	110978	3082	6154	695	168	98	127
1958	74378	40570	91720	15508	20580	40243	1618	2519	347	84	116
1959	385153	52194	26188	40018	7324	7275	14928	715	908	144	86
1960	314280	264331	35776	15617	17131	3465	3637	6210	355	375	106
1961	142446	190392	144752	17689	6959	8010	1590	1507	2809	154	206
1962	290162	85298	91665	59442	6768	2699	3274	658	611	1165	140
1963	312272	174851	37672	26424	17522	2634	1084	1229	272	244	537
1964	352016	198430	75281	12251	7708	5820	1210	439	508	121	344
1965	125910	239590	114578	30280	4181	2802	2269	530	198	218	209
1966	309997	82056	157982	61793	12353	1711	1282	951	267	91	187
1967	339255	199339	43463	72367	24770	4871	792	603	453	130	132
1968	18922	245403	117307	21887	35982	12431	2361	410	314	234	136
1969	20435	12261	140587	54877	10665	15737	5745	1167	197	156	175
1970	205947	12620	7606	69921	25065	5868	8058	3009	644	106	185
1971	111639	133298	7132	4530	33323	12264	3336	4544	1692	370	162
1972	1073335	80793	81228	4497	3094	17547	6735	2002	2771	1025	315
1973	310663	616875	45790	23323	1692	1531	7654	2912	922	1373	611
1974	65039	168377	252131	16477	10683	877	993	4440	1678	542	1210
1975	59149	36901	90274	140385	6834	4974	446	550	2146	817	925
1976	59157	33714	16548	44258	78807	3174	2772	245	324	1147	962
1977	120692	29930	13759	6456	17662	30361	1296	1185	102	144	812
1978	213186	54796	9582	4471	2890	7753	15037	631	563	45	432
1979	160795	116683	23131	3222	2037	1397	4089	7073	337	273	227
1980	23618	102289	58083	8308	1153	1041	711	2150	3479	173	240
1981	11101	16419	62843	26104	3462	551	554	377	1132	1717	214
1982	16377	7286	11243	31475	10522	1725	278	304	214	618	961

1983	8039	11101	4817	6840	13599	5594	983	147	175	124	807
1984	13082	4902	6625	2818	3898	8782	2900	577	81	103	521
1985	357657	8985	2837	3594	1808	2561	5341	1845	368	52	398
1986	476527	275573	5237	1562	1837	998	1463	2785	1025	205	260
1987	92051	250188	154962	2553	641	788	470	675	1206	470	208
1988	39771	70745	135394	46152	1065	230	318	204	298	506	279
1989	27846	26095	49207	70481	12235	544	95	151	98	143	364
1990	36089	20513	17347	26290	32738	5519	349	58	86	56	275
1991	107694	24388	13582	14123	20141	20224	3161	244	39	57	204
1992	317850	81879	15800	10055	10356	12558	12588	1896	161	25	157
1993	812363	219294	56430	10501	5906	6199	7596	7235	1053	98	106
1994	389416	563836	151681	31129	4641	3144	3709	4691	4271	593	113
1995	99474	220632	421856	77411	14506	2075	1427	1838	2162	2106	337
1996	98946	60985	164625	242974	31864	7203	1071	705	918	1080	1238
1997	118812	55173	37608	94538	102195	13880	2511	484	310	405	1068
1998	63028	79514	35162	17847	36685	38539	5199	986	205	129	683
1999	147657	48383	47142	17476	8805	15731	13722	1903	406	90	370
2000	83270	116941	30895	21507	6900	4238	6558	5390	806	185	219
2001	359701	69408	92333	16794	10241	3495	2538	3494	2657	433	227
2002	386866	290527	51867	47189	9163	5480	1869	1420	1912	1394	346
2003	332712	254138	191546	34400	24401	4592	3430	1197	812	1079	985
2004	255646	168392	162285	109698	16477	10768	2137	1627	598	384	1048
2005	354171	168003	93486	108417	50308	6630	5493	1128	724	299	765
2006	153663	212288	107151	51751	44669	20637	3195	2788	547	340	517
2007	514191	118872	161639	60744	26614	19160	8170	1731	1455	278	429
2008	1048186	439153	95399	101076	21536	14005	7127	3294	872	701	344
2009	982329	686754	364165	61483	39620	10207	5290	3125	1450	473	566
2010	235386	655241	582703	228805	32276	15057	4759	2697	1590	770	604
2011	117342	188975	532783	414270	121264	14258	6174	2107	1323	814	779
2012	331422	72976	135165	385424	261149	54458	6168	2565	1023	683	894
2013	117064	195098	57585	93695	267711	126218	23649	3152	1393	577	935
2014	399947	72708	143328	49531	86723	143927	61168	10836	1851	868	952
2015	71899	277123	65191	91417	40420	68908	72878	25634	5339	1006	998
2016	206289	49458	164387	45871	61192	33238	48731	37703	12782	2565	987
2017	191476	171737	33667	108363	28063	36233	18549	21695	17867	5598	1478
2018	353237	132741	122749	24567	43177	14578	17648	8793	9191	8406	3111
2019	774629	232081	86135	61292	16268	17196	6851	7501	3632	3827	4220

2020	414489	492059	152046	44238	21817	8432	7004	3353	3164	1705	3297
2021	153939	254448	327613	65201	17979	7888	3780	2845	1575	1437	2160
2022	44626	135191	176438	156957	26501	6387	2932	1497	1116	671	1441
2023	164015	30160	97785	107760	70973	10278	2712	1283	670	531	969
2024	469037	105164	18270	52217	44856	34295	4681	1276	611	321	713

Table 4.14. Northeast Arctic haddock. SAM model. Natural mortality estimated age 3-6 from 0.20 + consumption from cod, ages 7-13+ natural mortality set to 0.2

Year	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1950	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1951	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1952	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1953	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1954	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1955	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1956	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1957	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1958	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1959	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1960	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1961	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1962	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1963	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1964	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1965	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1966	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1967	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1968	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1969	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1970	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1971	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1972	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1973	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1974	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1975	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1976	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2

1977	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1978	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1979	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1980	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1981	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1982	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1983	0.343	0.255	0.24	0.238	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1984	0.215	0.219	0.212	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1985	0.209	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1986	0.635	0.261	0.2	0.21	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1987	0.2	0.206	0.414	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1988	0.38	0.2	0.2	0.385	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1989	0.2	0.2	0.2	0.23	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1990	0.33	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1991	0.202	0.214	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1992	0.215	0.203	0.202	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1993	0.252	0.246	0.273	0.258	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1994	0.288	0.211	0.291	0.223	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1995	0.38	0.339	0.313	0.29	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1996	0.72	0.319	0.245	0.277	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1997	0.501	0.265	0.254	0.275	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1998	0.231	0.29	0.266	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999	0.2	0.207	0.272	0.262	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2000	0.213	0.2	0.215	0.244	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2001	0.21	0.2	0.225	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2002	0.323	0.211	0.2	0.203	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2003	0.416	0.247	0.205	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2004	0.414	0.298	0.2	0.224	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2005	0.396	0.301	0.228	0.266	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2006	0.222	0.212	0.272	0.209	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2007	0.296	0.2	0.232	0.322	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2008	0.374	0.272	0.259	0.332	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2009	0.405	0.245	0.278	0.251	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2010	0.357	0.246	0.27	0.28	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2011	0.527	0.466	0.305	0.224	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2012	0.595	0.311	0.202	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2013	0.456	0.337	0.245	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

2014	0.282	0.205	0.218	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2015	0.34	0.395	0.208	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2016	0.304	0.2	0.242	0.225	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2017	0.341	0.295	0.231	0.407	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2018	0.437	0.265	0.267	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2019	0.374	0.261	0.22	0.279	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2020	0.361	0.359	0.291	0.216	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2021	0.221	0.205	0.236	0.21	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2022	0.412	0.2	0.2	0.208	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2023	0.274	0.283	0.202	0.227	0.2	0.2	0.2	0.2	0.2	0.2	0.2

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Table 4.15. Northeast Arctic haddock. Summary XSA (p-shrinkage not applied, F shrinkage= 0.5).

YEAR	RECR_a3	TOTBIO	TOTSPB	LANDINGS	YIELDSSB	SOPCOFAC	FBAR 4–7
1950	82150	242410	134545	132125	0.982	1.5897	0.8315
1951	667158	355315	101062	120077	1.1882	1.2272	0.624
1952	76664	235232	57466	127660	2.2215	1.7404	0.7248
1953	1271227	510739	82465	123920	1.5027	1.4279	0.5162
1954	152142	537327	117271	156788	1.337	1.474	0.3805
1955	68448	485090	178661	202286	1.1322	1.536	0.512
1956	208114	474546	243559	213924	0.8783	1.2623	0.4335
1957	65983	326149	186248	123583	0.6635	1.2455	0.4328
1958	86803	276778	156936	112672	0.7179	1.1252	0.519
1959	397380	364448	133259	88211	0.662	0.9405	0.3672
1960	288953	400688	114611	154651	1.3494	1.0411	0.4845
1961	130461	391055	129928	193224	1.4872	0.9942	0.637
1962	290185	346122	118846	187408	1.5769	1.0518	0.8005
1963	340061	310356	82631	146224	1.7696	1.1458	0.8652
1964	397118	301432	63818	99158	1.5538	1.3572	0.6525
1965	123978	357560	95394	118578	1.243	1.1507	0.4938
1966	293052	387189	127481	161778	1.269	1.1621	0.5838
1967	361268	467338	154495	136397	0.8829	0.9984	0.4152
1968	23865	421001	169448	181726	1.0725	0.9976	0.5032
1969	21372	342266	184063	130820	0.7107	0.882	0.3975
1970	201900	286413	156073	88257	0.5655	0.9762	0.358
1971	122159	345330	168562	78905	0.4681	0.7638	0.2468

YEAR	RECR_a3	TOTBIO	TOTSPB	LANDINGS	YIELDSSB	SOPCOFAC	FBAR 4–7
1972	1248517	618185	122976	266153	2.1643	1.0883	0.6925
1973	341012	602898	114640	322226	2.8108	1.1656	0.537
1974	69040	602980	200594	221157	1.1025	0.8946	0.4322
1975	60032	492721	256165	175758	0.6861	0.8957	0.4275
1976	66739	307280	206695	137264	0.6641	1.12	0.571
1977	134109	228870	141805	110158	0.7768	1.09	0.6842
1978	212923	255775	130576	95422	0.7308	0.9219	0.5118
1979	175560	317943	129512	103623	0.8001	0.7684	0.552
1980	34645	342858	133178	87889	0.6599	0.7568	0.3982
1981	13382	292659	148182	77153	0.5207	0.7174	0.4015
1982	17350	211794	127206	46955	0.3691	0.7224	0.3093
1983	9548	104337	71467	24600	0.3442	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	527830	343193	62296	100563	1.6143	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	36931	170799	95307	27182	0.2852	1.0159	0.1562
1991	104273	195368	110525	36216	0.3277	1.0374	0.2082
1992	207549	269161	125748	59922	0.4765	0.9797	0.2838
1993	661570	442097	130405	82379	0.6317	1.0031	0.359
1994	292115	544752	148236	135186	0.912	1.0056	0.425
1995	97797	543330	165440	142448	0.861	1.0247	0.3828
1996	102160	473717	188933	178128	0.9428	1.0175	0.4235
1997	115480	350987	164381	154359	0.939	1.0519	0.4862
1998	58311	250404	124351	100630	0.8092	1.0113	0.4235
1999	230847	253416	93666	83195	0.8882	1.021	0.4212
2000	89236	252319	87386	68944	0.789	1.026	0.2802
2001	365889	358870	113312	89640	0.7911	0.9903	0.2792
2002	342042	445297	131813	114798	0.8709	1.011	0.3173
2003	223157	477243	154897	138926	0.8969	1.019	0.43
2004	224240	456772	161350	158279	0.981	1.0192	0.3815
2005	345633	471321	169615	158298	0.9333	1.0029	0.493
2006	155579	415557	144582	153157	1.0593	0.9938	0.4088
2007	664161	496669	141235	161525	1.1437	0.9916	0.4285

YEAR	RECR_a3	TOTBIO	TOTSPB	LANDINGS	YIELDSSB	SOPCOFAC	FBAR 4–7
2008	1334075	737127	146844	155604	1.0597	0.9928	0.3952
2009	1450794	1078241	169700	200061	1.1789	1.0019	0.3572
2010	524017	1257239	237524	249200	1.0492	0.9994	0.2978
2011	243697	1282830	347281	309785	0.892	0.9978	0.32
2012	382605	1163293	427208	315627	0.7388	0.9994	0.2658
2013	149537	989123	469629	193744	0.4125	0.9967	0.1332
2014	376481	990579	513627	177522	0.3456	0.9968	0.1112
2015	100059	929113	528262	194756	0.3687	0.9953	0.159
2016	252390	834240	496074	233183	0.4701	1.0006	0.2268
2017	172479	704506	410993	227588	0.5538	0.994	0.3562
2018	321734	569472	295798	191276	0.6466	0.9943	0.4322
2019	732881	593040	213566	175402	0.8213	0.9963	0.5215
2020	381812	602431	169316	182468	1.0777	0.9962	0.587
2021	184361	542346	153608	204743	1.3329	0.9981	0.573
2022	59301	453987	150003	176906	1.1793	0.998	0.4768
2023	176914	491200	193180	178898	0.9261	0.9854	0.5082

Table 4.16. Northeast Arctic haddock. Input data for recruitment prediction (RCT3)- recruits as 3 year-olds. R3: recruitment estimate from SAM 2024. NT1: Norwegian Russian winter bottom trawl survey age 1 NT2: Norwegian Russian winter bottom trawl survey age. NAK1: Norwegian Russian winter acoustic survey age 1 NAK2: Norwegian Russian winter acoustic survey age 2. 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 forecast since.

YC	R3	NT1	NT2	NAK1	NAK2	ECO1	ECO2
1990	812363	NA	NA	NA	NA	NA	NA
1991	389416	NA	NA	314.53	NA	NA	348.73
1992	99474	NA	224.79	54.86	NA	187.96	41.47
1993	98946	604.20	199.52	55.84	887.82	88.59	29.97
1994	118812	1429.04	265.08	79.63	1198.18	94.52	57.27
1995	63028	300.78	90.81	21.68	132.6	26.51	33.78
1996	147657	1117.83	196.7	56.92	508.87	150.99	83.67
1997	83270	248.27	83.2	24.08	210.96	30.11	36.39
1998	359701	1207.98	437.22	294	653.4	404.77	233.45
1999	386866	832.3	446.84	312.87	1063.01	266.12	255.2
2000	332712	1230.98	475.31	352.24	753.01	267.9	203.68
2001	255646	1700.19	471.68	173.13	1315.15	362.35	151.01
2002	354171	3327.32	706.61	317.89	2743.74	466.54	221.33
2003	153663	700.86	386.39	78.8	528.97	143.98	56.32
2004	514191	4473.16	1310.22	443.27	2276.46	624.78	209.28

YC	R3	NT1	NT2	NAK1	NAK2	ECO1	ECO2
2005	1048186	4944.6	1684.83	1591.03	2091.11	953.5	812.41
2006	982329	3731.19	2042.01	1230.43	2015.71	1753.54	883.68
2007	235386	853.09	317.05	102.45	778.39	209.05	128.07
2008	117342	562.61	79.89	52.88	443.93	86.03	54.16
2009	331422	1634.82	353.87	316.08	1559.42	288.27	191.63
2010	117064	676.31	137.38	57.44	428.46	94.54	67.29
2011	399947	1866.96	490.28	381.17	1583.44	407.16	334.82
2012	71899	344.58	123.95	30.61	292.71	109.92	24.35
2013	206289	1281.4	342.02	163.38	1838.71	246.59	71.81
2014	191476	1133.97	561.96	134.94	1593.12	107.18	81.15
2015	353237	2299.37	770.04	336.31	1276	331.42	171.03
2016	774629	5065.43	1675.64	1075.55	3343.93	810.16	507.61
2017	414489	3823.29	1125.27	424.22	2925.9	687.8	286.32
2018	153939	1898.2	267.79	109.8	1544.96	260.72	50.76
2019	44626	110.62	25.12	12.2	272.94	15.69	11.4
2020	164015	406.3	110.3	82.5	431.68	70.2	77
2021	469037	1662.1	583.9	346.71	1797.1	511.1	337.4
2022	NA	1343.8	650.98	NA	1032.7	634.0	NA
2023	NA	2179.51	NA	NA	1690.2	NA	NA

Table 4.17. Northeast Arctic haddock Analysis by RCT3 ver3.1 - R translation. Data for 6 surveys over 34 year classes : 1990 – 2023 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.

`yearclas	s:2021`								
index	slope	intercept	se	rsquare	n	indices	prediction	se.pred	WAP.weights
NT1	0.826	6.455	0.375	0.849	20	7.416	12.583	0.429	0.070
NT2	0.740	8.017	0.339	0.873	20	6.371	12.730	0.390	0.085
NT3	0.662	8.958	0.103	0.987	20	5.851	12.830	0.119	0.322
NAK1	1.141	4.336	0.536	0.734	20	7.494	12.884	0.620	0.033
NAK2	0.799	8.056	0.381	0.845	20	6.239	13.040	0.446	0.065
NAK3	0.757	8.765	0.161	0.968	20	5.824	13.172	0.191	0.322
`yearclas	s:2022`								
index	slope	intercept	se	rsquare	n	indices	prediction	se.pred	WAP.weights
NT1	0.849	6.326	0.403	0.827	20	7.204	12.444	0.460	0.192
NT2	0.754	7.956	0.348	0.866	20	6.480	12.843	0.401	0.253
NT3	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAK1	1.141	4.331	0.517	0.744	20	6.941	12.248	0.590	0.117

NAK2	0.794	8.086	0.371	0.850	20	6.454	13.210	0.439	0.212
NAK3	NA	NA	NA	NA	NA	NA	NA	NA	NA
`yearclas	s:2023`								
index	slope	intercept	se	rsquare	n	indices	prediction	se.pred	WAP.weights
NT1	0.837	6.410	0.411	0.825	19	7.687	12.844	0.481	0.509
NT2	NA	NA	NA	NA	NA	NA	NA	NA	NA
NT3	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAK1	1.126	4.419	0.515	0.750	19	7.433	12.786	0.600	0.327
NAK2	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAK3	NA	NA	NA	NA	NA	NA	NA	NA	NA
	WAP	logWAP	int.se						
yearclass:2021	431599	12.98	0.08925						
yearclass:2022	352595	12.77	0.20178						
yearclass:2023	340315	12.74	0.34302						

Table 4.18. Northeast Arctic haddock. Prediction with management option table: Input data (based on SAM estimates and forecast estimates according to stock annex).

2024								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	469037	0.302	0.032	0	0	0.294	0.0450	0.723
4	105164	0.229	0.077	0	0	0.463	0.1810	0.872
5	18270	0.213	0.283	0	0	0.94	0.3960	1.285
6	52217	0.215	0.455	0	0	1.204	0.6050	1.455
7	44856	0.2	0.629	0	0	1.486	0.6180	1.667
8	34295	0.2	0.769	0	0	1.798	0.5870	1.947
9	4681	0.2	0.885	0	0	2.281	0.5870	2.227
10	1276	0.2	0.957	0	0	3.065	0.5870	2.594
11	611	0.2	1.000	0	0	3.515	0.5870	2.863
12	321	0.2	1.000	0	0	3.648	0.5870	3.227
13	713	0.2	1.000	0	0	4.137	0.5870	3.603
2025								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	352595	0.302	0.031	0	0	0.291	0.045	0.72
4	0	0.229	0.099	0	0	0.54	0.181	0.955
5	0	0.213	0.194	0	0	0.741	0.396	1.103
6	0	0.215	0.521	0	0	1.315	0.605	1.556
7	0	0.2	0.698	0	0	1.586	0.618	1.726
8	0	0.2	0.819	0	0	1.858	0.587	1.942

9	0	0.2	0.898	0	0	2.177	0.587	2.197
10	0	0.2	0.955	0	0	2.676	0.587	2.509
11	0	0.2	1.000	0	0	3.468	0.587	2.794
12	0	0.2	1.000	0	0	3.681	0.587	3.055
13	0	0.2	1.000	0	0	3.964	0.587	3.606
2026								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	340315	0.302	0.029	0	0	0.282	0.045	0.711
4	0	0.229	0.098	0	0	0.534	0.181	0.949
5	0	0.213	0.242	0	0	0.852	0.396	1.205
6	0	0.215	0.394	0	0	1.057	0.605	1.321
7	0	0.2	0.742	0	0	1.709	0.618	1.799
8	0	0.2	0.847	0	0	1.974	0.587	1.992
9	0	0.2	0.908	0	0	2.246	0.587	2.192
10	0	0.2	0.947	0	0	2.571	0.587	2.485
11	0	0.2	1.000	0	0	3.058	0.587	2.722
12	0	0.2	1.000	0	0	3.648	0.587	3.008
13	0	0.2	1.000	0	0	3.998	0.587	3.467

(TAC constraint applied for intermediate year) MFDP R version. Run22 data from file fhcr_fmgmt.xls.

Input units are thousands and kg - output in tonnes

Table 4.19. Northeast Arctic haddock. Prediction with management option table for 2024-2026

2024						
Biomass	SSB	FMult	FBar	Landings		
415806	150433	1.0962	0.4933	141000		
2025					2026	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
455463	128267	0	0	0	640041	202674
.	.	0.1	0.045	15525	626015	194426
.	.	0.2	0.09	30476	612564	186597
.	.	0.3	0.135	44880	599662	179164
.	.	0.4	0.18	58762	587279	172106
.	.	0.5	0.225	72148	575391	165401
.	.	0.6	0.27	85059	563973	159031
.	.	0.7	0.315	97520	553003	152978
.	.	0.8	0.36	109549	542458	147224
.	.	0.9	0.405	121167	532317	141753

.	.	1	0.45	132393	522562	136550
.	.	1.1	0.495	143245	513173	131600
.	.	1.2	0.54	153738	504134	126890
.	.	1.3	0.585	163890	495428	122408
.	.	1.4	0.63	173715	487038	118140
.	.	1.5	0.675	183228	478950	114075
.	.	1.6	0.72	192442	471151	110203
.	.	1.7	0.765	201371	463626	106513
.	.	1.8	0.81	210027	456363	102995
.	.	1.9	0.855	218421	449350	99642
.	.	2	0.9	226564	442575	96443

Table 4.20. Northeast Arctic haddock. Prediction single option table for 2023-2025 based on HCRMFDP R version, data from file fhcr_fmgmt.xls Fbar age range: 4-7. Input units are thousands and kg - output in tonnes

Year:	2024	F multiplier:	1.0962	Fbar:	0.4933	
age	CatchN	CatchYield	F	SSB (Jan)	StockBiomass (Jan)	StockN (Jan)
3	19510	14106	0.0493	4413	137897	469037
4	16980	14807	0.1984	3749	48691	105164
5	5839	7504	0.4341	4860	17174	18270
6	23048	33535	0.6632	28606	62869	52217
7	20231	33725	0.6775	41927	66656	44856
8	14908	29025	0.6435	47418	61662	34295
9	2035	4531	0.6435	9449	10677	4681
10	555	1439	0.6435	3743	3910.9	1276
11	266	760	0.6435	2148	2147.7	611
12	140	450	0.6435	1171	1171	321
13	310	1117	0.6435	2950	2949.7	713
TOTAL	103822	141000		150433	415806	731441
Year:	2025	F multiplier:	0.7778	Fbar:	0.35	
age	CatchN	CatchYield	F	SSB (Jan)	StockBiomass (Jan)	StockN (Jan)
3	10477	7543	0.035	3181	102605	352595
4	38845	37097	0.1408	17646	178246	330085
5	16465	18161	0.308	9860	50823	68587
6	3258	5069	0.4706	6553	12578	9565.4
7	7565	13057	0.4807	24019	34412	21697

8	6244	12125	0.4566	28383	34656	18652
9	4939	10850	0.4566	28843	32119	14754
10	674	1691	0.4566	5146	5388.9	2013.8
11	184	513	0.4566	1904	1903.7	548.94
12	88	269	0.4566	968	967.57	262.85
13	149	537	0.4566	1763	1763.3	444.83
TOTAL	88886	106912		128267	455463	819206
Year:	2026	F multiplier:	0.6487	Fbar:	0.32	
age	CatchN	CatchYield	F	SSB (Jan)	StockBiomass (Jan)	StockN (Jan)
3	9211	6549	0.0318	2783	95969	340315
4	27107	25725	0.1281	13173	134419	251721
5	50436	60776	0.2802	47021	194300	228052
6	12861	16989	0.4280	16965	43057	40736
7	1558	2803	0.4372	6111	8236	4819.1
8	3407	6787	0.4153	18366	21684	10985
9	3000	6577	0.4153	19728	21727	9673.8
10	2373	5897	0.4153	18630	19673	7651.9
11	324	882	0.4153	3194	3194	1044.4
12	88	266	0.4153	1039	1039	284.7
13	114	395	0.4153	1467	1467	367.03
TOTAL	110480	133645		148477	544765	895649

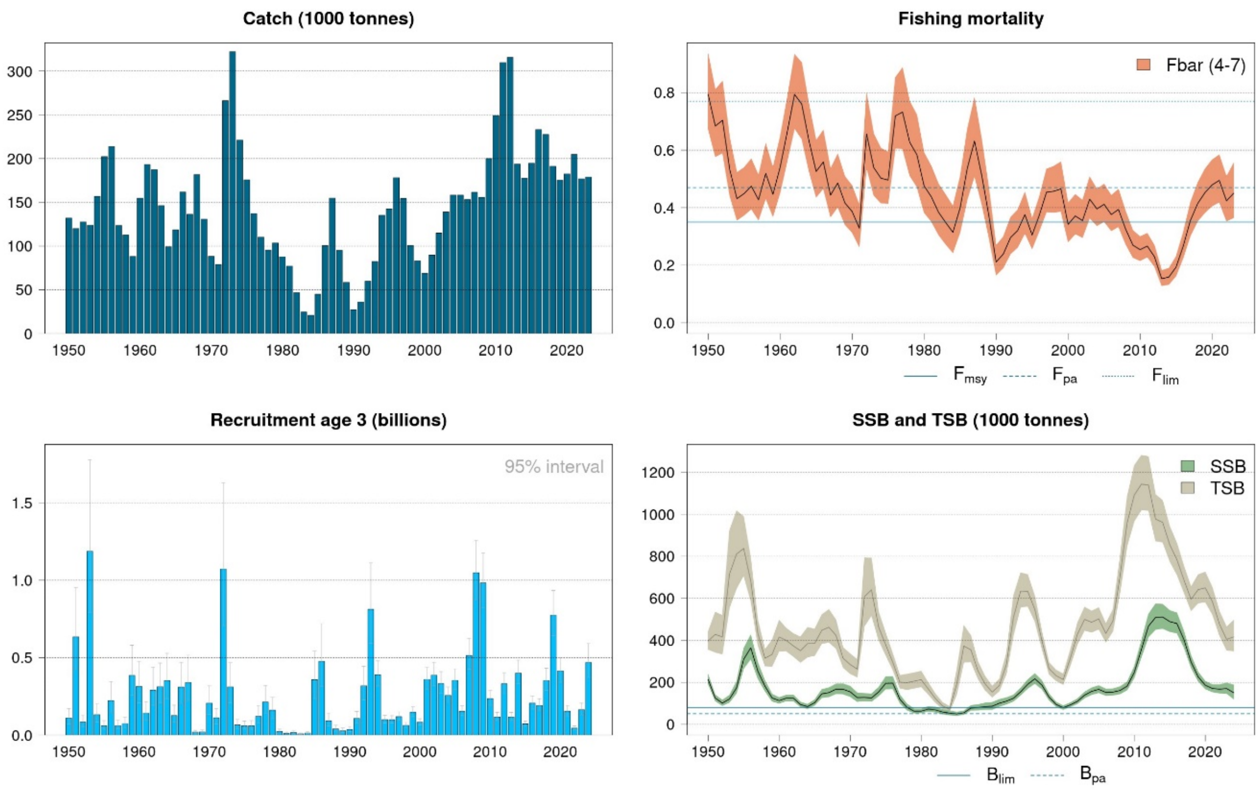

Figure 4.1 Northeast Arctic haddock landings (top left 1950-2023), fishing mortality (top right 1950-2023), recruitment (bottom left 1950-2024), and total stock biomass for ages 3+ (TSB) and spawning-stock biomass (SSB) (bottom right 1950–202 4). The reference points in the SSB and TSB plot refers to the spawning stock 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).

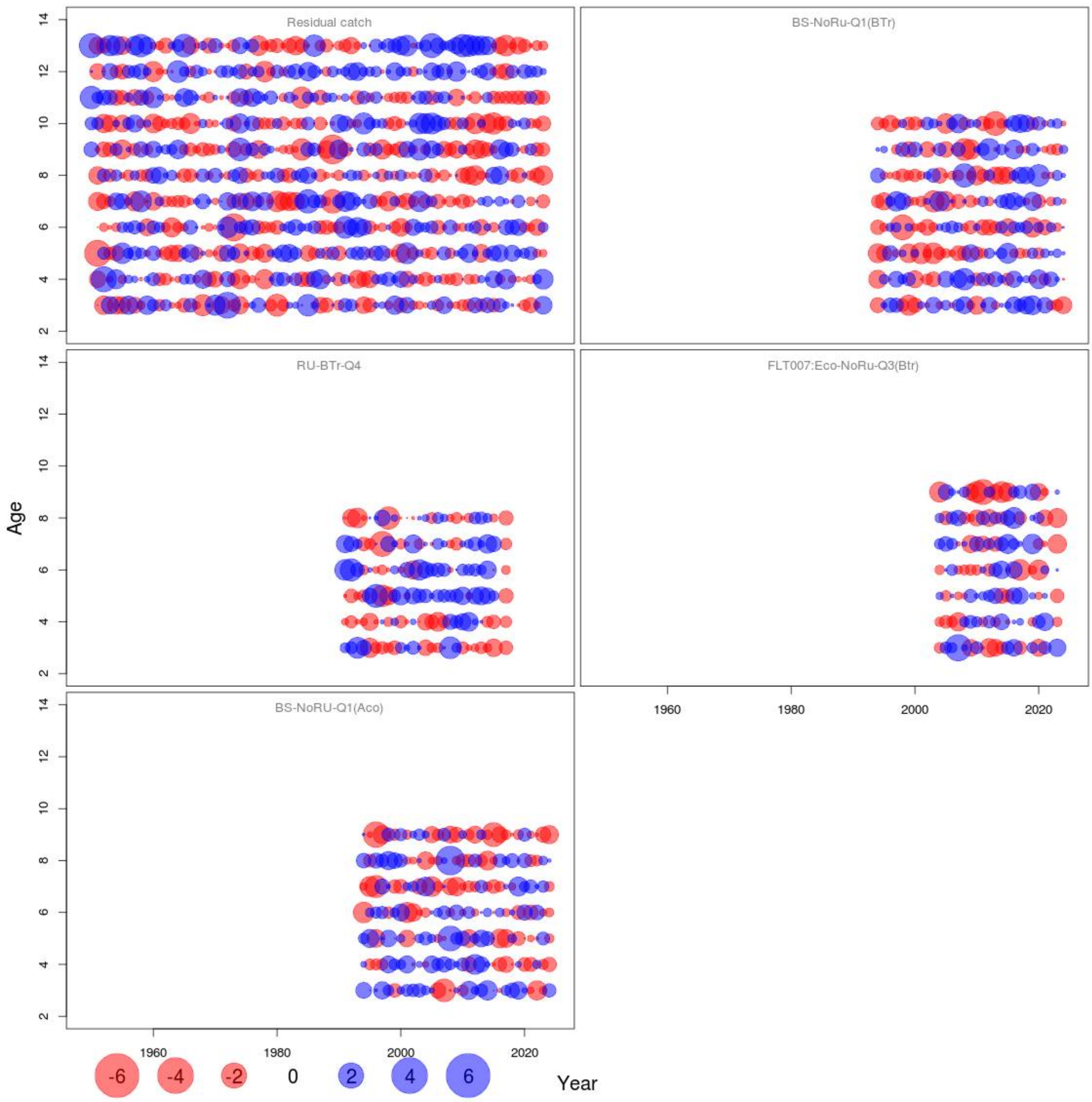

Figure 4.2. Northeast Arctic haddock; one step ahead residuals for the final SAM run 2024. Blue circles indicate positive residuals (observations larger than predicted) and red circles indicate negative residuals.

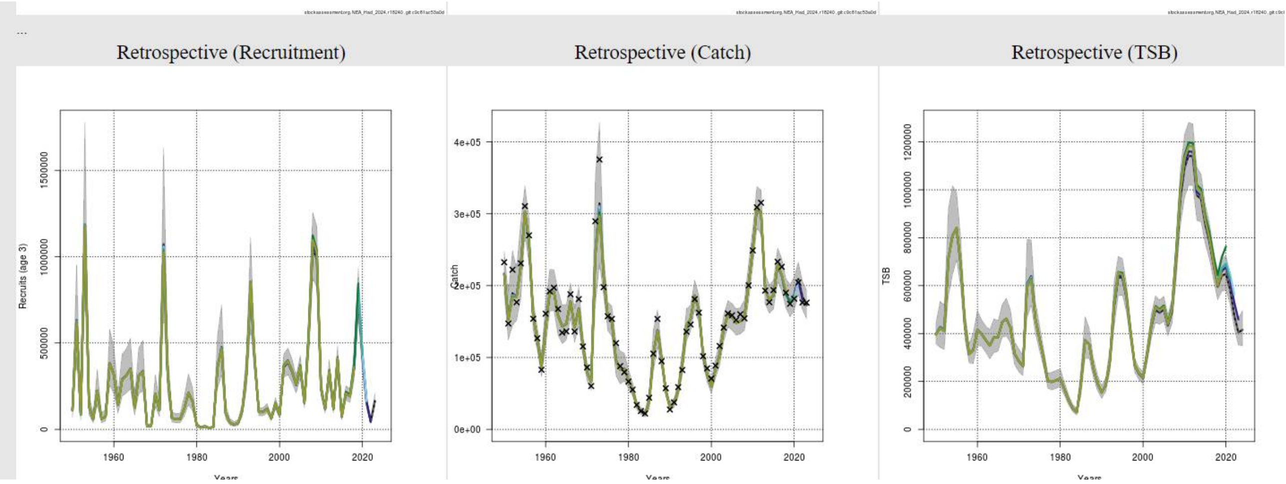

Figure 4.3.

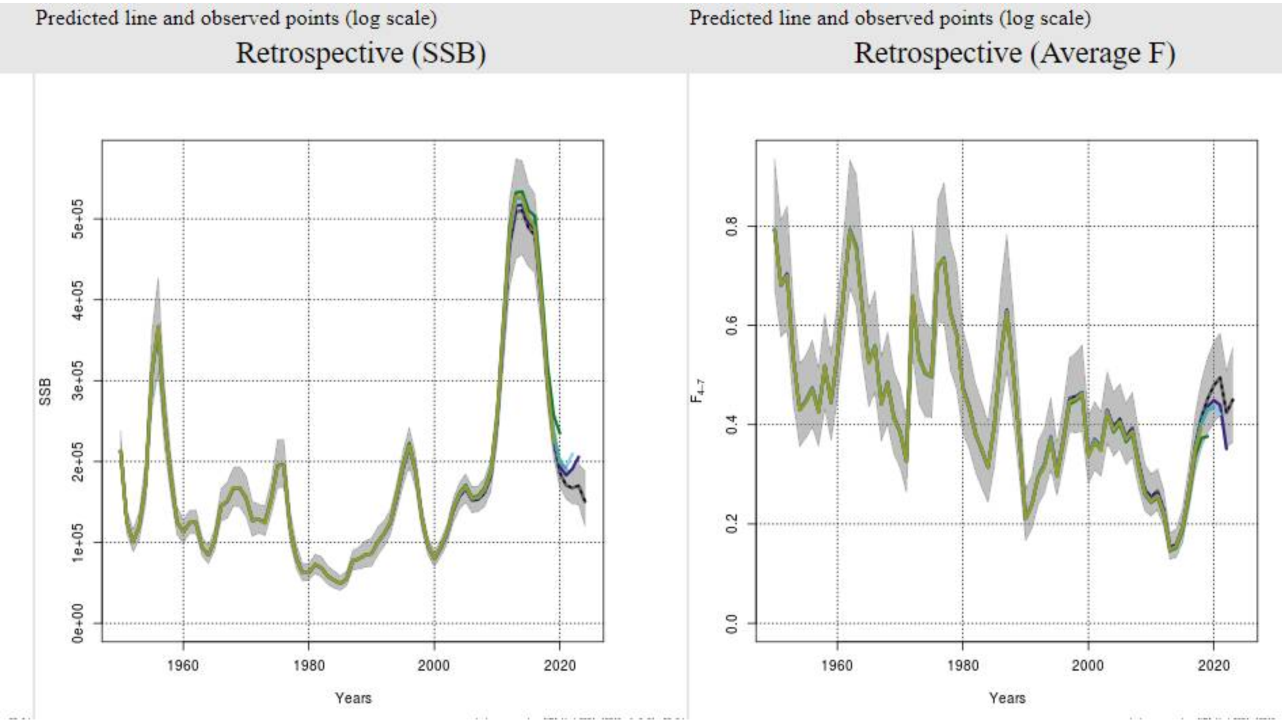

Figure 4.3. Northeast Arctic haddock. 5 year retrospective plots of Recruitment (top left), catch (top middle) and TSB (top right), SSB (bottom left), and fishing mortality TSB (bottom right) for years 1950–2024 (2023 catches and F) (SAM with 95% confidence intervals).

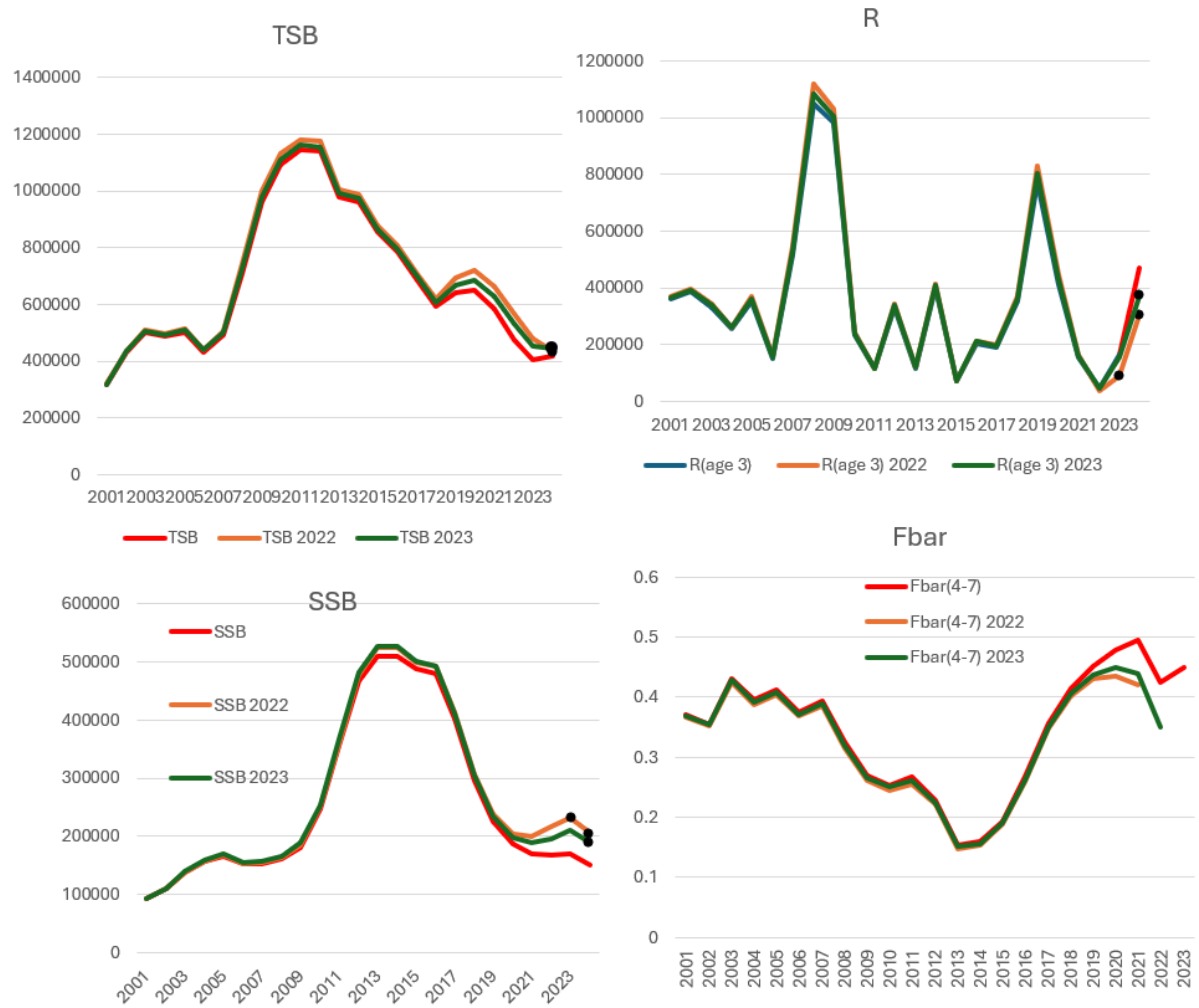

Figure 4.4. Results of assessment of NEA haddock. Fbar (4-7), TSB, recruits and SSB from AFWG 2022 (orange), JRN-AFWG 2023 (green) and this year's (2024) assessment (red) from 2001 and onwards. The last black circles on the lines for JRN-AFWG 2022 and 2023 are forecasts for 2023 and 2024.

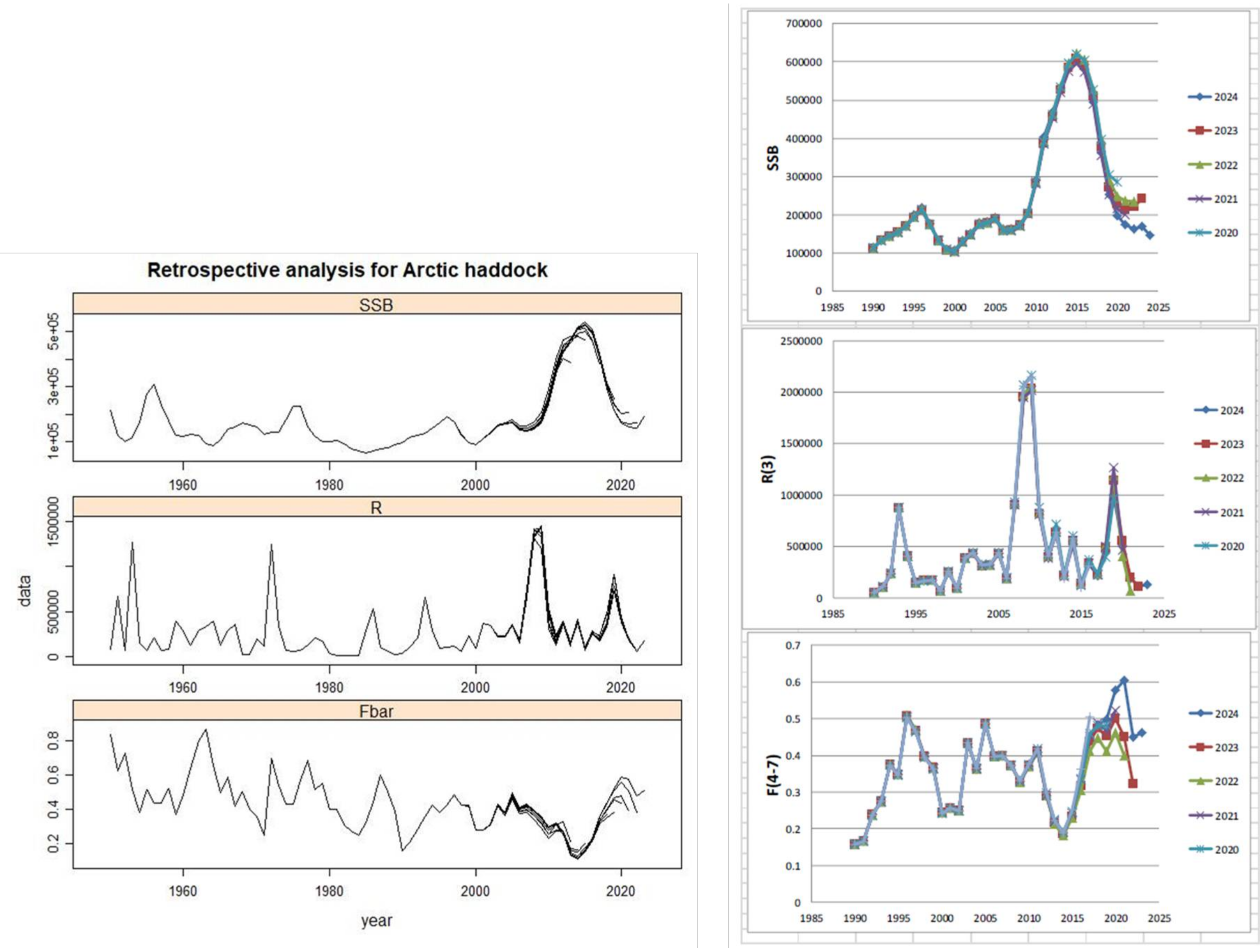

Figure 4.5. Northeast Arctic haddock. Retrospective plots of SSB, fishing mortality and recruitment for assessment years 1950–2023 (left - XSA without P shrinkage, F shrinkage= 0.5) and right - for assessment years 1990–2023 from the TSVPA model.

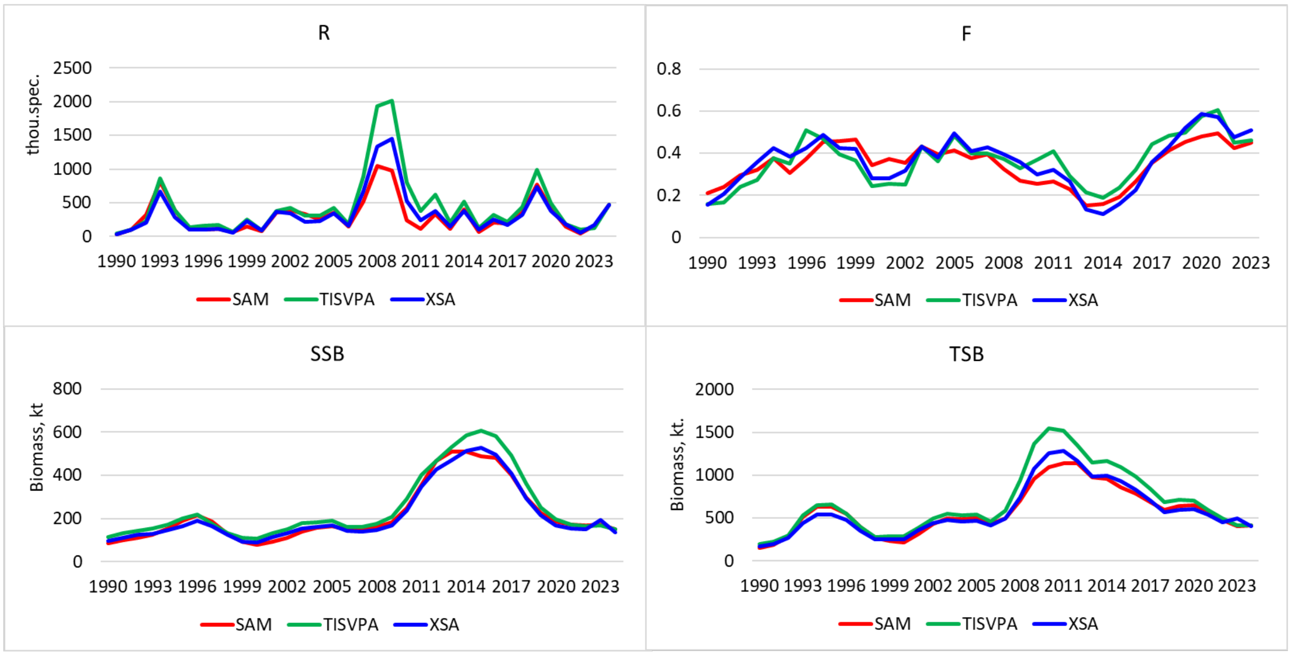

Figure 4.6. Comparison of results of assessment of NEA haddock. Recruits, biomass, spawning biomass and F in 1990–2023 by different models: median SAM estimates, XSA with setting mentioned at section 4.9 and TISVPA with settings established in WKDEM 2020.

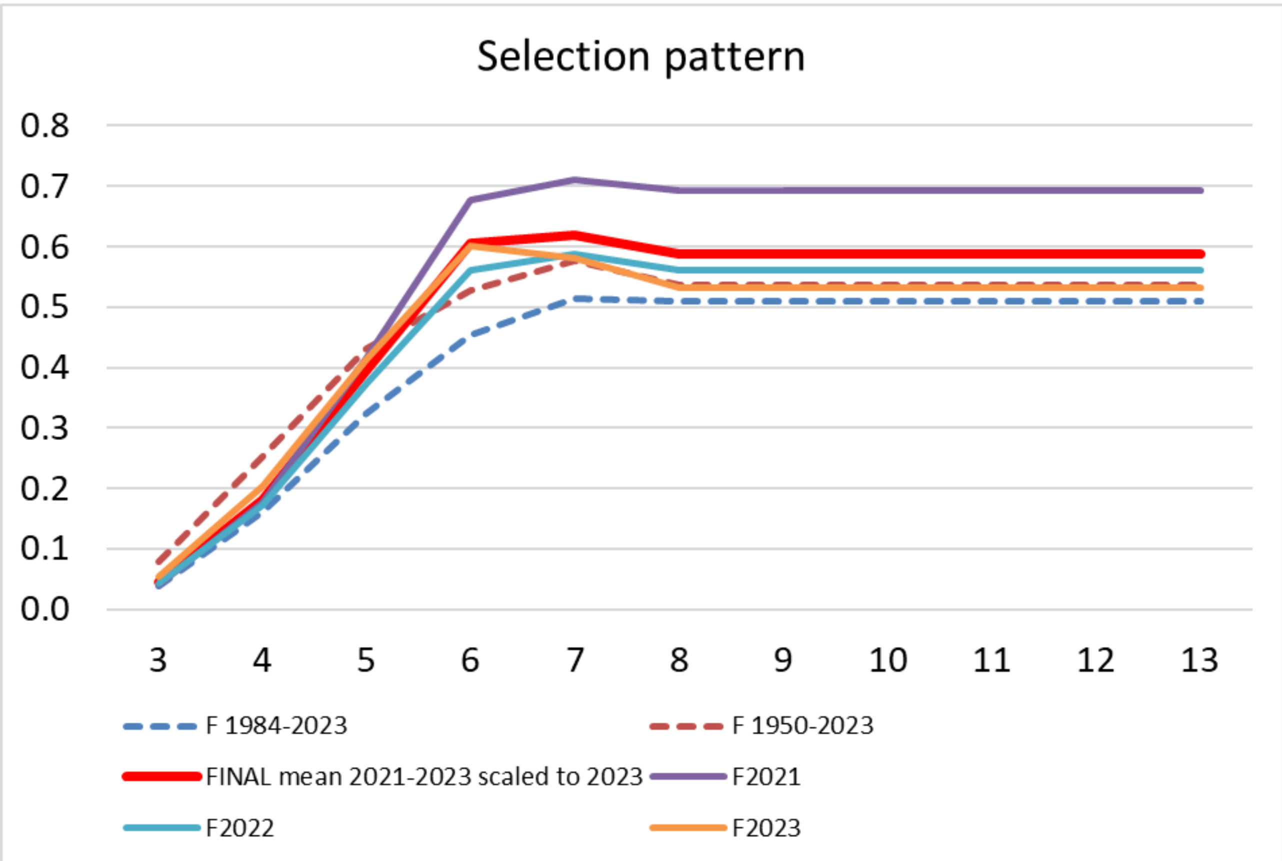

Figure 4.7 Standard selection pattern model (red) used for short-term forecasts at the current meeting.

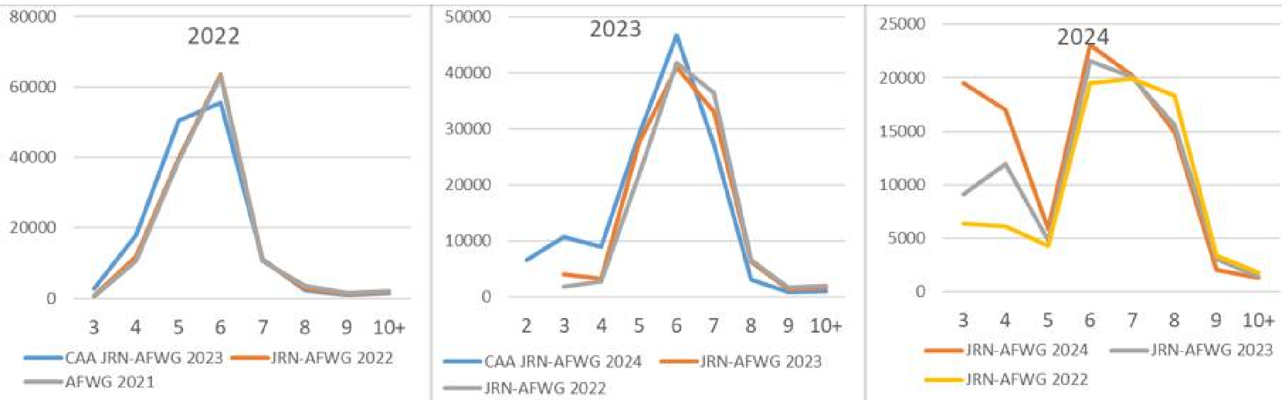

Figure 4.8 Catch in numbers in 2022 (left), 2023 (middle) and 2024 (left). Catch in numbers is in blue, forecasts for intermediate years are in orange, forecasts for Quota years are in grey and forecasts for Quota year + 1 in yellow. The numbers are taken for the working group reports from 2021, 2022, 2023 and 2024.

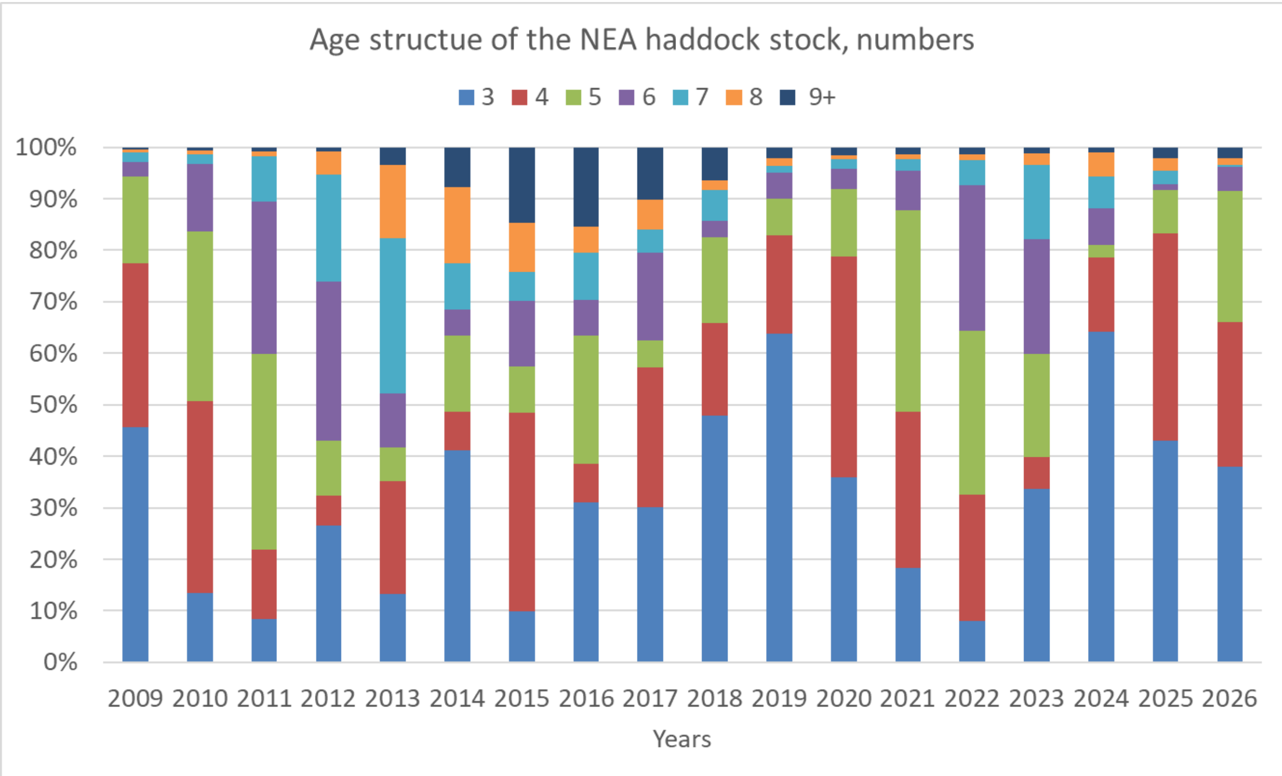

Figure 4.9.

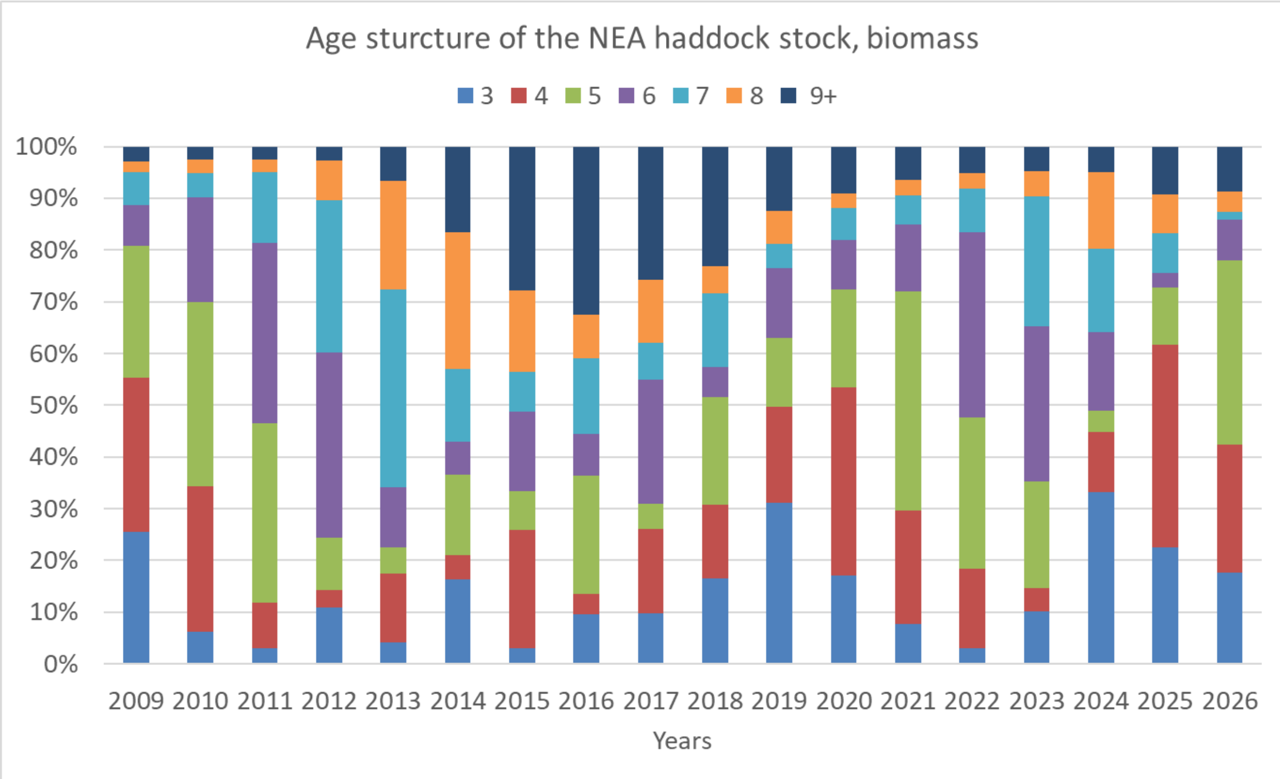

Figure 4.9. Age structure from assessment (2009-2024) and prediction (2025-2026).

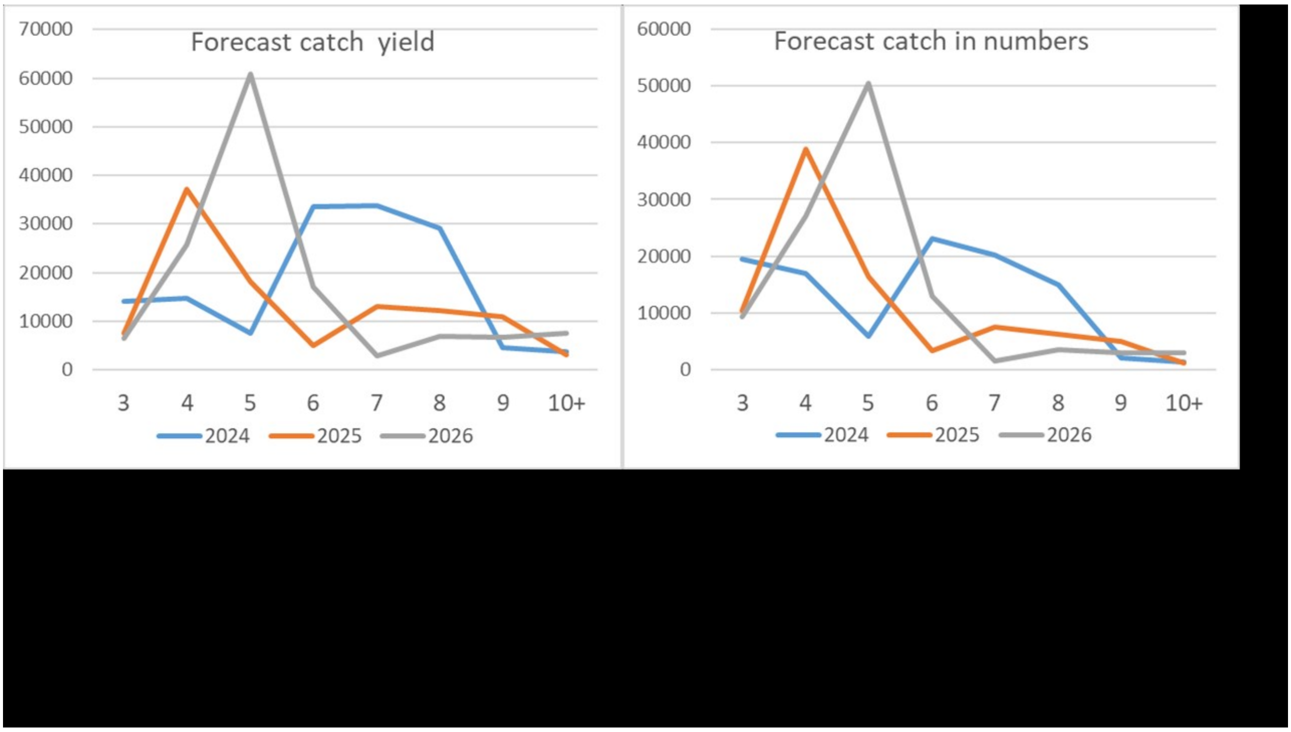

Figure 4.10 Forecasted catch for 2024 (blue), 2025 (orange) and 2026 (grey), left in biomass, right in numbers, all numbers taken from Table 4.20 this year's report.

Chapter 6. Beaked redfish in subareas 1 and 2 (Northeast Arctic)

Status of the fisheries

Development of the fishery

A description of the historical development of the fishery in subareas 1 and 2 is found in the ICES stock annex (ICES 2018c) 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.

Figure 6.2 shows the distribution of catch among national fishing fleets for 2018 to 2023 and the location of Norwegian *S. mentella* catches in the Norwegian EEZ in 2023 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.

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*.

Landings prior to 2024 (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 separately 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, 2 872 t in 2021, 2 680t in 2022 and only 5t in 2023, as 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 2023, and new figures presented for 2023. Total international landings in 1952–2023 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 ICES 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. JRN-AFWG advised an annual catch of no more than 66 779t in 2023 and 70 164t in 2024, corresponding to F = 0.097.

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, then increased from 34 754 t in 2016 to 63 479 t in 2021. This catch was 60 466 t in 2023, of which only 5 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, 2 679 t, 5 016 t and below the advised TAC in the years 2019-2022, respectively. The catch was 6 313 t below the TAC advised by the JRN-AFWG in 2023. 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 were up to 2003 between 1000–3000 t per year. Since 2005 the annual landings from this area have varied between 85 and 341 t (Table 6.7).

Expected landings in 2024

JRN-AFWG has advised on the basis of precautionary considerations that the annual catch should be set at no more than 70 164 t in 2024. The 53st sessions of the Joint Norwegian-Russian Fisheries Commission decided to follow this advice.

In 2024, Norwegian fishing vessels can catch and land up to 46 418 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. 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 2024 Russia may fish 15 730 t including transfer from Norway to Russia. The remaining 8 016 t are divided between third countries in the NEZ and Svalbard Zone and the NEAFC areas.

Catch in the NEAFC areas in 2023 amounted to 5 t while the catch in the national economic zones of Norway and Russia as well as the fisheries protection zone around Svalbard was 60 461 t. The total catch in 2023 was 6313 t lower than the agreed TAC.

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 1992–2023. 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 2012–2023. 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, 2019 and 2022, 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.

Length- composition from the fishery (Figure 6.4)

Comparison of length distributions of the Norwegian and Russian catches of *S. mentella* in 2022–2023 are shown in Figure 6.4. In 2022, the length distributions from Russian and Norwegian fleets were almost identical, with maximum catches around 38 cm length. In 2023, length of beaked redfish in Norwegian catches was slightly larger than in Russian catches. This may be due to differences in the fishing areas. The Russian fleet largely operated in area 2b, and the Norwegian fleet in area 2a.

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

For JRN-AFWG 2022, catch-at-age in the Norwegian fishery was estimated using StoX-Reca for 2014 and 2020. For 2015, 2016 and 2018, running StoX-Reca failed and 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.

For JRN-AFWG 2024, StoX-Reca again failed in producing catch-at-age data for Norwegian catch in 2022. In addition, the older Biomass program could not be run. A simplified method was therefore used. Catch-at-length was calculated (by gear “bottom trawl” and “pelagic trawl”, and by stratum “Norwegian statistical area 12/20” and “other areas”) through a length-weight relationship and length distributions from the Norwegian reference fleet. An age-length-key was used to convert catch-at-length to catch-at-age. Ages were not available for 2023, and proportions-at-age in the catch were derived from proportions at-age in earlier years, similar to earlier years.

Catch-at-age for the pelagic fleet in 2022 was derived from proportion-at-age in the scientific survey in the Norwegian Sea. Catch-at-age for the 2023 pelagic catches (only 5 tonnes) were extrapolated for 2023 like earlier years.

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.

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 (not updated after 2019).

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). Since JRN-AFWG 2024 maturity-at-age used in the statistical catch-at-age model are identical for every year, based on average values from the previous years.

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 2018 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, 2023) 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.

Scientific surveys

Following a dedicated review, ICES AFWG approved the use of the new SToX versions of winter and ecosystem surveys for use in the *S. mentella* assessment (WD 17 and WD 18 in ICES 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:

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 1986–2023 in fishing depths of 100–500 m (Figures 6.11–6.12). Data disaggregated by age for the period 1996–2009, 2011-2015, 2017 and 2019 (Tables 6.16b-6.17). ICES acronym: Since 2003 part of Eco-NoRu-Q3 (BTr), survey code: A5216.

Winter Barents Sea seabed-trawl survey (February) from 1986–2023 (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, 2013, 2018 and 2020 (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.

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).

Additional surveys (Figures 6.15–6.17)

The international 0-group survey in the Svalbard and Barents Sea areas in August-September 1980–2023, 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 29 February to 23 March 2024, following similar surveys in 2009, 2012, 2014, 2016, 2018, 2020 and 2022. 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).

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.

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

Stock trends

The temporal patterns in recruitment-at-age 2 (Figures 6.18, 6.21) imply 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) 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 has increased every year after 2017. SSB at the start of 2022 is estimated at 1 074 827 t.

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 2023 are of age 15 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 2023 F_{19+} is estimated at 0.08 (Table 6.21), with 0.077 for the demersal and 0.0002 for the pelagic fleets (Table 6.20a), respectively.

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.

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 2026 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.

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 2023) is consistent with previous runs. As observed in previous assessments, the SSB time-series is smoother than before, due to fixed weight-at-age for every year. New data led to an increase in estimated SSB, up to >26% in the early years and around 2% to 4% in later years. 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 2022 showed similar or up to ca. 7% upwards revision in SSB. The analytical retrospectives showed a consistent pattern for $F_{12\text{-}18}$ until 2018 after which it started to deviate. Likewise, the pattern for F_{19+} was very similar in the analytical retrospectives, with small deviations from 2018 onwards.

Projections

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

The estimated fishing mortality in 2023 is: $F_{19+} = 0.077$.

If the fishing mortality is maintained, this is expected to lead to a catch of 64 029 t in 2024, more than 6 000 t less than the advised TAC for 2024. This would lead to a SSB of 1 094 860 t in early 2025, catches of 67 191 t in 2025 and a SSB of 1 105 628 t in 2026. Zero catch in 2025 and 2026 would lead to SSB values of 1 168 451 t in 2026 and 1 246 963 t in 2027.

These projections assume that the selectivity patterns of the demersal and pelagic fleets are identical with those estimated for 2023. It is also assumed that the ratio of fishing mortality between these two fleets remains unchanged.

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 most of the recent years (i.e., not available in 2012, 2014-2017, 2019 or 2021-2023). 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.

Assessment summary (Table 6.21, Figure 6.21)

The history of the stock as described by the SCAA model for the period 1992–2023 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 0.002 and 0.085.

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 analytical assessments in future (WD 5 in 2016).

The SCAA model relies on the availability of reliable age data in surveys and in the catch, and it requires a continuous effort to keep these data at an appropriate level.

Biological reference points

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

Reference points

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.

Management advice

The present report updates the assessment and advises that when the status quo approach is applied, catches in 2025 should be no more than 67 191 tonnes, and catches in 2024 should be no more than 69 177 tonnes. This would correspond to a fishing mortality of F_{19+} = 0.077, whilst fishing pressure across the fishable age-classes would remain nearly constant.

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

Year		Estonia	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Latvia	Lithuania	Netherlands	Norway
2020	**Denmark - 1**		149	163	1807	67	8			1081	1483	32 950
2021	**Denmark - 1**		290	218	1166	85	6			1379		43 794
2022			235	221	1758	39	77			990	586	40 715
2023[1]	**Denmark - 35**		185	133	626	109	10			1		44 496

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**
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	**716**
2020	35	12	6	21	-	-	335	3	9	118	1	-	**540**
2021	87	31	-	14	-	-	195	-	4	367	1	-	**699**
2022	91	2	3	20	-	-	508	-	-	88	1	-	**713**

Year	Faroe Islands	France	Germany	Greenland	Iceland	Lithuania	Norway	Poland	Portugal	Russia	Spain	UK	Total
2023[1]	84	12	31	17	-	-	1 334	-	8	145	69	-	**1 700**

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
1998		-	73	58	14	-	6	-	-	9186	118	-
1999		-	16	160	50	-	3	-	-	7358	56	-
2000		50	11	35	29	-	-	-	-	5892	98	-
2001		63	12	161	17	-	4	-	-	13 636	105	-
2002		37	54	59	18	41	4	-	-	1937	124	-
2003		58	18	17	8	5	5	-	-	1014	17	-
2004	**Sweden** - 1	555	8	4	4	10	3	-	-	987	86	-
2005		1101	36	17	38	2	4	-	-	1083	71	-
2006	**Estonia** - 396 **Canada** - 433	3793	199	2475	52	2513	3	845	-	4010	1731	2467
2007	**Estonia** - 684	2157	226	519	29	1579	16	785	349	3043	1395	1079
2008	**Netherlands** - 13	1821	179	9	24	9	9	117	267	1952	666	1
2009	**EU** - 889	1316	7	23	-	25	-	-	-	2208	764	338
2010		961	175	13	12	2	-	457	243	1705	246	-
2011		932	175	697	-	2	-	561	536	1682	599	-
2012		259	-	469	-	32	-	449	447	1500	1038	311
2013	**Netherlands**	675	-	24	21	1	-	262	280	871	1055	68
2014	2	728	209	411	15	-	-	167	215	4089	505	100
2015	3	657	49	236	25	3	-	192	537	11 410	678	3
2016	-	495	107	493	61	-	24	1065	1243	8887	1052	183
2017	-	425	38	763	44	3	-	790	562	7348	1059	94
2018	374	400	47	2440	51	7	-	1010	876	14 057	699	272
2019	244	73	363	1599	59	10	-	652	-	17 741	1421	455
2020	1483	112	146	1797	42	7	-	1 081	-	22 854	880	-
2021	-	151	182	1128	70	6	-	1 379	-	35 798	377	-
2022	586	112	187	1693	16	77	-	990	-	28 666	441	-
2023[1]	**Denmark** - 1	75	38	518	92	10	-	-	-	37 391	338	-

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
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
2002		-	38	4	40	-	-	210	8	118	702	182
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
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	**Lithuania - **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
2018	**Lithuania** - 144	-	25	20	14	6	-	4281	3	-	5400	22
2019		-		4		543	-	5 734	-	-	5 873	19
2020	**Latvia** - 2	-	2	5	4	4	-	9 760	-	-	7 671	6
2021		-	52	6	38	1	-	7 801	2	-	8 512	79
2022		-	32	32	62	3	-	11 541	-	23	8 836	185
2023[1]		-	26	83	78	-	-	5 771	-	24	11 742	12

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
2002		-	-	-	9	-	-	-	-	-	-	-
2003		-	-	-	40	-	-	-	-	-	-	-
2004		-	500	-	2	-	-	-	-	-	-	1510
2005		-	1083	-	20	-	-	-	-	-	-	3299
2006	**CAN -** 433	396	3766	192	2475	2510	341	845	2862	2447	1697	9390
2007		684	1968	226	497	1579	349	785	1813	1079	1377	3645
2008		-	1797	-	-	-	267	117	330	-	641	4901
2009	**EU** - 889	-	1253	-	-	-	-	-	-	337	701	1975
2010		-	912	-	-	-	243	457	450	-	244	5103
2011		-	740	175	693	-	536	561	342	-	595	3621
2012		-	259	-	469	31	447	449	-	311	1038	2714
2013		8	675	-	-	-	280	262	1	68	1078	2720
2014		-	697	-	409	-	215	167	-	100	505	795
2015		-	606	-	231	-	537	192	-	-	678	-
2016		-	393	-	493	-	1243	1065	9	-	821	512
2017	**Netherlands**	-	296	-	761	-	562	790	-	14	791	1014
2018	374	-	400	-	2192	-	876	1010	-	116	372	-
2019	244	-	-	298	1157	-	-	652	1	364	1096	117
2020	1366	**Greenland** - 3		73	1 380			1 081			480	25
2021	-	-		117	514			1 379			84	498
2022	586			78	938			990			88	
2023[1]		**Denmark** - 1										

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
1984	-	-	-	-	2970	7457	-	-	-	-	18 650	-
1985	-	-	-	-	3326	6566	-	-	-	-	20 456	-
1986	-	**DK**	-	29	2719	4884	-	-	-	-	23 255	-
1987	-	+	-	450[3]	1611	5829	-	-	-	-	18 051	-
1988	-	-	-	973	3349	2355	-	-	-	-	24 662	-
1989	-	-	-	338	1849	4245	-	-	-	-	25 295	-
1990	-	37[3]	-	386	1821	6741	-	-	-	-	34 090	-

Year	Latvia	Lithuania	Estonia	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Netherlands	Norway	Poland
1991	-	23	-	639	791	981	-	-	-	-	49 463	-
1992	**CAN**	9	-	58	1301	530	614	-	-	-	23 451	-
1993	8[3]	4	-	152	921	685	15	-	-	-	18 319	-
1994	-	28	-	26	771	1026	6	4	3	-	21 466	-
1995	-	-	-	30	748	693	7	1	5	1	16 162	-
1996	-	-	-	42[3]	746	618	37	-	2	-	21 675	-
1997	-	-	-	7	1011	538	39[2]	-	11	-	18 839	1
1998	-	-	-	98	567	231	47[3]	-	28	-	26 273	13
1999	-	-	-	108	61[3]	430	97	14	10	-	24 634	6
2000	-	-	-	67[3]	25	222	51	64	1	-	19 052	2
2001	-	-	-	111[3]	46	436	34	3	5	-	23 071	5
2002	-	-	15	135[3]	89	141	49	44	4	-	10 713	8[3]
2003	**S**	-	-	173[3]	30	154	44[3]	9	5[3]	89	8063	7
2004	1	-	-	607	17[3]	78	24[3]	40	3	33	7608[1,2]	42
2005	**LV**	**LT**	5	1194	56	105	75[3]	12[2]	4[3]	55[2]	7845[1,2]	-
2006	341	845	396	3919	223	2518	107[3]	2544[3]	7[3]	21	11 015	2496[2]
2007	349	785	684	2343	249	587	113[3]	1655[2]	30[3]	20	8993[2]	1081[2]
2008	267	117	-	2123[3]	250	46	96[3]	36[3]	15[3]	15	7436[1]	8
2009	-	-	-	1413	16	100	81	99	-	4	8128	338
2010	243[3]	457[3]	-	1150	226	52	84[3]	24[3]	-	-	8059	1[3]
2011	536	565	-	1008[2]	228	844	51	24	-	1	7152	59
2012	447	449	-	346	182	588	58	59	12	5	6 361	352
2013	280	262	-	780	353	81	66	9	1	-	5586	103
2014	215	167	-	810	434	452	35	29	-	4	16589	124
2015	537	192	-	733	102	266	259	38	-	3	22166	22
2016	1243	1065	-	685	164	497	161	79	-	-	22322	234
2017	562	790	4	566	62	782	127	68	-	2	20644	129
2018	1020	1010	-	571	104	2539	159	77	-	374	23 563	311
2019	-	656	-	392	395	1692	671	93	-	244	29 795	491
2020	-	1081	-	315	164	1895	166	61	-	1483	39 453	13
2021[1]	-	1379	-	613	224	1242	177	78	-	-	51 497	22
2022	-	990	-	546	241	1818	200	297	-	586	48 268	-
2023	-	1		346	164	744	255	198	-	-	52 196	-

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.)
1998	2	27	12	570	370	4	21	1113		-	-	749
1999	3	52	1	-	58	39	16	862		-	-	532
2000	5	41	-	224	19	28	19	443		-	-	618
2001	4	96	-	272	13	19	+	421		-	-	538
2002	2	40	2	98	11	7	+	241		-	-	524
2003	1	71	2	26	2	-	-	474		-	-	463
2004	+	42	3	26	1	-	-	287		-	-	214
2005	2	34	-	10	1	-	-	84		-	-	28
2006	1	49	1	12	3	-	-	163	-	33	-	79
2007	+	27	-	8	1	-	-	116	1	-	-	77
2008	+	3	-	8	1	-	-	77	-	-	1	54
2009	+	4	1	38	+	-	-	119	-	-	+	86
2010	-	5	-	3	-	-	-	62	-	-	+	150
2011	-	9	-	90	1	-	-	66	-	-	+	71
2012	-	10	-	19	+	-	-	71	-	-	+	87
2013	-	7	-	40	+	-	-	54	-	-	-	176
2014	-	-	-	32	1	-	-	146	-	-	+	93
2015	+	1	-	14	1	-	-	157	-	-	+	61
2016	-	3	-	11	+	-	-	180	-	-	+	22
2017	-	3	-	10	+	-	-	168	-	-	+	38
2018	-	10	-	4	-	-	-	71	-	-	+	29
2019[1]	-	7	+	10	+	-	+	62	-	-	+	10
2020	-	9	-	4	+	-	+	54	-	-	+	28
2021	-	4	-	11	+	-	+	30	-	-	+	123
2022	+	4	3	14	+	-	+	40	-	-	+	24
2023	+	1	+	5	+	-	+	57	-	-	+	51

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, 2020-2021 and 2023, 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 methods 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	8 075
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	8 598
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	14 044
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	6 994
2003	6	37	103	93	132	220	384	391	434	466	513	199	231	1 193	4 402	2 520
2004	7	16	70	96	278	429	611	433	1 063	813	830	841	607	3 076	9 170	5 493
2005	2	20	57	155	244	262	295	754	783	1 896	817	1 087	1 023	6 065	13 460	8 466
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	20 218
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

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	+gp	Total No.	Tonnes Land.
2012	4	24	29	24	26	66	69	78	80	279	387	365	409	13 332	15 172	11 059
2013	0	3	19	101	90	44	41	42	9	177	146	185	317	12 826	14 000	9 389
2014	14	27	338	95	114	92	147	54	108	68	248	287	193	23 101	24 886	18 427
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	30 782
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
2020	5	14	616	239	2 368	1 948	2 085	3 541	2 861	2 882	3 974	3 454	3 136	53 208	80 331	53 657
2021	79	470	1 007	1 325	2 294	3 165	2 878	3 137	3 417	4 492	4 266	3 007	3 752	62 816	96 105	63 479
2022	0	0	0	263	667	1 600	4 071	6 377	7 329	7 367	8 715	4 173	4 529	51 317	96 408	62 194
2023	0	0	0	0	270	656	1 573	3 967	6 119	7 083	7 140	8 388	3 955	51 956	91 107	60 466

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

	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

	Age											
YEAR	7	8	9	10	11	12	13	14	15	16	17	18	19+
2019	25	5	200	400	220	242	197	279	183	155	135	161	6 696
2020[3]	0	44	8	345	672	353	362	270	345	206	163	136	5 496
2021[3]	0	0	45	8	339	631	309	290	195	228	127	96	2 380
2022	0	0	7	14	12	48	165	135	114	194	155	84	2 931
2023[3]	0	0	0	0	0	0	0	0	0	0	0	0	5

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, 2020-2021 and 2023, 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 2011–2014.

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
2015-2023	*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 2011–2014.

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
2015-2023	*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) from 1992-2019. 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

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
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
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) for 2006-2013.

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[1]	0.31	-	-	-	0.56	0.62	0.60	0.62	0.68
2014-2023	*No data*	-	-	-	-	-	-	-	-

1 - 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. Since JRN-AFWG 2024 maturity-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	0.00	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

year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
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
2022[1]	0.02	0.05	0.09	0.17	0.30	0.46	0.80	0.96	0.99	1.00	1.00	1.00	1.00	1.00
2023[1]	0.02	0.04	0.08	0.14	0.22	0.30	0.45	0.56	0.63	0.69	0.73	0.76	0.79	1.00
Model input	0.02	0.04	0.08	0.14	0.24	0.37	0.49	0.58	0.66	0.73	0.77	0.81	0.85	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	-
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

Year class	0	1	2	3	4	5	6	7	8	9	10	11
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										
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 1986–2023 (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**

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
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	10	49	243	45	1		**361**
2004	0	2	8	7	14	81	52	2	0	**166**
2005	22	1	4	4	10	68	46	1	0	**156**
2006	84	6	5	7	43	198	107	3	0	**453**
2007	73	39	1	4	9	91	102	3	0	**322**
2008	122	46	22	3	8	22	70	3		**296**
2009	9	122	88	14	3	27	219	5		**487**
2010	96	18	44	37	2	20	91	7		**315**
2011	126	91	81	48	10	7	67	5	1	**436**
2012	29	72	66	77	47	8	94	10		**403**
2013	33	43	127	106	67	19	85	13		**493**
2014	3	10	59	49	38	24	66	20	0	**269**
2015	89	8	29	159	116	66	69	25		**561**
2016	244	33	44	205	138	139	142	48	0	**993**
2017	41	38	8	20	59	76	57	17	0	**316**
2018	68	66	59	37	108	68	82	27		**515**
2019	3	27	89	32	59	83	74	26	1	**394**
2020	107	8	58	40	40	115	98	17		**483**
2021	502	136	15	39	16	58	88	18		**872**
2022	15	102	6	23	27	51	109	24	0	**357**
2023	5	65	90	20	68	42	87	23	0	**400**

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 1992–2023 (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**
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**
2020-2023	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 1996–2023 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]
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]

Year/ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total N	Total B
2020-2023	*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 1986–2023 (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**
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**

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
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]	616	981	54	112	76	87	152	20	0	**2098**
2023[3]	47	1091	335	94	149	131	194	31	1	**2072**

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 1992–2023 (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**
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**

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
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**
2014-2017	*No age readings*														
2018	171	218	106	34	24	35	50	59	44	58	58	62	92	49	**1060**
2019	*No age readings*														
2020	14 126 108 114 20 41 95 136 65 78 75 5 0 6 **883**														
2021-2023	*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, 2019 and 2022. Acoustic results for the 2022 survey were not available at the time of AFWG 2023.

	2008	2009	2013	2016	2019	2022
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	37.4/37.2/38.5
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	687/673/743
Mean age (y) All/M/F	25 / 25 / 25	25 / 25 / 24	28 / 29 / 28	27 / 27 / 26	- / - / -	30 / 31 / 31
Sex ratio (M/F)	45% / 55%	45% / 55%	59% / 41%	50% / 50%	51% / 49%	53%/47%
Occurrence	96%	100%	95%	80%	99%	89%
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.

Fy (demersal)	Fy (pelagic)	Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.039	0	1992	452 951	437 417	395 291	255 296	157 941	108 216	103 471	113 559	138 644	95 448	106 978	79 055	81 497	68 616	48 663	31 570	20 585	221 015
0.029	0	1993	302 438	430 952	416 173	376 092	241 004	148 808	101 729	97 024	106 196	129 293	88 764	99 225	73 149	75 247	63 239	44 782	29 016	221 092
0.026	0	1994	219 712	287 749	410 021	395 960	357 746	229 170	141 383	96 467	91 649	99 708	120 609	82 415	91 898	67 671	69 580	58 466	41 398	231 201
0.019	0	1995	210 082	209 041	273 774	390 107	376 448	339 824	217 312	133 653	90 779	85 810	92 968	112 158	76 532	85 279	62 777	64 538	54 225	252 815
0.013	0	1996	167 147	199 879	198 888	260 477	370 910	357 652	322 379	205 637	126 031	85 290	80 392	86 945	104 795	71 475	79 627	58 611	60 253	286 642
0.013	0	1997	116 283	159 029	190 171	189 229	247 761	352 646	339 671	305 492	194 236	118 692	80 182	75 518	81 648	98 399	67 110	74 763	55 030	325 701
0.018	0	1998	60 351	110 636	151 305	180 935	180 006	235 602	335 016	321 983	288 612	182 956	111 620	75 356	70 957	76 711	92 447	63 050	70 240	357 696
0.013	0	1999	48 801	57 420	105 262	143 956	172 134	171 197	223 765	316 769	302 448	270 148	171 086	104 356	70 449	66 336	71 715	86 426	58 944	400 066
0.011	0	2000	38 510	46 431	54 631	100 150	136 963	163 762	162 819	212 464	299 309	284 458	253 709	160 631	97 974	66 140	62 278	67 328	81 139	430 933
0.019	0	2001	36 793	36 640	44 176	51 978	95 286	130 310	155 788	154 705	200 830	281 892	267 760	238 804	151 193	92 217	62 254	58 619	63 372	481 986
0.007	0	2002	44 125	35 006	34 860	42 030	49 436	90 574	123 696	147 463	145 810	188 474	263 817	250 256	223 069	141 200	86 115	58 133	54 738	509 249
0.002	0	2003	47 619	41 982	33 305	33 167	39 988	47 031	86 145	117 539	139 829	137 968	178 171	249 328	236 496	210 801	133 434	81 379	54 936	532 967
0.005	0	2004	64 325	45 306	39 943	31 688	31 553	38 038	44 729	81 903	111 704	132 828	131 012	169 147	236 669	224 473	200 077	126 644	77 237	557 977
0.008	0	2005	125 352	61 201	43 106	38 003	30 146	30 014	36 173	42 514	77 783	105 974	125 893	124 091	160 154	224 045	212 482	189 382	119 872	601 242
0.005	0.034	2006	236 264	119 263	58 228	41 012	36 155	28 677	28 545	34 383	40 364	73 724	100 270	118 977	117 203	151 224	211 531	200 605	178 794	680 790
0.004	0.019	2007	336 307	224 789	113 471	55 400	39 020	34 398	27 267	27 127	32 644	38 259	69 701	94 497	111 717	109 596	140 778	196 066	185 247	787 153
0.004	0.012	2008	391 976	319 973	213 872	107 960	52 709	37 124	32 717	25 928	25 782	30 995	36 266	65 925	89 168	105 159	102 901	131 859	183 266	904 716
0.003	0.008	2009	379 212	372 939	304 433	203 484	102 717	50 149	35 314	31 116	24 648	24 482	29 369	34 293	62 244	84 061	98 975	96 697	123 739	1 017 845

Fy (demersal)	Fy (pelagic)	Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.004	0.009	2010	497 619	360 795	354 826	289 647	193 601	97 727	47 705	33 586	29 578	23 405	23 214	27 817	32 450	58 840	79 380	93 368	91 138	1 073 815
0.004	0.009	2011	626 739	473 450	343 272	337 593	275 577	184 193	92 960	45 369	31 926	28 091	22 199	21 989	26 316	30 663	55 532	74 830	87 929	1 094 667
0.004	0.008	2012	514 642	596 300	450 456	326 600	321 196	262 190	175 216	88 414	43 132	30 322	26 635	21 012	20 783	24 842	28 908	52 290	70 387	1 109 772
0.004	0.006	2013	276 469	489 646	567 339	428 578	310 735	305 589	249 413	166 650	84 064	40 983	28 779	25 242	19 881	19 637	23 442	27 250	49 247	1 109 350
0.015	0.006	2014	285 439	263 042	465 865	539 784	407 761	295 640	290 712	237 247	158 493	79 923	38 942	27 320	23 928	18 817	18 558	22 128	25 698	1 090 704
0.025	0.006	2015	240 181	271 576	250 266	443 239	513 554	387 937	281 226	276 493	225 575	150 614	75 877	36 911	25 833	22 556	17 679	17 385	20 684	1 039 962
0.032	0.010	2016	251 114	228 516	258 386	238 111	421 699	488 574	368 990	267 394	262 672	213 898	142 293	71 283	34 469	24 015	20 912	16 364	16 076	979 217
0.029	0.010	2017	305 166	238 918	217 417	245 837	226 531	401 147	464 571	350 601	253 643	248 301	200 983	132 670	65 999	31 760	22 061	19 171	14 981	908 810
0.038	0.012	2018	329 305	290 345	227 315	206 858	233 877	215 491	381 470	441 578	332 956	240 489	234 764	189 194	124 164	61 383	29 377	20 322	17 612	845 099
0.053	0.006	2019	302 303	313 311	276 244	216 274	196 771	222 435	204 849	362 392	419 010	315 325	227 045	220 616	176 708	115 162	56 546	26 909	18 537	781 239
0.069	0.005	2020	248 568	287 621	298 094	262 827	205 676	187 073	211 349	194 474	343 570	396 407	297 368	213 149	205 884	163 744	105 917	51 645	24 435	717 052
0.082	0.003	2021	242 188	236 495	273 652	283 617	250 051	195 668	177 936	200 971	184 820	326 146	375 468	280 480	199 579	190 665	149 624	95 577	46 175	655 003
0.081	0.001	2022	235 980	230 425	225 009	260 361	269 679	237 674	185 864	168 855	190 420	174 701	307 189	351 824	260 981	184 078	174 110	135 256	85 610	612 963
0.077	0.000	2023	229 939	224 519	219 234	214 081	247 671	256 496	225 988	176 633	160 318	180 489	165 107	288 914	328 431	241 136	168 023	157 018	120 761	612 477

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
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
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
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
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
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
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
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

Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
2022	0.000	0.000	0.000	0.002	0.004	0.008	0.014	0.025	0.046	0.082	0.141	0.232	0.358	0.507	0.655	0.778	0.886
2023	0.000	0.000	0.000	0.001	0.001	0.002	0.006	0.012	0.025	0.050	0.099	0.185	0.320	0.494	0.669	0.808	0.897

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 thousands	Stock Biomass (tonnes)	SSB (tonnes)	F (12–18)	F (19+)
1992	453	158	611 718	345 186	0.031	0.039
1993	302	241	661 914	366 087	0.028	0.029
1994	220	358	724 331	391 362	0.025	0.026
1995	210	376	793 908	420 379	0.018	0.019
1996	167	371	864 000	456 022	0.013	0.013
1997	116	248	932 292	499 100	0.013	0.013
1998	60	180	995 130	547 493	0.018	0.018

Year	Rec (age 2) in millions	Rec (age 6) in thousands	Stock Biomass (tonnes)	SSB (tonnes)	F (12–18)	F (19+)
1999	49	172	1 046 556	602 476	0.013	0.013
2000	39	137	1 090 086	661 852	0.011	0.011
2001	37	95	1 126 267	727 718	0.019	0.019
2002	44	49	1 142 259	780 491	0.007	0.007
2003	48	40	1 159 606	834 581	0.002	0.002
2004	64	32	1 173 472	885 324	0.005	0.005
2005	125	30	1 180 159	929 453	0.008	0.008
2006	236	36	1 182 896	968 427	0.022	0.038
2007	336	39	1 162 514	981 962	0.013	0.022
2008	392	53	1 156 443	996 543	0.011	0.017
2009	379	103	1 159 965	1 004 137	0.007	0.011
2010	498	194	1 171 314	997 409	0.008	0.012
2011	627	276	1 190 010	980 139	0.009	0.014
2012	515	321	1 217 415	961 307	0.008	0.012
2013	276	311	1 260 022	944 111	0.006	0.011
2014	285	408	1 319 257	931 923	0.012	0.021
2015	240	514	1 373 404	918 317	0.024	0.03
2016	251	422	1 415 521	911 015	0.033	0.041
2017	305	227	1 450 210	909 387	0.026	0.039
2018	329	234	1 487 606	925 707	0.031	0.049
2019	302	197	1 517 066	949 446	0.033	0.059
2020	249	206	1 540 451	977 404	0.039	0.074
2021	242	250	1 556 719	1 002 649	0.041	0.085
2022	236	270	1 562 771	1 023 195	0.041	0.082
2023	230	248	1 568 485	1 047 002	0.038	0.077

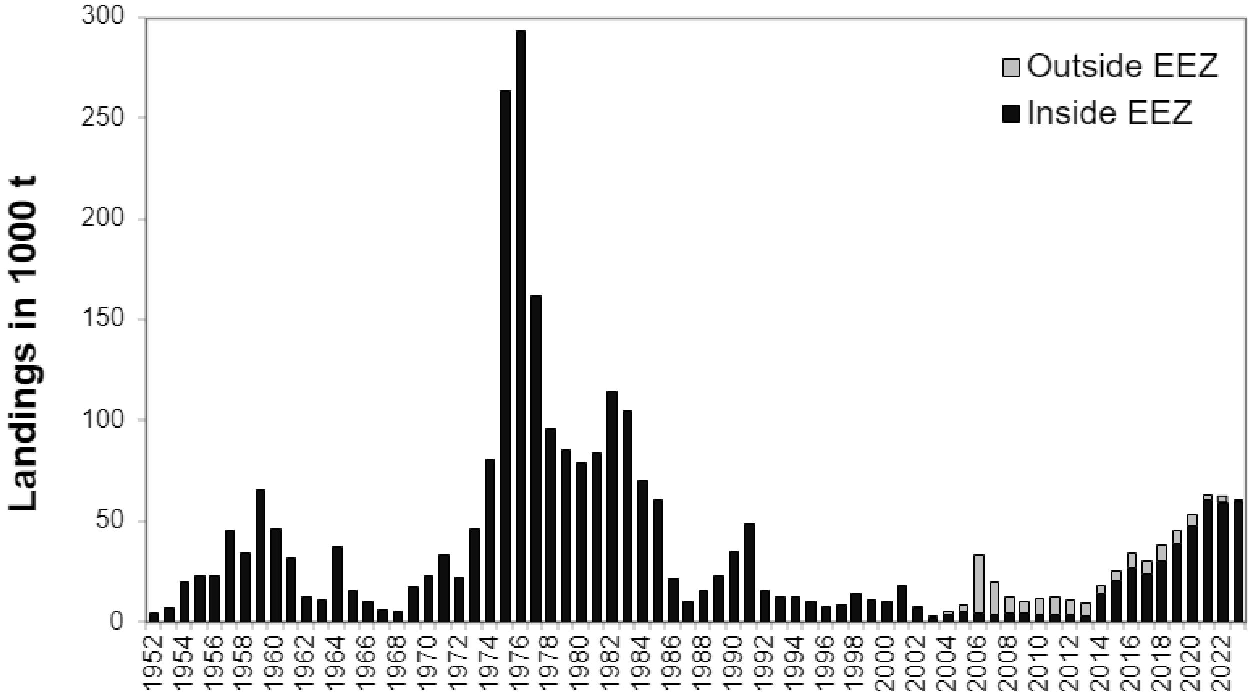


Figure 6.1. S. mentella in subareas 1 and 2. Total international landings 1952–2023 (thousand tonnes).

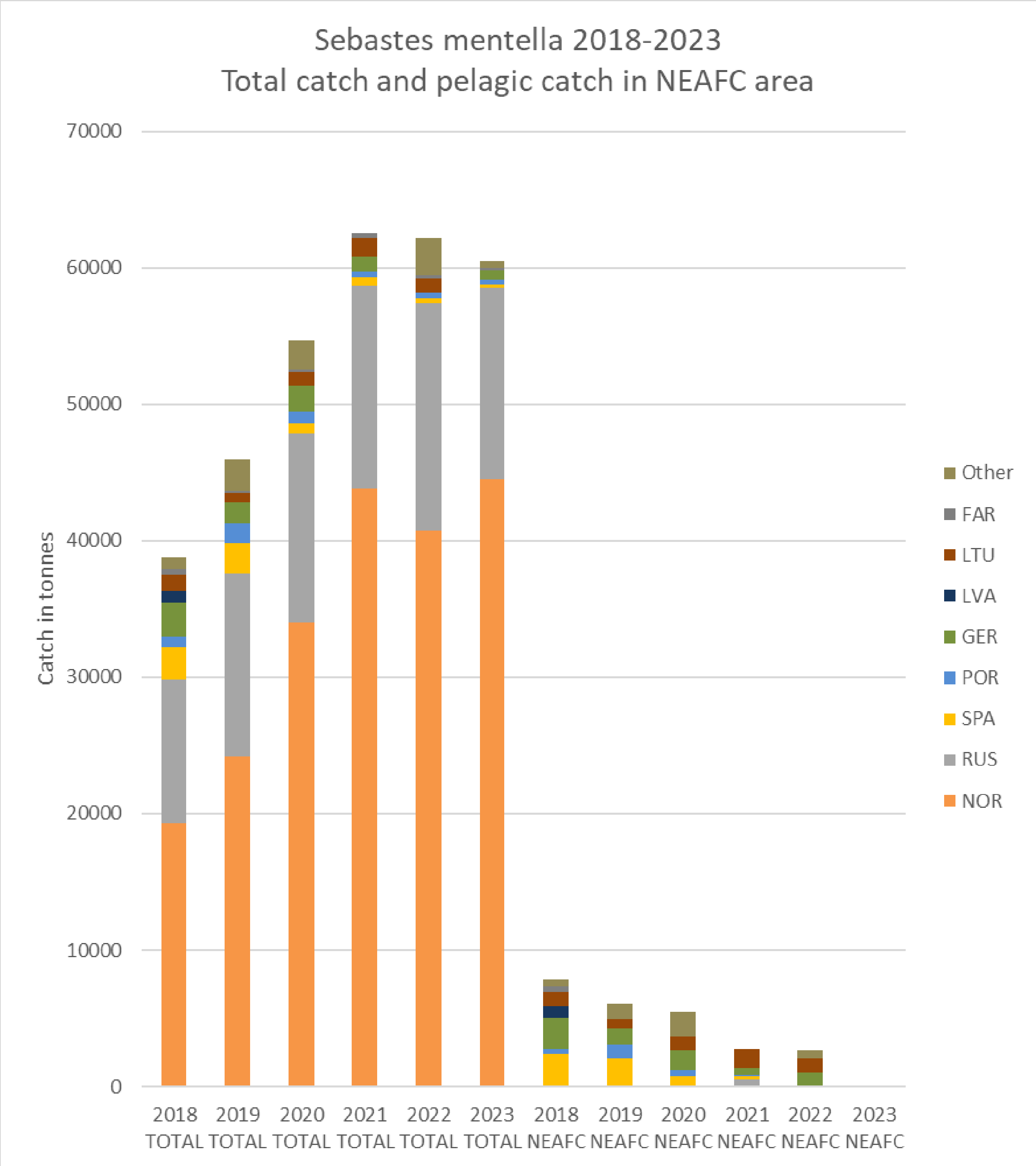

Sebastes mentella 2018-2023
Total catch and pelagic catch in NEAFC area
Catch in tonnes
70000
60000
50000
40000
30000
20000
10000
0
2018 TOTAL
2019 TOTAL
2020 TOTAL
2021 TOTAL
2022 TOTAL
2023 TOTAL
2018 NEAFC
2019 NEAFC
2020 NEAFC
2021 NEAFC
2022 NEAFC
2023 NEAFC
Other
FAR
LTU
LVA
GER
POR
SPA
RUS
NOR

Figure 6.2

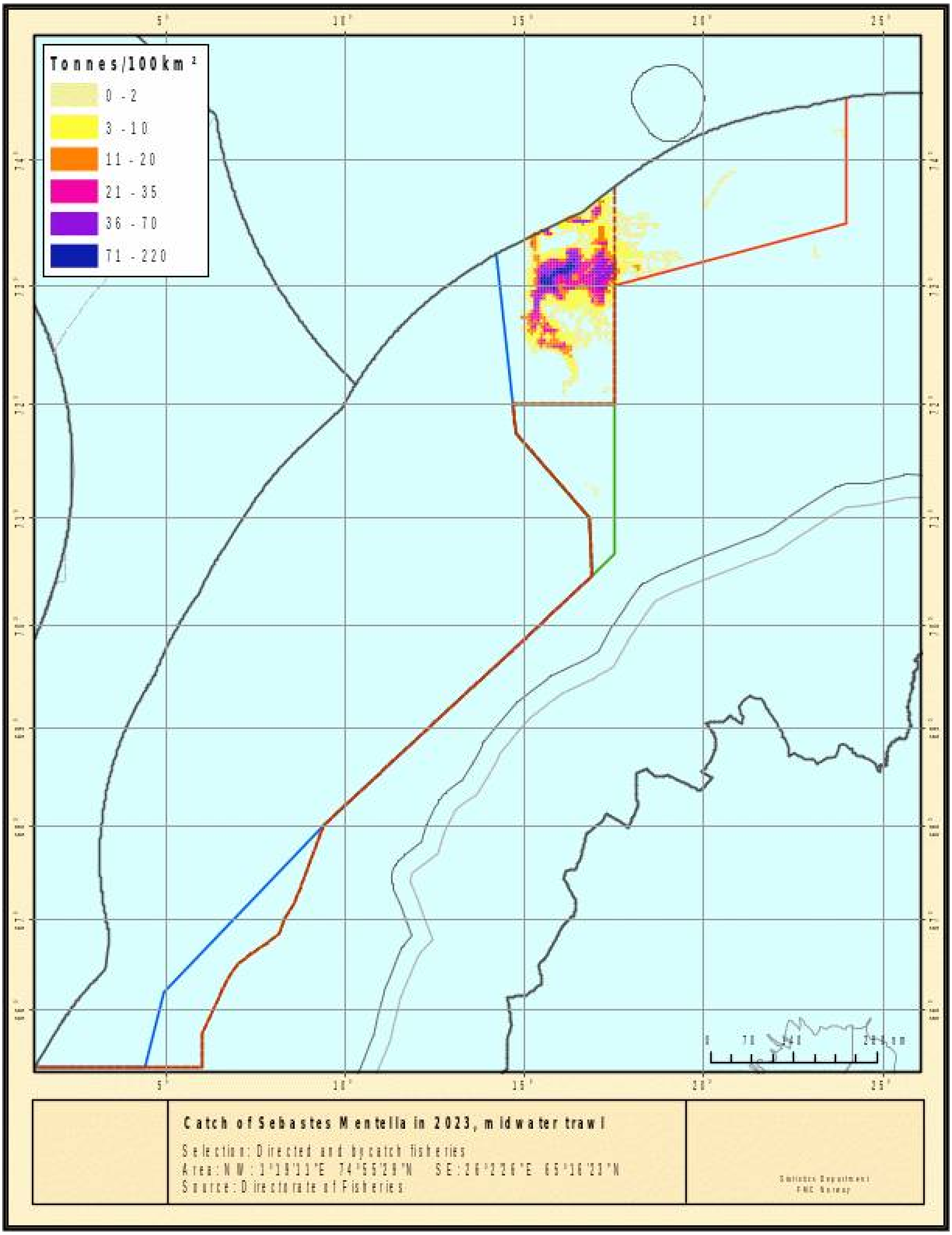


Figure 6.2. S. mentella in subareas 1 and 2. Left panel: Catch in tonnes reported by national fleets for the subareas 27.1 and 27.2 and in the NEACF regulatory area. Right panel: Geographical location of the directed Norwegian fishery in 2023 within the Norwegian Exclusive Economic Zone and bycatches 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.

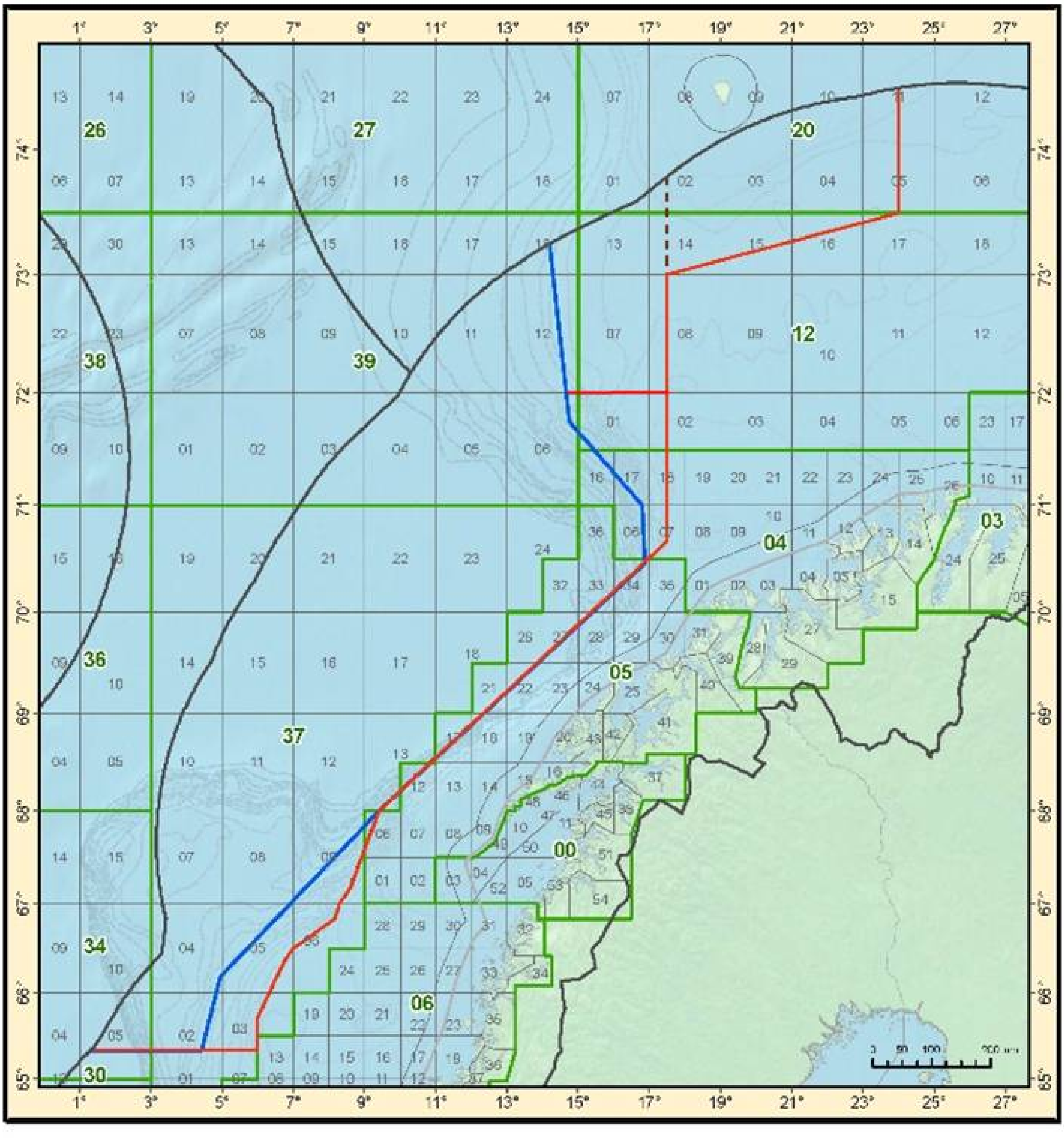


Figure 6.3. Delineation of the geographical limits for directed fishing in the Norwegian Economic Zone in 2014–2023. Directed pelagic trawling is only allowed west of the blue line. Directed demersal trawling is only allowed between the blue and the red line. The area east of the stippled line inside 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.

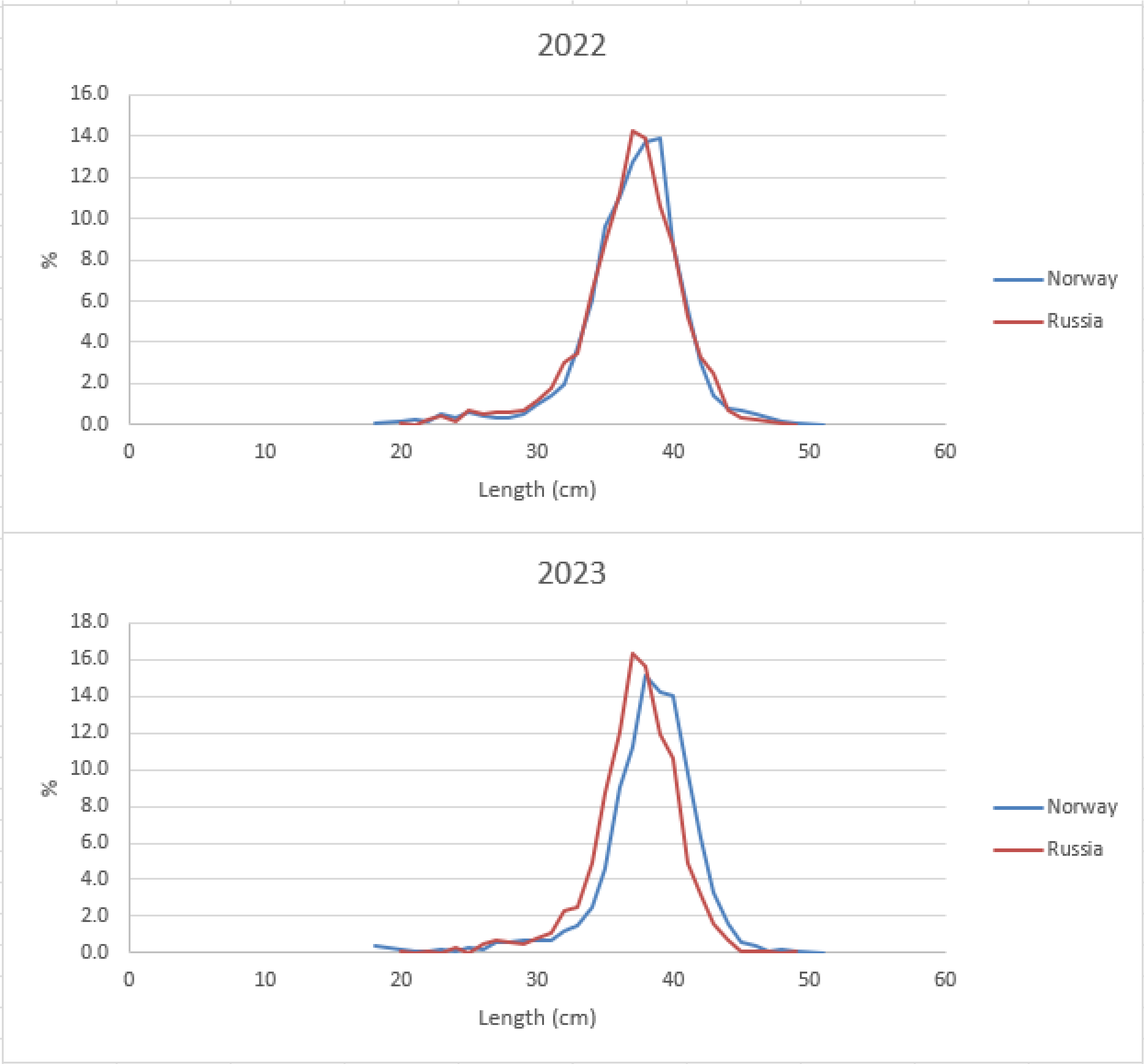


Figure 6.4. S. mentella in subareas 1 and 2. Length-distributions of the commercial demersal catches by Norway and Russia in 2022–2023.

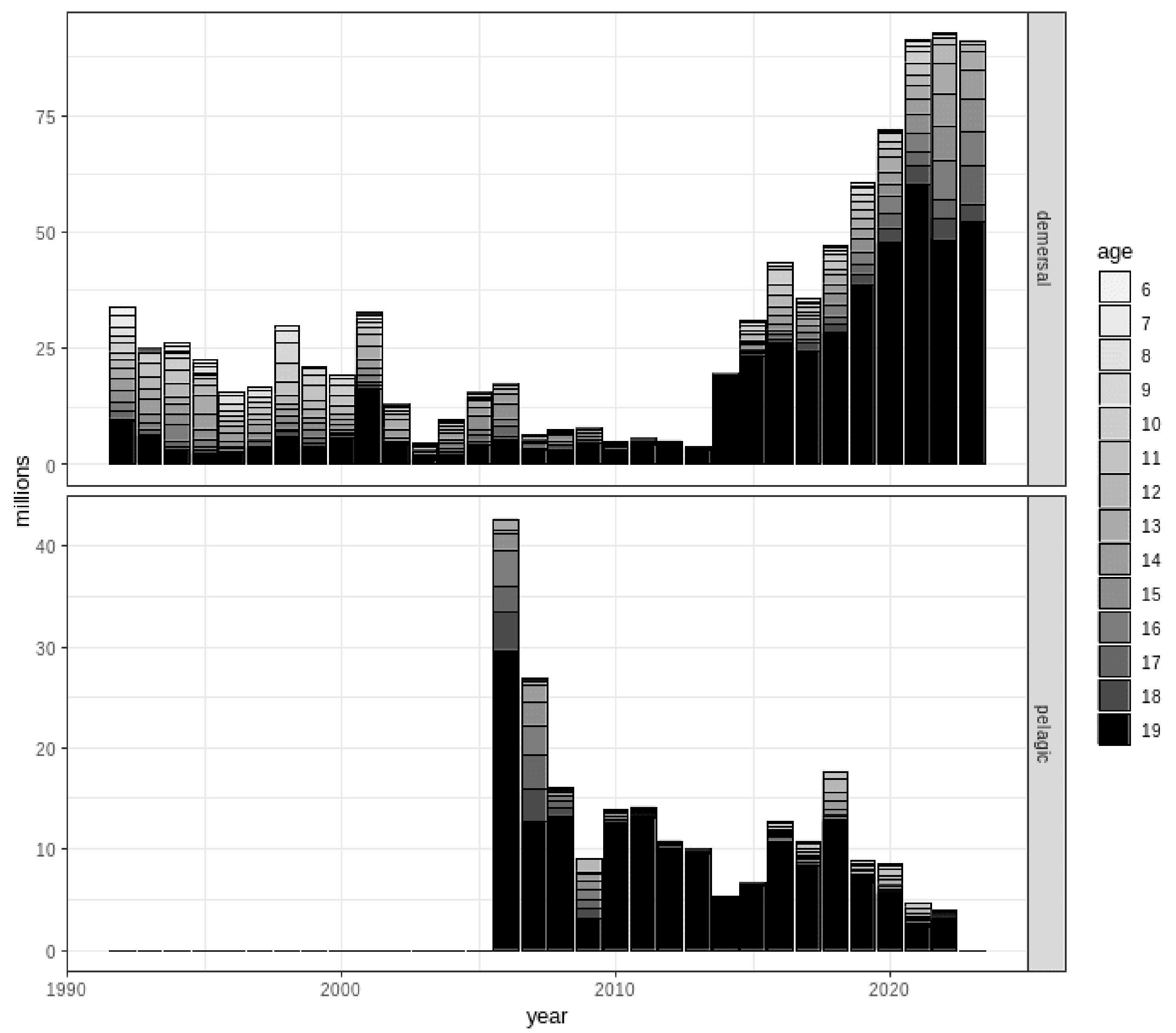

75
50
25
0
millions
40
30
20
10
0
1990
2000
2010
2020
year
demersal
pelagic
age
6
7
8
9
10
11
12
13
14
15
16
17
18
19

Figure 6.5.

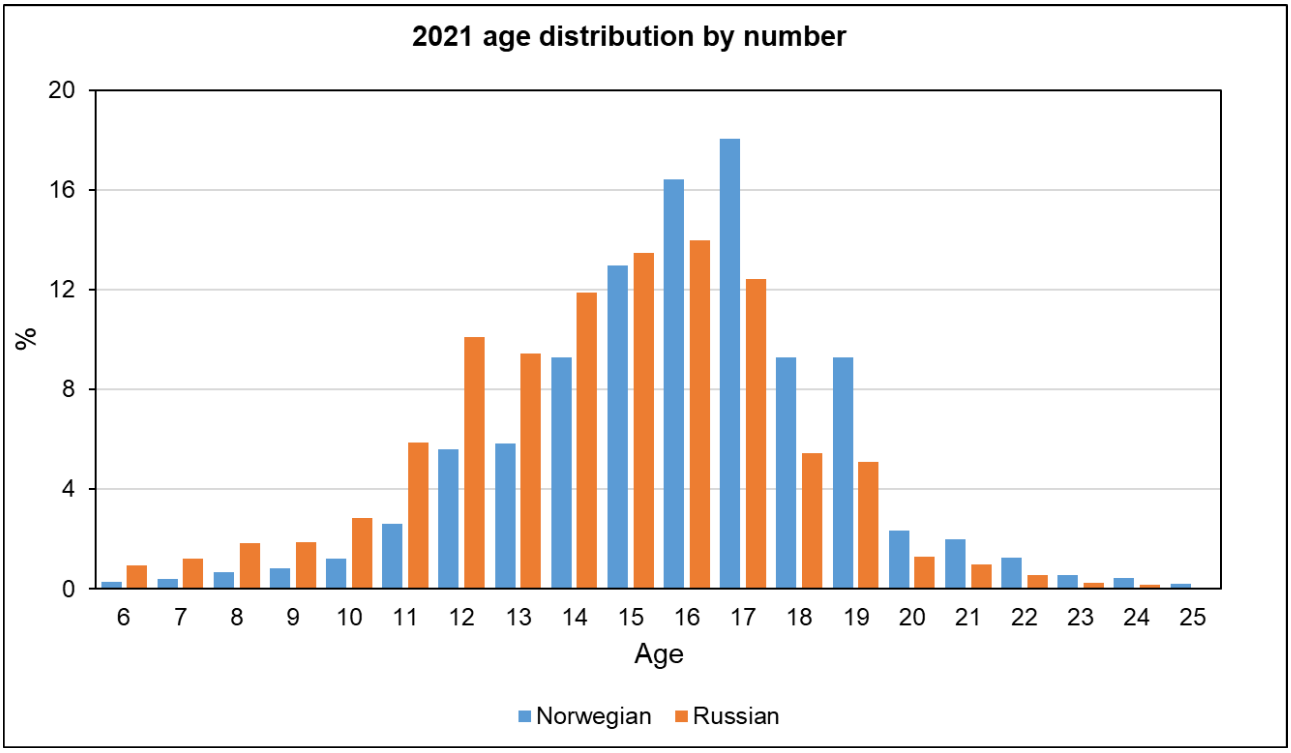


Figure 6.5. S. mentella in subareas 1 and 2. Upper panels: Catch numbers-at-age for the demersal fleets in 1992-2023 and pelagic fleets 1992–2022. Lower panel: Age composition of the commercial demersal catches by Norway and Russia in 2021 (calculated using ALK).

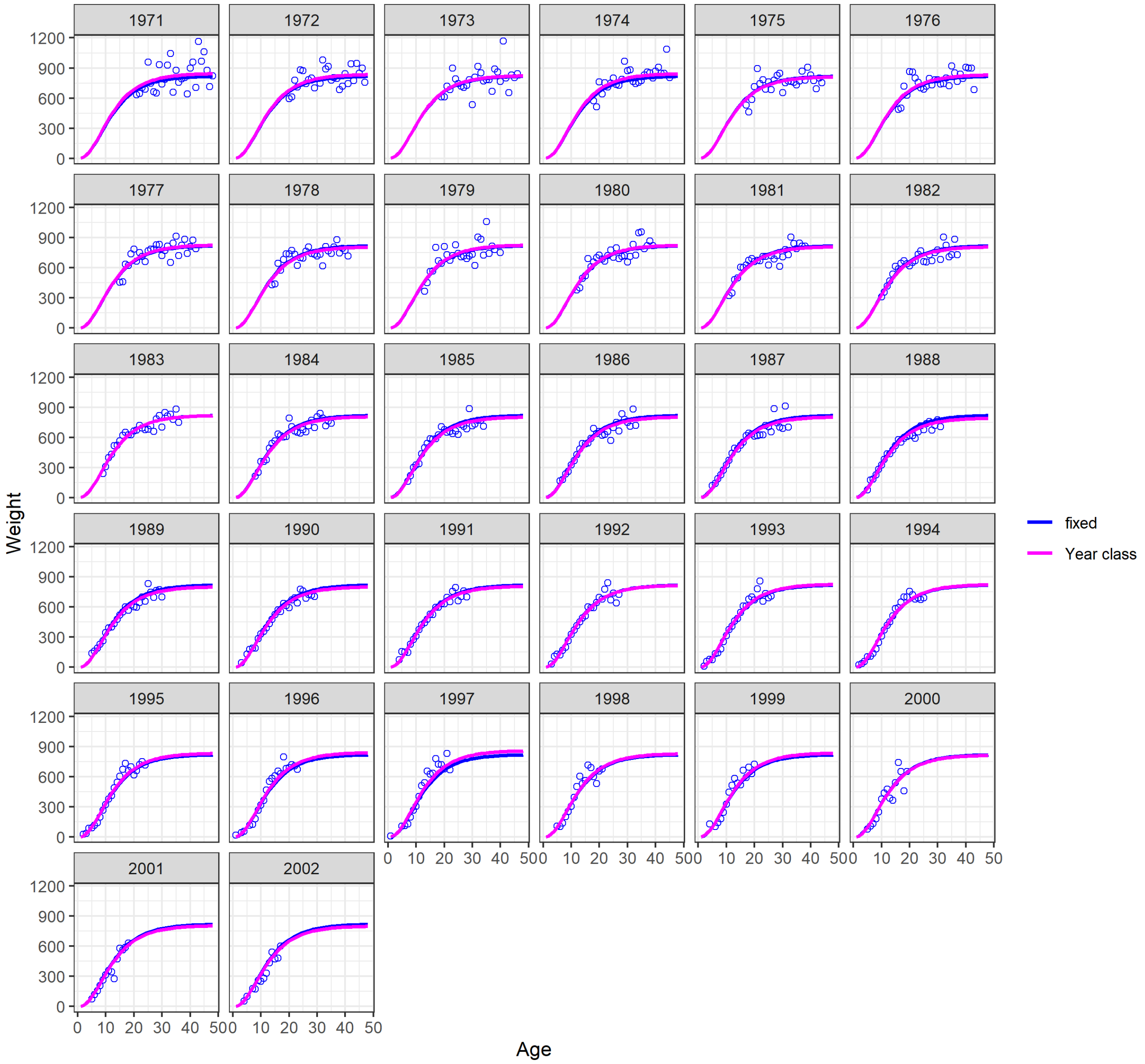


Figure 6.6. Weight-at-age of S. mentella per year class in subareas 1 and 2 derived from Norwegian commercial and survey data (Table 6.7). The weights were derived from samples with at least five individuals and are expressed in grammes. The blue and purple lines show the fitted mixed-effect models.

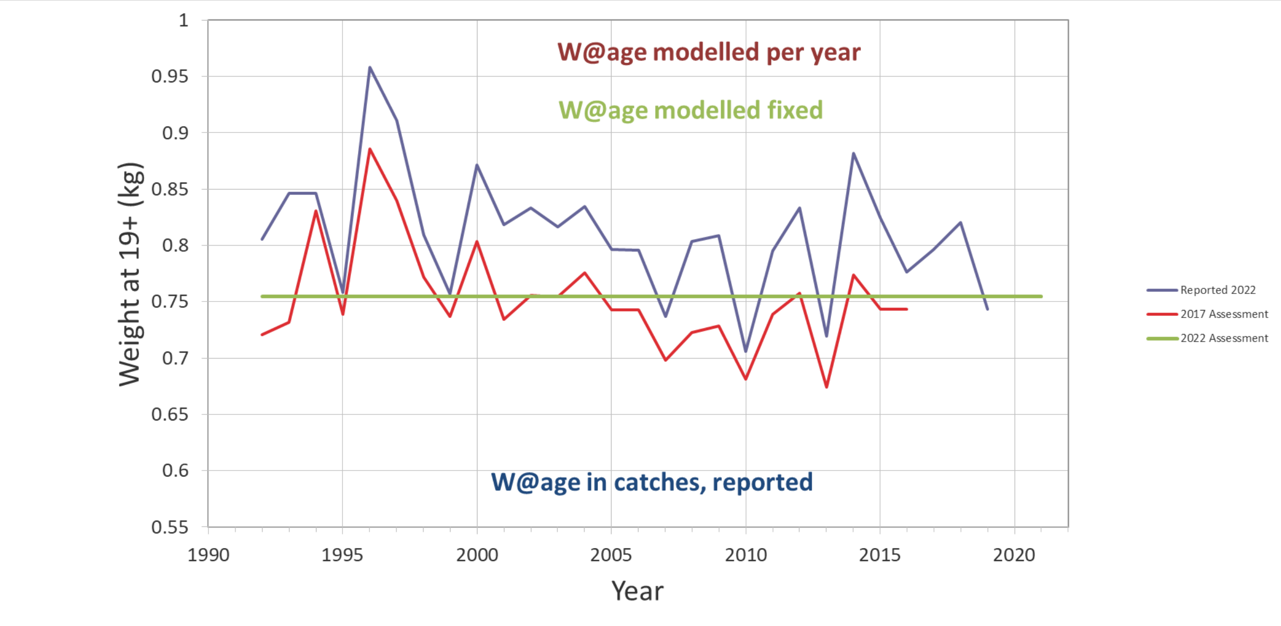


Figure 6.7

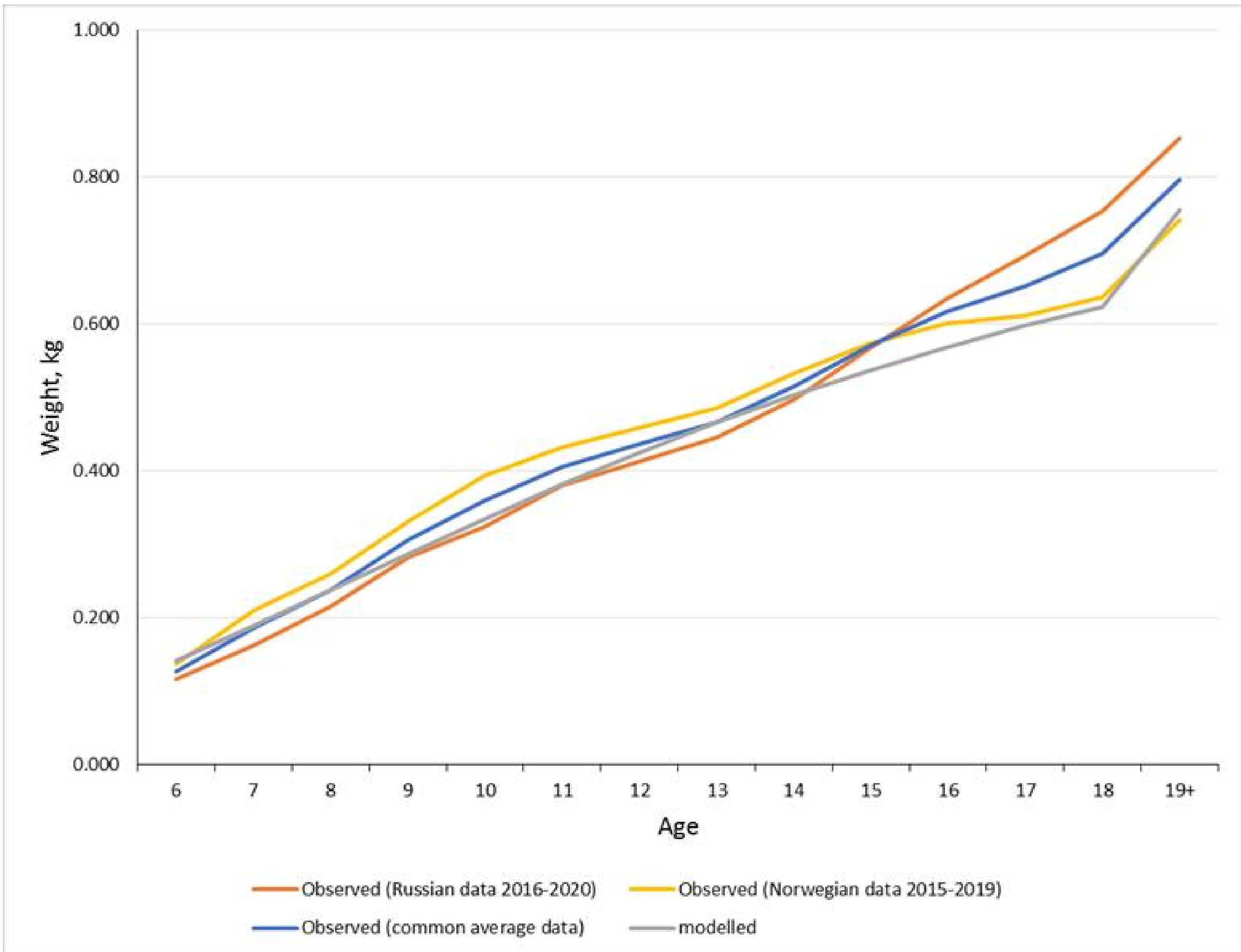


Figure 6.7. S. mentella in subareas 1 and 2. The upper panel shows weight-at-age 19+ as reported from catches (blue) or modelled from catches and survey observations (red) using a mixed effect model (Figure 6.5). AFWG 2017 was the last working group using the annual mixed effect model. The weights-at-age 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.

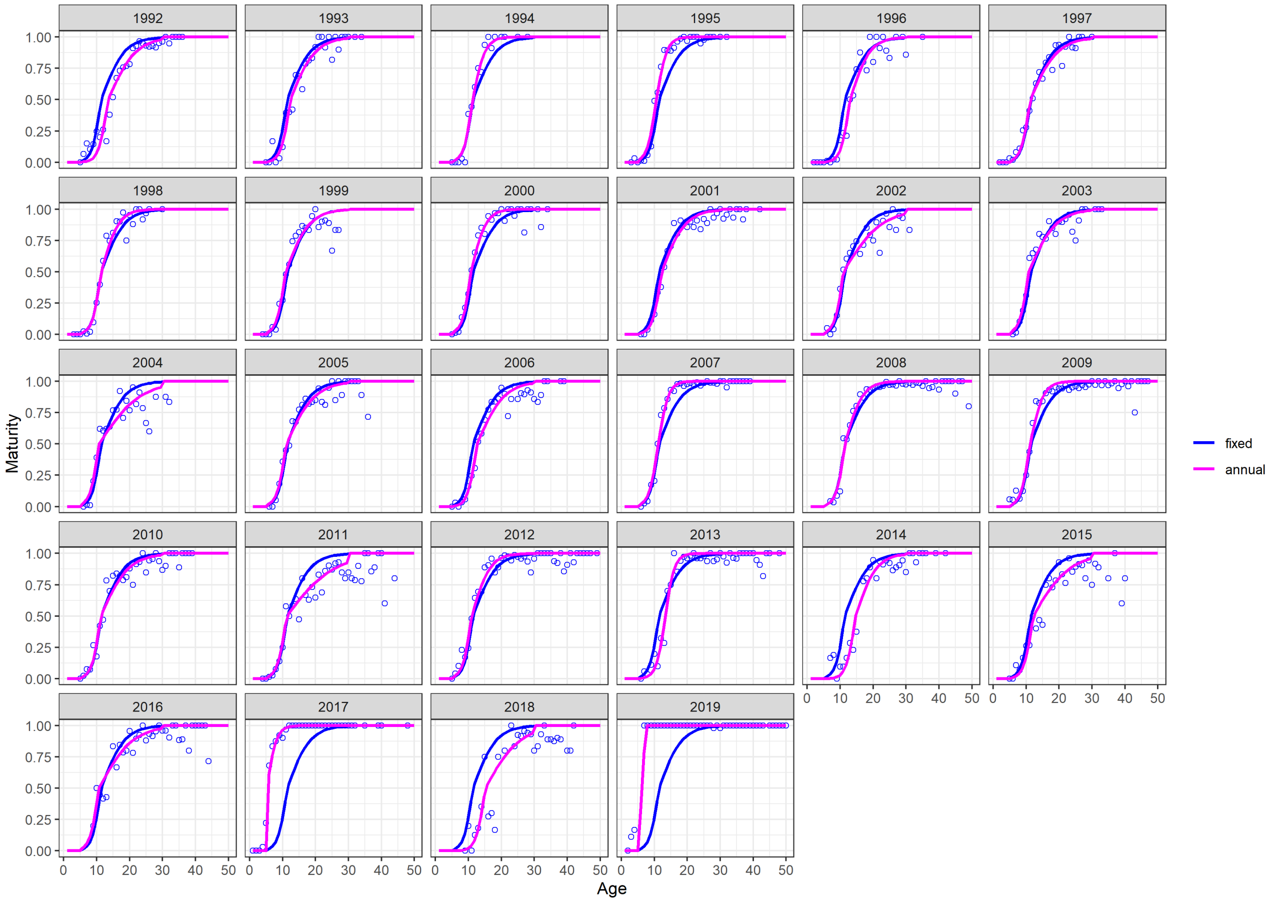


Figure 6.8. Proportion maturity-at-age of S. mentella in subareas 1 and 2 derived from Norwegian commercial and survey data (Table D7). The proportions were derived from samples with at least five individuals. The blue and purple lines show the fitted mixed-effect models. For 2008, 2011 and 2016–2019 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 2020-2023.

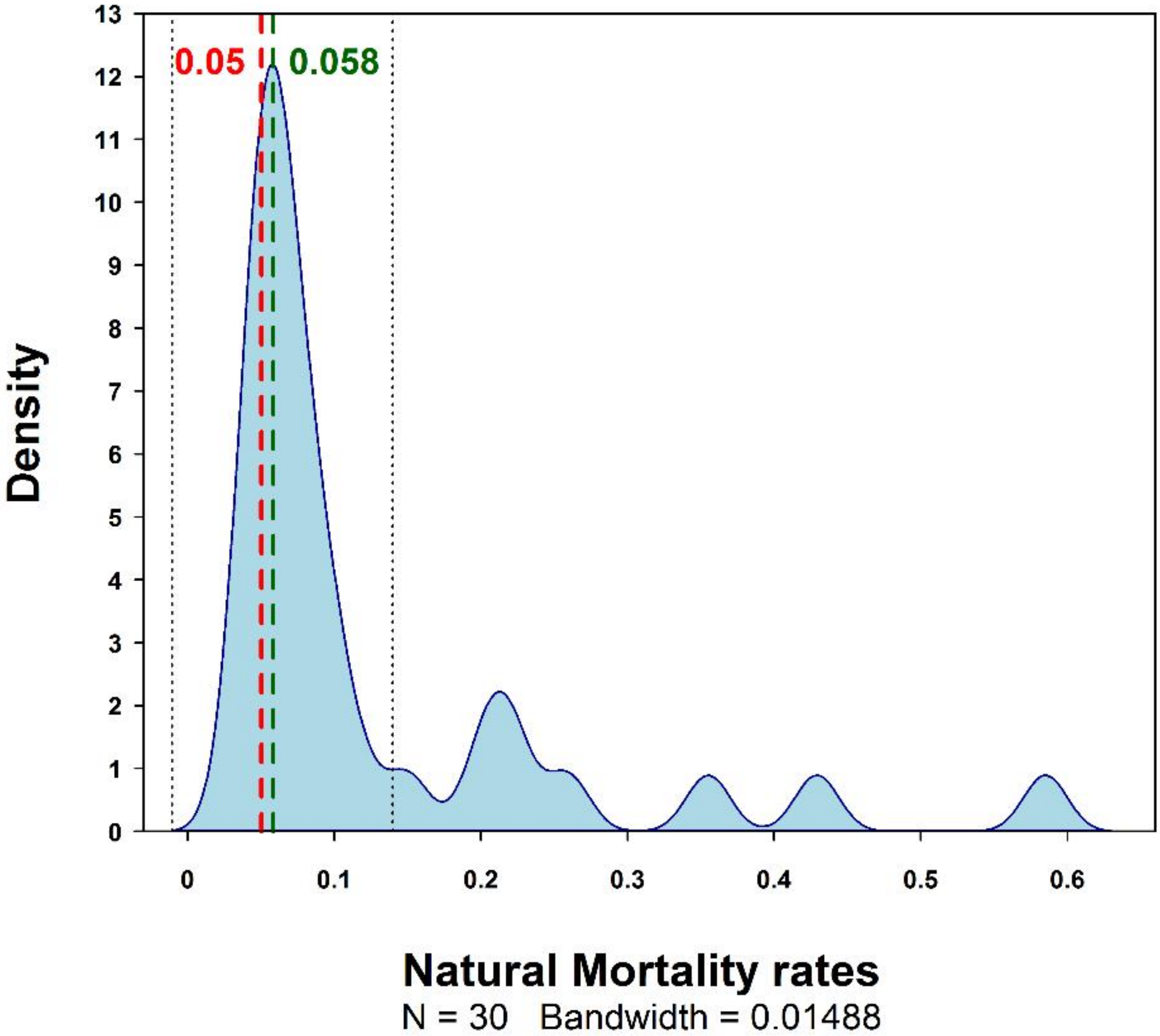


Figure 6.9. Density distribution of natural mortality rates calculated with 30 of the 39 compared methods. The excluded methods are those based on certain taxa or areas. The broken red line indicates the currently used value; the broken green line the most frequent one and the black dotted lines indicate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

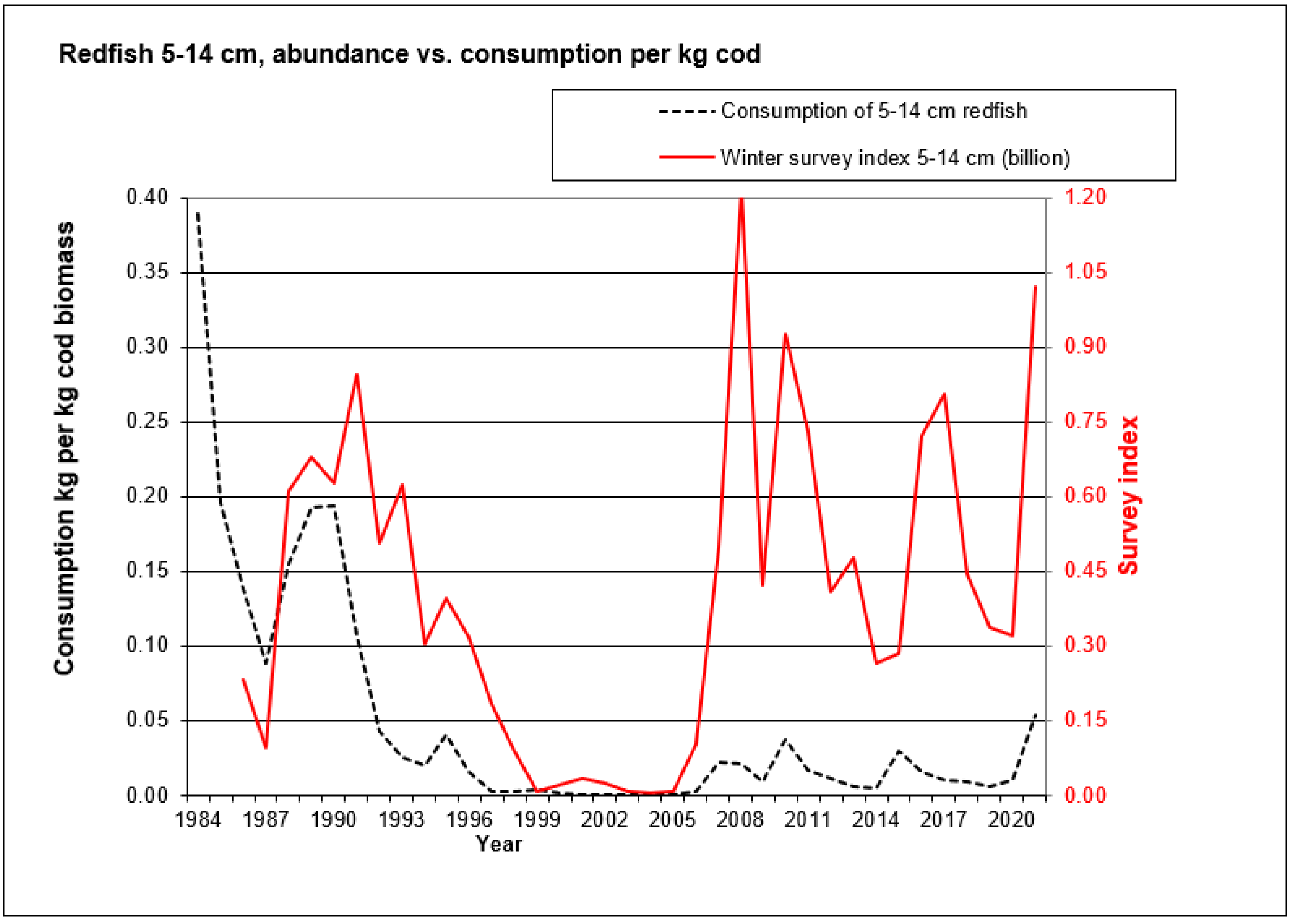


Figure 6.10. Abundance of S. mentella (5–14 cm) during the winter survey (February) in the Barents Sea compared with the consumption of redfish (mainly S. mentella) by cod (See Section 1 Table 1.1).

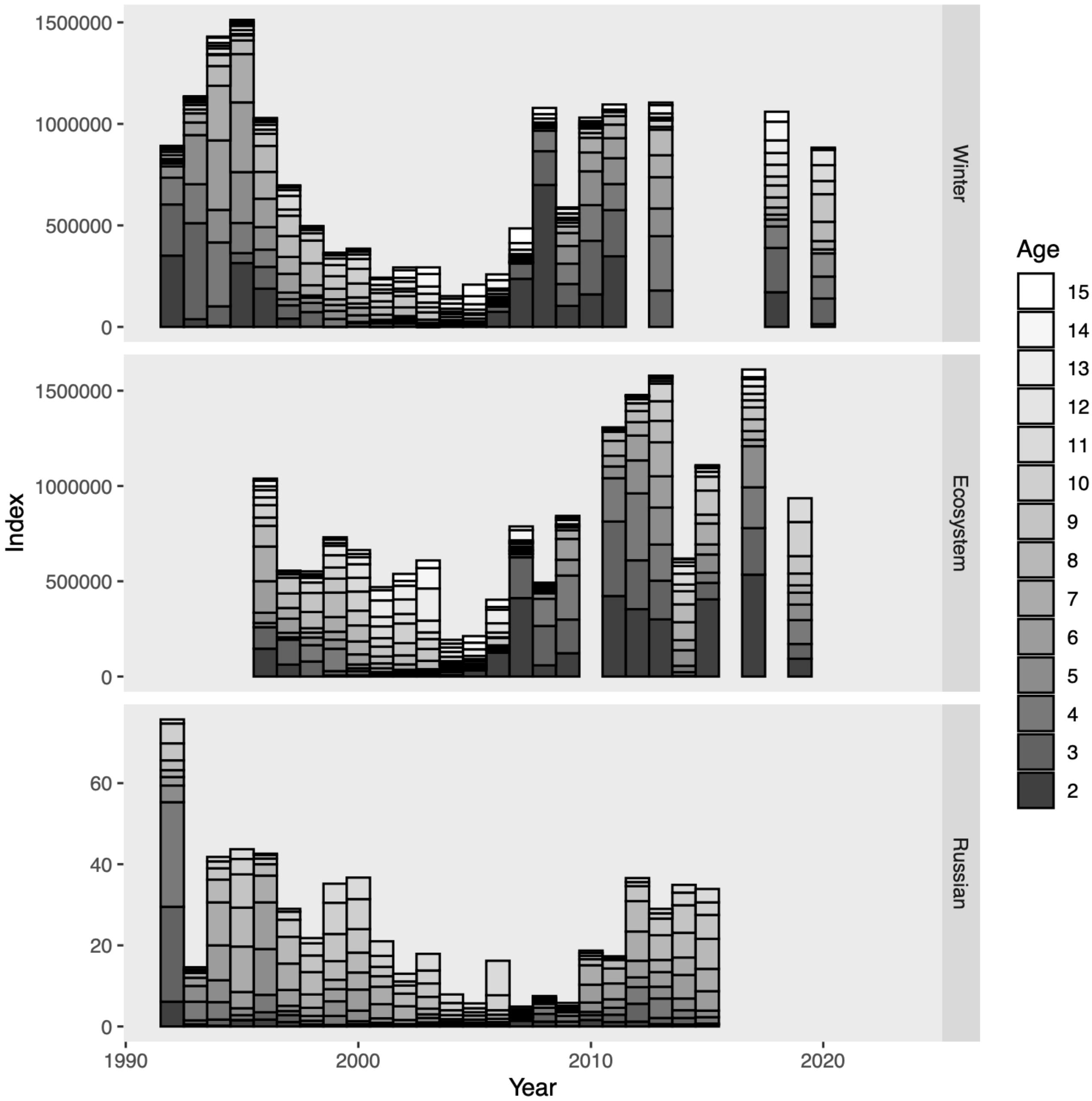


Figure 6.11. S. mentella in subareas 1 and 2. Age disaggregated abundance indices for bottom-trawl surveys 1992–2023 in the Barents Sea in winter (winter survey top) in summer (Ecosystem survey middle) and in autumn (Russian groundfish survey bottom).

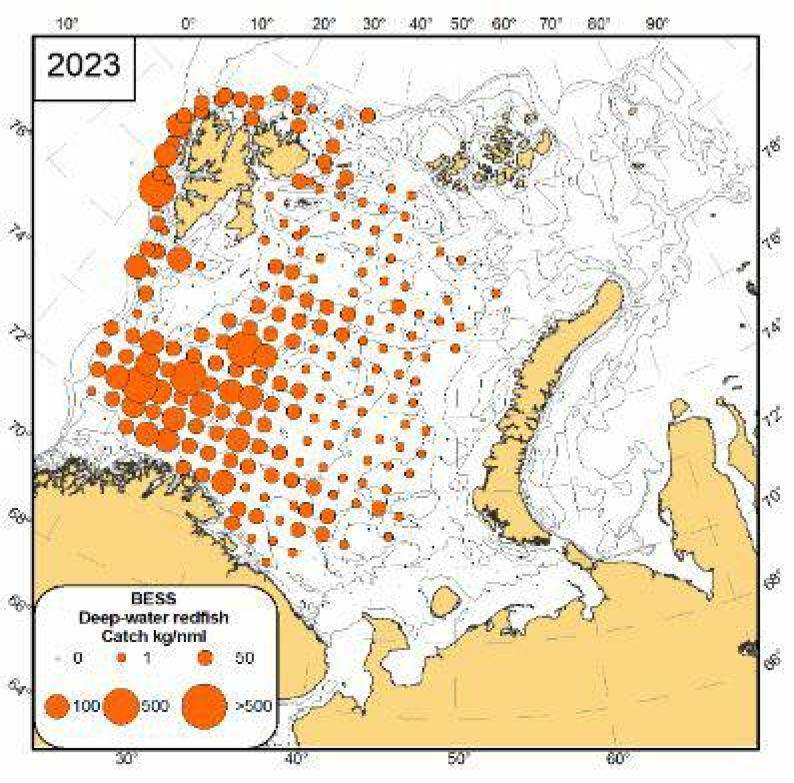
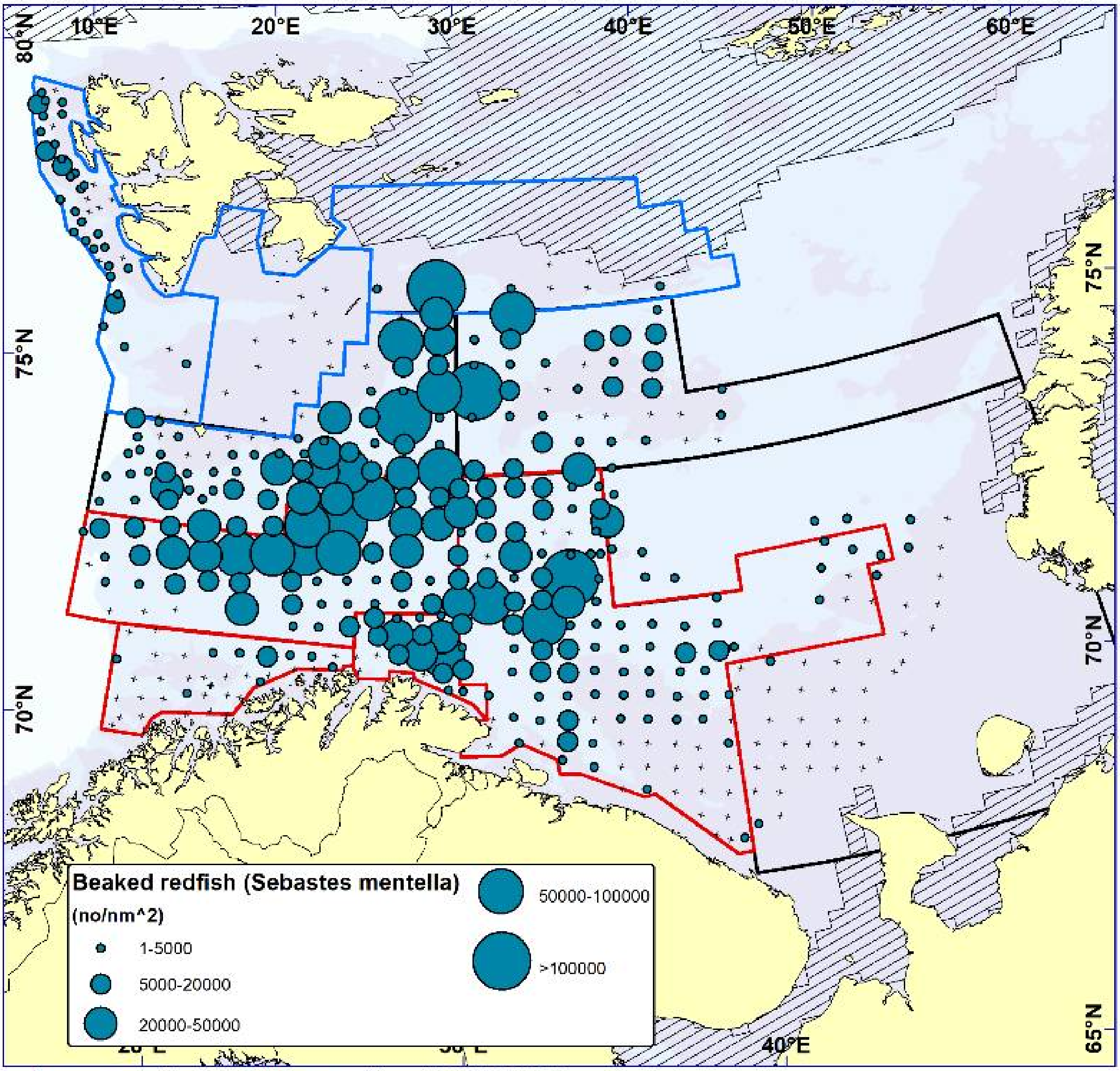


Figure 12.



Ice coverage - https://noaadata.apps.nsidc.org/NOAA/G02135/
north/monthly/shapefiles/shp_extent/02_Feb/

Figure 6.12. S. mentella in subareas 1 and 2. Abundance indices for individual trawl stations during the ecosystem survey in autumn 2023 (top) and winter survey 2023 (bottom).

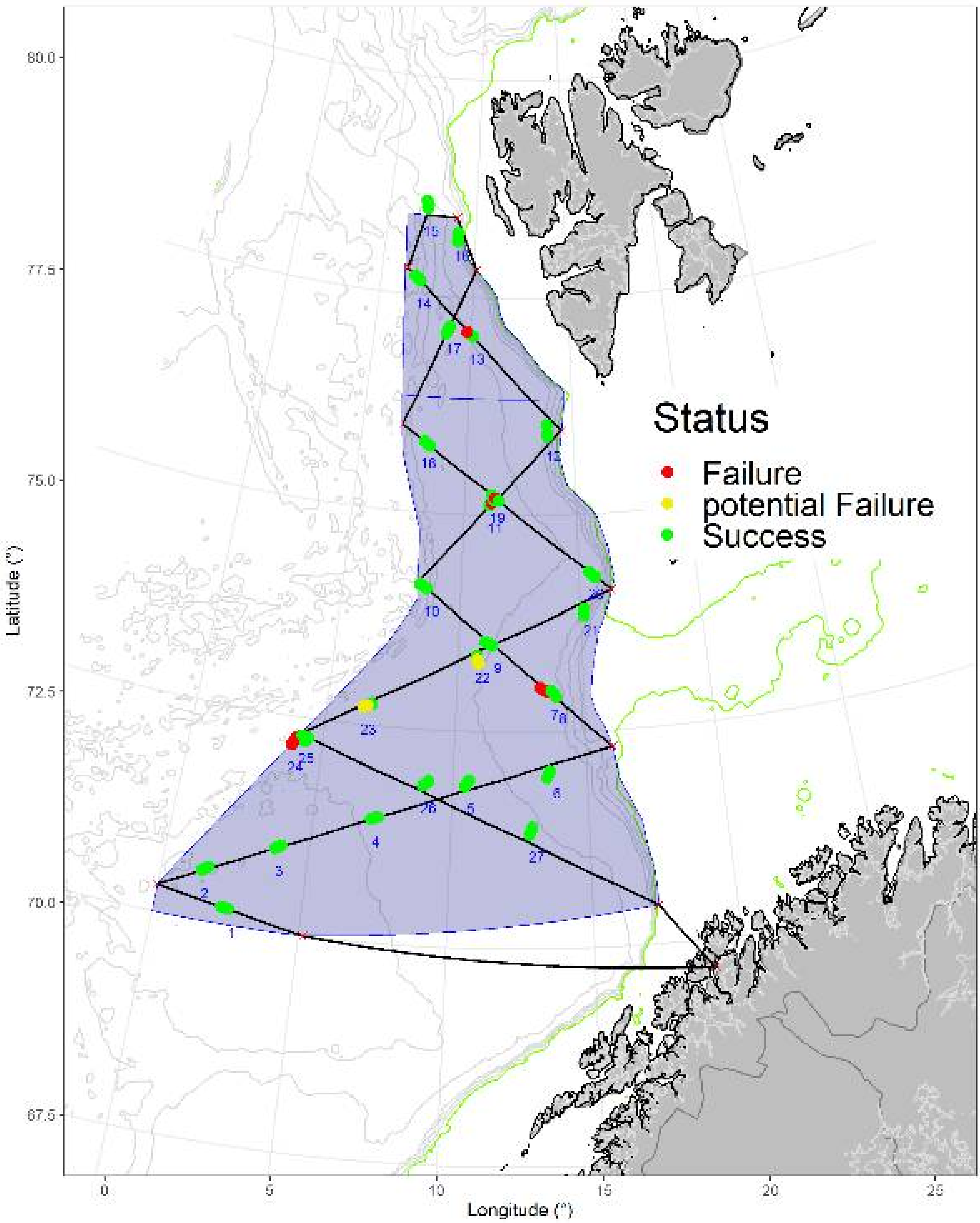

Status
Failure
potential Failure
Success
Latitude (°)
Longitude (°)
80.0
77.5
75.0
72.5
70.0
67.5
0
5
10
15
20
25

Figure 6.13.

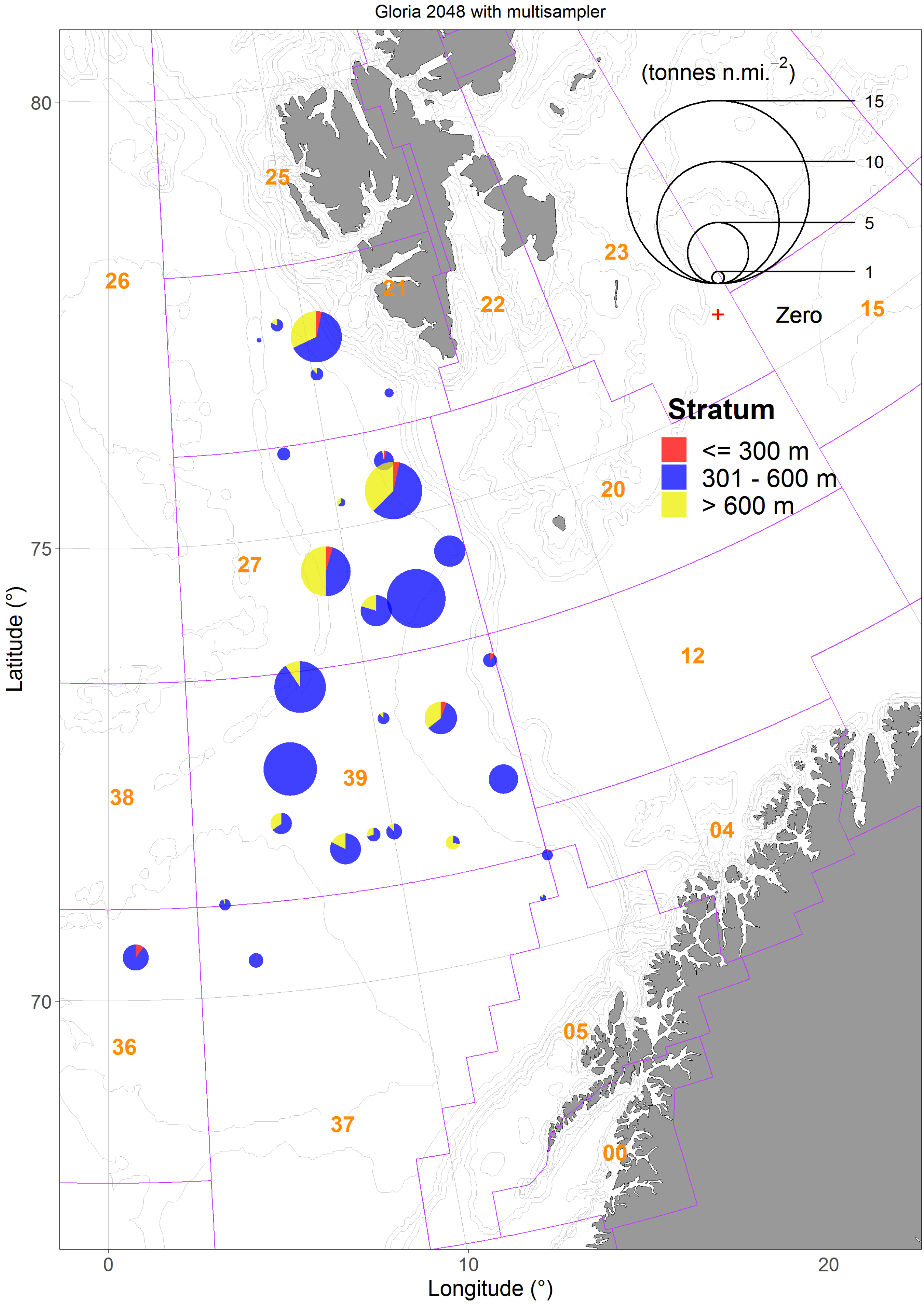


Figure 6.13. S. mentella in subareas 1 and 2. Left panel: Survey track of the Deep Pelagic Ecosystem Survey in 2022 and categorized trawls. Potential failures need further examination to determine their usability, whilst successful trawls can be used for the survey index without further consideration. 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 are not available.

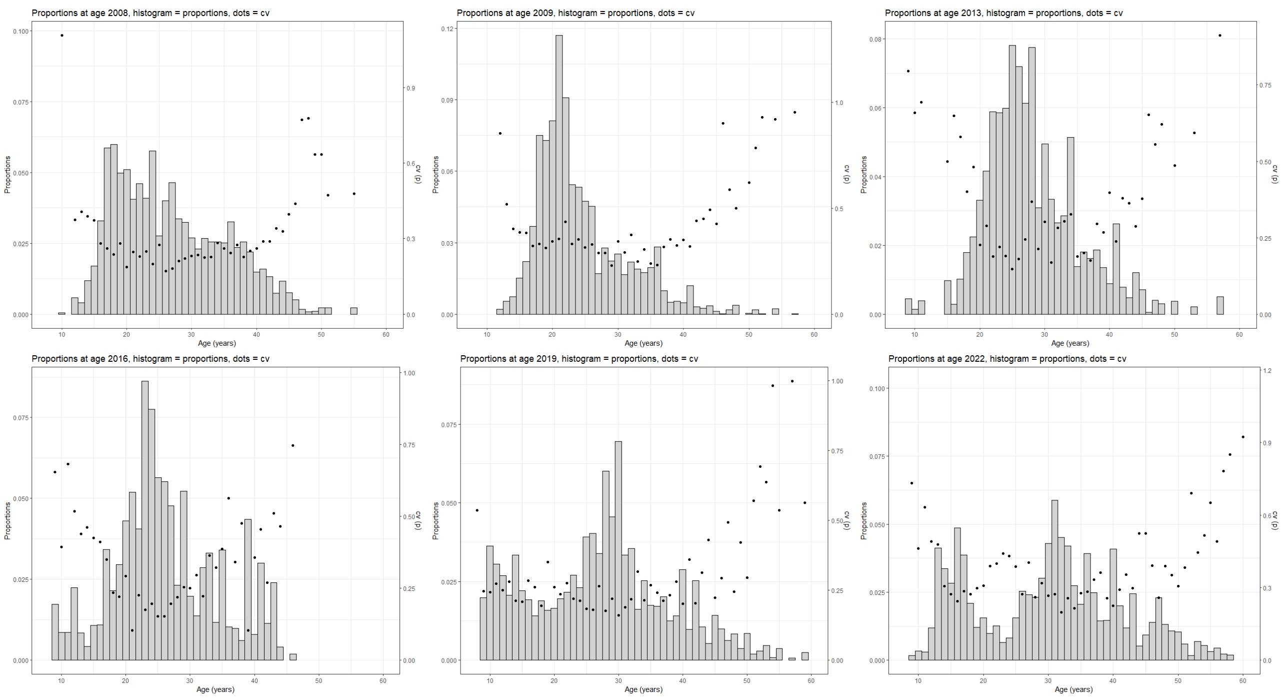


Figure 6.14. S. mentella in subareas 1 and 2. Proportions at age during the International Deep Pelagic Ecosystem Survey (WGIDEEPS) in the Norwegian Sea. Bars show proportions at age and dots shows the coefficient of variation for each age. Estimated with RStoX.

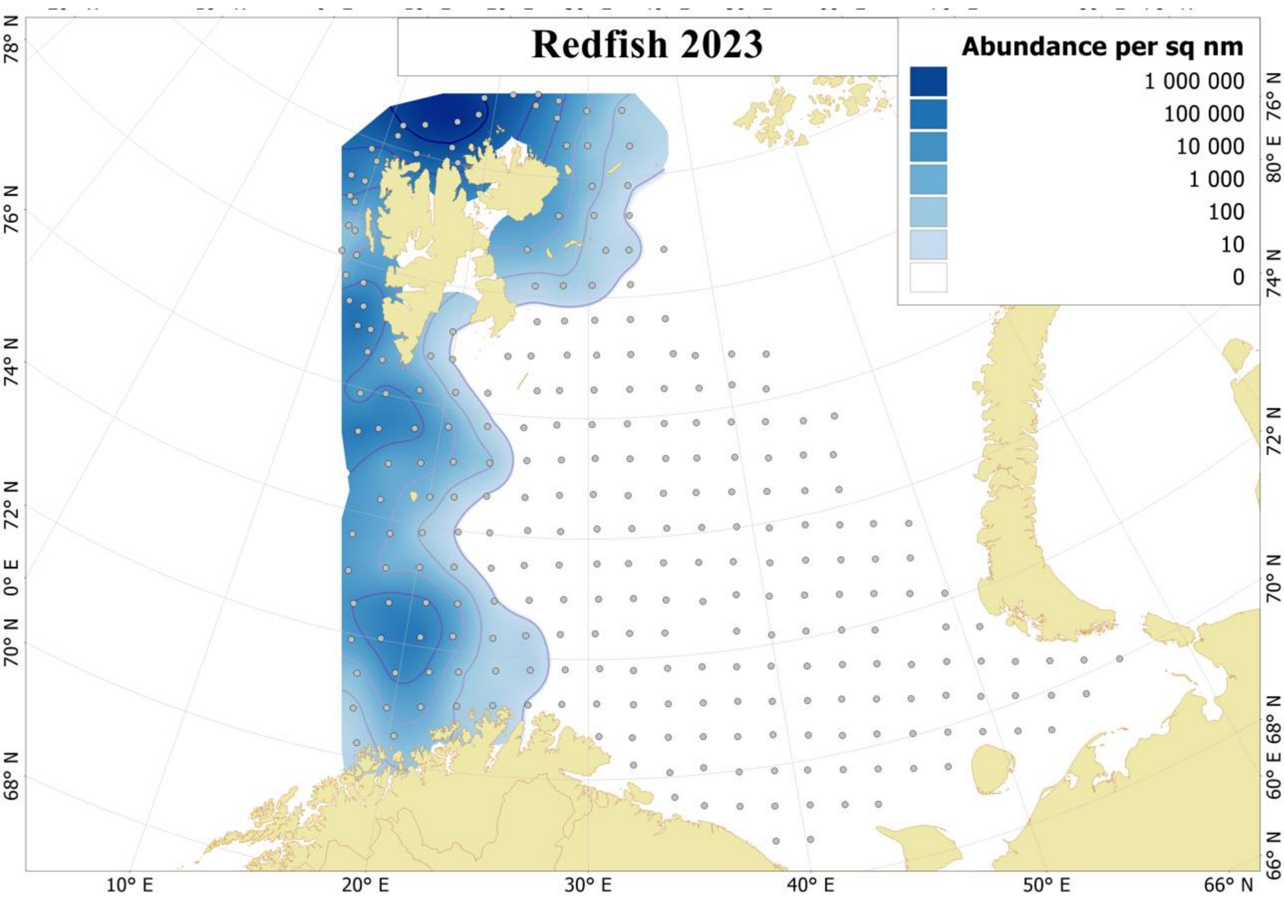


Figure 6.15. Map showing the specific pelagic 0-group trawl stations and the abundance of 0-group S. mentella during the joint Norwegian-Russian Ecosystem survey in the Barents Sea and Svalbard in 2023.

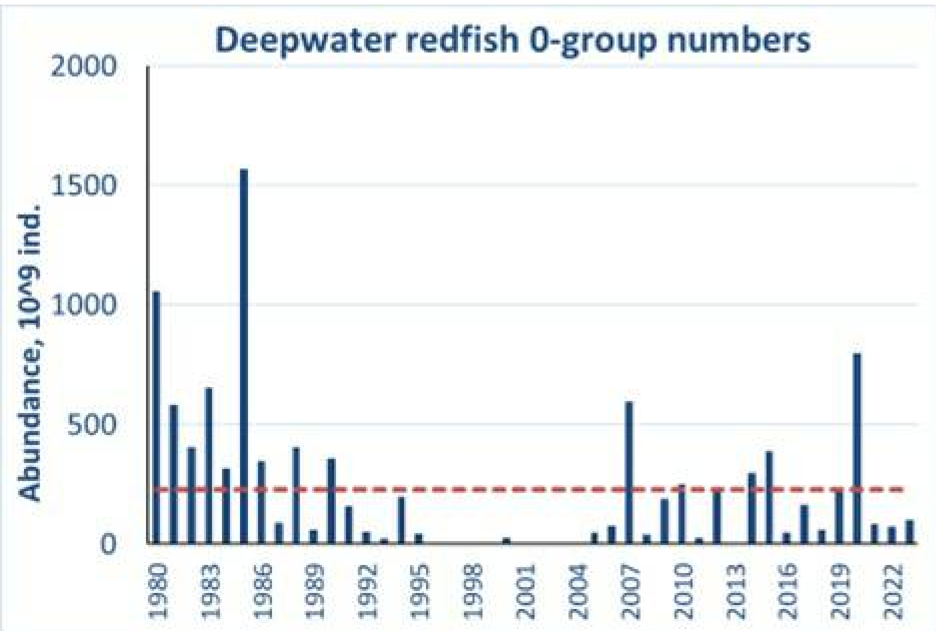


Figure 6.16. S. mentella in subareas 1 and 2. Abundance indices (in billions) of 0-group redfish (believed to be mostly S. mentella) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980–2023.

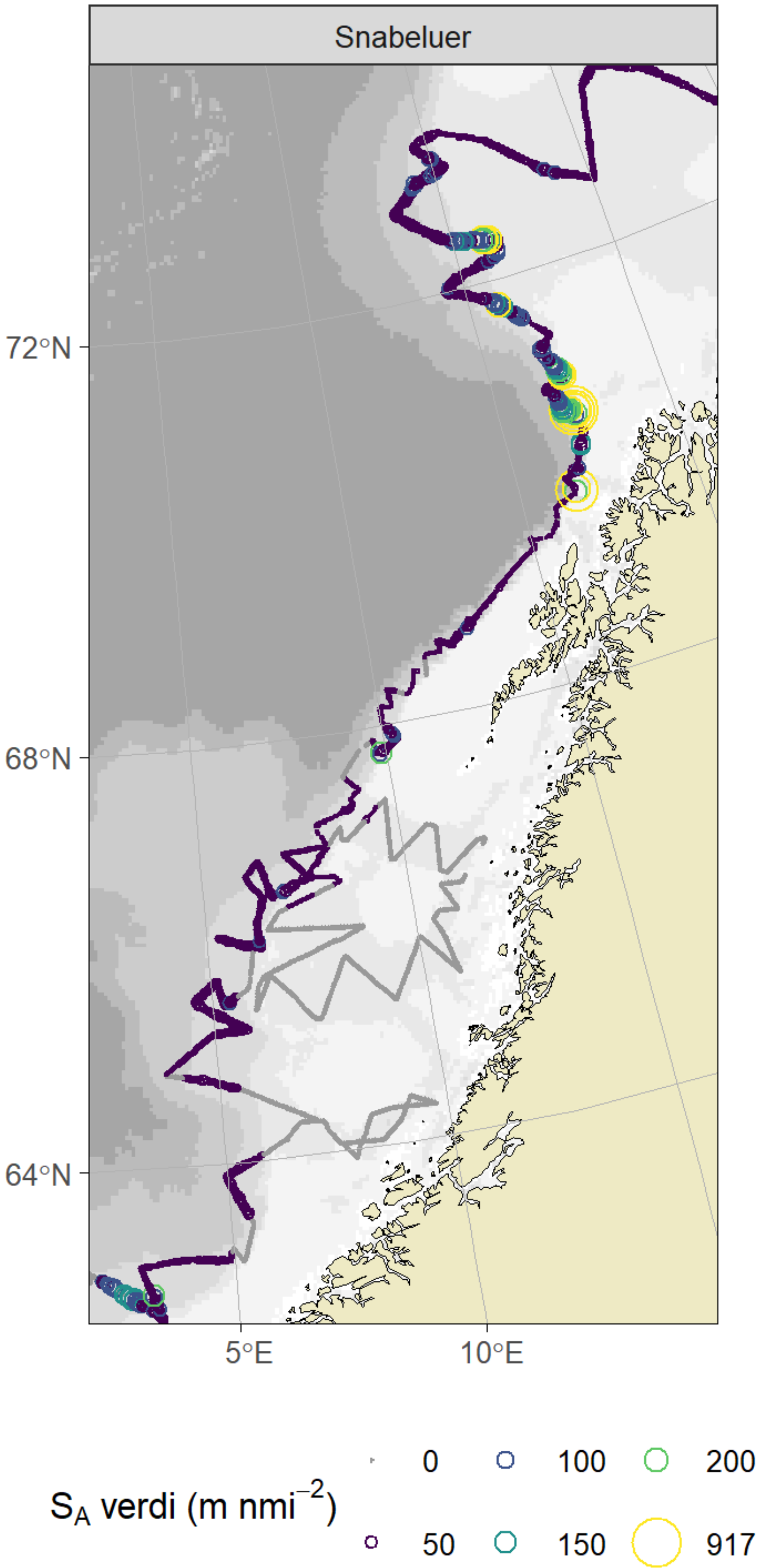
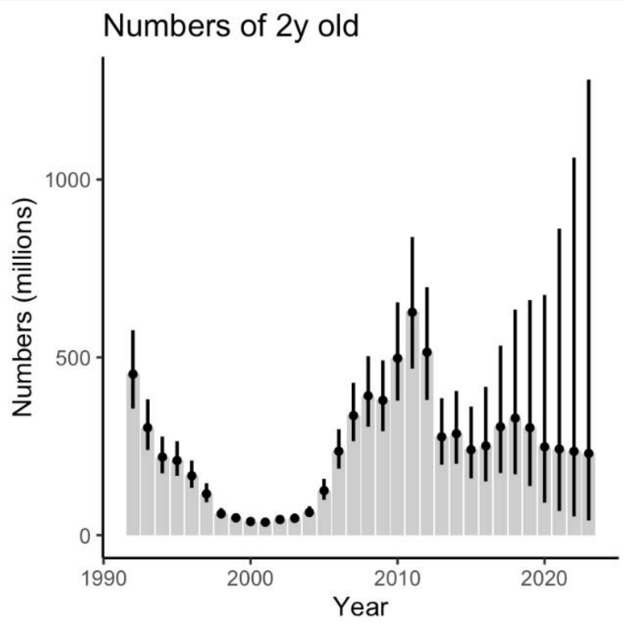
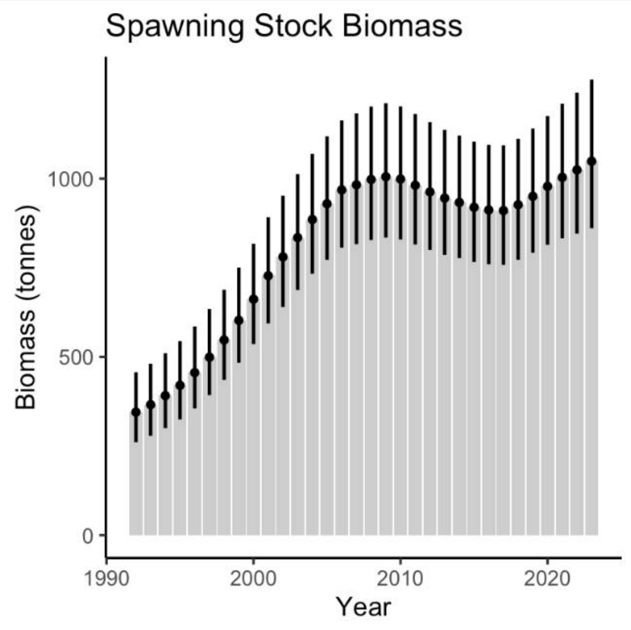


Figure 6.17. S. mentella in subareas 1 and 2. Horizontal distribution of S. mentella hydroacoustic backscattering (sA) during the Norwegian slope survey in spring 2024. The circles are proportional to the sA assigned to redfish along the vessel track.

Recruitment-at-age 2	**Spawning-stock biomass**
	
Fishing mortality – year component	

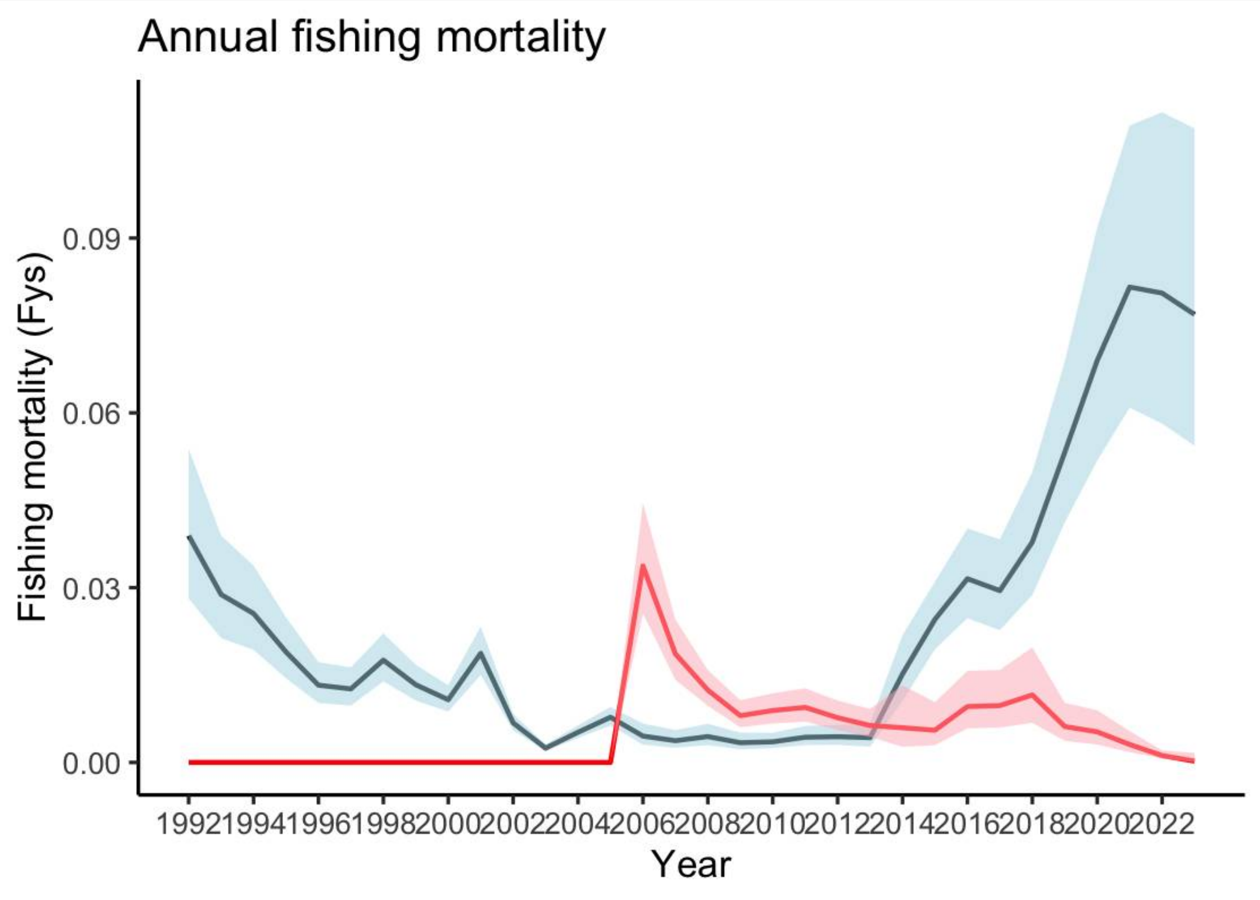


Figure 6.18. S. mentella in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the estimated recruitment-at-age 2 spawning-stock biomass from 1992 to 2023 and annual fishing mortality coefficients by year (Fy) from the demersal (blue) and pelagic (red) fleets. Error bars (top) and the colored envelope (bottom) indicate 95% confidence limits.

Fleet selectivity – age component

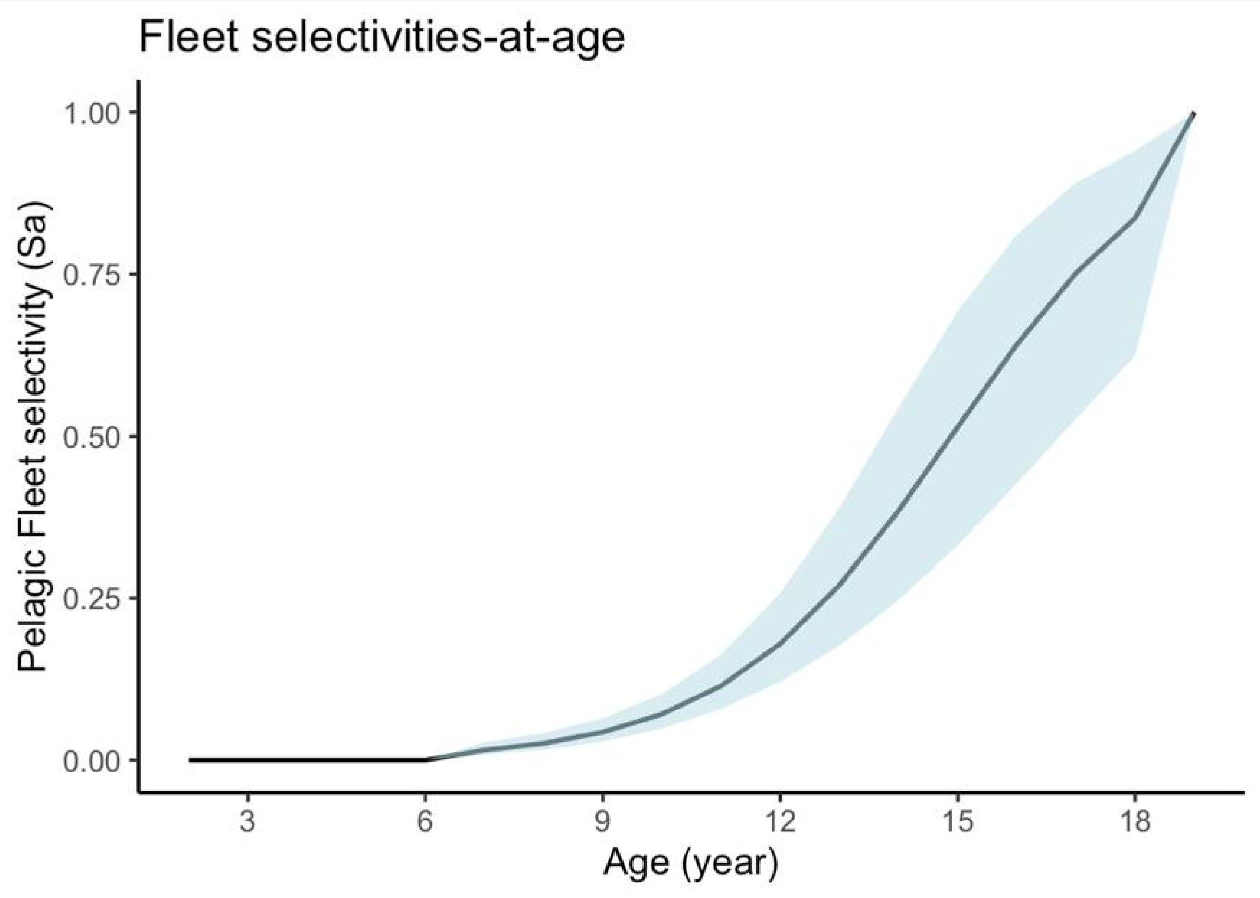

Fleet selectivities-at-age
Pelagic Fleet selectivity (Sa)
1.00
0.75
0.50
0.25
0.00
3
6
9
12
15
18
Age (year)

Figure 6.19

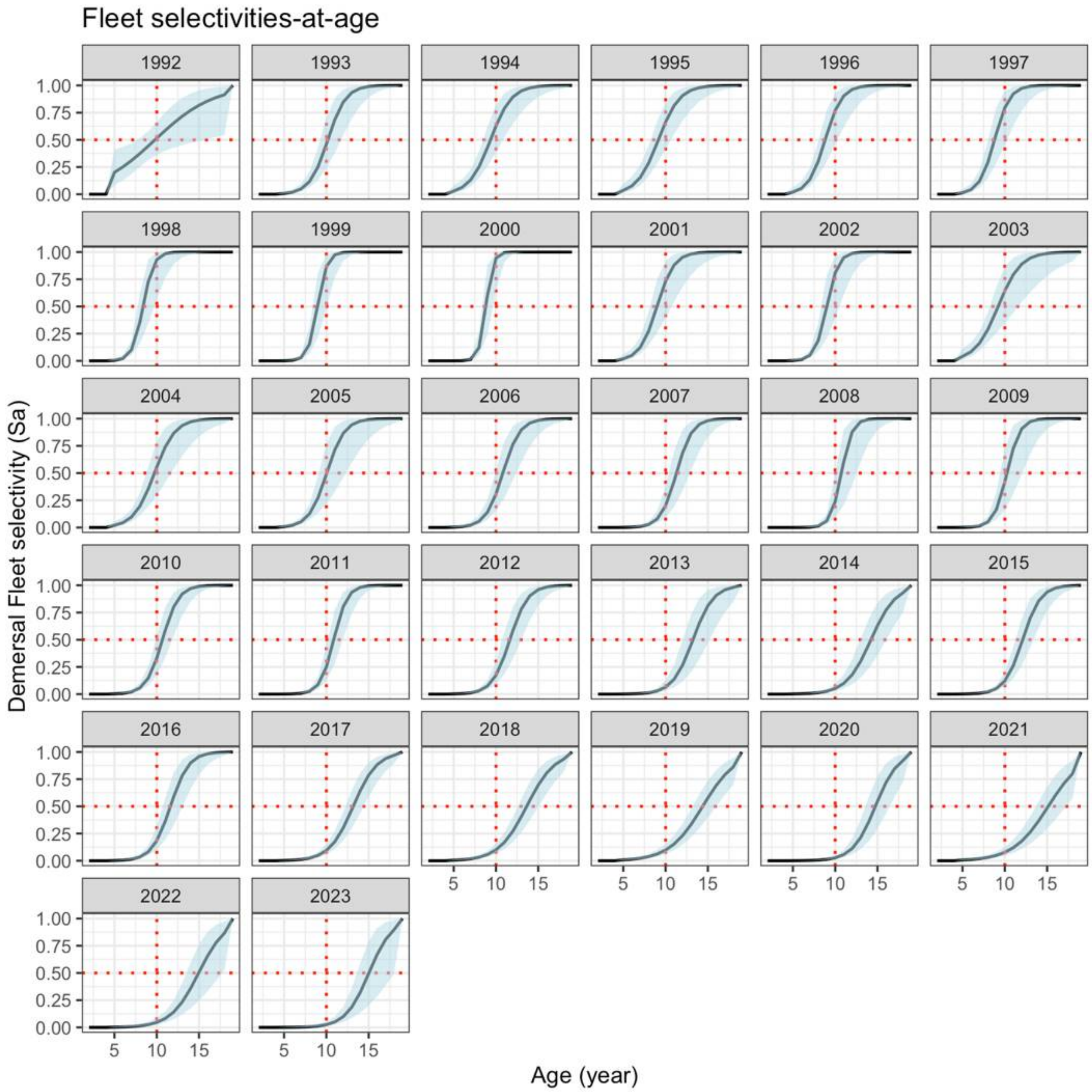


Figure 6.19. S. mentella in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the estimated annual fleet selectivity by age (Fa) from the pelagic (top panel) and demersal (lower panels) fleets. Colored envelopes indicate 95% confidence limits.

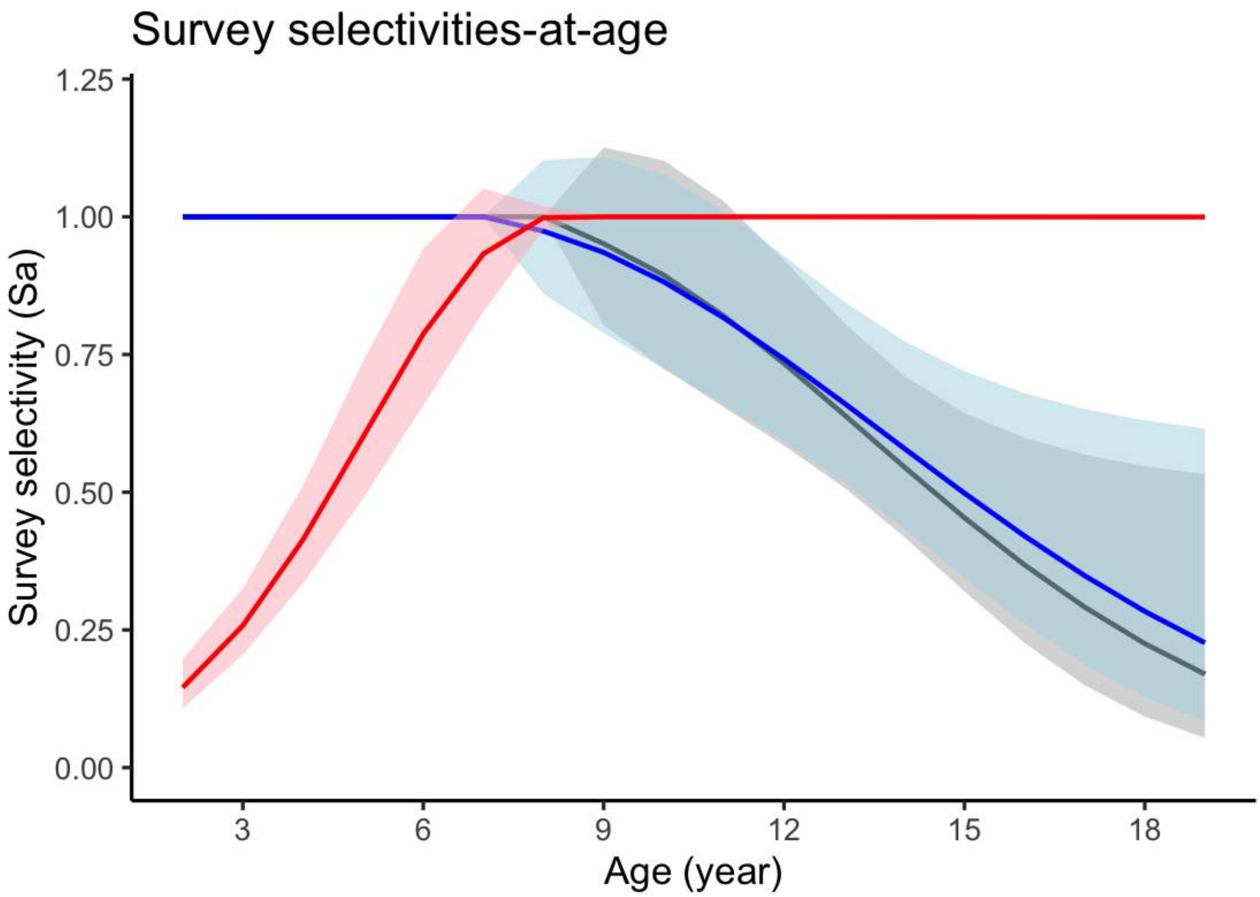


Figure 6.20. S. mentella in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the selectivity-at-age for winter (blue) ecosystem (grey) and Russian groundfish (red) surveys.

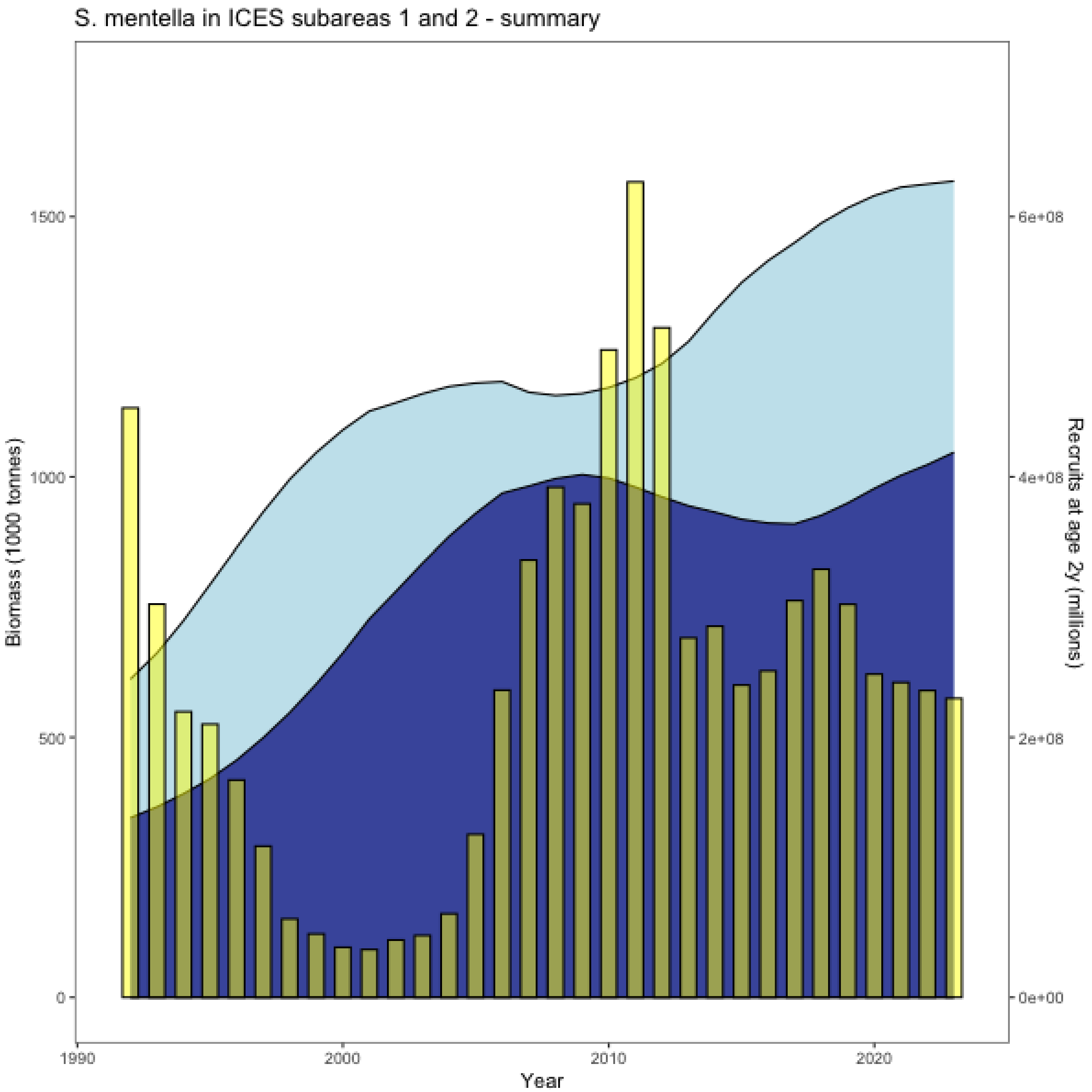


Figure 6.21. S. mentella in subareas 1 and 2. Results from the statistical catch-at-age model showing the evolution of total biomass (in tonnes light blue left axis) spawning-stock-biomass (in tonnes dark blue, left axis) and recruitment-at-age 2 (in numbers yellow, right axis) for the period 1992–2023 for S. mentella in subareas 1 and 2.

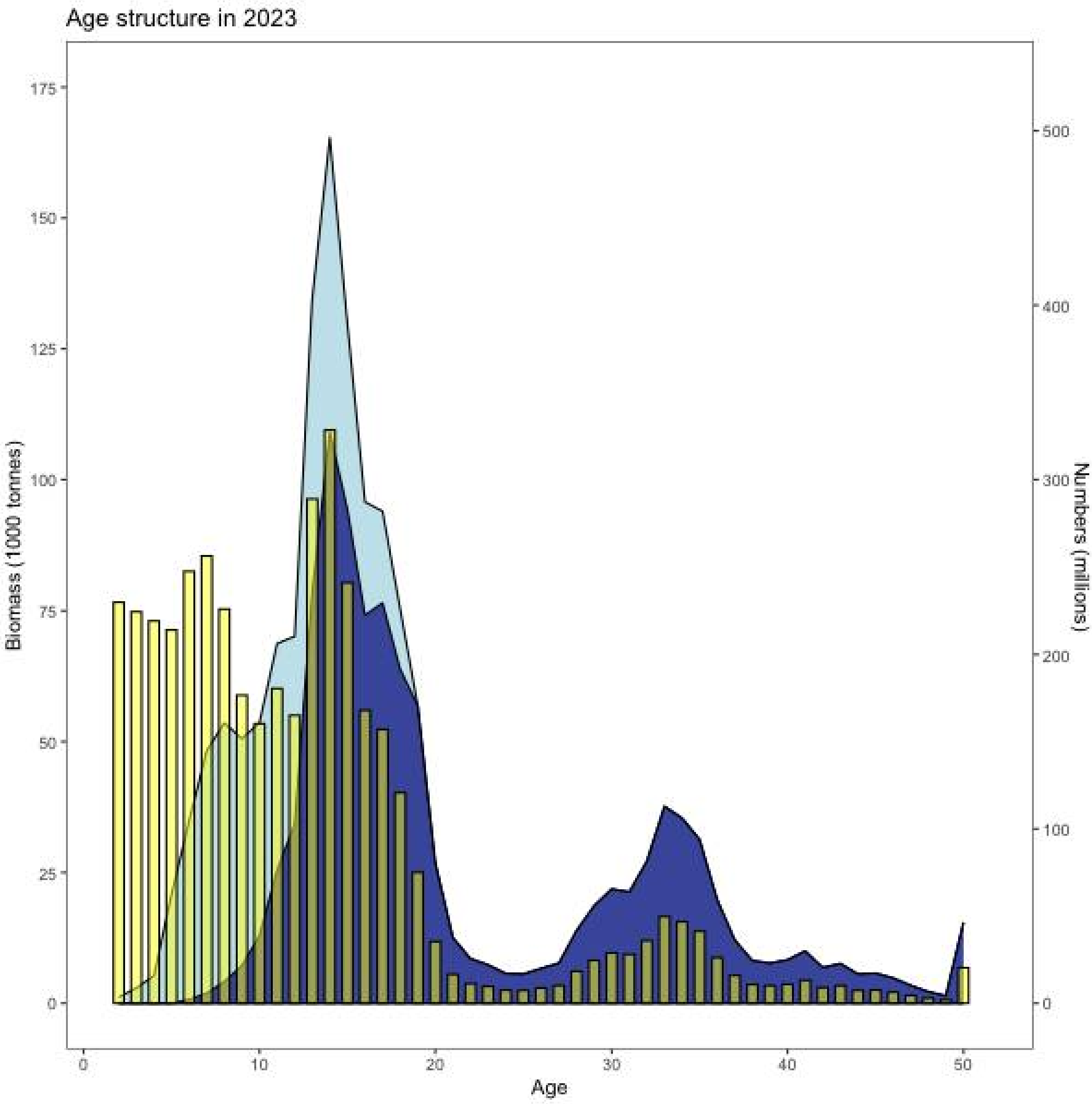


Figure 6.22. S. mentella in subareas 1 and 2. Modelled distribution of numbers (yellow bars right y-axis) biomass (light blue left y-axis) and spawning-stock-biomass (dark blue left y-axis) at age 2–45+ in 2023.

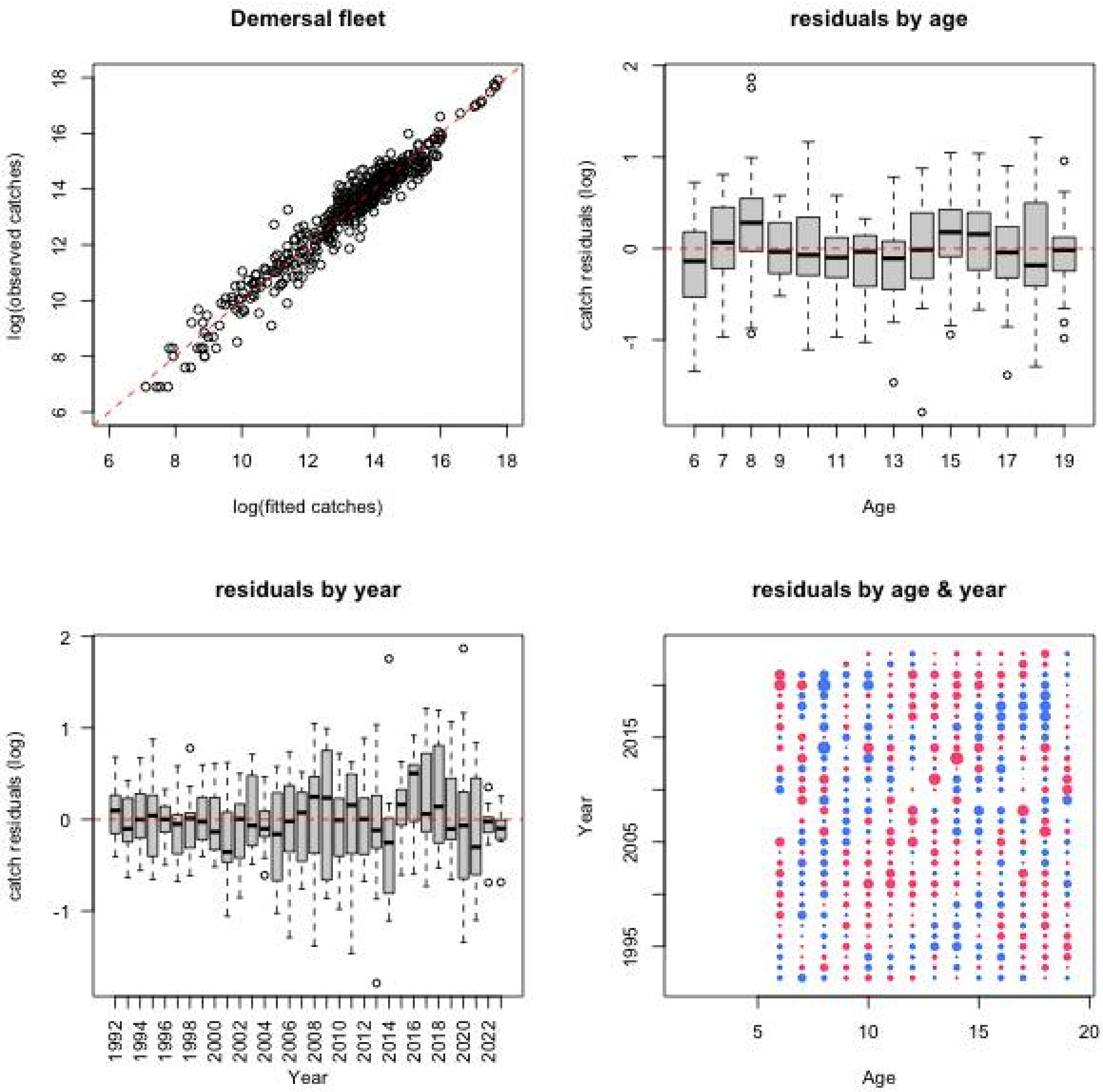


Figure 6.23a. Diagnostic plots for the demersal fleet catch-at-age data. Top-left: scatterplot of observed vs. fitted indices the dotted red line indicates 1:1 relationship. Top right: boxplot of residuals (observed-fitted) for each age. Bottom left: boxplot of residuals for each year. Bottom right: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

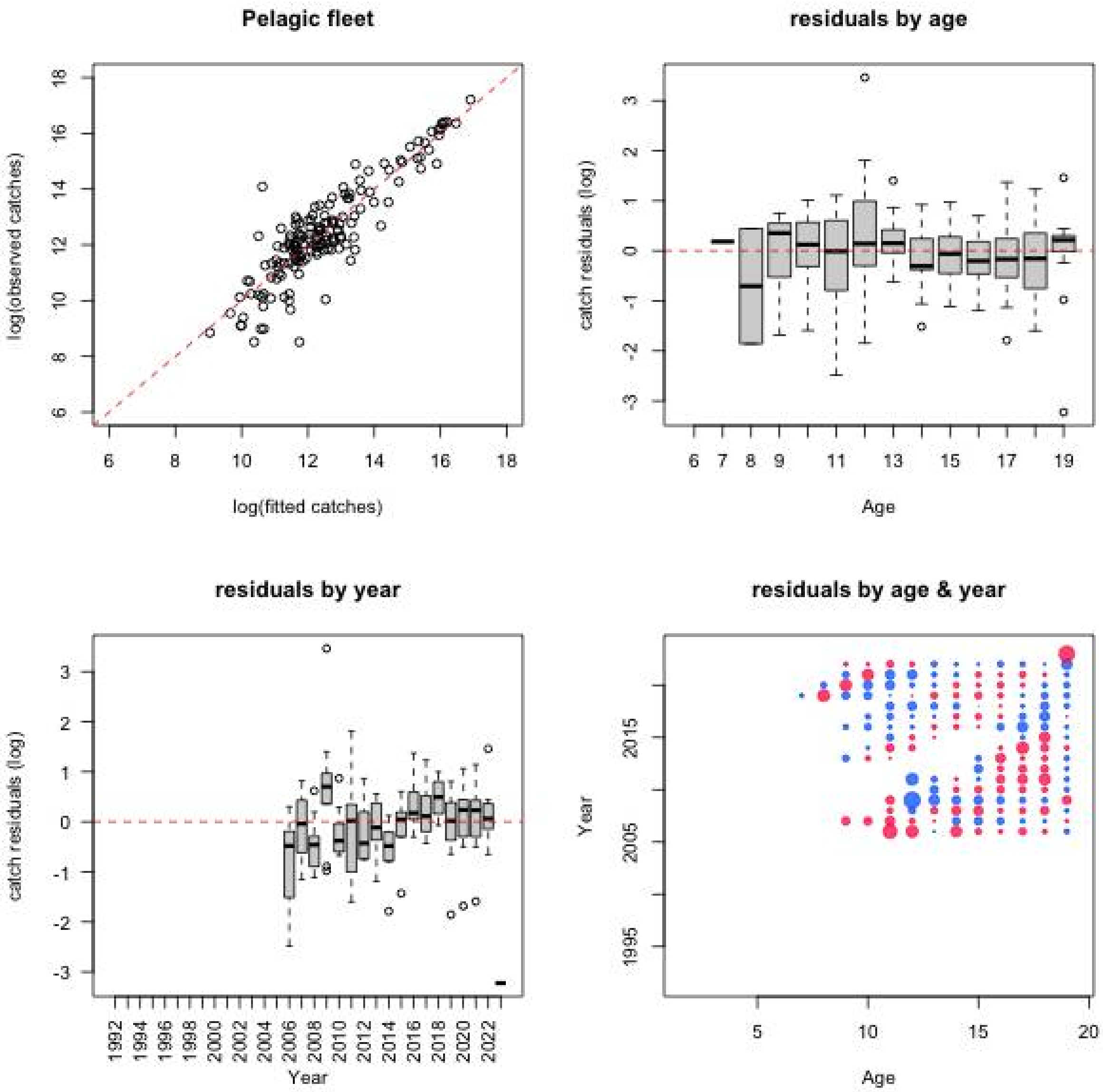


Figure 6.23b. Diagnostic plots for the pelagic fleet catch-at-age data. See legend from Figure 6.23a.

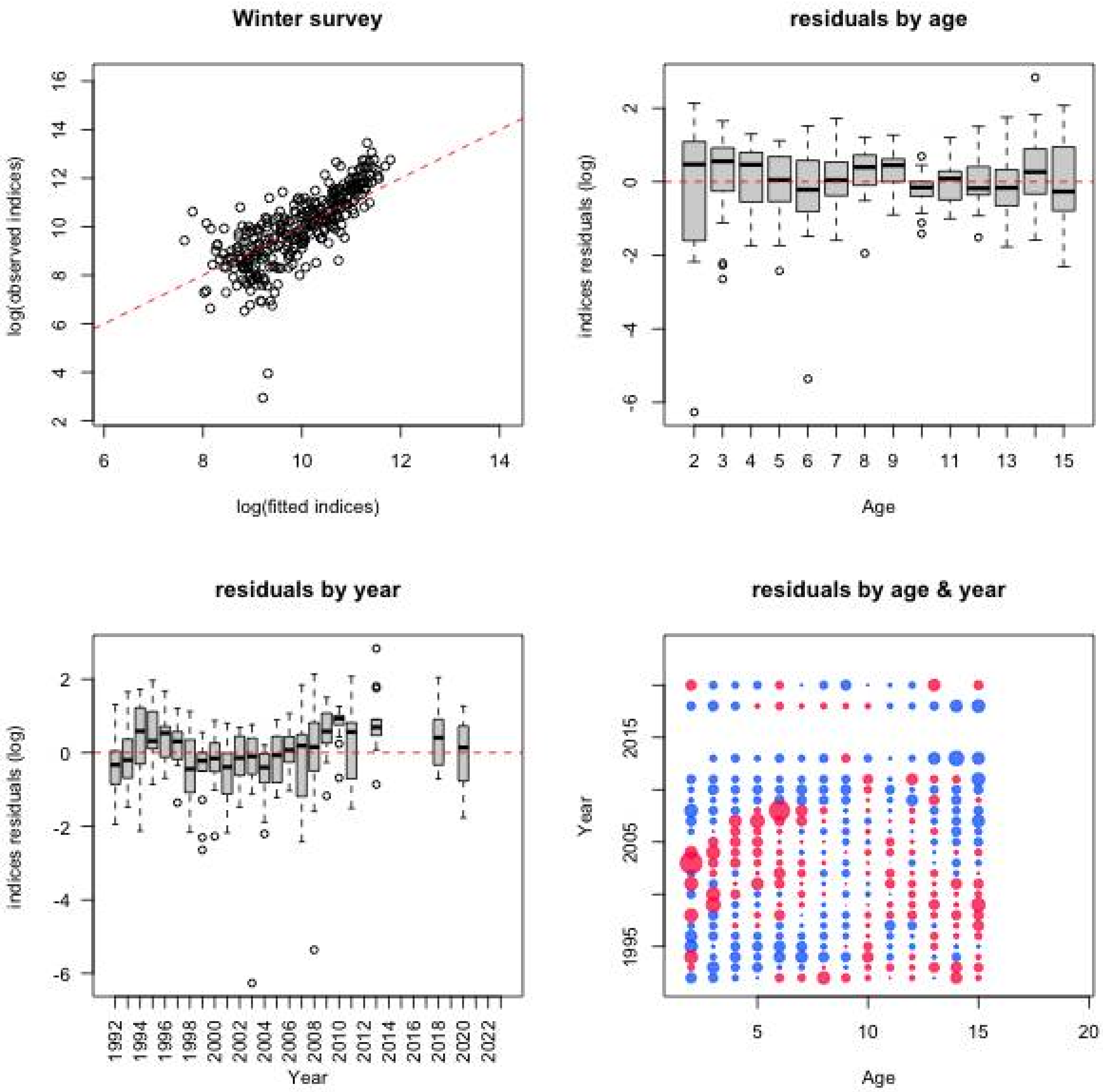


Figure 6.23c. Diagnostic plots for winter survey data. See legend from Figure 6.23a.

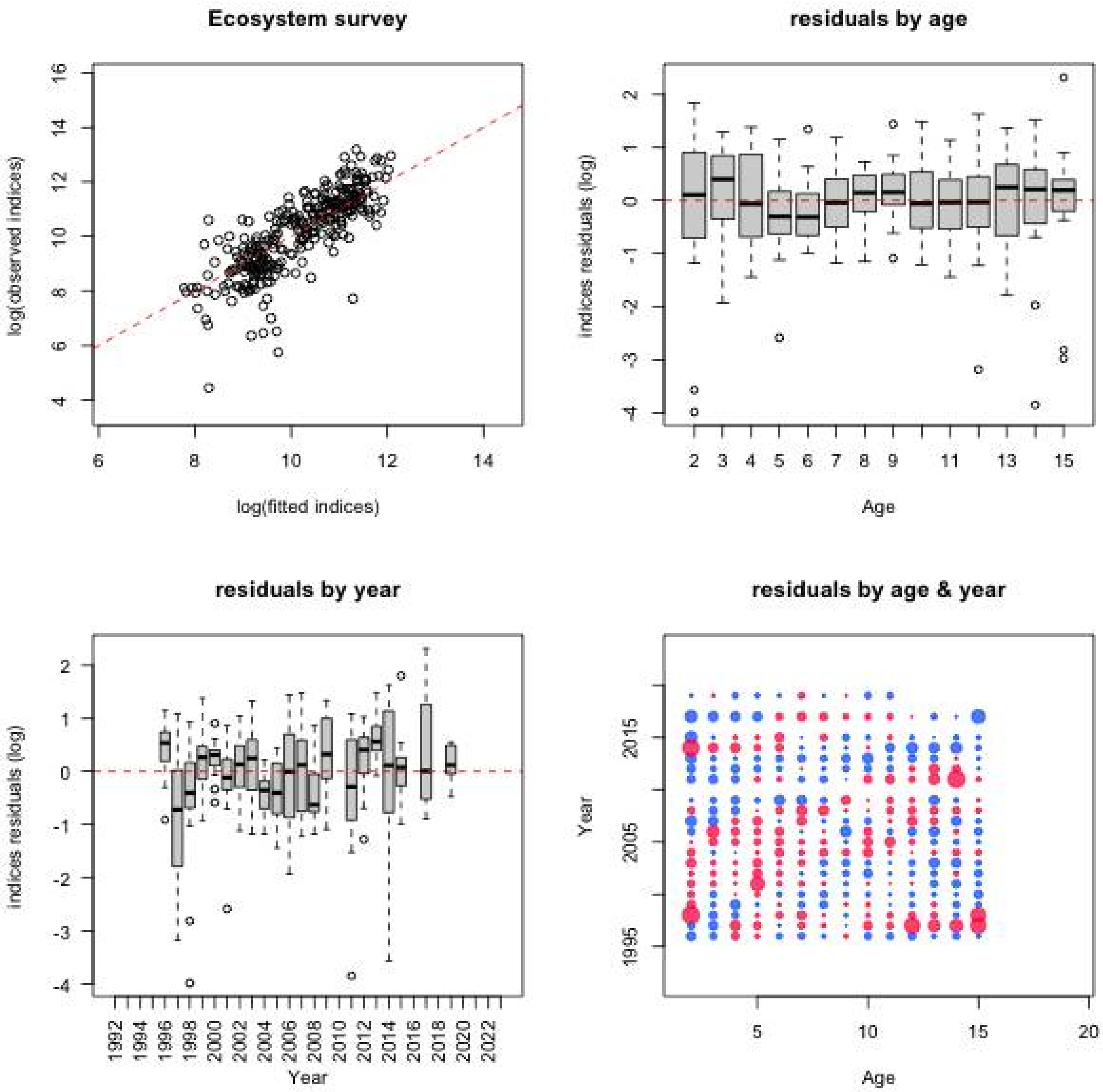


Figure 6.23d. Diagnostic plots for Ecosystem survey data. See legend from Figure 6.23a.

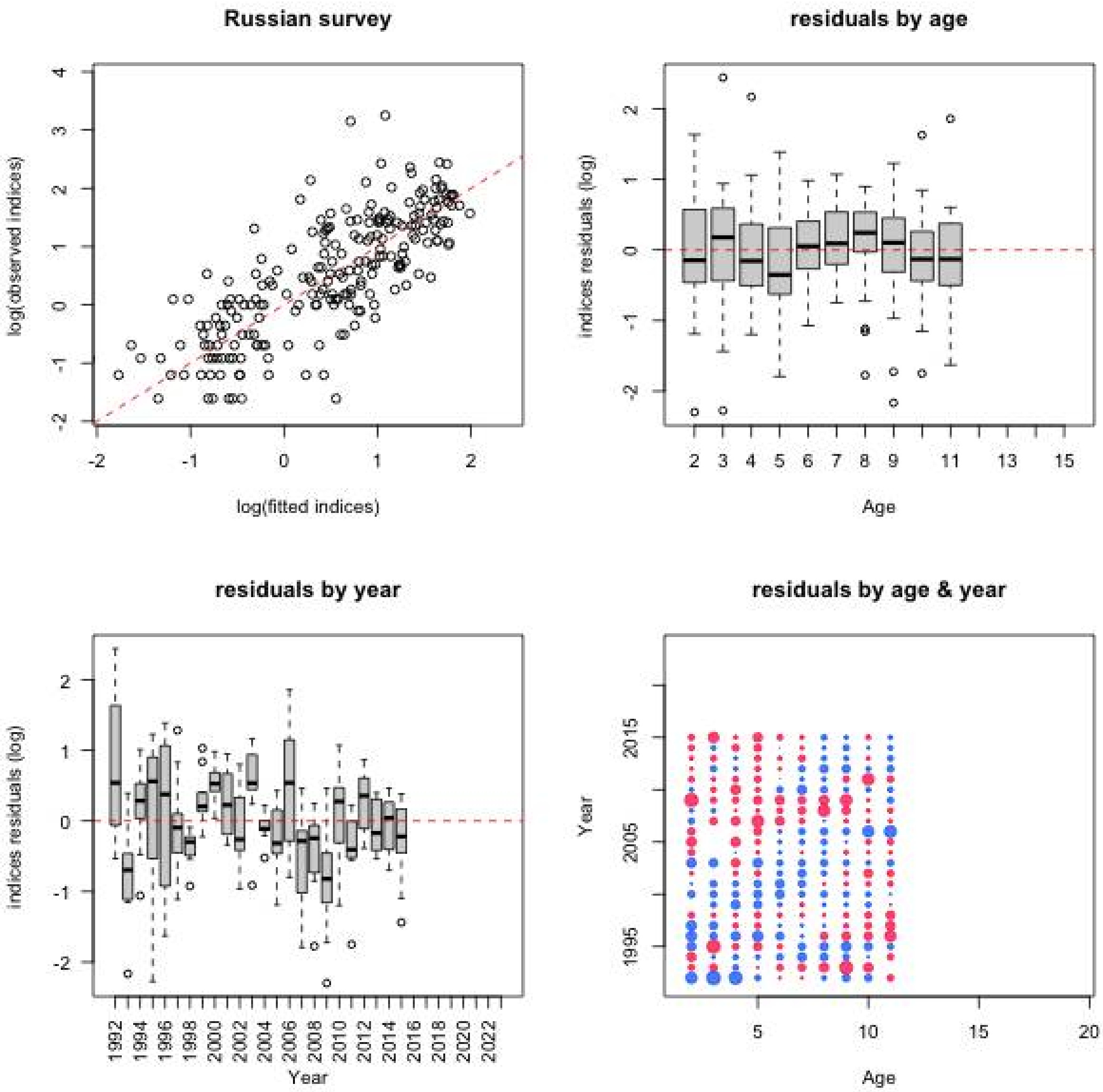


Figure 6.23e. Diagnostic plots for the Russian groundfish survey data. See legend from Figure 6.23a.

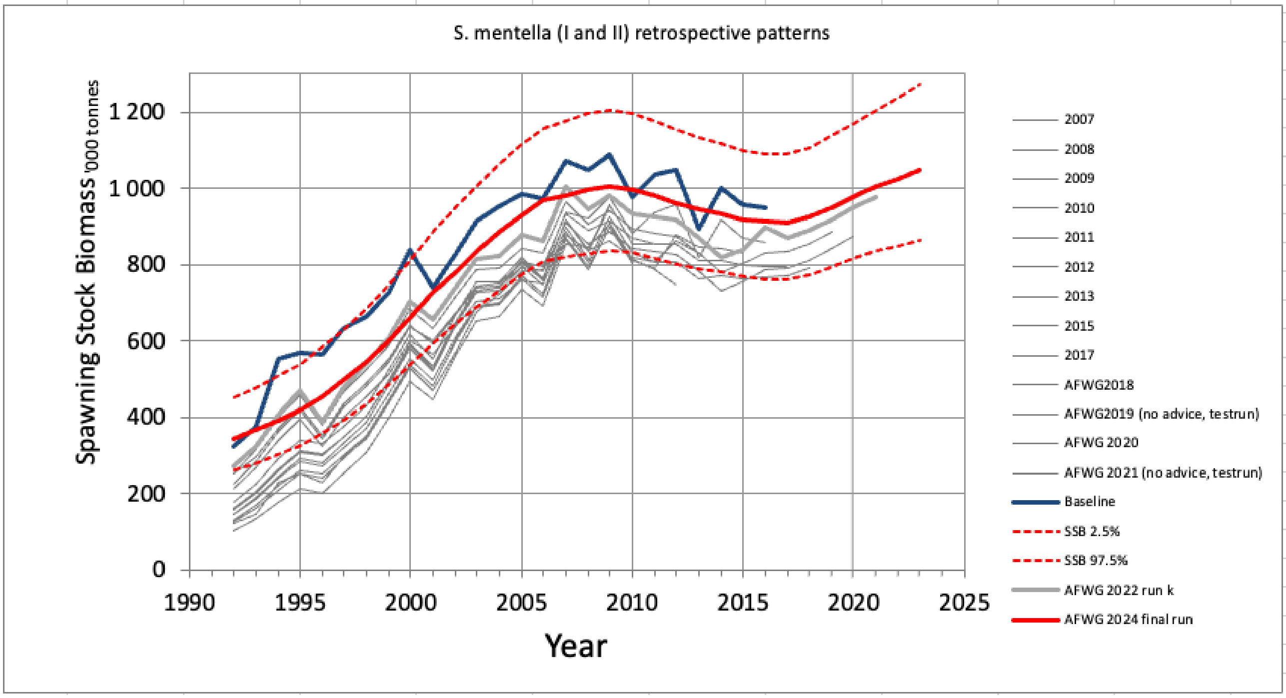


Figure 6.24

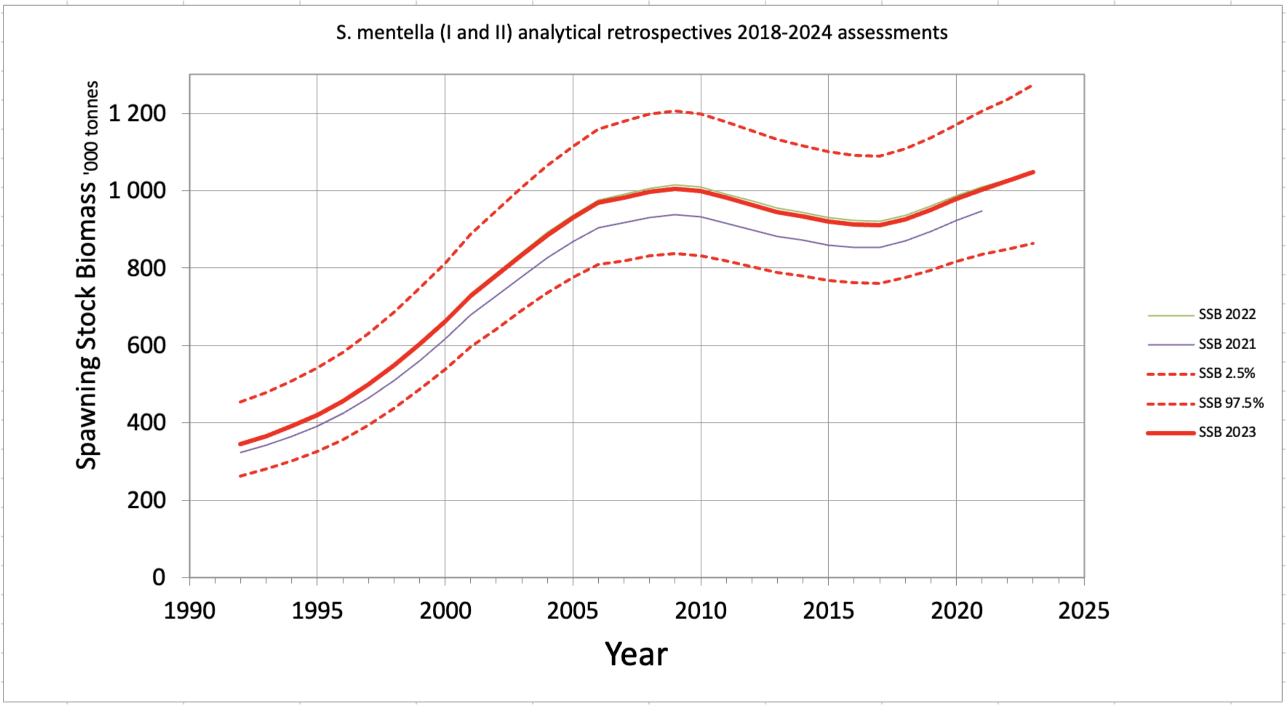


Figure 6.24. The upper panel shows the retrospective patterns of the spawning-stock biomass of S. mentella estimated by the SCAA model for runs up to years 2007–2023 and the baseline model of the 2018 benchmark. The lower panel presents the analytical retrospectives for the current assessment and back to 2021. Confidence Intervals are shown for the latest assessment.

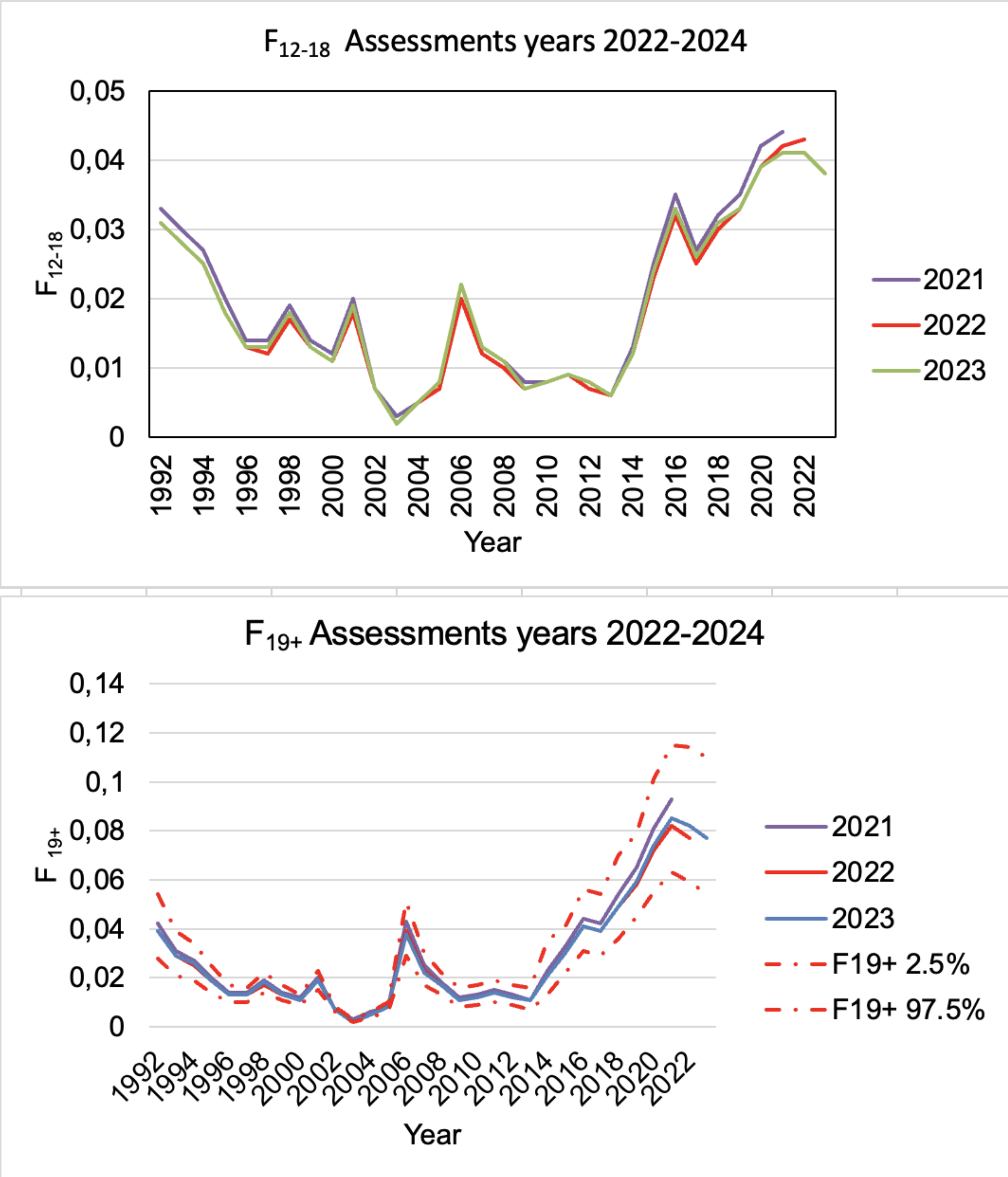


Figure 6.25. The upper panel shows the retrospective patterns of the fishing mortality for the age classes 12-18, estimated by the SCAA model for runs up to years 2018-2023. The lower panel presents fishing mortality for the age-19+ group for the same time period. Broken lines indicate the confidence intervals for the 2024 assessments.

3

Chapter 8. Northeast Arctic Greenland halibut

Status of the fisheries

Landings prior to 2024 (Tables 8.1–8.8, Figures 8.1–8.3)

Nominal landings by country for subareas 1 and 2 combined are presented in Table 8.1. Tables 8.2 to 8.4 give the landings for subarea 1 and divisions 2.a and 2.b separately. Landings separated by gear type are presented in Table 8.5. Catch per unit effort is presented in Table 8.6 and total catch from 1935 to now is presented in Table 8.7 and Figure 8.1. Norwegian catches by type (targeted or bycatch fishery) and by gear are presented in Figure 8.2 and 8.3.

The provisional estimate of the total landings for 2023 is 26 931 tonnes. This is 724 tonnes less than the landings in 2022 and 8437 tonnes more than the ICES advised maximum catch for 2023 (18 494 tonnes). Compared to 2022, the catches from most countries remained stable, except for Faroe Islands where there is an increase in catch the last years. Combined landings exceeded the quotas set by the Joint Russian-Norwegian Fisheries Commission for 2023 by 1931 tonnes (total TAC 25000 tonnes). Catches in the report include all landings in ICES 1 and 2, and thus include catches in EU waters in the southern part of ICES 2.

Some fishing for Greenland halibut has taken place in the northern part of Division 4.a during the past 20–30 years, varying between a few tonnes and up to 2577 in 1999. From 2000 total catch has ranged from 64 to 1330 tonnes, primarily taken by Norway, France, and the UK. Preliminary numbers show 705 tonnes in 2023 (Table 8.8, Figures 8.2 and 8.3). Although there is a continuous distribution of this species from the southern part of Division 2a along the continental slope towards the Shetland area, the stock structure is unclear in this area. These landings are therefore not added to the total from subareas 1 and 2 and are not used int he assessment. Recent mark-recapture and genetic investigations indicate that the stock might have a more south and westward distribution than the current ICES definition of the stock boundaries (Albert and Vollen, 2015; Ubeda *et al*., 2023; Vithakari *et al*., 2022; Westgaard *et al.,* 2016).

Advice applicable to 2024

JRN-AFWG advice applicable to 2024 was 15 560 tonnes. This corresponds to a harvest rate of 0.134. TAC for 2024 was set to 21 250 tonnes. All catches are assumed to be landed.

Additional considerations

A benchmark and data workshop process led to an agreed ICES analytic assessment in 2023 (category 1). The JRN-AFWG approved the use of this assessment method to generate advice for 2024. To get in sync with the Norwegian slope survey, that is conducted every other year, advice for 2025 and 2026 will be given in this year's assessment. Next advice will be given in 2026 (for 2027 and 2028) and every other year thereafter.

The assessment is described in the ICES stock annex, and in the benchmark report (ICES 2023).

Management

The 38th JRNFC's (Joint Norwegian-Russian Fisheries Commissions) session in 2009 decided to cancel the ban against targeted Greenland halibut fishery and established the TAC at 15 000 tonnes for the next two years (2010–2011). Since then, the TAC gradually increased to 27000 tonnes in 2021. The TAC for 2022 and 2023 was reduced to 25000 tonnes and the TAC for 2024 was further reduced to 21250 tonnes. The TAC for NEA

Greenland halibut set by JNRFC applies to catches in ICES areas 1, 2a and 2b, except the Jan Mayen EEZ and the part of the UK EEZ which is north of 62°N.

In 2023, 58 tonnes were taken in the Jan Mayen area (within ICES Subarea 2), where Greenland halibut fisheries are not regulated by TAC.

Norway previously had a quota for Greenland halibut in the EU EEZ which could be fished in ICES areas 2a and 6. Thus this TAC was given partly within and partly outside the stock boundary. This area is now in UK EEZ and there was no agreement for quota to Norway in this area for 2021. In recent years, Norway and UK has agreed on a quota for this area varying between 600-700 tonnes. EU has set a TAC of 2571 tonnes for 2023 in area 6; United Kingdom and Union waters of 4; United Kingdom waters of 2a and United Kingdom and international waters of 5b (GHL/2A-C46)3. For the Greenland halibut stock in area 1 and 2, the EU/UK TAC in the part of area 2a that Is within UK EEZ is of most interest. Further investigations need to be conducted to reveal historical catches in this area.

Further information on regulations is found in the Stock Annex.

Expected landings in 2024

Catches in 2023 were 26931 t, which exceeded the TAC set by JRNFC and the official advice. The total Greenland halibut landings in the Barents Sea and adjacent waters (ICES Subarea 1 and divisions 2a and 2b) in 2024 may thus be higher than the JRNFC TAC of 25 000 t. The quota for 2024 was 15 % lower than the quota for 2023. Total catch for 2024 will therefore probably be lower than total catch in 2023. In the period 2018-2023, TAC was exceeded by 1600 to 2655 tonnes, with an average of 1800 tonnes above TAC, catch by 3rd countries. Expected landings for 2024 are therefore set to be the TAC for 2024 + 1800 tonnes, which corresponds to 23050 tonnes.

Discards are not regarded as a problem.

Status of research

Survey results (Tables 8.9–8.11, Figures 8.4–8.10)

The Russian bottom-trawl surveys in October-December (ICES acronym: G5348, hereafter Russian survey) are important since they usually cover large parts of the total known distribution area of the Greenland halibut within 100–900 m depth. A working document with a revision of the Russian index was provided to the 2021 ICES AFWG meeting (Russkikh et al. 2021, WD12). Revised and recalculated length distributions were implemented in the 2023 assessment. Abundance indices by length and year are given in Table 8.9. The biomass indices for this survey increased steeply from 2005 to 2011, decreased until 2015 after which the biomass level flattened out (Figure 8.4). Sex distribution is presented in Figure 8.5. This survey has not been conducted since 2019.

Total biomass indices from the Norwegian autumn slope survey (G1165, hereafter EggaN) showed an upward trend in biomass estimates between 1994 and 2003, then a downward trend until 2008 until it increased again in 2009 but levelled out again in 2011, 2013, and 2015 (Figures 8.4 and 8.6). Since then, there has been a general downward trend, and the index is now at its lowest in the time-series. The length distributions from this survey (Figure 8.7, Tables 8.10 and 8.11) show modes that can be followed through the years and indicate new recruitment to the adult stock short time before the survey started, and in 2007. Since then, no such large recruit events are apparent in these length distributions, and since 2009 abundance of fish in adult lengths has been declining as well. Sex distribution is presented in Figure 8.5. This survey has been conducted every year during

1994–2009 and biennially since then.

The joint winter survey in the Barents Sea (A6996, hereafter Winter survey) has been run from 1986 to the present (jointly with Russia since 2000, except 2006 and 2007). The survey mainly covers depths of 100–500 m and does not cover the deeper slope areas. Spatially, the survey focuses on the central Barents Sea, and west of Svalbard for some years. The northward coverage is limited by sea ice in some years. It is conducted in February and can thus give information on the stock at a different time of the year, as the other surveys are run in autumn. The coverage of this survey has varied throughout the time-series, and the abundance indices are therefore not used in assessment. From this survey, only length distribution in the survey data is used in the assessment model (Figure 8.8).

Norwegian slope survey in spring (G5678, hereafter EggaS) is a trawl acoustic survey conducted in 2009, 2012 and biennially since then, along the continental slope in Norwegian EEZ from 62–74°N (subareas 1 and 2). Compared to the other surveys this is a short time series and abundance indices are not used in the assessment. Considering the evidence for extended west and southward distribution of the stock the survey, if continued, may gradually become of increased importance for this stock in the future. From this survey, only length distribution in the survey data is used in the assessment model (Figure 8.8).

The Joint Ecosystem Survey in autumn (A5216, hereafter Ecosystem survey) covers a large part of the Barents Sea down to 500 m and concerning Greenland halibut, the northern part of the survey covers areas where mainly juveniles and immature fish are found. Three indices for Greenland halibut are based on the Joint Ecosystem Survey in the Barents Sea, one for fish between 10-17 cm, denoted Juv_SI_1, (Figure 8.9), one for fish between 17-27 cm, denoted Juv_SI_2 (Figure 8.9) and one for fish between 28 and 65 cm, denoted EcoS (Figure 8.10). For juveniles there are distinct modes in the length distributions that can be used as proxy for age (Albert et.al 2009). The juvenile indices (Eco_SI_1 and Eco_Si_2), indicates a highly variable recruitment success with several years between good year classes. There is a strong indication of a recruitment event around 2017 that is now entering the survey. The EcoS index shows large fluctuations, with a positive trend the last two years.

Commercial catch-per-unit-effort (Table 8.6)

The CPUE series (Table 8.6) for the stock was subject to the 2015 benchmark and associated data workshops (see reports from WKBUT 2013, DCWKNGHD 2014 and IBPHALI 2015, and working documents by Bakanev (WD14 WKBUT 2013) and Nedreaas (WD 2 DCWKNGHD 2014). An alternative CPUE series for the Russian fisheries for the years 2004–2015 was presented at the 2016 meeting (Mikhaylov, WD14 AFWG 2016). It shows some discrepancies compared to the previous CPUE series used for the Russian fisheries for the same years. In the CPUE series, values before 1992, when the partial moratorium was implemented, are not comparable with values after 1992 due to reduced effort leading to increased catchability. See the Stock Annex for further comments. The CPUE series are not currently used in the assessment.

Age reading

Based on the scientific understanding that the species is slower growing than the previous age readings suggest, the Norwegian age reading methods were changed in 2006. The new Norwegian age readings are not comparable with older data or the Russian age readings.

The report from Workshop on Age Reading of Greenland Halibut (WKARGH) 14–17 February 2011 (ICES CM 2011/ACOM:41) described and evaluated several age reading methods for Greenland halibut.

The different methods can be classified into two groups: A) Those that produce age–length relationships that broadly compare with the traditional methods described by the joint NAFO-ICES workshop in 1996 (ICES CM 1997/G:1); and B) Several recently developed techniques that show much higher longevity and approximately half the growth rate from 40–50 cm onwards compared to the traditional method.

A second workshop on age reading of Greenland halibut (WKARGH2) was conducted in August 2016 and worked on further validation on new age reading methods. The workshop recommended that two of the new methods can be used to provide age estimations for stock assessments. Further, recognizing some bias and low precision in methods, the WKARGH2 suggested that an aging error matrix or growth curve with error be provided for use in future stock assessments (WKARGH2 report, ICES 2016).

WKARGH2 recommends regular inter-lab calibration exercises to improve precision (i.e. exchange of digital images between readers for each method and between methods). At the annual meeting between Russian and Norwegian scientists in 2024, the party confirmed an interest in establishing cooperation on age reading of Greenland halibut, to work out issues of disagreements on Greenland halibut aging (IMR-PINRO, 2024).

Data used in the assessment

At the 2023 benchmark all input data were scrutinised and revised (Windsland et al. 2023, WD 2 ICES WKBNORTH), with the exception of the Russian slope survey that was revised by Russkikh et al. (ICES 2021, AFWG WD12), and in preparation for the 2023 JRN AFWG.

In the assessment, the catch data are split into five aggregated fleets by gear and countries. Longline/gillnet fleets include landings from gillnet, longline, and handline. Trawl fleets include landings from bottom trawl, purse-seine (very minor catches, can be bycatch or misreporting) and Danish seine. Catch in tonnes and length distributions per quarter per fleet and sex from 1992–2020 are used in the assessment. Fleets are split between Norwegian catches, Russian catches, and catches from 3 rd countries. Selectivities are allowed to vary by sex to account for sexual dimorphism influencing vulnerability to fishing. Catches are aggregated into following fleets:

- Russian, trawl and minor gears.
- Russian, gillnet and longline .
- Norwegian, trawl and minor gears.
- Norwegian, gillnet and longline.
- 3 rd countries.

No survey covers the whole stock distribution area. The model uses length distributions and biomass indices from three surveys. From these surveys the following indices go into the current assessment:

- EggaN_SI– based on the Norwegian slope survey in autumn for >27 cm fish.
- Juv_SI_1 and Juv_SI_2 - juvenile indices based on 10-17 cm and 18-27 cm fish in the Joint Ecosystem survey.
- EcoS_SI - an index for 28-65 cm fish, based on data from the Joint Ecosystem survey.

- RussianS_SI - Russian bottom-trawl survey in the Barents Sea in autumn, for >27 cm fish.

In addition, length distributions from the Norwegian Slope Survey South and the Joint Winter Survey (from survey data, not abundance indices) are used in the assessment.

Age data from the Norwegian slope survey was used in the tuning. The age data was provided using the frozen whole right otolith method recommended by WKARGH2 (ICES 2017).

No CPUE indices are used in the tuning.

Methods used in the assessment (Table 8.12)

A new assessment method with a length and age-based GADGET model was benchmarked in 2023. The assessment is further described in the Stock Annex.

At the meeting the revision of the Russian Slope Survey was implemented in the assessment. This required recalculation of reference points that are given in table 8.12.

Advice for the stock is normally given biennially. Last advice was given in 2023 for 2024 only, in order synchronise with the Norwegian slope survey in autumn, that is conducted every other year. This year’s assessment provides advice for 2025 and 2026.

Model settings

Model used: Gadget3 (Lentin et al. 2022)

- Start year 1980.
- One year time-step.
- Single area model, with spatial variation in demography handled through fleet selectivity (“fleets as areas” approach).
- Two sexes, split into mature and immature stock components.
- Logistic maturity estimated for each sex.
- 1 cm length classes and 1-year age classes
- Lengths: females; immature 1-100 cm, mature 1-120 cm - males; immature 1-65 cm, mature 1-90 cm
- Age: immature 1-25+, mature 3-25+
- Von Bertanlanffy growth estimated separately for males and females, with estimated L_{inf} for females and L_{inf} for males fixed at 68 cm. Length at age one fixed.
- Natural mortality set to 0.12 for females and 0.16 for males.
- Initial size of recruits fixed at 14 cm (model has proved unable to estimate this).
- Recruitment modelled as annual numbers, no relationship with SSB (estimated directly), assumed equal recruitment between males and females.

- Initial population follows a simplifying assumption of constant recruitment, M and F, giving an exponential decay by age. A fixed maturity ogive is used to split immature and mature proportions. Standard deviations of lengths at age is externally fixed.
- Fisheries and surveys are modelled with fixed catch in tonnes per fleet, and sex-specific selectivity estimated using length distribution data and sex-at-length data.
- Five aggregated commercial fleets (as described above), each with sex-specific logistic selectivity.
- Three surveys used for indices (EcoS, EggaN and RussianS), with logistic selectivity (but with a min:max length range to avoid bias in indices on fish suspected to be poorly selected).
- Only length distributions used from the Winter and EggaS surveys.

More detailed model description, as well as outputs and diagnostics are shown in ICES stock annex and in Vihtakari et al. 2023 (WD 17, WKBNORTH).

Results of the assessment (Figure 8.11-8.15, Tables 8.13-8.14)

Model results, retrospective pattern, jitter, and short-term projections are shown in Figures 8.11-8.14. Reference point and catch scenarios are shown in tables 8.12-8.14. The stock biomass is presented for the total $\geq$ 45 cm (minimum legal landing size) population and the spawning stock (Figure 8.11). Biomass peaks around 2013–2014 and shows a clear downward trend since then. This trend is broadly in line with all tuning series (Figures 8.4, 8.6, 8.9 and 8.10). SSB was above B_{pa} in 2023 but has now fallen below. The harvest rate has been steadily increasing since 2009 and is now above HR_{pa} and HR_{MSY}.

The retrospective analysis for model biomass has negative Mohn’s rho values (Figure 8.12). The retrospective patterns by year got lumped following the availability of survey data, with the Norwegian slope survey run every other year and missing years in the Russian autumn survey. As a result of this pattern, it is recommended that the assessment be run every other year rather than annually. There is a retrospective trend to increase the stock estimate over time. Peaks in recruitment were most likely exaggerated in the assessment model used before the benchmark, while in the present model they are probably underestimated. Large uncertainties in the age reading probably smooths out the peaks, distributing the recruitment over multiple years. The recruitment peak in the latest years is based on little data and is unreliable. Even though the assessment most likely smooths out the recruitment, the modelled peaks show reasonably good agreement to the data from the juvenile survey indices. This stock is dominated by sporadic recruitment events, and the model does a reasonable job of capturing this.

Biological reference point

Estimates of trends and biomass levels in stock dynamics are stable in the revised assessment. Therefore, the suggested reference points are for ICES category 1 stock (ICES, 2021).

The HR_{TARGET} is set to HR_{MSY} which equals 0.139. As recommended at the recent Benchmark (ICES 2023), this value was calculated during the 2023 meeting following the revision of the Russian survey index (Russkikh et al. WD12, AFWG 2021). The fishable biomass is taken to be the 45+ cm biomass. The $B_{TRIGGER}$ in the ICES Advice Rule is set to be B_{pa}, which equals 46747 t. B_{MSY} has not been calculated.

Exploratory assessments; surplus production models and TSVPA

Results of the assessment of the Barents Sea Greenland halibut stock based on a Bayesian surplus production model was provided by Bakanev in 2013, (WKBUT WD 14). Different sets of abundance indices were used for tuning the model. The analysis of model run results has shown that K is estimated within the range of 810 to 1139 kt, B_{MSY} of 405 to 570 kt and MSY of 23 to 47 kt. However, the model was sensitive to the choice of prior on K. Taking into consideration a high probability of the stock size being at the level, which was quite a bit above BMSY, the risk of the biomass being below this optimal one was very small in 2002–2012 (<1%). The risk analysis of the stock size in the prediction years (2013–2020) under the catch of 0 to 30 kt indicated that the probability of the stock size being under the threshold levels (B_{MSY}, B_{LIM}) was also minor (less than 1%). It was concluded that further work was needed on the historical CPUE series. Based on scrutiny of the CPUE series it was recommended to examine runs with the surplus production model for the period 1964-1991 and 1964-2005, in addition to runs for the whole 1964–2013 period. Fisheries CPUE series were considered less reliable to reflect stock dynamics than survey indices in the period after regulations of the fishery were introduced in 1992. The Bayesian surplus model was not updated for presentation at the current meeting.

A production model was presented at the 2016 meeting (Mikhaylov, 2016, WD 14), although this model has not been reviewed at a benchmark, nor were biomass trends presented at this meeting. The model has been proposed as a possible method for the estimation of long-term reference points. An update was presented at the 2019 meeting (Mikhaylov 2019, AFWG 2019 WD21). In the current version, the MSY would be around 34 kt, the B_{MSY} around 500 kt and F_{MSY} on the level 0.069. It should be noted that these values are not directly transferable to a different model with different biomass levels and in any case a long-term average. The WD concluded that, in general, the stock can withstand the fishing pressure in 2016 and the fishing regime was approaching optimum, indicating that the results of the exploratory surplus production model were in general alignment with the assessment.

F_{MSY} is not appropriate to this stock given the recent extended run of poor recruitment, and such values have not been evaluated for precautionarity. In a plenary, it was concluded that it would be useful for further development of the production model to conduct separate exploratory runs for CPUE split into before and after 1992 and run with CPUE only before 1992 and survey data after 1992. This production model was not updated for presentation at the current meeting.

At the 2018 meeting, AFWG results from SPiCT production model were presented (AFWG report 2018). In the run that is presented in this report, all available data up to 2016 were used. For run with default, priors applied K = 995 421 t and deterministic reference points were B_{MSY} = 419 955 t, F = 0.07 and MSY = 29 742 t. Stochastic reference points for this run were in a similar range. Run with default priors deactivated gives similar MSY estimates but otherwise, rather different estimates; K = 2 504 006 t, B_{MSY} = 609 410 t, F = 0.05 and MSY = 28 097 t. Further utilization of this approach demands closer scrutiny of model settings in relation to diagnostics. The SPiCT model can be a flexible tool to examine the production model approach to Greenland halibut, however, concerns highlighted below still apply.

In principle, a production model could be used in conjunction with the GADGET assessment model to extend the simulations back in time and provide better estimates for B_{LIM}. However, the inability of production models to follow variable recruitment, and especially runs of above or below average recruitment, limits their ability to advise on this stock. In the benchmark report (IBPHALI 2015) Table 3.3 gives CPUE series and survey estimates that can be helpful for this task.

A working document (Bulatov et al. 2023, WD1 JNR-AFWG 2023) presents a comparison of two types of models: several different formulations of production models for Greenland halibut and age-structured TSVPA mode alongside a production model (the “combi” model) tuned to an index constructed from the TSVPA results. Tuning data for production model included catch in tonnes, Norwegian CPUE, Russian Survey and Winter survey indices. The biomass models showed F_{MSY} (in a biomass model context) of around 0.05 to 0.07 and B_{msy} of 437-620 kt, giving long term MSY yields of between 32.3kt and 37.47kt. A TSVPA model was constructed, and the overall trend (with F_{MSY} at age 9 at 0.14, and MSY yield of between 28.2kt and 31.5kt) was presented. A biomass model tuned to TSVPA as a relative index of abundance gave a F_{MSY} (again in production model context) of 0.15 and long term MSY yield of 28.4kt. The use of TISVPA results allowed us to build a recruitment model (Beverton-Holt and “hockey stick” models) that predicts an approximately constant replenishment level (25 million at age 5), which justifies the assumptions accepted in new version of GADGET. However, given difficulties in the tuning indices noted below, the group does not feel that reliance can be placed on the absolute level of these results.

The group notes that there are two key problems in tuning data used in this WD, one is that the CPUE has an artificial step-change (increase) after the reduction in effort due to the partial moratorium in 1992 and will thus likely drive the hypothetical artificial fast rise in population from that point. The other is that the winter survey has had a trend to expand coverage area over time, and therefore the increasing trend in the swept area index is, at least partially, driven by this rather than any stock trends. Therefore, neither the full time series of CPUE nor the simple winter survey estimate should be used for model tuning. Furthermore, the new age reading methods imply considerably slower growth rate and increased longevity, compared to the traditional method used for age data in the TSVPA model (ICES WKARGH 2011, ICES WKARGH2 2016), and the old age readings should not be used in model tuning. It is also questionable if a biomass model is able to track the trends of this stock (where the population seems to be driven by variability in recruitment success).

In terms of trends, the TSVPA and the “Combi” biomass model tuned to a TSVPA-derived index were broadly similar to each other and to the new Gadget model. Key differences were that the TSVPA rose more steeply than Gadget after the 1992 low point, and the Combi model more steeply again. It seems likely that this could be explained by the use of CPUE tuning data (with its artificial rise post 1992) in the Combi and TSVPA models. The other key point of difference is that the Gadget model shows a downturn starting in c. 2012, while the other models only turn down in 2021. One possible reason for this is that the Gadget model uses Ecosystem and Norwegian slope survey indices alongside the Russian index, while the models presented here use the Winter Survey (which has an artificial increasing trend due to increasing coverage).

The group felt that the TSVPA model was worth continuing developing, with a potential use as an auxiliary model (as for NEA cod and haddock), although its accuracy would continue to be hampered by the limited age reading on this species with new age reading methods. Using different tuning series and the more modern age reading method should result in a TSVPA model which could be used as an auxiliary model and could then be compared with the Gadget assessment. Effort should also be placed into continuing the age reading work, as an improved age data series would benefit both Gadget and age-based models such as TSVPA.

Comments to the assessment

An overview of model exploration before, and at, the benchmark is given in the benchmark report (ICES 2023) and in a working document to the benchmark (Vihtakari et al. WD 17, ICES 2023). At the JRN-AFWG in 2023 the assessment was updated by adding the revised Russian survey index. Between the end of the physical benchmark meeting and completion of the final model the following adjustments were made: Recalculation of data weighting, and flat top selectivity applied to all fleets. In addition, the Russian survey was revised as noted previously.

Within the fisheries in the Barents Sea and the associated continental slope, fish tend to move to the slope as they mature. This means that fisheries on the shelf tend to catch fewer of the large mature fish. The Barents Sea Greenland halibut Gadget model was designed to be a “fleets as areas model”, where fleet selectivity would take care of the issue of the larger fish moving out of the areas covered by some fleets and surveys. However, the dome shaped selectivity required for this was problematic. Dome-shaped selectivity increased the estimated biomass for mature females early on during the time-series but did not influence female SSB estimates toward the end of the time-series. This led to unrealistically pessimistic ratio between current stock status and recalculated B_{lim} reducing the TAC estimate for 2025 to 7200 tonnes, which was deemed too low in the current situation by the experience and other model exploration using compiled survey indices. The model was therefor again run with logistic (flat-topped) selectivities, as in the 2023 assessment.

Prior to the 2024 assessment meeting it was experimented with changing the likelihood components weights as suggested in last year’s report. This did, however, not improve model stability any further.

The Greenland halibut population extends past the Joint Norwegian Russian Fisheries Commission (JNRFC) domain and surveys considered in the assessment do not cover the entire distribution (Albert & Vollen 2015, Westgaard et al. 2017, Vihtakari et al. 2022, Ubeda et al. 2023).

In this year’s assessment, the international catches were recalculated using the ICES official catch statistic, to ensure transparency and reproducibility. The catches may therefore vary slightly to previous reports, but these differences are likely too small to affect model results.

After the 2023 Benchmark, the procedures for data handling and calculations were improved, which led to minor changes in the length distributions compared to previous reports.

According to the jitter analysis, the model trends can be considered stable (Figure 8.13).

Future work

Effort to improve stock assessment in the future should include:

- Gather age data over more years.
- Examine further Norwegian and joint Norwegian/Russian survey indices using VAST (mixed models) or similar statistical analysis. Preliminary work on the topic was presented to the meeting.
- Develop a harvest control rule.
- Examine how to implement new evidence for south and westward extension of stock structure. Extensive work studying this extension as presented at the meeting.

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Tables and figures

Table 8.1. Greenland halibut in subareas 1 and 2. Nominal Catch (t) by countries (Subarea 1, divisions 2a, and 2b combined) as officially reported to ICES.

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Po
1984	0	0	0	2165	138	0	0	0	0	0	3540	0	
1985	0	0	0	4000	239	0	0	0	0	0	5287	0	
1986	0	0	42	2718	13	0	0	0	0	0	7783	0	
1987	0	0	0	2024	13	0	0	0	0	0	6893	0	
1988	0	0	186	744	67	0	0	0	0	0	8811	0	
1989	0	0	67	600	31	0	0	0	0	0	8837	0	
1990	0	0	163	954	49	0	0	0	0	0	16615	0	
1991	11	2564	314	101	119	0	0	0	0	0	27585	0	
1992	0	0	16	13	111	13	0	0	0	0	7668	0	
1993	2	0	61	22	80	8	56	0	0	30	10379	0	
1994	4	0	18	296	55	3	15	5	0	4	8428	0	
1995	0	0	12	35	174	12	25	2	0	0	9368	0	
1996	0	0	2	81	219	123	70	0	0	0	11623	0	
1997	0	0	27	56	253	0	62	2	0	0	7661	12	
1998	0	0	57	34	67	0	23	2	0	0	8435	31	
1999	0	0	94	34	0	38	7	2	0	0	15004	8	
2000	0	0	0	15	45	0	16	1	0	0	9083	3	
2001	0	0	0	58	122	0	18	1	0	0	10896	2	
2002	0	219	0	42	7	22	4	6	0	0	7143	5	
2003	0	0	459	18	2	14	0	1	0	0	8215	5	

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Por
2004	0	0	0	9	0	0	10	0	0	0	13939	1	
2005	0	170	0	8	32	0	0	0	0	0	13011	0	
2006	0	0	204	8	46	0	8	0	0	196	11118	201	
2007	0	0	203	8	40	198	15	0	0	0	8230	200	
2008	0	0	663	5	41	0	28	0	0	0	7393	201	
2009	0	0	422	19	16	16	15	2	0	0	8446	204	2
2010	0	0	272	14	102	15	16	0	0	0	7700	3	
2011	0	0	538	80	46	4	7	0	0	234	8348	169	
2012	0	0	563	40	40	12	13	0	0	0	9331	22	
2013	0	0	783	49	168	22	106	1	0	0	10404	30	
2014	0	0	887	33	269	24	86	0	0	0	10997	19	
2015	0	0	724	33	230	16	98	0	0	0	10874	13	
2016	2	353	1078	9	229	18	75	0	0	0	12932	26	
2017	0	523	993	21	177	26	10	0	3	72	13741	26	
2018	2	574	401	50	150	20	24	0	0	206	14875	27	
2019	0	588	350	44	105	23	10	0	0	348	14867	122	
2020	1	579	514	73	39	48	19	0	0	261	14526	97	
2021	1	382	749	88	137	14	0	0	0	125	14008	14	
2022*	0	253	1055	94	85	47	27	0	75	136	13800	0	
2023*	1	98	1017	82	60	14	32	0	84	75	13919	0	

*** Provisional figures.**

Table 8.2. Greenland halibut in subareas 1 and 2. Nominal catch (t) by countries in Subarea 1 as officially reported to ICES.

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Por
1984	0	0	0	0	0	0	0	0	0	0	398	0	
1985	0	0	0	0	0	0	0	0	0	0	524	0	
1986	0	0	0	1	0	0	0	0	0	0	538	0	
1987	0	0	0	2	0	0	0	0	0	0	771	0	
1988	0	0	9	4	0	0	0	0	0	0	901	0	
1989	0	0	0	0	0	0	0	0	0	0	2038	0	
1990	0	0	7	0	0	0	0	0	0	0	1304	0	
1991	0	164	0	0	0	0	0	0	0	0	2027	0	
1992	0	0	0	0	0	0	0	0	0	0	2349	0	
1993	0	0	32	0	0	0	56	0	0	0	1754	0	
1994	0	0	17	217	0	0	15	0	0	0	1165	0	

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Por
1995	0	0	12	0	0	0	25	0	0	0	1352	0	
1996	0	0	2	0	0	0	70	0	0	0	911	0	
1997	0	0	15	0	0	0	62	0	0	0	610	0	
1998	0	0	47	0	0	0	23	0	0	0	859	0	
1999	0	0	91	0	0	13	7	0	0	0	1101	0	
2000	0	0	0	0	0	0	16	0	0	0	1021	0	
2001	0	0	0	0	0	0	9	0	0	0	858	0	
2002	0	0	0	3	0	0	0	0	0	0	834	0	
2003	0	0	48	0	0	2	0	1	0	0	962	1	
2004	0	0	0	0	0	0	1	0	0	0	866	0	
2005	0	0	0	0	1	0	0	0	0	0	572	0	
2006	0	0	17	1	0	0	1	0	0	0	575	0	
2007	0	0	18	0	1	198	3	0	0	0	514	0	
2008	0	0	13	0	1	0	5	0	0	0	599	0	
2009	0	0	33	0	0	16	5	0	0	0	734	0	
2010	0	0	15	0	0	0	16	0	0	0	659	0	
2011	0	0	63	0	0	0	6	0	0	0	862	0	
2012	0	0	8	5	0	0	7	0	0	0	921	0	
2013	0	0	39	1	8	0	100	0	0	0	1055	4	
2014	0	0	143	8	11	19	38	0	0	0	1036	7	
2015	0	0	108	14	5	14	47	0	0	0	1091	5	
2016	0	353	88	2	3	3	38	0	0	0	1265	12	
2017	0	519	133	4	4	2	8	0	3	72	1389	9	
2018	0	574	104	9	16	2	20	0	0	199	1008	4	
2019	0	588	116	27	9	6	6	0	0	348	939	119	
2020	0	579	123	37	3	15	18	0	0	258	1389	96	
2021	0	382	200	17	1	10	0	0	0	125	1617	9	
2022*	0	253	120	21	24	5	0	0	75	136	1151	0	
2023*	0	98	177	6	11	5	0	0	84	74	951	0	

*** Provisional figures.**

Table 8.3. Greenland halibut in subareas 1 and 2. Nominal catch (t) by countries in Division 2a as officially reported to ICES.

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Por
1984	0	0	0	265	138	0	0	0	0	0	3062	0	
1985	0	0	0	254	239	0	0	0	0	0	4691	0	

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Por
1986	0	0	6	97	13	0	0	0	0	0	6302	0	
1987	0	0	0	75	13	0	0	0	0	0	5550	0	
1988	0	0	177	150	67	0	0	0	0	0	7671	0	
1989	0	0	67	104	31	0	0	0	0	0	6265	0	
1990	0	0	133	12	49	0	0	0	0	0	7605	0	
1991	0	1400	314	21	119	0	0	0	0	0	11189	0	
1992	0	0	16	1	108	13	0	0	0	0	3586	0	
1993	0	0	29	14	78	8	0	0	0	0	7977	0	
1994	0	0	0	33	47	3	0	4	0	0	6382	0	
1995	0	0	0	30	174	12	0	2	0	0	6354	0	
1996	0	0	0	34	219	123	0	0	0	0	9508	0	
1997	0	0	0	23	253	0	0	0	0	0	5702	0	
1998	0	0	0	16	67	0	0	1	0	0	6661	0	
1999	0	0	0	20	0	25	0	2	0	0	13064	0	
2000	0	0	0	10	43	0	0	0	0	0	7536	0	
2001	0	0	0	49	122	0	9	1	0	0	8935	0	
2002	0	0	0	9	7	22	4	0	0	0	5877	0	
2003	0	0	390	5	2	12	0	0	0	0	6713	0	
2004	0	0	0	4	0	0	9	0	0	0	11704	0	
2005	0	0	0	3	31	0	0	0	0	0	11216	0	
2006	0	0	175	0	38	0	7	0	0	0	8897	0	
2007	0	0	162	2	37	0	12	0	0	0	6761	0	
2008	0	0	646	4	38	0	23	0	0	0	5566	1	
2009	0	0	379	0	13	0	10	0	0	0	6456	0	
2010	0	0	255	0	102	15	0	0	0	0	6426	0	
2011	0	0	467	0	45	4	1	0	0	0	7080	0	
2012	0	0	553	0	37	12	6	0	0	0	7934	0	
2013	0	0	739	0	150	22	6	0	0	0	8213	0	
2014	0	0	741	0	255	1	48	0	0	0	8640	0	
2015	0	0	614	2	221	2	51	0	0	0	8742	0	
2016	0	0	986	6	216	14	37	0	0	0	10073	6	
2017	0	0	841	0	161	21	2	0	0	0	10126	0	
2018	0	0	296	1	104	9	4	0	0	1	11255	2	
2019	0	0	232	15	95	16	4	0	0	0	12143	3	
2020	0	0	385	21	34	28	1	0	0	0	11430	0	

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Po
2021	0	0	530	20	123	4	0	0	0	0	9647	0	
2022*	0	0	888	10	26	14	27	0	0	0	9814	0	
2023*	0	0	770	20	13	5	32	0	0	0	11283	0	

*** Provisional figures.**

Table 8.4. Greenland halibut in subareas 1 and 2. Nominal catch (t) by countries in Division 2b as officially reported to ICES.

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Po
1984	0	0	0	1900	0	0	0	0	0	0	80	0	
1985	0	0	0	3746	0	0	0	0	0	0	71	0	
1986	0	0	36	2620	0	0	0	0	0	0	944	0	
1987	0	0	0	1947	0	0	0	0	0	0	572	0	
1988	0	0	0	590	0	0	0	0	0	0	239	0	
1989	0	0	0	496	0	0	0	0	0	0	533	0	
1990	0	0	23	942	0	0	0	0	0	0	7706	0	
1991	11	1000	0	80	0	0	0	0	0	0	14369	0	
1992	0	0	0	12	3	0	0	0	0	0	1732	0	
1993	2	0	0	8	2	0	0	0	0	30	649	0	
1994	4	0	1	46	8	0	0	1	0	4	881	0	
1995	0	0	0	5	0	0	0	0	0	0	1662	0	
1996	0	0	0	47	0	0	0	0	0	0	1204	0	
1997	0	0	12	33	0	0	0	2	0	0	1349	12	
1998	0	0	10	18	0	0	0	1	0	0	915	31	
1999	0	0	3	14	0	0	0	0	0	0	839	8	
2000	0	0	0	5	2	0	0	1	0	0	526	3	
2001	0	0	0	9	0	0	0	0	0	0	1103	2	
2002	0	219	0	30	0	0	0	6	0	0	432	5	
2003	0	0	21	13	0	0	0	0	0	0	541	4	
2004	0	0	0	5	0	0	0	0	0	0	1369	1	
2005	0	170	0	5	0	0	0	0	0	0	1223	0	
2006	0	0	12	7	8	0	0	0	0	196	1647	201	
2007	0	0	23	6	2	0	0	0	0	0	955	200	
2008	0	0	4	1	2	0	0	0	0	0	1229	200	
2009	0	0	10	19	3	0	0	2	0	0	1256	204	2
2010	0	0	2	14	0	0	0	0	0	0	615	3	
2011	0	0	8	80	1	0	0	0	0	234	406	169	

Year	Denmark	Estonia	Faroe Islands	Germany	France	Greenland	Iceland	Ireland	Latvia	Lithuania	Norway	Poland	Po
2012	0	0	2	35	3	0	0	0	0	0	476	22	
2013	0	0	5	48	10	0	0	1	0	0	1136	26	
2014	0	0	3	25	3	4	0	0	0	0	1321	12	
2015	0	0	2	17	4	0	0	0	0	0	1042	8	
2016	2	0	4	1	10	1	0	0	0	0	1594	8	
2017	0	4	19	17	12	3	0	0	0	0	2226	17	
2018	2	0	1	40	30	9	0	0	0	6	2611	21	
2019	0	0	2	2	1	1	0	0	0	0	1784	0	
2020	1	0	6	15	2	5	0	0	0	3	1707	1	
2021	1	0	19	51	13	0	0	0	0	0	2744	5	
2022*	0	0	47	63	35	28	0	0	0	0	2835	0	
2023*	1	0	70	56	36	4	0	0	0	1	1685	0	

*** Provisional figures.**

Table 8.5. Greenland halibut in subareas 1 and 2. Landings by gear (t).

Year	Gillnet	Longline	Trawl	Danish seine	Other
1980	1189	336	11759	-	-
1981	730	459	13829	-	-
1982	748	679	15362	-	-
1983	1648	1388	19111	-	-
1984	1198	3760	16072	9	7
1985	1668	2484	15532	2	83
1986	1637	2626	18501	4	0
1987	2021	2198	14456	7	61
1988	2691	2381	14226	21	3
1989	1282	1738	15304	-	29
1990	1264	2322	18539	0	430
1991	1904	4652	26698	53	10
1992	1598	1913	5030	33	28
1993	1497	3047	7359	29	-
1994	1548	2319	5330	29	0
1995	1588	4167	5902	68	8
1996	1495	4582	8123	87	60
1997	998	3388	4984	15	25
1998	1327	3834	6660	25	46
1999	2570	6842	9970	75	61

Year	Gillnet	Longline	Trawl	Danish seine	Other
2000	1765	4972	7431	62	67
2001	2111	6239	7832	124	67
2002	1737	5273	6120	117	46
2003	2049	5330	5791	242	34
2004	2384	7126	8766	614	9
2005	1842	7512	9014	441	24
2006	1503	6137	10023	205	10
2007	998	4500	9836	120	4
2008	901	3574	9318	9	8
2009	1409	4954	6567	34	17
2010	1449	5440	8166	170	10
2011	1583	5040	9807	239	15
2012	1929	5601	12337	413	5
2013	2397	5805	13601	176	0
2014	2647	6146	13628	183	8
2015	2508	6287	15778	489	18
2016	2646	7290	14769	650	30
2017	2677	7221	15832	681	27
2018	3021	7303	17422	842	11
2019	3343	7027	17335	1118	0
2020	2976	6984	17541	1055	17
2021	2930	7382	16987	884	33
2022*	2996	6426	17228	990	16
2023*	3392	6242	15989	1293	15

*** Provisional figures.**

Table 8.6. Greenland halibut in subareas 1 and 2. Catch per unit effort and total effort.

Year	USSR catch/hour trawling (t)		Norway[10] catch/hour trawling (t)		Average CPUE		Total effort (in 1000 hrs trawling)[5]	CPUE 7+[6]	GDR[7] (catch/day tonnage (kg))
	RT[1]	PST[2]	A[8]	B[9]	A[3]	B[4]			
1965	0.80	-	-	-	0.80	-	-	-	-
1966	0.77	-	-	-	0.77	-	-	-	-
1967	0.70	-	-	-	0.70	-	-	-	-
1968	0.65	-	-	-	0.65	-	-	-	-
1969	0.53	-	-	-	0.53	-	-	-	-
1970	0.53	-	-	-	0.53	-	169	0.50	-
1971	0.46	-	-	-	0.46	-	172	0.43	-

Year	USSR catch/hour trawling (t)			Norway catch/hour trawling (t)		Average CPUE		Total effort (in 1000 hrs trawling)	CPUE 7+	GDR (catch/day tonnage (kg))
	RT		PST	A	B	A	B			
1972	0.37		-	-	-	0.37	-	116	0.33	-
1973	0.37		-	0.34	-	0.36	-	83	0.36	-
1974	0.40		-	0.36	-	0.38	-	100	0.36	-
1975	0.39		0.51	0.38	-	0.39	0.45	99	0.37	-
1976	0.40		0.56	0.33	-	0.37	0.45	100	0.34	-
1977	0.27		0.41	0.33	-	0.30	0.37	96	0.26	-
1978	0.21		0.32	0.21	-	0.21	0.27	123	0.17	-
1979	0.23		0.35	0.28	-	0.26	0.32	67	0.19	-
1980	0.24		0.33	0.32	-	0.28	0.33	47	0.25	-
1981	0.30		0.36	0.36	-	0.33	0.36	42	0.28	-
1982	0.26		0.45	0.41	-	0.34	0.43	39	0.37	-
1983	0.26		0.40	0.35	-	0.31	0.38	58	0.32	-
1984	0.27		0.41	0.32	-	0.30	0.37	59	0.30	-
1985	0.28		0.52	0.37	-	0.33	0.45	44	0.37	-
1986	0.23		0.42	0.37	-	0.30	0.40	57	0.32	-
1987	0.25		0.50	0.35	-	0.30	0.43	44	0.35	-
1988	0.20		0.30	0.31	-	0.26	0.31	63	0.26	4.26
1989	0.20		0.30	0.26	-	0.23	0.28	73	0.19	2.95
1990	-		0.20	0.27	-	-	0.24	95	0.16	1.66
1991	-		-	0.24	-	-	-	134	0.18	-
1992	-		-	0.46	0.72	-	-	20	0.29	-
1993	-		-	0.79	1.22	-	-	15	0.65	-
1994	-		-	0.77	1.27	-	-	11	0.70	-
1995	-		-	1.03	1.48	-	-	-	-	-
1996	-		-	1.45	1.82	-	-	-	-	-
1997	0.71		-	1.23	1.60	-	-	-	-	-
1998	0.71		-	0.98	1.35	-	-	-	-	-
1999	0.84		-	0.82	1.77	-	-	-	-	-
2000	0.94		-	1.38	1.92	-	-	-	-	-
2001	0.82	[11]	-	1.18	1.57	-	-	-	-	-
2002	0.85		-	1.07	1.82	-	-	-	-	-
2003	0.97	[12]	-	0.86	2.45	-	-	-	-	-
2004	0.63	[13]	-	1.16	1.79	-	-	-	-	-
2005	0.61	[12]	-	1.30	2.29	-	-	-	-	-

Year		USSR catch/hour trawling (t)				Norway catch/hour trawling (t)		Average CPUE		Total effort (in 1000 hrs trawling)	CPUE 7+	GDR (catch/day tonnage (kg))
		RT		PST		A	B	A	B			
2006		0.57	12	-		0.96	2.09	-	-	-	-	-
2007		0.64	12	-		-	-	-	-	-	-	-
2008		0.48	12	-		-	-	-	-	-	-	-
2009		0.77	13	-		-	-	-	-	-	-	-
2010				1.57	12	-	-	-	-	-	-	-
2011				2.32	12							
2012				2.06	12							
2013				2.25	12							
2014				2.52	12							

[1] Side trawlers, 800–1000 hp. From 1983 onwards, stern trawlers (SRTM), 1000 hp. From 1997 based on research fishing.

[2] Stern trawlers, up to 2000 HP.

[3] Arithmetic average of CPUE from USSR RT (or SRTM trawlers) and Norwegian trawlers.

[4] Arithmetic average of CPUE from USSR PST and Norwegian trawlers.

[5] For the years 1981–1990, based on average CPUE type B. For 1991–1993, based on the Norwegian CPUE, type A.

[6] Total catch (t) of seven years and older fish divided by total effort.

[7] For the years 1988–1989, frost-trawlers 995 BRT (FAO Code 095). For 1990, factory trawlers S IV, 1943 BRT (FAO Code 090).

[8] Norwegian trawlers, ISSC-code 07, 250–499.9 GRT.

[9] Norwegian factory trawlers, ISSCFV-code 09, 1000-1999.9 GRT

[10] From 1992 based on research fishing. 1992–1993: two weeks in May/June and October; 1994–1995: 10 days in May/June

[11] Based on fishery from April-October only, a period with relatively low CPUE. In previous years fishery was carried out throughout the whole year.

[12] Based on fishery from October-December only, a period with relatively high CPUE.

[13] Based on fishery from October-November only.

Table 8.7. Greenland halibut in subareas 1 and 2. Catch history back to 1935.

Year	Norway	Russia	Other	Total	Year	Norway	Russia	Other	Total
1935	1534	-	-	1534	1980	2528	7670	2457	12655
1936	830	-	-	830	1981	3648	9276	1541	14465

Year	Norway	Russia	Other	Total	Year	Norway	Russia	Other	Total
1937	616	-	-	616	1982	2997	12394	1189	16580
1938	329	-	-	329	1983	4509	15152	2112	21773
1939	459	-	-	459	1984	3540	15181	2326	21047
1940	846	-	-	846	1985	5287	10237	4244	19768
1941	1663	-	-	1663	1986	7783	12200	2785	22768
1942	955	-	-	955	1987	6893	9733	2118	18744
1943	824	-	-	824	1988	8811	9430	1081	19322
1944	678	-	-	678	1989	8837	8812	704	18353
1945	1148	-	-	1148	1990	16615	4764	1176	22555
1946	1337	25	-	1362	1991	27585	2490	3243	33318
1947	1409	28	-	1437	1992	7668	718	217	8603
1948	1877	110	-	1987	1993	10379	1235	318	11932
1949	198	177	-	375	1994	8428	283	515	9226
1950	1853	221	-	2074	1995	9368	794	1572	11734
1951	2438	423	-	2861	1996	11623	1576	1148	14347
1952	2576	377	-	2953	1997	7661	1038	711	9410
1953	2208	393	-	2601	1998	8435	2659	799	11893
1954	3674	416	-	4090	1999	15004	3823	690	19517
1955	3010	290	-	3300	2000	9083	4568	646	14297
1956	3493	446	-	3939	2001	10896	4694	784	16374
1957	4130	505	-	4635	2002	7143	5584	566	13293
1958	2931	1261	-	4192	2003	8215	4384	847	13446
1959	4307	3632	-	7939	2004	13939	4662	299	18900
1960	6662	4299	-	10961	2005	13011	4883	940	18834
1961	7977	3836	-	11813	2006	11118	6055	703	17876
1962	11600	1760	-	13360	2007	8230	6484	744	15458
1963	11300	3240	-	14540	2008	7393	5294	1122	13809
1964	14200	26191	-	40391	2009	8446	3335	1201	12982
1965	18000	16682	-	34682	2010	7700	6888	647	15235
1966	16434	9768	119	26321	2011	8348	7053	1283	16684
1967	17528	5737	1002	24267	2012	9331	10041	912	20284
1968	22514	3397	257	26168	2013	10404	10306	1270	21980
1969	14856	19760	9173	43789	2014	10997	10061	1553	22611
1970	15871	35578	38035	89484	2015	10874	12953	1254	25081
1971	9466	54339	15229	79034	2016	12932	10561	1892	25385
1972	15983	16193	10872	43048	2017	13741	10713	1983	26437

Year	Norway	Russia	Other	Total	Year	Norway	Russia	Other	Total
1973	13989	8561	7349	29899	2018	14875	12071	1654	28600
1974	8791	16958	11972	37721	2019	14867	12196	1760	28823
1975	4858	20372	12914	38144	2020	14526	12265	1781	28572
1976	6005	16580	13469	36054	2021	14008	12396	1812	28216
1977	3017	15045	9613	27675	2022*	13800	11746	2109	27655
1978	2980	14651	5884	23515	2023*	13919	11317	1695	26931
1979	2314	10311	4088	16713					

*** Provisional figures.**

Table 8.8. Greenland halibut in ICES Division 4.a (North Sea). Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment.

Year	Denmark	Faroe Islands	France	Germany	Greenland	Ireland	Norway	Russia	United Kingdom	Netherlands	Belgium	Icelar
1973	0	0	0	4	0	0	9	8	28	0	0	0
1974	0	0	0	2	0	0	2	0	30	0	0	0
1975	0	0	0	1	0	0	4	0	12	0	0	0
1976	0	0	0	1	0	0	2	0	18	0	0	0
1977	0	0	0	2	0	0	2	0	8	0	0	0
1978	0	0	2	30	0	0	0	0	1	0	0	0
1979	0	0	2	16	0	0	2	0	1	0	0	0
1980	0	177	0	34	0	0	5	0	0	0	0	0
1981	0	0	0	0	0	0	7	0	0	0	0	0
1982	0	0	2	26	0	0	17	0	0	0	0	0
1983	0	0	1	64	0	0	89	0	0	0	0	0
1984	0	0	3	50	0	0	32	0	0	0	0	0
1985	0	1	2	49	0	0	12	0	0	0	0	0
1986	0	0	30	2	0	0	34	0	0	0	0	0
1987	0	28	16	1	0	0	35	0	0	0	0	0
1988	0	71	62	3	0	0	19	0	1	0	0	0
1989	0	21	14	1	0	0	197	0	5	0	0	0
1990	0	10	30	3	0	0	29	0	4	0	0	0
1991	0	48	291	1	0	0	216	0	2	0	0	0
1992	1	15	416	3	0	0	626	0	1	0	0	0
1993	1	0	78	1	0	0	858	0	10	0	0	0
1994	0	103	84	4	0	0	724	0	6	0	0	0
1995	0	706	165	2	0	0	460	0	335	0	0	0
1996	0	0	249	1	0	0	1496	0	264	0	0	0

Year	Denmark	Faroe Islands	France	Germany	Greenland	Ireland	Norway	Russia	United Kingdom	Netherlands	Belgium	Icelar
1997	0	0	316	3	0	0	873	0	163	0	0	0
1998	0	0	71	10	0	10	804	0	470	0	0	0
1999	0	0	0	1	0	18	2157	0	401	0	0	0
2000	0	0	41	10	0	19	498	0	259	0	0	0
2001	0	0	43	0	0	10	470	0	324	0	0	0
2002	0	0	8	0	0	2	200	0	256	0	0	0
2003	0	0	1	0	0	0	453	0	122	0	0	0
2004	0	0	0	0	0	0	413	0	90	0	0	0
2005	0	0	2	0	0	0	58	0	4	0	0	0
2006	0	0	3	0	0	0	90	0	7	0	0	0
2007	0	1	0	0	0	0	133	0	7	0	0	0
2008	0	0	0	0	0	0	15	0	22	0	0	0
2009	0	9	23	0	0	0	5	0	129	0	0	0
2010	0	1	38	0	0	0	10	0	49	0	0	1
2011	0	1	39	0	0	0	95	0	44	0	0	0
2012	0	0	14	0	0	0	788	0	43	0	0	0
2013	0	0	25	0	0	0	377	0	174	0	0	0
2014	0	2	27	0	0	0	723	0	104	0	0	0
2015	0	0	34	1	0	0	1151	0	127	0	0	0
2016	0	0	31	0	0	0	983	0	120	0	0	0
2017	0	0	20	0	0	0	753	0	73	0	0	0
2018	0	1	15	0	0	0	472	0	42	2	0	0
2019	0	0	21	0	0	0	241	0	14	4	0	0
2020	0	0	10	0	0	0	663	0	45	4	0	0
2021	0	4	19	0	0	0	0	0	121	0	0	0
2022*	0	207	13	0	0	0	522	0	150	0	0	0
2023*	0	58	7	0	0	0	473	0	168	0	0	0

*** Provisional figures.**

Table 8.9. Abundance indices (in thousands) of different length groups in Russian autumn survey.

Year	(0,30]	(30,35]	(35,40]	(40,45]	(45,50]	(50,55]	(55,60]	(60,65]	(65,70]	(70,75]	(75,80]	80+	Total
1984	1138	2975	5319	9159	7185	5597	2256	1731	1539	1033	536	246	38713
1985	5606	2581	5506	7348	6676	3978	2038	1279	1154	834	414	173	37587
1986	2273	3488	6409	8074	7712	6427	2596	1263	1335	918	398	142	41034
1987	1666	2857	4025	4357	3065	1670	696	505	357	162	105	31	19496
1988	1194	1975	2647	2007	1599	1179	270	282	181	69	118	77	11599

Year	(0,30]	(30,35]	(35,40]	(40,45]	(45,50]	(50,55]	(55,60]	(60,65]	(65,70]	(70,75]	(75,80]	80+	Total
1989	419	2180	5852	6088	3742	1990	804	490	448	233	43	30	22318
1990	254	1601	4303	3911	3608	2729	915	309	204	191	41	40	18106
1991	306	1026	3632	5059	3590	2257	639	544	153	128	56	27	17417
1992	36	879	9184	16058	12586	10043	4542	2209	1322	380	173	53	57464
1993	0	72	1456	6016	9200	5377	1954	1324	991	574	145	122	27231
1994	107	87	725	5931	6872	5827	2262	927	602	314	40	41	23736
1995	0	14	1024	10123	12263	5162	1722	1063	640	371	101	32	32516
1996	0	21	1451	17480	30966	17523	5763	1852	1029	576	151	32	76844
1997	70	121	1056	7606	16561	10309	3292	1116	943	436	107	36	41653
1998	26	166	1559	7456	19972	15019	5668	1851	869	285	105	43	53018
1999	236	131	766	5583	16452	15352	6263	2966	1435	446	194	78	49902
2000	755	708	2266	8003	17910	17443	8610	3513	2125	791	221	101	62448
2001	427	1335	4399	11113	23242	20938	9356	4117	2607	1201	518	299	79553
2002	310	1407	3845	7322	9536	5214	2657	1262	678	174	64	25	32494
2003	122	1162	3339	6484	9135	5230	3218	2948	2557	722	301	187	35403
2004	266	1529	6759	9240	13358	11174	7596	5329	3867	1819	674	506	62117
2005	136	1680	4136	8258	8866	8399	4791	3777	2361	852	293	464	44013
2006	73	1565	14827	25958	25724	18234	9501	4934	3461	1506	565	504	106850
2007	678	2394	12640	14752	15438	12187	7122	3749	2186	799	273	152	72369
2008	338	2444	10242	17093	21842	24209	18308	8870	7414	3776	1657	850	117044
2009	80	3270	22312	31713	28283	24096	16933	5995	3994	2158	706	590	140130
2010	144	3998	30662	51444	39762	32576	16815	7180	6761	3539	1334	1259	195474
2011	200	1001	18079	42924	55212	46426	38215	15612	8480	6278	3031	864	236322
2012	10	524	8728	39585	41830	33768	23212	9040	5025	3093	1598	835	167248
2013	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	16	1319	8446	30085	37787	26980	16527	5917	3299	1657	571	360	132964
2015	39	1119	9310	29876	34420	24963	12575	6904	2702	820	506	183	123416
2016	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	7	1270	5064	14951	24982	29977	17329	7054	3473	1502	343	387	106339
2018	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	144	2186	13500	27130	28572	22536	13943	5825	3080	1654	707	466	119742

Table 8.10. Abundance indices of different length groups in Norwegian autumn slope survey (in thousands).

Year	(0,30]	(30,35]	(35,40]	(40,45]	(45,50]	(50,55]	(55,60]	(60,65]	(65,70]	(70,75]	(75,80]	(80,200]	Sum
1996	2	29	1009	10692	20030	11244	3760	1536	1014	411	133	58	49918
1997	1	80	1421	10690	19311	10802	3807	1837	1052	484	184	95	49764

1998	3	74	957	5763	14474	12658	5265	2243	1309	523	192	115	43577
1999	3	57	550	4629	13893	15236	6684	3356	2305	922	393	176	48203
2000	8	169	1121	4495	9538	11646	5816	2590	1347	590	220	111	37650
2001	22	355	1955	5980	11835	12829	6680	3084	1863	694	317	131	45746
2002	43	449	1897	5234	9620	11161	6319	2987	1571	636	239	126	40281
2003	23	748	3515	6958	10931	13029	8279	4769	2547	928	469	222	52419
2004	22	1014	3674	5504	8941	11044	6255	4019	2176	968	402	232	44251
2005	110	2128	5859	8307	8145	6792	4108	2866	1724	670	294	199	41202
2006	35	1214	5140	7416	8448	8047	5092	3315	2022	809	370	253	42162
2007	144	4034	18450	16416	10410	6954	4086	2026	1125	414	163	110	64331
2008	458	6041	12820	11714	7884	5978	3023	1743	1110	440	149	176	51538
2009	54	2645	13536	16751	11332	8344	4747	2413	1823	711	284	211	62851
2011	0	377	5536	14368	13765	10668	5352	1793	1612	881	440	330	55123
2013	4	134	2420	11053	12859	7408	3880	1389	688	357	213	115	40520
2015	9	774	3982	13688	15619	9195	4165	1859	867	440	194	151	50943
2017	18	342	2259	6006	9796	8924	5035	1841	832	259	132	125	35570
2019	0	677	4192	8117	9053	5738	3064	1215	570	222	73	84	33005
2021	86	1644	4635	10264	12302	9064	4643	2445	917	275	112	32	46418
2023	362	2698	3624	5179	6120	5472	2881	1388	557	183	44	63	28571

Table 8.11. Abundance indices of females of different length groups in Norwegian autumn slope survey (in thousands).

Year	(0,30]	(30,35]	(35,40]	(40,45]	(45,50]	(50,55]	(55,60]	(60,65]	(65,70]	(70,75]	(75,80]	(80,200]	Sum
1996	0	11	334	2127	4277	2893	1893	1347	942	404	133	58	14420
1997	0	42	657	2052	3711	2902	1897	1643	1008	484	182	95	14671
1998	2	26	353	1037	2785	3986	2864	2050	1281	521	192	115	15210
1999	1	11	207	880	2367	4214	3510	2996	2235	906	385	176	17889
2000	5	64	435	1083	1377	2012	2428	2109	1292	589	220	111	11725
2001	11	159	758	1407	1648	1905	2556	2595	1838	694	317	131	14020
2002	29	207	733	1243	1297	1749	2297	2352	1528	632	239	126	12434
2003	18	345	1649	2009	1670	2340	3434	4121	2493	925	469	222	19695
2004	9	445	1534	1550	1436	2113	3029	3675	2145	950	401	232	17517
2005	35	737	1910	1925	1254	1341	2093	2576	1703	668	294	199	14735
2006	19	542	2096	2163	1789	1587	2158	2890	1971	801	369	249	16634
2007	85	2111	8639	6230	2667	1620	1897	1735	1106	405	163	107	26766
2008	249	3159	5536	3703	2137	1456	1463	1577	1095	440	149	175	21137
2009	28	1052	5223	5459	3072	2176	2155	2038	1736	700	268	200	24107
2011	0	149	1623	2757	2367	1578	1063	1354	1553	875	440	330	14088
2013	0	35	492	1632	2023	1421	1004	1035	679	354	213	115	9003

2015	5	308	1385	1954	2623	2502	1694	1374	854	440	194	151	13484
2017	15	169	864	1435	1863	1725	1908	1270	820	259	132	125	10587
2019	0	321	1714	2004	1867	1530	1379	952	531	222	73	84	10678
2021	40	851	1775	1793	2203	1798	2152	2066	880	275	112	32	13976
2023	164	1284	1578	1298	1390	1338	1318	1187	546	183	44	63	10392

Table 8.12. Reference points, values, and their technical basis for NEA G. halibut.

Framework	Reference point	Value	Technical basis
MSY approach	MSY	19142 t	Maximum sustainable yield
	HR_{MSY}	0.139	HR (>=45cm) leading to MSY
Precautionary approach	B_{lim}	33391 t	Lowest modelled mature female substock biomass
	B_{pa}	46747 t	B_{lim} x 1.4
	$B_{trigger}$	46747 t	B_{pa}
	HR_{lim}	0.165	HR (>=45cm) leading to P(SSB<B_{lim})=0.5
	HR_{pa}	0.145	HR(>=45cm), when ICES AR is applied, leading to P(SSB > Blim) = 0.05

Table 8.13. Greenland halibut in ICES subareas 1 and 2 (Northeast Arctic). Annual catch scenarios for 2025. All weights are in tonnes. The advice basis using HR MSY and three other scenarios are listed in the first column. Columns thereafter: total allowable catch (TAC), harvest rate (HR) for ≥ 45 cm fish, female spawning stock biomass (SSB) in the beginning of 2026.

Basis	Total catch (2025)	HR (2025)	SSB (2026)	% Biomass change *	% TAC change **	% Advice change ***
ICES advice basis						
MSY approach: HR_{MSY} x SSB_{2025}/B_{pa}	12 431	0.117	41 231	4.5	-42	-20
Other scenarios						
HR_{MSY}	14 726	0.139	40 214	1.9	-31	-5.4
HR=0	0	0	46 739	18	-100	-100
Assumed catch in 2024	23 050	0.217	35 756	-9.4	8.5	48

*** SSB start of 2026 relative to end of 2024.**

**** Advice value for 2025 relative to the TAC value in 2024 (21 250 tonnes).**

***** Advice value for 202 5 relative to the advice value for 202 4 (15560 tonnes) .**

Table 8.14. Greenland halibut in ICES subareas 1 and 2 (Northeast Arctic). Annual catch scenarios for 2026. All weights are in tonnes. The advice basis using HR MSY and three other scenarios are listed in the first column. Columns thereafter: total allowable catch (TAC), harvest rate (HR) for ≥ 45 cm fish, female spawning stock biomass (SSB) in the beginning of 2027.

Basis	Total catch (2026)	HR (2026)	SSB (2027)	% Biomass change *	% TAC change **	% Advice change ***
ICES advice basis						
MSY approach: HR_{MSY} x SSB_{2026}/B_{pa}	14 891	0.123	43 042	9.1	-30	-4.3

Other scenarios						
HR_{MSY}	16 538	0.139	41 278	4.6	-22	6.3
HR=0	0	0	55 330	40	-100	-100
Assumed catch in 2024	23 050	0.209	33 330	-16	8.5	48

*** SSB start of 2027 relative to end of 2024, i.e the cumulative change over the 2-year advice period.**

**** Advice value for 2026 relative to the TAC value in 2024 (21 250 tonnes).**

***** Advice value for 202 6 relative to the advice value for 202 4 (15 560 tonnes) .**

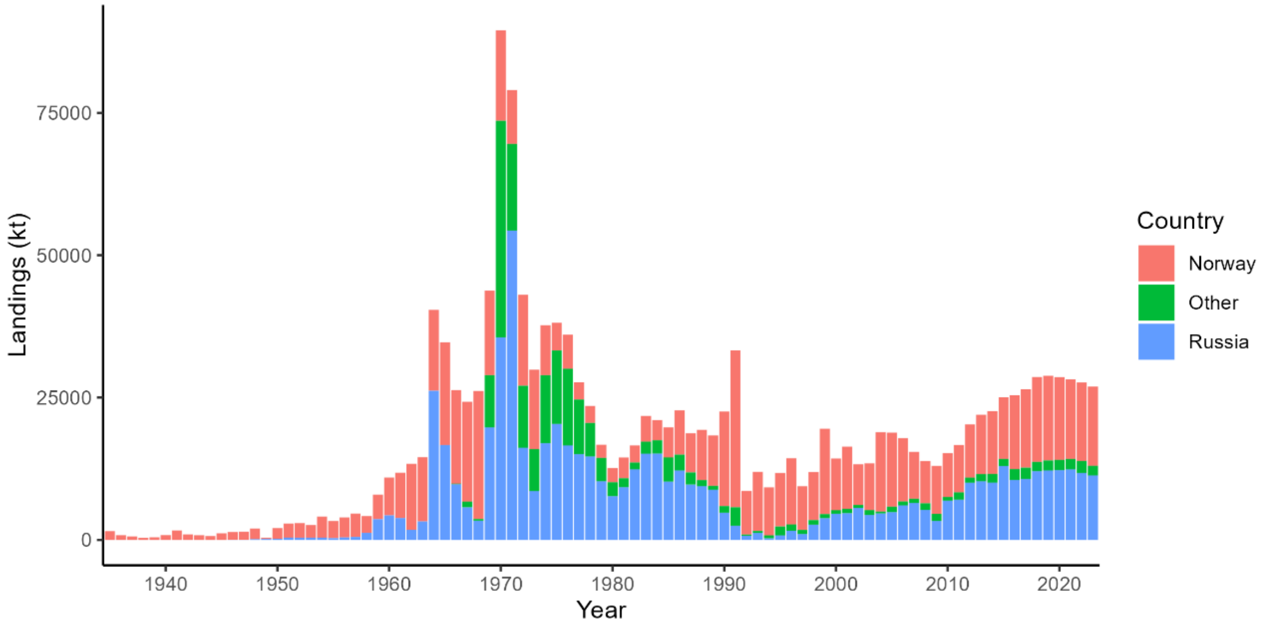

Figure 8.1. NEA Greenland halibut landings. Historical landings (Nedreaas and Smirnov 2003 and AFWG).

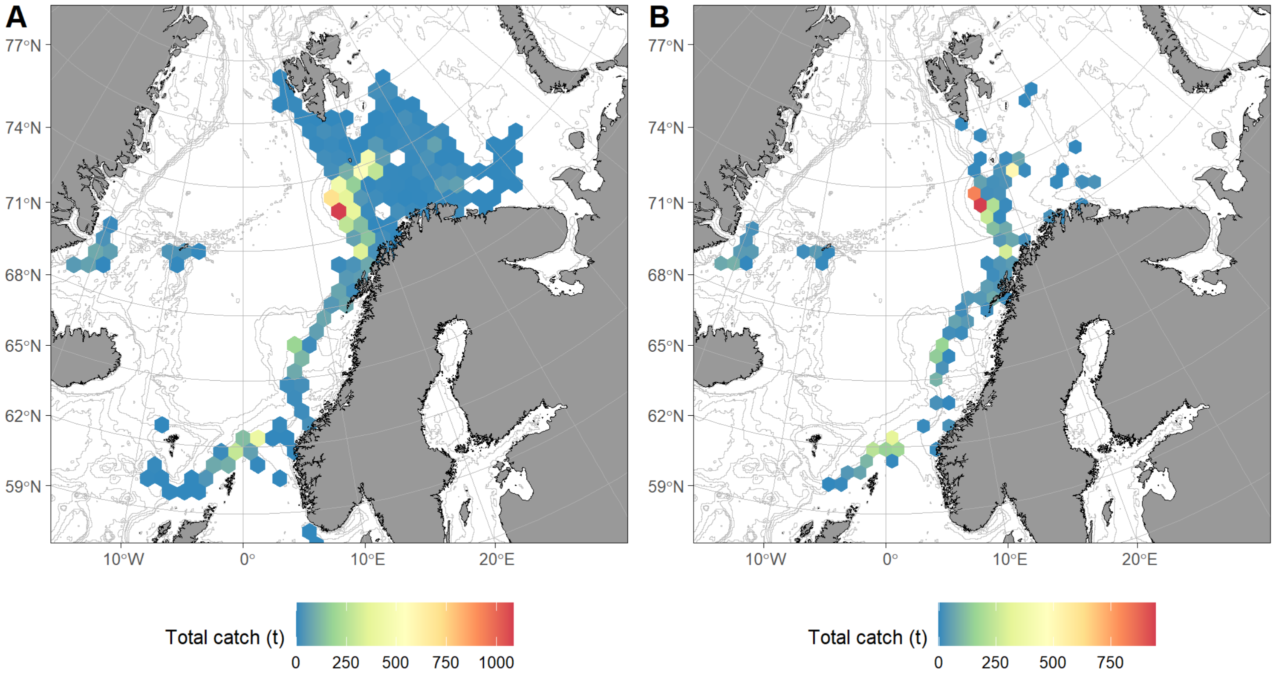

Figure 8.2. Spatial distribution of Greenland halibut catches in 2023 according to Norwegian electronic logbooks, in all registered fisheries including bycatch (A), and catches where Greenland halibut make more than 50% of the total catches (B).

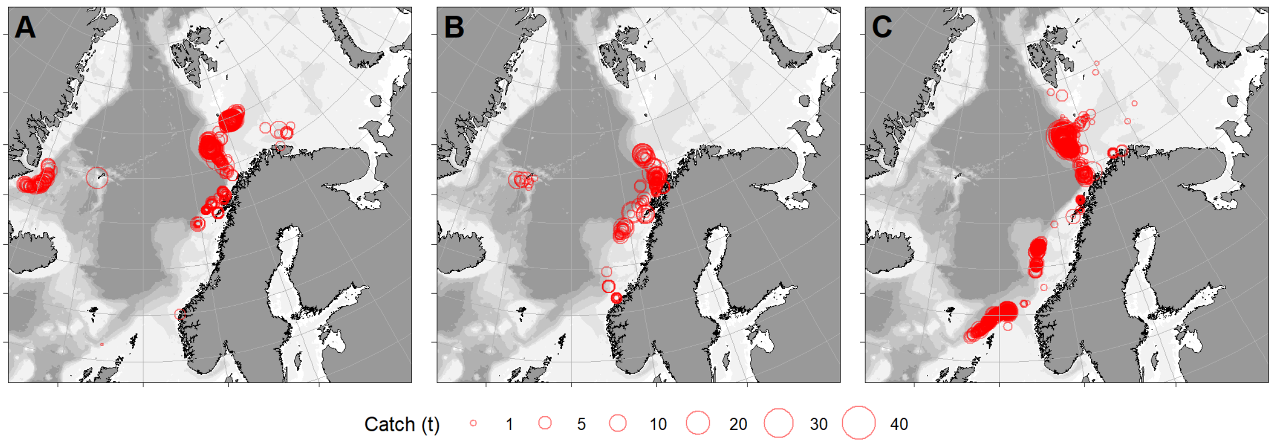

Figure 8.3. Spatial distribution of catches where Greenland halibut make more than 50% of the total catches, according to Norwegian electronic logbooks from 2023. Bubble area is proportional to the size of single catches expressed in metric tonnes. The panels show longline (A), gillnet (B) and trawl (C) catches.

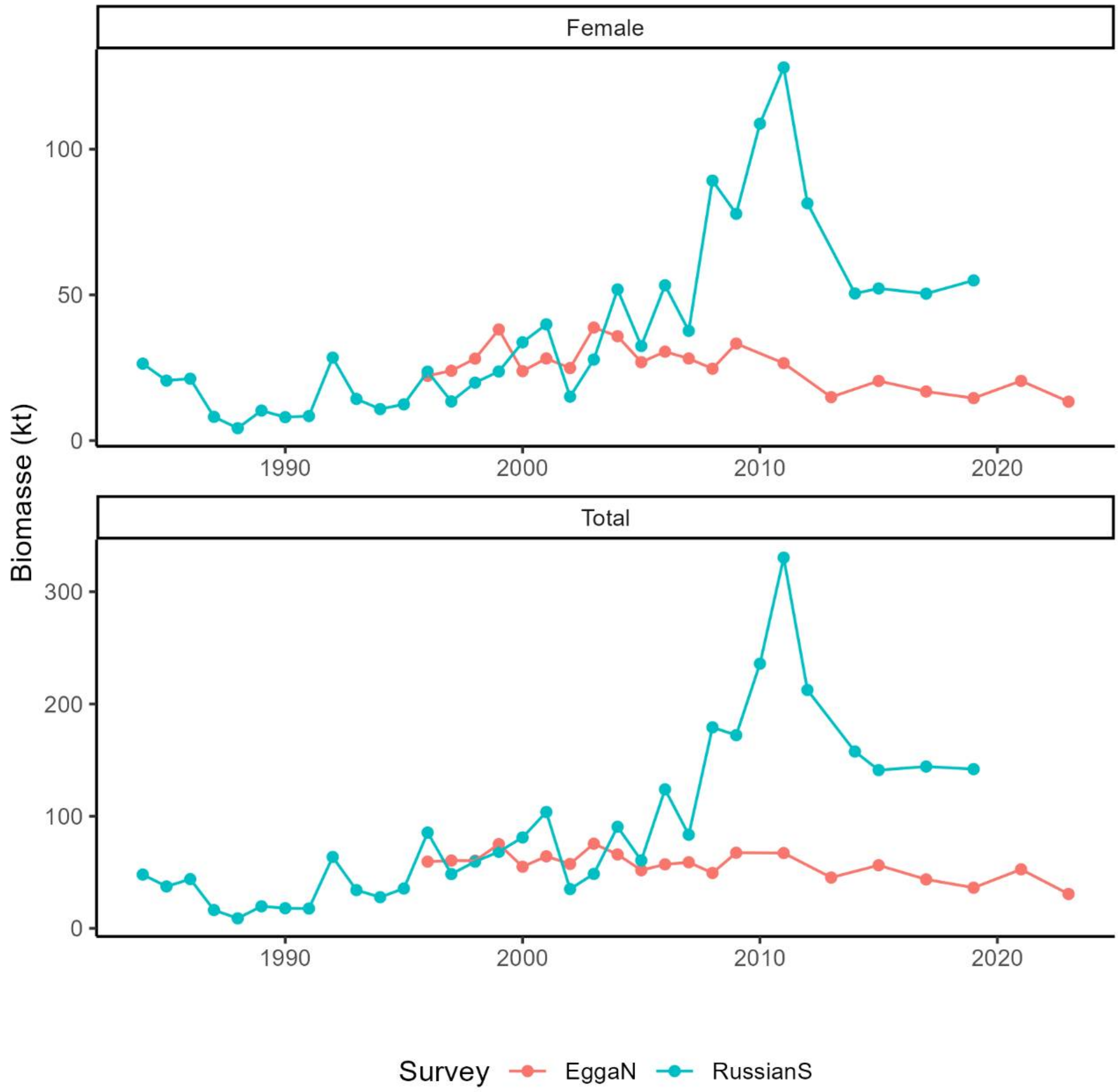

Figure 8.4. NEA Greenland halibut. Total biomass estimates from Russian autumn survey and the Norwegian slope survey (for females (top panel) and sexes combined (bottom panel)). Note that the Norwegian survey is run every other year since 2009. Uncertain estimate for 2013 from the Russian survey. Russian data from 1992 and onwards are revised in 2021 (Russkikh WD12). No Russian data for 2016, 2018 and from 2020 and after.

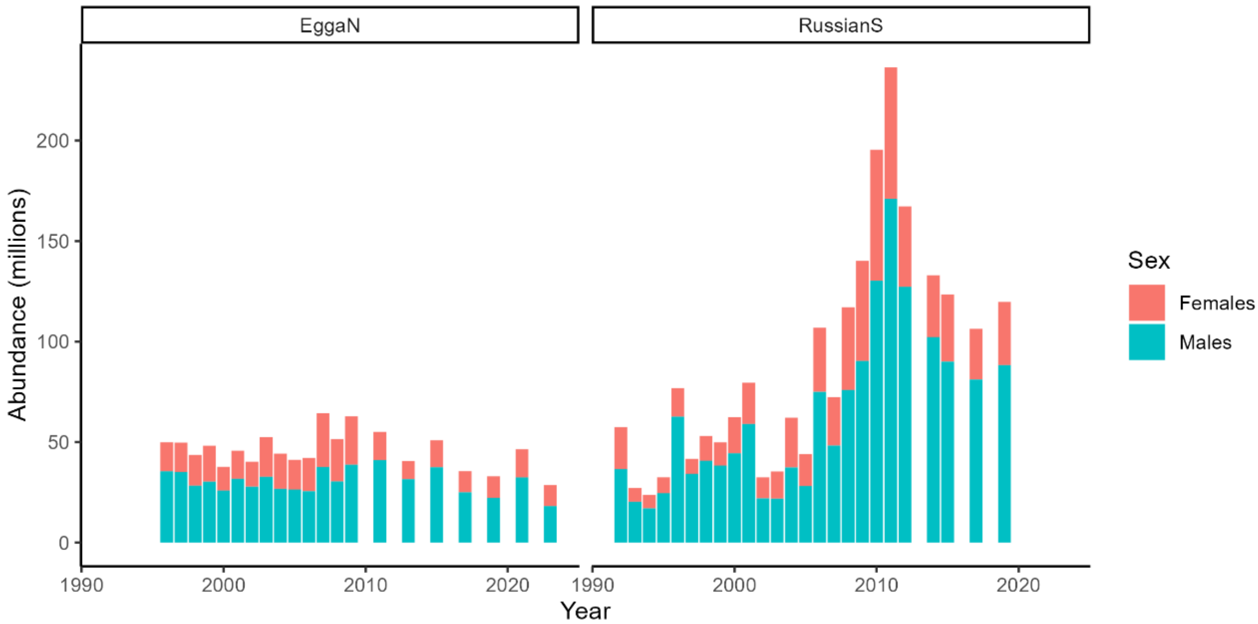

Figure 8.5. Greenland halibut abundance by sex for Russian autumn survey (Russkikh and Smirnov, WD16 AFWG 2016) and Norwegian slope survey. Russian data from 1992 and onwards are revised in 2021 (Russkikh WD12).

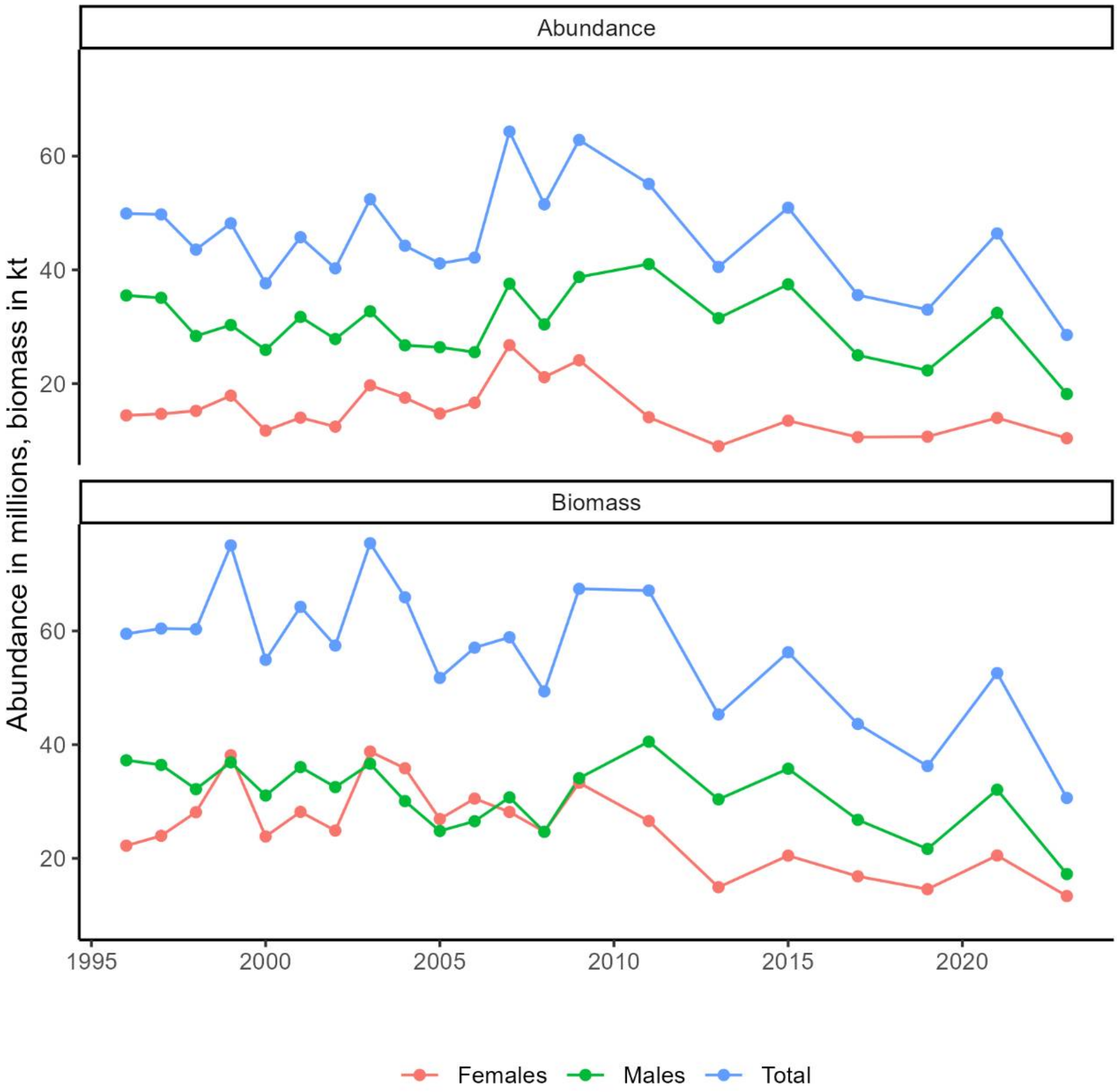

Figure 8.6. Estimated Greenland halibut abundance (upper panel) and biomass (lower panel), by sex, from the Norwegian autumn slope survey.

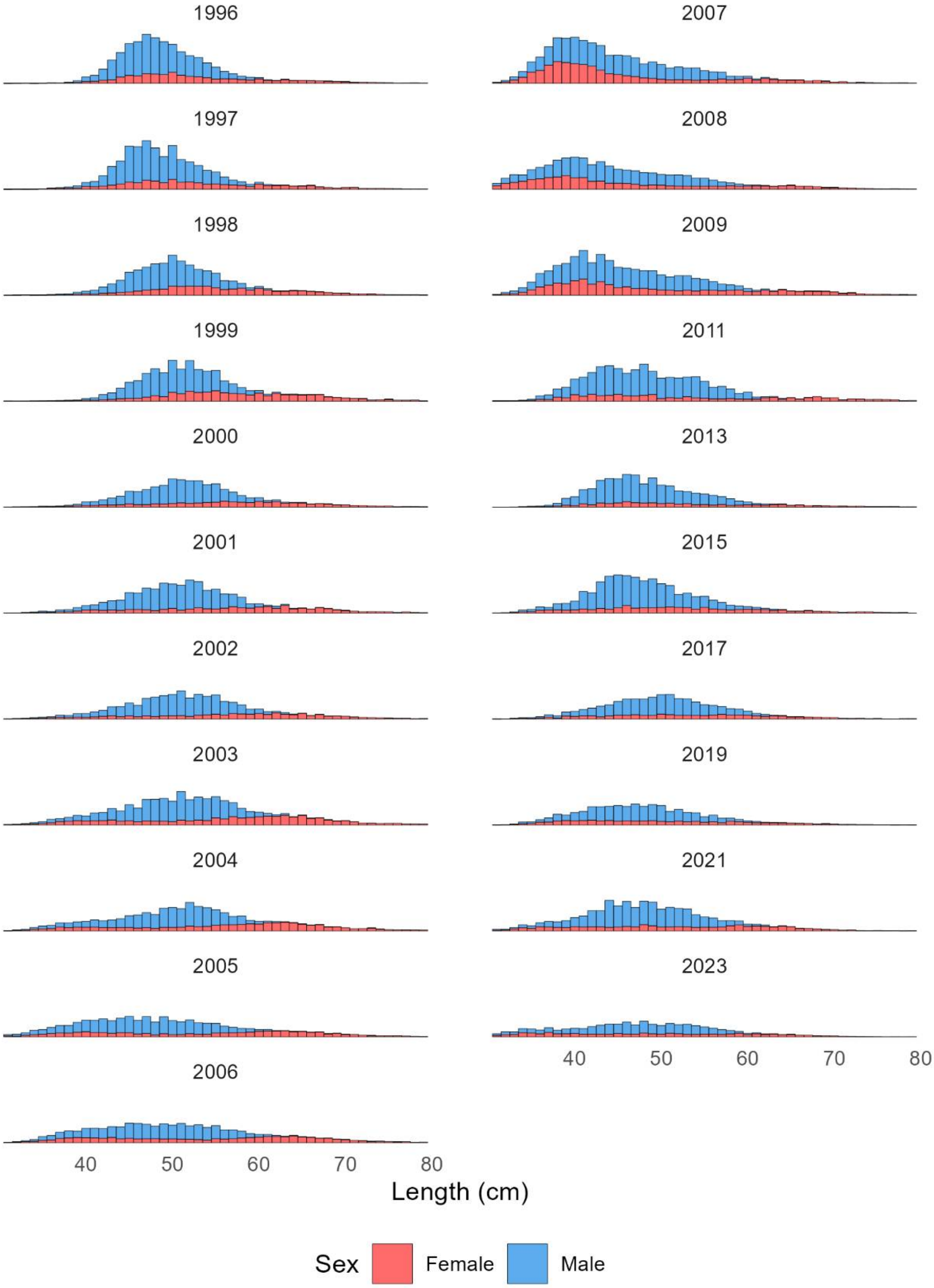

Figure 8.7. Length frequency distribution in the EggaN abundance index. Note biennial surveys after 2009.

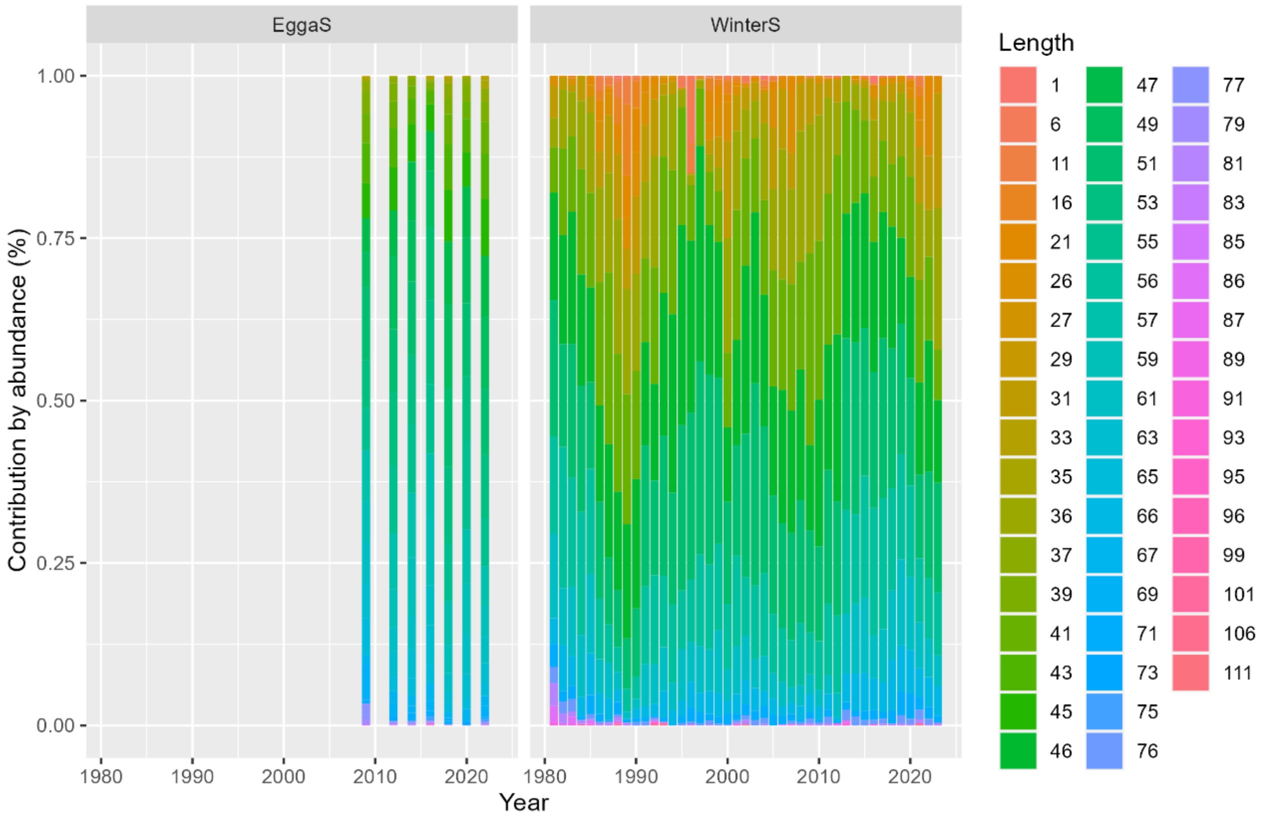

Figure 8.8 Length distributions from survey data: EggaS (left) and WinterS (right).

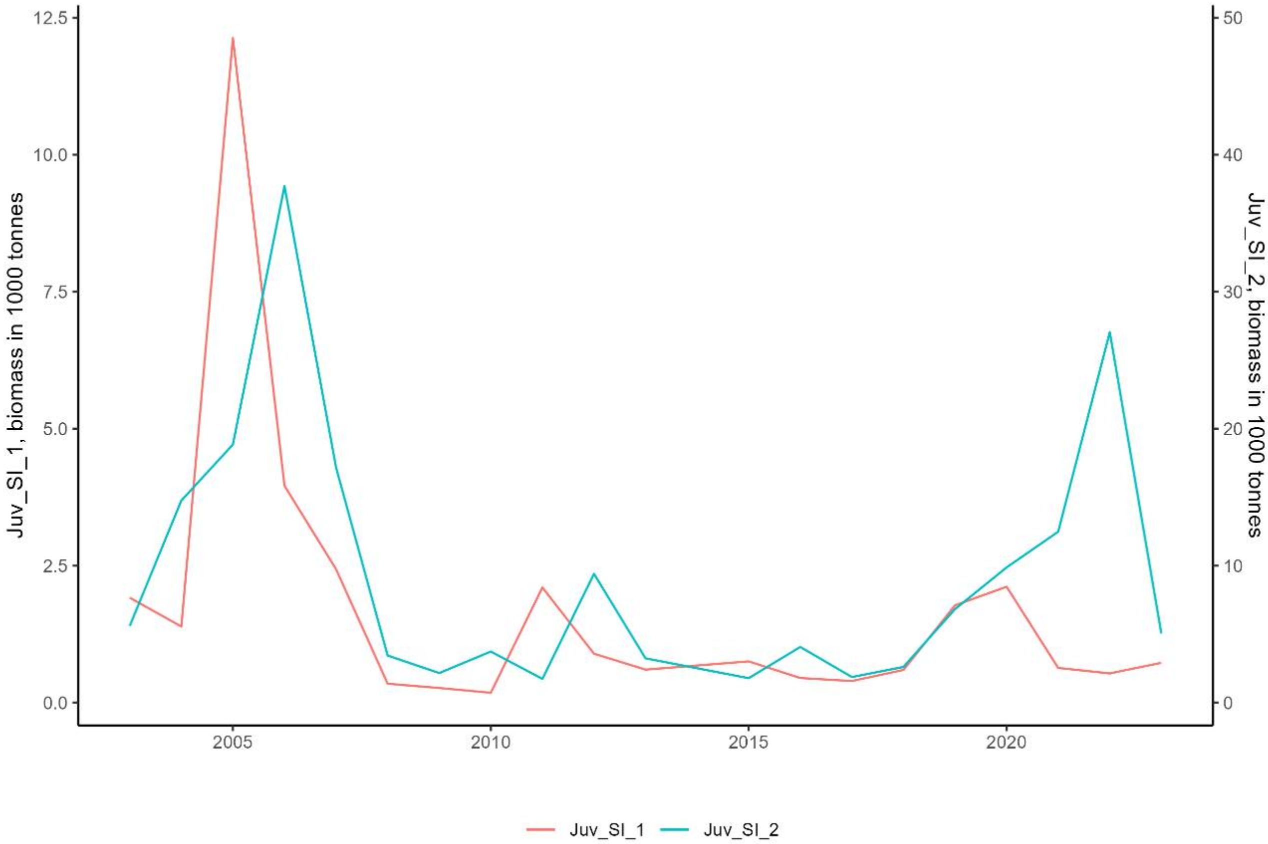

Figure 8.9. Total juvenile biomass indices Eco_SI_1 (10-17cm) and Eco_SI_2(18-27cm) (sex distribution is assumed 50/50 in the juvenile area) for Greenland halibut based on the Barents Sea Ecosystem Survey (A5216) (2014 not included due to poor survey coverage in the juvenile area) and the juvenile survey 1996−2002 (for area see Hallfredsson and Vollen, WD20 AFWG 2015).

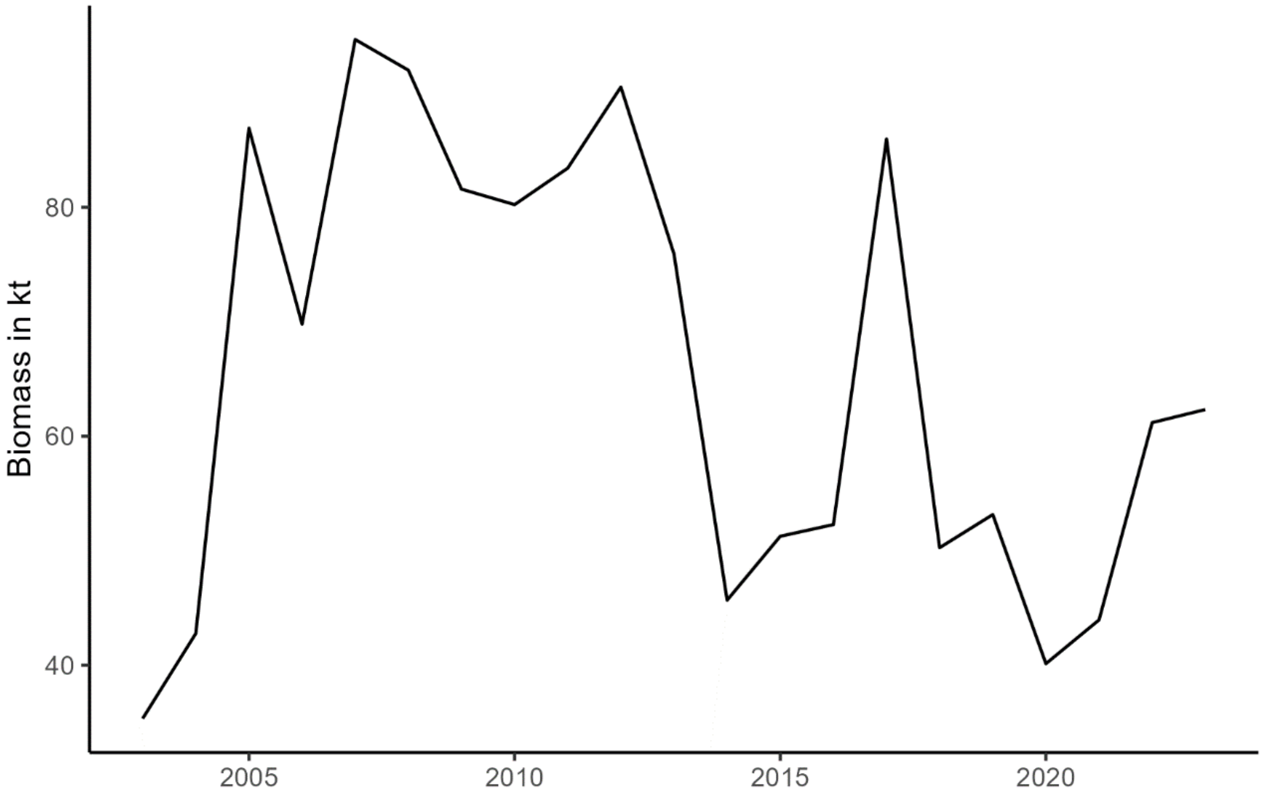

Figure 8.10. EcoS biomass index for Greenland halibut in the Barents Sea Ecosystem Survey (A5216)

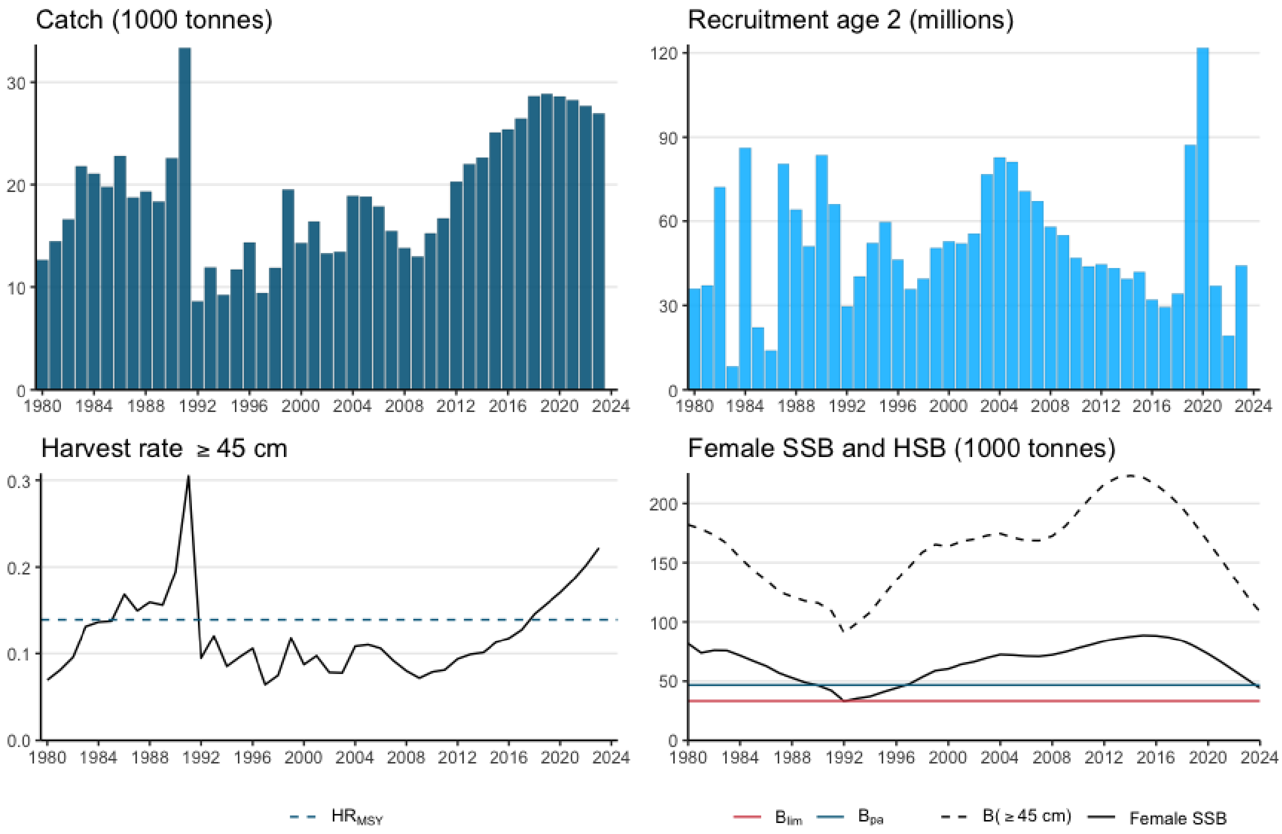

Figure 8.11. From top left to bottom right: Catch (1000 tonnes), recruitment estimate (in millions) for 2 year olds, harvest rate and Spawning stock biomass (SSB) and total stock biomass (TSB) for Greenland halibut as estimated by the GADGET model. Note that the recruitment spike around 2019-2020 is uncertain.

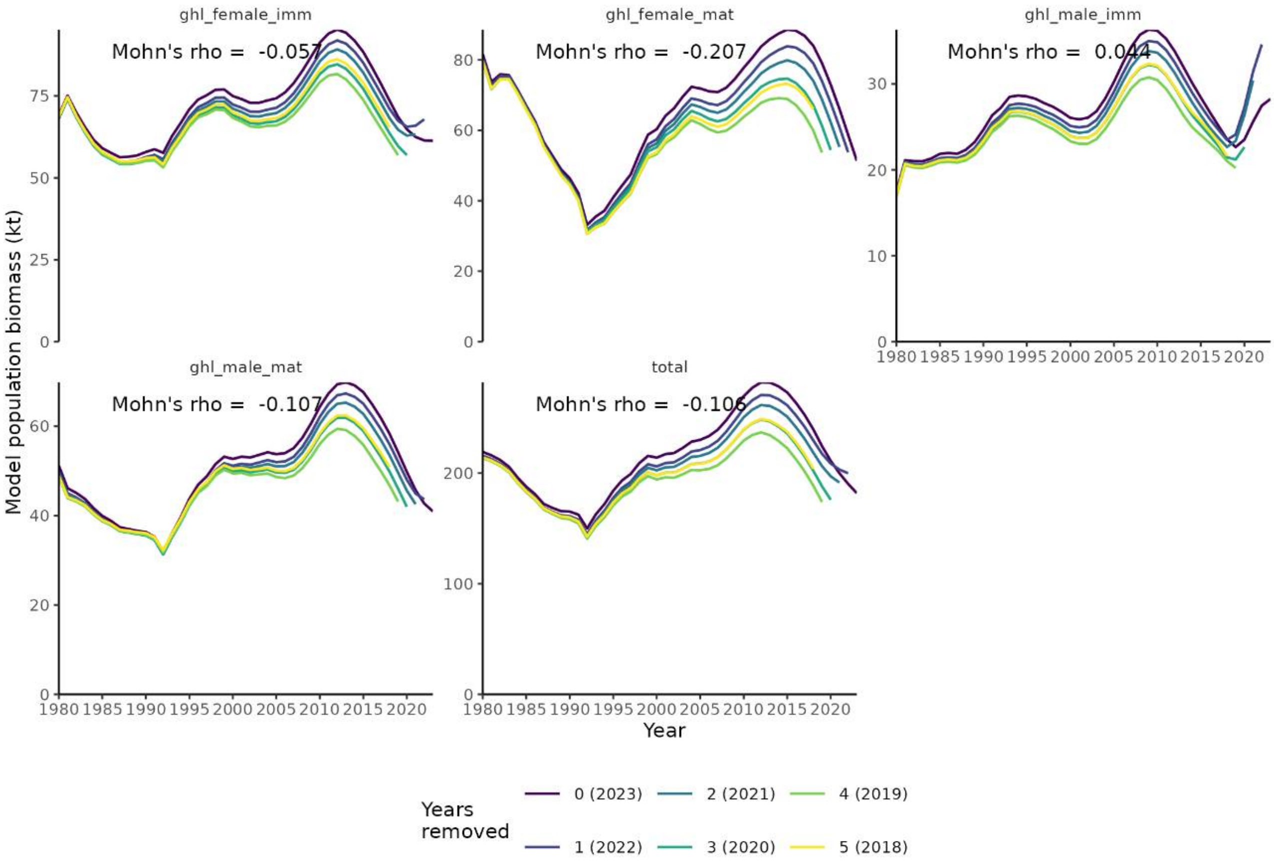

Figure 8.12. Retrospective analysis using model biomass for each sub-stock and total biomass. Colors are scaled to the number of years removed.

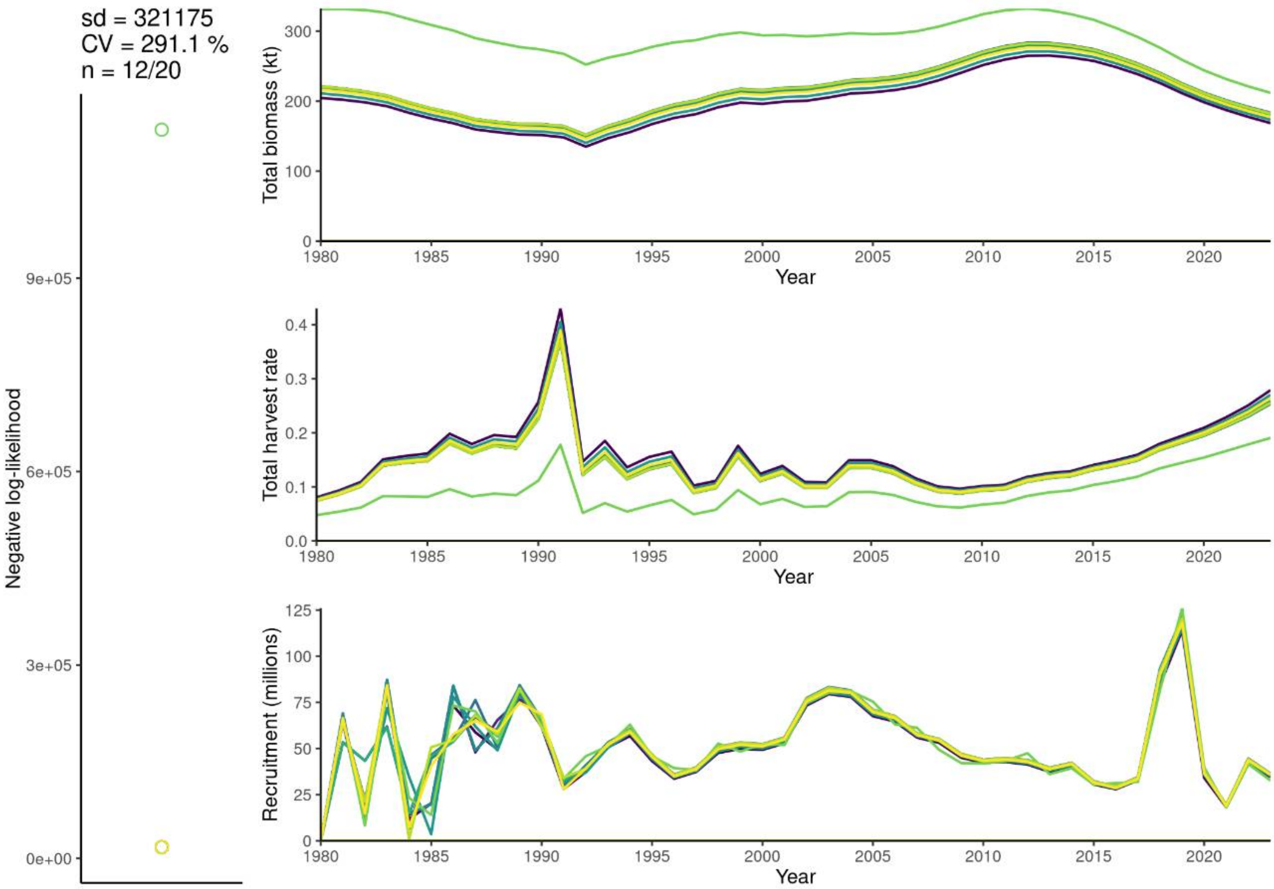

Figure 8.13. Jitter results for the model. Negative log-likelihood scores of jitter runs are shown on the left together with standard deviation and CV (in percentage). Total biomass, harvest rate and recruitment are on top of each other on the right. Colour indicates the run number and is standardized across all panels.

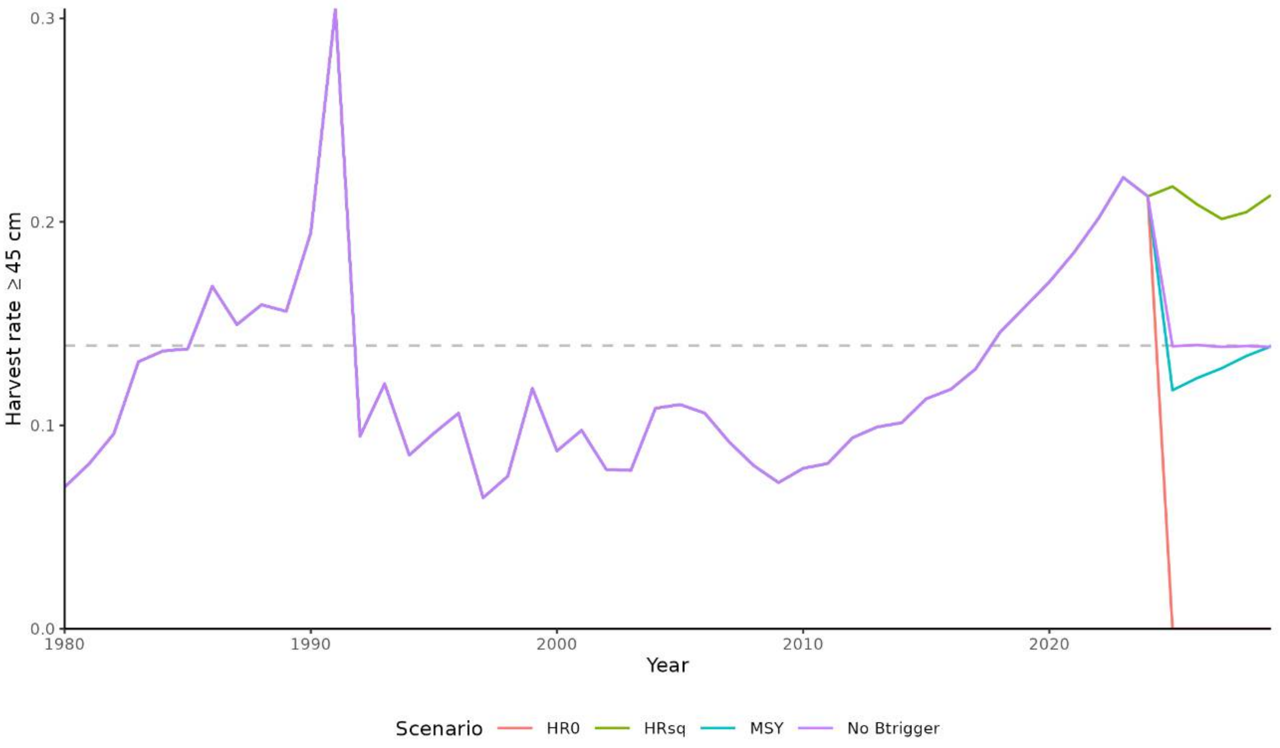

Figure 8.14. Internal harvest rates of short-term projection scenarios. Harvest rates are influenced by B pa .

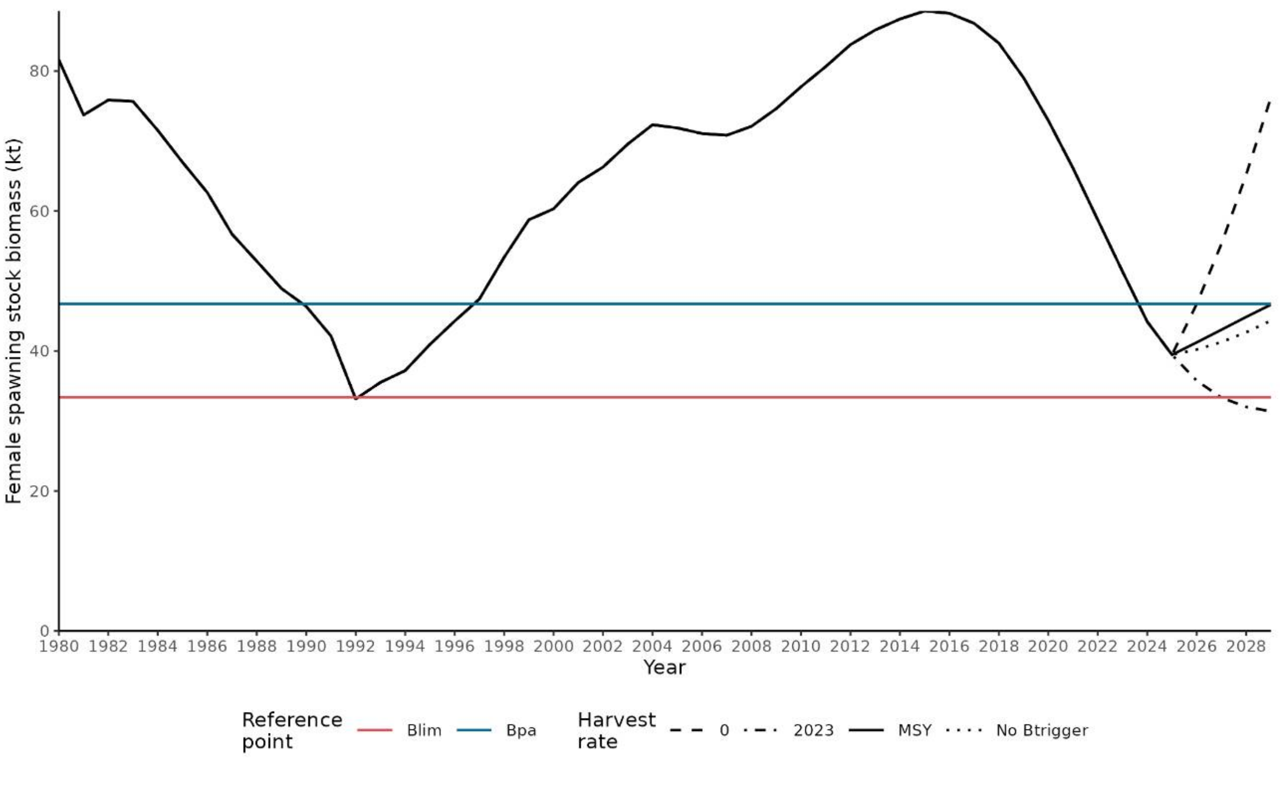

Figure 8.15. Female spawning stock biomass (SSB) of short-term projection scenarios.

1 Greenland halibut (*Reinhardtius hippoglossoides*) in subareas 1 and 2 (Northeast Arctic); ghl.27.1-2.

Annex 1: Working Document no. 6

Analysis of the NEA Cod recruitment prediction quality

Introduction

AFWG/JRN-AFWG currently use the Hybrid model to estimate recruitment of NEA cod at the age of 3 (Anon. 2013). The model comprises three components – TES, TEL, RCT3 (Titov, 2021; Shepherd, 1997). Over the last few years, errors in recruitment forecast derived from the Hybrid model have considerably increased. This reason has brought us to test the forecast quality of the three models using the retrospective analysis provided in the methodology. Additionally, five new alternative models - M1, M2, M4, M5, M6 (Trofimov, 2023) - and different scenarios of the persistence forecast were also tested.

Materials and Methods

The study is based on data from the 2023 JRN-AFWG meetings.

Equations of the models and coefficients of determination are given in Table 1. The TES and TEL models use the environmental data collected on the Kola Section (Annex A, Table A1). The RCT3 model uses abundance indices from research surveys of cod at the age of 0, 1, and 2 (Annex A, Table A2). The new models (M1 – M6) use environment and cod spawning stock biomass as predictors (Annex A, Table A3). The models enable forecasting recruitment for various time ahead: TES - 1-2 years in advance, TEL - 1-4 years, RCT3 - 1-3 years, M1, M2, M5 - 1-2 years, M4 - 1 year, M6 - 1-3 years (Trofimov, 2023).

Table 1. Regression equations for the NEA cod recruitment forecast at the age of 3 and coefficients of determination for the models configured based on the full dataset available.

Model's Acronym	Regression Equation	R^2
TES	$R3 \sim DOxSat_{t-13}{}^2 + ITw_{t-43} + expIce_{t-40} + Ice_{t-15}$	0.59
TEL	$R3 \sim OxSat_{t-39} + ITw_{t-43}$	0.36
RCT3	R3 ~ BST1 +BST2 + BST3 + BSA1 + BSA2 + BSA3	-
M1	$R3 \sim Tw_{-3} + FLI_{-3}$	0.24
M2	$R3 \sim Storms_{-3} + Tw_{-3} + FLI_{-3}$	0.26
M4	$R3 \sim Tw_{-1} + FLI_{-3} + SSB_{-3}$	0.37
M5	$R3 \sim Tw_{-2} + FLI_{-3} + SSB_{-3}$	0 .20
M6	$R3 \sim Tw_{-3} + FLI_{-3} + SSB_{-3}$	0 .23

A subscript indicates a lagged predictor (in years for M models and months for TES and TEL)

The following parameters were used in the models:

TES and TEL models

$DOxSat_{t-13}{}^2$ - a parameter indicating that aeration of bottom layers has a complicated impact on the abundance of cod year-classes;

$OxSat_{t-39}$ - monthly anomalies of saturation with oxygen in bottom layers at Stations 3-7 of the Kola Section;

ITw $_{t-43}$ - a feature of active interaction between Arctic and boreal ocean systems on the Barents Sea shelf;

Ice $_{t-15}$ - monthly average anomalies of ice conditions in the Barents Sea (the percentage ratio of an ice-covered area to the overall area);

expIce $_{t-40}$ - an exponent of the parameter Ice $_{t-40}$;

"t-k" next to a parameter means the latter is applied with a k-month lag.

RCT3 model

BST1, BST2, BST3 are abundance indices of trawl catches from the February survey at the age of 1, 2, and 3;

BSA1, BSA2, BSA3 are acoustic indices from the February and Lofoten surveys at the age of 1, 2, and 3

M1-M6 models

wNAO - winter index of the NAO (North Atlantic Oscillation);

Storms - storm activity above the Barents Sea;

Tw - the temperature of Atlantic waters in the Kola section;

FLI - the length index of thermal frontal zones of the Barents Sea;

SSB - spawning stock biomass of NEA cod;

-1 next to a parameter means that the latter is applied with one-year lag (similarly -3 is a 3-year lag).

Results

The results of the forecasts made for a retrospective period of 2010-2022 by configured models are given in Table 2. Each of the forecasts was made while setting the models using all data available including the year preceding the year of the forecast, i.e. coefficients of equations were changed for each of the forecasts in the retrospective.

Table 2. The results of the retrospective forecasts of cod recruitment at the age of 3 by different models, and "true" recruitment values (as estimated by JRN-AFWG in 2023).

Year	TES_1	TEL_1	RCT3_1	TES_2	TEL_2	RCT3_2	TEL_3	RCT3_3	TEL_4	R3 fact
2010	429963	268790	218783			457975		731500		205517
2011	343148	295954	368131	369514	300072	664085		593655		363991
2012	343207	290064	477902	341501	286545	453712	290600	658421		510052
2013	670599	618883	384057	662654	614753	556172	613414	546706	614609	471175
2014	761859	661909	698943	780945	664695	613273	661208	836924	660039	854919
2015	583804	607977	640748	576658	602474	1015260	605004	955217	599357	452525
2016	346312	406355	664434	354775	419309	1004147	413350	482939	415662	285806
2017	592125	528864	763196	595769	534347	432163	540097	536758	535828	770881
2018	784667	682861	522673	767749	676294	722142	683000	761351	690740	492321
2019	583086	554912	948465	606025	560848	989306	554254	685093	560697	635422
2020	493876	502494	881363	490547	498210	746192	510067	385523	498872	540952

2021	558380	588099	510993	556169	586192	315413	583827	388660	590183	386652
2022	614112	602544	244140	621029	609899	342082	606869	494901	603692	197418

An index next to the acronym indicates the time ahead of a forecast ("_1" is a forecast for a year ahead)

Table 2 (continued)

Year	M1_1	M2_1	M4_1	M1_2	M2_2	M5_1	M5_2	M6_1	M6_2	M6_3
2010	721403	692425	560213			610350		734671		
2011	459259	438650	468824	608576	589437	503591	625848	508768	664696	
2012	499871	480753	658033	518672	496045	669632	708275	627759	665322	810862
2013	204481	233083	353094	201610	225144	326267	395485	317007	369425	437364
2014	602930	619334	1232034	586965	603580	1237695	1186676	987173	927850	993699
2015	704726	703236	915112	690076	689641	889062	1104750	953006	1025272	947723
2016	491328	394738	718498	528656	432341	671535	879541	632305	850173	940718
2017	434831	361921	566405	459930	383945	549545	671896	476070	592891	795476
2018	546719	469913	560996	510647	394699	608547	570729	579398	530679	611012
2019	595058	550967	477652	601837	546820	515714	531525	578452	588296	560140
2020	724588	644775	665343	720824	631435	707720	698863	743963	739058	747196
2021	580701	494388	482874	594132	513401	492166	499301	570324	584097	577462
2022	421299	365699	412999	434145	378634	418376	425584	417841	430180	437129

An index next to the acronym indicates the time ahead of a forecast ("_1" is a forecast for a year ahead)

Forecasts for 2 years ahead in all models are highly similar to the one-year-ahead forecast made in the next year (e.g., for TES - Figure 1, Figure 2), with extremely high coefficient of determination between pairs of the forecasts (Table 3). This is deemed natural as the same data series with a different lag are used and the difference only originates from adding one year into the input data series and some changes being made to the parameters of the equation. RCT3 is the only exception since this model uses different datasets for forecasts with different lead times (Figure 3).

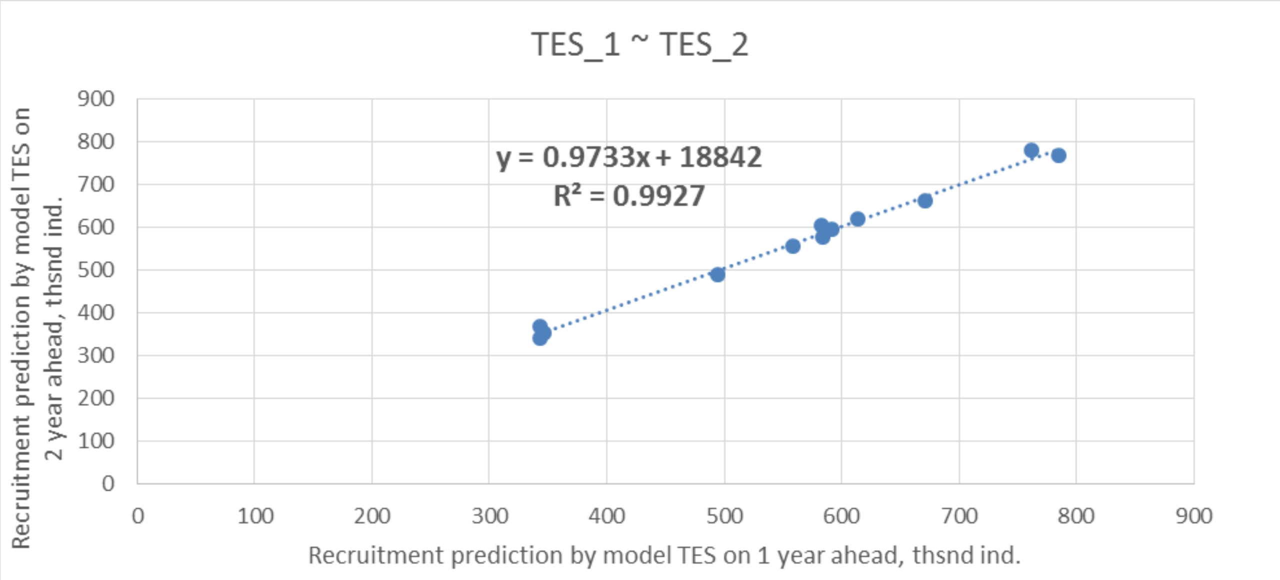

Figure 1. Correlation between retrospective TES forecasts for 1 and 2 years ahead.

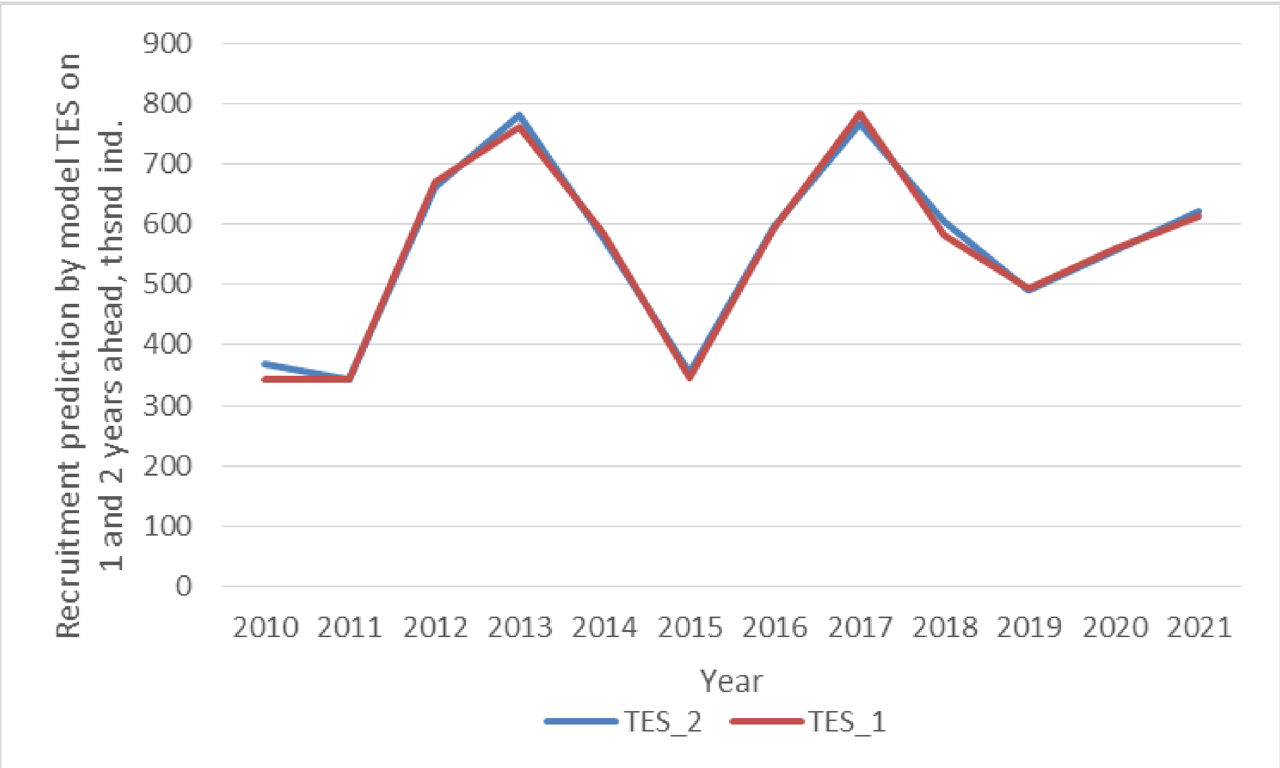

Figure 2. Comparison of recruitment between retrospective TES forecasts for 1 and 2 years ahead.

Table 3. Coefficients of determination between retrospective forecasts of the models for 1-4 years ahead within each thereof.

	TES_1~ TES_2	TEL_1~ TEL_2	TEL_1~ TEL_3	TEL_1~ TEL_4	RCT3_1~ RCT3_2	RCT3_1~ RCT3_3	M1_1~ M1_2	M2_1~ M2_2	M4_1~ M4_2

R^2	0.99	1.00	1.00	0.92	0.33	0.00	0.89	0.85	0.89
	M5_1~ M5_2	**M6_1~ M6_2**	**M6_1~ M6_3**						
R^2	0.87	0.83	0.65						

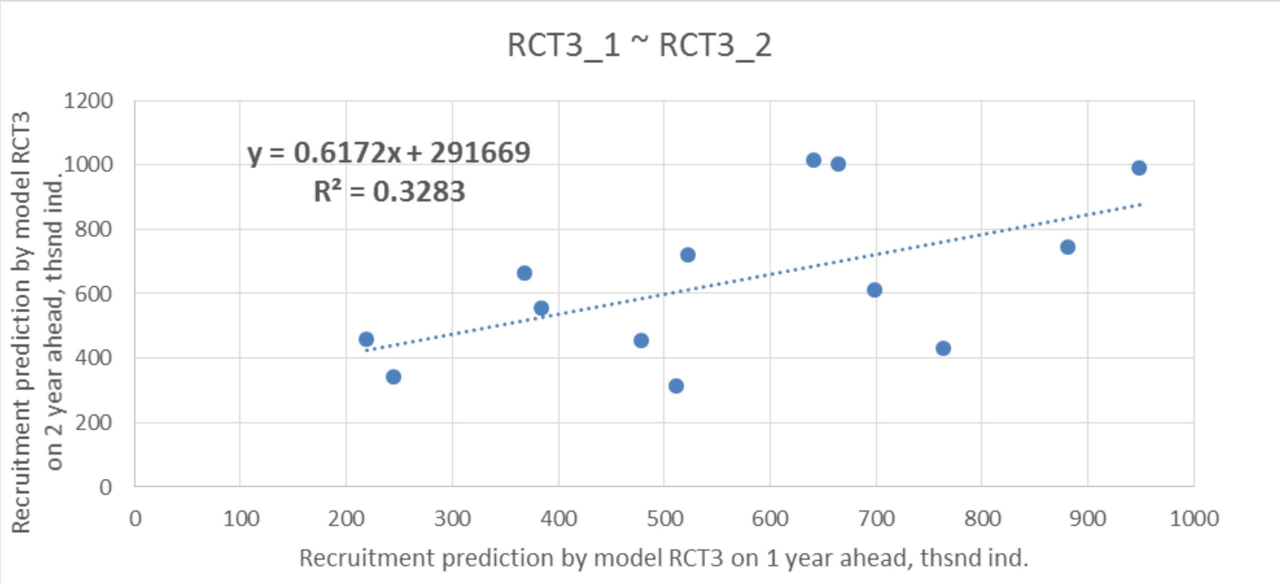

Figure 3. Correlation between retrospective recruitment RCT3 forecasts for 1 and 2 years ahead.

In a further analysis, therefore, we are comparing the models made for one year ahead, and using the results of that comparison in all the other versions. There is an exception being made for RCT3 and all the versions of the forecast are considered (for 1, 2 and 3 years ahead).

Even though they had had some better results, ***TES and TEL*** later also worked relatively well. The retrospective analysis indicated that by the end of the period TES and TEL have a serious deviation from the values observed in cod recruitment (Figure 4). Moreover, in 2023, the observation series of oxygen in the Kola Section broke and the use of these two models in the future is questionable.

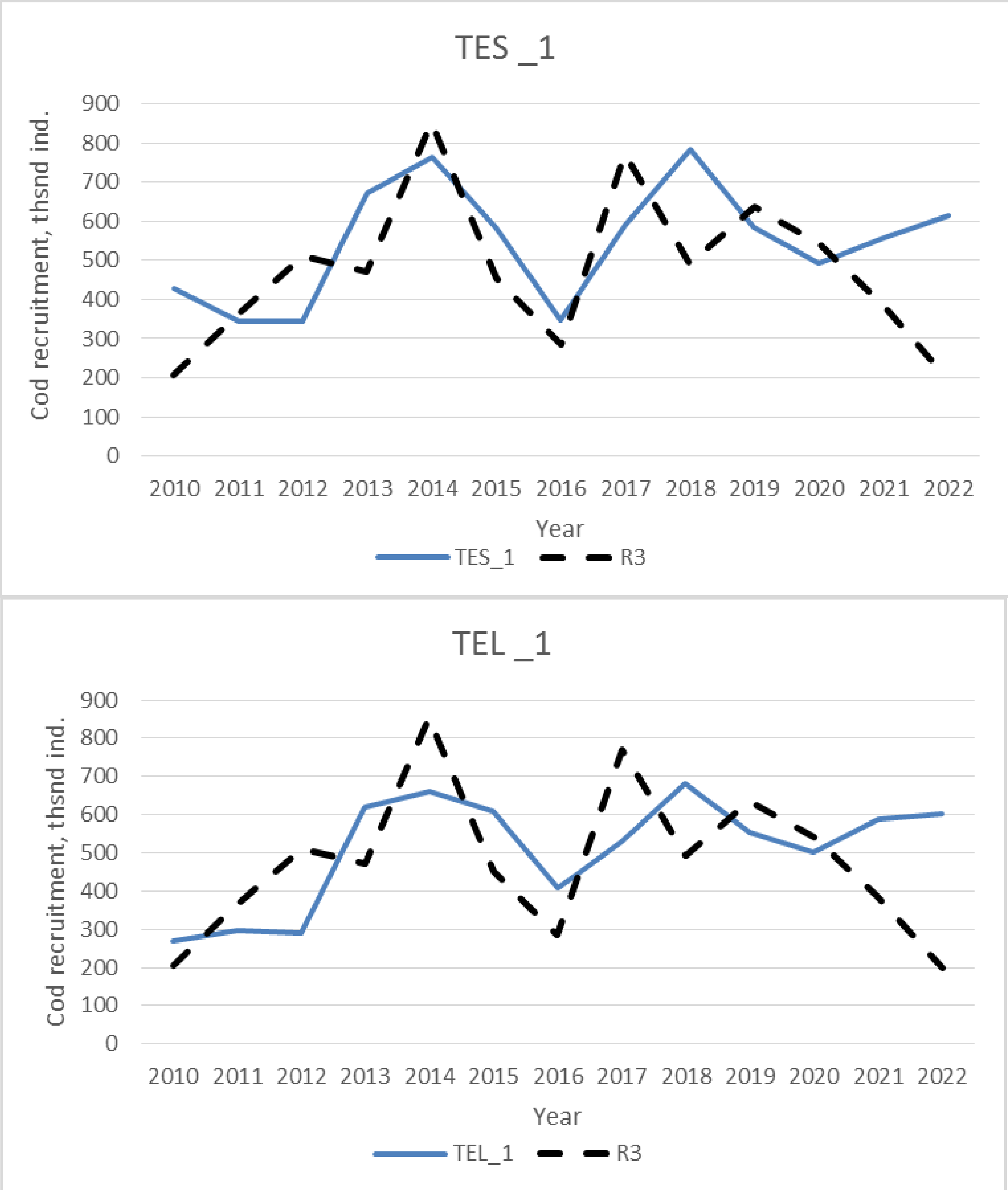

Figure 4. Comparison of the "true" cod recruitment values and the ones predicted by TES and TEL for one year ahead.

In some years, ***RCT3*** has great deviations from the recruitment values observed, but by the end of the period, the forecasts are rather close to the actual information. In the forecast for one year ahead, it indicates the best value of R^2 (0.48) among all the models taken (Figure 5). Generally speaking, RCT3 is prone to overestimate recruitment (e.g., in 2015-2016, 2019-20). At the same time, underestimates of recruitment are less frequent and deviations are less critical in this model. Since this model is totally based on the abundance indices at younger ages, it can be concluded that a number of cod year-classes of the review period were relatively more numerous at earlier stages than at the age of 3 and, therefore, their survival rate was below average.

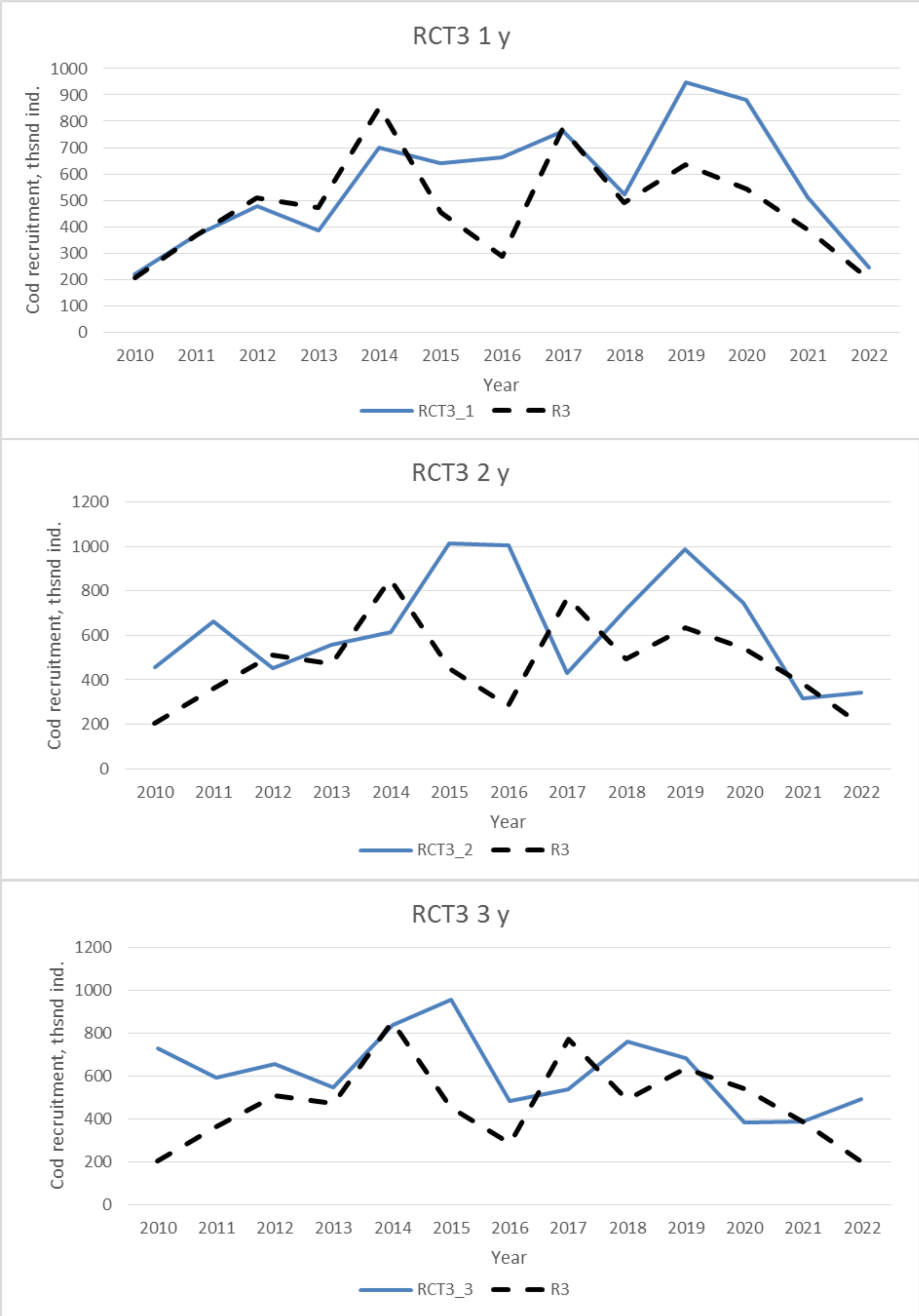

Figure 5. Comparison of the "true" cod recruitment values and the ones predicted by RCT3 for 1-3 years ahead.

Just like TES and TEL, ***the new suggested models*** to forecast recruitment using environment data show great consistency between forecasts for 1 and 2 years (Figure 6). Therefore, when comparing the models, we consider only the forecasts for one year ahead.

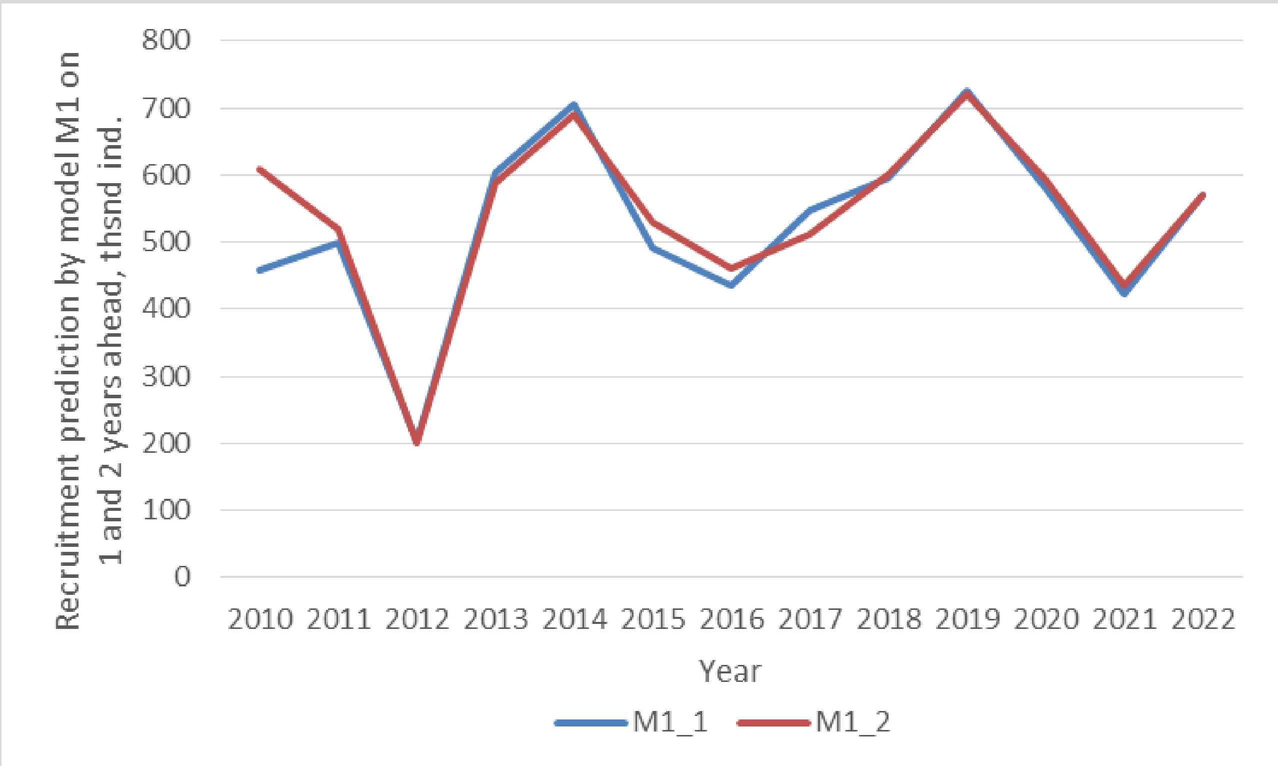

Figure 6. Comparison of the M1 retrospective forecasts for 1 and 2 years ahead in dynamics

M1 model

Values of the Intercept parameter and the parameters of the equation of the regressive M1 are given below (Table 4, Table 5).

Table 4. "True" cod recruitment values and parameter values of the regression equation in M1 that change when the model is reset in the retrospective and are predicted by this model for 1 and 2 years ahead.

Year	(Intercept)	TW3	FLI3	M1_1	M1_2	R3 fact
2009	-1042.0	301.1	0.90	721.4	608.6	
2010	-1031.8	233.6	1.44	459.3	518.7	205.5
2011	-1046.7	227.0	1.52	499.9	201.6	364.0
2012	-1046.2	227.6	1.52	204.5	587.0	510.1
2013	-972.5	239.5	1.26	602.9	690.1	471.2
2014	-976.6	243.7	1.25	704.7	528.7	854.9

2015	-895.8	215.8	1.31	491.3	459.9	452.5
2016	-900.4	206.9	1.40	434.8	510.6	285.8
2017	-870.9	215.2	1.27	546.7	601.8	770.9
2018	-866.9	212.5	1.28	595.1	720.8	492.3
2019	-874.9	215.4	1.28	724.6	594.1	635.4
2020	-818.3	202.3	1.26	580.7	434.1	541.0
2021	-796.9	193.2	1.30	421.3	571.1	386.7
2022	-838.1	194.4	1.37	571.0	462.1	197.4

Table 5. Values of the predictors/factors used in M1

Year	TW3	FLI3	M1_1	M1_2	R3 fact
2009	5.08	362	721.4	608.6	
2010	4.94	307	459.3	518.7	205.5
2011	4.64	283	499.9	201.6	364.0
2012	4.69	317	204.5	587.0	510.1
2013	4.75	111	602.9	690.1	471.2
2014	4.37	421	704.7	528.7	854.9
2015	5.36	302	491.3	459.9	452.5
2016	4.87	256	434.8	510.6	285.8
2017	4.74	254	546.7	601.8	770.9
2018	5.00	269	595.1	720.8	492.3
2019	5.32	258	724.6	594.1	635.4
2020	5.15	385	580.7	434.1	541.0
2021	5.12	287	421.3	571.1	386.7
2022	4.63	249	571.0	462.1	197.4

According to M1, an increase of the water temperature and length of the thermal frontal zones results in an increase of cod recruitment (parameter values are positive).

Retrospective forecasts carried out by M1 indicated a positive trend in the Intercept value and respectively negative trend in the parameter value for the TW3 predictor (Figure 7). It means that the temperature starts having less impact on recruitment when new data added. At the same time, the importance of the temperature in the review period increases.

There are no trends seen in the parameter value by the FLI predictor but its variability is high and that is attributed to high variability of the factor and relatively short observation series. However, since factor values in the following years would have had no crucial impact on the model, the parameter value stabilized after there was an abnormally low factor value of 2014 added to the data series and the impact of this point on the regression was very high.

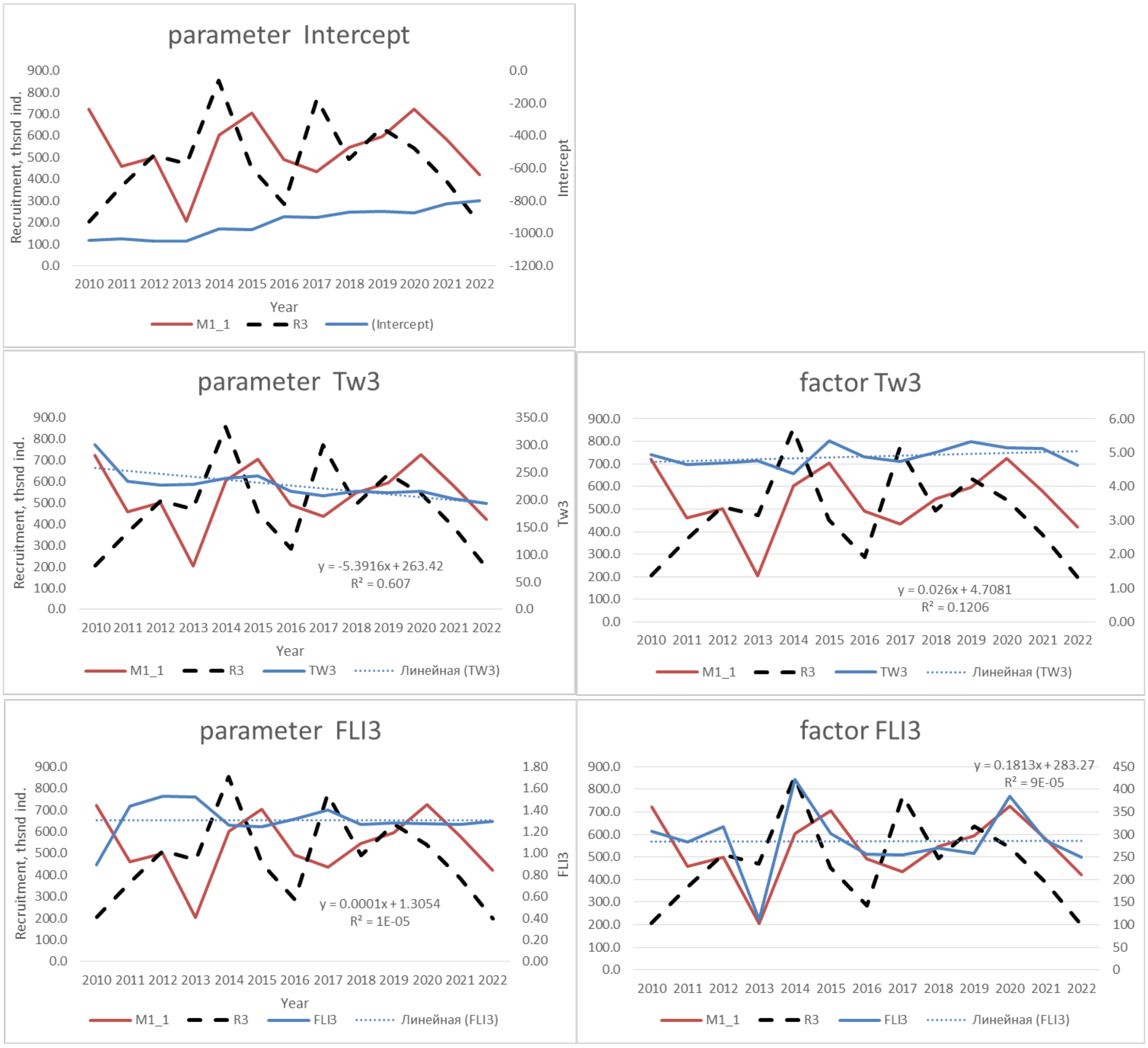

Figure 7. Dynamics of the parameter values of M1 that vary when the model is reset in the retrospective (on the left), and the values of the predictors/factors (on the right), given along with "true" recruitment and predicted one.

M2 model

The retrospective forecasts carried out by M1 also indicated a positive trend in the Intercept value and respectively negative trend in the parameter value for TW3 (Figure 8, Figure 6). It can again be concluded that the temperature starts to have less impact on recruitment when it increases simultaneously (Table 7) as in M1.

The behavior of the parameter for FLI is similar to M1 but there is a very weak (but crucial at the level of 0.01) negative trend observed here (R^2 = 0.06).

There is a negative trend observed in the parameter for Storms3 when there is a huge increase of values of the factor in this period, i.e. the number of stormy days over the review period grew remarkably but the impact of the predictor on cod recruitment decreased even though less remarkably. The factor has a negative impact on recruitment (the parameter is negative) and that means recruitment decreases if there are more storms.

Table 6. "True" cod recruitment values and parameter values of the regressive equation in M2 that change when the model is reset in

the retrospective and are derived from this model for 1 and 2 years ahead.

Year	(Intercept)	TW $_{y-3}$	FLI3	Storms3	M2_1	M2_2	R3 fact
2009	-958.1	312.1	0.92	-1.37	692.4	589.4	
2010	-872.0	262.0	1.42	-2.62	438.6	496.0	205.5
2011	-878.8	257.7	1.48	-2.70	480.8	225.1	364.0
2012	-879.3	259.2	1.47	-2.67	233.1	603.6	510.1
2013	-797.5	272.8	1.23	-2.94	619.3	689.6	471.2
2014	-788.5	279.1	1.22	-3.15	703.2	432.3	854.9
2015	-707.2	251.6	1.29	-3.17	394.7	383.9	452.5
2016	-683.8	252.3	1.32	-3.60	361.9	394.7	285.8
2017	-712.5	248.8	1.20	-2.55	469.9	546.8	770.9
2018	-718.7	248.8	1.19	-2.48	551.0	631.4	492.3
2019	-744.3	252.4	1.18	-2.32	644.8	513.4	635.4
2020	-696.2	251.5	1.16	-2.67	494.4	378.6	541.0
2021	-671.2	252.6	1.16	-2.98	365.7	439.6	386.7
2022	-689.6	259.0	1.21	-3.26	439.6	300.7	197.4

Table 7. Values of the predictors/factors used in M2.

Year	TW3	FLI3	Storms3	M2_1	M2_2	R3 fact
2009	5.08	362	103	692.4	589.4	
2010	4.94	307	127	438.6	496.0	205.5
2011	4.64	283	117	480.8	225.1	364.0
2012	4.69	317	118	233.1	603.6	510.1
2013	4.75	111	106	619.3	689.6	471.2
2014	4.37	421	100	703.2	432.3	854.9
2015	5.36	302	118	394.7	383.9	452.5
2016	4.87	256	143	361.9	394.7	285.8
2017	4.74	254	135	469.9	546.8	770.9
2018	5.00	269	150	551.0	631.4	492.3
2019	5.32	258	146	644.8	513.4	635.4
2020	5.15	385	157	494.4	378.6	541.0
2021	5.12	287	161	365.7	439.6	386.7
2022	4.63	249	142	439.6	300.7	197.4

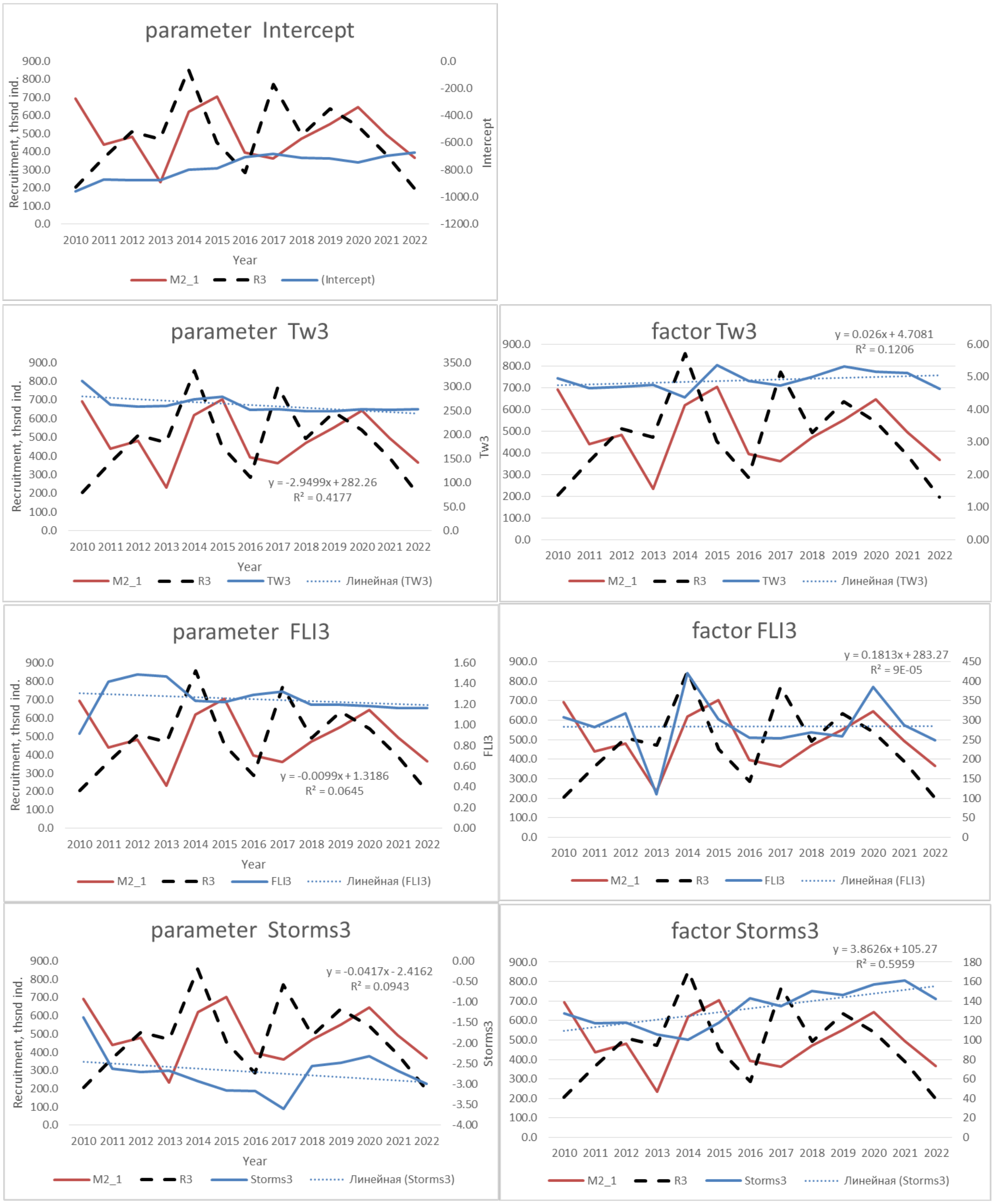

Figure 8. Dynamics of the parameter values of the regression equation in M2 that vary when the model is reset in the retrospective (on the left), and the values of the predictors/factors (on the right), given along with "true" recruitment values and derived ones

M4 model

In M4, all predictors (temperature, length of thermal frontal zones and spawning stock biomass) are positively correlated with cod recruitment (Table 8, Table 9).

In interpretation of M4, the impact of the SSB on cod recruitment at the beginning of the review period was significant and then it notably decreased (Figure 9). Unlike M1 and M2, there is a remarkable positive trend observed in the parameter for the factor of the temperature that has been particularly notable since 2011. As if the model would be trying to describe the recruitment dynamics by swapping the impact of the temperature and SSB. The behaviour of the parameter for FLI is similar to the two previous models.

Table 8. "True" cod recruitment values and parameter values of the regressive equation in M4 that change when the model is reset in the retrospective and are derived from this model for 1 year ahead.

Year	(Intercept)	TW1	FLI3	SSB3	M4_1	R3 fact
2009	-416.3	33.3	1.37	0.62	560.2	
2010	-451.5	8.4	1.70	0.56	468.8	205.5
2011	-459.0	2.2	1.79	0.54	658.0	364.0
2012	-479.1	5.4	1.84	0.48	353.1	510.1
2013	-487.6	13.8	1.76	0.51	1232.0	471.2
2014	-367.5	19.4	1.59	0.35	915.1	854.9
2015	-378.9	37.7	1.56	0.23	718.5	452.5
2016	-359.7	42.1	1.57	0.14	566.4	285.8
2017	-401.5	49.6	1.56	0.17	561.0	770.9
2018	-394.2	47.4	1.57	0.16	477.7	492.3
2019	-404.6	54.3	1.53	0.16	665.3	635.4
2020	-402.8	56.4	1.51	0.15	482.9	541.0
2021	-425.9	59.3	1.54	0.15	413.0	386.7
2022	-480.7	63.3	1.61	0.15	583.2	197.4

Table 9. Values of the predictors/factors used in M4.

Year	TW1	FLI3	SSB3	M4_1	R3 fact
2009	4.64	362	581.8	560.2	
2010	4.69	307	647.9	468.8	205.5
2011	4.75	283	718.0	658.0	364.0
2012	4.37	317	1008.9	353.1	510.1
2013	5.36	111	1239.3	1232.0	471.2
2014	4.87	421	1798.1	915.1	854.9
2015	4.74	302	2016.1	718.5	452.5
2016	5.00	256	2239.0	566.4	285.8
2017	5.32	254	2123.6	561.0	770.9
2018	5.15	269	1714.2	477.7	492.3
2019	5.12	258	1370.5	665.3	635.4
2020	4.63	385	1395.7	482.9	541.0
2021	4.56	287	1258.2	413.0	386.7

2022	4.63	249	1198.6	583.2	197.4

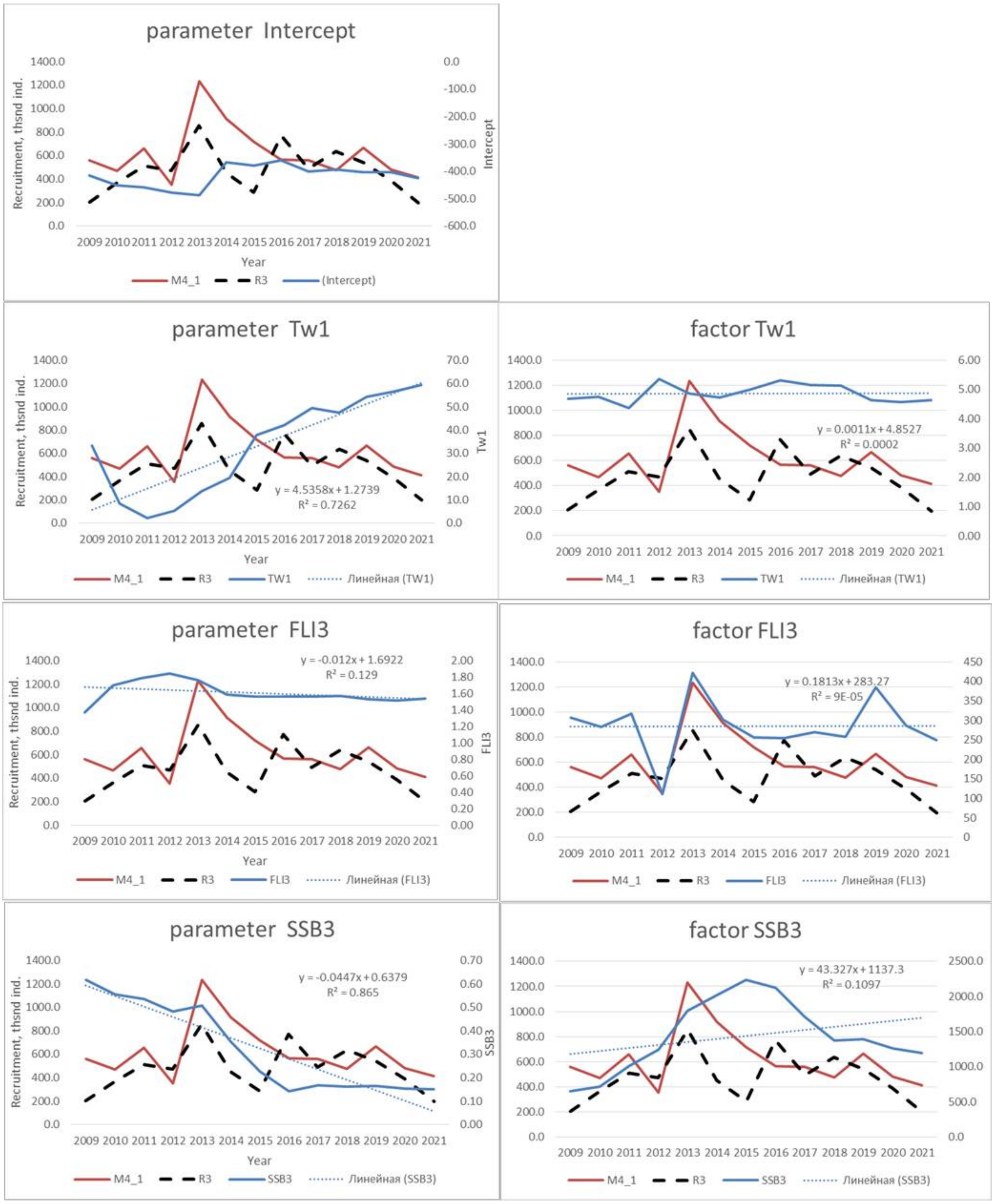

Figure 9. Dynamics of the parameters' values in the regression equation in M4 model, varying when the model is reset retrospectively (left) and the values of predictors/factors (right), presented in contrast to the "true" values and forecast-recruitment values derived from the model.

M5-M6 models

Models M5 and M6 practically repeat the M4 method, but the temperature factor is taken with lags of 2 and 3 years, respectively. This allows to increase the number of years for forecast by 2-3 years. Otherwise, both models are characterized almost completely similarly to the M4 model (Tables 10-13, Figs. 10-11).

Table 10. "True" cod recruitment values and parameter values of the regressive equation in M5 that change when the model is reset in the retrospective and are derived from this model for 1 and 2 years ahead.

Year	(Intercept)	TW2	FLI3	SSB3	M5_1	R3 fact
2009	-661.9	118.4	1.19	0.55	610.3	
2010	-698.5	83.7	1.60	0.50	503.6	205.5
2011	-709.9	74.3	1.72	0.48	669.6	364.0
2012	-706.1	71.0	1.79	0.42	326.3	510.1
2013	-655.4	66.2	1.69	0.46	1237.7	471.2
2014	-503.4	64.7	1.51	0.31	889.1	854.9
2015	-526.0	90.0	1.45	0.18	671.5	452.5
2016	-580.7	115.2	1.42	0.09	549.5	285.8
2017	-586.1	114.1	1.42	0.12	608.5	770.9
2018	-558.4	105.2	1.44	0.12	515.7	492.3
2019	-575.0	114.1	1.40	0.11	707.7	635.4
2020	-531.8	106.2	1.38	0.11	492.2	541.0
2021	-544.2	106.6	1.40	0.11	418.4	386.7
2022	-584.8	107.3	1.48	0.11	578.5	197.4

Table 11. Values of the predictors/factors used in M5.

Year	TW2	FLI3	SSB3	R3	M5_1	R3 fact
2010	4.64	307.0	647.9	205.5	610.3	205.5
2011	4.69	283.0	718.0	364.0	503.6	364.0
2012	4.75	317.0	1008.9	510.1	669.6	510.1
2013	4.37	111.0	1239.3	471.2	326.3	471.2
2014	5.36	421.0	1798.1	854.9	1237.7	854.9
2015	4.87	302.0	2016.1	452.5	889.1	452.5
2016	4.74	256.0	2239.0	285.8	671.5	285.8
2017	5.00	254.0	2123.6	770.9	549.5	770.9
2018	5.32	269.0	1714.2	492.3	608.5	492.3
2019	5.15	258.0	1370.5	635.4	515.7	635.4
2020	5.12	385.0	1395.7	541.0	707.7	541.0
2021	4.63	287.0	1258.2	386.7	492.2	386.7

2022	4.56	249.0	1198.6	197.4	418.4	197.4

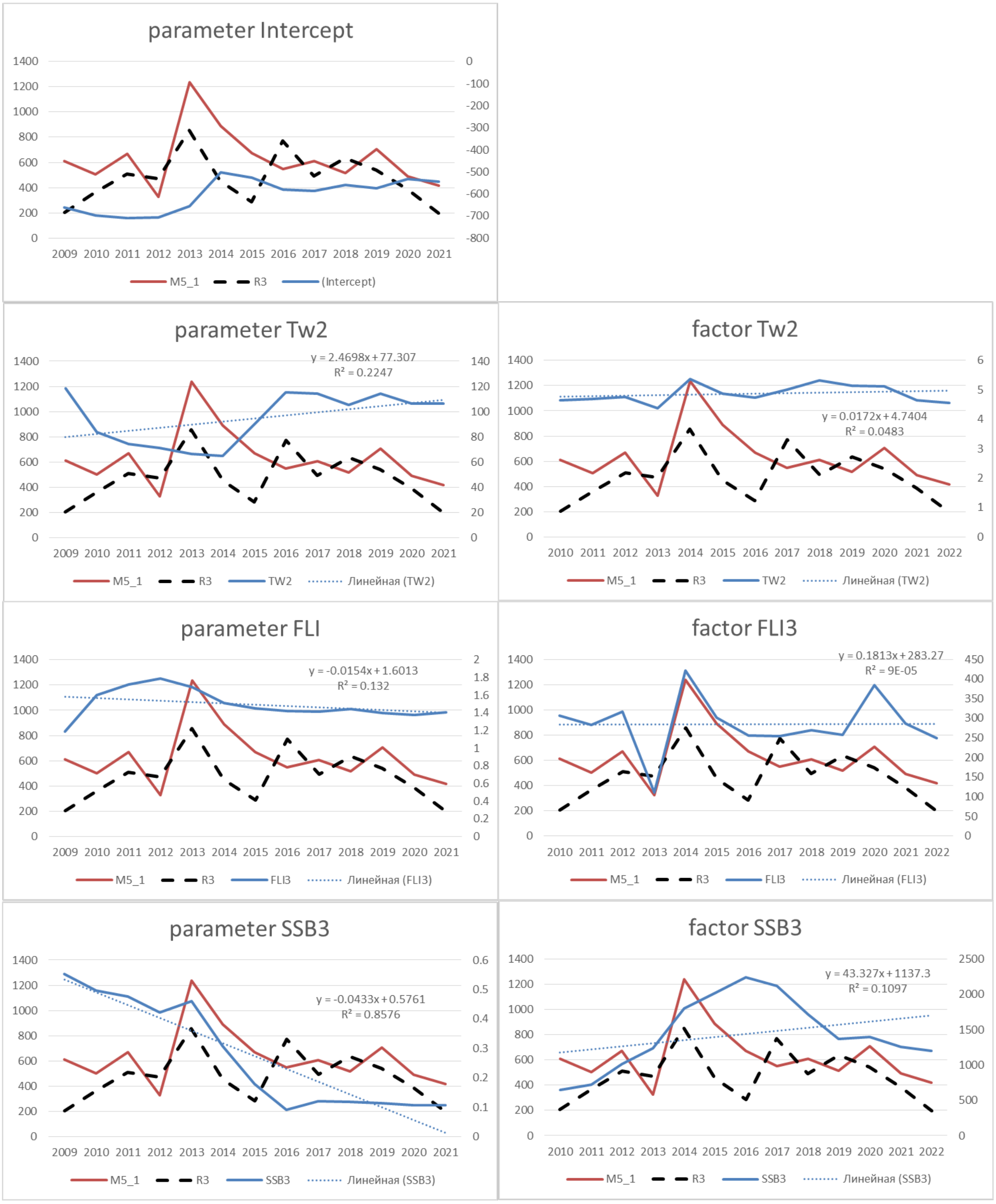

Figure 10. Dynamics of the parameters' values in the regression equation in M5 model, varying when the model is reset retrospectively (left) and the values of predictors/factors (right), presented in contrast to the "true" values and forecast-recruitment values derived from the model.

Table 12. "True" cod recruitment values and parameter values of the regressive equation in M6 that change when the model is reset in the retrospective and are derived from this model for 1-3 years ahead.

Year	(Intercept)	TW3	FLI3	SSB3	M6_1
2009	-951.9	234.0	0.98	0.35	734.7
2010	-946.2	168.4	1.54	0.33	508.8
2011	-974.0	162.9	1.66	0.31	627.8
2012	-989.5	165.9	1.70	0.27	317.0
2013	-943.1	162.8	1.59	0.31	987.2
2014	-948.3	177.7	1.53	0.24	953.0
2015	-842.5	169.5	1.49	0.12	632.3
2016	-882.5	188.3	1.48	0.04	476.1
2017	-841.1	174.1	1.47	0.09	579.4
2018	-836.5	172.1	1.49	0.08	578.5
2019	-848.3	177.1	1.47	0.08	744.0
2020	-788.8	166.4	1.44	0.07	570.3
2021	-767.0	155.7	1.48	0.08	417.8
2022	-806.9	156.2	1.56	0.08	576.1

Table 13. Values of the predictors/factors used in M5.

Year	TW3	FLI3	SSB3	R3 fact	M6_1
2010	4.94	307.0	647.9	205.5	734.7
2011	4.64	283.0	718.0	364.0	508.8
2012	4.69	317.0	1008.9	510.1	627.8
2013	4.75	111.0	1239.3	471.2	317.0
2014	4.37	421.0	1798.1	854.9	987.2
2015	5.36	302.0	2016.1	452.5	953.0
2016	4.87	256.0	2239.0	285.8	632.3
2017	4.74	254.0	2123.6	770.9	476.1
2018	5.00	269.0	1714.2	492.3	579.4
2019	5.32	258.0	1370.5	635.4	578.5
2020	5.15	385.0	1395.7	541.0	744.0
2021	5.12	287.0	1258.2	386.7	570.3
2022	4.63	249.0	1198.6	197.4	417.8

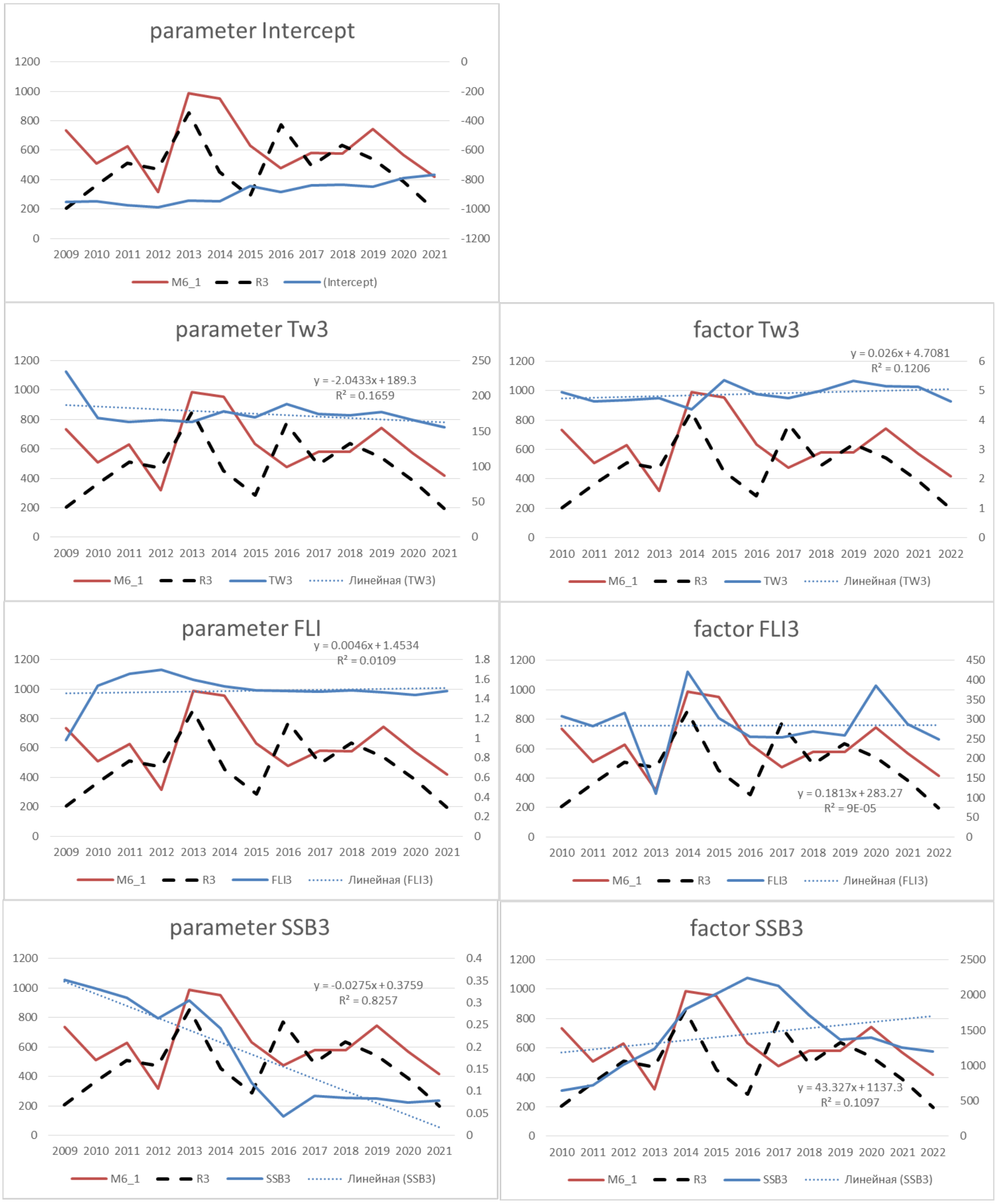

Figure 11. Dynamics of the parameters' values in the regression equation in M6 model, varying when the model is reset retrospectively (left) and the values of predictors/factors (right), presented in contrast to the "true" values and forecast-recruitment values derived from the model.

Regarding all five new models, they can be assessed as very unstable: parameter values can vary greatly and demonstrate clear trends in their dynamics. This instability is probably caused by the relatively short series of observations and correlations between certain predictors.

Comparison of models

The determination coefficients for most models were very low (Table 14). At its previous meetings, the Working Group used the average forecast-recruitment value for all observation series when a reliable model was unavailable. However, this approach is currently inappropriate, for the average recruitment has decreased significantly in recent years. Instead, we tried several scenarios of the persistence forecast (the latest recruitment or the average recruitment in recent years shall be considered as a forecast for future years) and compared them with the RCT3 forecast (Figure 12, Table 14).

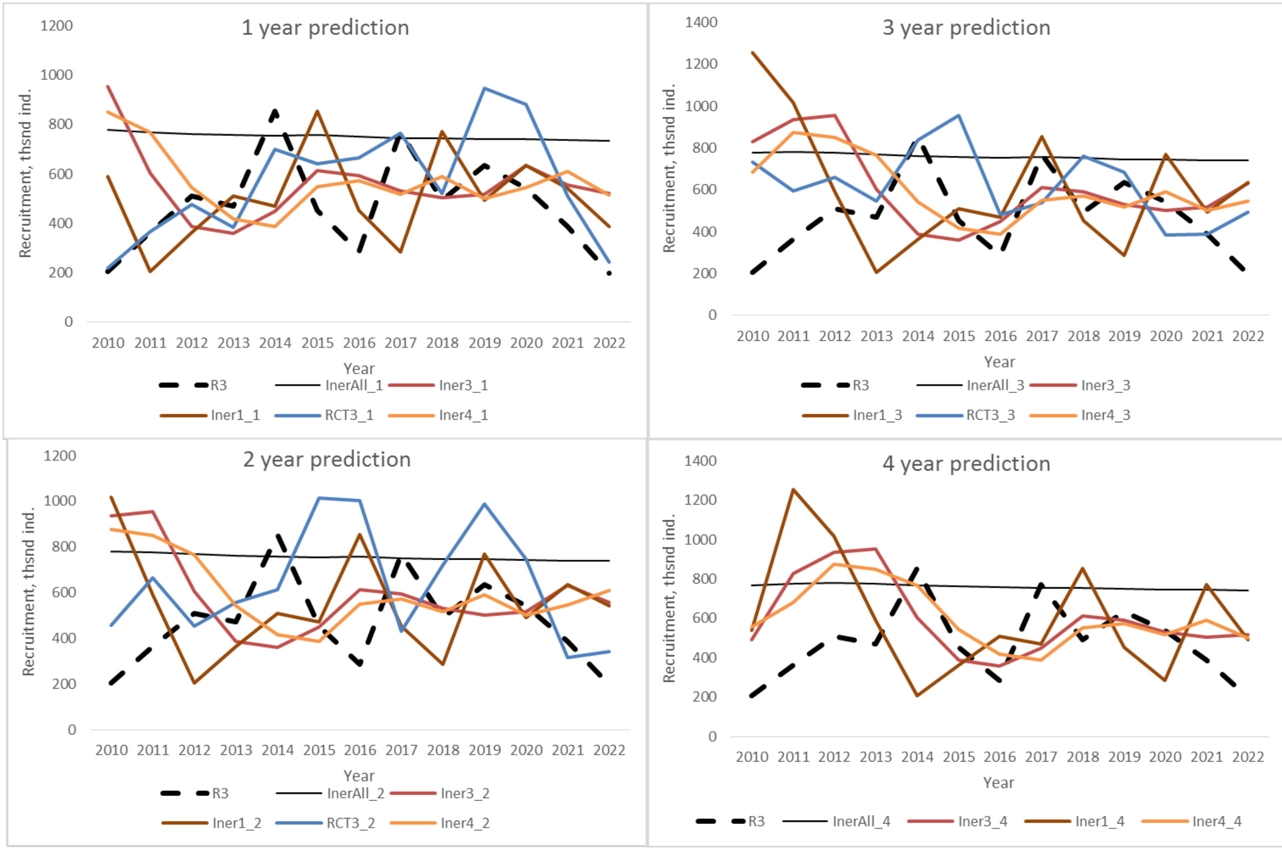

Figure 12. The dynamics of "true" values (2023 JRN-AFWG assessment) of cod recruitment at age 3 in comparison with the values predicted using RCT3 for 1, 2 and 3 years ahead; "InerAll" – average value from the start of observations till the forecast year; "Iner1", "Iner3" and "Iner4" – average recruitment for recent 1, 3 and 4 years, respectively, regarded as a forecast for 1-3 years ahead (The figure after the underscore shows the lead time of the forecast).

Table 14. Statistical measures of cod recruitment series projected by the below-listed models in comparison with "true" recruitment values (JRN-AFWG 2023). Statistic since 2010-2022 only!

Model	R^2 with R3	RSS, thsnd	Mohn`s Rho	R^2 with R3	RSS, thsnd	Mohn`s Rho
	for 1 year ahead			for 2 year s ahead		
TES	0.22	473	0.33	0.20	409	0.27
TEL	0.16	462	0.23	0.06	458	0.23
InerAll	0.03	1487	0.91	0.02	1513	0.92
Iner4	0.38	1135	0.52	0.22	1262	0.59

Iner3	0.23	1145	0.50	0.30	1491	0.60
Iner1	0.00	935	0.27	0.17	1602	0.54
RCT3	0.48	444	0.24	0.01	1416	0.55
M1	0.00	755	0.37	0.01	549	0.24
M2	0.01	656	0.25	0.04	477	0.12
M4	0.24	859	0.48			

Table 1 4 (continued) .

Model	R^2 with R3	RSS, thsnd	Mohn`s Rho	R^2 with R3	RSS, thsnd	Mohn`s Rho
	for 3 years ahead			for 4 years ahead		
TEL	0.03	449	0.27	0.06	405	0.33
Iner4	0.01	1008	0.52	0.03	826	0.48
Iner3	0.11	1440	0.61			
RCT3	0.06	891	0.54			

The figures highlighted above are suggested to be used at the annual JRN-AFWG meeting.

Possible candidates for R3 prediction in 2024 AFWG

Table 15. Statistical measures of cod recruitment series projected by the below-listed models in comparison with "true" recruitment values (JRN-AFWG 2024 data used). Statistic since 2014-2023 only!

Model	R^2 with R3	RSS, thsnd	Mohn`s Rho	R^2 with R3	RSS, thsnd	Mohn`s Rho
	for 1 year ahead			for 2 year s ahead		
Iner4 *	0.10	586	0.36	0.08	576	0.39
RCT3 *	0.51	453	0.34	0.12	1086	0.61
RCT3 +Eco	NA					
M2	0.1 5	39 4	0.2 4	0.11	41 1	0.25
M5 *	0.32	768	0.59	0.21	1128	0.73
M6 *	0.19	731	0.59	0.10	949	0.69

els statistic taken from period 2014-2023

Table 1 5 (continued) .

Model	R^2 with R3	RSS, thsnd	Mohn`s Rho	R^2 with R3	RSS, thsnd	Mohn`s Rho
	for 3 years ahead			for 4 years ahead		
Iner4 *	0.04	450	0.37	0.14	419	0.38
RCT3 *	0.23	610	0.51			
M6 *	0.22	989	0.76			

Further text needs editorial work

The models' comparison using only determination coefficients is rather disputable. For example, Iner4 model (simple average for recent 4 years) demonstrates a relatively high consistency between the forecast for 1 year ahead and the data of observations, i.e. $R^2 = 0.38$ (see Table 14). However, this method shows high RSS values, i.e. the total forecast error is high. This model has also demonstrated one of the worst values of the Mohn`s Rho criterion which indicates a significant bias, particularly, an overestimation of the recruits' number in the forecast in relation to "true" values. Moreover, in the medium term, a low forecast error (low RSS values) and no bias (low Mohn`s Rho values) are perhaps more important than more accurate descriptions of short-cycle variabilities (R^2). Therefore, a combination of all 3 criteria is appropriate when choosing the best forecast method.

From these considerations, TES and TEL models perform relatively well for forecasts with all options of lead times. Unfortunately, it is currently impossible to use them for the observation data is unavailable for 2023, and similar challenges are expected in the nearest future.

Model M4 demonstrates some potential to forecast recruitment for 1 year ahead, however R^2 is low and the error and bias' values are high. The rest of the models in this group (M1, M2) show a low accuracy of the forecast. The persistence approach, when averaging for 3 and 4 years (Iner3, Iner4) has some potential, but as it was mentioned above, it shows a high error and forecast bias.

RCT3 model demonstrates the best recruitment dynamics for forecast for 1 year ahead. The average RSS forecast error is also minimal. However, this model has shown an overestimation of the recruitment abundance (bias = 0.24).

The results of persistence forecasting method are disputable. The use of different averaging periods shows that the highest coefficient of determination together with the observed recruitment has several averaged values over 4 years (Table 16). However, the values of RSS and Mohn`s Rho are rather high.

Table 16. – Coefficients of determination between the "true" recruitment values (JRN-AFWG 2023) and the recruitment values projected as running average values for different periods.

R^2 for data series of different lengths	Averaging time, years						
	7	6	5	4	3	2	1
A ll time series since 1946	0.18	0.14	0.10	0.09	0.12	0.21	0.32
period 2010-2022	0.03	0.09	0.31	0.38	0.23	0.14	0.00

Conclusion

The use of Hybrid Model in its current configuration for future forecasts of cod recruitment abundance is impossible, because forecasts made by TES and TEL models are not possible unless the oxygen observation series are restored. Moreover, there were grave errors of these models in the forecasts in recent two years, and the reasons for those errors are still undefined.

The considered models M1-M6, which use water temperature, frontal zone area indices, the number of storms and the spawning stock biomass of cod as predictors, demonstrate unstable results and they should be used carefully.

The use of persistence forecast (averaged recruitment values for a series of years as forecast values) failed to show good results when averaging for the entire observation period, or high consistency when using the values for the last year as a forecast. Averaging for 4 years allows obtaining the best results among persistence forecasts.

For a forecast for1 year ahead, the best is RCT3 model.

For a forecast for 2 years ahead, the persistence method is suggested to be used: a running average of recruitment for recent 4 years.

For a forecast for 3 years ahead, RCT3 model or the persistence method is suggested to be used: a running average of recruitment for recent 4 years.

For a forecast for 4 years ahead, the persistence method is suggested to be used: a running average of recruitment for recent 4 years.

ences:

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A .

Table A1. TES and TEL models' parameters of cod recruitment.

Year	$Cod3_t$ *10 ^{6} (Final run)	$OxSat_{t-39}$	$DOxSat_{t-13}$	ITw_{t-43}	Ice_{t-15}	exp Ice_{t-40} *10 ^{6}
1962	1252410	-0,19	-6,60	1,86	0,5	0,0
1963	903275	-0,94	-2,37	1,59	1,5	0,0
1964	469684	1,63	1,23	2,47	9,0	0,0
1965	873788	0,88	-0,20	3,91	15,7	0,0
1966	1843986	-1,09	-3,98	7,97	5,3	0,0
1967	1312965	-0,23	-2,84	8,23	5,0	9,3
1968	183253	1,50	-0,13	3,78	15,5	0,0
1969	110586	0,85	0,63	1,77	15,9	0,0
1970	206069	-0,17	-0,23	3,51	19,8	7,9
1971	403741	0,06	-0,12	-0,13	18,8	2,7
1972	1047824	-3,32	-6,59	14,55	-0,6	428,9
1973	1722535	-2,10	-10,37	19,14	1,8	768,6
1974	566462	1,06	-1,73	2,40	2,0	0,0
1975	608537	1,90	0,78	-2,64	-1,2	0,0
1976	605635	1,33	-1,28	-3,07	-1,9	0,0
1977	372244	-0,07	-1,84	-2,44	2,5	0,0
1978	623729	1,19	0,10	1,05	-1,0	0,0
1979	202654	0,50	-1,48	-0,12	3,5	0,0
1980	130651	-0,31	-2,72	1,98	12,9	0,0

1981	144579	0,76	-0,18	1,94	14,7	0,0
1982	183316	0,80	0,61	-3,15	8,0	0,1
1983	141734	0,78	0,22	1,87	12,2	8,5
1984	442510	-2,21	-2,35	-3,08	12,9	0,0
1985	532199	-0,10	-1,17	3,59	-1,2	0,1
1986	1366725	-2,14	-4,39	1,39	-8,5	2,9
1987	357345	-0,33	-1,69	2,12	0,6	0,0
1988	333545	0,87	-1,40	-2,34	3,8	0,0
1989	158308	0,32	-3,42	-5,17	10,5	0,0
1990	131572	1,11	-1,32	-4,21	10,5	0,0
1991	298762	0,88	0,70	2,42	6,5	0,0
1992	716299	1,34	0,48	1,37	-0,9	0,0
1993	988449	-1,98	-3,86	6,12	-0,6	0,0
1994	751986	-0,50	-2,26	8,25	-4,9	0,0
1995	538918	0,83	-2,42	4,36	1,8	0,0
1996	405634	0,86	-0,08	0,55	0,7	0,0
1997	781603	0,88	0,17	3,11	-7,3	0,0
1998	1056937	0,30	-6,08	-2,32	-2,5	0,0
1999	628182	-0,72	-2,40	-6,81	2,9	0,0
2000	747488	1,86	1,55	-2,29	13,6	0,0
2001	592230	0,62	0,05	-6,04	2,3	0,0
2002	375690	-0,88	-0,98	3,63	-9,9	0,8
2003	758556	-0,39	-0,64	8,50	-5,8	0,0
2004	243303	-2,20	-2,53	-4,62	-1,4	0,0
2005	697364	-1,65	-1,82	-1,45	4,9	0,0
2006	540024	-1,18	-1,65	-4,00	-6,0	0,0
2007	1263197	-1,39	-4,42	7,42	-12,3	0,0
2008	1021555	-1,14	-1,59	3,39	-18,0	0,0
2009	591759	0,79	-1,83	-1,61	-17,5	0,0
2010	205822	-0,38	-2,60	-8,94	-9,0	0,0
2011	364388	0,83	-0,07	-5,00	-4,3	0,0
2012	511945	0,91	-0,13	-5,05	-4,3	0,0
2013	476228	0,04	-0,09	1,44	-10,5	0,0
2014	864972	-0,46	-1,00	1,43	-17,8	0,0
2015	461254	-1,26	-1,62	-2,22	-10,5	0,0
2016	292950	-1,31	-1,92	-7,52	-5,8	0,0
2017	798494	-0,33	-0,64	-1,69	-14,4	0,0

2018	518825	-1,24	-1,41	0,10	-20,9	0,0
2019	677714	-0,63	-1,08	-1,71	-13,2	0,0
2020	580643	-2,02	-2,19	-6,35	-13,6	0,0
2021	419355	-0,80	-1,10	-1,33	-9,2	0,0
2022		-1,55	-2,10	-2,50	-12,7	0,0
2023		-1,52	-3,02	-4,18	-8,4	0,0
2024		-0,31		-5,57		0,0
20 25		0,36		-7,48		0,0

Table A2. RCT3 model parameters of cod recruitment.

yearclass	recruitment	BST1	BST2	BST3	BSA1	BSA2	BSA3
1982	530	NA	NA	NA	NA	NA	NA
1983	1370	NA	NA	NA	NA	NA	NA
1984	357	NA	NA	NA	NA	NA	NA
1985	334	NA	NA	NA	NA	NA	NA
1986	159	NA	NA	NA	NA	NA	NA
1987	132	NA	NA	NA	NA	NA	NA
1988	299	NA	NA	NA	NA	NA	NA
1989	714	NA	NA	NA	NA	NA	NA
1990	989	NA	NA	NA	NA	NA	NA
1991	750	NA	NA	293.92	NA	NA	323.88
1992	538	NA	556.68	282.84	NA	624.38	137.74
1993	402	1043.78	541.25	163.08	902.64	212.29	99.4
1994	777	5356.43	791.62	317.99	2175.25	271.71	158.57
1995	1048	5899.23	1422.92	355.1	1826.33	565.31	391.16
1996	627	5044.09	496.48	188.48	1698.49	475.15	147.62
1997	748	2490.54	350.21	245.81	2523.56	231.51	294.83
1998	591	473.04	242.33	182.79	364.84	262.81	177.44
1999	375	128.57	78.03	118.36	153.42	51.45	61.37
2000	757	712.77	418.73	376.7	363.55	209.1	306.71
2001	243	34.11	65.78	63.88	19.22	52.53	33.41
2002	694	3022.23	242.94	248.88	1505	117.19	125.03
2003	539	322.87	216.67	116.49	161.2	138.66	64.77
2004	1255	853.43	289.39	361.13	499.71	157.95	58.49
2005	1017	674.21	369.74	194.37	411.21	47.09	199.85
2006	591	594.69	101.96	126.28	85.13	94.2	107.83
2007	206	68.83	35.59	36.81	50.87	25.46	22.82
2008	364	389.48	95.14	85.4	204.9	43.56	40.36

2009	510	1027.59	225.81	75.72	620.25	91	82.79
2010	471	617.18	100.3	68.84	266	40.23	60.55
2011	855	702.97	142.96	226.85	496.49	89.17	286.89
2012	453	435.72	191.48	144.07	313.11	211.04	138.71
2013	286	1245.71	342.76	99.37	1758.58	211.41	56.29
2014	771	1642	305.57	179.25	1903.54	201.89	111.54
2015	492	312.16	128.92	139.41	240.8	73.3	109.03
2016	635	644.51	500.69	281.57	439.4	280.29	203.63
2017	541	2714.35	559.44	237.73	2057.6	362.38	117.32
2018	387	1790.57	273.82	111.5	1437.21	157.92	64.9
2019	197	164.75	34.87	51.98	92.68	28.5	29.4
2020	NA	80.88	65.64	41.21	45.9	43.4	28.661
2021	NA	667.82	163.06	NA	524.7	103.241	NA
2022	NA	305.403	NA	NA	244.43	NA	NA

Table A3. M1, M2 and M4 models' parameters of cod recruitment.

YEAR	Cod3	TW3	FLI3	Storms3	TSB	TSB1	SSB3	TW1
1984	443.366	3.033333	398	100	831.318	747.007	161.362	4.5425
1985	529.829	3.658333	469	103	1003	831.318	321.353	4.08
1986	1369.81	4.5425	476	108	1403.861	1003	311.52	3.6825
1987	357.271	4.08	455	99	1238.186	1403.861	243.628	3.649167
1988	334.096	3.6825	376	116	1008.624	1238.186	195.463	3.426667
1989	158.52	3.649167	434	93	956.866	1008.624	164.102	3.750833
1990	132.388	3.426667	278	75	912.593	956.866	115.111	4.441667
1991	298.599	3.750833	468	80	1348.024	912.593	191.558	4.565833
1992	714.479	4.441667	641	96	1690.944	1348.024	237.29	4.508333
1993	988.559	4.565833	569	89	2203.392	1690.944	303.044	4.556667
1994	749.508	4.508333	451	89	2116.329	2203.392	636.493	4.050833
1995	537.661	4.556667	375	93	1850.415	2116.329	804.452	3.840833
1996	402.269	4.050833	451	112	1695.858	1850.415	701.423	4.330833
1997	777.417	3.840833	496	90	1538.124	1695.858	570.797	3.751667
1998	1048.459	4.330833	508	92	1353.358	1538.124	533.335	3.550833
1999	626.609	3.751667	527	100	1202.556	1353.358	550.636	3.644167
2000	747.832	3.550833	458	88	1225.859	1202.556	545.65	4.231667
2001	591.465	3.644167	491	99	1479.452	1225.859	385.769	4.630833
2002	374.563	4.231667	557	104	1596.045	1479.452	280.6	4.483333
2003	757.474	4.630833	470	110	1682.972	1596.045	255.331	4.415

2004	242.78	4.483333	561	118	1568.986	1682.972	383.395	4.1475
2005	694.272	4.415	527	103	1518.705	1568.986	520.889	4.793333
2006	538.504	4.1475	481	153	1542.202	1518.705	571.223	4.816667
2007	1254.871	4.793333	515	110	1869.439	1542.202	665.197	5.081667
2008	1016.97	4.816667	438	122	2559.427	1869.439	578.178	4.943333
2009	590.98	5.081667	362	103	3100.56	2559.427	581.768	4.64
2010	205.517	4.943333	307	127	3342.036	3100.56	647.938	4.685
2011	363.991	4.64	283	117	3571.135	3342.036	718.024	4.754167
2012	510.052	4.685	317	118	3646.79	3571.135	1008.86	4.3675
2013	471.175	4.754167	111	106	3727.573	3646.79	1239.289	5.356667
2014	854.919	4.3675	421	100	3456.531	3727.573	1798.145	4.869167
2015	452.525	5.356667	302	118	3288.414	3456.531	2016.129	4.735833
2016	285.806	4.869167	256	143	2864.959	3288.414	2238.973	5.000833
2017	770.881	4.735833	254	135	2796.188	2864.959	2123.627	5.321791
2018	492.321	5.000833	269	150	2587.932	2796.188	1714.21	5.14622
2019	635.422	5.321791	258	146	2472.943	2587.932	1370.535	5.120753
2020	540.952	5.14622	385	157	2184.578	2472.943	1395.722	4.633893
2021	386.652	5.120753	287	161	1977.195	2184.578	1258.206	4.56115
2022	197.418	4.633893	249	142	1745.79	1977.195	1198.577	4.6281
2023	NA	4.56115	381	157	1609.757	1745.79	964.937	4.78
2024	NA	4.6281	292	172	1412.58	1609.757	835.773	4.99
2025	NA	4.78		155			711.549	

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