

6 Beaked redfish (*Sebastes mentella*) in subareas 1 and 2

Following the recommendation from the benchmark assessment for redfish stocks in January 2018 (WKREDFISH, ICES 2018a) the analytical assessment is conducted using a statistical catch-at-age model (SCAA, for the period 1992–2018). Advice on beaked redfish in subareas 1 and 2 is to be provided every third year and should be provided in 2020. The present report therefore updates the assessment for this stock but does not provide advice.

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.

A pelagic fishery for *S. mentella* has developed in the Norwegian Sea outside EEZs since 2004 (Figure 6.1). This fishery, which is further described in the quality handbook for this stock, is managed by the Northeast Atlantic Fisheries Commission (NEAFC). A new directed demersal and pelagic fishery is permitted in the Norwegian Economic Zone since 2014. The spatial regulation for this new fishery is illustrated in Figures 6.2 and 6.23. In 2018, 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 2017 and 2018 and the location of *S. mentella* catches in the Norwegian EEZ in 2018. The catch of *S. mentella* in the pelagic fishery reported to NEAFC and/or ICES amounted to 7 398 t in 2016, 6 852 in 2017 and 7 823 in 2018. The 44th Session of the Joint Norwegian-Russian Fisheries Commission decided to split the total TAC among countries as follows: Norway: 72%, Russia: 18%, Third countries: 10% (as bycatch in the fishery protection zone at Svalbard (Spitsbergen): 4.1%, and international waters of the Norwegian Sea (NEAFC-area): 5.9%). This split was reconducted at the 48th session of the commission in 2018.

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 and Svalbard Fisheries Protection Zone. 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 in order to give a higher protection to *S. norvegicus*.

6.1.3 Landings prior to 2018 (Tables 6.1–6.5, 6.12, 6.13, Figure 6.1)

Nominal catches of *S. mentella* by country for subareas 1 and 2 combined are presented in Table 6.1, and for both redfish species (i.e. *S. mentella* and *S. norvegicus*) in Table 6.12. The nominal

catches by country for Subarea 1 and divisions 2.a and 2.b are shown in Tables 6.2–6.4, while Table 6.5 shows the catches by country for the pelagic fishery in the Norwegian Sea. The sources of information used are catches reported to ICES, NEAFC, Norwegian authorities (foreign vessels fishing in the Norwegian economic zone) 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 information and prior knowledge. All tables have been updated for the years 2016 and 2017 and new figures presented for 2018. Total international landings in 1952–2018 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. There was no advice provided for 2019–2020 because ICES conducted a benchmark assessment for this stock early in 2018. Following the benchmark (WKREDFISH, ICES 2018a) and the subsequent evaluation of a management plan for the stock (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 $F = 0.06$.

Because of the novelty of the situation regarding management regulations and fleet dynamics, the total landings of *S. mentella* in subareas 1 and 2 in 2014, demersal and pelagic catches, amounted to only 18 780 t. The total landings of the demersal and pelagic fishery increased to 25 856 t in 2015, to 35 646 t in 2016, 30 934 t in 2017 and 38 765 t in 2018. Of this, 7823 t were reported from the pelagic fishery in international waters of the Norwegian Sea. The total landings in 2016 to 2018 were respectively 5429 t, 1201 t and 6107 t above the TAC advised by ICES. Norway caught the major share of the demersal catches, but Russian demersal catches increased substantially, 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 114 and 333 t (Table 6.13).

6.1.4 Expected landings in 2019

ICES has advised on the basis of precautionary considerations that the annual catch should be set at no more than 32 658 t in 2018 and no more than 53 757 t in 2019. The 47th/48th sessions of the Joint Norwegian-Russian Fisheries Commission decided to follow these advices.

In 2019 Norwegian fishing vessels can catch and land up to 34 705 t of redfish in the Norwegian economic zone (NEZ) in a limited area north of 65°20'N (see map in Figure 6.24), in international waters and the fisheries zone around Jan Mayen. Of this quantity 100 t are allocated to cover bycatch in other fisheries and 34 t for research/surveillance and education purposes, while the remaining 34 571 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 of 1000 t. 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 20 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 (marked in Figure 6.24) can be opened for directed fishing, either with or without sorting grid. 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 2019 Russia may fish 9676 t (18%) and 2000 t transferred from Norway to Russia to cover bycatch of redfish in Russian fishery targeting other species. It is expected that 50% of this redfish bycatch will be *S. mentella*. The remaining 5376 t are divided between third countries in the NEZ and Svalbard Zone (2204 t) and the NEAFC areas (3172 t). Catch in the NEAFC areas in 2018 amounted to 7357 t while the catch in the NEZ and Svalbard zone amounted to 31 408 t. The total catch in 2018 exceeded the TAC advised by ICES by 6107 t. Assuming similar fishing patterns in 2019, the total catch should not exceed the TAC of 53 757 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 primarily on a statistical catch-at-age model (SCAA) covers the period 1992–2018. The input data consists of the following tables:

- Total catch in tonnes (Table 6.1)
- Catch in tonnes in the pelagic fishery (Table 6.5)
- Total catch numbers-at-age 6–19+ (Table 6.6)
- Catch numbers-at-age 7–19+ in the pelagic fishery (Table 6.8)
- Weight-at-age 2–19+ in the population (Table 6.7)
- Maturity-at-age 2–19+ in the population (Table 6.19)
- Winter survey numbers-at-age 2–15 (Table 6.16b)
- Ecosystem survey numbers-at-age 2–15 (Table 6.18)
- Russian autumn survey numbers-at-age 0–11 (Table 6.14)

There was no direct observation of catch numbers-at-age for the pelagic fishery operating in 2012–2018. 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 and 2016, 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 6.3)

Length distributions of the pelagic and demersal catches of *S. mentella* are shown in Figure 6.3. In 2018, data were available from the Spanish and Portuguese pelagic fleets and the Russian and Norwegian demersal fleets.

6.2.2 Catch-at-age (Tables 6.6 and 6.8, Figure 6.4)

Catch-at-age in the Norwegian fishery was estimated using ECA for 2014. For 2015, 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. Not enough age readings were available to estimate catch-at-age in 2016. For the pelagic and demersal fisheries in 2016, 2017, and 2018 proportions-at-age in the catch were derived from proportions at-age in earlier years, weight-at-age and fleet selectivities (section 6.2.2 in AFWG report 2013). Updated age readings and estimations of catch-at-age for 2015 to 2019 are expected from Norway at the next assessment in 2020.

The procedure for estimating catch-at-age for recent years in which age data are not available is somehow problematic. This is because the last year of observation has a large impact 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. The new data available for 2015 (demersal) and 2016 (pelagic) are substantially different from these earlier extrapolations.

Catch-at-age in the Russian demersal fishery were calculated using age reading. Ages of 884 individuals of *S. mentella* were estimated. The estimated Age-Length-Key was then used to estimate the age distribution of the Russian demersal catches depicted in Figure 6.4. Age-Length-Keys for *S. mentella* are uncertain because of the slow growth rate of individuals and therefore these data were not used in the assessment but may be considered in future. 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 (Table 6.7, Figures 6.5, 6.6)

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. As a result, 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 6.7 as well as Figures 6.5 and 6.6.

6.2.4 Maturity-at-age (Table 6.19, Figure 6.7)

The proportion maturity-at-age was estimated for individual years using a mixed-effect statistical model (Table 6.19, Figure 6.7). The modelled values of maturity-at-age for individual years are used in the analytical assessment models, except in 2011, 2014, 2015, and 2016 when the fixed effects only were considered. There were no age readings available for 2017 and 2018 and the fixed effect model was therefore used for these year.

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 papers published recently (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 6.15). WKREDFISH_2018 decided to continue using 0.050 as the value of *M* in the assessment model.

Figure 6.16 shows cod's predation on juvenile (5–14 cm) redfish during 1984–2018. 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

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, 1.3-1.4, 6.14-6.18, Figures 6.8–6.10)

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 6.14, Figure 6.8). ICES acronym: RU-BTr-Q4

Russian-Norwegian Barents Sea ‘Ecosystem survey’ (bottom-trawl survey, August–September) from 1986–2016 in fishing depths of 100–500 m (Figures 6.8–6.9). Data disaggregated by age for the period 1992–2016 (Table 6.18). ICES acronym: since 2003 part of Eco-NoRu-Q3 (BTr)

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 6.8–6.9). Data disaggregated by age for the period 1992–2016 (Table 6.16b). ICES acronym: BS-NoRu-Q1 (BTr)

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 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)

6.2.6.2 Pelagic survey in the Norwegian Sea (Figures 6.13 and 6.14)

The international deep pelagic ecosystem survey in the Norwegian Sea (WGIDEEPS, ICES 2016, no ICES-acronym) monitors deep pelagic ecosystems, with a particular focus on beaked redfish (*Sebastes mentella*). The latest survey was conducted in the open Norwegian Sea from 11 August until 1 September 2016, following similar surveys in 2008, 2009, and 2013. The spatial coverage of the surveys and the distribution of beaked redfish registered by acoustic is presented in Figure 6.13. The survey is scheduled every three year and previous cruises took place in 2008, 2009, 2013, and 2016. 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. 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 y (Figure 6.13).

6.2.6.3 Additional surveys (Figures 6.10–6.12)

The international 0-group survey in the Svalbard and Barents Sea areas in August–September 1980–2016, now part of the Ecosystem survey (Figures 6.10 and 6.11). ICES acronym: Eco-NoRu-Q3

A slope survey “Egga-sør survey” was carried out by IMR from 20 March to 14 April 2018, following similar surveys ran in 2009, 2012, 2014, and 2016. The spatial coverage of the surveys and the distribution of beaked redfish registered by acoustic is presented in Figure 6.12. Egga-Sør and Egga-Nor 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 6.17—6.23)

6.3.1.1 Stock trends

The temporal patterns in recruitment-at-age 2 (Figures 6.17, 6.20) 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 (after the 2011 year class) are uncertain due to a lack of age data from the Winter and Summer 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 1.0 to approximately 1.3 million tonnes in the last 10 years (Table 6.21 and Figure 6.20). The decline in SSB in the same period can be attributed to the weak year classes (1996—2003) entering the mature stock. This trend has now levelled off and is expected to reverse in the coming years. SSB at the start of 2019 is estimated at 820 862 t.

6.3.1.2 Fishing mortality (Table 6.21, Figure 6.18)

The patterns of fleet selectivity-at-age indicate that most of the fish captured by the demersal fleet are of age 11 years and older, while the pelagic fleet mostly captures fish of age 14 and older (Figure 6.18). 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 2018 F19+ is estimated at 0.05 (Table 6.21), with 0.041 for the demersal and 0.009 for the pelagic fleets, respectively.

6.3.1.3 Survey selectivity patterns (Figure 6.19)

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*. 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. The reason for these will need to be investigated further. Alternative methods for the estimation of the survey selectivity patterns will be investigated in the forthcoming benchmark assessment and could resolve the issue. Residual patterns for the demersal fleet indicate a better fit of the model than the

run at the AFWG2017. This is likely resulting from the implementation of a time varying selectivity-at-age for this fleet.

6.3.1.5 Retrospective patterns (Figure 6.21)

The historical retrospective patterns for the years 2007 to 2016 are presented in Figure 6.21. All model parameters were estimated in each individual run. The most recent model run (last year of data 2018) is consistent with previous runs. The SSB time-series is smoother, due to fixed weight-at-age for every year. The benchmark run stands out and this is due to the unavailability of recent catch-at-age data during the benchmark assessment (see section 6.2.2). The estimate of SSB in the early years is revised upward and this results from the use of new number-at-age indices from the WGIDEEPS survey.

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 2018 is: $F_{19+} = 0.05$.

If the fishing mortality is maintained, this is expected to lead to a catch of 42 190 t in 2019, well below the advised TAC of 53 757 t. This would lead to an SSB of 852 268 t in early 2020, catches of 53 500 t in 2020 and SSB of 872 998 t in 2021.

Raising F_{19+} to F_{MSY} ($F_{19+} = 0.084$) in 2020–2022 would lead to average catches of 75 221 t during that period and a SSB of 842 290 t by 2023 (SSB at the start of 2019 is estimated at 820 862 t).

These projections assume that the selectivity patterns of the demersal and pelagic fleets are identical with those estimated for 2018. 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 6.17 and 6.20) are consistent with the 0-group survey index (Figure 6.11), 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 used (yet) 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 readings from winter survey were not available for years 2012–2015 and no survey data were available for 2016. 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 6.20)

The history of the stock as described by the SCAA model for the period 1992–2018 is summarized in Table 6.21 and Figure 6.20. The key elements are as follows:

- upward trend in Total-stock biomass from 1992 to 2006 followed by stabilization until 2011 and new upward trend until 2018,
- upward trend in spawning-stock biomass from 1992 to 2007 followed by stabilization (or slight decline) until 2017,
- recruitment failure for year classes 1996–2003 (2y old fish in 1998–2005),
- good (although uncertain) recruitment for year classes born after 2005. There is not data available for recruits (at age 2y) after 2014.

- fishing mortality for the 19+ is below natural mortality except in the first years of the assessment period (1992–1994) and the last year (2018) in which it is equal.

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 2015).

The SCAA model relies on the availability of reliable age data in surveys and in the catch. In recent years, these data have not been available at an appropriate level and the results of the analytical assessment are becoming less reliable.

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}	227 000 t
B_{pa}	315 000 t
F_{MSY19+}	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 $F_{MSY19+} = 0.08$.

6.6 Management advice

The present report updates the assessment for this stock but does not provide advice.

The currently valid advice was released on 28 September 2018, containing the evaluation of HCRs as well as the standard advice sheet with catch scenarios for each of the HCRs evaluated to be precautionary. It recommends a TAC of 53 757 t for 2019 and 55 860 t for 2020 at a fishing mortality of $F = 0.06$.

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).

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

- Increase in the number of age readings from surveys and from the fishery, in particular for recent years;
- Use of standardized methods (StoX and ECA) for the determination of numbers-at-age in the surveys and in the catch. The use of StoX for survey indices will be evaluated at the beginning of AFWG 2020;
- 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 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.

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.

Table 6.1. *Sebastes 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	-	-	-	9 733	13	125	3 646	177	134	14 045
1999		-	73	26	202	50	-	3	-	-	-	7 884	6	65	2 731	29	140	11 209
2000		-	50	12	62	29	48	1	-	-	-	6 020	2	115	3 519	87	130	10 075
2001		-	74	16	198	17	3	4	-	-	-	13 937	5	179	3 775	90	120	18 418
2002		15	75	58	99	18	41	4	-	-	-	2 152	8	242	3 904	190	188	6 993
2003		-	64	22	32	8	5	5	-	-	-	1 210	7	44	952	47	124	2 520
2004	Sweden - 1	-	588	13	10	4	10	3	-	-	-	1 375	42	235	2 879	257	76	5 493
2005		5	1 147	46	33	39	4	4	-	-	7	1 760	-	140	5 023	163	95	8 465
2006	Canada - 433	396	3 808	215	2 483	63	2 513	4	341	845	-	4 710	2 496	1 804	11 413	710	1 027	33 261
2007		684	2 197	234	520	29	1 587	17	349	785	-	3 209	1 081	1 483	5 660	2 181	202	20 219
2008		-	1 849	187	16	25	9	9	267	117	13	2 220	8	713	7 117	463	83	13 096
2009	EU - 889	-	1 343	15	42	-	33	-	-	-	3	2 677	338	806	3 843	177	80	10 246
2010		-	979	175	21	12	2	-	243	457	-	2 065	-	293	6 414	1 184	79	11 924
2011		-	984	175	835	-	2	-	536	565	-	2 471	11	613	5 037	1 678	55	12 962

2012	-	259	-	517	-	36	-	447	449	-	2 114	318	1 038	4 101	1 780	-	11 059
2013	-	697	-	80	21	1	-	280	262	-	1 835	84	1 078	3 677	1 459	-	9 474
2014	-	743	215	446	15	-	-	215	167	3	13 503	103	505	1 704	1 162	-	18 780
2015	-	657	49	242	48	3	-	537	192	3	19 720	5	678	1 142	2 529	52	25 857
2016	-	502	134	493	74	24	0	1 243	1 065	-	19 083	208	1 066	8 419	3 213	122	35 646
2017	4	443	45	763	66	3	-	562	790	-	17 228	102	1060	6 593	2 838	436	30 934
2018 ¹	-	425	67	2 473	82	10	-	876	1 178	374	19 289	275	699	10 497	2 457	63	38 765

¹ Provisional figures.

Table 6.2. *Sebastes mentella* in subareas 1 and 2. Nominal catch (t) by countries in Subarea 1.

Year	Faroe Islands	Germany	Greenland	Iceland	Norway	Poland	Russia	Spain	UK	Total
1998	20	-	-	-	26	-	378	-	-	424
1999	69	-	-	-	69	-	489	-	-	627
2000	-	-	-	482	47	-	406	-	-	501
2001	-	-	-	32	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	-	-	-	-	61	-	27	-	-	88
2014	-	-	-	-	36	-	63	-	-	99
2015	-	-	18	-	76	1	125	-	-	220
2016	-	-	-	-	176	1	229	342	-	748
2017	-	-	12	-	165	3	196	-	-	376
2018 ¹	-	19	26	3	195	-	376	-	-	619

¹ Provisional figures.

Table 6.3. *Sebastes 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	Ger-many	Green-land	Iceland	Ireland	Lithuania	Latvia	Norway	Portugal	Poland	Russia	Spain	UK	Total
1998		-	73	58	14	-	6	-	-	9186	118	-	2626	55	106	12 242
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	-	-	13 636	105	-	2716	18	95	16 827
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
2006	Estonia - 396 Canada - 433	3793	199	2475	52	2513	3	845	-	4010	1731	2467	10 110	589	958	30 574
2007	Estonia - 684	2157	226	519	29	1579	16	785	349	3043	1395	1079	5061	2159	120	19 201
2008	Netherland - 13	1821	179	9	24	9	9	117	267	1952	666	1	6442	430	62	12 001
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	10 955
2011		932	175	697	-	2	-	561	536	1682	599	-	4326	1656	19	11 185
2012		259	-	469	-	32	-	449	447	1500	1038	311	3478	1770	-	9753

Year		Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Lithuania	Latvia	Norway	Portugal	Poland	Russia	Spain	UK	Total
2013		675	-	24	21	1	-	262	280	921	1055	68	3293	1435	-	8035
2014	Netherlands - 2	728	209	411	15	-	-	167	215	4367	505	100	1334	1159	-	9212
2015	Netherlands - 3	657	49	236	25	3	-	192	537	11 214	678	3	480	2508	47	16 632
2016		495	107	493	61	-	24	1065	1243	9546	1052	183	3949	2862	71	21 151
2017		425	38	763	44	3	-	790	562	7405	1059	94	3922	2813	429	18 347
2018 ¹	Netherlands - 374	400	47	2440	51	7	-	1034	876	14 644	699	272	4721	2435	62	28 062

¹ Provisional figures

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

Year		Netherland	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	1082
2010		-	18	-	8	-	-	339	-	47	501	1	-	24	938
2011	Lithuania - 4	-	52	-	139	-	-	741	11	14	698	23	-	36	1717
2012	Iceland - 4	-	-	-	48	-	-	581	7	-	606	10	-	-	1256
2013		-	22	-	56	-	-	854	16	23	357	23	-	-	1351

2014	1	15	6	34	-	-	9099	3	-	307	3	-	-	9468
2015	-	-	-	6	5	-	8429	1	-	536	21	-	5	9003
2016	-	7	27	-	14	-	9361	24	14	4241	9	-	50	13 747
2017	-	18	7	1	10	-	9658	5	1	2476	25	4	7	12 211
2018 ¹ Lithuania - 144	-	25	20	14	6	-	4449	3	-	5400	22	-	1	10 083

¹ Provisional figures.

Table 6.5. *Sebastes 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	Canada - 433	396	3766	192	2475	2510	341	845	2862	2447	1697	9390	575	841	28 770
2007		684	1968	226	497	1579	349	785	1813	1079	1377	3645	2155	-	16 157
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	Netherland	-	296	-	761	-	562	790	-	14	791	1014	2624	-	6852

2018 ¹	374	400	-	2276	-	876	1010	-	116	372	-	2399	-	7823
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¹ Provisional figures.

Table 6.6. *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.	Tons Land.
1992	1873	2498	1898	1622	1780	1531	2108	2288	2258	2506	2137	1512	677	9258	33 946	15 590
1993	159	159	174	512	2094	3139	2631	2308	2987	1875	1514	1053	527	6022	25 154	12 814
1994	738	730	722	992	2561	2734	3060	1535	2253	2182	3336	1284	734	3257	26 118	12 721
1995	662	941	1279	719	740	1230	2013	4297	3300	2162	1454	757	794	2404	22 752	10 284
1996	223	634	1699	1554	1236	1078	1146	1413	1865	880	621	498	700	2247	15 794	8075
1997	125	533	1287	1247	1297	1244	876	1416	1784	1217	537	1177	342	3568	16 650	8598
1998	37	882	2904	4236	3995	2741	1877	1373	1277	1595	1117	784	786	6241	29 845	14 045
1999	9	83	441	1511	2250	3262	1867	1454	1447	1557	1418	1317	658	3919	21 193	11 209
2000	1	24	390	1235	2460	2149	1816	1205	1001	993	932	505	596	5705	19 012	10 075
2001	117	372	542	976	925	1712	2651	2660	1911	1773	1220	714	814	16 234	32 621	18 418
2002	2	40	252	572	709	532	1382	1893	1617	855	629	163	237	4082	12 965	6993
2003	6	37	103	93	132	220	384	391	434	466	513	199	231	1193	4402	2520
2004	11	24	108	148	427	624	931	580	1385	1047	937	927	549	2055	9753	5493
2005	5	44	128	347	540	567	432	1607	1332	3174	1041	1216	1024	4266	15 723	8465
2006	0	10	8	89	153	256	877	1980	2774	4580	5154	4823	4261	35 350	60 315	33 261
2007	0	1	3	22	33	86	235	631	2194	2825	3657	4359	3540	15 824	33 410	20 219

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	+gp	Total No.	Tons Land.
2008	0	0	1	10	44	128	186	492	541	1444	1423	923	1730	16 389	23 311	13 096
2009	0	1	16	22	42	48	1507	520	983	1136	1623	1292	2347	7389	16 926	10 246
2010	10	4	6	19	34	55	61	237	540	532	848	828	792	14 659	18 625	11 924
2011	4	4	4	25	55	114	234	186	177	482	415	445	394	17 315	19 854	12 962
2012	4	24	29	24	48	95	88	372	226	209	528	537	362	12844	15390	11056
2013	0	14	156	122	531	139	200	138	179	331	315	321	749	11390	14585	9474
2014	14	27	350	220	129	474	226	179	179	181	341	384	266	22670	25640	18780
2015	68	309	307	812	1603	1410	1608	1311	547	985	426	678	731	27968	38763	25857
2016	243	233	1022	1089	2607	4330	3039	2992	2133	911	1627	964	1017	34414	56621	35646
2017	4	232	263	1341	1608	4014	6288	3852	3296	2140	883	1542	941	25122	51526	30934
2018	0	6	397	523	3012	3679	8694	11948	6377	4981	3074	1236	2125	22472	68524	38765

Table 6.7. *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. Modelled numbers and those for 2016 are updated using additional age data.

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	0.400	0.450	0.436	0.460	0.499	0.462	0.846
1994	0.174	0.188	0.235	0.298	0.361	0.396	0.415	0.480	0.492	0.562	0.642	0.636	0.720	0.846
1995	0.158	0.185	0.226	0.261	0.324	0.360	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	0.690	0.800	0.683	0.958
1997	0.152	0.191	0.228	0.280	0.324	0.367	0.435	0.492	0.521	0.615	0.601	0.611	0.671	0.911
1998	0.120	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	0.170	0.226	0.286	0.343	0.382	0.441	0.483	0.537	0.565	0.620	0.644	0.672	0.757
2000	0.109	0.144	0.199	0.276	0.332	0.392	0.437	0.490	0.540	0.585	0.631	0.650	0.671	0.872
2001	0.115	0.137	0.183	0.262	0.310	0.356	0.400	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	0.520	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	0.180	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	0.370	0.408	0.451	0.478	0.523	0.550	0.551	0.640	0.797

Year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
2006	0.107	0.143	0.200	0.266	0.314	0.374	0.419	0.462	0.489	0.527	0.570	0.602	0.590	0.796
2007	0.115	0.131	0.180	0.252	0.305	0.364	0.409	0.449	0.485	0.513	0.523	0.554	0.569	0.737
2008		0.158	0.177	0.242	0.304	0.402	0.465	0.486	0.511	0.546	0.600	0.596	0.635	0.803
2009	0.129	0.179	0.206	0.249	0.326	0.394	0.510	0.550	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	0.530	0.626	0.654	0.730	0.699	0.833
2013	0.129	0.145	0.189	0.230	0.270	0.282	0.345	0.384	0.534	0.559	0.634	0.627	0.661	0.720
2014	0.129	0.149	0.193	0.168	0.192	0.239	0.333	0.277	0.364	0.516	0.713	0.780	0.797	0.875
2015	0.160	0.167	0.232	0.294	0.346	0.383	0.457	0.436	0.474	0.538	0.665	0.690	0.724	0.824
2016 ¹				0.405	0.394	0.409	0.497	0.488	0.662	0.575	0.618	0.605	0.669	0.729
2017	No data available at the time of the working group													
2018	No data available at the time of the working group													
Modelled	0.143	0.190	0.239	0.289	0.337	0.384	0.427	0.468	0.506	0.541	0.572	0.600	0.626	0.757

¹ preliminary figures

Table 6.8 Pelagic *Sebastes mentella* in the Norwegian Sea (outside the EEZ). Catch numbers-at-age.

Numbers 10 ³							Age						
YEAR	7	8	9	10	11	12	13	14	15	16	17	18	19+
2006	0	0	0	0	23	93	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 ¹	0	0	0	22	29	19	294	146	132	217	288	126	8939
2013 ²	11	137	98	465	123	158	96	169	246	196	238	598	7968
2014 ³	0	10	125	88	406	103	125	70	113	151	112	130	4398
2015 ³	0	0	0	0	114	38	39	0	0	0	92	29	6073
2016 ³	0	0	121	241	213	228	115	71	84	188	350	180	8634
2017	0	0	0	175	344	299	312	152	90	102	215	381	7706
2018	0	0	0	0	307	594	502	507	236	133	143	288	8566

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.

Table 6.9 Pelagic *Sebastes 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 ¹	-	-	0,62	0,56	0,54	0,59	0,59	0,56	0,61
2011 ¹	-	0,48	0,54	0,54	0,64	0,59	0,54	0,59	0,59
2012	No data	-	-	-	-	-	-	-	-
2013 ²	0,31	-	-	-	0,56	0,62	0,60	0,62	0,68
2014	No data	-	-	-	-	-	-	-	-
2015	No data	-	-	-	-	-	-	-	-
2016	No data	-	-	-	-	-	-	-	-
2017	No data								
2018	No data								

1 preliminary figures**4 As observed in the research survey in the Norwegian Sea in September 2013**

Table 6.10. *S. mentella* in subareas 1 and 2. Total catch numbers-at-length, in thousands, for 2011–2018.

[illegible]

Table 6.11. *S. mentella* in subareas 1 and 2. Catch numbers-at-length, in thousands, in the pelagic fishery for 2011–2018.

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	0	0	0	1	8	244	2562	5887	4425	1537	287	13	0	1	0	0
2012	0	0	0	0	0	0	106	2014	5092	3681	952	48	0	0	0	0	0
2013	0	0	0	0	0	0	75	1352	4791	2967	730	87	6	0	0	0	0
2014	0	0	0	0	0	3	14	349	2408	2454	827	80	6	1	0	0	0
2015	Data not available at the time of the working group																
2016	Data not available at the time of the working group																
2017	Data not available at the time of the working group																
2018	Data not available at the time of the working group																

Table 6.12 REDFISH in subareas 1 and 2. Nominal catch (t) by countries in Subarea 1, divisions 2.a and 2.b combined for both *Sebastes mentella* and *S. norvegicus*.

Year	Canada	Denmark	Estoia	Faroe Islands	France	Germany ⁴	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia ⁵	Spain	UK (E&W)	UK (Scot.)	Total
1984	-	-	-	-	2970	7457	-	-	-	-	18 650	-	1806	69689	25	716	-	101 313
1985	-	-	-	-	3326	6566	-	-	-	-	20 456	-	2056	59943	38	167	-	92 552
1986	-	-	-	29	2719	4884	-	-	-	-	23 255	-	1591	20694	-	129	14	53 315
1987	-	+	-	450 ³	1611	5829	-	-	-	-	18 051	-	1175	7215	25	230	9	34 595
1988	-	-	-	973	3349	2355	-	-	-	-	24 662	-	500	9139	26	468	2	41 494
1989	-	-	-	338	1849	4245	-	-	-	-	25 295	-	340	14344	5 ²	271	1	46 688
1990	-	37 ³	-	386	1821	6741	-	-	-	-	34 090	-	830	18918	-	333	-	63 156
1991	-	23	-	639	791	981	-	-	-	-	49 463	-	166	15354	1	336	13	67 768
1992	-	9	-	58	1301	530	614	-	-	-	23 451	-	977	4335	16	479	3	31 773
1993	8 ³	4	-	152	921	685	15	-	-	-	18 319	-	1040	7573	13	734	1	29 465
1994	-	28	-	26	771	1026	6	4	3	-	21 466	-	985	6220	34	259	13	30 841
1995	-	-	-	30	748	693	7	1	5	1	16 162	-	936	6985	67	252	13	25 900
1996	-	-	-	42 ³	746	618	37	-	2	-	21 675	-	522	1641	409	305	121	26 118
1997	-	-	-	7	1011	538	39 ²	-	11	-	18 839	1	535	4556	308	235	29	26 109
1998	-	-	-	98	567	231	47 ³	-	28	-	26 273	13	131	5278	228	211	94	33 200
1999	-	-	-	108	61 ³	430	97	14	10	-	24 634	6	68	4422	36	247	62	30 195
2000	-	-	-	67 ³	25	222	51	65	1	-	19 052	2	131	4631	87	-	203 ⁶	24 536
2001	-	-	Est	111 ³	46	436	34	3	5	-	23 071	5	186	4738	91	-	239 ⁶	28 965
2002	-	-	15	135 ³	89	141	49	44	4	-	10 713	8 ³	276	4736	193 ²	-	234 ⁶	16 636
2003	Swe	-	-	173 ³	30	154	44 ³	9	5 ³	89	8063	7	50	1431	47 ²	-	258 ⁶	10 360
2004	1	-	-	607	17 ³	78	24 ³	40	3	33	7608 ¹²	42	240	3601 ²	260 ²	-	145 ⁶	12 699
2005	Can	Lith	5	1194	56	105	75 ³	12 ²	4 ³	55 ²	7845 ¹²	-	196	5637	171 ³	-	147 ⁶	15 502
2006	433	845	396	3919	223	2518	107 ³	2544 ³	12 ³	21	11 015	2496 ²	1873	12126	719 ²	-	1066 ⁶	40 649
2007	Latv	785	684	2343	249	587	84 ³	1655 ²	7 ³	20	8993 ²	1081 ²	1708	6550	2186 ²	-	257 ⁶	27 591
2008	267	117	-	2123 ³	250	46	96 ³	36 ³	15 ³	15	7436 ¹	8	785	7866	467 ²	EU⁷	168 ⁶	19 695
2009	-	-	-	1413	16	100	81	99	-	4	8128	338	836	4541	177	889	111	16 733
2010	243 ³	457 ³	-	1150	226	52	84 ³	24 ³	-	-	8059	1 ³	321	6979	1187	-	123	18 906

Year	Canada	Denmark	Estoia	Faroe Islands	France	Germany ⁴	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia ⁵	Spain	UK (E&W)	UK (Scot.)	Total
2011	536	565	-	1008 ²	228	844	51	24	-	1	7152	59	638	5956	1684 ²	-	68	18 814
2012	447	449	-	346	182	588	58	59	12	5	6361	352	1055	4782	1780 ²	<u>Denm</u>	100	16 576
2013	280	262	-	780	353	81	66	9	1	-	5606	103	1114	4474	1459	1	493	15 082
2014	215	167	-	810	434	452	35	29	-	4	16 556	124	510	2510	1162	-	211	23 219
2015	537	192	-	733	102	266	259	38	-	3	22 208	22	678	1806	2531	1	109	29 485
2016 ¹	1243	1065	-	685	164	497	161	79	-	-	22 322	234	1066	9283	32013	7	198	40 217
2017 ¹	562	790	4	566	62	782	127	68	-	2	20 581	129	1150	7890	2882	-	596	36 192
2018 ¹	876	1083	4	571	104	2252	159	77	-	374	23 565	311	766	12 331	2469	1	100	45 412

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 6.13. 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	Nether-lands	Norway	Portugal	Sweden	UK (Scot.)	Total
1998	2	27	12	570	370	4	21	1113	-	-	749	2868
1999	3	52	1	-	58	39	16	862	-	-	532	1563
2000	5	41	-	224	19	28	19	443	-	-	618	1397
2001	4	96	-	272	13	19	+	421	-	-	538	1363
2002	2	40	2	98	11	7	+	241	-	-	524	925
2003	1	71	2	26	2	-	-	474	-	-	463	1071
2004	+	42	3	26	1	-	-	287	-	-	214	578
2005	2	34	-	10	1	-	-	84	-	-	28	159
2006	1	49	1	12	3	-	-	155	33	-	79	333
2007 ¹	+	27	-	8	1	-	-	107	-	+	78	221
2008 ¹	+	3	-	8	1	-	-	77	-	1	54	144
2009	-	4	1	38	-	-	-	119	-	+	86	248
2010	-	5	-	3	-	-	-	62	-	-	150	220
2011	-	10	-	90	1	-	-	66	-	+	71	238
2012	-	10	-	19	-	-	-	71	-	+	87	187
2013	-	7	-	40	+	-	-	54	-	+	176	277
2014	-	-	-	32	1	-	-	160	-	-	933	286
2015	+	1	-	14	1	-	-	157	-	+	61	235
2016	-	3	-	11	+	-	-	180	-	+	22	216
2017	-	3	-	10	+	-	+	168	-	+	38	218
2018 ¹		10		4	+			71		+	29	114

1 Provisional figures.**+ less than 0.5 tonne.**

Table 6.14. *Sebastes mentella*. Average catch (numbers of specimens) per hour trawling of different ages of *Sebastes mentella* in the Russian groundfish survey in the Barents Sea and Svalbard areas (1976–1983 published in "Annales Biologiques"). The survey was not conducted in 2016 took place in 2017 with insufficient coverage and was terminated after that year.

Year class	0	1	2	3	4	5	6	7	8	9	10	11
1974	-	-	4.8	-	4.9	22.8	4.8	4.8	-	-	-	3
1975	-	7.4	-	1.7	6.4	2.4	3.5	5	-	-	4	-
1976	7	-	8.1	1.2	2.5	6.8	4.9	5	1	13	-	-
1977	-	0.2	0.2	0.2	0.9	5.1	3.7	1	19	2	-	-
1978	0.8	0.02	0.9	1	5	3.8	2	20	6	-	-	-
1979	-	1.9	1.4	3.6	2.3	9	11	16	1	-	-	0.1
1980	0.3	0.4	2	2.5	16	6	11	25	2	-	1.5	2
1981	-	2.2	3.9	20	6	12	47	18	6.3	1.6	0.5	1
1982	19.8	13.2	13	15	34	44	39	32.6	4.3	3.1	4.9	+
1983	12.5	3	5	6	31	34	32.3	13.3	4	4.2	0.6	1.1
1984	-	10	2	-	5	18.3	19	2.2	2.4	0.2	1.7	2.4
1985	107	7	-	1	5.2	16.2	1.7	1.7	0.6	2.8	3.8	0.3
1986	2	-	1	1.8	8.4	3.6	2.1	1.2	5.6	8.2	0.9	0.7
1987	-	3	37.9	1.3	8	4.1	2	10.6	9.6	1.4	2	1.3
1988	4	58.1	4.3	13.3	25.8	3.9	8.6	11.2	2.8	4.2	3	4.7
1989	8.7	9	17	23.4	4.6	5.4	4	6.6	6.6	4.1	7.7	5.3
1990	2.5	6.3	6.1	1	4.3	1.7	11.5	6.5	5.5	6.7	7.4	3.6
1991	0.3	1	0.5	1.5	1.2	11.3	3.9	3.3	4.6	5.8	2.7	1.9
1992	0.6	+	0.2	0.1	4.3	1.3	2	2.3	4.9	2.3	1	4.1
1993 ¹	-	+	1.5	1.8	1	1.2	3	4.2	2.6	2	3.2	2.1
1994	0.3	3.5	1.7	1.7	0.9	3.6	5.2	4.3	3.1	3.3	1.8	1.2
1995	2.8	1	1.1	0.4	2.2	2.6	3.5	3.4	2.9	1.2	1	8.5
1996 ²	+	0.1	0.1	0.4	0.7	1.1	1	1.4	1	0.8	3.7	0.6
1997	-	-	+	0.4	0.5	0.3	0.9	0.6	1	1.1	0.5	0.4
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

Year class	0	1	2	3	4	5	6	7	8	9	10	11
2001	-	0.1	0.4	-	0.1	0.2	0.2	0.3	0.2	0.8	0.1	1
2002 ³	0.1	0.5	0.1	-	-	0.1	0.5	0.4	1.5	0.5	1	1.1
2003	-	-	0.1	-	0.3	1.0	0.5	4.8	2.1	3.7	1.3	1.9
2004	-	0.2	0.3	0.5	1.5	0.9	4.4	3.7	7.5	4.1	3.1	3.3
2005	-	-	1.4	1.9	1.4	2.3	3.9	7.2	6.1	6.8	3.1	
2006 ⁴	0.1	1.8	1.2	1.1	0.8	2.1	4.1	3.0	6.1	5.9		
2007	2.5	0.4	0.1	1.2	1.7	2.4	3.6	4.3	7.4			
2008	0.1	0.1	1.6	1.8	4.1	2.9	5.8	5.5				
2009	1.6	1.9	1.1	4.4	4.8	2.9	4.8					
2010	7.5	0.7	1.2	1.5	1.9	1.6						
2011	0.1	0.3	0.6	1.6	1.6							
2012	0.2	0.7	0.5	0.3								
2013	0.1	0.1	0.4									
2014	3.6	1.0										
2015	6.6											

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

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

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

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

Table 6.15a. *Sebastes mentella*¹ in Division 2.b. Abundance indices (on length) from the bottom-trawl survey in the Svalbard area (Division 2.b) in summer/fall 1986–2018 (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 ²	6	101	192	17	10	5	2	4	+	338
1987 ²	20	14	140	19	6	2	1	2	+	208
1988 ²	33	23	82	77	7	3	2	2	+	228
1989	566	225	24	72	17	2	2	8	4	921
1990	184	820	59	65	111	23	15	7	3	1287
1991	1533	1426	563	55	138	38	30	7	1	3791
1992	149	446	268	43	22	15	4	7	4	958

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	
1993	9	320	272	89	16	13	3	1	+	722
1994	4	284	613	242	10	9	2	2	1	1165
1995	33	33	417	349	77	18	5	1	+	933
1996	56	69	139	310	97	8	4	1	1	685
1997	3	44	13	65	57	9	5	+	+	195
1998	+	37	35	28	132	73	45	2	+	353
1999	4	3	121	62	259	169	42	1	0	661
2000	+	10	31	59	126	143	21	1	0	391
2001	1	5	3	32	57	228	50	3	0	378
2002	1	4	6	21	62	266	47	4	+	410
2003	1	5	7	11	56	271	50	1	0	403
2004	0	2	7	6	14	78	53	2	0	163
2005	1	1	6	11	19	93	63	1	0	196
2006	82	6	5	7	49	211	101	3	0	463
2007	98	68	1	5	11	95	109	3	0	387
2008	119	45	20	3	9	25	79	4	0	303
2009	8	114	83	14	3	23	191	5	0	440
2010	96	19	46	39	2	20	88	7	0	317
2011	124	91	82	46	11	8	67	5	1	436
2012	27	73	68	78	48	8	91	9	0	401
2013	33	44	131	112	71	19	86	12	0	509
2014 ³	3	12	56	49	39	23	58	17	+	257
2015	74	7	28	144	114	64	69	25	0	525
2016	215	30	41	201	146	150	152	51	+	984
2017	Not available for AFWG 2018									
2018	Not available for AFWG 2019									

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 6.15b. *Sebastes mentella*¹ in Division 2.b. Norwegian bottom-trawl survey indices (on age) in the Svalbard area (Division 2.b) in summer/fall 1992–2018 (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	+	1050
1994	7	280	290	202	235	42	94	1	1	3	4	1	1	+	1161
1995	4	50	365	237	132	61	19	17	11	+	1	3	0	0	900
1996	23	47	15	37	105	144	84	17	51	32	34	9	6	2	605
1997	8	43	6	6	40	20	30	25	7	3	1	2	2	1	194
1998	+	26	28	14	10	13	69	66	49	15	1	6	15	5	317
1999	3	16	114	27	36	53	117	78	67	41	45	11	19	13	640
2000	4	6	6	14	35	22	31	54	81	60	24	24	10	8	379
2001	2	4	3	1	9	16	22	30	34	57	57	50	54	6	344
2002	3	2	4	2	5	22	34	23	88	36	62	64	15	21	379
2003	0.3	3	4	3	5	4	29	31	50	59	45	70	38	23	365
2004	1	1	3	3	1	4	2	9	9	18	15	17	19	9	113
2005	1	1	2	3	3	6	9	15	14	16	14	21	22	25	152
2006	33	1	3	3	2	9	17	27	24	35	29	45	25	34	287
2007	23	45	0	0	3	2	5	5	8	5	5	9	29	19	158
2008	6	22	22	12	1	2	2	5	4	4	3	5	10	6	102
2009	14	43	55	41	34	19	7	1	2	2	9	10	26	7	270
2010	No age readings														
2011	112	45	57	43	34	35	22	7	2	0	1	0	0	2	360
2012	26	33	38	33	39	49	30	30	14	4	1	1	1	0	298
2013	31	2	29	50	49	65	55	79	21	5	14	11	1	1	509
2014 ²	+	3	2	4	23	29	17	29	15	19	12	13	6	2	290
2015	60	2	12	45	61	45	52	68	37	12	9	6	7	4	547
2016	No age readings available														
2017	No age readings available														
2018	No age readings available														

¹ - Includes some unidentified *Sebastes* specimens mostly less than 15 cm.² - Poor survey coverage in 2014

Table 6.16a. *Sebastes mentella*¹. Abundance indices (on length) from the bottom-trawl survey in the Barents Sea in the winter 1986–2019 (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. NOTE: newly calculated values 2014–2018 differ from the ones reported in this table.

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	13.8	950
1987	72	25	227	56	35	11	5	1	0.1	433
1988	587	25	133	182	40	50	48	4	0.1	1068
1989	623	55	28	177	58	9	8	2	0.3	961
1990	324	305	36	56	80	13	13	2	0.2	828
1991	395	449	86	39	96	35	24	3	0.2	1127
1992	139	367	227	35	55	34	8	2	0.5	867
1993	31	593	320	116	24	25	6	1	+	1117
1994	8	296	479	488	74	74	17	3	0	1440
1995	310	84	571	391	83	58	24	3	0	1523
1996	215	102	199	343	136	42	17	1	0	1054
1997 ²	65	118	22	242	258	70	39	4	0	819
1998 ²	1	88	62	101	203	40	13	2	0	511
1999	2	7	70	37	171	74	22	3	1	385
2000	9	13	40	78	142	95	25	7	2	410
2001	10	23	7	57	79	75	10	1	0	261
2002	17	8	19	37	96	117	24	1	0	318
2003	4	4	10	13	70	198	46	6	0	351
2004	2	3	7	19	33	86	32	2	1	183
2005	0	6	7	11	28	154	86	4	0	297
2006	100	2	10	15	23	104	83	3	1	339
2007	374	122	3	7	12	121	121	7	0	767
2008	858	359	27	5	12	104	165	5	0	1534
2009	95	325	136	5	9	67	163	6	0	806
2010	652	276	215	64	7	74	191	6	0	1485
2011	502	230	213	149	14	47	157	5	0	1316

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	
2012	129	280	86	125	47	14	154	18	0	855
2013	250	227	245	159	143	35	193	27	0	1280
2014	91	175	250	114	125	51	115	14	0	934
2015	175	111	216	302	290	215	171	18	0	1498
2016	615	105	149	332	213	163	124	14	1	1715
2017	604	202	70	199	287	309	232	11	0	1915
2018	190	253	83	110	191	270	217	23	1	1339
2019	53	305	277	93	160	257	213	20	0	1377

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 6.16b. *Sebastes mentella*¹ in subareas 1 and 2. Preliminary Norwegian bottom-trawl indices (on age) from the annual Barents Sea survey in February 1992–2019 (numbers in millions). The area coverage was extended from 1993 onwards.

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	351	252	132	56	14	11	3	9	18	16	12	11	2	5	892
1993	38	473	192	242	62	45	19	22	13	11	10	4	2	3	1136
1994	7	85	332	189	370	228	73	42	3	30	8	14	25	7	1413
1995	308	45	146	264	364	211	69	23	7	17	23	9	11	10	1507
1996	173	119	109	114	128	122	106	64	24	19	12	7	8	4	1009
1997 ²	43	101	19	54	96	43	44	171	76	74	39	29	10	9	808
1998 ²	1	73	49	27	13	52	107	104	41	18	7	4	3	3	502
1999	1	+	32	43	30	24	30	81	79	28	2	1	6	+	357
2000	9	12	21	17	9	39	77	73	50	41	14	10	7	6	385
2001	1	17	8	1	7	22	39	30	34	23	24	17	9	3	236
2002	18	4	12	7	4	14	49	55	27	19	34	24	28	11	306
2003	0	2	2	4	6	6	14	39	24	34	39	65	46	20	301
2004	0	2	3	1	9	12	15	20	36	8	28	3	25	12	172
2005	0	4	3	3	6	6	11	15	23	14	21	40	35	49	229
2006	4	1	5	5	5	8	15	12	6	15	21	17	32	36	180
2007	428	82	13	1	2	2	5	7	8	8	21	20	31	35	144
2008	648	173	107	11	0	2	5	7	5	10	10	28	27	40	1073
2009	107	112	104	82	63	32	14	9	9	6	16	7	21	11	593
2010	150	239	172	161	103	71	27	13	4	7	13	12	21	33	1027
2011	391	211	106	125	109	67	47	14	5	4	1	3	2	10	1095
2012	No age readings														
2013	No age readings														
2014	No age readings														
2015	No age readings														
2016	No age readings														
2017	No age readings														
2018	No age readings														
2019	No age readings														

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 6.17. Comparison of results on *Sebastes mentella* from the Norwegian Sea pelagic surveys in 2008, 2009 2013 and 2016.

	2008	2009	2013	2016
mean length (cm) All/M/F ¹	37.0 / 36.4 / 37.5	36.6 / 36.0 / 37.1	37.5 / 37.0 / 38.1	37.7 / 37.0 / 38.3
mean length (cm) S/DSL/D ²	37.2 / 36.8 / 39.1	37.2 / 36.5 / 38.3	37.1 / 37.4 / 38.9	38.1 / 37.6 / 38.4
mean weight (g) All/M/F	619 / 585 / 648	625 / 609 / 666	659 / 625 / 706	656 / 619 / 694
Mean age (y) All/M/F	25 / 25 / 25	25 / 25 / 24	- / - / -	- / - / -
Sex ratio	45% (M) / 55% (F)	45% (M) / 55% (F)	59% (M) / 41% (F)	50% (M) / 50% (F)
Occurrence	96%	100%	95%	80%
Catch rates	3.80 t/NM ²	3.94 t/NM ²	3.47 t/NM ²	101 t/NM ²
mean s_A	33 m ² /NM ²	34 m ² /NM ²	19 m ² /NM ²	5.2 m ² /NM ²
Total Area	53 720 NM ²	69 520 NM ²	69 520 NM ²	67 150 NM ²
Abundance (Acoustics) ³	395 000 t	532 000 t	297 000 t	136 000 t
Abundance (Trawl) ⁴	406 000 t	548 000 t	482 000 t	116 000 t

¹ M = males only F = females only² S = shallower than DSL DSL = deep scattering layer D = deeper than DSL³The 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).⁴Trawls: 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 6.18. *Sebastes mentella* in subareas 1 and 2. Abundance indices (on age) from the Ecosystem survey in August-September 1996–2018 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 1500 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	1 056 120	171
1997	62682	130816	12492	23452	74342	55880	76607	82503	17640	14274	675	2238	1723	633	8765	564 723	73
1998	313	78767	85715	39849	25805	23413	84825	100332	54287	24329	11334	7457	15250	576	25212	577 464	105
1999	5359	23240	117170	47851	41608	76797	128677	73306	58018	64781	49890	13565	18458	12171	24672	755 562	155
2000	5964	23169	14336	19960	52666	68081	83857	77513	100442	72294	71148	36599	17183	20590	26501	690 304	178
2001	5026	6541	10957	1093	19766	25591	36594	51644	44407	61704	50083	86122	53952	15699	31877	501 057	162
2002	9112	6646	7379	3821	8635	28215	47456	63903	103368	49964	76133	71970	25241	36765	34957	573 565	181
2003	3954	7394	6142	3540	8030	9388	48564	59051	98554	69901	83192	73521	69970	37162	47323	625 687	213
2004	9068	10837	9008	7292	2510	7896	8193	15268	25544	29654	35249	21142	39581	25976	66792	314 010	111
2005	1310	4406	5241	5031	5722	8740	13452	20672	16207	19353	17430	32028	37564	34815	57103	279 072	103
2006	156578	5162	6695	5217	3768	10754	18771	29174	25278	38958	31869	46885	30895	44299	147951	602 255	184
2007	302988	224153	290	7686	11346	2031	7903	10770	12182	6578	6367	9998	41425	22090	211178	876 986	172
2008	86880	183796	121430	21430	4178	3009	3334	6991	5120	4441	3581	6008	10352	10172	99808	570 530	89
2009	98726	133218	196908	118322	131668	37586	18194	3679	8633	3494	9736	14091	25949	8384	251370	1 059 960	200
2010	No age reading																
2011	389536	285787	222753	60809	80266	67419	39695	12409	4144	1175	1174	2246	324	3379	93382	1 264 495	

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total N	Total B
2012	468 668	201 121	355 968	171 789	111 821	89 591	55 393	36 823	18 795	7 308	7 521	838	4 859	1 770	131 470	1 663 736	
2013	209 352	153 814	160 189	169 748	158 030	137 012	78 817	129 898	52 762	24 338	19 775	23 891	1 405	1 041	129 156	1 449 229	
2014 ¹	2 440	23 091	38 542	69 219	49 720	86 768	74 944	69 021	48 043	45 568	42 281	17 440	16 739	3 584	162 911	783 055	
2015	450 847	32 390	53 292	84 098	84 938	101 485	67 651	94 248	69 453	17 908	17 962	8 112	8 073	4 771	141 040	1 269 508	
2016	No age reading																
2017	No age reading																
2018	No age reading																

¹ - Poor survey coverage in 2014

Table 6.19. Proportion of maturity-at-age 6–30 in *Sebastes 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 $0.5 \left((1 + \tanh(\text{age} - a50)/w1) \right)$ for age < a50 and $0.5 \left((1 + \tanh((\text{age} - a50)/w2)) \right)$ 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	0.00	0.01	0.02	0.04	0.09	0.18	0.32	0.50	0.57	0.63	0.69	0.75	1.00
1993	0.01	0.02	0.03	0.07	0.15	0.28	0.45	0.55	0.61	0.67	0.73	0.78	0.82	1.00
1994	0.02	0.03	0.07	0.14	0.27	0.45	0.60	0.72	0.81	0.88	0.93	0.96	0.97	1.00
1995	0.03	0.06	0.12	0.23	0.39	0.57	0.71	0.82	0.90	0.94	0.97	0.98	0.99	1.00
1996	0.00	0.01	0.02	0.04	0.09	0.18	0.33	0.51	0.59	0.67	0.74	0.80	0.85	1.00
1997	0.02	0.04	0.08	0.15	0.29	0.47	0.55	0.61	0.66	0.71	0.76	0.80	0.83	1.00
1998	0.01	0.03	0.07	0.14	0.26	0.43	0.56	0.65	0.73	0.80	0.85	0.90	0.93	1.00
1999	0.02	0.05	0.10	0.19	0.34	0.51	0.58	0.64	0.70	0.75	0.79	0.83	0.87	1.00
2000	0.02	0.05	0.10	0.20	0.35	0.53	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	0.18	0.33	0.50	0.57	0.63	0.69	0.74	0.79	0.83	1.00
2002	0.02	0.05	0.10	0.19	0.33	0.51	0.55	0.59	0.63	0.67	0.71	0.74	0.77	1.00
2003	0.02	0.05	0.11	0.21	0.37	0.52	0.58	0.63	0.68	0.73	0.78	0.81	0.85	1.00
2004	0.03	0.06	0.11	0.22	0.38	0.51	0.55	0.59	0.63	0.66	0.70	0.73	0.76	1.00
2005	0.02	0.04	0.09	0.17	0.31	0.49	0.55	0.61	0.66	0.71	0.75	0.79	0.83	1.00
2006	0.01	0.01	0.03	0.06	0.12	0.23	0.40	0.53	0.59	0.65	0.70	0.75	0.79	1.00

year/Age	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
2007	0.02	0.04	0.08	0.16	0.29	0.48	0.64	0.77	0.87	0.93	0.96	0.98	0.99	1.00
2008	0.01	0.03	0.07	0.13	0.25	0.42	0.56	0.65	0.73	0.80	0.85	0.89	0.92	1.00
2009	0.02	0.04	0.08	0.16	0.29	0.47	0.61	0.72	0.81	0.87	0.92	0.95	0.97	1.00
2010	0.02	0.04	0.07	0.15	0.28	0.46	0.55	0.60	0.66	0.71	0.75	0.80	0.83	1.00
2011 ¹	0.01	0.03	0.06	0.12	0.24	0.40	0.53	0.60	0.67	0.73	0.78	0.82	0.86	1.00
2012	0.02	0.04	0.09	0.17	0.31	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	0.03	0.07	0.14	0.27	0.44	0.63	0.78	0.89	0.94	0.97	1.00
2014 ¹	0.01	0.03	0.06	0.12	0.24	0.40	0.53	0.60	0.67	0.73	0.78	0.82	0.86	1.00
2015 ¹	0.01	0.03	0.06	0.12	0.24	0.40	0.53	0.60	0.67	0.73	0.78	0.82	0.86	1.00
2016 ¹	0.01	0.03	0.06	0.12	0.24	0.40	0.53	0.60	0.67	0.73	0.78	0.82	0.86	1.00
2017 ¹	0.01	0.03	0.06	0.12	0.24	0.40	0.53	0.60	0.67	0.73	0.78	0.82	0.86	1.00
2018	0.01	0.03	0.06	0.12	0.24	0.40	0.53	0.60	0.67	0.73	0.78	0.82	0.86	1.00

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

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	0.009	0.017	0.035	0.068	0.128	0.229	0.376	0.550	0.712	0.834	0.910	0.954	1.000
Fy (demersal)	Fy (pelagic)	Year \ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.051	0	1992	394 428	369 626	328 046	215 359	127 853	89 226	89 635	96 352	115 919	78 462	87 187	66 288	68 269	55 970	51 269	36 074	23 398	165 040
0.036	0	1993	264 183	375 271	351 674	312 114	202 350	119 866	83 451	83 617	89 639	107 542	72 589	80 442	61 001	62 673	57 537	47 059	33 110	172 948
0.032	0	1994	202 742	251 352	357 045	334 594	296 890	192 409	113 868	79 087	78 847	83 847	99 744	66 940	73 971	56 028	51 648	53 032	43 372	189 908
0.024	0	1995	182 269	192 895	239 144	339 704	318 095	281 965	182 343	107 475	74 193	73 473	77 726	92 178	61 768	68 209	63 389	47 994	49 278	216 763
0.016	0	1996	148 238	173 417	183 527	227 530	322 973	302 158	267 346	172 320	101 094	69 454	68 536	72 355	85 722	57 415	53 734	59 324	44 916	248 981
0.016	0	1997	116 177	141 039	164 994	174 613	216 421	307 050	286 880	253 094	162 434	94 934	65 086	64 171	67 726	80 229	75 139	50 324	55 560	275 245
0.022	0	1998	61 161	110 534	134 189	156 981	166 099	205 784	291 628	271 750	238 740	152 635	89 021	60 982	60 107	63 431	59 040	69 937	46 840	307 905
0.017	0	1999	47 176	58 190	105 166	127 671	149 342	157 961	195 399	275 501	254 636	222 624	142 128	82 866	56 761	55 947	52 341	55 235	65 430	331 884
0.013	0	2000	37 256	44 885	55 364	100 058	121 469	142 077	150 223	185 515	260 198	239 000	208 426	132 987	77 528	53 104	49 856	49 140	51 857	373 017
0.023	0	2001	28 975	35 446	42 705	52 675	95 198	115 568	135 156	142 728	175 236	244 537	224 409	195 682	124 854	72 787	67 660	46 341	45 675	394 907
0.008	0	2002	38 012	27 568	33 725	40 631	50 096	90 479	109 676	127 878	134 391	164 124	228 135	208 915	181 999	116 078	109 533	63 845	43 728	415 740
0.003	0	2003	39 022	36 166	26 229	32 087	38 657	47 659	86 055	104 198	121 158	126 988	154 920	215 286	197 138	171 737	162 921	103 909	60 566	435 874
0.006	0	2004	51 669	37 126	34 409	24 955	30 526	36 772	45 324	81 804	98 992	115 035	120 519	146 994	204 249	187 022	176 854	154 061	98 258	469 441
0.009	0	2005	97 950	49 160	35 323	32 738	23 740	29 034	34 959	43 050	77 592	93 765	108 863	114 001	139 017	193 150	182 076	166 713	145 227	535 145

Fy (demersal)	Fy (pelagic)	Year \ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
0.011	0.032	2006	224 157	93 193	46 772	33 608	31 144	22 579	27 597	33 183	40 770	73 314	88 473	102 656	107 476	131 051	120 633	166 949	152 488	620 748
0.005	0.02	2007	401 392	213 270	88 666	44 500	31 974	29 629	21 471	26 223	31 480	38 557	69 017	82 844	95 570	99 461	92 818	112 287	155 150	717 395
0.005	0.011	2008	380 836	381 897	202 912	84 360	42 339	30 421	28 184	20 419	24 924	29 886	36 525	65 164	77 906	89 505	84 066	87 064	105 239	817 065
0.005	0.008	2009	348 342	362 340	363 349	193 057	80 263	40 282	28 940	26 808	19 414	23 670	28 313	34 512	61 438	73 302	69 015	79 074	81 844	866 443
0.005	0.01	2010	530 566	331 424	344 742	345 702	183 679	76 363	38 321	27 525	25 481	18 427	22 421	26 772	32 583	57 920	54 460	64 811	74 200	889 076
0.005	0.011	2011	472 171	504 798	315 327	327 998	328 909	174 753	72 642	36 445	26 163	24 193	17 464	21 204	25 266	30 689	28 822	51 076	60 732	901 784
0.005	0.009	2012	481 821	449 238	480 281	300 013	312 067	312 931	166 244	69 093	34 648	24 844	22 924	16 506	19 994	23 773	22 358	27 073	47 941	902 697
0.003	0.01	2013	167 415	458 420	427 420	456 955	285 440	296 905	297 693	158 121	65 689	32 911	23 560	21 690	15 582	18 836	17 743	21 032	25 449	892 834
0.014	0.012	2014	117 682	159 284	436 156	406 661	434 760	271 575	282 457	283 173	150 371	62 436	31 249	22 331	20 514	14 704	13 729	16 517	19 544	851 600
0.029	0.007	2015	176 106	111 966	151 547	414 972	386 901	413 625	258 333	268 627	269 192	142 825	59 209	29 553	21 035	19 234	17 710	12 620	15 169	799 324
0.04	0.009	2016	168 841	167 553	106 528	144 187	394 782	368 030	393 307	245 457	254 814	254 505	134 290	55 285	27 418	19 425	17 673	16 082	11 448	738 097
0.033	0.008	2017	161 891	160 641	159 415	101 355	137 162	375 460	349 804	373 343	232 348	239 923	237 666	124 229	50 738	25 028	22 905	16 155	14 690	684 136
0.041	0.009	2018	155 241	154 028	152 839	151 673	96 430	130 490	357 113	332 505	354 228	219 391	224 484	220 157	114 327	46 530	22 905	16 155	14 690	684 136

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	0.248	0.291	0.339	0.390	0.444	0.499	0.554	0.608	0.659	0.707	0.751	0.790	0.824	0.854	1.000
1993	0.000	0.000	0.000	0.006	0.016	0.043	0.109	0.248	0.472	0.708	0.868	0.947	0.980	0.992	0.997	0.999	1.000	1.000
1994	0.000	0.000	0.000	0.025	0.056	0.124	0.251	0.443	0.653	0.817	0.914	0.962	0.984	0.993	0.997	0.999	0.999	1.000
1995	0.000	0.000	0.000	0.030	0.068	0.146	0.285	0.483	0.686	0.836	0.922	0.965	0.985	0.993	0.997	0.999	0.999	1.000
1996	0.000	0.000	0.000	0.016	0.047	0.127	0.303	0.564	0.794	0.920	0.971	0.990	0.997	0.999	1.000	1.000	1.000	1.000
1997	0.000	0.000	0.000	0.013	0.039	0.111	0.279	0.545	0.788	0.920	0.973	0.991	0.997	0.999	1.000	1.000	1.000	1.000
1998	0.000	0.000	0.000	0.004	0.021	0.091	0.323	0.695	0.916	0.981	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.000	0.000	0.001	0.005	0.026	0.126	0.437	0.807	0.958	0.992	0.998	1.000	1.000	1.000	1.000	1.000	1.000
2000	0.000	0.000	0.000	0.000	0.001	0.011	0.104	0.542	0.923	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	0.018	0.045	0.109	0.238	0.445	0.673	0.841	0.931	0.972	0.989	0.996	0.998	0.999	1.000	1.000
2002	0.000	0.000	0.000	0.002	0.009	0.042	0.176	0.508	0.834	0.960	0.992	0.998	1.000	1.000	1.000	1.000	1.000	1.000
2003	0.000	0.000	0.000	0.030	0.069	0.150	0.297	0.502	0.707	0.852	0.932	0.970	0.987	0.995	0.998	0.999	1.000	1.000
2004	0.000	0.000	0.000	0.021	0.053	0.128	0.278	0.502	0.726	0.874	0.948	0.979	0.992	0.997	0.999	1.000	1.000	1.000
2005	0.000	0.000	0.000	0.013	0.037	0.103	0.252	0.500	0.747	0.897	0.963	0.987	0.996	0.999	0.999	1.000	1.000	1.000
2006	0.000	0.000	0.000	0.003	0.009	0.025	0.068	0.170	0.365	0.618	0.819	0.927	0.973	0.990	0.996	0.999	1.000	1.000
2007	0.000	0.000	0.000	0.001	0.003	0.009	0.024	0.065	0.163	0.352	0.604	0.810	0.923	0.971	0.989	0.996	0.999	1.000
2008	0.000	0.000	0.000	0.000	0.001	0.003	0.014	0.058	0.215	0.550	0.844	0.960	0.991	0.998	1.000	1.000	1.000	1.000

Year \ age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2009	0.000	0.000	0.000	0.001	0.003	0.012	0.043	0.142	0.380	0.695	0.894	0.969	0.991	0.998	0.999	1.000	1.000	1.000
2010	0.000	0.000	0.000	0.002	0.006	0.018	0.049	0.127	0.293	0.541	0.770	0.905	0.964	0.987	0.995	0.998	0.999	1.000
2011	0.000	0.000	0.000	0.001	0.002	0.007	0.023	0.079	0.235	0.526	0.800	0.935	0.981	0.995	0.999	1.000	1.000	1.000
2012	0.000	0.000	0.000	0.001	0.004	0.010	0.030	0.080	0.200	0.418	0.673	0.855	0.944	0.980	0.993	0.998	0.999	1.000
2013	0.000	0.000	0.000	0.001	0.002	0.006	0.015	0.041	0.105	0.243	0.467	0.706	0.868	0.947	0.980	0.993	0.997	1.000
2014	0.000	0.000	0.000	0.002	0.003	0.007	0.015	0.032	0.065	0.129	0.239	0.400	0.586	0.751	0.865	0.931	0.967	1.000
2015	0.000	0.000	0.000	0.003	0.008	0.018	0.042	0.095	0.202	0.378	0.593	0.778	0.894	0.953	0.980	0.991	0.996	1.000
2016	0.000	0.000	0.000	0.004	0.010	0.023	0.054	0.120	0.245	0.437	0.651	0.817	0.914	0.962	0.984	0.993	0.997	1.000
2017	0.000	0.000	0.000	0.001	0.002	0.007	0.024	0.075	0.212	0.472	0.748	0.908	0.970	0.991	0.997	0.999	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	394	128	496483	214407	0.037	0.051
1993	264	202	536630	270189	0.035	0.036
1994	203	297	588073	342415	0.031	0.032
1995	182	318	646281	395232	0.023	0.024
1996	148	323	705411	325177	0.016	0.016
1997	116	216	764253	402525	0.016	0.016
1998	61	166	818272	456936	0.022	0.022
1999	47	149	861767	516780	0.017	0.017
2000	37	121	899905	602594	0.013	0.013
2001	29	95	931845	568541	0.023	0.023
2002	38	50	945499	637100	0.008	0.008
2003	39	39	962078	704700	0.003	0.003
2004	52	31	975692	712073	0.006	0.006
2005	98	24	982342	763444	0.009	0.009
2006	224	31	985038	751913	0.031	0.042
2007	401	32	964605	881343	0.018	0.025
2008	381	42	958935	841711	0.012	0.016
2009	348	80	967245	863056	0.010	0.013
2010	531	184	986719	820136	0.011	0.015
2011	472	329	1011172	809331	0.012	0.016
2012	482	312	1042517	807249	0.011	0.014
2013	167	285	1091558	765724	0.009	0.013
2014	118	435	1147532	771905	0.017	0.026
2015	176	387	1200437	765510	0.030	0.036
2016	169	395	1234519	767049	0.042	0.049
2017	162	137	1254186	772982	0.037	0.042
2018	155	96	1276995	793980	0.045	0.050

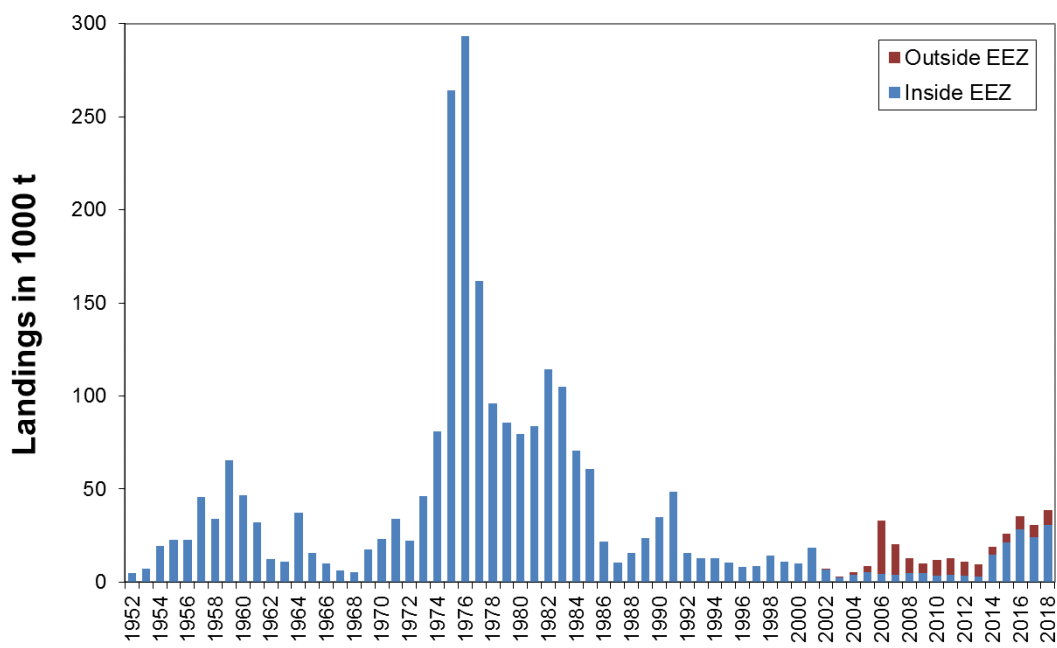


Figure 6.1. *Sebastes mentella* in subareas 1 and 2. Total international landings 1952–2018 (thousand tonnes).

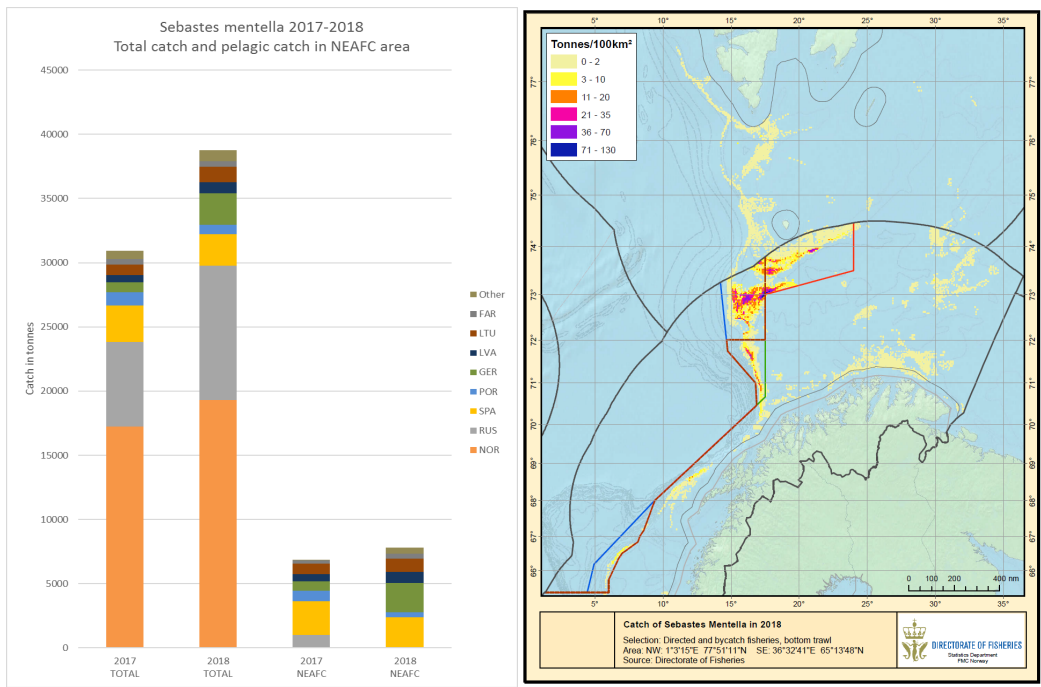


Figure 6.2. *Sebastes mentella* in subareas 1 and 2. Left panel: Catch in tonnes reported by national fleets for the Subarea 27.1 and 27.2 and in the NEACF regulatory area. Right panel: Geographical location of the directed Norwegian fishing within the Norwegian Exclusive Economic Zone and bycatches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

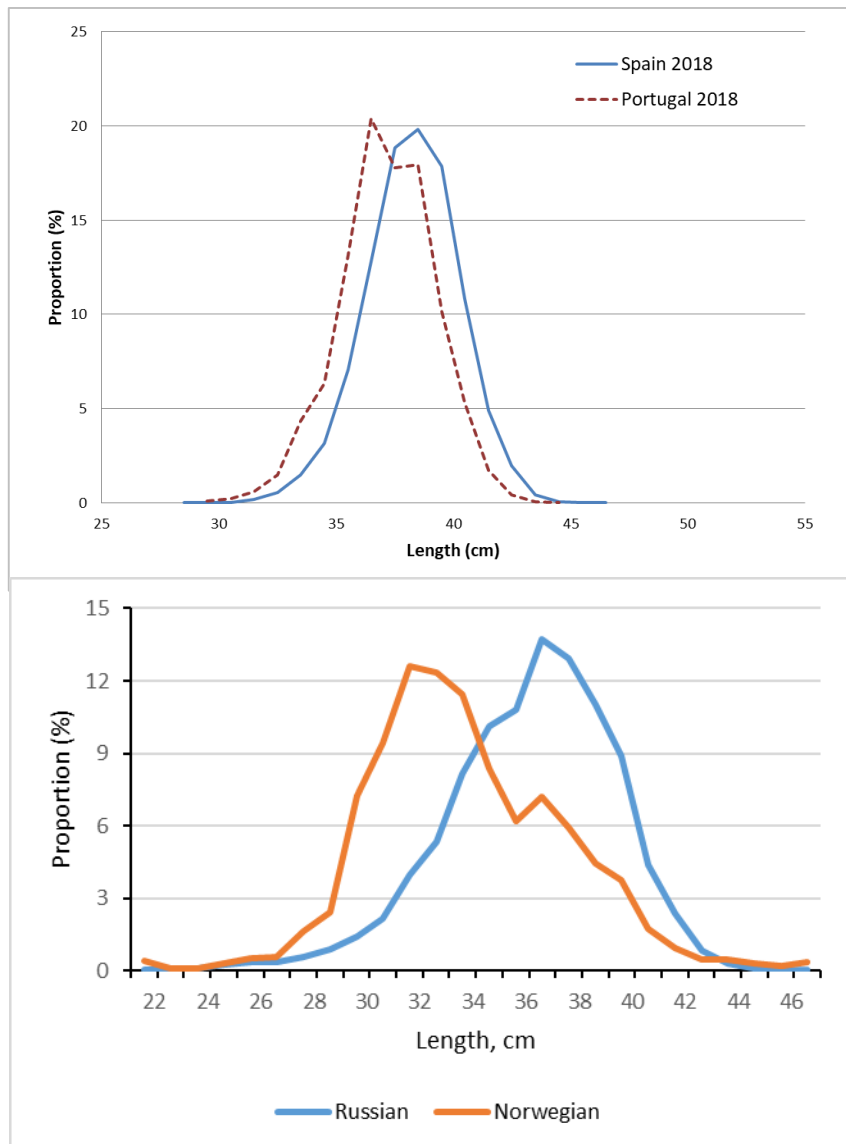


Figure 6.3. Upper panel: *Sebastes mentella* in Subarea 2. Length-distributions of the commercial pelagic catches by Spain and Portugal in 2018. Lower panel: *Sebastes mentella* in subareas 1 and 2. Length-distributions of the commercial demersal catches by Norway and Russia in 2018.

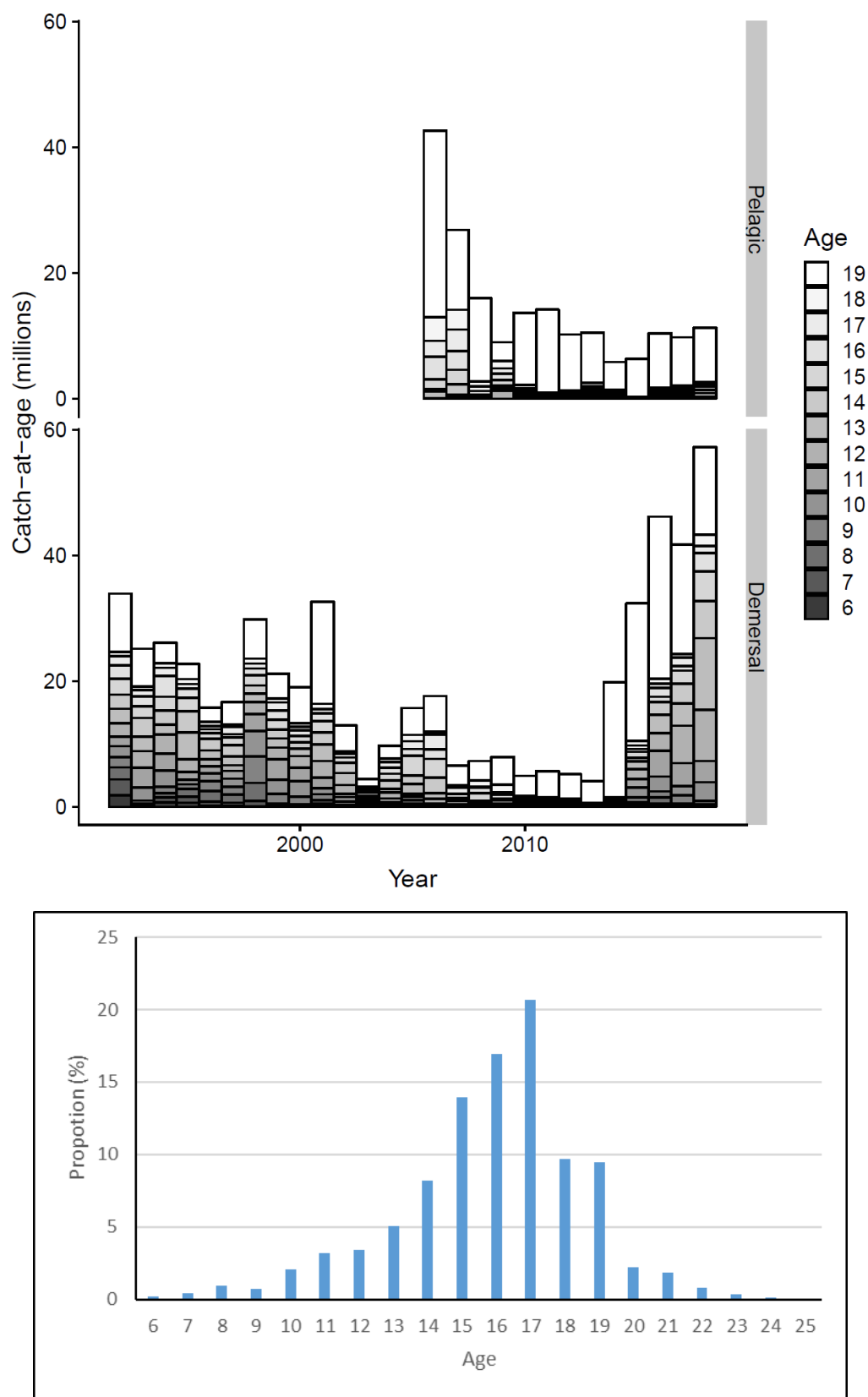


Figure 6.4. *Sebastes mentella* in subareas 1 and 2. Upper panels: Catch numbers-at-age for the pelagic and demersal fleets 1992–2018. Lower panel: Age composition of the commercial demersal catches by Russia in 2018.

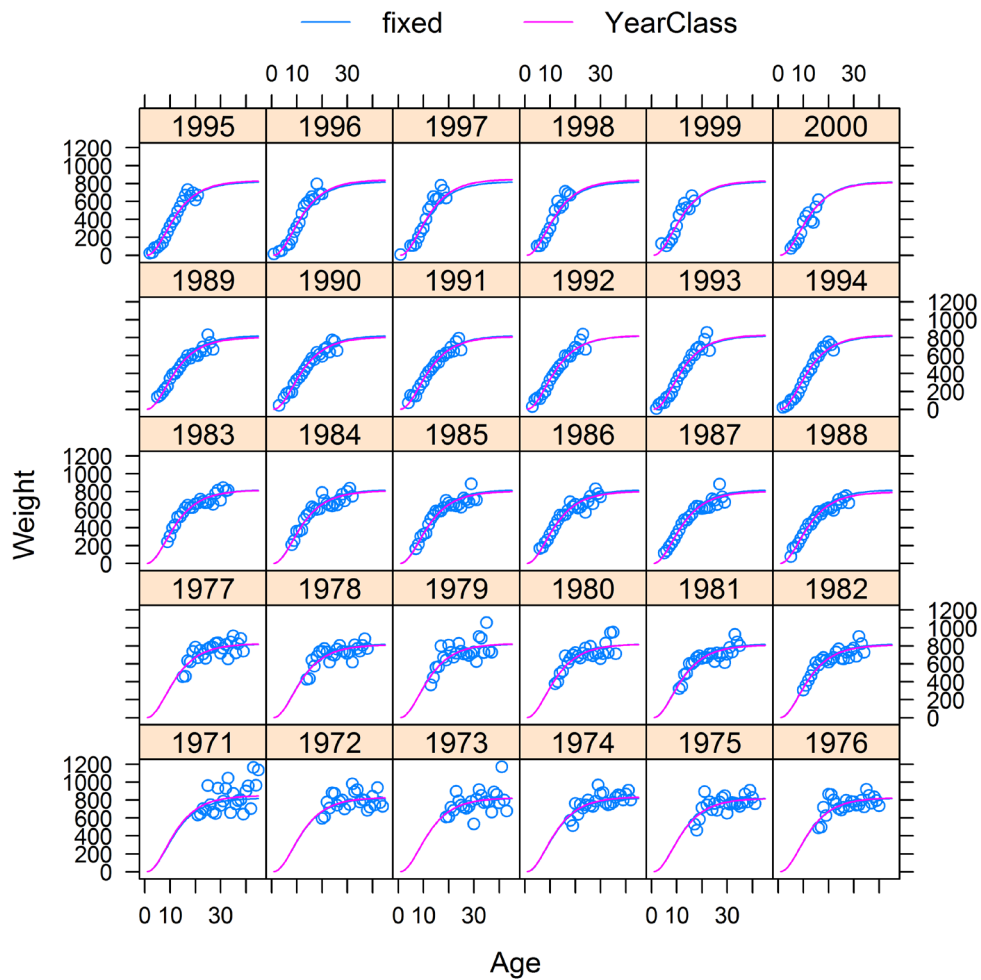


Figure 6.5. Weight-at-age of *S. mentella* per year class in subareas 1 and 2 derived from Norwegian commercial and survey data (Table 6.7). The weights were derived from samples with at least five individuals and are expressed in grammes. The blue and purple lines show the fitted mixed-effect models. Data for 2017 and 2018 were not available at the time of the meeting.

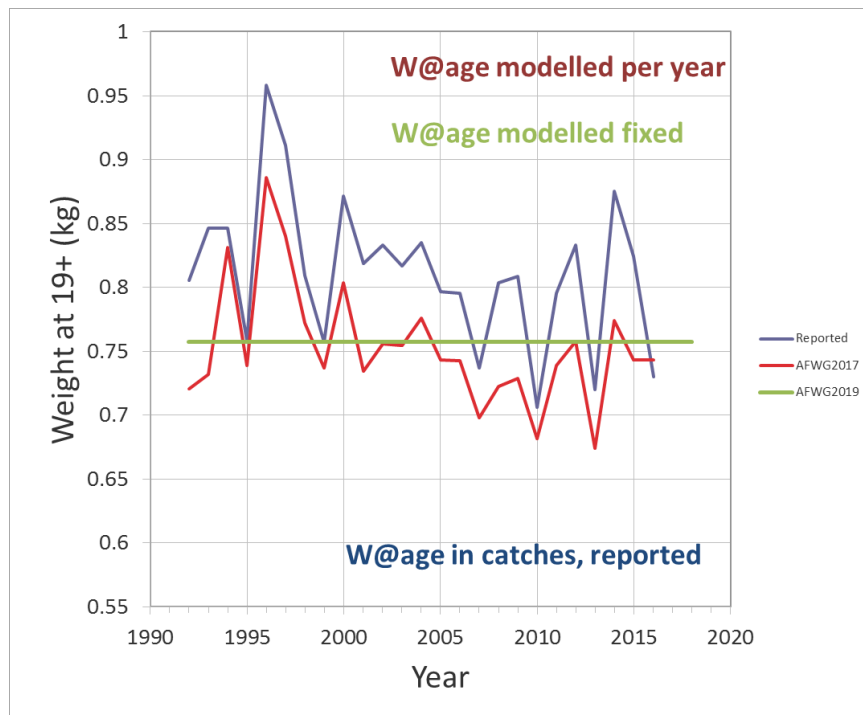


Figure 6.6. *S. mentella* in subareas 1 and 2. Weight-at-age 19+ as reported from catches (blue) or modelled from catches and survey observations (red) using a mixed effect model (Figure 6.5). The weights-at-age used in the assessment were based on the fixed effects model and are therefore the same for every year. These weights were updated in 2019 and differ only slight from those estimated in 2018.

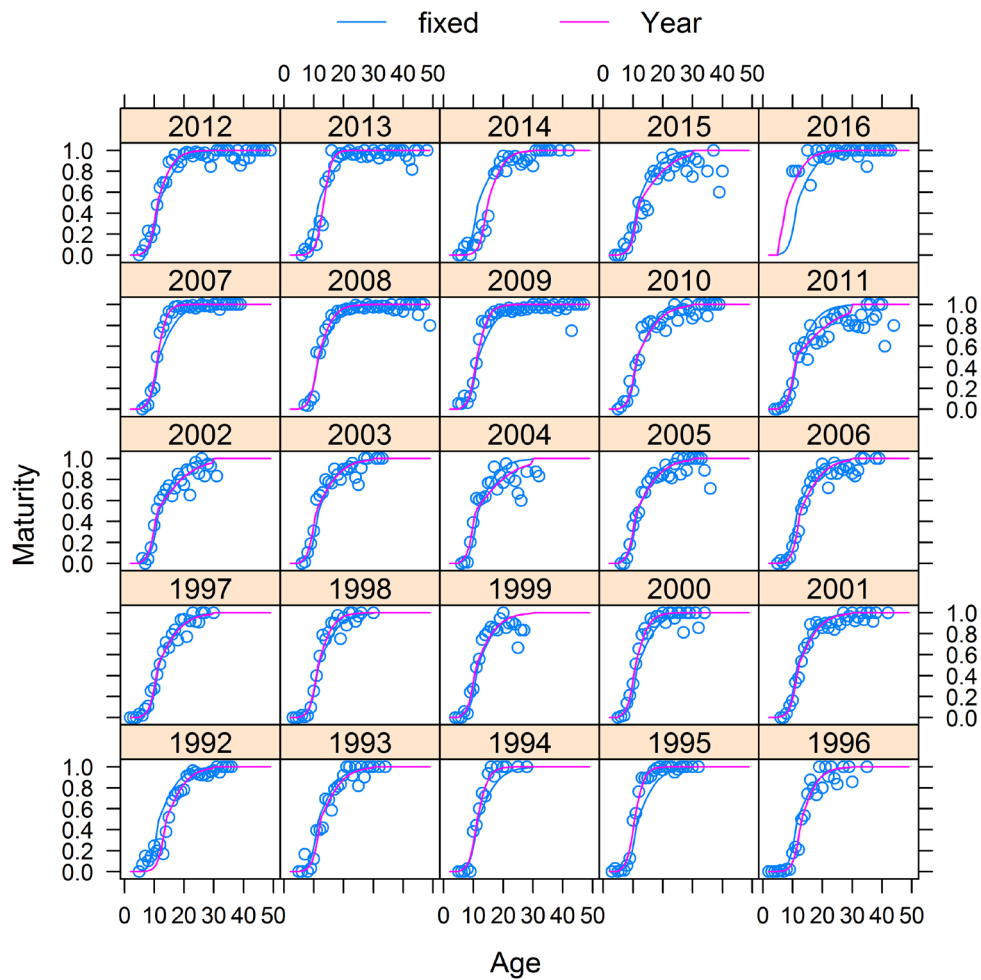


Figure 6.7. Proportion maturity-at-age of *S. mentella* in subareas 1 and 2 derived from Norwegian commercial and survey data (Table D7). The proportions were derived from samples with at least five individuals. The blue and purple lines show the fitted mixed-effect models. For 2011, 2014, 2015, and 2016 the common model (fixed effects blue) was used for other years the annual models (random effects purple) were used. Data for 2017 and 2018 were not available at the time of the meeting and the fixed effect model was used.

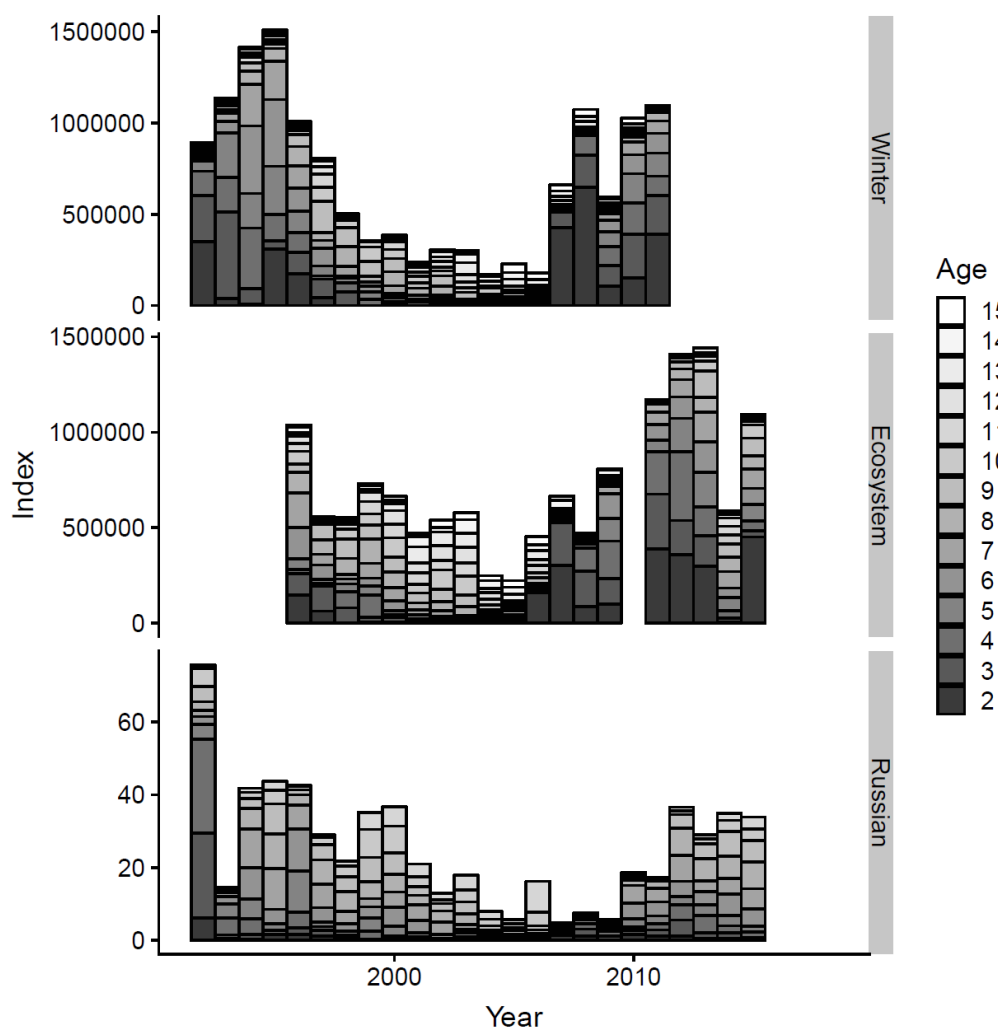


Figure 6.8. *Sebastes mentella* in subareas 1 and 2. Age disaggregated abundance indices for bottom-trawl surveys 1992–2016 in the Barents Sea in winter (winter survey top) in summer (Ecosystem survey middle) and in autumn (Russian groundfish survey bottom).

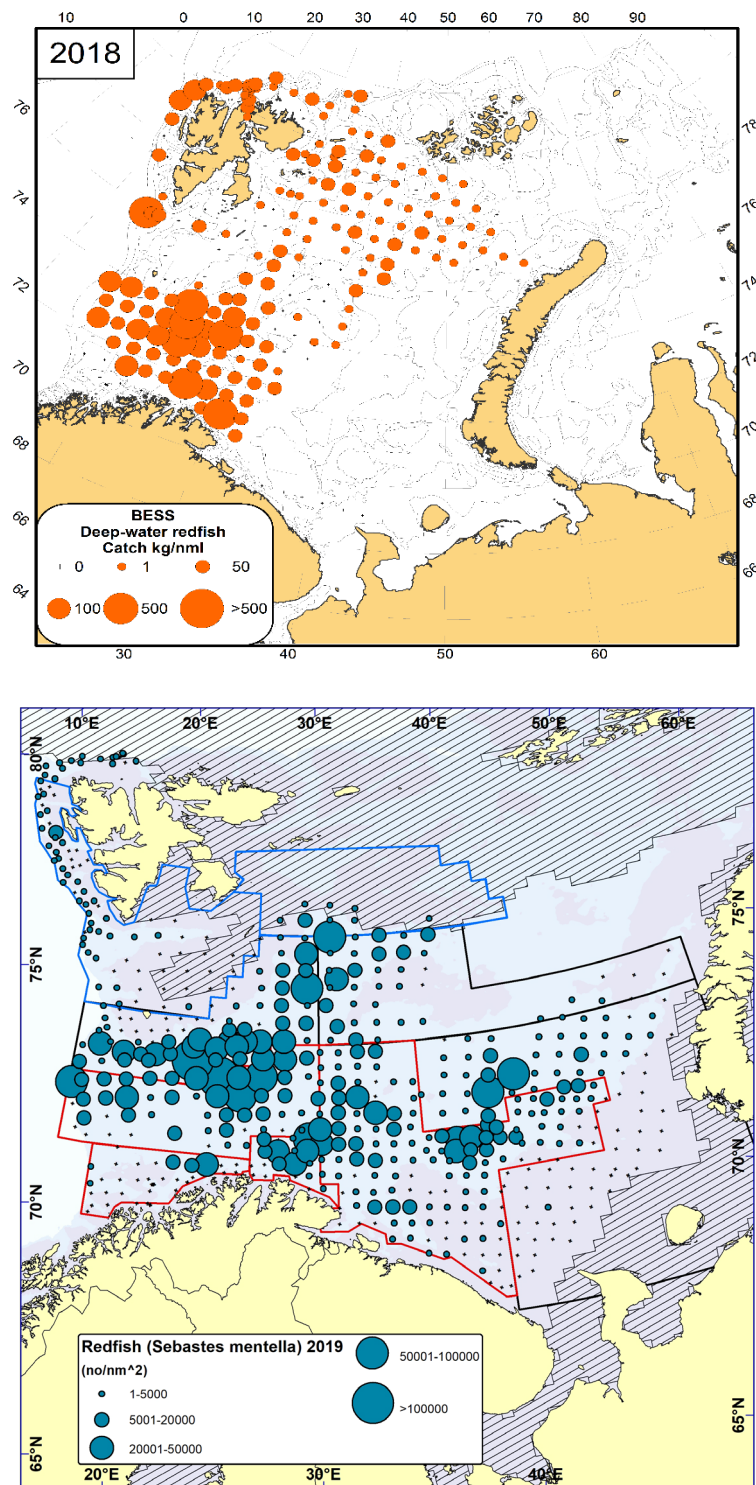


Figure 6.9. *Sebastes mentella* in subareas 1 and 2. Abundance indices for individual trawl stations during the ecosystem survey in autumn 2018 (top) and winter survey 2019 (bottom).

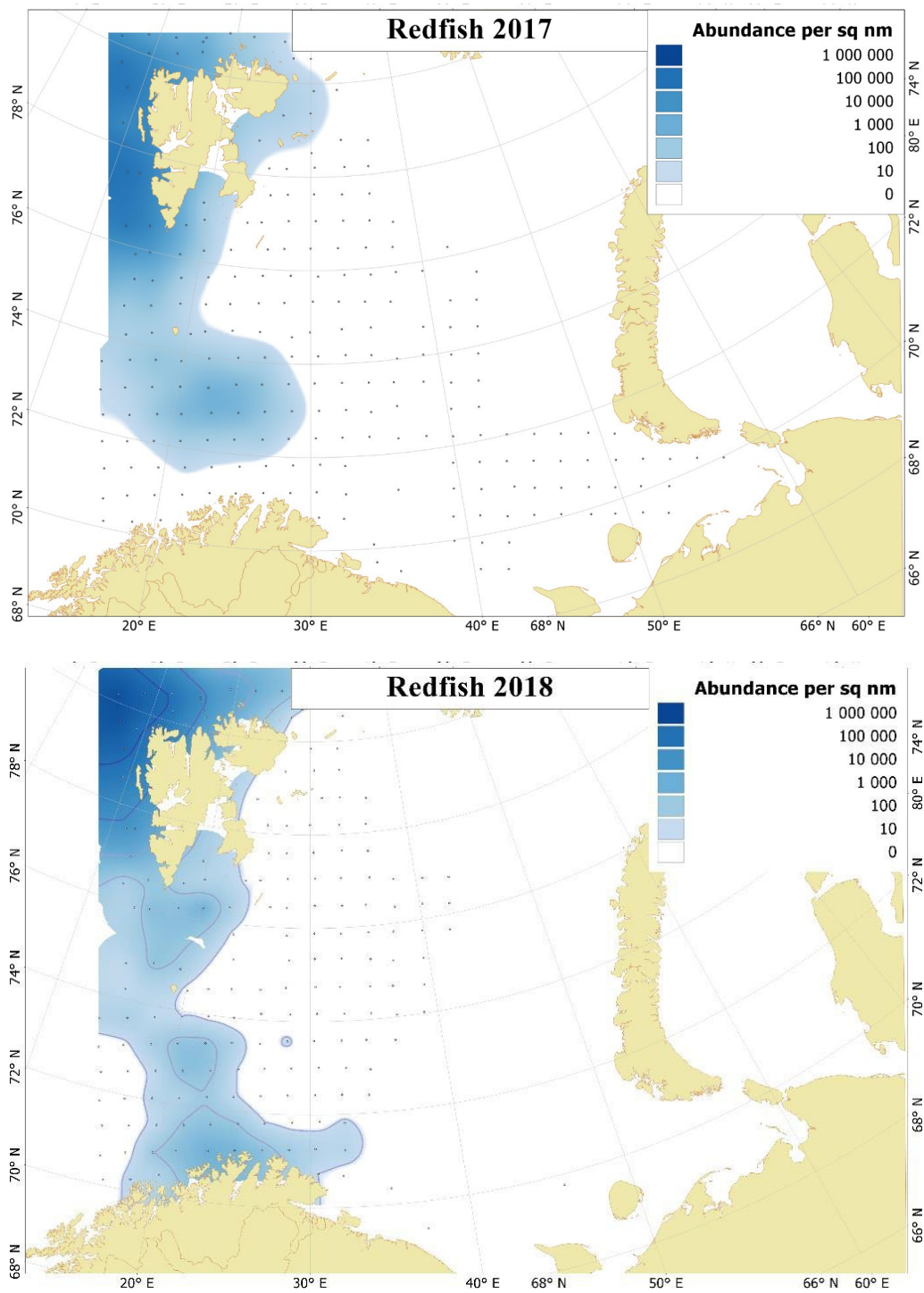


Figure 6.10. Map showing the specific pelagic 0-group trawl stations and the abundance of 0-group *Sebastes mentella* during the joint Norwegian-Russian Ecosystem survey in the Barents Sea and Svalbard in 2017 (upper panel) and 2018 (lower panel).

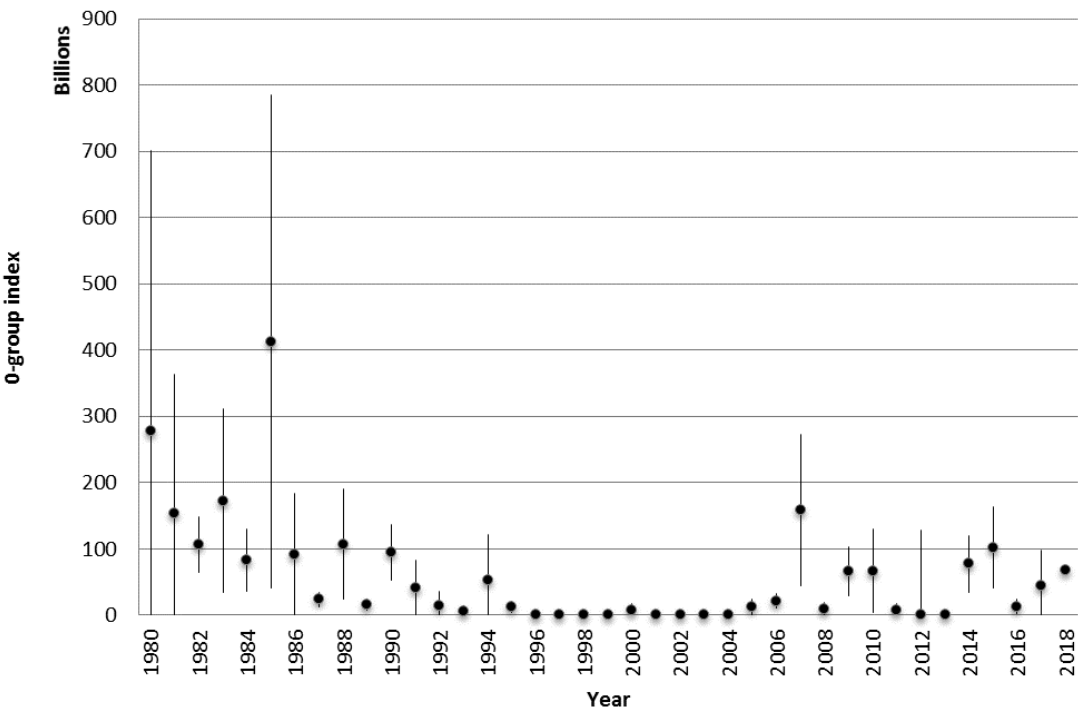


Figure 6.11. *Sebastes mentella* in subareas 1 and 2. Abundance indices (in billions) with 95% confidence limits of 0-group redfish (believed to be mostly *S. mentella*) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980–2018. For 2018 the method of estimation has changed and does not provide confidence limits. Numbers are given in Table 1.1.

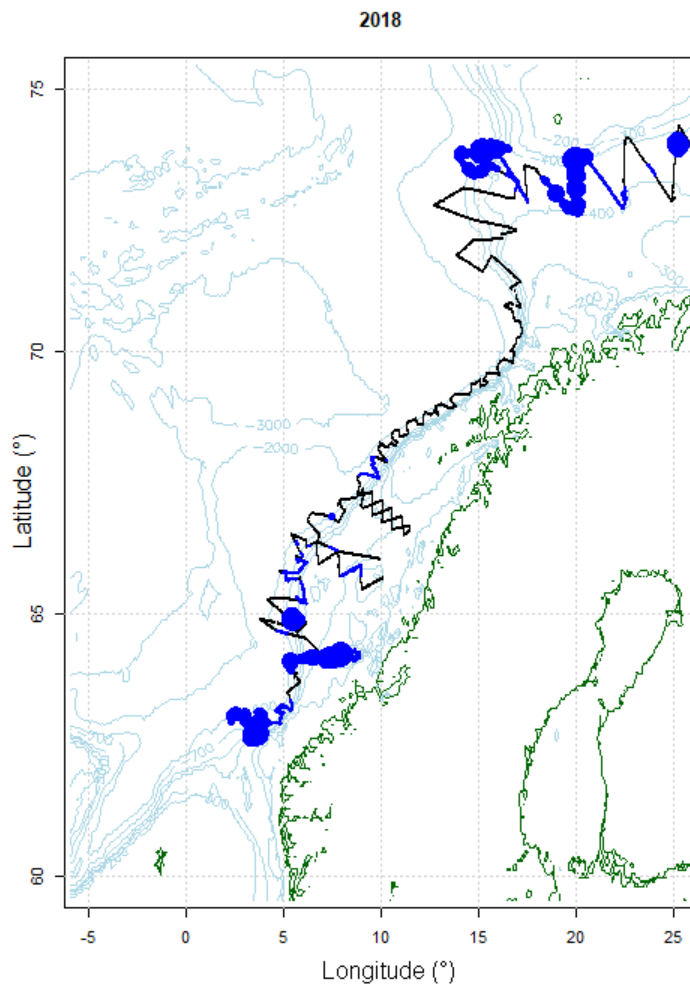


Figure 6.12. *Sebastes mentella* in subareas 1 and 2. Horizontal distribution of *S. mentella* hydroacoustic backscattering (sA) during the Norwegian slope survey in spring 2018. The circles are proportional to the sA assigned to redfish along the vessel track.

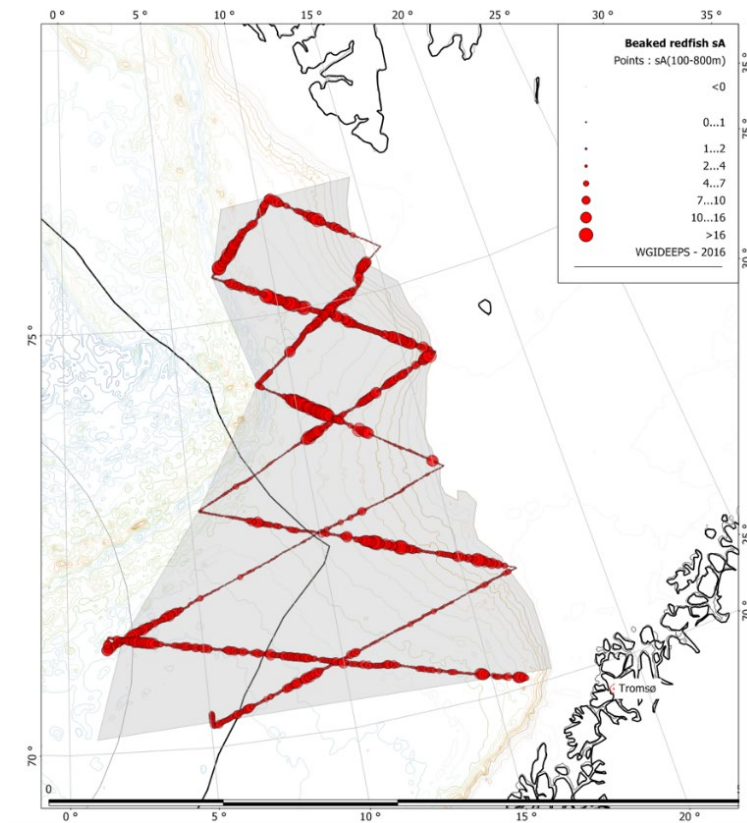


Figure 6.13. *Sebastes mentella* in subareas 1 and 2. Horizontal distribution of *S.mentella* hydroacoustic backscattering (sA) during the Norwegian Deep Pelagic Ecosystem survey in summer 2016. The circles are proportional to the sA assigned to redfish along the vessel track.

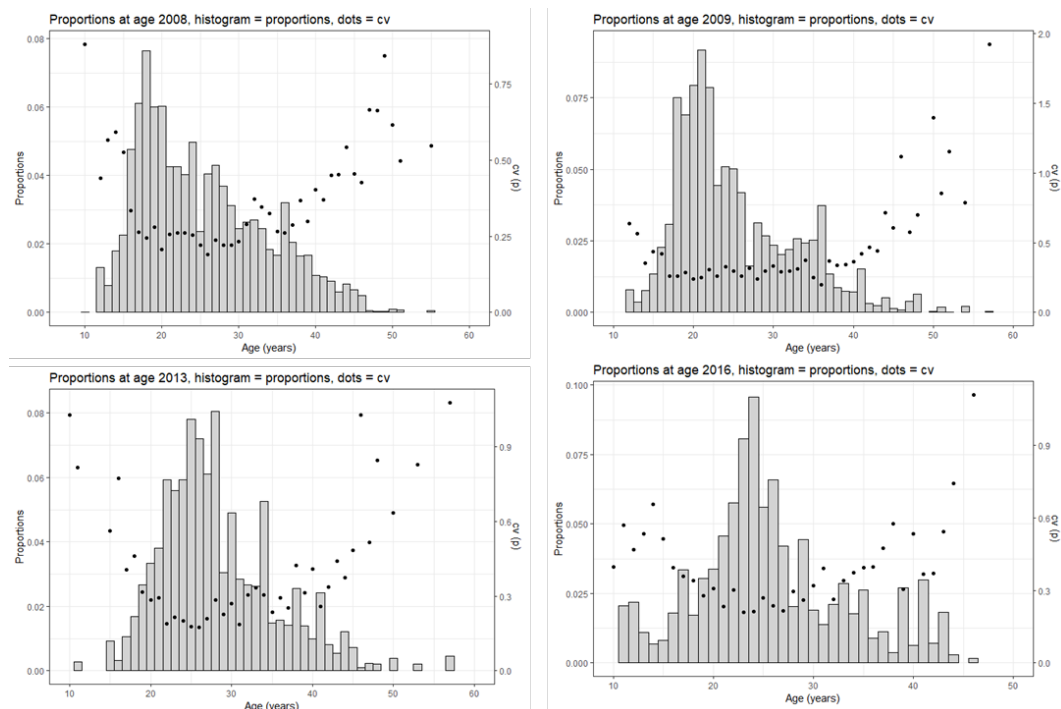


Figure 6.14. *Sebastes mentella* in subareas 1 and 2. Proportions at age during the International Deep Pelagic Ecosystem Survey (WGIDEPS) in the Norwegian Sea. Bars show proportions at age and dots shows the coefficient of variation for each age. Estimated with RStoX.

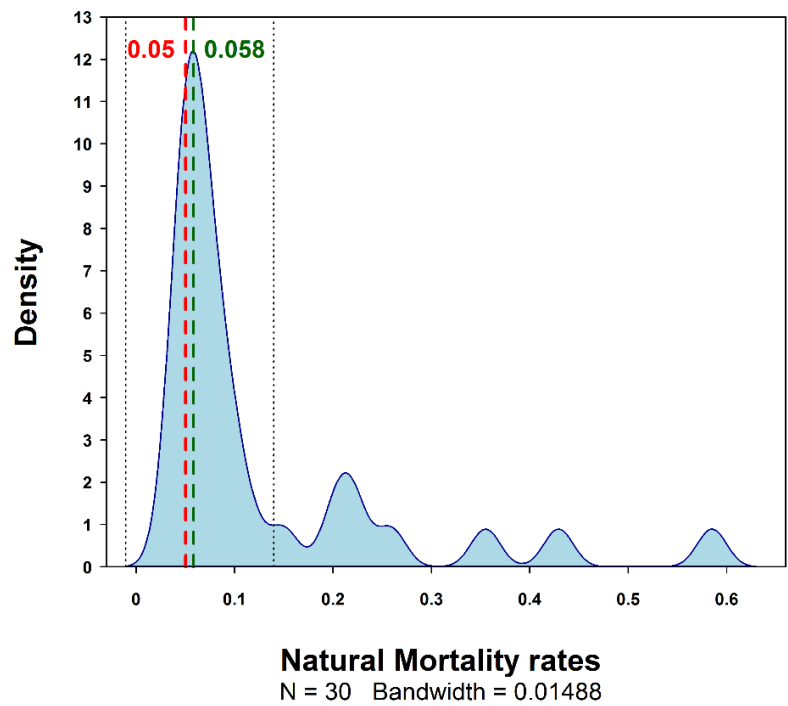


Figure 6.15. Density distribution of natural mortality rates calculated with 30 of the 39 compared methods. The excluded methods are those based on certain taxa or areas. The broken red line indicates the currently used value; the broken green line the most frequent one and the black dotted lines indicate the beginning and end of the distribution’s peak.

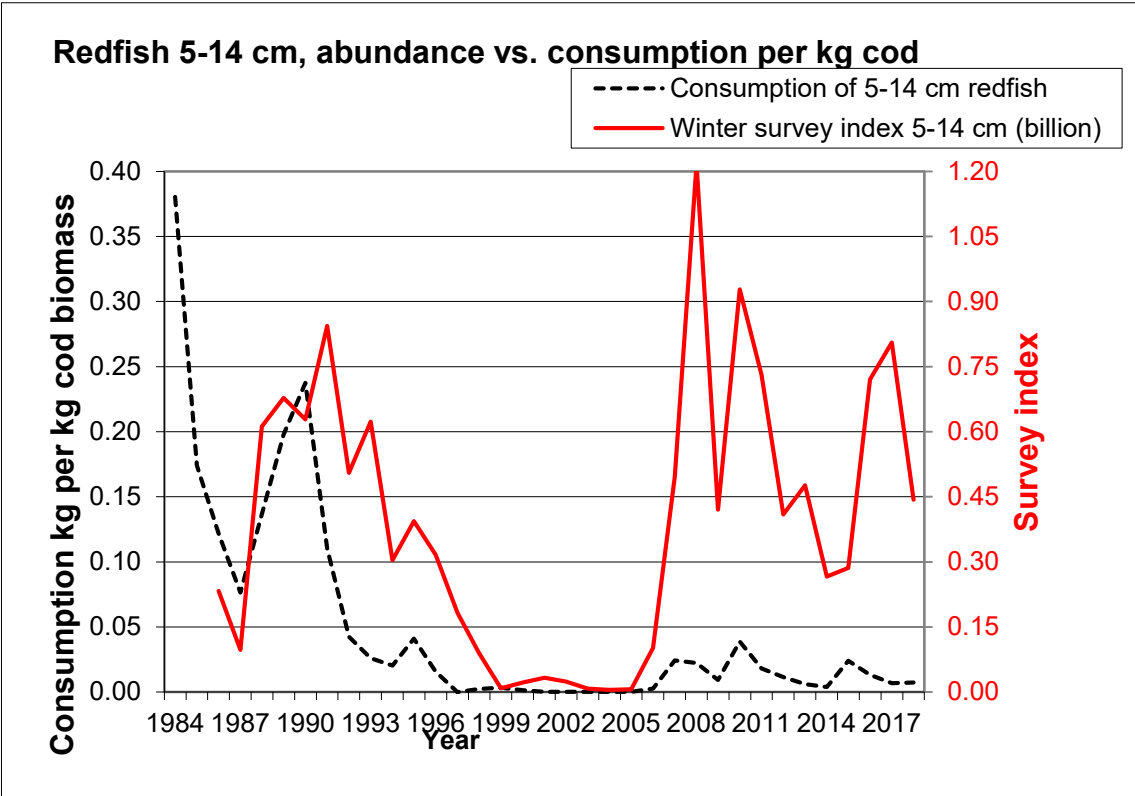


Figure 6.16. Abundance of *S. mentella* (5–14 cm) during the winter survey (February) in the Barents Sea compared with the consumption of redfish (mainly *S. mentella*) by cod (See Chapter 1 Table 1.3).

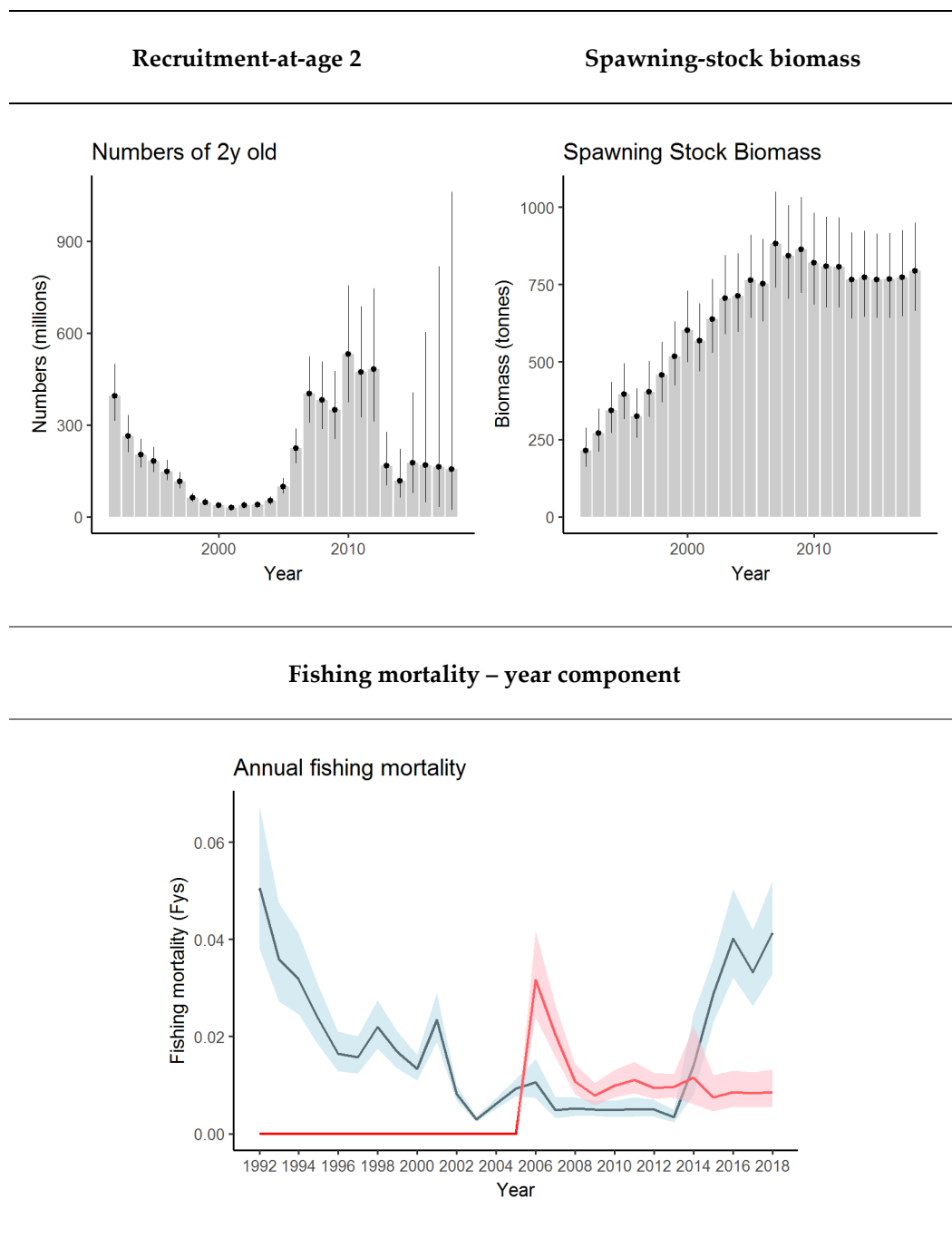


Figure 6.17. *Sebastes mentella* in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the estimated recruitment-at-age 2 spawning-stock biomass from 1992 to 2018 and annual fishing mortality coefficients by year (Fy) from the demersal (blue) and pelagic (red) fleets. Error bars (top) and the colored envelope (bottom) indicate 95% confidence limits.

Fleet selectivity – age component

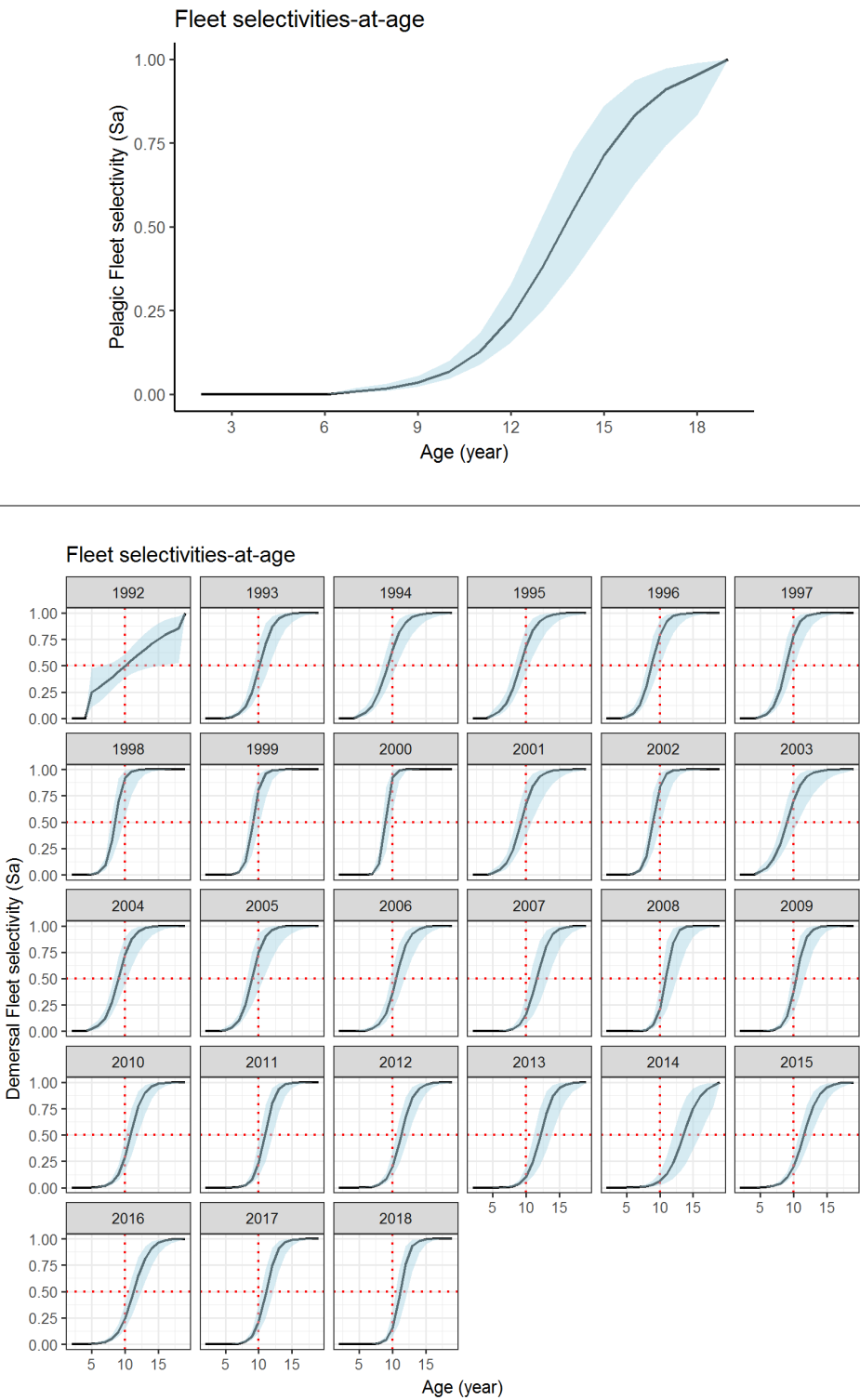


Figure 6.18. *Sebastes mentella* in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the estimated annual fleet selectivity by age (F_a) from the pelagic (top panel) and demersal (lower panels) fleets. Colored envelopes indicate 95% confidence limits.

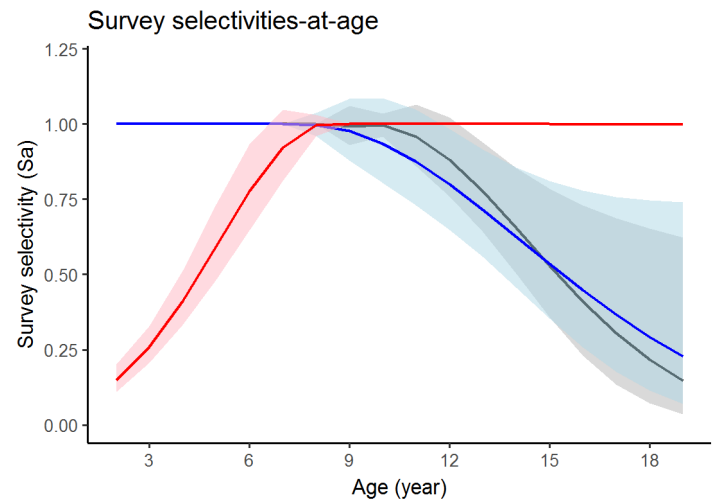


Figure 6.19. *Sebastes mentella* in subareas 1 and 2. Results from the statistical catch-at-age assessment run showing the selectivity-at-age for winter (blue) ecosystem (grey) and Russian groundfish (red) surveys.

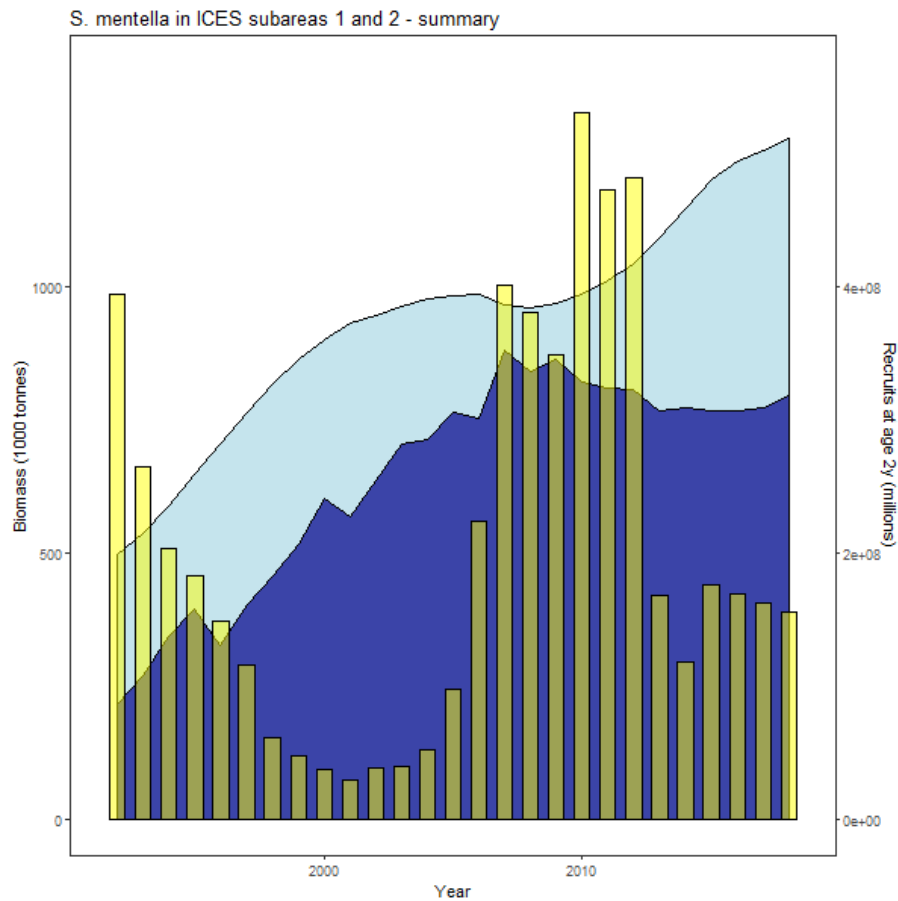


Figure 6.20. *Sebastes mentella* in subareas 1 and 2. Results from the statistical catch-at-age model showing the evolution of total biomass (in tonnes light blue left axis) spawning-stock-biomass (in tonnes dark blue left axis) and recruitment-at-age 2 (in numbers yellow right axis) for the period 1992–2018 for *S. mentella* in subareas 1 and 2.

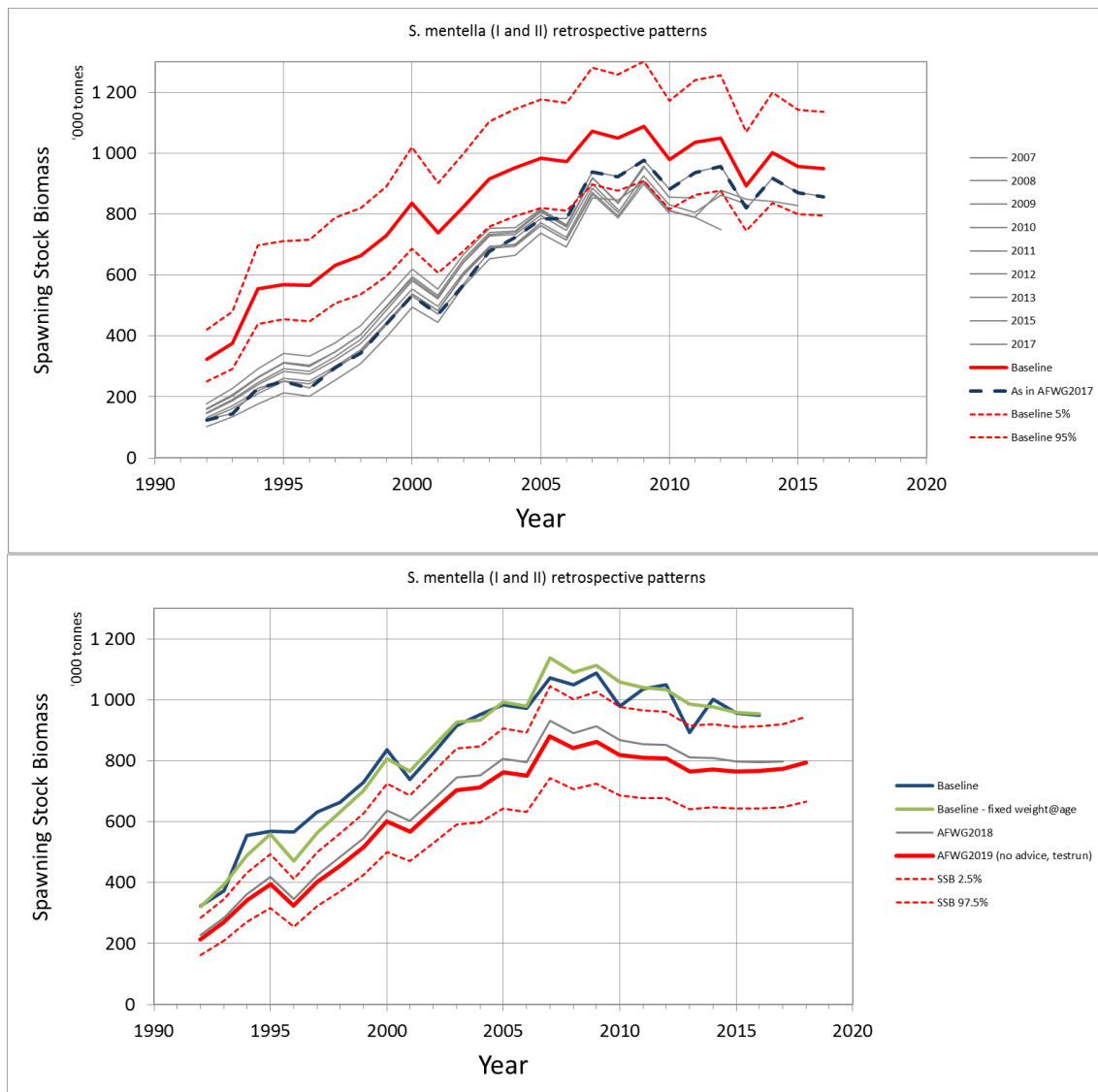


Figure 6.21. The upper panel shows the retrospective patterns of the spawning-stock biomass of *S. mentella* estimated by the SCAA model for runs up to years 2007–2017 and the baseline model of the 2018 benchmark. The lower panel presents the baseline the baseline model with fixed weights-at-age and the assessment models for 2018 and 2019. Confidence Intervals are shown for the latest assessment.

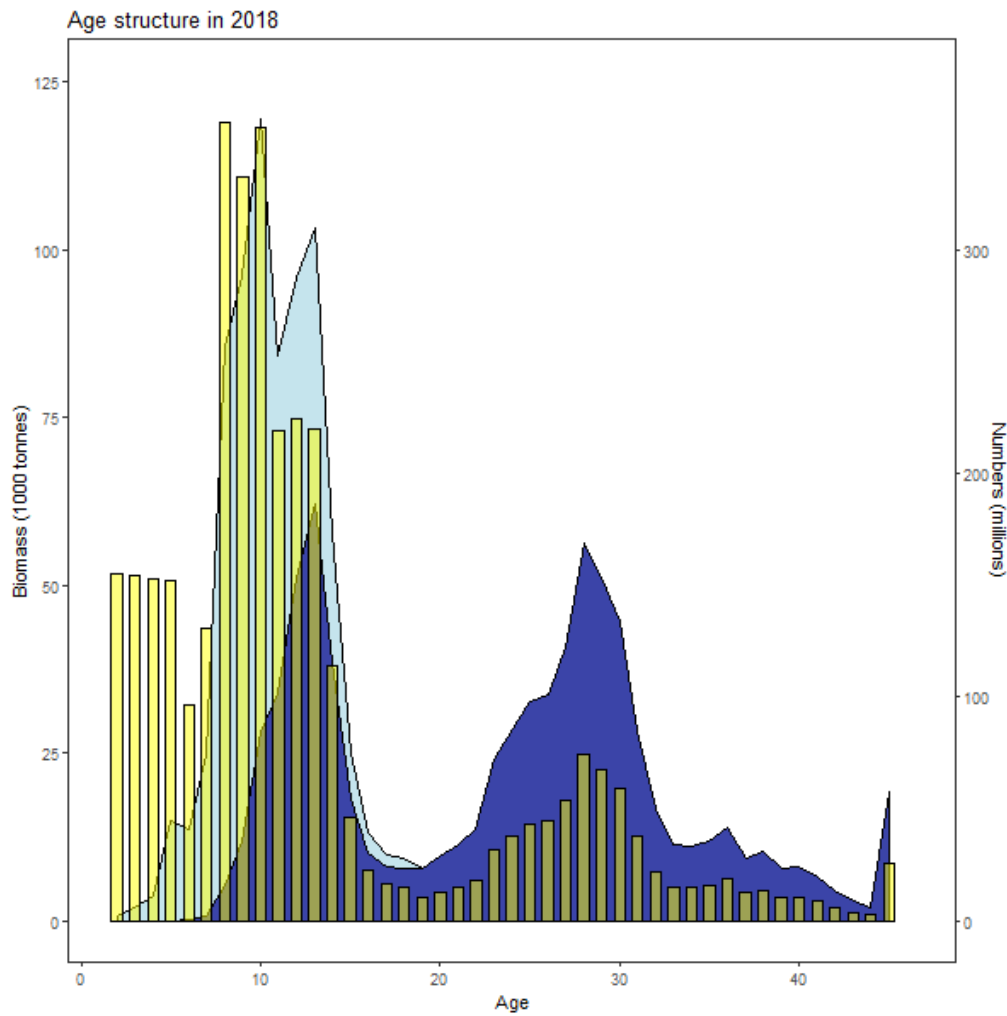


Figure 6.22. *Sebastes mentella* in subareas 1 and 2. Modelled distribution of numbers (yellow bars right y-axis) biomass (light blue left y-axis) and spawning-stock-biomass (dark blue left y-axis) at age 2-44+ in 2018.

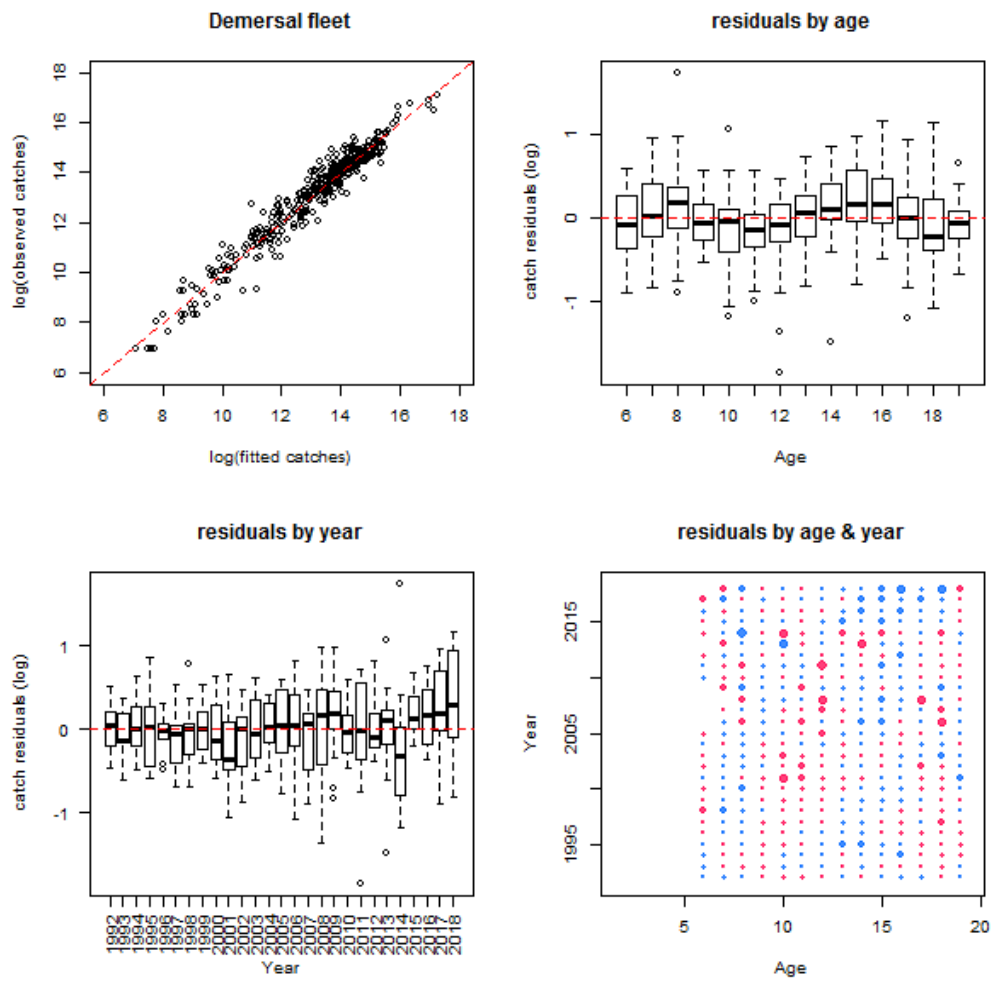


Figure 6.23a. Diagnostic plots for the demersal fleet catch-at-age data. Top-left: scatterplot of observed vs. fitted indices the dotted red line indicates 1:1 relationship. Top right: boxplot of residuals (observed-fitted) for each age. Bottom left: boxplot of residuals for each year. Bottom right: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

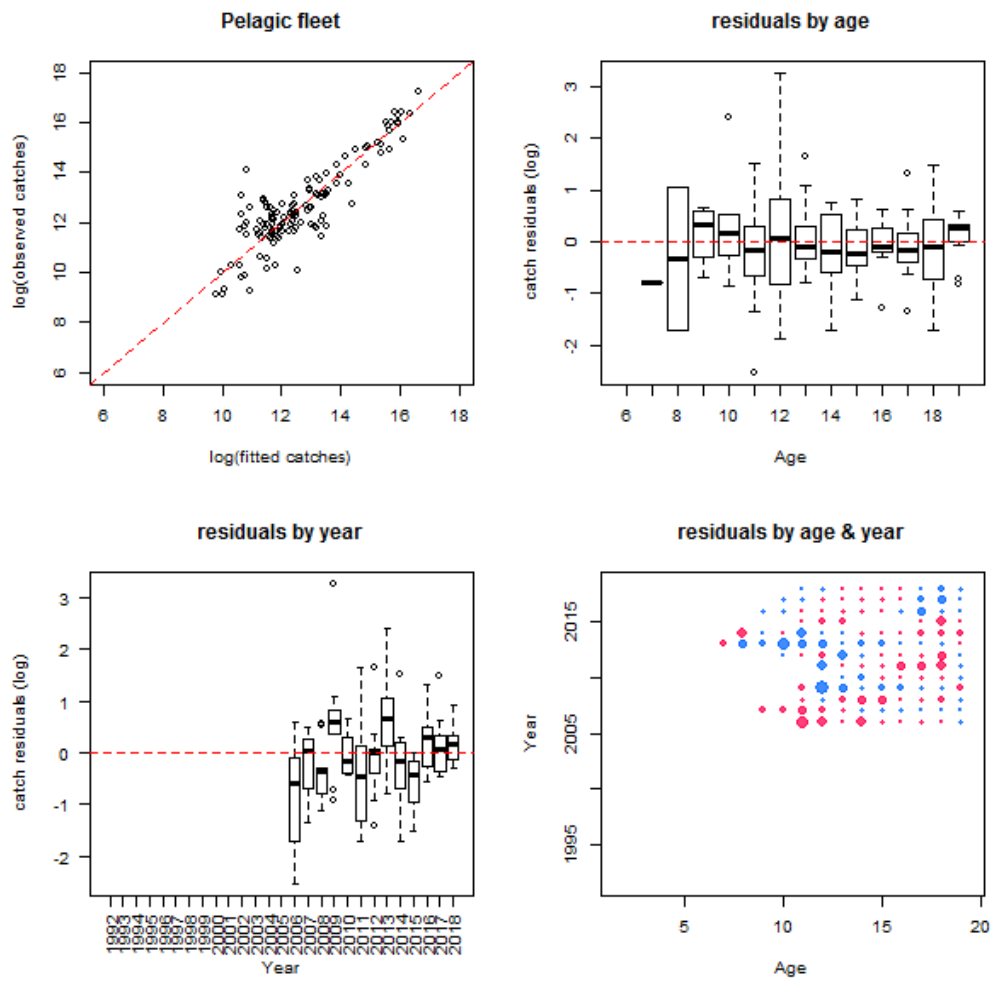


Figure 6.23b. Diagnostic plots for the pelagic fleet catch-at-age data. See legend from Figure 6.23a.

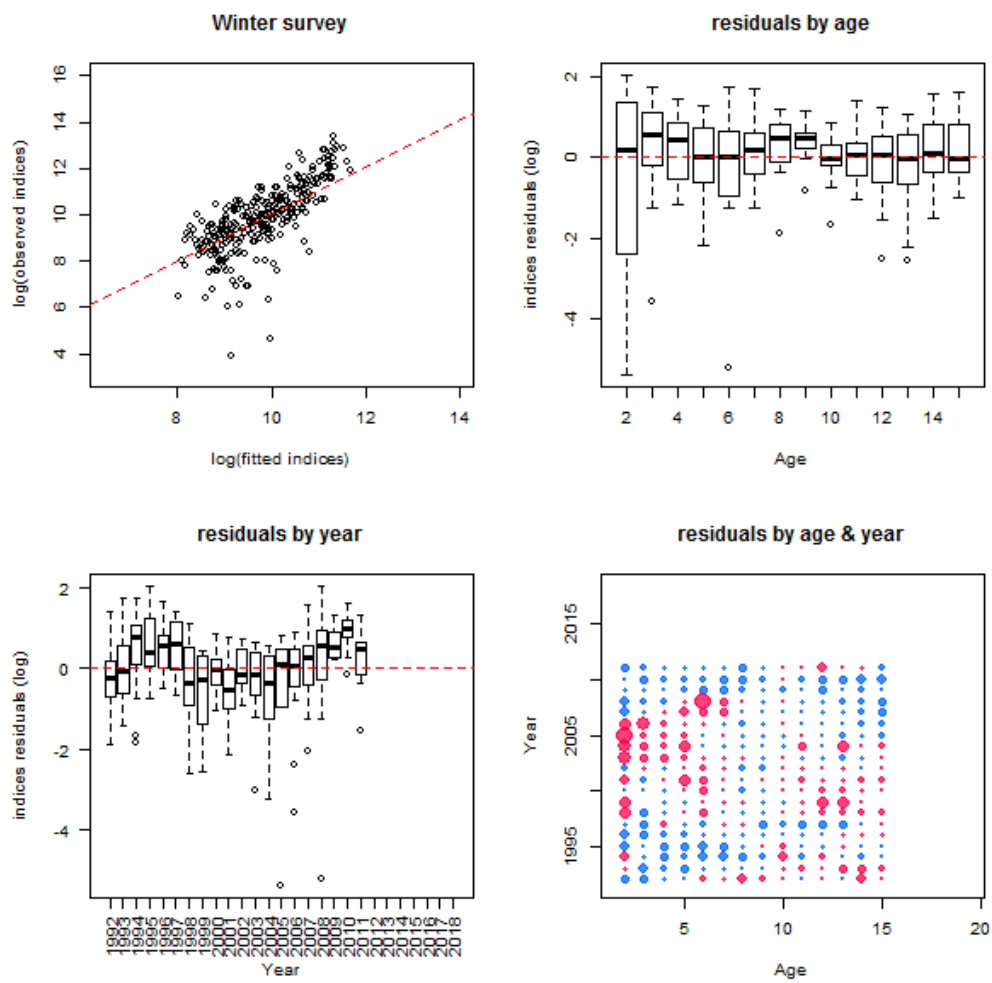


Figure 6.23c. Diagnostic plots for the Winter survey data. See legend from Figure 6.23a.

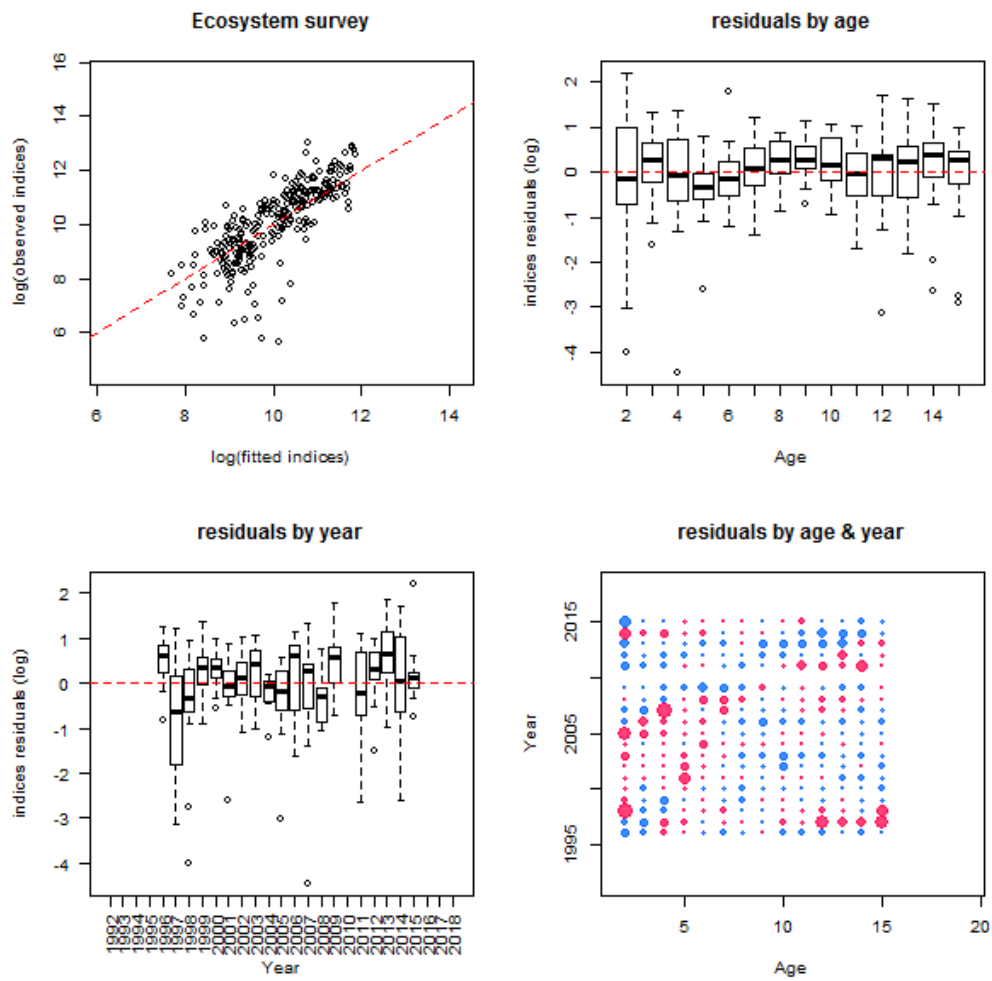


Figure 6.23d. Diagnostic plots for Ecosystem survey data. See legend from Figure 6.23a.

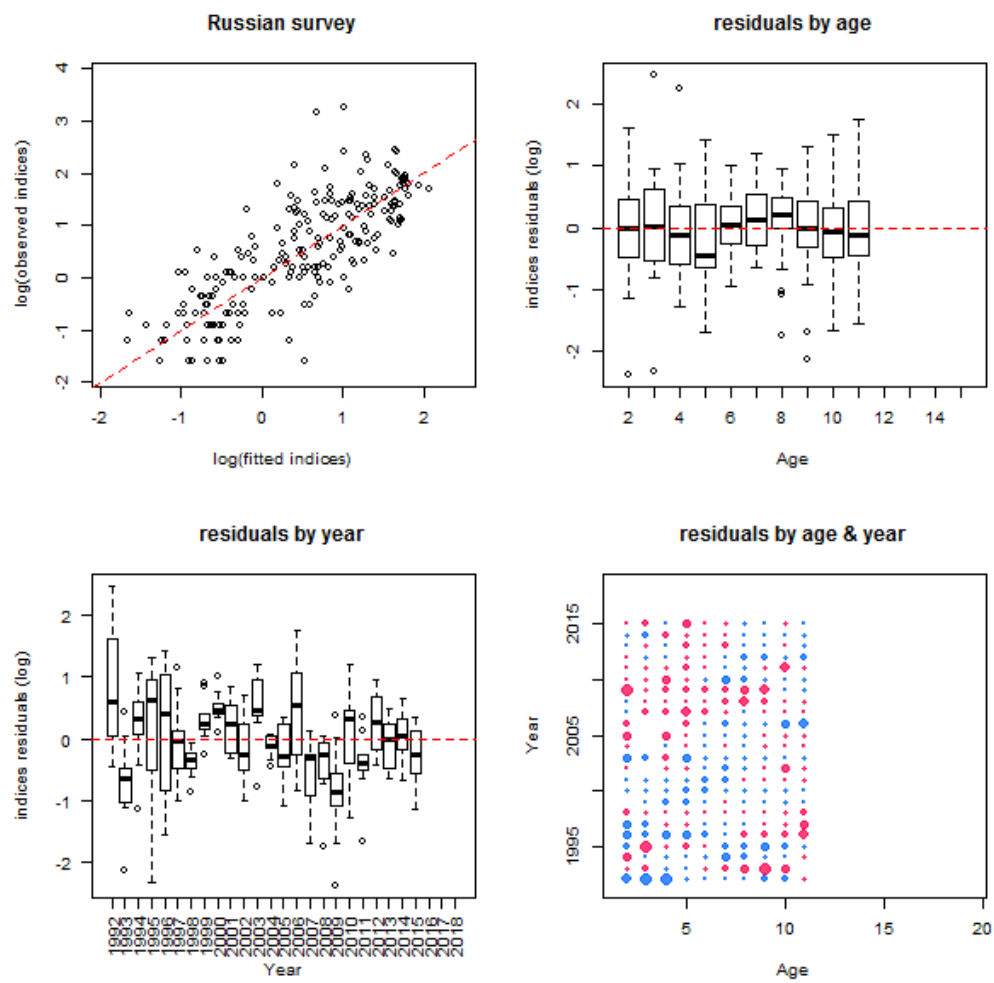


Figure 6.23e. Diagnostic plots for the Russian groundfish survey data. See legend from Figure 6.23a.

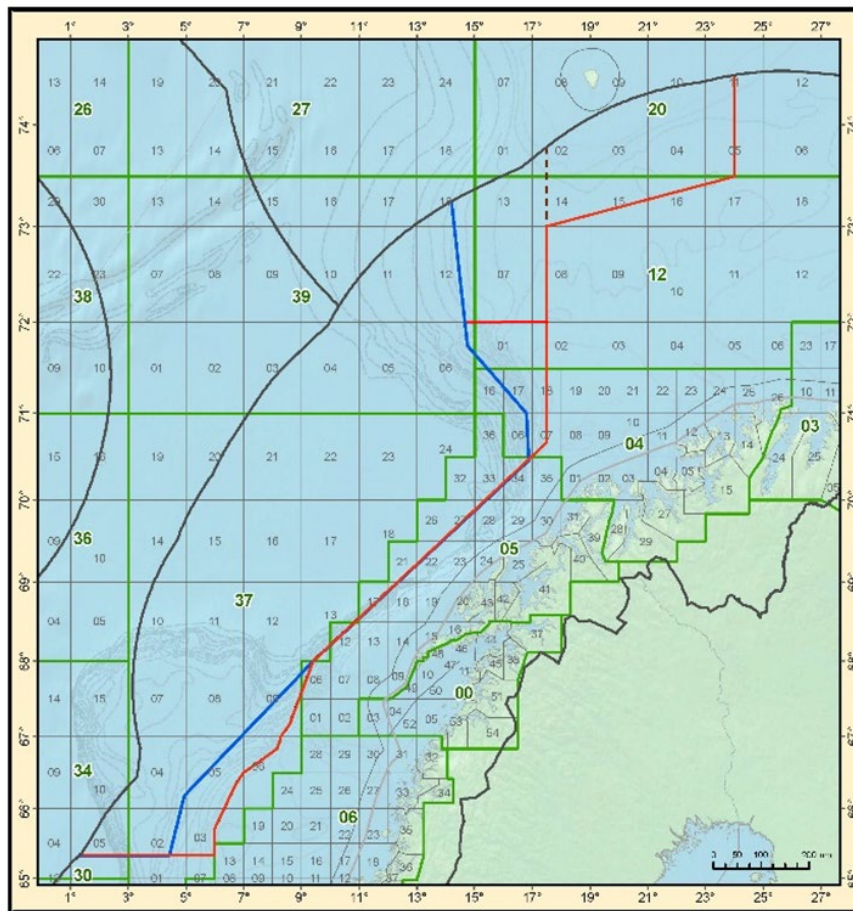


Figure 6.24. Delineation of the geographical limits for directed fishing in the Norwegian Economic Zone in 2014–2018. Directed pelagic trawling is only allowed west of the blue line. Directed demersal trawling is only allowed between the blue and the red line. The area east of the stippled line inside 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–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.