

## 6 Northeast Arctic beaked redfish<sup>1</sup>

On 30 March 2022 all Russian participation in ICES was suspended. As a result of this decision, it is not possible to run ICES stock assessments or provide ICES advice for the Barents Sea stocks of NEA cod, NEA haddock, *Sebastes mentella* or Greenland Halibut, as management and data collection for these stocks are shared between Norway and Russia. There is therefore no stock assessment for NEA cod this year, but input data to the assessment are updated as far as possible.

The chapter was therefore updated as in a non-assessment year. This comprises tables 6.1 through to 6.7 and tables 6.12, to 6.19. Updated figures comprise figures 6.1, 6.2, 6.6, 6.7 (upper panel), 6.8, 6.10, 6.12, 6.15 and 6.16.

### 6.1 Status of the fisheries

#### 6.1.1 Development of the fishery

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

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

Figure 6.2 shows the distribution of catch among national fishing fleets for 2018 to 2021 and the location of Norwegian *S. mentella* catches in the Norwegian EEZ in 2021 as well as bycatch in other areas. The 44<sup>th</sup> 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 51<sup>st</sup> session of the commission in 2021.

#### 6.1.2 Bycatch in other fisheries

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

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<sup>1</sup> Beaked redfish (*Sebastes mentella*) in subareas 1 and 2 (Northeast Arctic); reb.27.1-2.

### 6.1.3 Landings prior to 2021 (Tables 6.1–6.7, Figure 6.1)

Nominal catches of *S. mentella* by country for subareas 1 and 2 combined are presented in Table 6.1, while they are presented for Subarea 1 and divisions 2.a and 2.b in Tables 6.2–6.4. The pelagic catch of *S. mentella* in the Norwegian Sea outside EEZs reported to NEAFC and/or ICES amounted to 7739 t in 2018, 6060 t in 2019, 5469 t in 2020 and 2872 t in 2021, and is shown by country in Table 6.5. Nominal catches for both redfish species combined (i.e. *S. mentella* and *S. norvegicus*) by country are presented in Table 6.6. The sources of information used are catches reported to ICES, NEAFC, Norwegian and Russian authorities (foreign vessels fishing in the Norwegian and Russian economic zones) or direct reporting to the AFWG. Where catches are reported as *Sebastes sp.*, they are split into *S. norvegicus* and *S. mentella* by AFWG experts based on available correlation between official catches of these two species in the considered areas. All tables have been updated for 2020, and new figures presented for 2021. Total international landings in 1952–2021 are also shown in Figure 6.1.

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

Because of the novelty of the situation, related with reopening fisheries after 10 years of its ban, the total landings of *S. mentella* in subareas 1 and 2 in 2014, demersal and pelagic catches, amounted to only 18 426 t. The total landings of the demersal and pelagic fishery increased to 34 754 t in 2016, 30 783 t in 2017, 38 046 t in 2018, 45 640 t in 2019, 53 631 t in 2020 and 63 482 t in 2021. Of this, 2872 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 5388 t above the TAC advised by ICES, but were 8117 t, 2229 t and 2676 t below TAC in 2019, 2020 and 2021, respectively. Norway caught the major share of the demersal catches, but Russian demersal catches increased substantially after 2017, particularly in ICES Division 2.b.

The redfish population in Subarea 4 (North Sea) is believed to belong to the Northeast Arctic stock. Since this area is outside the traditional areas handled by this Working Group, the catches are not included in the assessment. The total redfish landings (golden and beaked redfish combined) from Subarea 4 have up to 2003 been 1000–3000 t per year. Since 2005 the annual landings from this area have varied between 90 and 333 t (Table 6.7).

### 6.1.4 Expected landings in 2022

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

In 2022 Norwegian fishing vessels, can catch and land up to 44 291 t of redfish in the Norwegian economic zone (NEZ) in a limited area north of 65°20'N (see map in Figure 6.3), in international waters and the fisheries zone around Jan Mayen. Of this quantity, 100 t are allocated to cover bycatch in other fisheries and 52 t for research/surveillance and education purposes, while the remaining 43 139 t can be taken in a directed fishery. Only vessels with cod and saithe trawl permits can participate in the directed fishery for redfish. Each vessel which has the right to participate is assigned a maximum quota, which can be adjusted during the year, per how much of the national quota is exploited. The fishery may be stopped if the total quota is reached. This

quota must also cover catches of redfish (both species) in other fisheries. It is prohibited to fish for redfish with bottom trawls in the period from 1 March until 10 May. Investigations were conducted in 2015–2016 to see if the protection of females during the main time of larvae release should be improved by extending the period of prohibited fishing until later in May, and to see if the area south of Bear Island (Area 20 in Figure 6.3) can be opened for directed fishing, either with or without sorting grid, and permissions were granted to a small number of vessels of the Norwegian reference fleet for an earlier onset of fishing to gain further data. The hitherto conclusion is that males dominated the catches (more than 70%) in the main fishing areas south and southwest of Bear Island during the investigations from late April until the directed fishery started on 10 May, and that the area south of Bear Island should stay closed during January–February due to smaller *S. mentella* inhabiting this area at the beginning of the year.

Since 2015, Russia has had access to the NEZ when fishing their quota share. In 2021 Russia may fish 11 908 t (18%) plus 2000 t transferred from Norway to Russia. Apart from this an additional 2100 t were transferred from Norway to Russia to cover bycatch of redfish (both species) in Russian fisheries targeting other species. The remaining 6616 t are divided between third countries in the NEZ and Svalbard Zone (2713 t) and the NEAFC areas (3903 t). Catch in the NEAFC areas in 2021 amounted to 2872 t while the catch in the national economic zones of Norway and Russia as well as the fisheries protection zone around Svalbard was 60 610 t. The total catch in 2021 was 2676 t lower than the advised TAC. It is assumed that the total catch in 2022 should not exceed the TAC of 67 210 t set by ICES.

## 6.2 Data used in the assessment

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

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

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

### 6.2.1 Length- composition from the fishery (Figure 6.4)

Comparison of length distributions of the Norwegian and Russian catches of *S. mentella* in 2019–2020 are shown in Figure 6.4. In 2020, the Russian and Norwegian fleets fished smaller fish than

in 2019, reflecting good year classes due to enter the fishable stock. In 2020 length of beaked redfish in Norwegian catches was larger than in Russian catches. This is probably due to differences in the fishing areas. The Russian fleet largely operated in area 2b, and the Norwegian fleet in area 2a.

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

Catch-at-age in the Norwegian fishery was estimated using ECA for 2014. For 2015, 2016 and 2018, it was not possible to run ECA and the catch-at-age for the Norwegian Fishery was estimated using the older Biomass program in SAS (Table 6.8). Not enough age readings were available to estimate catch-at-age in 2017, 2019 and 2020. For the demersal fisheries 2017, 2019 and 2020 as well as the pelagic fisheries 2017, 2018 and 2020 (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).

The 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.

Age composition of the Russian and Norwegian catches in 2020 was calculated using the age-length key, based on Russian age readings. The joint age-length key for the last three years (2018–2020) 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. (Figure 6.5). The proportion (by numbers) of individuals at age 18 and older in the Norwegian catches was almost twice as large as in the Russian ones.

Age-length-keys for *S. mentella* are uncertain because of the slow growth rate of individuals and therefore these data should be used with caution. They were not used in the current assessment but may be considered in future assessments. 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.

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

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

#### 6.2.4 Maturity-at-age (Table 6.14, Figure 6.8)

The proportion maturity-at-age was estimated for individual years using a mixed-effect statistical model (Table 6.14, Figure 6.8). The modelled values of maturity-at-age for individual years are used in the analytical assessment models, except in 2008, 2011 and 2016–2020 when the fixed effects only were considered, at least in the two latest years due to a lack of age data.

#### 6.2.5 Natural mortality

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

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

#### 6.2.6 Scientific surveys

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

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

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

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

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

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

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

#### **6.2.6.2 Pelagic survey in the Norwegian Sea (Table 6.19, Figures 6.13, 6.14)**

The international deep pelagic ecosystem survey in the Norwegian Sea (WGIDEEPS, ICES 2016, survey code: A3357) monitors deep pelagic ecosystems, focusing on beaked redfish (*S. mentella*). The latest survey was conducted in the open Norwegian Sea from 11 August until 28 August 2019, following similar surveys in 2008, 2009, 2013 and 2016. The spatial coverage of the survey and the catch rates of beaked redfish in the trawl 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).

#### **6.2.6.3 Additional surveys (Figures 6.15–6.17)**

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

A slope survey “Egga-sør survey” was carried out by IMR from 07 March to 07 April 2020, following similar surveys in 2009, 2012, 2014, 2016 and 2018. 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).

## **6.3 Assessment**

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

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

#### **6.3.1.1 Stock trends**

The temporal patterns in recruitment-at-age 2 (Figures 6.18, 6.21) confirm the previously reported recruitment failure for the year classes 1996 to 2003 and indicate a return to high levels of recruitment. The estimates of year-class strength for recent years are uncertain due to limited age

data from winter and ecosystem surveys. Modelled spawning-stock biomass (SSB) has increased from 1992 to 2007 (Table 6.21). In the late 2000s the total-stock biomass (TSB) consisted of a larger proportion of mature fish than in the 1990s. This is reversing as individuals from new successful year classes, but still immature, are growing. TSB has increased from about 1.0 to above 1.4 million tonnes in the last 10 years (Table 6.21 and Figures 6.21–6.22). The concurrent decline in SSB from 2007 to 2014 can be attributed to the weak year classes (1996–2003) entering the mature stock. This trend has levelled off and SSB increases again. SSB at the start of 2021 is estimated at 900 221 t.

#### **6.3.1.2 Fishing mortality (Tables 6.20a,b–6.21, Figure 6.19)**

The patterns of fleet selectivity-at-age indicate that most of the fish captured by the demersal fleet in 2020 are of age 8 years and older, while the pelagic fleet mostly captures fish of age 14 and older (Tables 6.20a,b and Figure 6.19). While model results at the benchmark workshop showed a gradual shift in the demersal selectivity towards older ages in recent years, this is no longer observed after the 2015 catch-at-age data were incorporated in the model. The demersal fleet selectivity appears shifted towards later ages only in 2014. In 2020  $F_{19+}$  is estimated at 0.05 (Table 6.21), with 0.04 for the demersal and 0.008 for the pelagic fleets (Table 6.20a), respectively.

#### **6.3.1.3 Survey selectivity patterns (Figure 6.20)**

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

#### **6.3.1.4 Residual patterns (Figure 6.23)**

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

#### **6.3.1.5 Retrospective patterns (Figure 6.24)**

The historical retrospective patterns for the years 2007 to 2016 are presented in Figure 6.24. All model parameters were estimated in each individual run. The most recent model run (last year of data 2020) is consistent with previous runs. As in 2018 the SSB time-series is smoother than before, due to fixed weight-at-age for every year. The new estimates for winter and Ecosystem surveys in 2020 led to an increase in estimated SSB, up to 19% in the early years and around 7% to 9% in later years. Contrarily, the 2021 update revised SSB moderately down, by about 5% to 6%. Retrospective bias (Mohn's rho) over the last 5 assessments was -48% for recruitment, -2% for  $F_{19+}$  and +7% for SSB. 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).

#### **6.3.1.6 Projections**

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

The estimated fishing mortality in 2020 is:  $F_{19+} = 0.05$ .

If the fishing mortality is maintained, this is expected to lead to a catch of 57 743 t in 2021, well below the advised TAC of 66 158 t. This would lead to an SSB of 925 932 t in early 2022, catches of 59 466 t in 2022 and SSB of 955 688 t in 2023.

Raising  $F_{19+}$  to the precautionary approach ( $F_{19+} = 0.06$ ), recommended in the latest advice, in 2022–2024 would lead to average catches of 72 263 t during that period and a SSB of 999 340 t by 2025 (SSB at the start of 2020 is estimated at 874 727 t).

These projections assume that the selectivity patterns of the demersal and pelagic fleets are identical with those estimated for 2019. It is also assumed that the ratio of fishing mortality between these two fleets remains unchanged.

#### 6.3.1.7 Additional considerations

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

The population age structure derived from the model outputs for the old individuals (beyond 19+, Figure 6.22) is consistent with the age structure reported from the slopes 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 few years of observations and since the age readings from winter survey were not available for years 2014–2021. The use of the autoregressive model for recruitment (random effects in the SCAA) which was introduced in this assessment allows for a projection of the recruitment in recent years, despite the current lack of age data.

#### 6.3.1.8 Assessment summary (Table 6.21, Figure 6.21)

The history of the stock as described by the SCAA model for the period 1992–2019 is summarized in Table 6.21 and Figure 6.21. The key elements are as follows:

- upward trend in Total-stock biomass from 1992 to 2006 followed by stabilization until 2011 and a new upward trend until the present,
- upward trend in spawning-stock biomass from 1992 to 2007 followed by stabilization (or slight decline) until 2014 and subsequent increase,
- recruitment failure for year classes 1996–2003 (2y old fish in 1998–2005),
- good (although uncertain) recruitment for year classes born after 2005. Age data for recruits (at age 2y) after 2014 is limited.
- Annual fishing mortality for the 19+ group throughout the assessment period varied between 0.003 and 0.05.

## 6.4 Comments to the assessment

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

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



## 6.5 Biological reference points

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

Reference point	Value
$B_{lim}$	227000 t
$B_{pa}$	315000 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  $F_{MSY19+} = F_{0.1} = 0.08$ .

## 6.6 Management advice

The present report neither assesses the stock nor does it give advice.

## 6.7 Possible future development of the assessment

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

Recommendations that have been followed since comprise:

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

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

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

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

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

## 6.8 Tables and figures

Table 6.1. *S. mentella* in subareas 1 and 2. Nominal catch (t) by countries in Subarea 1, divisions 2.a and 2.b combined.

Year		Estonia	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Russia	Spain	UK	Total
1998		-	20	73	100	14	-	9	-	-	-	9733	13	125	3646	177	134	14045
1999		-	73	26	202	50	-	3	-	-	-	7884	6	65	2731	29	140	11209
2000		-	50	12	62	29	48	1	-	-	-	6020	2	115	3519	87	130	10075
2001		-	74	16	198	17	3	4	-	-	-	13937	5	179	3775	90	120	18418
2002		15	75	58	99	18	41	4	-	-	-	2152	8	242	3904	190	188	6993
2003		-	64	22	32	8	5	5	-	-	-	1210	7	44	952	47	124	2520
2004	Sweden - 1	-	588	13	10	4	10	3	-	-	-	1375	42	235	2879	257	76	5493
2005		5	1147	46	33	39	4	4	-	-	7	1760	-	140	5023	163	95	8465
2006	Canada - 433	396	3808	215	2483	63	2513	4	341	845	-	4710	2496	1804	11413	710	1027	33261
2007		684	2197	234	520	29	1587	17	349	785	-	3209	1081	1483	5660	2181	202	20219
2008		-	1849	187	16	25	9	9	267	117	13	2220	8	713	7117	463	83	13096
2009	EU - 889	-	1343	15	42	-	33	-	-	-	3	2677	338	806	3843	177	80	10246
2010		-	979	175	21	12	2	-	243	457	-	2065	-	293	6414	1184	79	11924
2011		-	984	175	835	-	2	-	536	565	-	2471	11	613	5037	1678	55	12962

Year	Estonia	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Russia	Spain	UK	Total
2012	-	259	-	517	-	36	-	447	449	-	2114	318	1038	4101	1780	-	11059
2013	-	697	-	80	21	1	-	280	262	-	1750	84	1078	3677	1459	-	9389
2014	-	743	215	446	15	-	-	215	167	3	13149	103	505	1704	1162	-	18426
2015	-	657	49	242	48	3	-	537	192	3	19433	5	678	1142	2529	52	25570
2016	-	502	134	493	74	24	0	1243	1065	-	18191	208	1066	8419	3213	122	34754
2017	4	443	45	763	66	3	-	562	790	-	17 077	102	1060	6593	2838	436	30783
2018	-	425	67	2473	82	10	-	1020	1010	374	18594	275	699	10497	2457	63	38 046
2019	-	156	370	1599	615	10	-	-	653	244	23844	471	1422	13444	2222	590	45640
2020	-	149	163	1807	62	5	-	2	1081	1483	32950	4	870	13874	744	437	53631
2021 <sup>1</sup>	-	290	218	1166	85	6	-	-	1379	-	43797	2	381	14887	615	655	63482

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

Year	Faroe Islands	France	Germany	Greenland	Iceland	Lithuania	Norway	Poland	Portugal	Russia	Spain	UK	Total
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

Year	Faroe Islands	France	Germany	Greenland	Iceland	Lithuania	Norway	Poland	Portugal	Russia	Spain	UK	Total
2018	-	-	19	26	3	-	255	-	-	376	-	-	679
2019	83	4	-	13	-	1	369	16	1	206	19	4	715
2020	35	12	6	18	1	-	335	3	2	118	1	-	532
2021 <sup>1</sup>	87	31	-	14	-	-	195	-	4	367	1	-	699

1 - Provisional figures.

Table 6.3. *S. mentella* in subareas 1 and 2. Nominal catch (t) by countries in Division 2.a (including landings from the pelagic trawl fishery in the international waters).

Year		Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Lithuania	Latvia	Norway	Portugal	Poland	Russia	Spain	UK	Total
1998		-	73	58	14	-	6	-	-	9186	118	-	2626	55	106	12242
1999		-	16	160	50	-	3	-	-	7358	56	-	1340	14	120	9117
2000		50	11	35	29	-	-	-	-	5892	98	-	2167	18	103	8403
2001		63	12	161	17	-	4	-	-	13636	105	-	2716	18	95	16827
2002		37	54	59	18	41	4	-	-	1937	124	-	2615	8	157	5054
2003		58	18	17	8	5	5	-	-	1014	17	-	448	8	102	1700
2004	Sweden - 1	555	8	4	4	10	3	-	-	987	86	-	2081	7	18	3764
2005		1101	36	17	38	2	4	-	-	1083	71	-	3307	20	15	5694

Year		Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Lithuania	Latvia	Norway	Portugal	Poland	Russia	Spain	UK	Total
2006	Estonia - 396 Canada – 433	3793	199	2475	52	2513	3	845	-	4010	1731	2467	10110	589	958	30574
2007	Estonia - 684	2157	226	519	29	1579	16	785	349	3043	1395	1079	5061	2159	120	19201
2008	Netherlands - 13	1821	179	9	24	9	9	117	267	1952	666	1	6442	430	62	12001
2009	EU – 889	1316	7	23	-	25	-	-	-	2208	764	338	3305	137	62	9074
2010		961	175	13	12	2	-	457	243	1705	246	-	5903	1183	55	10955
2011		932	175	697	-	2	-	561	536	1682	599	-	4326	1656	19	11185
2012		259	-	469	-	32	-	449	447	1500	1038	311	3478	1770	-	9753
2013	NL	675	-	24	21	1	-	262	280	871	1055	68	3293	1435	-	7985
2014	2	728	209	411	15	-	-	167	215	4089	505	100	1334	1159	-	8934
2015	3	657	49	236	25	3	-	192	537	11410	678	3	480	2508	47	16828
2016		495	107	493	61	-	24	1065	1243	8887	1052	183	3949	2862	71	20492
2017		425	38	763	44	3	-	790	562	7348	1059	94	3922	2813	429	18287
2018	374	400	47	2440	51	7	-	1010	876	14057	699	272	4721	2435	62	27451
2019	244	73	363	1599	59	10	-	652	-	17741	1421	455	7366	2184	569	32736
2020	1483	112	146	1797	41	4	-	1081	-	22854	868	-	6085	737	403	35613
2021 <sup>1</sup>	-	151	182	1128	70	6	-	1379	-	35799	377	-	6008	535	552	46187

1 - Provisional figures.

Table 6.4. *S. mentella* in subareas 1 and 2. Nominal catch (t) by countries in Division 2.b.

Year		Netherlands	Faroe Islands	France	Germany	Greenland	Ireland	Norway	Poland	Portugal	Russia	Spain	Denmark	UK	Total
1998		-	-	-	42	-	3	521	13	7	642	122	-	29	1379
1999		-	4	10	42	-	-	457	6	9	902	15	-	20	1465
2000		-	-	1	27	-	1	82	2	17	946	69	-	27	1172
2001		-	11	4	37	-	-	293	5	74	763	72	Estonia	25	1284
2002		-	38	4	40	-	-	210	8	118	702	182	15	31	1348
2003		-	6	4	15	-	-	190	7	27	212	39	-	22	522
2004		-	33	5	6	-	-	386	42	149	443	250	-	58	1372
2005	Iceland - 2	7	46	10	17	1	-	673	-	69	1389	143	5	80	2442
2006		-	13	16	8	11	1	688	29	73	843	121	-	67	1870
2007		-	40	8	1	-	1	155	2	88	389	22	-	62	768
2008		-	28	8	7	1	-	263	6	47	520	33	-	19	932
2009	Canada - 3	3	27	8	19	-	-	466	1	42	458	41	-	17	1085
2010		-	18	-	8	-	-	339	-	47	501	1	-	24	938
2011	LT - 4	-	52	-	139	-	-	741	11	14	698	23	-	36	1717
2012	Iceland - 4	-	-	-	48	-	-	581	7	-	606	10	-	-	1256
2013		-	22	-	56	-	-	815	16	23	357	23	-	-	1312



Year		Netherlands	Faroe Islands	France	Germany	Greenland	Ireland	Norway	Poland	Portugal	Russia	Spain	Denmark	UK	Total
2014		1	15	6	34	-	-	8901	3	-	307	3	-	-	9270
2015		-	-	-	6	5	-	7885	1	-	536	21	-	5	8459
2016		-	7	27	-	14	-	9078	24	14	4241	9	-	50	13464
2017		-	18	7	1	10	-	9522	5	1	2476	25	4	7	12075
2018	LT - 144	-	25	20	14	6	-	4281	3	-	5400	22	-	1	9915
2019		-	-	4	-	543	-	5734	-	-	5873	19	-	17	12190
2020 <sup>1</sup>	LV - 2	-	2	5	4	2	-	9760	-	-	7671	6	-	34	17486
2021 <sup>1</sup>		-	52	6	38	1		7803	2	-	8512	79	1	103	16596

1 - Provisional figures.

Table 6.5. *S. mentella* in subareas 1 and 2. Nominal catch (t) by countries of the pelagic fishery in international waters of the Norwegian Sea (see text for further details).

Year		Estonia	Faroe Islands	France	Germany	Iceland	Latvia	Lithuania	Norway	Poland	Portugal	Russia	Spain	UK	Total
2002		-	-	-	9	-	-	-	-	-	-	-	-	-	9
2003		-	-	-	40	-	-	-	-	-	-	-	-	-	40
2004		-	500	-	2	-	-	-	-	-	-	1510	-	-	2012
2005		-	1083	-	20	-	-	-	-	-	-	3299	-	-	4402
2006	CAN - 433	396	3766	192	2475	2510	341	845	2862	2447	1697	9390	575	841	28770

Year		Estonia	Faroe Islands	France	Germany	Iceland	Latvia	Lithuania	Norway	Poland	Portugal	Russia	Spain	UK	Total
2007		684	1968	226	497	1579	349	785	1813	1079	1377	3645	2155	-	16157
2008		-	1797	-	-	-	267	117	330	-	641	4901	390	-	8443
2009	EU - 889	-	1253	-	-	-	-	-	-	337	701	1975	135	-	5290
2010		-	912	-	-	-	243	457	450	-	244	5103	820	-	8229
2011		-	740	175	693	-	536	561	342	-	595	3621	1648	-	8911
2012		-	259	-	469	31	447	449	-	311	1038	2714	1768	-	7486
2013		8	675	-	-	-	280	262	1	68	1078	2720	1435	-	6527
2014		-	697	-	409	-	215	167	-	100	505	795	1146	-	4034
2015		-	606	-	231	-	537	192	-	-	678	-	2508	-	4752
2016		-	393	-	493	-	1243	1065	9	-	821	512	2862	-	7398
2017	NL	-	296	-	761	-	562	790	-	14	791	1014	2624	-	6852
2018	374	-	400	-	2192	-	876	1010	-	116	372	-	2399	-	7739
2019	244	Greenland	-	298	1157	-	-	652	1	364	1096	117	1908	223	6060
2020	1366	3	-	73	1380	-	-	1081	-	-	480	25	737	324	5469
2021 <sup>1</sup>	-	-	-	117	514	-	-	1379	-	-	84	498	280	-	2872

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 <sup>4</sup>	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia <sup>5</sup>	Spain	UK (E&W)	UK (Scot.)	Total
1984	-	-	-	-	2970	7457	-	-	-	-	18650	-	1806	69689	25	716	-	101313
1985	-	-	-	-	3326	6566	-	-	-	-	20456	-	2056	59943	38	167	-	92552
1986	-	DK	-	29	2719	4884	-	-	-	-	23255	-	1591	20694	-	129	14	53315
1987	-	+	-	450 <sup>3</sup>	1611	5829	-	-	-	-	18051	-	1175	7215	25	230	9	34595
1988	-	-	-	973	3349	2355	-	-	-	-	24662	-	500	9139	26	468	2	41494
1989	-	-	-	338	1849	4245	-	-	-	-	25295	-	340	14344	5 <sup>2</sup>	271	1	46688
1990	-	37 <sup>3</sup>	-	386	1821	6741	-	-	-	-	34090	-	830	18918	-	333	-	63156
1991	-	23	-	639	791	981	-	-	-	-	49463	-	166	15354	1	336	13	67768
1992	CAN	9	-	58	1301	530	614	-	-	-	23451	-	977	4335	16	479	3	31773
1993	8 <sup>3</sup>	4	-	152	921	685	15	-	-	-	18319	-	1040	7573	13	734	1	29465
1994	-	28	-	26	771	1026	6	4	3	-	21466	-	985	6220	34	259	13	30841
1995	-	-	-	30	748	693	7	1	5	1	16162	-	936	6985	67	252	13	25900
1996	-	-	-	42 <sup>3</sup>	746	618	37	-	2	-	21675	-	522	1641	409	305	121	26118
1997	-	-	-	7	1011	538	39 <sup>2</sup>	-	11	-	18839	1	535	4556	308	235	29	26109
1998	-	-	-	98	567	231	47 <sup>3</sup>	-	28	-	26273	13	131	5278	228	211	94	33200
1999	-	-	-	108	61 <sup>3</sup>	430	97	14	10	-	24634	6	68	4422	36	247	62	30195

Year	Latvia	Lithuania	Estonia	Faroe Islands	France	Germany <sup>4</sup>	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia <sup>5</sup>	Spain	UK (E&W)	UK (Scot.)	Total
2000	-	-	-	67 <sup>3</sup>	25	222	51	65	1	-	19052	2	131	4631	87	-	203 <sup>6</sup>	24536
2001	-	-	-	111 <sup>3</sup>	46	436	34	3	5	-	23071	5	186	4738	91	-	239 <sup>6</sup>	28965
2002	-	-	15	135 <sup>3</sup>	89	141	49	44	4	-	10713	8 <sup>3</sup>	276	4736	193 <sup>2</sup>	-	234 <sup>6</sup>	16636
2003	S	-	-	173 <sup>3</sup>	30	154	44 <sup>3</sup>	9	5 <sup>3</sup>	89	8063	7	50	1431	47 <sup>2</sup>	-	258 <sup>6</sup>	10360
2004	1	-	-	607	17 <sup>3</sup>	78	24 <sup>3</sup>	40	3	33	7608 <sup>12</sup>	42	240	3601 <sup>2</sup>	260 <sup>2</sup>	-	145 <sup>6</sup>	12699
2005	CAN	LT	5	1194	56	105	75 <sup>3</sup>	12 <sup>2</sup>	4 <sup>3</sup>	55 <sup>2</sup>	7845 <sup>12</sup>	-	196	5637	171 <sup>3</sup>	-	147 <sup>6</sup>	15502
2006	433	845	396	3919	223	2518	107 <sup>3</sup>	2544 <sup>3</sup>	12 <sup>3</sup>	21	11015	2496 <sup>2</sup>	1873	12126	719 <sup>2</sup>	-	1066 <sup>6</sup>	40649
2007	LV	785	684	2343	249	587	84 <sup>3</sup>	1655 <sup>2</sup>	7 <sup>3</sup>	20	8993 <sup>2</sup>	1081 <sup>2</sup>	1708	6550	2186 <sup>2</sup>	-	257 <sup>6</sup>	27591
2008	267	117	-	2123 <sup>3</sup>	250	46	96 <sup>3</sup>	36 <sup>3</sup>	15 <sup>3</sup>	15	7436 <sup>1</sup>	8	785	7866	467 <sup>2</sup>	EU <sup>7</sup>	168 <sup>6</sup>	19695
2009	-	-	-	1413	16	100	81	99	-	4	8128	338	836	4541	177	889	111 <sup>6</sup>	16733
2010	243 <sup>3</sup>	457 <sup>3</sup>	-	1150	226	52	84 <sup>3</sup>	24 <sup>3</sup>	-	-	8059	1 <sup>3</sup>	321	6979	1187	-	123 <sup>6</sup>	18906
2011	536	565	-	1008 <sup>2</sup>	228	844	51	24	-	1	7152	59	638	5956	1684 <sup>2</sup>	-	68 <sup>6</sup>	18814
2012	447	449	-	346	182	588	58	59	12	5	6361	352	1055	4782	1780 <sup>2</sup>	DK	100 <sup>6</sup>	16576
2013	280	262	-	780	353	81	66	9	1	-	5606	103	1114	4474	1459	1	493 <sup>6</sup>	15082
2014	215	167	-	810	434	452	35	29	-	4	16556	124	510	2510	1162	-	211 <sup>6</sup>	23219
2015	537	192	-	733	102	266	259	38	-	3	22208	22	678	1806	2531	1	109 <sup>6</sup>	29485
2016	1243	1065	-	685	164	497	161	79	-	-	22322	234	1066	9283	32013	7	198 <sup>6</sup>	40217

Year	Latvia	Lithuania	Estonia	Faroe Islands	France	Germany <sup>4</sup>	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia <sup>5</sup>	Spain	UK (E&W)	UK (Scot.)	Total
2017	562	790	4	566	62	782	127	68	-	2	20581	129	1150	7890	2882	-	596 <sup>6</sup>	36192
2018	1020	1010	-	571	104	2539	159	77	-	374	23563	311	766	12331	2469	1	100 <sup>6</sup>	45395
2019	-	656	-	392	395	1692	671	93	-	244	29795	491	1495	15373	2287	-	615 <sup>6</sup>	54199
2020	2	1081	-	315	164	1895	161	57	-	1483	39453	13	956	16489	750		456 <sup>6</sup>	63277
2021 <sup>1</sup>	-	1379	-	613	224	1242	177	78	-	-	51498	22	441	16624	623		751 <sup>6</sup>	73675

1 - Provisional figures.

2 - Working Group figure.

3 - As reported to Norwegian authorities or NEAFC.

4 - Includes former GDR prior to 1991.

5 - USSR prior to 1991.

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

7 - EU not split on countries.

Table 6.7. REDFISH in Subarea 4 (North Sea). Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment.

Year	Belgium	Denmark	Faroe Islands	France	Germany	Ireland	Netherlands	Norway	Poland	Portugal	Sweden	UK (Scot.)	Total
1998	2	27	12	570	370	4	21	1113		-	-	749	2868
1999	3	52	1	-	58	39	16	862		-	-	532	1563

Year	Belgium	Denmark	Faroe Islands	France	Germany	Ireland	Netherlands	Norway	Poland	Portugal	Sweden	UK (Scot.)	Total
2000	5	41	-	224	19	28	19	443		-	-	618	1397
2001	4	96	-	272	13	19	+	421		-	-	538	1363
2002	2	40	2	98	11	7	+	241		-	-	524	925
2003	1	71	2	26	2	-	-	474		-	-	463	1039
2004	+	42	3	26	1	-	-	287		-	-	214	578
2005	2	34	-	10	1	-	-	84		-	-	28	159
2006	1	49	1	12	3	-	-	163	-	33	-	79	341
2007	+	27	-	8	1	-	-	116	1	-	-	77	230
2008	+	3	-	8	1	-	-	77	-	-	1	54	144
2009	+	4	1	38	+	-	-	119	-	-	+	86	248
2010	-	5	-	3	-	-	-	62	-	-	+	150	220
2011	-	9	-	90	1	-	-	66	-	-	+	71	237
2012	-	10	-	19	+	-	-	71	-	-	+	87	187
2013	-	7	-	40	+	-	-	54	-	-	-	176	277
2014	-	-	-	32	1	-	-	146	-	-	+	93	272
2015	+	1	-	14	1	-	-	157	-	-	+	61	234
2016	-	3	-	11	+	-	-	180	-	-	+	22	216

Year	Belgium	Denmark	Faroe Islands	France	Germany	Ireland	Netherlands	Norway	Poland	Portugal	Sweden	UK (Scot.)	Total
2017	-	3	-	10	+	-	-	168	-	-	+	38	21
2018	-	10	-	4	-	-	-	71	-	-	+	29	114
2019 <sup>1</sup>	-	7	+	10	+	-	+	62	-	-	+	10	89
2020	-	10	-	4	+	-	+	54	-	-	+	27	95
2021 <sup>1</sup>	-	4	-	11	+	-	+	30	-	-	+	123	168

1 - Provisional figures.

+ denotes less than 0.5 tonnes.

**Table 6.8. *S. mentella* in subareas 1 and 2. Catch numbers-at-age 6 to 18 and 19+ (in thousands) and total landings (in tonnes). For the period 2012–2016 age data are missing from the pelagic fishery. For the period 2015–2018, age data are missing from all fisheries. The numbers-at-age have been estimated following the method outlined in section 6.2.2.**

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	+gp	Total No.	Tonnes Land.
1992	1873	2498	1898	1622	1780	1531	2108	2288	2258	2506	2137	1512	677	9258	33946	15590
1993	159	159	174	512	2094	3139	2631	2308	2987	1875	1514	1053	527	6022	25154	12814
1994	738	730	722	992	2561	2734	3060	1535	2253	2182	3336	1284	734	3257	26118	12721
1995	662	941	1279	719	740	1230	2013	4297	3300	2162	1454	757	794	2404	22752	10284
1996	223	634	1699	1554	1236	1078	1146	1413	1865	880	621	498	700	2247	15794	8075
1997	125	533	1287	1247	1297	1244	876	1416	1784	1217	537	1177	342	3568	16650	8598
1998	37	882	2904	4236	3995	2741	1877	1373	1277	1595	1117	784	786	6241	29845	14045

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	+gp	Total No.	Tonnes Land.
1999	9	83	441	1511	2250	3262	1867	1454	1447	1557	1418	1317	658	3919	21193	11209
2000	1	24	390	1235	2460	2149	1816	1205	1001	993	932	505	596	5705	19012	10075
2001	117	372	542	976	925	1712	2651	2660	1911	1773	1220	714	814	16234	32621	18418
2002	2	40	252	572	709	532	1382	1893	1617	855	629	163	237	4082	12965	6993
2003	6	37	103	93	132	220	384	391	434	466	513	199	231	1193	4402	2520
2004	7	16	70	96	278	429	611	433	1063	813	830	841	607	3076	9170	5493
2005	2	20	57	155	244	262	295	754	783	1896	817	1087	1023	6065	13460	8465
2006	0	4	3	38	64	121	423	1461	1356	2835	4271	3487	3969	32084	50116	33261
2007	0	1	3	22	33	86	235	631	2194	2825	3657	4359	3540	15824	33410	20219
2008	0	0	1	10	46	100	197	469	612	1502	1384	894	1886	11906	19007	13095
2009	0	1	16	22	42	39	254	258	577	364	823	692	1856	11706	16650	10246
2010	10	4	6	19	34	55	61	241	267	390	566	655	667	13879	16854	11924
2011	4	4	4	25	55	114	11	103	286	394	408	479	567	15223	17677	12962
2012	4	24	29	24	26	66	69	78	80	279	387	365	409	13332	15172	11056
2013	0	3	19	92	88	41	42	42	10	167	144	174	299	11726	12847	9474
2014	14	28	346	97	124	96	152	55	111	69	252	293	197	23744	25578	18780
2015	43	41	135	569	849	1362	1254	721	388	952	291	599	877	29612	37693	25856
2016	42	0	1015	687	3469	2670	3089	2067	2037	1314	1385	1288	1143	37744	57950	35646



Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	+gp	Total No.	Tonnes Land.
2017	0	84	0	4479	2823	11454	5380	4385	2451	2235	1396	1437	1290	20897	58311	30934
2018	1173	4126	4511	4873	7166	4872	2339	2925	3570	6944	1973	2330	2677	30661	80140	38739
2019	0	4106	14968	14423	12882	15533	8137	2059	3499	4599	10818	2992	3576	11058	108650	45954
2020	0	0	8772	23581	18571	15195	17516	9091	2319	3883	5056	11870	3273	9248	128375	54686

Table 6.9. Pelagic *S. mentella* in the Norwegian Sea (outside the EEZ). Catch numbers-at-age.

Numbers 10 <sup>3</sup>					Age								
YEAR	7	8	9	10	11	12	13	14	15	16	17	18	19+
2006	0	0	0	0	23	93	1083	323	1563	3628	2514	3756	29704
2007	0	0	9	18	25	154	444	1642	2302	3021	3394	3156	12684
2008	0	0	0	0	28	146	115	143	214	594	752	753	13258
2009	0	0	0	0	9	1314	294	471	889	999	869	1150	2981
2010	0	0	0	0	0	0	130	336	254	466	467	508	11510
2011	0	0	0	0	0	223	83	83	168	136	166	136	13182
2012 <sup>1</sup>	0	0	0	22	29	19	294	146	132	217	288	126	8939
2013 <sup>2</sup>	11	137	98	465	123	158	96	169	246	196	238	598	7968
2014 <sup>3</sup>	0	10	125	88	406	103	125	70	113	151	112	130	4398
2015 <sup>3</sup>	0	0	0	0	169	54	51	0	0	0	85	22	6345
2016 <sup>3</sup>	0	0	154	307	271	276	134	90	107	239	445	229	10499

- 1 - No age data in 2012, catch numbers-at-age are estimated from proportions at age in 2011 and in 2013.
- 2 - No age data from the catches in 2013. Age readings from the research survey conducted in September 2013 are used to derive catch numbers-at-age.
- 3 - No age data in 2014 – 2018, catch numbers-at-age are estimated from previous year according to protocol described in section 6.2.2.
- 4 - No age data in 2020, 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 2011–2020.**

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	Data not available at the time of the working group																
2016	Data not available at the time of the working group																



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
2018	Data not available at the time of the working group																
2019	Data not available at the time of the working group																
2020	Data not available at the time of the working group																
2021	Data not available at the time of the working group																

Table 6.12. *S. mentella* in subareas 1 and 2. Observed mean weights-at-age (kg) from the Norwegian data (Catches and surveys combined). Weights-at-age used in the statistical catch-at-age model are identical for every year and given at the bottom line of the table.

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1992	0.167	0.164	0.211	0.241	0.309	0.324	0.378	0.366	0.428	0.454	0.487	0.529	0.571	0.805
1993	0.141	0.181	0.217	0.254	0.306	0.357	0.349	0.4	0.45	0.436	0.46	0.499	0.462	0.846
1994	0.174	0.188	0.235	0.298	0.361	0.396	0.415	0.48	0.492	0.562	0.642	0.636	0.72	0.846
1995	0.158	0.185	0.226	0.261	0.324	0.36	0.432	0.468	0.496	0.519	0.566	0.573	0.621	0.758
1996	0.175	0.189	0.224	0.272	0.323	0.337	0.377	0.518	0.536	0.603	0.69	0.8	0.683	0.958
1997	0.152	0.191	0.228	0.28	0.324	0.367	0.435	0.492	0.521	0.615	0.601	0.611	0.671	0.911
1998	0.12	0.148	0.192	0.261	0.326	0.373	0.427	0.496	0.537	0.566	0.587	0.625	0.658	0.809
1999	0.133	0.17	0.226	0.286	0.343	0.382	0.441	0.483	0.537	0.565	0.62	0.644	0.672	0.757
2000	0.109	0.144	0.199	0.276	0.332	0.392	0.437	0.49	0.54	0.585	0.631	0.65	0.671	0.872

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
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 <sup>1</sup>	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 <sup>1</sup>	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

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
2019 <sup>1</sup>	0.118	0.38	0.341	0.47	0.538	0.523	0.539	0.565	0.572	0.62	0.656	0.601	0.633	0.744
Modelled	0.141	0.188	0.237	0.286	0.334	0.381	0.424	0.465	0.503	0.537	0.569	0.597	0.623	0.755

1 - Provisional figures.

Table 6.13. Pelagic *S. mentella* in the Norwegian Sea (outside the EEZ). Catch weights-at-age (kg).

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

2020	<i>No data</i>	-	-	-	-	-	-	-	-	-	-	-	-	-
2021 <sup>1</sup>	<i>No data</i>	-	-	-	-	-	-	-	-	-	-	-	-	-

1 - Provisional figures.

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

**Table 6.14.** Proportion of maturity-at-age 6–19+ in *S. mentella* in subareas 1 and 2 derived from Norwegian commercial and survey data. The proportions were derived from samples with at least 5 individuals. a50 w1 and w2 are the annual coefficients for modelled maturity ogives using a double half sigmoid of the form  $0.5 ((1+\tanh(\text{age}- a50)/w1))$  for age < a50 and  $0.5 (1+\tanh((\text{age}- a50)/w2))$  for age > a50. a50 equals the age at 50% maturity.

year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1992	0.00	0.01	0.02	0.04	0.07	0.14	0.26	0.42	0.53	0.59	0.65	0.70	0.75	1.00
1993	0.01	0.02	0.04	0.08	0.15	0.28	0.44	0.55	0.61	0.67	0.72	0.77	0.82	1.00
1994	0.02	0.04	0.08	0.15	0.28	0.44	0.59	0.72	0.81	0.88	0.93	0.96	0.98	1.00
1995	0.03	0.07	0.13	0.24	0.39	0.57	0.71	0.83	0.90	0.95	0.97	0.98	0.99	1.00
1996	0.01	0.01	0.02	0.05	0.10	0.19	0.33	0.50	0.59	0.66	0.73	0.79	0.84	1.00
1997	0.02	0.04	0.08	0.16	0.29	0.46	0.55	0.61	0.66	0.71	0.76	0.80	0.84	1.00
1998	0.02	0.04	0.08	0.15	0.26	0.43	0.56	0.65	0.73	0.80	0.85	0.90	0.93	1.00
1999	0.03	0.05	0.10	0.20	0.34	0.51	0.57	0.64	0.70	0.75	0.80	0.84	0.87	1.00
2000	0.03	0.06	0.11	0.21	0.36	0.52	0.63	0.73	0.81	0.87	0.91	0.94	0.96	1.00
2001	0.01	0.02	0.04	0.09	0.17	0.30	0.47	0.56	0.62	0.68	0.74	0.79	0.83	1.00
2002	0.02	0.05	0.10	0.19	0.33	0.50	0.54	0.59	0.63	0.67	0.70	0.74	0.77	1.00
2003	0.03	0.06	0.12	0.21	0.36	0.51	0.57	0.63	0.69	0.73	0.78	0.82	0.85	1.00
2004	0.03	0.06	0.12	0.22	0.37	0.51	0.55	0.59	0.63	0.67	0.70	0.73	0.76	1.00

year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
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 <sup>1</sup>	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 <sup>1</sup>	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 <sup>1</sup>	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00
2018 <sup>1</sup>	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 <sup>1</sup>	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 <sup>1</sup>	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 <sup>1</sup>	0.02	0.04	0.08	0.15	0.27	0.43	0.55	0.62	0.68	0.74	0.79	0.83	0.87	1.00

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



**Table 6.15. *S. mentella*. Average catch (numbers of specimens) per hour trawling of different ages of *S. mentella* in the Russian groundfish survey in the Barents Sea and Svalbard areas (1976–1983 published in *Annales Biologiques*). The survey was not conducted in 2016 took place in 2017 with insufficient coverage and was terminated after that year.**

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

Year class	0	1	2	3	4	5	6	7	8	9	10	11
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 <sup>1</sup>	-	+	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 <sup>2</sup>	+	0.1	0.1	0.4	0.7	1.1	1	1.4	1	0.8	3.7	0.6
1997	-	-	+	0.4	0.5	0.3	0.9	0.6	1	1.1	0.5	0.4
1998	-	0.1	0.2	0.3	0.2	1.1	0.5	0.7	1	0.4	0.4	0.7
1999	0.1	-	0.1	+	0.1	0.3	0.5	0.8	0.5	0.2	0.4	0.6
2000	-	0.6	0.1	0.5	0.3	0.3	0.6	0.4	0.1	0.1	0.7	0.3
2001	-	0.1	0.4	-	0.1	0.2	0.2	0.3	0.2	0.8	0.1	1
2002 <sup>3</sup>	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 <sup>4</sup>	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				

Year class	0	1	2	3	4	5	6	7	8	9	10	11
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. mentella*<sup>1</sup> in Division 2.b. Abundance indices (on length) from the bottom trawl survey in the Svalbard area (Division 2.b) in summer/autumn 1986–2021 (numbers in millions).

Year	Length group (cm)									Total
	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	
1986 <sup>2</sup>	6	101	192	17	10	5	2	4	0	337
1987 <sup>2</sup>	20	14	140	19	6	2	1	2	0	204
1988 <sup>2</sup>	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

Year	Length group (cm)									Total
	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	
1991	1533	1426	563	55	138	38	30	7	1	3791
1992	149	446	268	43	22	15	4	7	4	958
1993	9	320	272	89	16	13	3	1	0	723
1994	4	284	613	242	10	9	2	2	1	1167
1995	33	33	417	349	77	18	5	1	0	933
1996	56	69	139	310	97	8	4	1	1	685
1997	3	44	13	65	57	9	5	0	0	195
1998	0	37	35	28	132	73	45	2	0	352
1999	3	3	124	62	260	169	42	1	0	664
2000	0	10	30	59	126	143	21	1	0	391
2001	1	5	3	32	57	227	50	3	0	378
2002	1	4	6	21	62	266	47	4	0	410
2003	1	5	7	11	51	244	45	1	0	364
2004	0	2	8	6	14	78	49	2	0	160
2005	22	1	4	4	10	70	47	1	0	158
2006	85	6	5	7	43	200	108	3	0	457
2007	97	68	1	5	11	102	119	3	0	406

Year	Length group (cm)									Total
	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	
2008	124	47	22	3	8	22	70	3	0	299
2009	9	122	88	14	3	27	219	5	0	486
2010	96	18	44	37	2	20	91	7	0	315
2011	126	91	81	48	10	7	67	5	1	436
2012	29	71	65	77	47	8	94	10	0	400
2013	33	43	127	106	67	19	89	13	0	497
2014 <sup>3</sup>	3	10	59	49	38	24	66	20	0	268
2015	85	7	28	157	115	65	69	25	0	552
2016	244	33	44	205	138	139	142	48	0	993
2017	41	39	8	20	59	76	57	17	0	317
2018	66	62	55	35	100	65	80	26	0	489
2019	3	25	84	31	59	82	72	25	1	381
2020	97	8	57	39	40	115	97	16	0	470
2021	492	135	15	39	16	58	88	18	0	860

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

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

3 - Poor survey coverage in 2014.

Table 6.16b. *S. mentella*<sup>1</sup> in Division 2.b. Norwegian bottom trawl survey indices (on age) in the Svalbard area (Division 2.b) in summer/autumn 1992–2019 (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

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
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 <sup>2,3</sup>	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	No age readings available														
2021	No age readings available														

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

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

3 - Poor survey coverage in 2014.

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

Year/ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total	N	Total B
1996	146198	112742	22353	53507	165531	181980	108738	43328	65310	40546	38254	19843	29446	10931	17414	1056120	171	

Year/ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total	N	Total B
1997	62682	130816	12492	23452	74342	55880	76607	82503	17640	14274	675	2238	1723	633	8765	564723	73	
1998	313	78767	85715	39849	25805	23413	84825	100332	54287	24329	11334	7457	15250	576	25212	577464	105	
1999	5359	23240	117170	47851	41608	76797	128677	73306	58018	64781	49890	13565	18458	12171	24672	755562	155	
2000	5964	23169	14336	19960	52666	68081	83857	77513	100442	72294	71148	36599	17183	20590	26501	690304	178	
2001	5026	6541	10957	1093	19766	25591	36594	51644	44407	61704	50083	86122	53952	15699	31877	501057	162	
2002	9112	6646	7379	3821	8635	28215	47456	63903	103368	49964	76133	71970	25241	36765	34957	573565	181	
2003	4086	8218	7368	3140	7885	7983	43821	62360	52015	34782	61735	168703	107298	39760	26882	636036	257 <sup>2</sup>	
2004	8554	15793	11443	7399	3554	7560	6164	11686	8566	22973	25920	23199	20392	19472	50960	243635	91 <sup>2</sup>	
2005	32526	6856	5546	5616	3772	5980	6985	13151	5803	5700	16554	34393	34987	34336	53165	265370	101 <sup>2</sup>	
2006	125437	4833	6844	6602	4255	8486	7424	38309	3983	24756	48733	71491	13957	37991	159909	563010	199 <sup>2</sup>	
2007	411738	213851	15844	5121	11830	3234	8884	10298	14652	7217	4200	7925	53657	19308	237861	1025620	199 <sup>2</sup>	
2008	58894	206727	142254	29386	7745	3182	2895	6352	6132	3538	3445	5380	7018	9717	95279	587944	84 <sup>2</sup>	
2009	122459	176405	231265	82701	109509	45607	15812	2775	5807	2950	3929	22097	12431	9299	331974	1175019	260 <sup>2</sup>	
2010	<i>No age reading</i>																	
2011	422533	390888	227693	61575	56025	78022	47213	12153	3176	2049	2607	856	85	2948	103653	1411479	120 <sup>2</sup>	
2012	353610	256305	351327	173183	130446	70403	58164	40645	21408	12671	3553	1044	1568	3374	139887	1617588	184 <sup>2</sup>	
2013	299841	203094	189851	194068	164206	178236	112427	103262	92160	13848	13956	8579	2784	2857	144033	1723202	271 <sup>2</sup>	
2014 <sup>1</sup>	2247	20884	33295	82052	52428	94324	93771	68765	35193	56728	40647	19047	16518	3335	163869	783104	239 <sup>2</sup>	



Year/ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total	N	Total B
2015	404973	86648	53046	95737	53022	109686	46714	126156	73141	25441	19583	6569	5284	3335	119261	1228596		207 <sup>2</sup>
2016	No age reading																	
2017	534647	244469	213984	215852	33595	45809	61428	62449	37597	33901	39670	37492	10364	40052	85250	1696557		213 <sup>2</sup>
2018	No age reading																	
2019 <sup>3</sup>	93518	77195	125457	81499	62447	38668	61615	91672	178887	124876	0	0	0	0	60931	996765		211 <sup>2</sup>
2020	No age reading																	
2021	No age reading																	

1 - Poor survey coverage in 2014.

2 – Calculated using modelled weight-at-age.

3 – Provisional figures.

Table 6.18a. *S. mentella*<sup>1</sup>. Abundance indices (on length) from the bottom trawl survey in the Barents Sea in winter 1986–2021 (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)									Total
	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	
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

Year	Length group (cm)									Total
	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	
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 <sup>2</sup>	38	83	19	198	266	82	39	3	0	728
1998 <sup>2</sup>	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

Year	Length group (cm)									Total
	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	
2009	95	325	136	5	9	67	163	6	0	806
2010	652	276	215	64	7	74	191	6	0	1485
2011	501	230	212	149	14	47	157	5	0	1315
2012	129	280	86	125	47	14	154	18	0	855
2013	249	227	245	159	143	35	193	27	0	1279
2014	91	174	250	114	125	51	115	14	0	933
2015	175	110	215	302	290	215	171	18	0	1495
2016	615	105	149	332	213	163	124	14	1	1714
2017	568	185	68	197	286	310	231	11	0	1855
2018	189	250	83	109	192	270	214	22	1	1329
2019	42	288	263	92	158	255	211	20	0	1330
2020	196	122	207	92	118	231	209	25	1	1200
2021	887	132	142	124	81	186	172	23	1	1749
2022 <sup>3</sup>	640	1025	45	104	76	87	153	20	0	2149

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

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

3- Russian data not provided in time for AFWG 2022.

**Table 6.18b. *S. mentella*<sup>1</sup> in subareas 1 and 2. Preliminary Norwegian bottom trawl indices (on age) from the annual Barents Sea survey in February 1992–2020 (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															
1993															
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 <sup>2</sup>	41	65	30	33	92	83	103	100	30	67	29	13	7	3	697
1998 <sup>2</sup>	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
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

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
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	<i>No age readings</i>														
2013	0	179	268	136	154	108	126	14	31	8	7	20	41	112	1105
2014	<i>No age readings</i>														
2015	<i>No age readings</i>														
2016	<i>No age readings</i>														
2017	<i>No age readings</i>														
2018	<i>No age readings</i>														
2019	<i>No age readings</i>														
2020	<i>No age readings</i>														
2021	<i>No age reading</i>														
2022	<i>No age reading</i>														

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

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

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

	2008	2009	2013	2016	2019
mean length (cm) All/M/F <sup>1</sup>	37.0/36.4/37.5	36.6/36.0/37.1	37.5/37.0/38.1	37.7/37.0/38.3	37.6/37.2/38.0
mean length (cm) S/DSL/D <sup>2</sup>	37.2/36.8/39.1	37.2/36.5/38.3	37.1/37.4/38.9	38.1/37.6/38.4	37.4/37.6/37.7
mean weight (g) All/M/F	619/585/648	625/609/666	659/625/706	656/619/694	683/644/724
Mean age (y) All/M/F	25 / 25 / 25	25 / 25 / 24	28 / 29 / 28	27 / 27 / 26	- / - / -
Sex ratio (M/F)	45% / 55%	45% / 55%	59% / 41%	50% / 50%	51% / 49%
Occurrence	96%	100%	95%	80%	99%
Catch rates	3.80 t/NM2	3.94 t/NM2	3.47 t/NM2	1.01 t/NM2	3.40 t/NM2
mean $s_A$	33 m <sup>2</sup> /NM2	34 m <sup>2</sup> /NM2	19 m <sup>2</sup> /NM2	5.2 m <sup>2</sup> /NM2	-
Total Area	53720 NM2	69520 NM2	69520 NM2	67150 NM2	73364 NM2
Abundance (Acoustics) <sup>3</sup>	395000 t	532000 t	297000 t	136000 t	-
Abundance (Trawl) <sup>4</sup>	406000 t	548000 t	482000 t	116000 t	499000 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  $TS=20\log(L)-68.0$ . In 2016 the TS equation used was  $TS=20\log(L)-69.6$  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	0.011	0.021	0.040	0.072	0.128	0.218	0.345	0.500	0.654	0.781	0.871	0.927	1.00	
Fy (dem- seral)	Fy (pe- lagic)	Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.047	0	1992	40048 2	38974 1	35323 0	22634 7	13548 8	92234	89791	93917	11766 3	81823	93165	68973	70343	61008	44144	28865	19263	18959 4
0.033	0	1993	26963 5	38103 1	37081 2	33607 4	21261 6	12702 6	86296	83827	87482	10934 9	75866	86189	63671	64803	56096	40520	26454	18979 0
0.029	0	1994	18668 4	25654 0	36252 5	35280 2	31969 3	20218 5	12068 4	81795	79052	81844	10150 9	70092	79457	58648	59674	51651	37307	19909 5
0.022	0	1995	17688 0	17761 8	24408 0	34491 8	33543 5	30366 3	19163 8	11392 2	76744	73703	75960	93978	64817	73442	54197	55140	47725	21843 1
0.015	0	1996	14161 9	16828 9	16899 1	23222 6	32794 9	31866 2	28796 7	18115 2	10720 6	71896	68826	70808	87530	60347	68366	50448	51324	24773 1
0.015	0	1997	10033 1	13474 1	16011 6	16078 3	22089 0	31179 0	30257 3	27267 1	17083 5	10074 7	67437	64508	66347	82008	56538	64050	47263	28017 5
0.021	0	1998	51116	95458	12819 7	15233 9	15294 2	21003 3	29614 8	28670 3	25739 1	16068 4	94563	63242	60476	62193	76869	52995	60036	30691 7
0.016	0	1999	44153	48634	90822	12197 1	14492 4	14544 1	19941 9	27982 8	26889 8	24032 2	14981 6	88137	58940	56361	57961	71639	49389	34198 3
0.013	0	2000	34755	42009	46272	86411	11604 5	13787 2	13831 4	18935 4	26449 1	25269 2	22522 3	14030 3	82528	55187	52772	54269	67077	36644 8

Fy (dem- seral)	Fy (pe- lagic)	Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.022	0	2001	37339	33067	39968	44024	82214	11040 7	13115 5	13141 0	17889 8	24872 5	23742 9	21160 0	13181 5	77535	51848	49579	50986	40729 8
0.008	0	2002	38941	35525	31461	38027	41864	78123	10474 9	12406 4	12375 0	16766 6	23227 9	22128 3	19702 1	12268 1	72149	48243	46130	42639 8
0.003	0	2003	43637	37050	33800	29933	36180	39827	74299	99503	11753 2	11695 2	15831 4	21927 4	20888 4	18597 9	11580 5	68106	45540	44604 6
0.006	0	2004	57553	41518	35251	32158	28476	34415	37875	70629	94536	11160 3	11100 9	15023 3	20805 6	19818 7	17645 0	10987 1	64615	46638 9
0.009	0	2005	13268 2	54758	39501	33539	30594	27087	32725	35992	67041	89612	10567 3	10504 3	14211 5	19678 9	18744 4	16688 2	10391 2	50220 3
0.005	0.037	2006	23245 0	12623 8	52099	37583	31908	29103	25760	31100	34148	63456	84646	99708	99070	13401 4	18556 1	17674 6	15735 7	57151 8
0.005	0.02	2007	33451 4	22116 0	12010 7	49568	35757	30357	27676	24483	29525	32351	59910	79557	93210	92061	12381 1	17062 2	16197 6	66517 5
0.005	0.014	2008	32929 0	31826 7	21041 9	11427 4	47161	34020	28875	26317	23268	28028	30647	56583	74873	87407	86043	11541 1	15875 4	76782 8
0.003	0.01	2009	34773 1	31329 7	30280 9	20019 9	10872 3	44870	32362	27463	25018	22092	26541	28937	53298	70366	81967	80545	10790 3	86491 0
0.004	0.011	2010	49962 1	33084 3	29808 1	28810 3	19047 5	10344 1	42683	30778	26103	23751	20941	25123	27351	50295	66297	77127	75720	91342 6
0.006	0.01	2011	56485 4	47535 6	31477 4	28360 4	27410 7	18121 9	98398	40592	29255	24786	22518	19820	23735	25792	47347	62323	72432	92768 6
0.005	0.01	2012	43051 9	53742 0	45226 9	29948 6	26982 9	26079 2	17239 2	93587	38590	27780	23486	21284	18693	22343	24238	44435	58434	93650 7



Fy (dem- seral)	Fy (pe- lagic)	Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.004	0.009	2013	26696 4	40961 0	51131 9	43030 3	28493 8	25671 9	24808 7	16396 8	88987	36672	26371	22258	20126	17635	21037	22787	41732	93320 5
0.016	0.01	2014	25856 0	25399 8	38971 6	48648 5	40940 4	27109 9	24422 4	23599 0	15594 3	84602	34842	25026	21082	19016	16625	19798	21423	91542 3
0.027	0.009	2015	36516 6	24600 2	24166 2	37078 8	46284 4	38949 8	25787 6	23226 7	22435 5	14815 8	80286	33001	23636	19836	17820	15521	18433	86860 2
0.038	0.009	2016	45110 7	34743 0	23405 4	22992 5	35276 9	44033 1	37046 8	24517 5	22060 5	21260 2	13975 4	75203	30686	21858	18283	16392	14262	81396 7
0.029	0.009	2017	51101 2	42919 8	33055 6	22268 7	21874 6	33558 2	41870 1	35191 9	23229 1	20777 2	19826 0	12899 0	68930	28016	19909	16628	14894	75159 7
0.031	0.009	2018	45055 9	48619 3	40835 3	31450 2	21186 8	20810 5	31913 0	39761 5	33252 4	21720 3	19258 6	18308 5	11889 6	63437	25746	18275	15250	70218 4
0.035	0.008	2019	43062 2	42867 6	46258 0	38852 0	29843 4	20055 7	19620 2	29925 1	37067 9	30845 9	20075 5	17753 9	16842 7	10917 2	58153	23572	16717	65548 2
0.042	0.008	2020	43054 4	40970 8	40785 6	44011 3	36880 6	28217 8	18813 5	18226 1	27605 9	34079 2	28313 3	18406 7	16259 4	15405 1	99729	53069	21495	61235 5

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

Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1992	0.000	0.000	0.000	0.274	0.315	0.359	0.406	0.454	0.503	0.553	0.601	0.647	0.691	0.731	0.768	0.802	0.831	1.000
1993	0.000	0.000	0.000	0.006	0.016	0.044	0.115	0.270	0.512	0.749	0.895	0.960	0.986	0.995	0.998	0.999	1.000	1.000
1994	0.000	0.000	0.000	0.024	0.057	0.129	0.269	0.477	0.693	0.848	0.933	0.972	0.988	0.995	0.998	0.999	1.000	1.000

Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1995	0.000	0.000	0.000	0.030	0.069	0.150	0.296	0.500	0.704	0.850	0.931	0.970	0.987	0.995	0.998	0.999	1.000	1.000
1996	0.000	0.000	0.000	0.017	0.048	0.131	0.311	0.574	0.801	0.923	0.973	0.991	0.997	0.999	1.000	1.000	1.000	1.000
1997	0.000	0.000	0.000	0.014	0.041	0.113	0.274	0.528	0.768	0.908	0.967	0.989	0.996	0.999	1.000	1.000	1.000	1.000
1998	0.000	0.000	0.000	0.005	0.024	0.100	0.334	0.693	0.910	0.979	0.995	0.999	1.000	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.000	0.000	0.001	0.006	0.029	0.125	0.411	0.773	0.943	0.988	0.997	0.999	1.000	1.000	1.000	1.000	1.000
2000	0.000	0.000	0.000	0.000	0.001	0.013	0.112	0.556	0.925	0.992	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2001	0.000	0.000	0.000	0.024	0.056	0.126	0.260	0.460	0.674	0.834	0.924	0.967	0.986	0.994	0.998	0.999	1.000	1.000
2002	0.000	0.000	0.000	0.002	0.011	0.050	0.201	0.545	0.851	0.964	0.992	0.998	1.000	1.000	1.000	1.000	1.000	1.000
2003	0.000	0.000	0.000	0.037	0.081	0.165	0.309	0.503	0.696	0.838	0.921	0.964	0.984	0.993	0.997	0.999	0.999	1.000
2004	0.000	0.000	0.000	0.016	0.038	0.092	0.203	0.392	0.620	0.805	0.912	0.963	0.985	0.994	0.998	0.999	1.000	1.000
2005	0.000	0.000	0.000	0.005	0.016	0.047	0.130	0.310	0.576	0.804	0.925	0.974	0.991	0.997	0.999	1.000	1.000	1.000
2006	0.000	0.000	0.000	0.002	0.007	0.018	0.051	0.134	0.306	0.558	0.783	0.912	0.967	0.988	0.996	0.999	0.999	1.000
2007	0.000	0.000	0.000	0.001	0.003	0.008	0.024	0.065	0.166	0.363	0.620	0.824	0.930	0.975	0.991	0.997	0.999	1.000
2008	0.000	0.000	0.000	0.000	0.001	0.003	0.012	0.053	0.204	0.540	0.844	0.961	0.991	0.998	1.000	1.000	1.000	1.000
2009	0.000	0.000	0.000	0.001	0.005	0.017	0.060	0.190	0.461	0.757	0.919	0.976	0.993	0.998	1.000	1.000	1.000	1.000
2010	0.000	0.000	0.000	0.003	0.008	0.022	0.060	0.154	0.343	0.600	0.812	0.925	0.973	0.990	0.997	0.999	1.000	1.000
2011	0.000	0.000	0.000	0.000	0.002	0.006	0.020	0.069	0.210	0.487	0.773	0.924	0.978	0.994	0.998	0.999	1.000	1.000
2012	0.000	0.000	0.000	0.002	0.004	0.010	0.022	0.050	0.108	0.217	0.389	0.594	0.771	0.885	0.947	0.976	0.989	1.000

Year/ Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2013	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.007	0.020	0.056	0.144	0.326	0.581	0.799	0.919	0.970	0.989	1.000
2014	0.000	0.000	0.000	0.002	0.003	0.007	0.013	0.024	0.045	0.083	0.147	0.248	0.387	0.548	0.699	0.816	0.895	1.000
2015	0.000	0.000	0.000	0.001	0.003	0.007	0.020	0.050	0.124	0.273	0.500	0.727	0.876	0.950	0.980	0.993	0.997	1.000
2016	0.000	0.000	0.000	0.001	0.004	0.013	0.036	0.100	0.249	0.496	0.745	0.896	0.962	0.987	0.996	0.999	0.999	1.000
2017	0.000	0.000	0.000	0.001	0.003	0.013	0.059	0.228	0.581	0.867	0.969	0.993	0.999	1.000	1.000	1.000	1.000	1.000
2018	0.000	0.000	0.000	0.084	0.161	0.287	0.456	0.636	0.785	0.884	0.941	0.971	0.986	0.993	0.997	0.998	0.999	1.000
2019	0.000	0.000	0.000	0.064	0.176	0.397	0.670	0.863	0.951	0.984	0.995	0.998	0.999	1.000	1.000	1.000	1.000	1.000
2020	0.000	0.000	0.000	0.061	0.185	0.441	0.733	0.905	0.971	0.991	0.998	0.999	1.000	1.000	1.000	1.000	1.000	1.000

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

Year	Rec (age 2) in millions	Rec (age 6) in millions	Stock Biomass (tonnes)	SSB (tonnes)	F (12–18)	F(19+)
1992	400	135	529902	251287	0.034	0.047
1993	270	213	572073	296819	0.032	0.033
1994	187	320	625480	372504	0.029	0.029
1995	177	335	685167	427268	0.022	0.022
1996	142	328	745628	353633	0.015	0.015
1997	100	221	804167	434166	0.015	0.015
1998	51	153	857764	490259	0.021	0.021
1999	44	145	900559	552753	0.016	0.016
2000	35	116	936871	640611	0.013	0.013
2001	37	82	966732	593973	0.022	0.022
2002	39	42	978051	669920	0.008	0.008
2003	44	36	992518	739317	0.003	0.003
2004	58	28	1004779	744162	0.006	0.006
2005	133	31	1010390	794940	0.009	0.009
2006	232	32	1012716	782416	0.028	0.042
2007	335	36	992659	911254	0.017	0.025
2008	329	47	987952	853677	0.014	0.019
2009	348	109	992652	886130	0.009	0.013
2010	500	190	1006686	844048	0.01	0.014
2011	565	274	1025073	833040	0.012	0.016
2012	431	270	1052231	827546	0.01	0.014
2013	267	285	1095856	782106	0.008	0.013
2014	259	409	1152683	733907	0.015	0.026
2015	365	463	1202973	757372	0.029	0.036
2016	451	353	1244958	787325	0.041	0.047
2017	511	219	1280146	790415	0.034	0.038
2018	451	212	1327151	811748	0.037	0.041

Year	Rec (age 2) in millions	Rec (age 6) in millions	Stock Biomass (tonnes)	SSB (tonnes)	F (12–18)	F(19+)
2019	431	298	1373398	842086	0.04	0.043
2020	431	369	1418249	874727	0.047	0.05

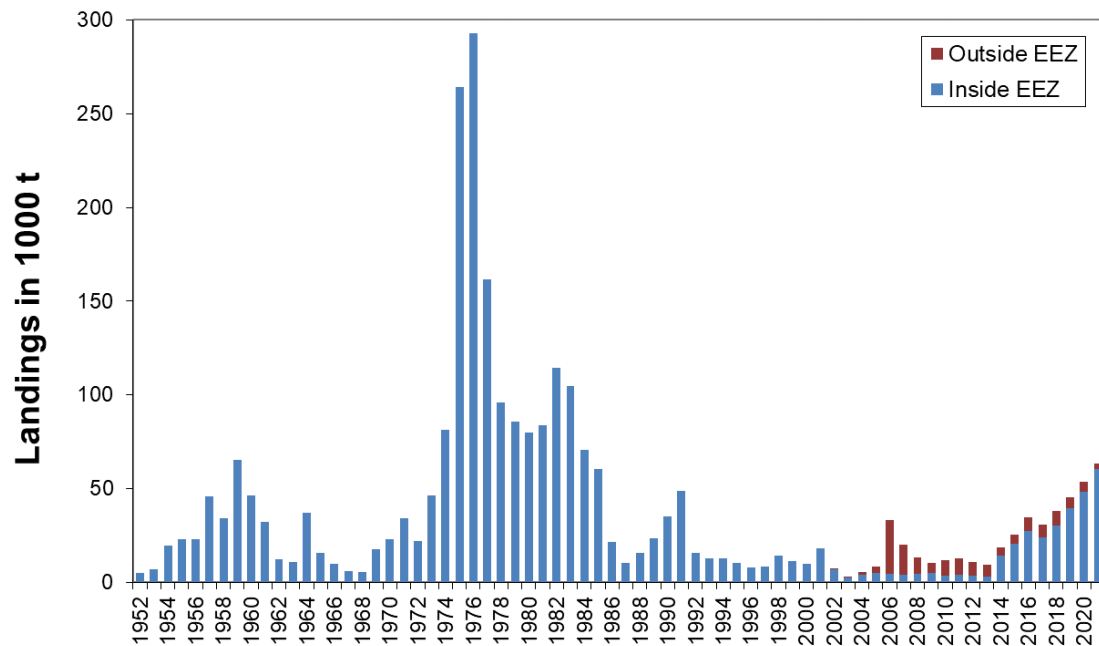


Figure 6.1. *S. mentella* in subareas 1 and 2. Total international landings 1952–2020 (thousand tonnes).

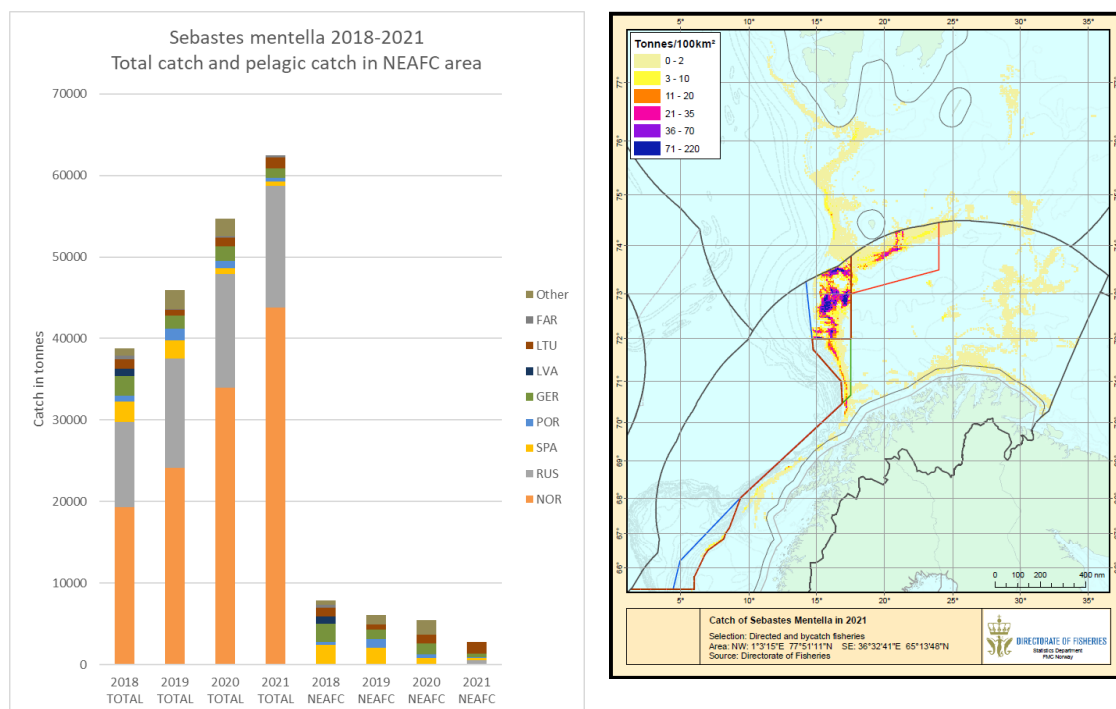
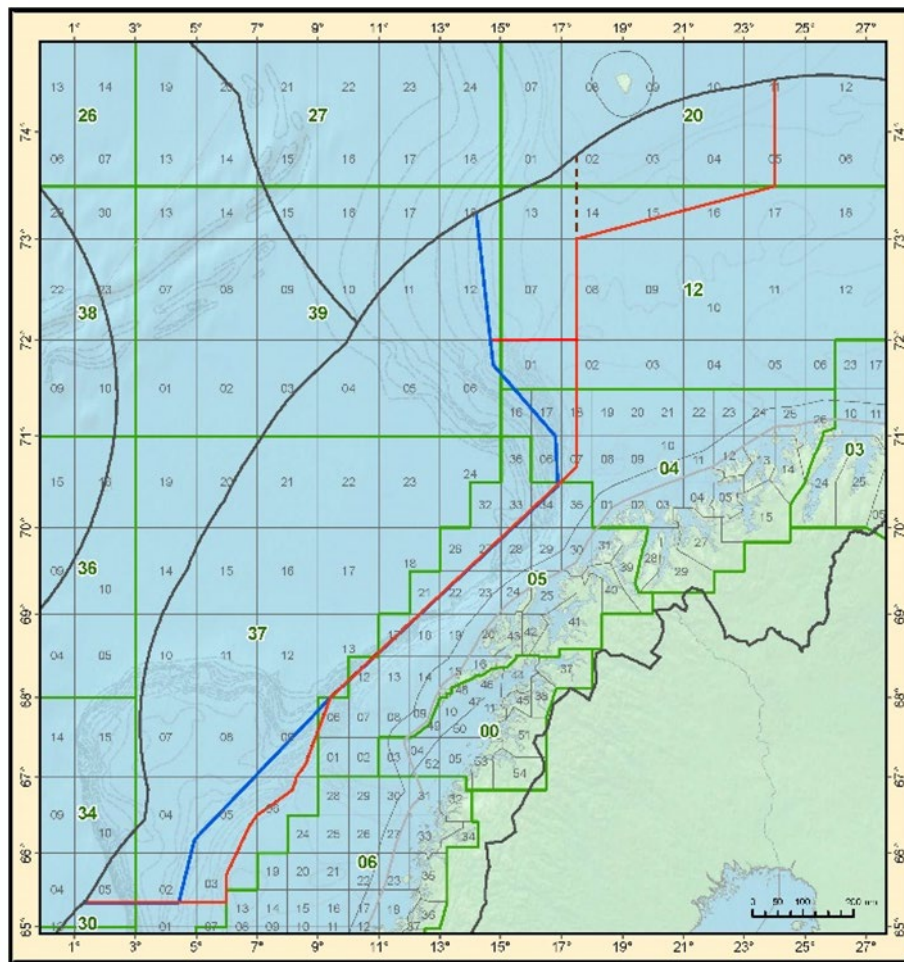


Figure 6.2. *S. mentella* in subareas 1 and 2. Left panel: Catch in tonnes reported by national fleets for the subareas 27.1 and 27.2 and in the NEACF regulatory area. Right panel: Geographical location of the directed Norwegian fishery in 2021 within the Norwegian Exclusive Economic Zone and bycatches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



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

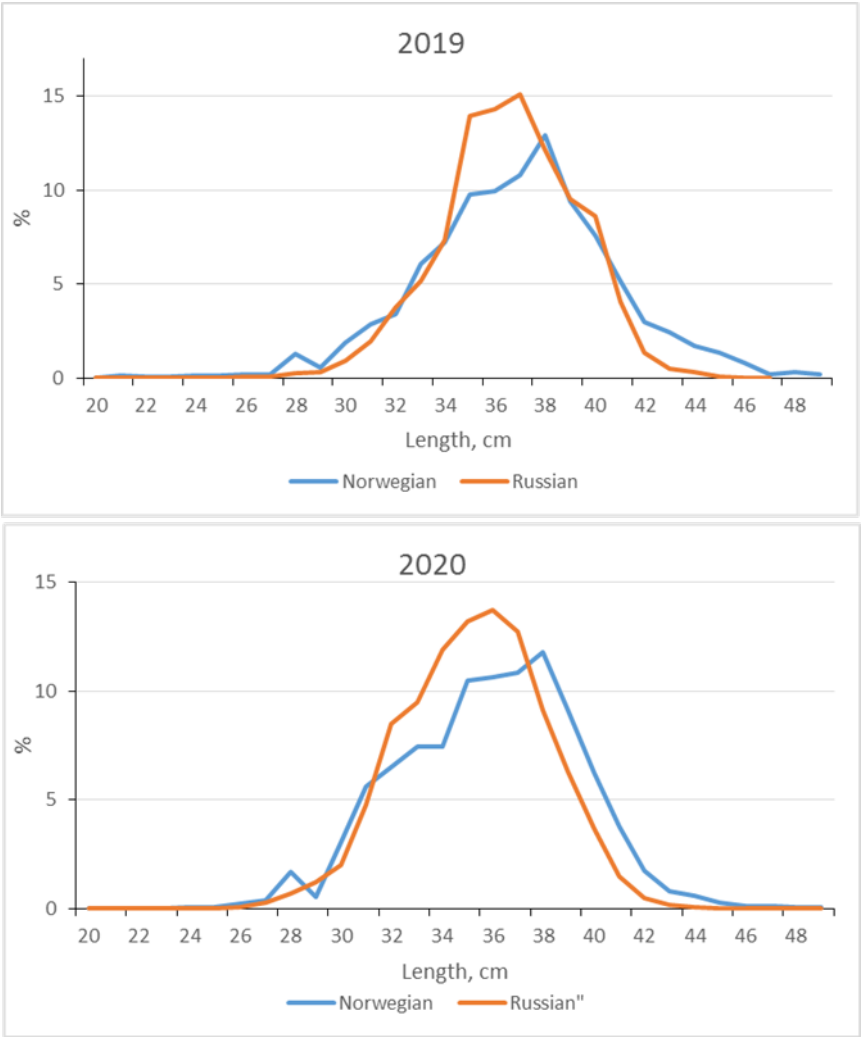


Figure 6.4. *S. mentella* in subareas 1 and 2. Length-distributions of the commercial demersal catches by Norway and Russia in 2019–2020.



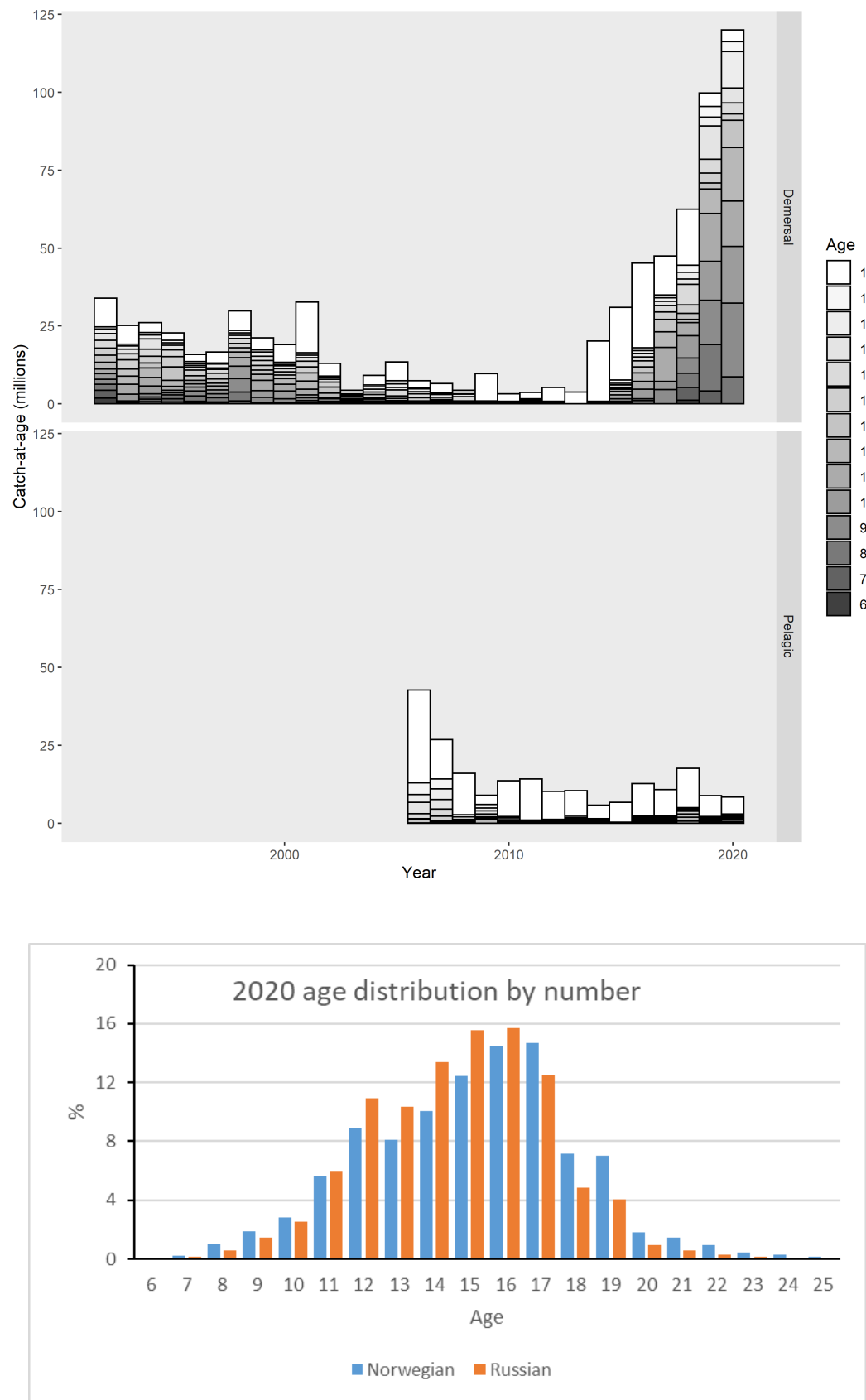
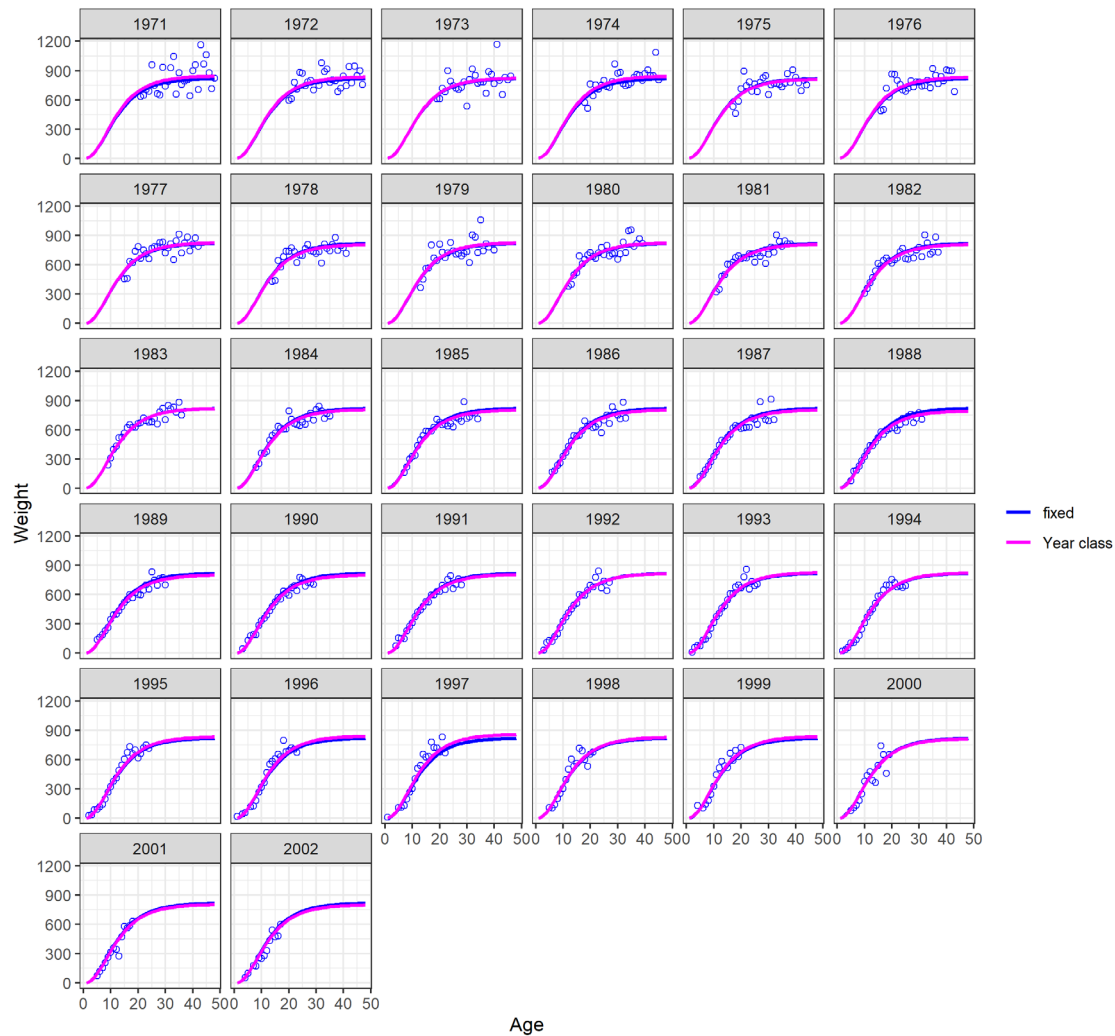


Figure 6.5. *S. mentella* in subareas 1 and 2. Upper panels: Catch numbers-at-age for the demersal and pelagic fleets 1992–2020. Lower panel: Age composition of the commercial demersal catches by Norway and Russia in 2020 (calculated using ALK).



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

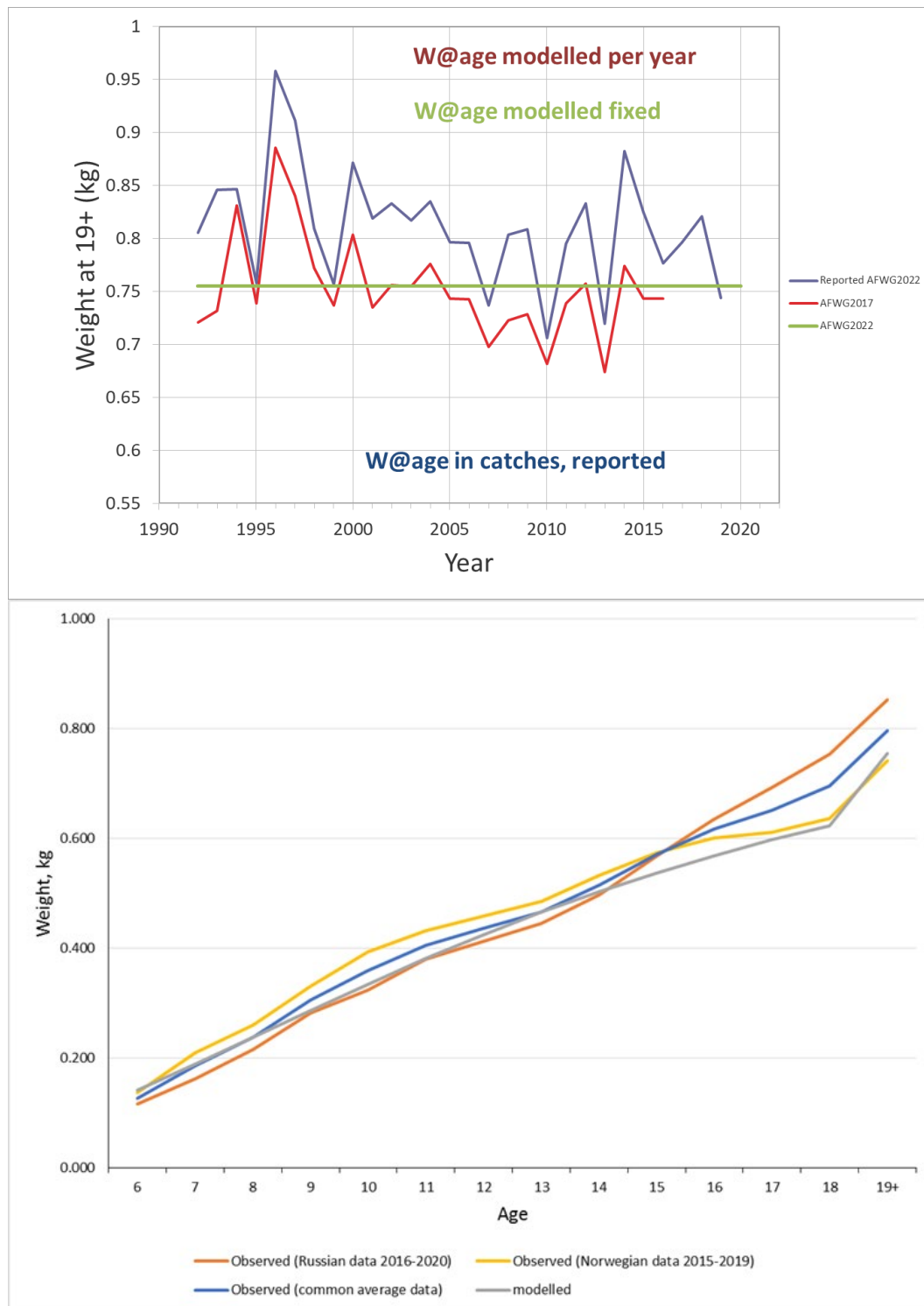


Figure 6.7. *S. mentella* in subareas 1 and 2. The upper panel shows weight-at-age 19+ as reported from catches (blue) or modelled from catches and survey observations (red) using a mixed effect model (Figure 6.5). AFWG 2017 was the last working group using the annual mixed effect model. The weights-at-age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

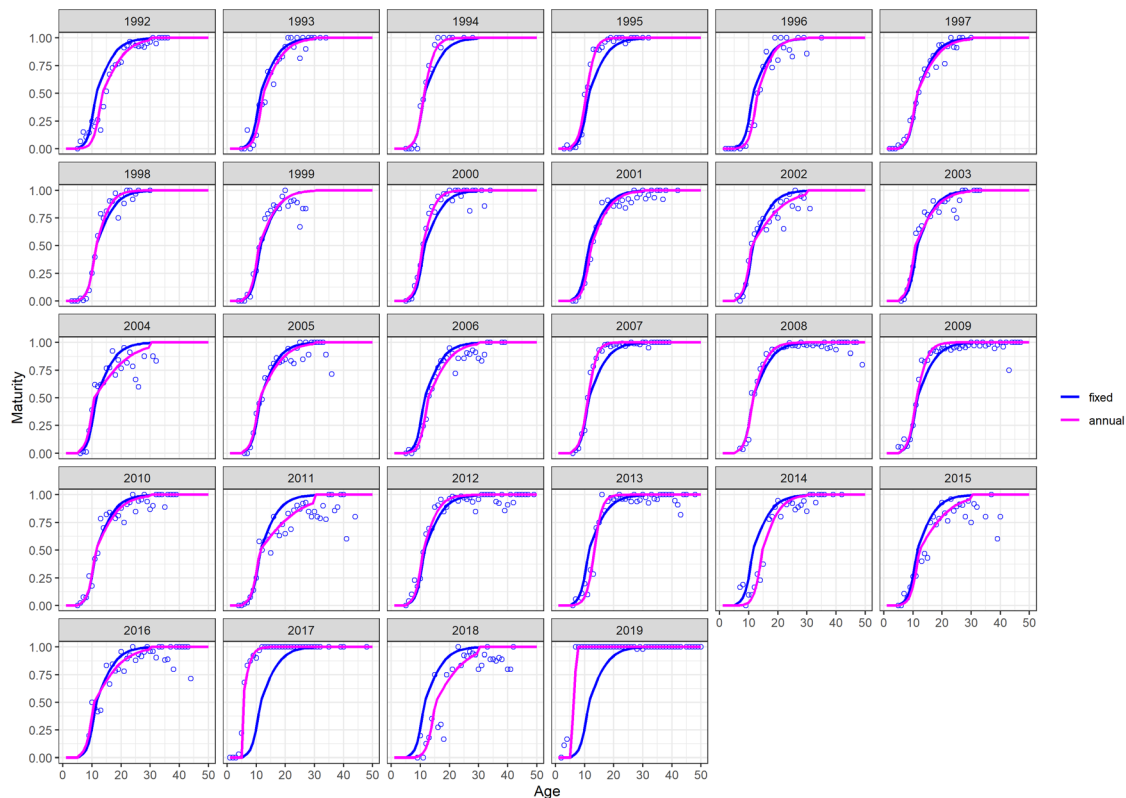


Figure 6.8. Proportion maturity-at-age of *S. mentella* in subareas 1 and 2 derived from Norwegian commercial and survey data (Table D7). The proportions were derived from samples with at least five individuals. The blue and purple lines show the fitted mixed-effect models. For 2008, 2011 and 2016–2019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

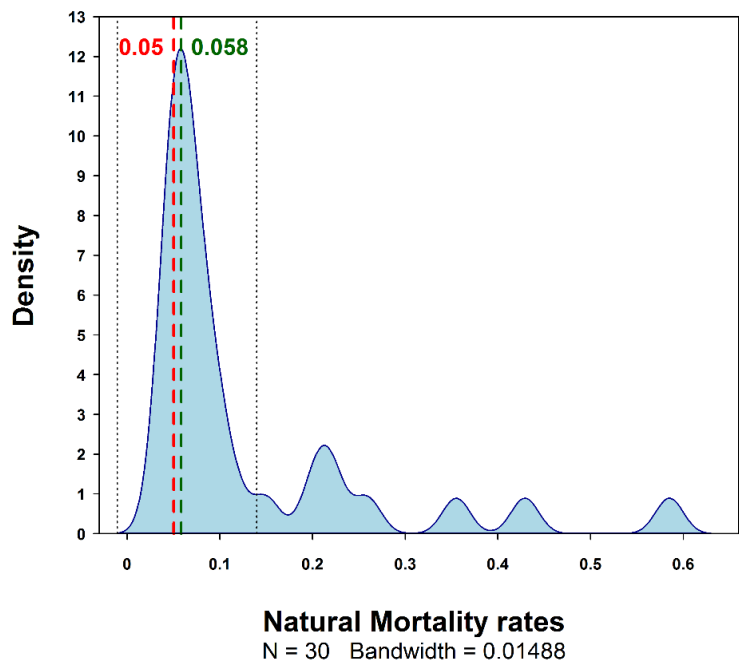


Figure 6.9. Density distribution of natural mortality rates calculated with 30 of the 39 compared methods. The excluded methods are those based on certain taxa or areas. The broken red line indicates the currently used value; the broken green line the most frequent one and the black dotted lines indicate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

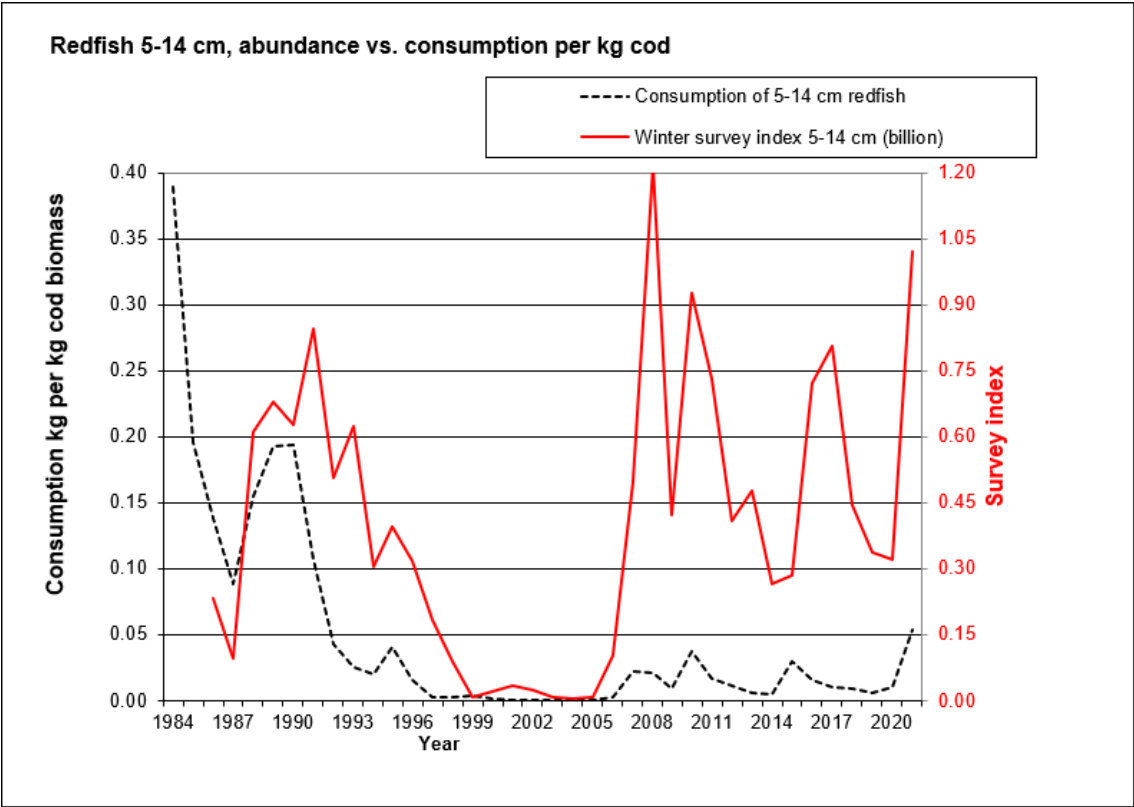
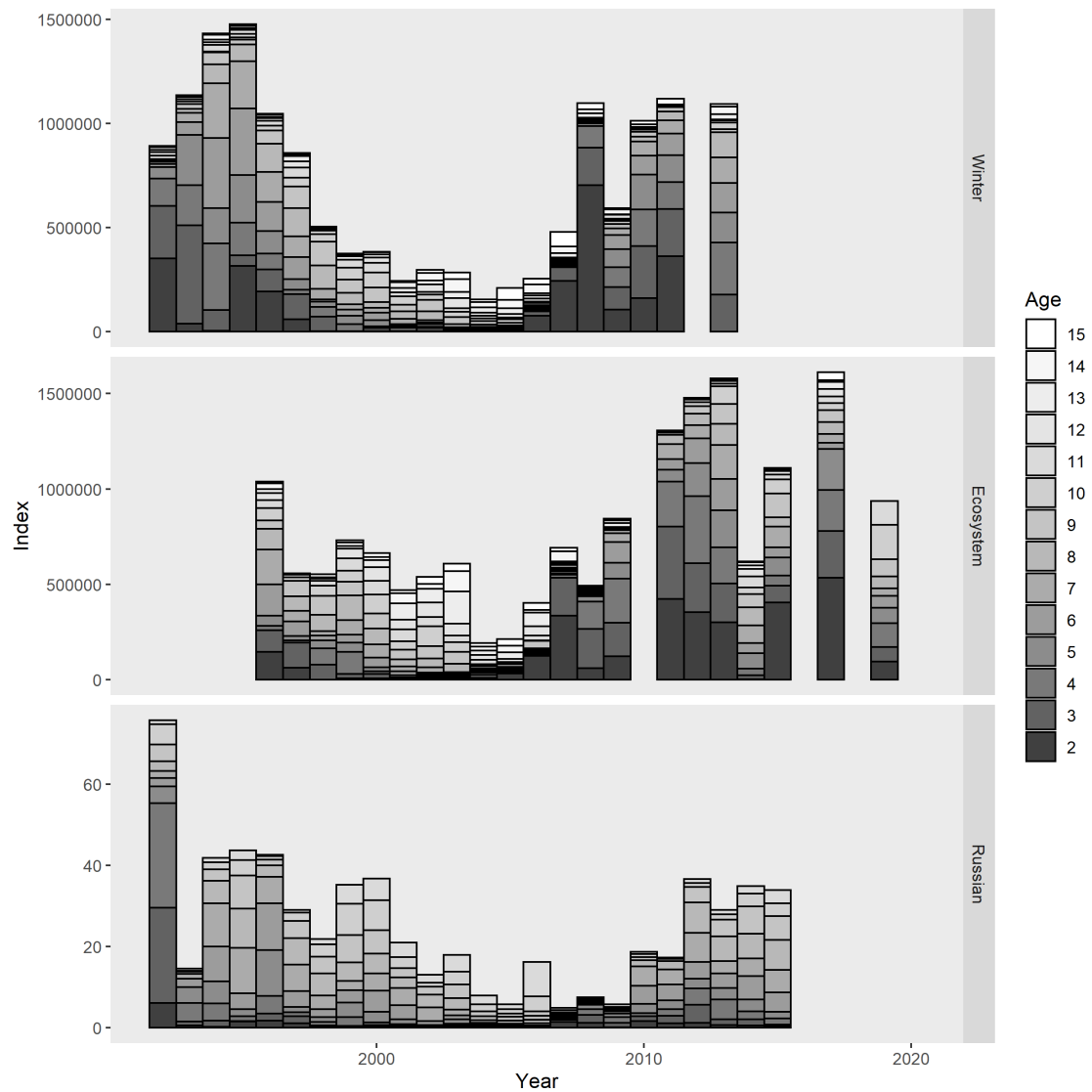


Figure 6.10. Abundance of *S. mentella* (5–14 cm) during the winter survey (February) in the Barents Sea compared with the consumption of redfish (mainly *S. mentella*) by cod (See Section 1 Table 1.1).



**Figure 6.11. *S. mentella* in subareas 1 and 2. Age disaggregated abundance indices for bottom trawl surveys 1992–2020 in the Barents Sea in winter (winter survey top) in summer (Ecosystem survey middle) and in autumn (Russian groundfish survey bottom).**

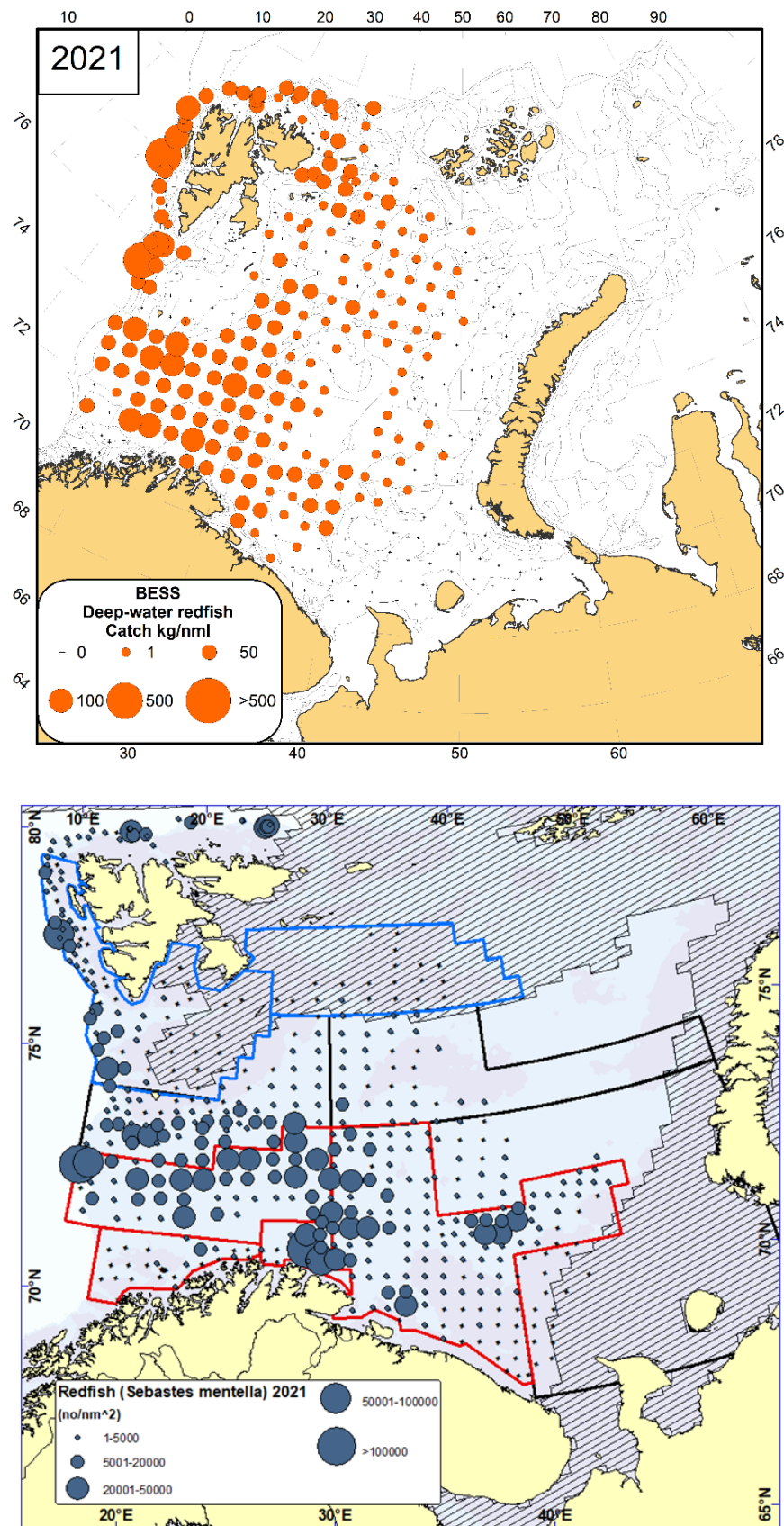


Figure 6.12. *S. mentella* in subareas 1 and 2. Abundance indices for individual trawl stations during the ecosystem survey in autumn 2021 (top) and winter survey 2021 (bottom).

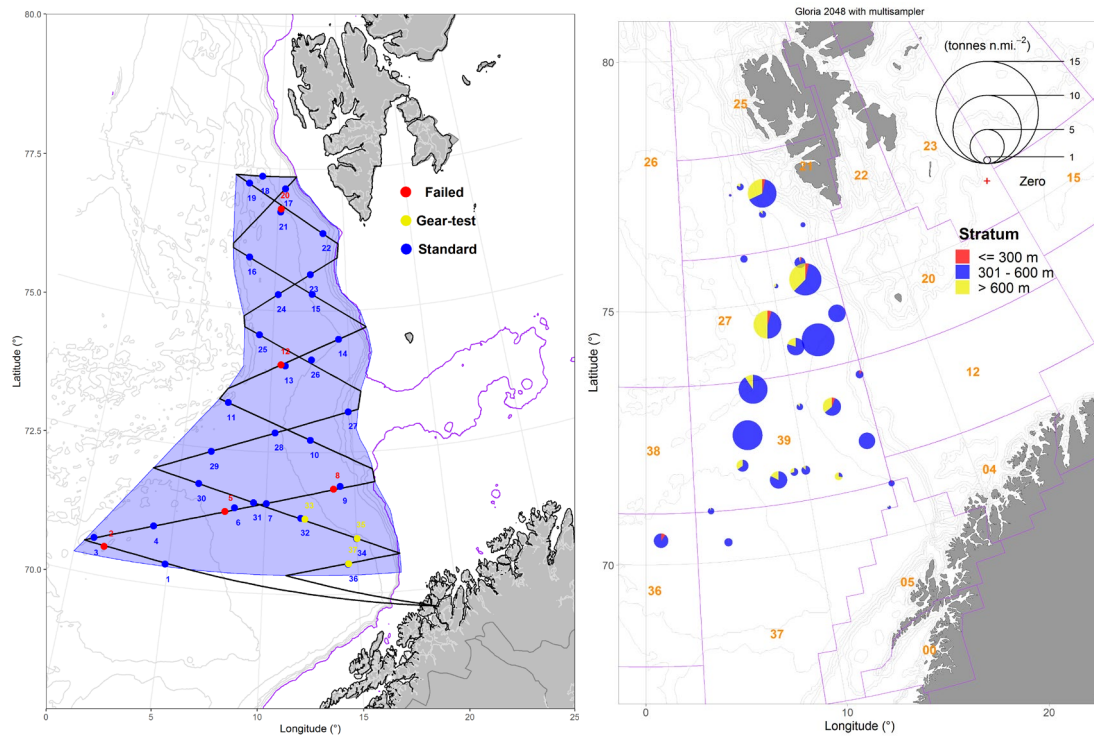
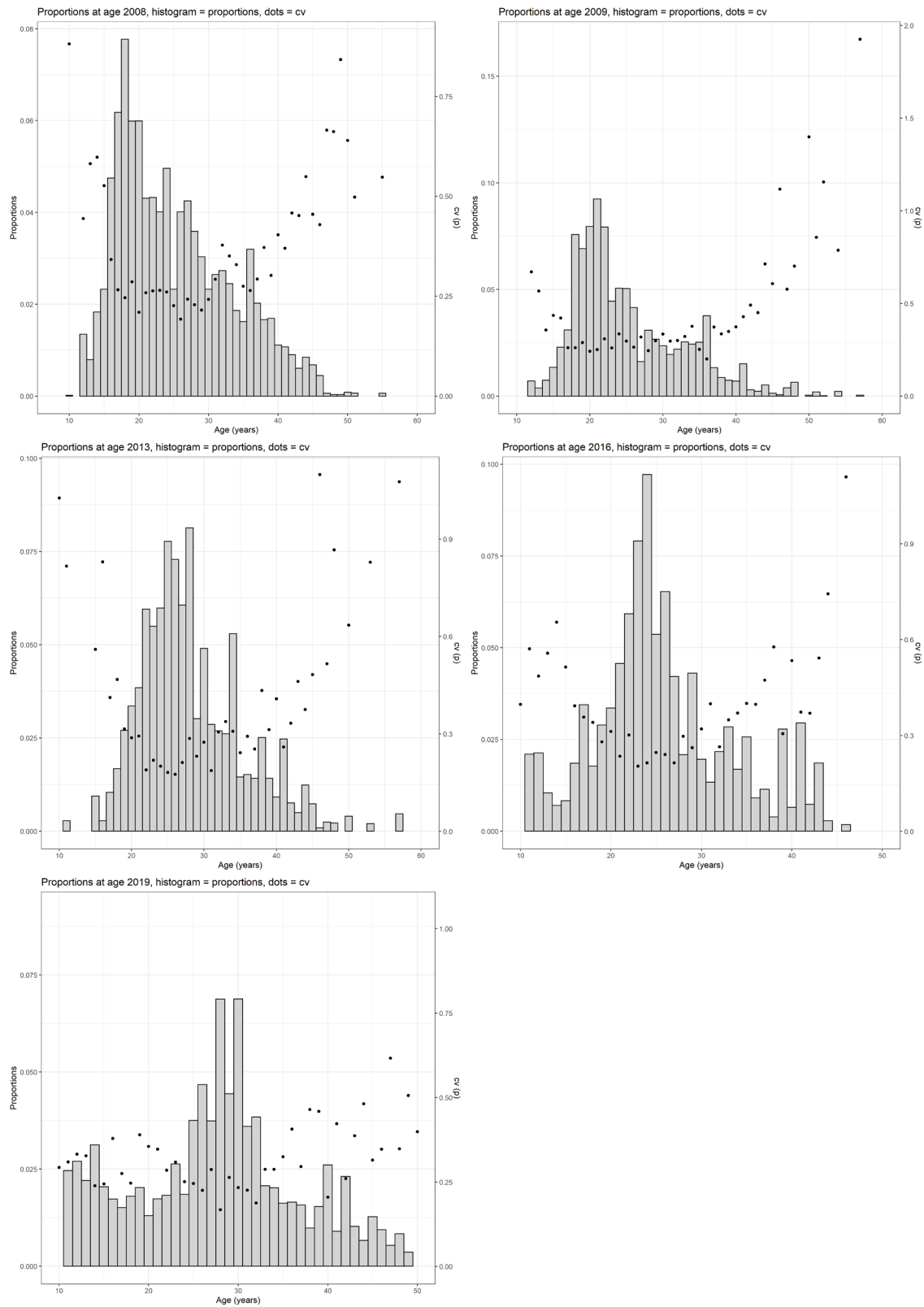


Figure 6.13. *S. mentella* in subareas 1 and 2. Left panel: Survey track of the Deep Pelagic Ecosystem Survey in 2019 and categorized trawls. Only trawls in the category “Standard” served as input for the survey index. Right panel: Catch rates in tonnes per square nautical mile for the surveyed depth layers ( $\leq 300$  m, 301–600 m and  $> 600$  m).





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

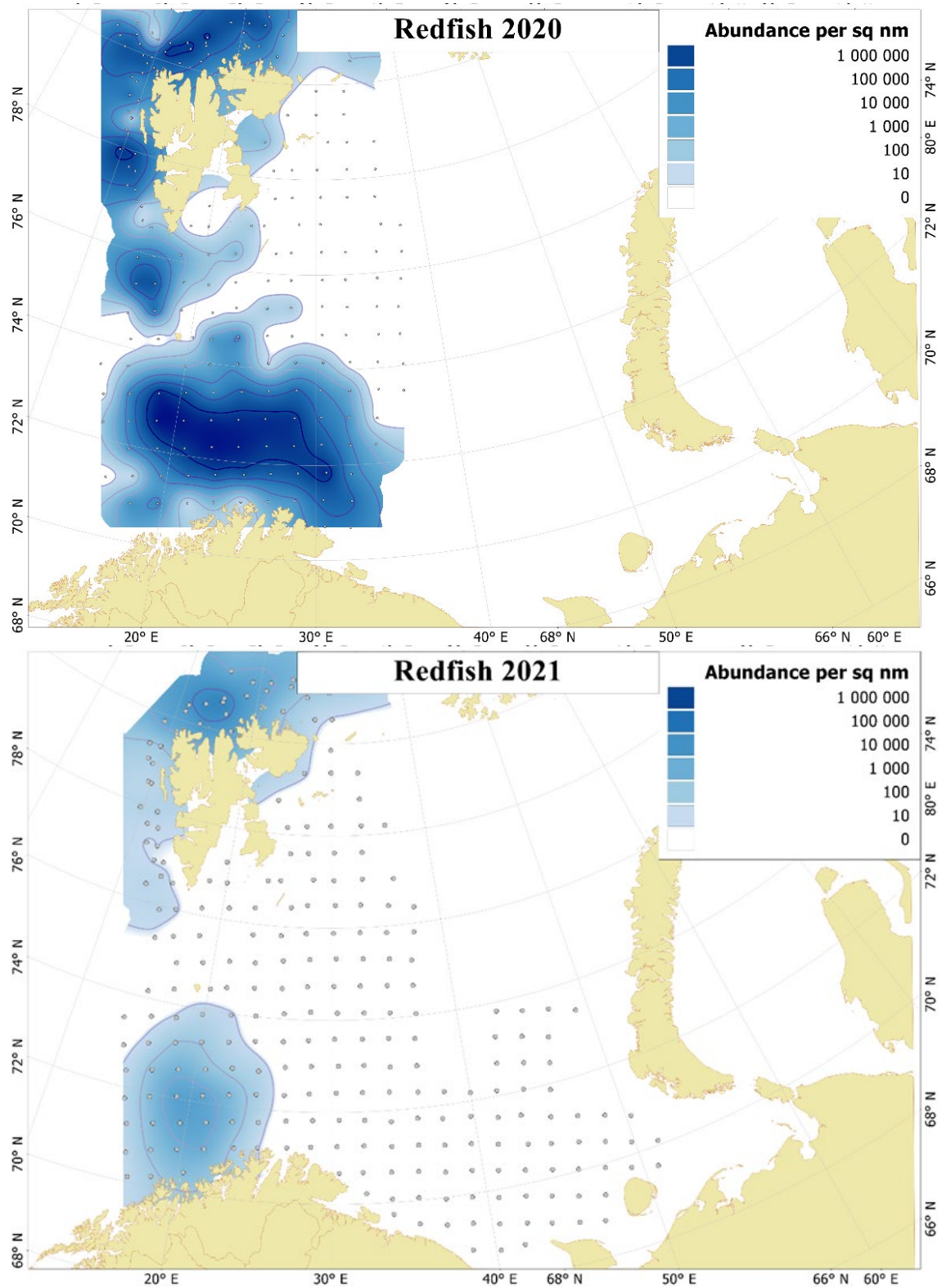


Figure 6.15. Map showing the specific pelagic 0-group trawl stations and the abundance of 0-group *S. mentella* during the joint Norwegian-Russian Ecosystem survey in the Barents Sea and Svalbard in 2020 (upper panel) and 2021 (lower panel).

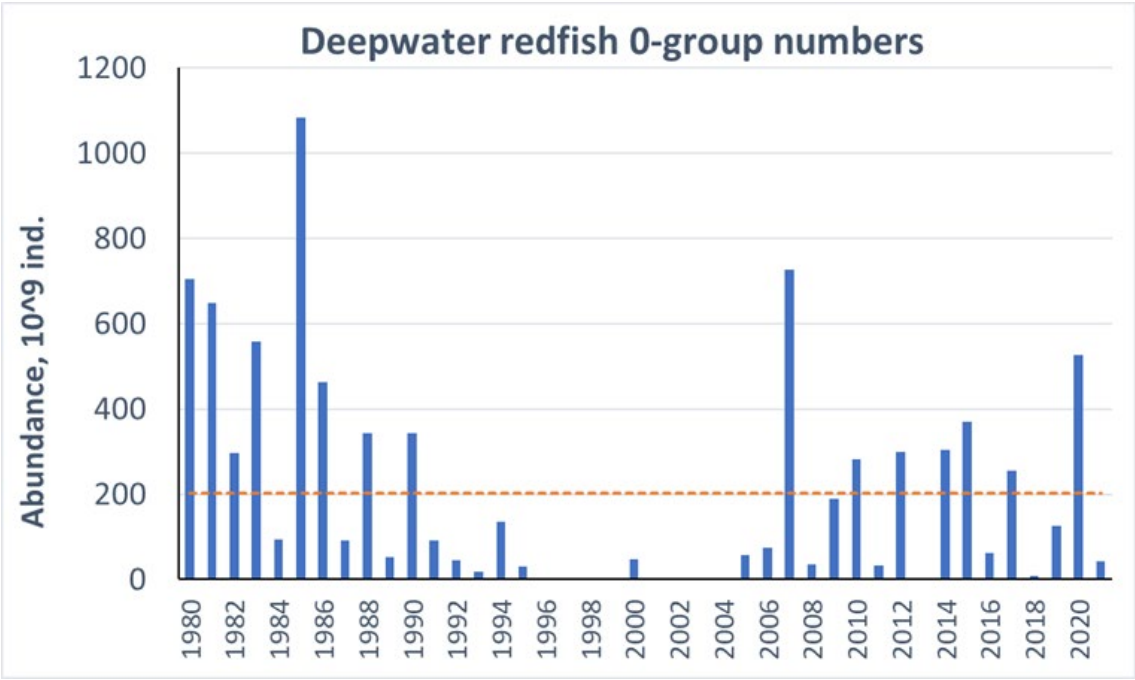


Figure 6.16. *S. mentella* in subareas 1 and 2. Abundance indices (in billions) of 0-group redfish (believed to be mostly *S. mentella*) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980–2021.

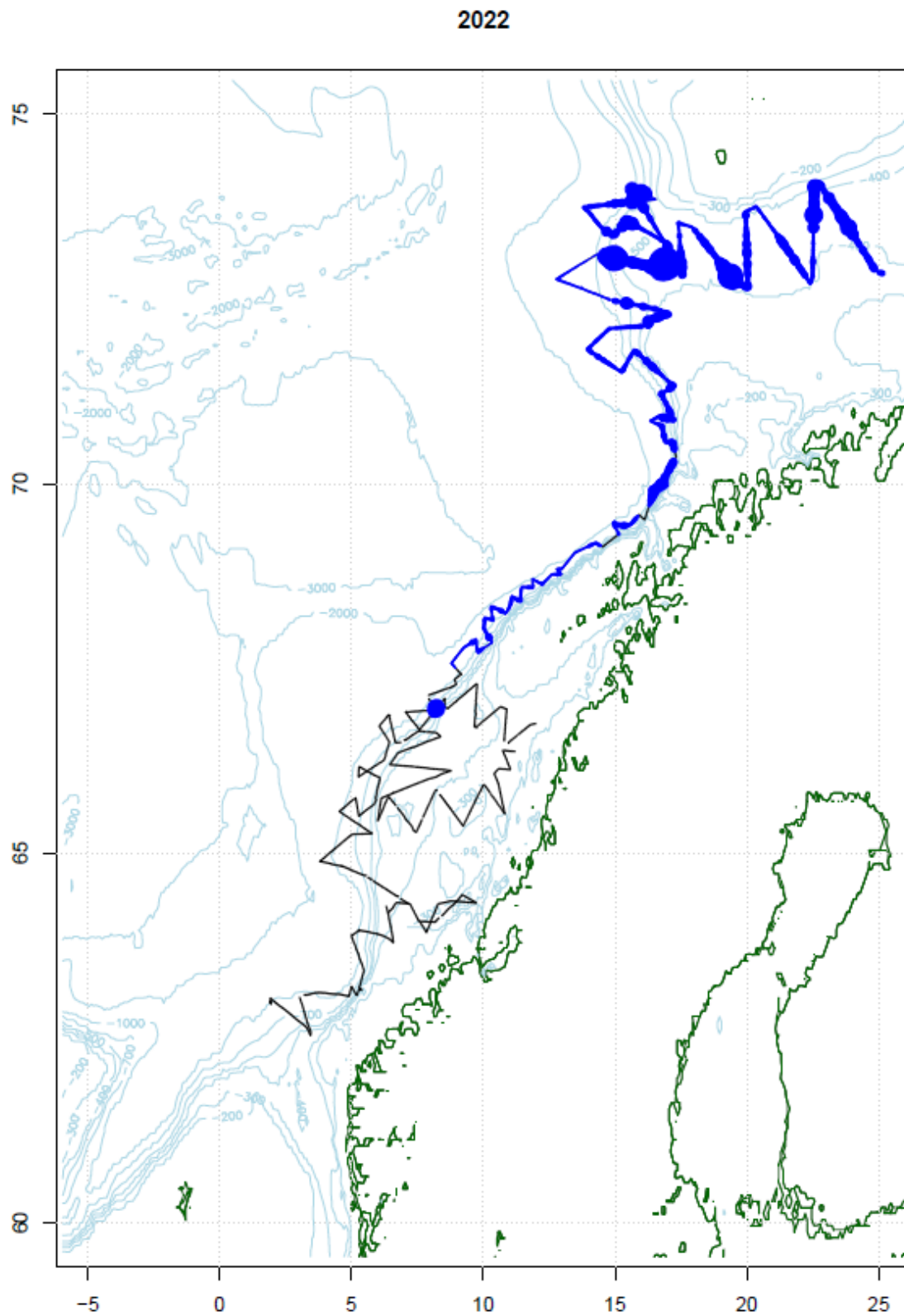


Figure 6.17. *S. mentella* in subareas 1 and 2. Horizontal distribution of *S. mentella* hydroacoustic backscattering (sA) during the Norwegian slope survey in spring 2020. The circles are proportional to the sA assigned to redfish along the vessel track.

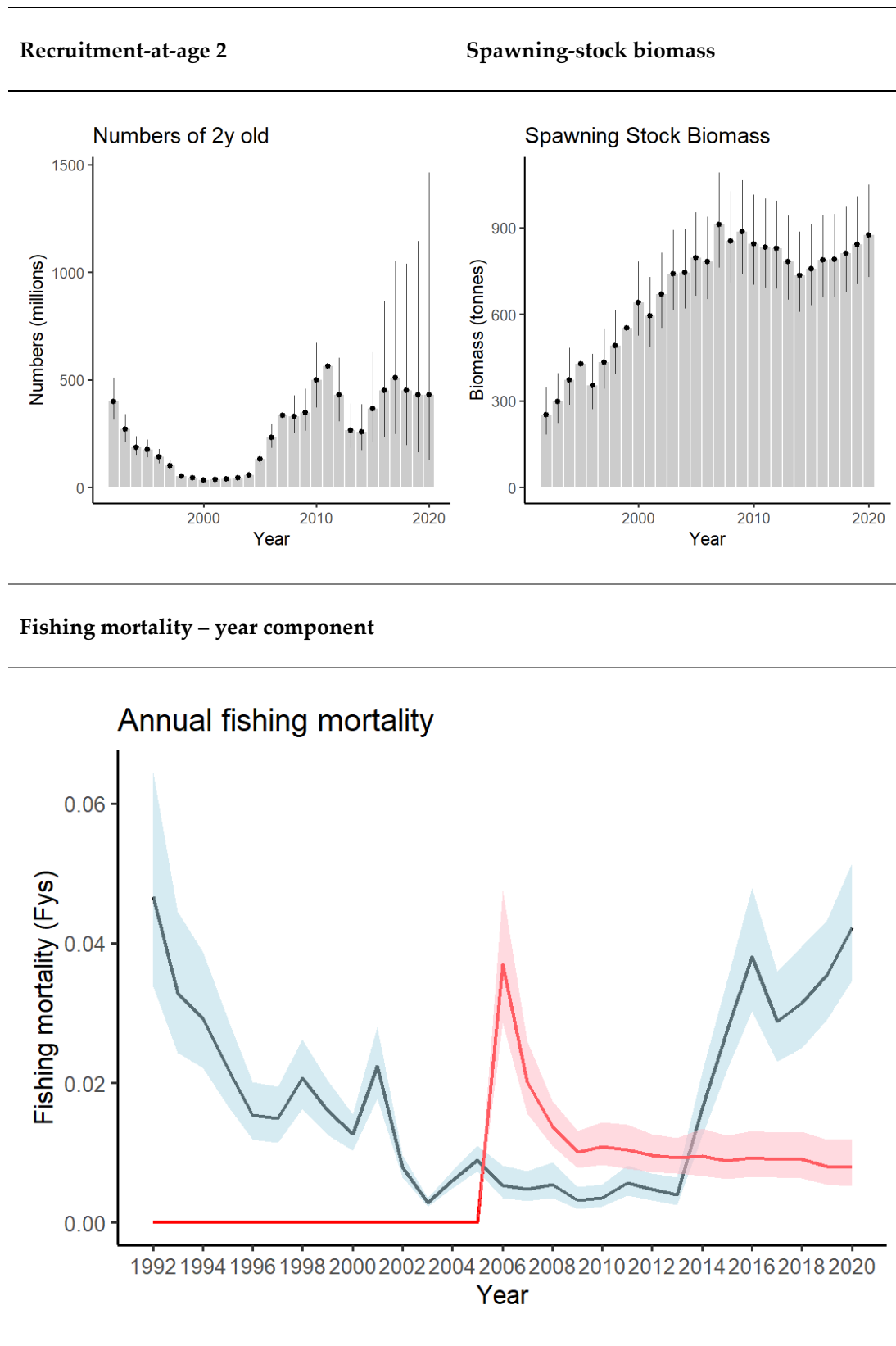
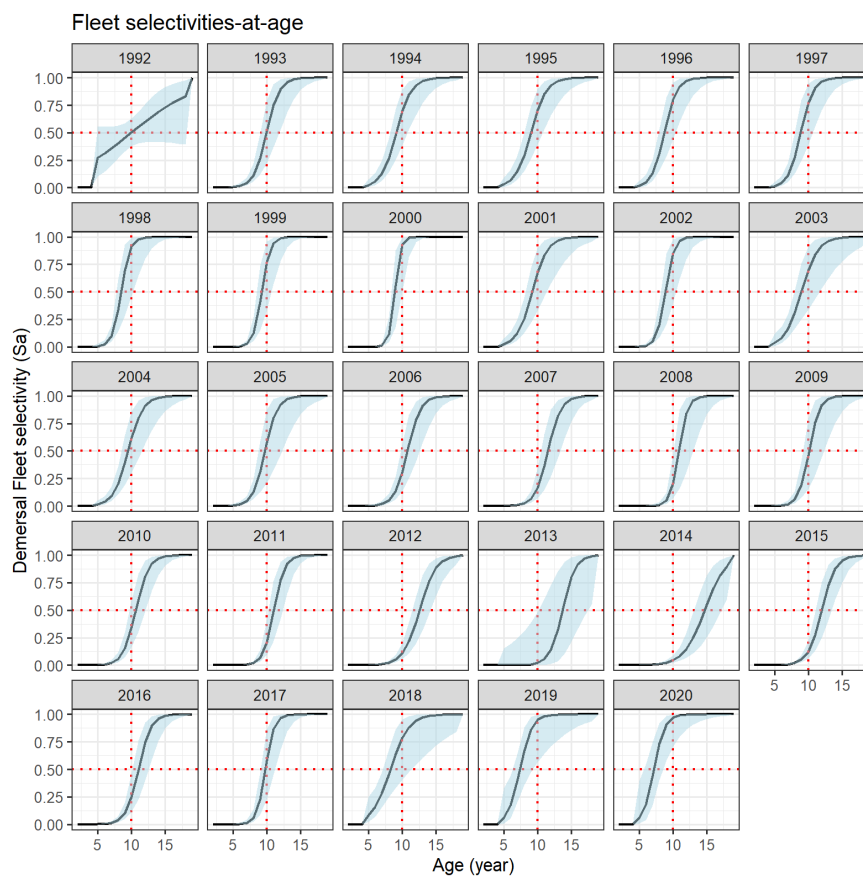
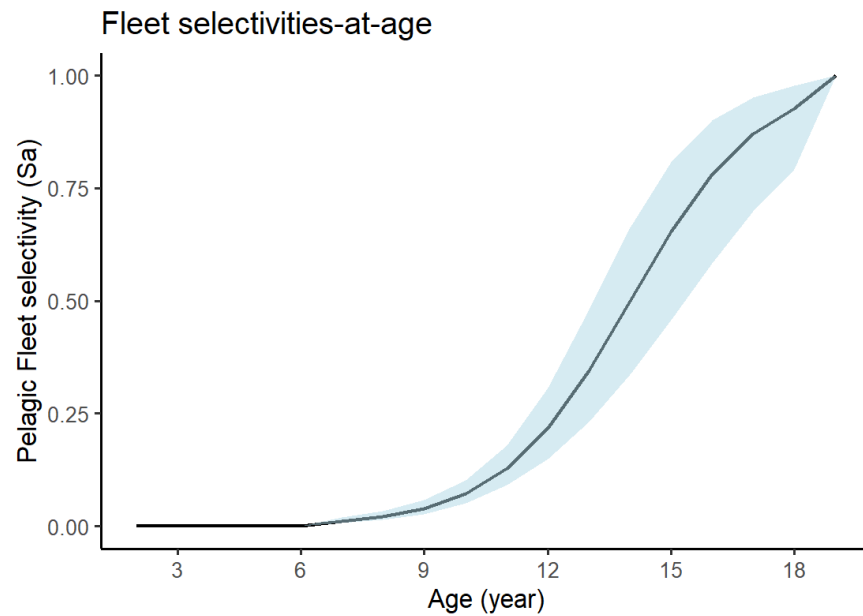


Figure 6.18. *S. mentella* in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the estimated recruitment-at-age 2 spawning-stock biomass from 1992 to 2020 and annual fishing mortality coefficients by year ( $F_y$ ) from the demersal (blue) and pelagic (red) fleets. Error bars (top) and the coloured envelope (bottom) indicate 95% confidence limits.

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**Fleet selectivity – age component**


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**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 ( $F_a$ ) from the pelagic (top panel) and demersal (lower panels) fleets. Colored envelopes indicate 95% confidence limits.

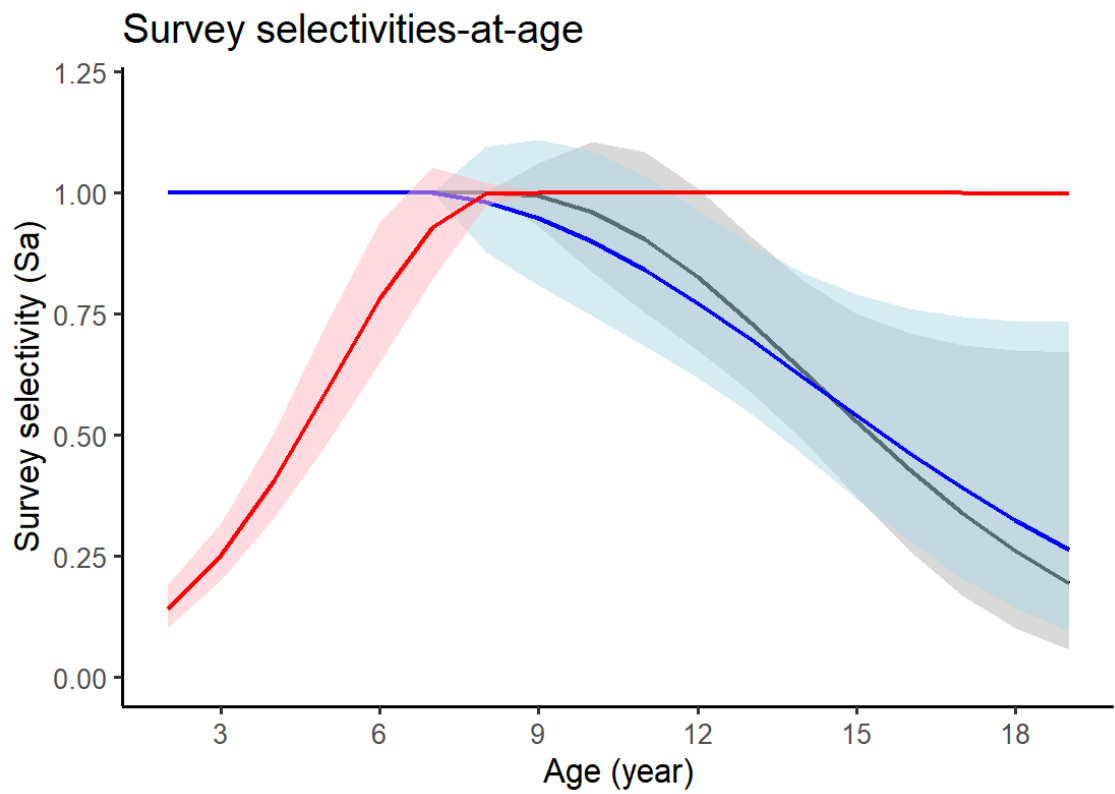


Figure 6.20. *S. mentella* in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the selectivity-at-age for winter (blue) ecosystem (grey) and Russian groundfish (red) surveys.

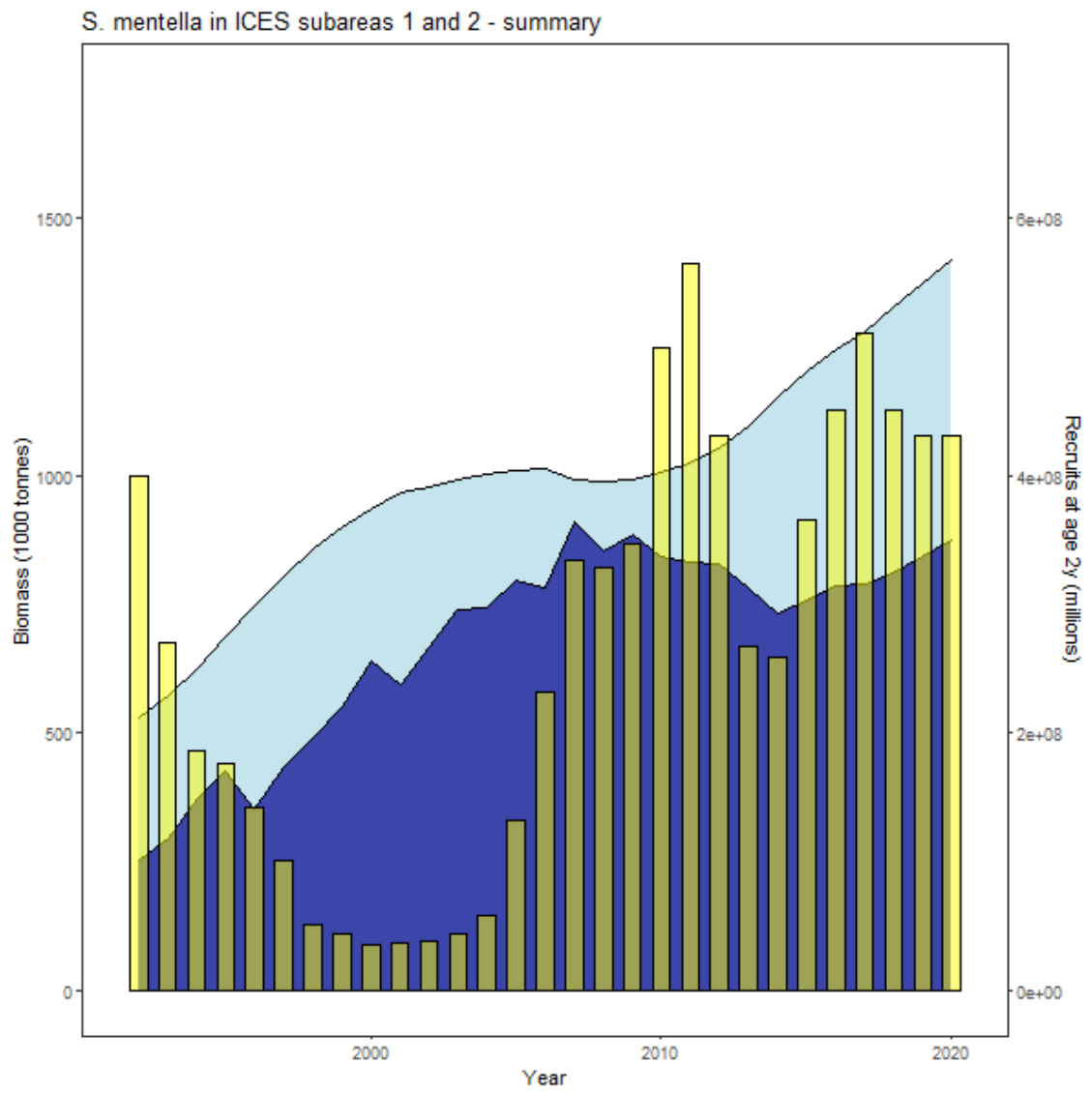


Figure 6.21. *S. mentella* in subareas 1 and 2. Results from the statistical catch-at-age model showing the evolution of total biomass (in tonnes light blue left axis) spawning-stock-biomass (in tonnes dark blue, left axis) and recruitment-at-age 2 (in numbers yellow, right axis) for the period 1992–2020 for *S. mentella* in subareas 1 and 2.



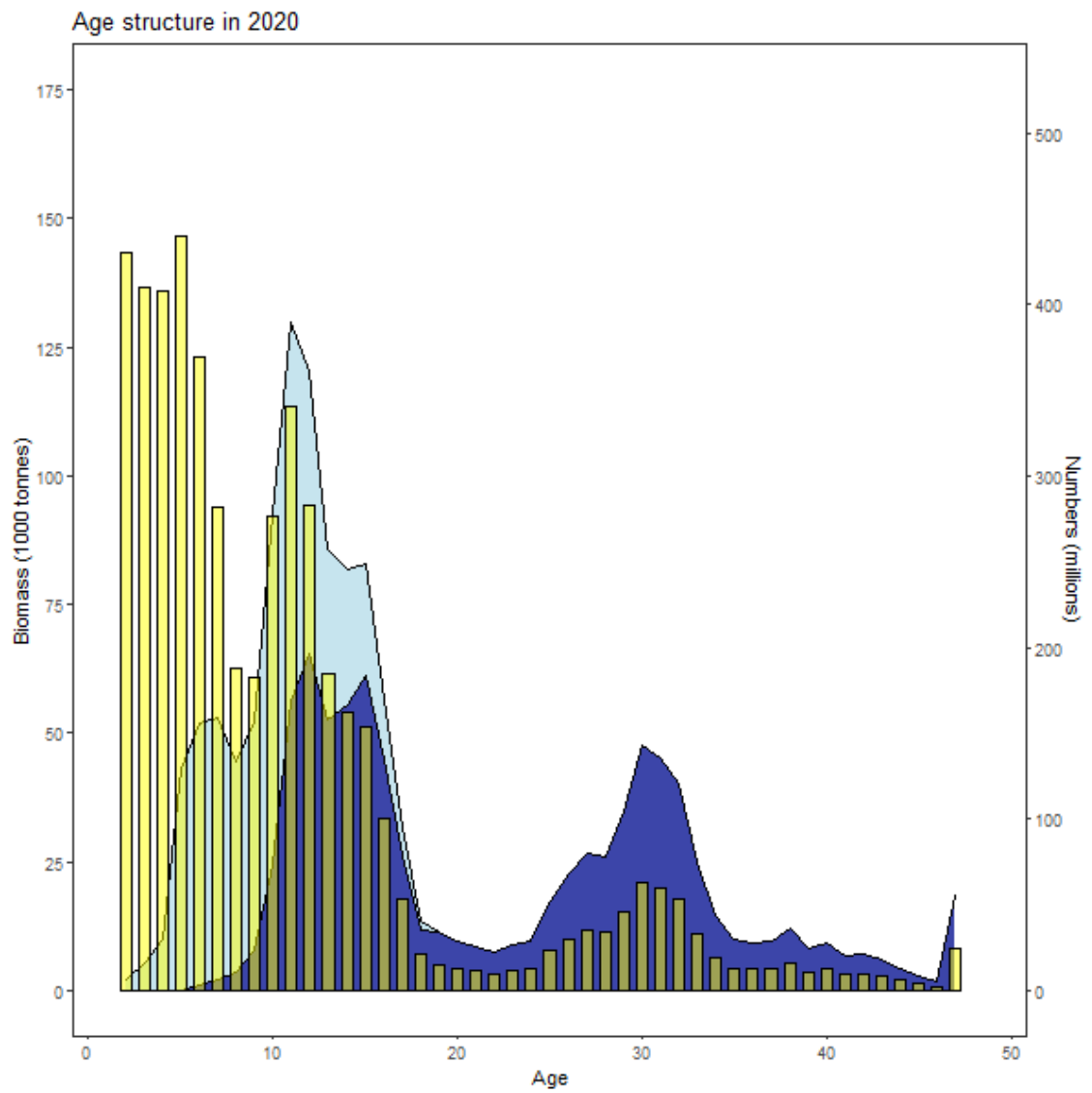


Figure 6.22. *S. mentella* in subareas 1 and 2. Modelled distribution of numbers (yellow bars right y-axis) biomass (light blue left y-axis) and spawning-stock-biomass (dark blue left y-axis) at age 2–45+ in 2020.

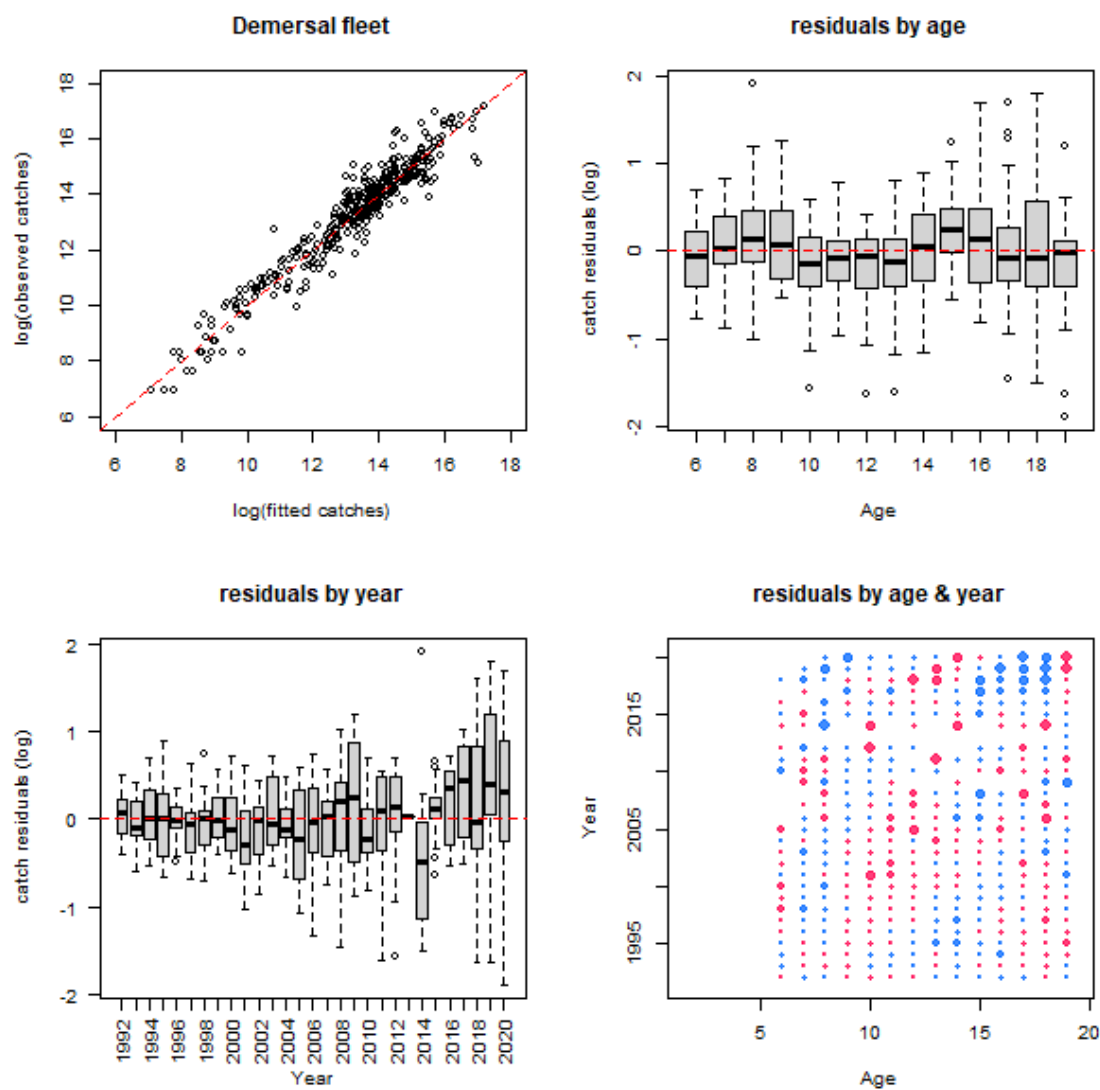


Figure 6.23a. Diagnostic plots for the demersal fleet catch-at-age data. Top-left: scatterplot of observed vs. fitted indices the dotted red line indicates 1:1 relationship. Top right: boxplot of residuals (observed-fitted) for each age. Bottom left: boxplot of residuals for each year. Bottom right: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

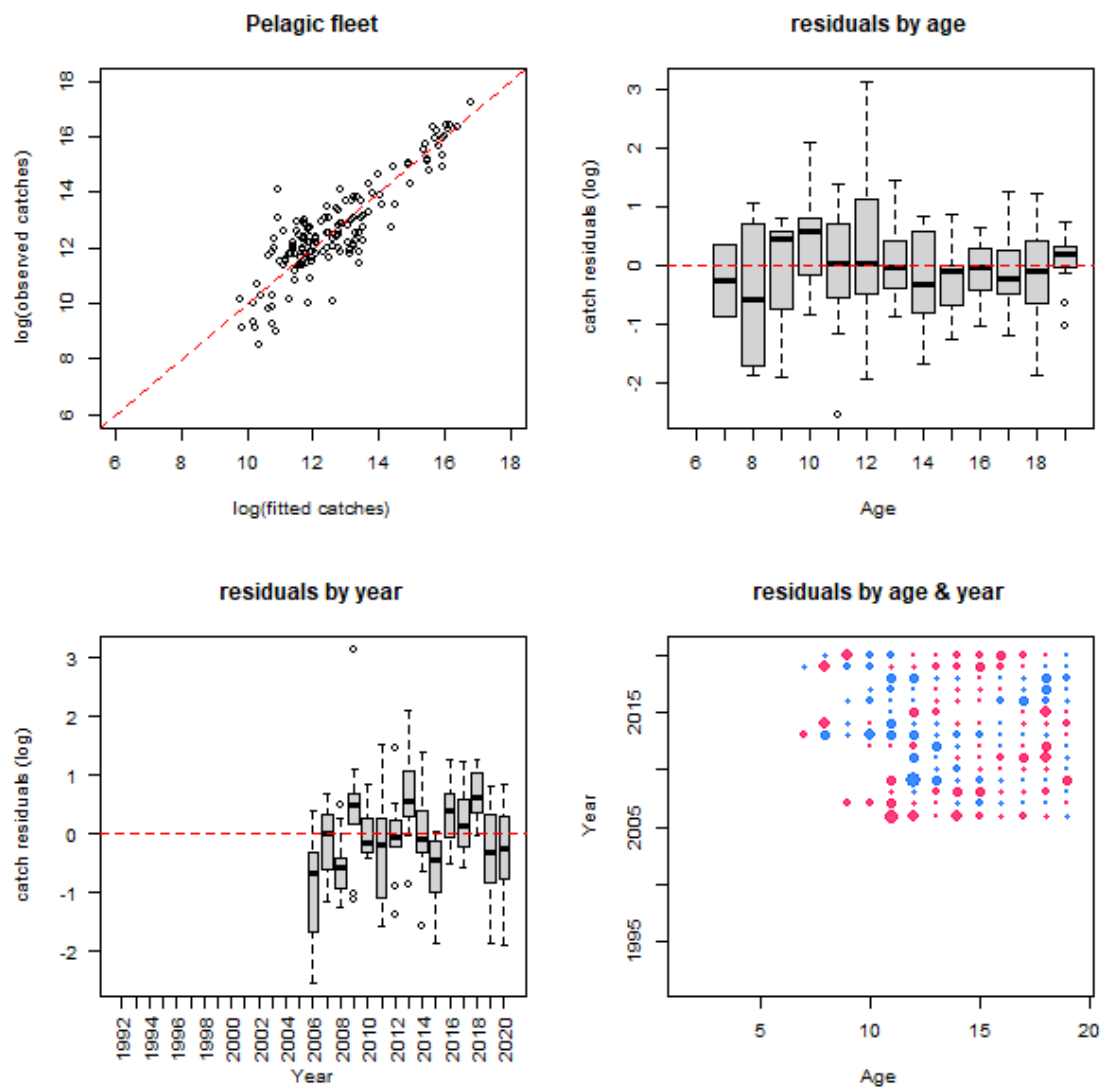


Figure 6.23b. Diagnostic plots for the pelagic fleet catch-at-age data. See legend from Figure 6.23a.

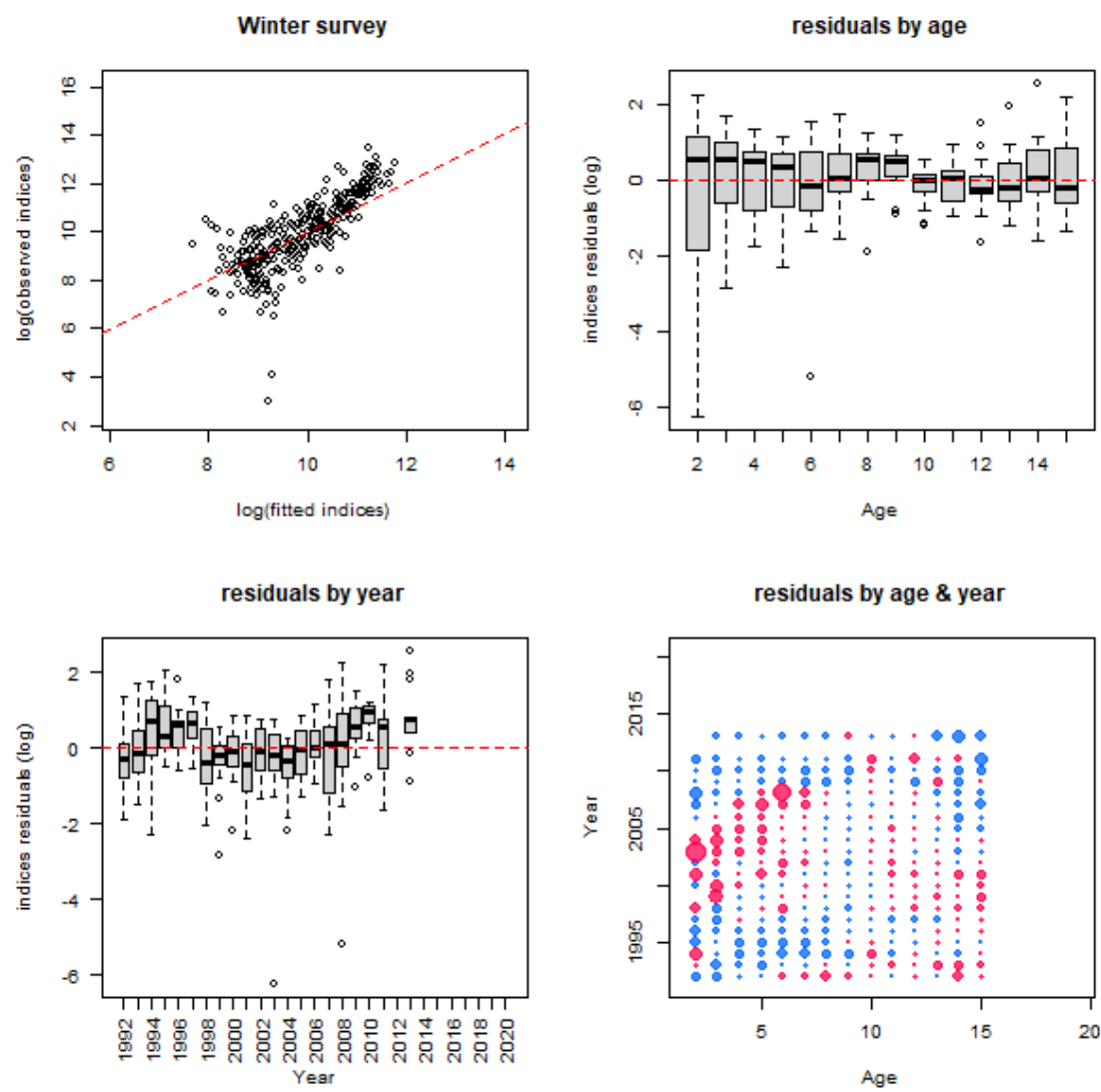


Figure 6.23c. Diagnostic plots for winter survey data. See legend from Figure 6.23a.

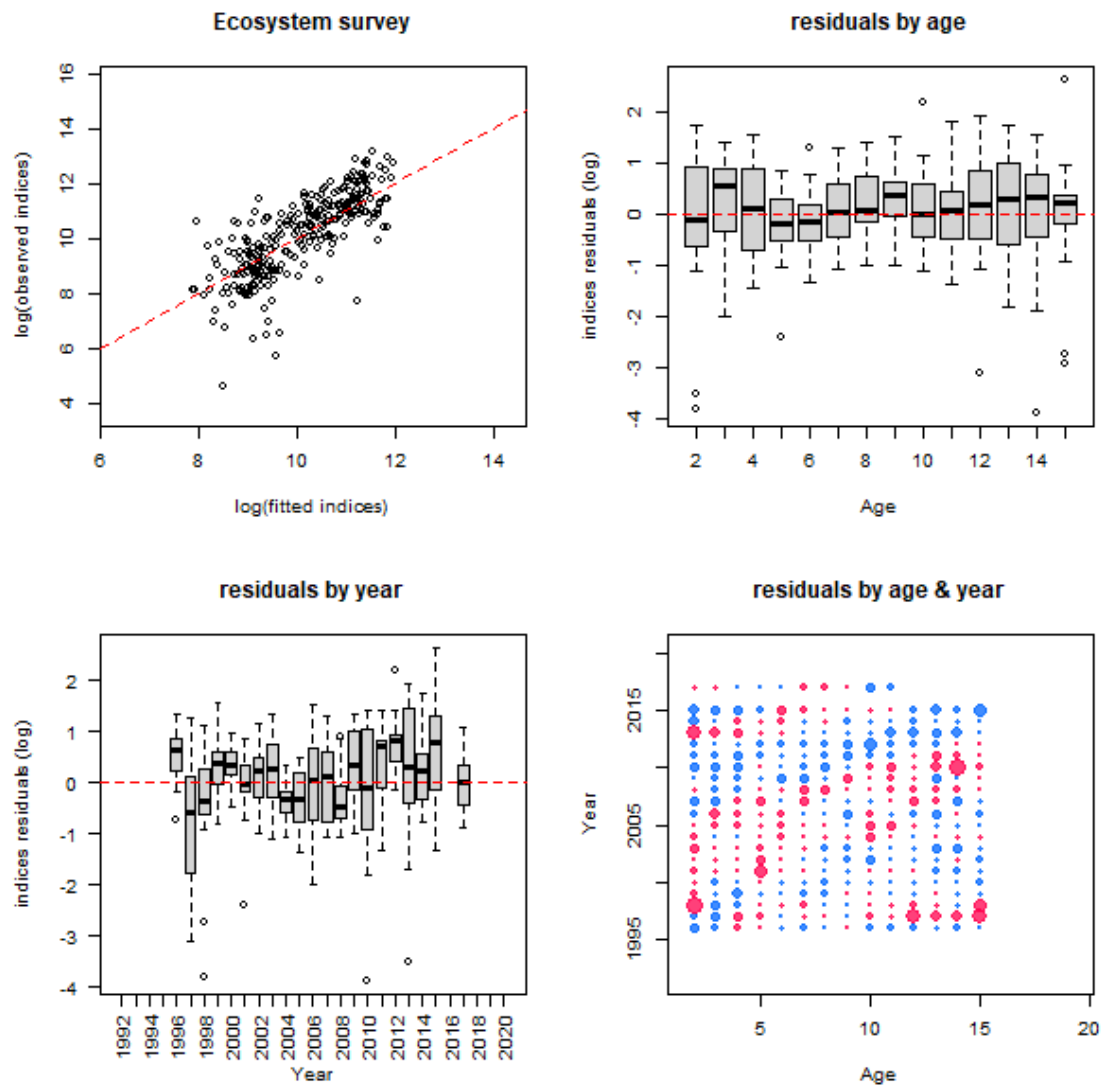


Figure 6.23d. Diagnostic plots for Ecosystem survey data. See legend from Figure 6.23a.

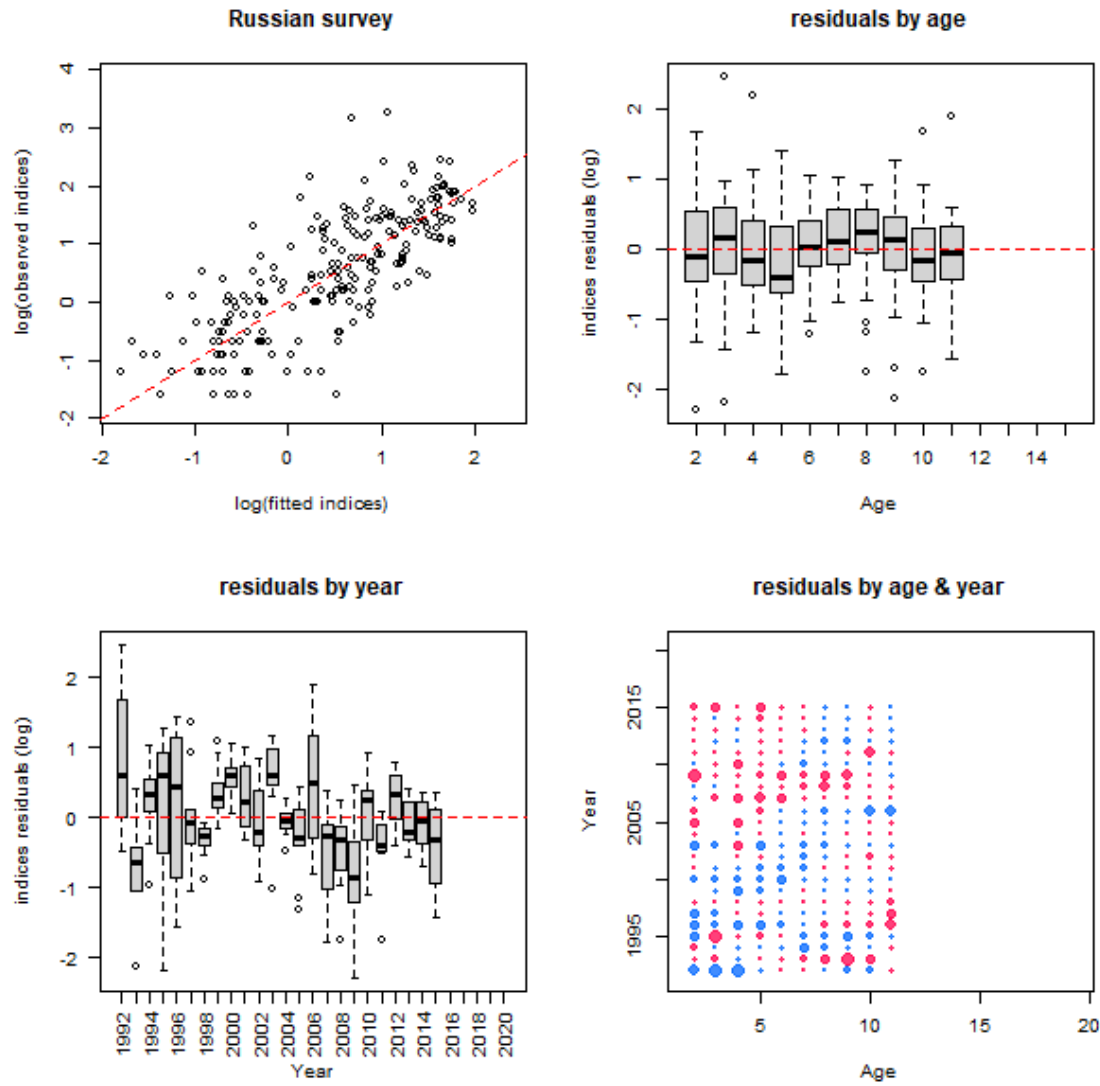
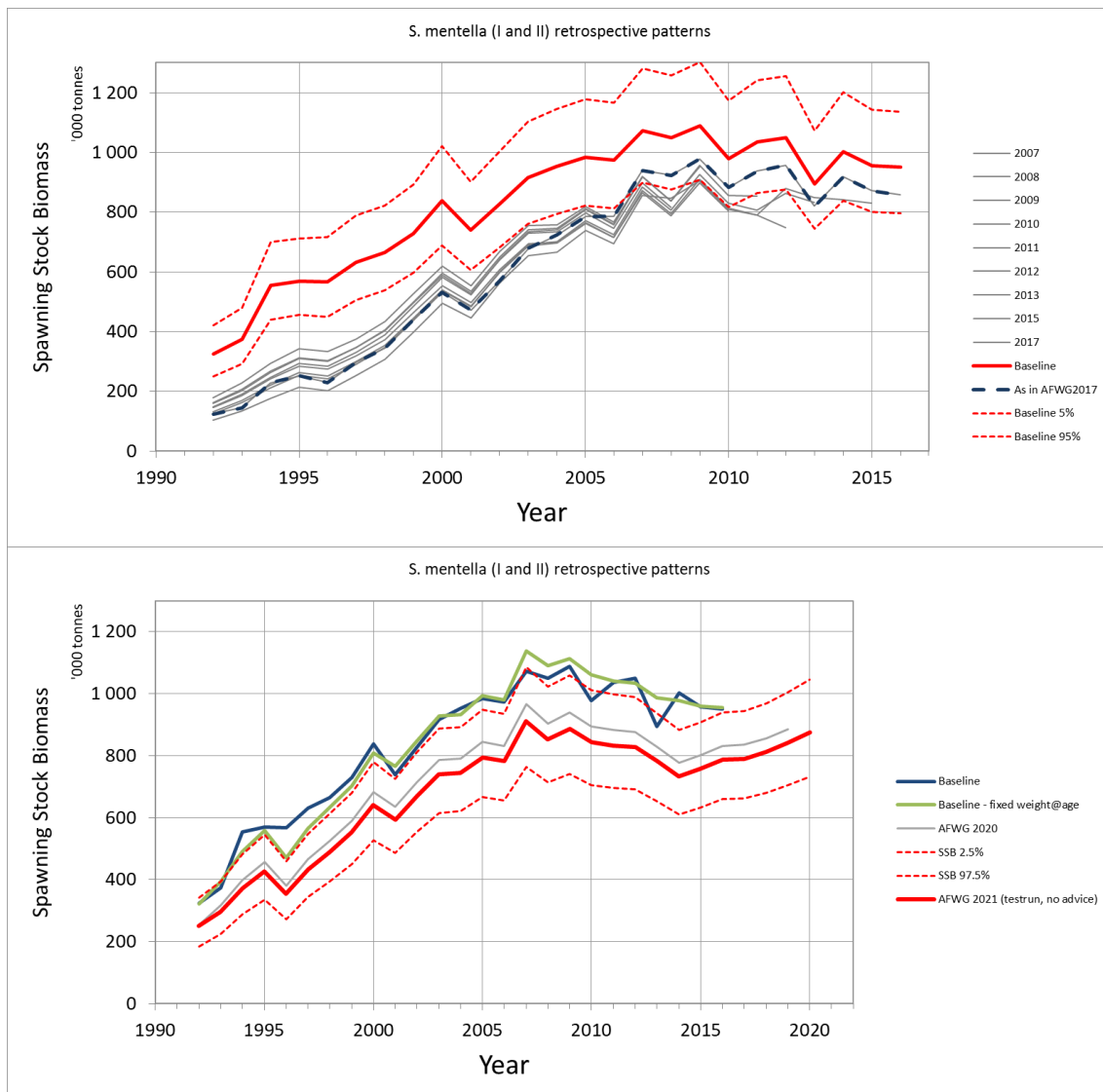


Figure 6.23e. Diagnostic plots for the Russian groundfish survey data. See legend from Figure 6.23a.



**Figure 6.24.** The upper panel shows the retrospective patterns of the spawning-stock biomass of *S. mentella* estimated by the SCAA model for runs up to years 2007–2017 and the baseline model of the 2018 benchmark. The lower panel presents the baseline model with fixed weights-at-age and the assessment models for 2020 and 2021. Confidence Intervals are shown for the latest assessment.

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