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## 22 Deep Pelagic *Sebastes mentella*

*Please note: This Section was updated in October 2018.*

### 22.1 Stock description and management unit

This section addresses the fishery for the biological stock deep pelagic *S. mentella* in the Irminger Sea and adjacent areas: NAFO 1-2, ICES 5, 12, and 14 at depths >500 m, including demersal habitats west of the Faeroe Islands. This stock corresponds to the management unit in the northeast Irminger Sea (ICES areas 5a, 12 and 14).

The following text table summarizes the available information from fishing fleets in the Irminger Sea and adjacent waters in 2017. No information was available from Russia and Spain about number of factory trawlers participating in the fishery. It should be noted that some these fleets are also fishing the Shallow Pelagic stock:

Country	Number of trawlers
Faroes	1 factory trawlers
Iceland	4 factory trawlers
Germany	1 factory trawler
Lithuania	1 factory trawler
Norway	1 factory trawler
Russia	Not known
Spain	Not known
<b>Total</b>	<b>Not nown</b>

### 22.2 The fishery

The historic development of the fishery can be found in the Stock Annex. Tables 22.2.1 and 22.2.2 show annual catches, as estimated by the Working Group, disaggregated by ICES and NAFO regulatory areas and by country, respectively.

The changes in the spatial pattern of the fishery for the period 1992–2017 are shown in Figure 22.2.1, and annual catches are presented in Figure 22.2.2. Catches increased by 1200 t in 2017 to 29 891 t (Table 22.2.2).

Standardized CPUE series for Faroe Islands, Iceland, Greenland, and Norway 1994–2017 are estimated with a GLM model including the factors year, ship, month and towing time. The results from the model show that the CPUE oscillates without trend since 1995 (Figure 22.2.3). The model residuals are in Figure 22.2.4.

### 22.3 Biological information

Age reading of deep pelagic beaked redfish in the Irminger Sea and adjacent waters has not been systematic. Age data are available from Iceland and Norway for some years during 1996–2013. Most of the age data come from the commercial catch except in 1999 where 797 age readings come from the international redfish survey (note: as the age readings from the survey correspond to a similar depth range and location as other samples, they have been included together with the commercial fishery samples). In total, 6566 otoliths have been age read. The number of age readings by year and nation is given in Table 22.3.1. Age distributions for the Icelandic data are shown in Figure 22.3.1 and for the Norwegian data in Figure 22.3.2.

Length data are available from the international redfish survey (see Section 22.6) and from the Icelandic commercial fishery. Biological information is collected from commercial catches from other nations (Russia, Norway, Spain and other EU countries). However, the data were not available to the group.

The length data from the Icelandic commercial fishery is considered to provide a reasonable representation for all nations participating in the fishery, as the fishery is conducted in a concentrated area along the Icelandic EEZ (Figure 22.2.1) in a relatively short period (mainly May and June).

The length samples from the Icelandic commercial catch are either collected by observers on board or by the fishers who send samples for further analysis to the MFRI (Marine and Freshwater Research Institute, Iceland). The number of fish measured for length and the number of hauls sampled are given in Table 22.3.2. In each sample 100–200 fish are length measured. Length distributions are shown in Figure 22.3.3 and indicate that the bulk of the catches is at around 35–45 cm of length.

## 22.4 Discards

Discards are not considered to be significant for the time being, according to available data from various institutes.

## 22.5 Illegal, Unregulated and Unreported Fishing (IUU)

The Group had again difficulties in obtaining catch estimates from several fleets. Furthermore, there are problems caused by misreported catches. The Group requests NEAFC and NAFO to provide ICES in time with all the necessary information.

## 22.6 Surveys

The international trawl-acoustic surveys were carried out biennially 1999–2015 and then in 2018. The survey in 2015 was carried out by Iceland and Germany (ICES, 2015). The participation of Russia was cancelled and the scope of the survey therefore had to be altered. The emphasis was on covering the deep pelagic stock found below 500 m.

In 2018, only one vessel from Russia participated in the survey as Iceland and Germany cancelled their participation (ICES, 2018). Yet again the scope of the survey had to be altered and only the northeast area (Subarea A) was surveyed (Figure 22.6.1). This is only a part of the geographical distribution of deep pelagic *S. mentella* so no total biomass was obtained.

### 22.6.1 Survey trawl estimates

Considering the conclusion of WKREDS (ICES, 2009a) and the recommendation of ICES on stock structure of redfish in the Irminger Sea and adjacent waters, the Group decided in the planning meeting (ICES, 2009b) to sample redfish separately above and below 500 m, i.e. to sample redfish as was done in the 1999, 2001 and 2003 surveys. The deep identification hauls covered the depth layers (headline) 550 m, 700 m, and 850 m.

The most recent trawl-acoustic survey on pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters was carried out by Russia in June/ July 2018. Only the northeast area (Subarea A) was surveyed or approximately 103 000 NM<sup>2</sup> compared to 200 000 NM<sup>2</sup> in 2015 and 340 000 NM<sup>2</sup> in 2013. A total biomass of 130 000 t was estimated in Subarea A, compared to 153 000 t observed in Subarea A in 2015 and 193 000 t in 2013 (Table 22.6.2). The results showed therefore large biomass declines in Subarea A, the main distribution area of the stock (see Figure 22.6.1 for area definition) (Table

21.6.2). Biological samples from the trawls taken at depth >500 m showed a mean length of 36.1 cm, compared to 38.6 cm mean length in 2015. Figure 22.6.2 shows the spatial distribution of samples used in the survey and Figure 22.6.3 shows the corresponding length distribution.

## 22.7 Methods

The stock was benchmarked in August 2016 (The Workshop on Assessment and Catch Advice for Deep Pelagic Redfish in the Irminger Sea – WKDEEPRED, ICES 2016). At the WKDEEPRED meeting a Gadget model for deep pelagic beaked redfish in the Irminger Sea was proposed as an assessment model. A description of the model setup, data, results, diagnostics and recommendations for data and model needs are found in the WKDEEPRED report (ICES, 2016). A detailed description of Gadget and references to published papers can be found in the Stock Annex for deep pelagic redfish ([smn-dp SA](#)).

An age-length structured stock assessment model was developed with Gadget; this model also used age and length composition data. The inclusion of these data in the assessment lent stability to the assessment results and no strong retrospective pattern emerged. Fits to the data were considered overall adequate and WKDEEPRED concluded that this model provides an appropriate way of assessing the stock at this time. Although the Gadget assessment appears to capture trends on stock biomass and fishing mortality reliably, some aspects of the assessment still require further exploration, the data currently available cover only a short period relative to the lifespan of the species, and additional age data that might bring in additional insights are expected to become available over the next few years. WKDEEPRED therefore concluded that at present this assessment should be considered as a Category 2 (instead of Category 1) assessment.

In the survey conducted in June/July 2018, only part of the survey area was covered, and the biomass estimate is not considered adequate. In the assessment, the 2018 estimate was scaled to the area of the 2015 survey by the proportion of biomass found outside of the 2018 survey area. In the 2015 survey, 78.1% of the total biomass observed in Subarea A and 21.9% in Subarea B. By scaling the observed biomass estimate in Subarea A in 2018, the total biomass estimate used in the current assessment was 166 kt.

The model predicts that the total biomass peaked in the early 1990s, but since it has been on a steady decline and is now below  $B_{lim}$  of 559 kt (Figure 22.7.1). Although catches have decreased the fishing mortality has increased substantially since the late 1990, with a mortality of almost five to ten times the natural mortality. Fishing mortality has exceeded  $F_{lim}$  (0.057) since 1994. Recruitment of 5 year old fish into the stock is seen to have been variable between 1990 and 2006. In the years following, recruitment to the stock is estimated to have decreased substantially after 2006. The model predicts an increase in recruitment in 2011, although data available on recruitment is currently limited. Recruitment estimates of age 5 after 2011 is similarly unreliable. The estimates of recruitment could potentially be improved with more recent data on age composition of the catches.

## 22.8 Reference points

WKDEEPRED (ICES, 2016) also derived precautionary and MSY reference points ( $B_{lim}$ ,  $B_{pa}$ ,  $F_{lim}$ ,  $F_{pa}$ ,  $F_{MSY}$  and MSY  $B_{trigger}$ ) following the ICES technical guidelines for the calculation of reference points.

Below is a summary of reference points agreed by WKDEEPRED (ICES, 2016). Note: the reference point values in the ICES advice sheet will be presented as relative values with respect to the average of the F and SSB estimates over the stock assessment series, as corresponds to Category 2 assessments.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	782 kt	$B_{pa}$
	$F_{MSY}$	0.041	F that maximizes median long-term catch in stochastic simulations with recruitment drawn from 1985–2006 estimates while incorporating a factor to gradually reduce recruitment when $SSB < SSB(2001)$ (where $SSB(2001)$ is the $B_{loss}$ from the converged stock–recruitment period). $F_{MSY}$ is constrained not to exceed $F_{pa}$ .
Precautionary approach	$B_{lim}$	559 kt	$B_{pa} / 1.4$
	$B_{pa}$	782 kt	$SSB(2001)$ , corresponding to $B_{loss}$ from the years with converged SSB and recruitment estimates (year classes 1990–2001)
	$F_{lim}$	0.057	F corresponding to 50% long-term probability of $SSB > B_{lim}$ .
	$F_{pa}$	0.041	$F_{lim} / 1.4$

## 22.9 State of the stock

### 22.9.1 Short term forecast

During WKDEEPRED (ICES, 2016) the workshop agreed settings to conduct short-term projection based for 2019 and 2020 as follows. The model used was the same age-length structured population dynamics model used in the stock assessment (implemented in Gadget). The results are as follows:

#### Assumptions needed for projections:

Recruitment (age 5) in 2019 and 2020 was assumed to be equal to the geometric mean of the estimated recruitment during 1985–2008, i.e. 67 million fish.

Catch in 2018 was assumed to be 30 kt, based on the active TAC for all nations participating in the fishery. This assumption about catch results in  $F(2018) = 0.712$  and  $SSB(2019) = 170$  kt (which is below  $B_{lim}$ ).

Projections at different values of F in 2019–2021 are given in Table 22.7.1.

## 22.9.2 Uncertainties in assessment and forecast

### 22.9.2.1 Data considerations

Preliminary official landings data were provided by the ICES Secretariat, NEAFC and NAFO, and various national data were reported to the Group. The Group, however, repeatedly faces problems to obtain reliable catch data due to unreported catches of pelagic redfish and lack of catch data disaggregated by depth from some countries.

As in previous years, detailed descriptions on the horizontal, vertical and seasonal distribution of the fisheries are given.

The need and importance of having catch and biological data disaggregated by depth from all nations taking part in the fishery cannot be stressed strongly enough, and the Group urges all nations involved on supplying better data. With this need in mind, ICES sent a data call to all EU countries participating in the redfish fishery, encouraging stockholders to deliver detailed catch data before the WG would meet, but the response was very limited.

Additional age composition data could be available from currently un-aged otoliths sampled from Icelandic commercial catches and should be explored for possible incorporation in future assessments.

### 22.9.2.2 Assessment quality

The results of the international trawl-acoustic survey are given in Section 22.6. Given the high variability in the correlation between trawl and acoustic estimates as well as the assumptions that need to be made about constant catchability across depth and areas, the uncertainty of these estimates is very high. Furthermore, there are high uncertainties regarding the biomass estimates due to low area coverage, especially in 2018.

The reviewers of WKDEEPRED (ICES, 2016) recommend that in the future the survey procedures and gear standardization should be considered, and data should be examined to determine if the mean catch rate is better estimated across countries or by country.

An age-length-based assessment model was applied in 2016 to give relative estimates of abundance and exploitation rates for this stock. This model utilizes age and length information from the fishery in addition to the biomass index and lengths from the trawl-acoustic survey. Even though the time-series available from the fishery and the survey are short relative to the life-time of the species, the assessment captures trends in stock biomass and fishing mortality reliably and this framework is considered a major improvement to the quality of the assessment. As some aspects of the assessment and short-term forecast still require further exploration and the data presently available cover only a short period relative to the life-span of the species, ICES presently consider this assessment to be in Category 2.

Recruitment (age 5) estimates from the assessment take about 8–10 years to stabilize. For this reason, the original recruitment estimates obtained from the assessment model for the years 2009 and onwards have been replaced with the geometric mean of the estimates from 1985–2008. This has resulted in a 13% increase in the SSB and 43% increase in harvestable biomass estimates in 2018 in comparison with the estimates obtained from the assessment model without replacing recruitment. The assumed year classes, corresponding to fish at ages less than or equal to 15 in 2019, constitute approximately 67% of the SSB and 45% of the harvestable biomass in 2019. While this indicates

uncertainty in the catch and SSB values presented in the catch options table (Table 22.9.1). The conclusion that the SSB will remain below  $B_{lim}$  even without any catches in 2019 and 2020 is still valid.

It is not known to what extent CPUE reflect changes in the stock status of pelagic *S. mentella*, since the fishery focuses on aggregations. Therefore, stable or increasing CPUE series might not indicate or reflect actual trends in stock size, although decreasing CPUE indexes are likely to reflect a decreasing stock.

### 22.9.3 Comparison with previous assessment and forecast

An analytical retrospective analysis for the base model going back between 1 and 10 years was conducted. Figure 22.7.2 shows how the estimates of the spawning stock biomass, recruitment, fishing mortality and the fit to the survey biomass series changes for each year which is omitted from the model. Notably, the recruitment estimates decrease substantially as the data available is decreased in a somewhat clustered fashion. Model runs omitting the 2013 age data show substantially fewer recruits, and similarly the three runs omitting the 2009 age data have even fewer recruits.

Fishing mortality and spawning stock biomass appear to be adjusted with each new year of data as the biomass estimate needs to be adjusted with each new data point in the survey biomass series.

The results presented here show some downwards revision of the assessment in 2016 in addition to an even more pessimistic view of recent recruitment. This revision is a response to an even lower survey biomass estimate in 2018 than the value that the 2016 assessment would have predicted. There is, as noted above, uncertainty in the survey biomass estimate in 2018 due to survey coverage.

As mentioned in Section 22.7 the stock was benchmarked in 2016 (ICES, 2016) and the age-length based stock assessment model was applied for the first time to give relative estimates of abundance and exploitation rates for this stock. Previously, the assessment of pelagic redfish in the Irminger Sea and adjacent waters is based on survey indices, catches, CPUE and biological data.

### 22.9.4 Management considerations

The Group needs more and better data and requests that NEAFC and NAFO provide ICES with all information leading to more reliable catch statistics.

The main feature of the fishery since 1998 is a clear distinction between two widely separated fishing grounds with pelagic redfish fished at different seasons and different depths. Since 2000, the southwestern fishing grounds extended also into the NAFO Convention Area. Biological data, however, suggest that the aggregations in the NAFO Convention Area do not constitute a separate stock. The NAFO Scientific Council agreed with this conclusion (NAFO, 2005). The Group concludes that at that time there is not enough scientific basis available to propose an appropriate split of the total TAC among the two fisheries/areas.

The 7500 t TAC set by NEAFC for 2017 was overshoot by about 22 000 t. This excess is due to the unilateral decision of the Russian Federation to self-allocate an annual TAC, which was 27 300 t for 2017. It was taken from both Shallow and Deep pelagic (24 365 t) stocks, since the Russian Federation does not agree on the division of the *S. mentella* management units.



### 22.9.5 Ecosystem considerations

The fisheries on pelagic redfish in the Irminger Sea and adjacent waters are generally regarded as having negligible impact on the habitat and other fish or invertebrate species due to very low bycatch and discard rates, characteristic of fisheries using pelagic gear.

### 22.9.6 Changes in the environment

The hydrography in the survey of June/July 2013 show that temperature in the survey area is above average but it was lower than in 2011 in most of the surveyed area, except for the Irminger Current (ICES, 2013).

The increase of water temperature in the Irminger Sea may influence spatial and vertical distribution of *S. mentella* in the feeding area (Pedchenko, 2005). The abundance and distribution of *S. mentella* in relation to oceanographic conditions were analysed in a special multistage workshop (WKREDOCE1-3, see ICES, 2012b). Based on 20 years of survey data, the results reveal the average relation of redfish to their physical habitat in shallow and intermediate waters: The most preferred latitude, longitude, depth, salinity and temperature for *S. mentella* are approximately 58°N, 40°W, 300 m, 34.89 and 4.4°C, respectively. The spatial distribution of *S. mentella* in the Irminger Sea mainly in waters <500 m (and thus mainly relating to the “shallow” stock) appears strongly influenced by the Irminger Current Water (ICW) temperature changes, linked to the Sub-polar Gyre (SPG) circulation and the North Atlantic Oscillation (NAO). The fish avoid waters mainly associated with the ICW (>4.5°C and salinity >34.94) in the north-eastern Irminger Sea, which may cause displacing towards the southwest, where fresher and colder water occurs (ICES, 2012b).

Results based on international redfish survey data suggest that the inter-annual distribution of fish above 500 m will shift in a southwest/northeast direction depending on integrated oceanographic conditions (ICES, 2012b). Whether the results of the study mentioned are applicable to the conditions for the deep pelagic stock needs further investigation.

## 22.10 References

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**Table 22.2.1 Deep Pelagic *S. mentella* (stock unit >500 m). Catches (in tonnes) by area as used by the Working Group.**

Year	Va	XII	XIV	NAFO 1 F	Total
1991	0	7	52	0	59
1992	1 862	280	1 257	0	3 398
1993	2 603	6 068	6 393	0	15 064
1994	14 807	16 977	20 036	0	51 820
1995	1 466	53 141	21 100	0	75 707
1996	4 728	20 060	113 765	0	138 552
1997	14 980	1 615	78 485	0	95 079
1998	40 328	444	52 046	0	92 818
1999	36 359	373	47 421	0	84 153
2000	41 302	0	51 811	0	93 113
2001	27 920	0	59 073	0	86 993
2002	37 269	2	65 858	0	103 128
2003	46 627	21	57 648	0	104 296
2004	14 446	0	77 508	0	91 954
2005	11 726	0	33 759	0	45 485
2006	16 452	51	50 531	254	67 288
2007	17 769	0	40 748	0	58 516
2008	4 602	0	25 443	0	30 045
2009	16 828	4 658	32 920	0	54 406
2010	8 552	0	50 736	0	59 288
2011	0	7	47 326	0	47 333
2012	5 530	608	26 668	0	32 806
2013	5 274	0	40 778	0	46 052
2014	603	0	23 152	0	23 755
2015	1 821	0	25 612	0	27 433
2016	2 601	0	26 053	0	28 654
2017	1 639	0	28 252	0	29 891

Table 22.2.2. Deep pelagic *S. mentella* catches (in tonnes) in ICES Div.Va, Subareas XII, XIV and NAFO Div. 1F, 2H and 2J by countries used by the Working Group.

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Nederland	Norway	Poland	Portugal	Russia	Spain	UK	Ukraine	Total
1991								59												59
1992								3 398												3 398
1993				310		1 135		12 741					878							15 064
1994						2 019		47 435					523		377	1 465				51 820
1995	1 140	181	5 056	1 572	68	8 271	1 579	25 898	396	1 501	6 868	4	3 169		2 955	15 868	227		956	75 707
1996	1 654	307	3 351	3 748		15 549	1 671	57 143	196	512	5 031		5 161		1 903	36 400	5 558	123	245	138 552
1997		9	315	435		11 200		36 830	3				2 849		3 307	33 237	6 895			95 079
1998			76	4 484		8 368	302	46 537	1		34		438		4 073	25 748	2 758			92 818
1999			53	3 466		8 218	3 271	40 261					3 337		4 240	11 419	9 885	5		84 153
2000			7 733	2 367		6 827	3 327	41 466			0		3 108		3 694	14 851	9 740			93 113
2001			878	3 377		5 914	2 360	27 727			7 515		4 275		2 488	23 810	8 649			86 993
2002			15	3 664		7 858	3 442	39 263			9 771		4 197		2 208	25 309	7 402			103 128
2003				3 938		7 028	3 403	44 620			0		5 185		2 109	28 638	9 374			104 296
2004				4 670		2 251	2 419	31 098			0		6 277	1 889	2 286	31 067	9 996			91 954
2005				1 800		1 836	1 431	12 919			1 027		3 950	1 240	1 088	16 323	3 871			45 485
2006				3 498		1 830	744	20 942			1 294		5 968	1 356	1 313	23 670	6 673			67 288
2007				2 902		1 110	1 961	18 097		575	1 394		4 628	636	2 067	21 337	3 810			58 516
2008				2 632			1 170	6 723			749		571	219	1 733	15 106	1 142			30 045
2009				3 206			1 519	15 125		1 355	2 613			178	1 596	25 309	2 907			54 006
2010				3 195			1 932	14 772		1 963	2 228		2 388	3	2 203	22 803	7 801			59 288
2011				2 028		1 787		11 994		845	1 348		1 066		1 540	22 364	4 361			47 333
2012				1 438		1 523		5 912		724	558		3 362		250	18 377	632			32 806
2013				1 882		1 176		8 545		1 200	1 163		2 979			26 463	2 644			46 052
2014				721		890		2 081		867	1 024		1 965			15 475	732			23 755
2015				779		918		1 968			330		1 547		202	20 214	1 475			27 433
2016				567		715		2 601		549	803		1 396			21 619	404			28 654
2017 <sup>1)</sup>				559		772		1 929			911		970			24 355	395			29 891

1) Provisional. Official Spanish catch data were lower than the data provided by NEAFC and the WG decided to use the highest catch data as a precautionary measure.

**Table 22.3.1 Available age data (number of otoliths read) of deep pelagic beaked redfish in the Irminger Sea and adjacent waters.**

<b>Year</b>	<b>Iceland</b>	<b>Norway</b>	<b>Total</b>
1996	304		304
1999	1052	258	1310
2001	158	758	916
2003		75	75
2004	399		399
2006	200		200
2009	783		783
2011	585		585
2012	672	628	1300
2013	535	159	694
Total	4688	1878	6566

**Table 22.3.2 Number of length measurements of deep pelagic beaked redfish and number of hauls sampled from the Icelandic commercial fishery.**

<b>Year</b>	<b>Number of fish</b>	<b>Hauls sampled</b>
1992	447	5
1994	6915	41
1995	8128	49
1996	12185	141
1997	19258	200
1998	10104	94
1999	16264	115
2000	11079	97
2001	10589	83
2002	3840	48
2003	6705	63
2004	14774	87
2005	5693	34
2006	15296	78
2007	14449	79
2008	4993	40
2009	9231	73
2010	4113	34
2011	7339	52
2012	9458	70
2013	4093	35
2014	2927	19
2015	998	6
2016	4020	20
2017	3366	

**Table 22.6.1 Deep pelagic *S. mentella*. Survey estimates for depth >500 m from trawl samples taken in 2015. Areas C-F (Figure 22.6.2) were not surveyed.**

	A	B	C	D	E	F	Total
Area (NM <sup>2</sup> )	103 075						
Mean length (cm)	36.1						
Mean weight (g)	613						
Biomass (t)	130 221						

**Table 22.6.2. Results (biomass in '000 t) for the international redfish surveys conducted since 1999–for deep pelagic *S. mentella* for each Subarea (see Figure 22.6.2) and total. Areas C–F were not surveyed in 2015.**

Subarea								
Year	A	B	C	D	E	F	Total	Area (NM <sup>2</sup> )
1999	277	568	12	27	52	0	935	296
2001	497	316	28	79	64	18	1001	420
2003	476	142	20	13	27	0	678	405
2005	221	95	0	8	65	3	392	386
2007	276	166	1	5	62	11	522	349
2009	291	121	0	8	37	1	458	360
2011	342	112	0	1	18	0	474	343
2013	193	75	0	2	10	0	280	340
2015	153	43	-	-	-	-	196	201
2018	130	-	-	-	-	-	-	103

**Table 22.9.1: Short-term forecast. Values of catch and SSB are in kt.**

man.type	F 2019	SSB 2019	Catch 2019	F 2020	SSB 2020	Catch 2020	F 2021	SSB 2021	Catch 2021
0.1 * Status quo	0.115	170.31	4.521	0.115	187.89	5.287	0.115	204.95	6.090
0.2 * Status quo	0.230	170.31	8.432	0.230	184.15	9.519	0.230	197.14	10.611
0.3 * Status quo	0.345	170.31	11.825	0.345	180.91	12.944	0.345	190.60	14.031
0.4 * Status quo	0.460	170.31	14.778	0.460	178.09	15.743	0.460	185.10	16.661
0.5 * Status quo	0.574	170.31	17.354	0.574	175.63	18.049	0.574	180.43	18.715
0.6 * Status quo	0.689	170.31	19.607	0.689	173.48	19.966	0.689	176.44	20.342
0.7 * Status quo	0.804	170.31	21.581	0.804	171.60	21.570	0.804	173.03	21.646
0.8 * Status quo	0.919	170.31	23.314	0.919	169.95	22.922	0.919	170.08	22.703
0.9 * Status quo	1.034	170.31	24.838	1.034	168.50	24.067	1.034	167.54	23.568
1 * Status quo	1.149	170.31	26.180	1.149	167.22	25.042	1.149	165.33	24.283
Fmsy	0.041	170.31	1.683	0.041	190.60	2.018	0.041	210.82	2.382
Scale * Fmsy	0.010	170.31	408	0.010	191.82	495	0.010	213.51	590
Zero catch	0.0	170.31	0	0.0	192.21	0	0.0	214.38	0

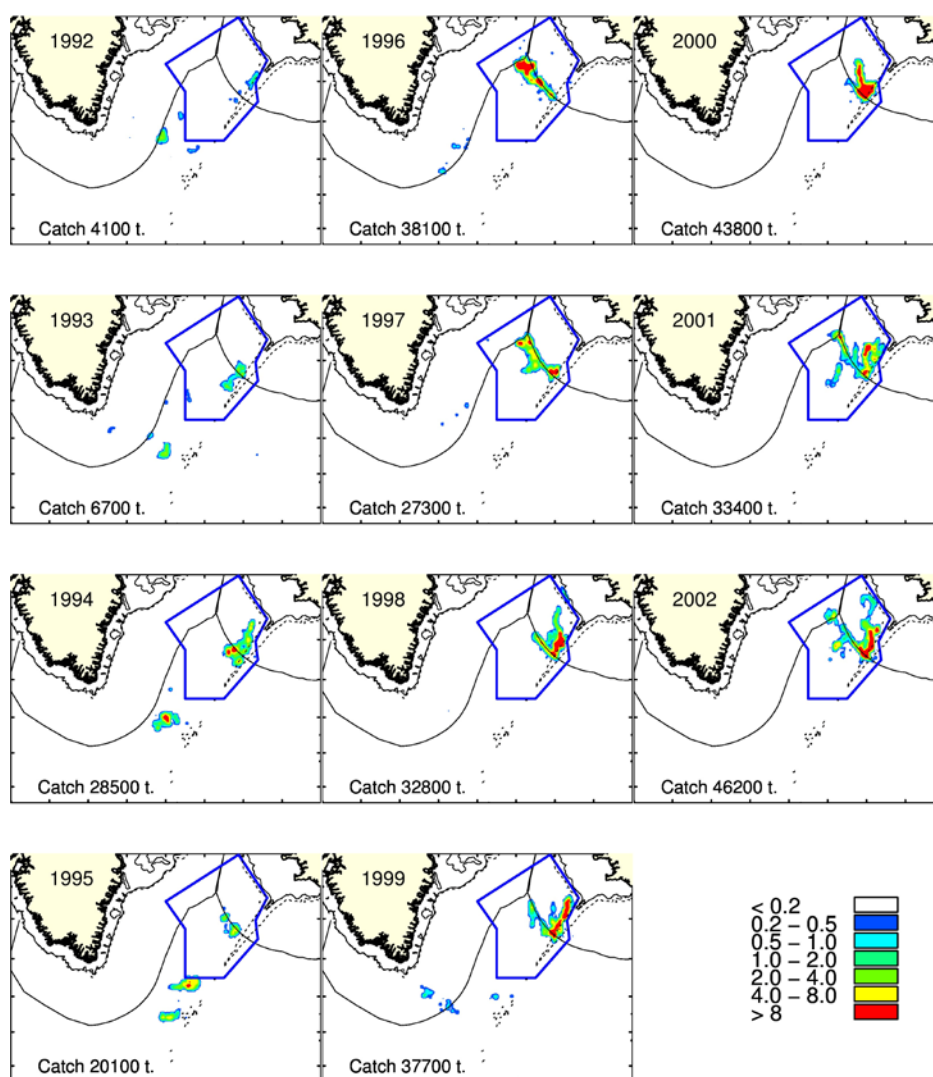


Figure 22.2.1 Fishing areas and total catch of deep pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1992–2017. Data are from the Faroe Islands (1995–2017), Germany (2011–2017) Greenland (1999–2003 and 2009–2010), Iceland (1995–2017), and Norway (1995–2003 and 2010–2017). The catches in the legend are given as tonnes per square nautical mile. The blue box represents the proposed management unit.

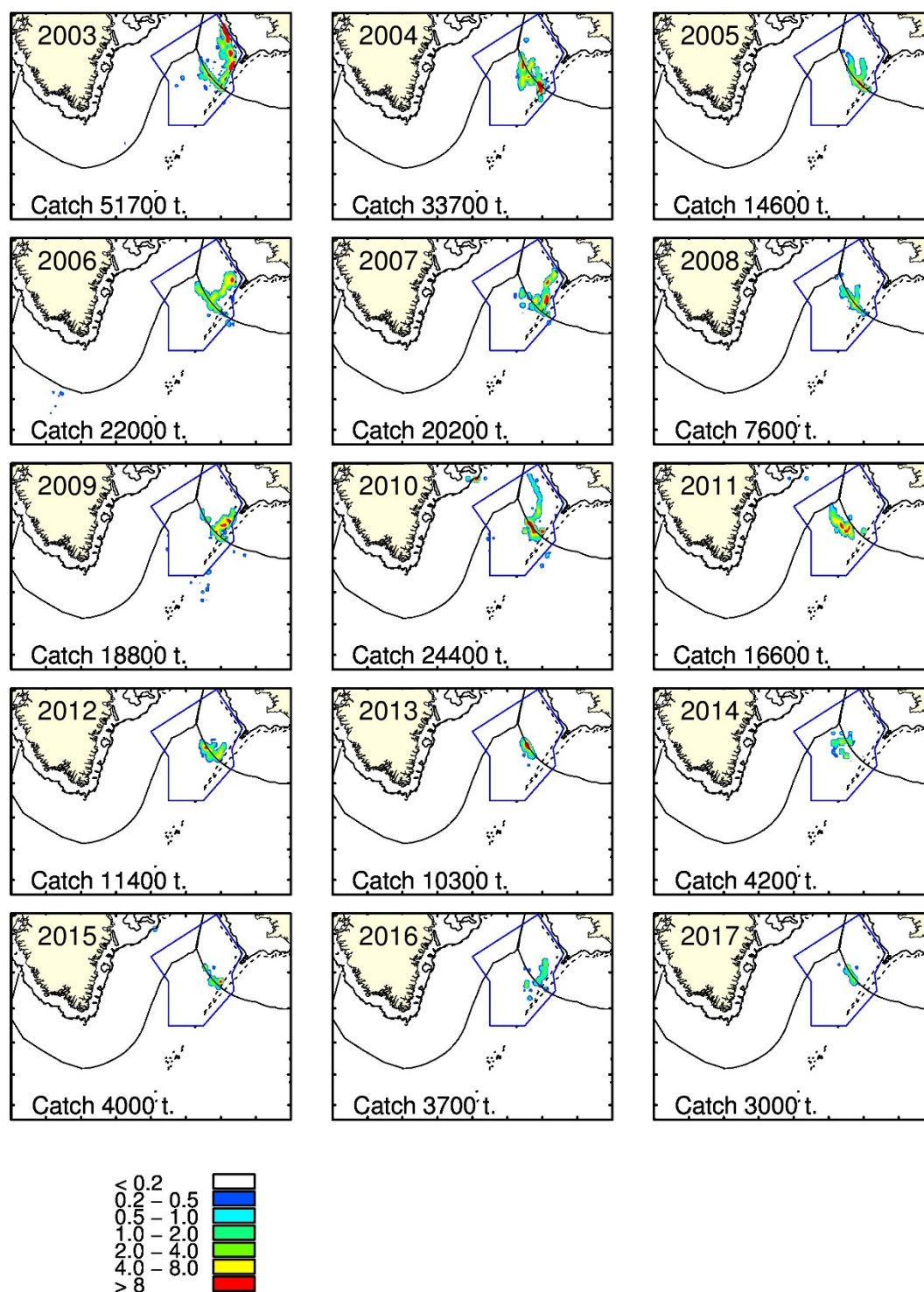


Figure 22.2.1 (Cont.) Fishing areas and total catch of deep pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1992–2017. Data are from the Faroe Islands (1995–2017), Germany (2011–2017) Greenland (1999–2003 and 2009–2010), Iceland (1995–2017), and Norway (1995–2003 and 2010–2017). The catches in the legend are given as tonnes per square nautical mile. The blue box represents the proposed management unit.

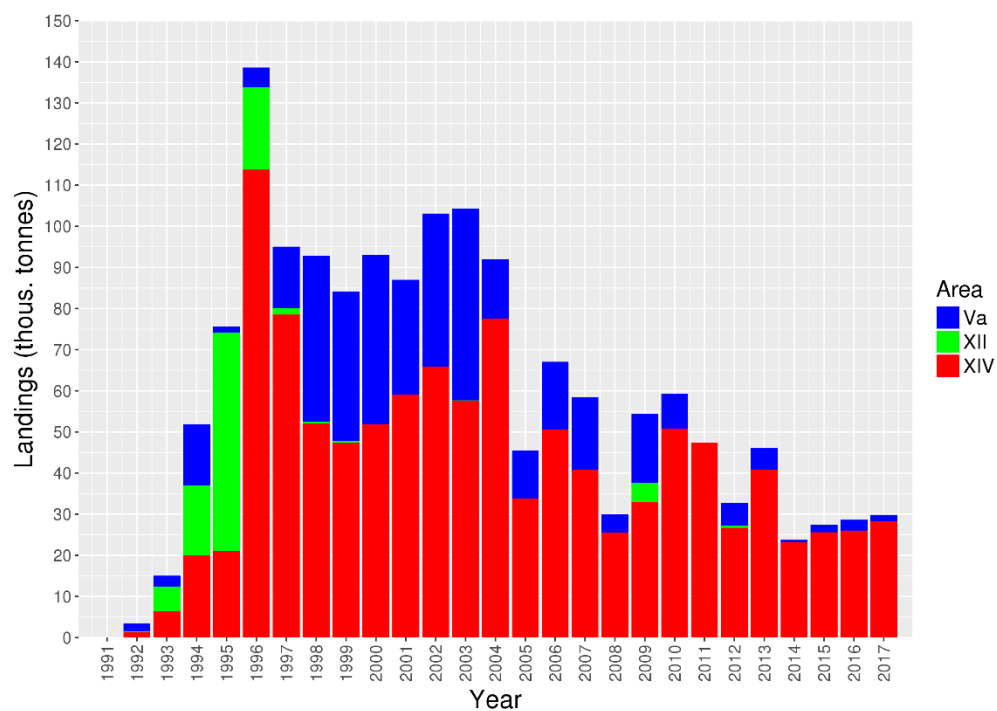


Figure 22.2.2 Landings of deep pelagic *S. mentella* (Working Group estimates, see Table 21.2.1).

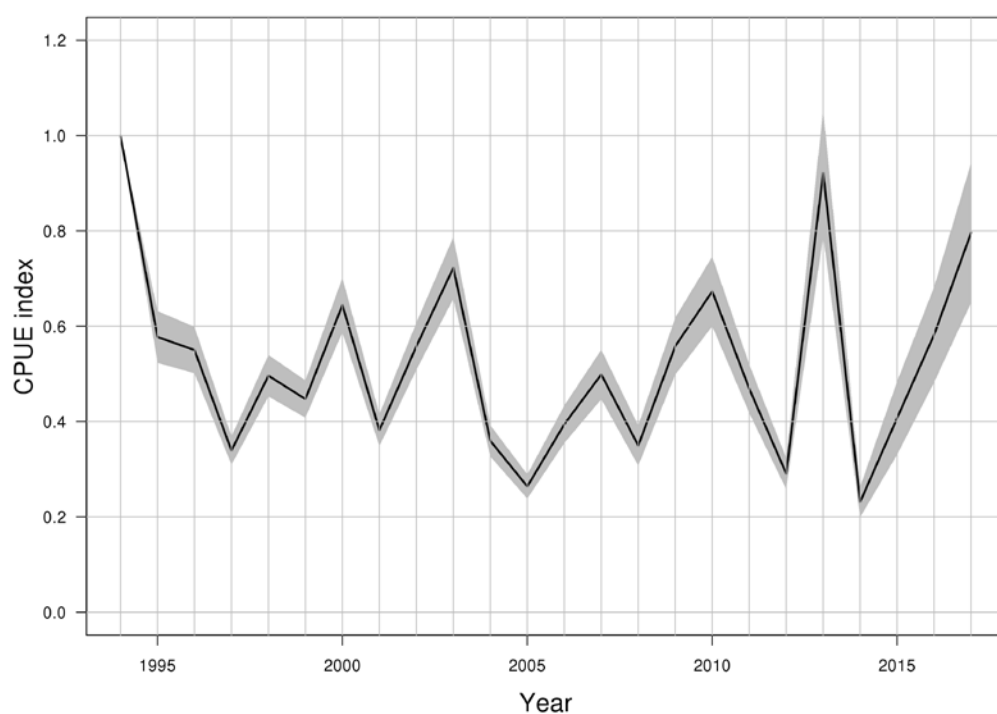
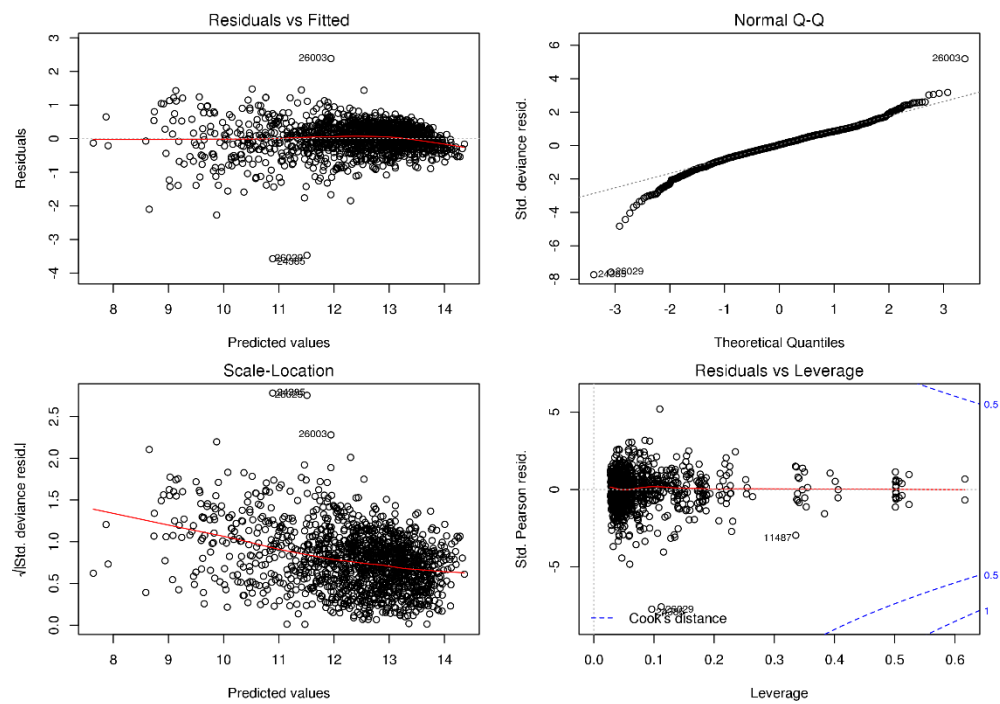


Figure 22.2.3 Trends in standardised CPUE of the deep pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book data from Faroe Islands, Iceland, Germany, Greenland and Norway.





**Figure 22.2.4** Residuals from the GLM model used to standardize CPUE, based on log-book data from Faroe Islands, Iceland, Greenland and Norway.

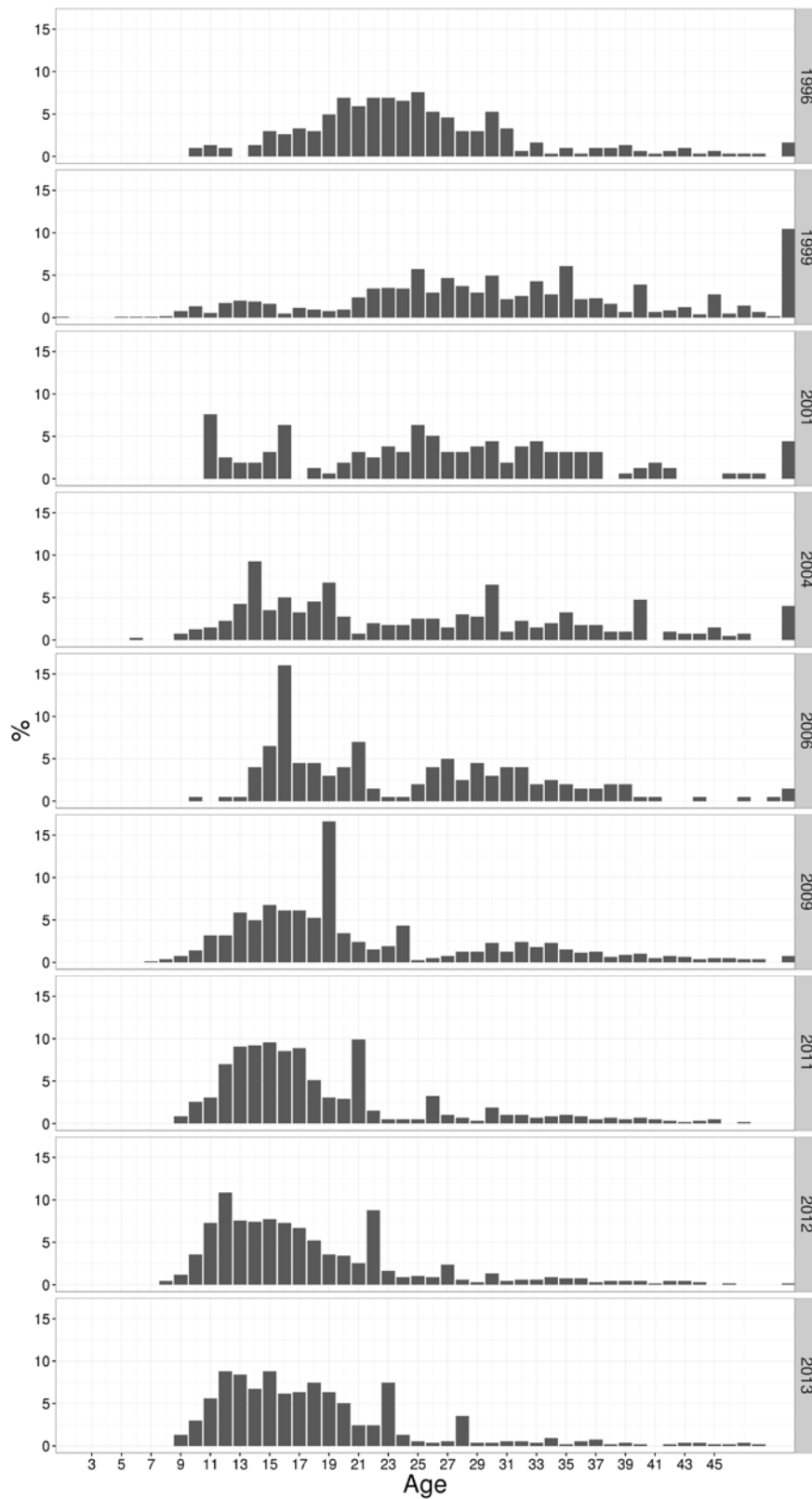


Figure 22.3.1 Age distribution of deep pelagic beaked redfish based on age reading from the Icelandic commercial catch.

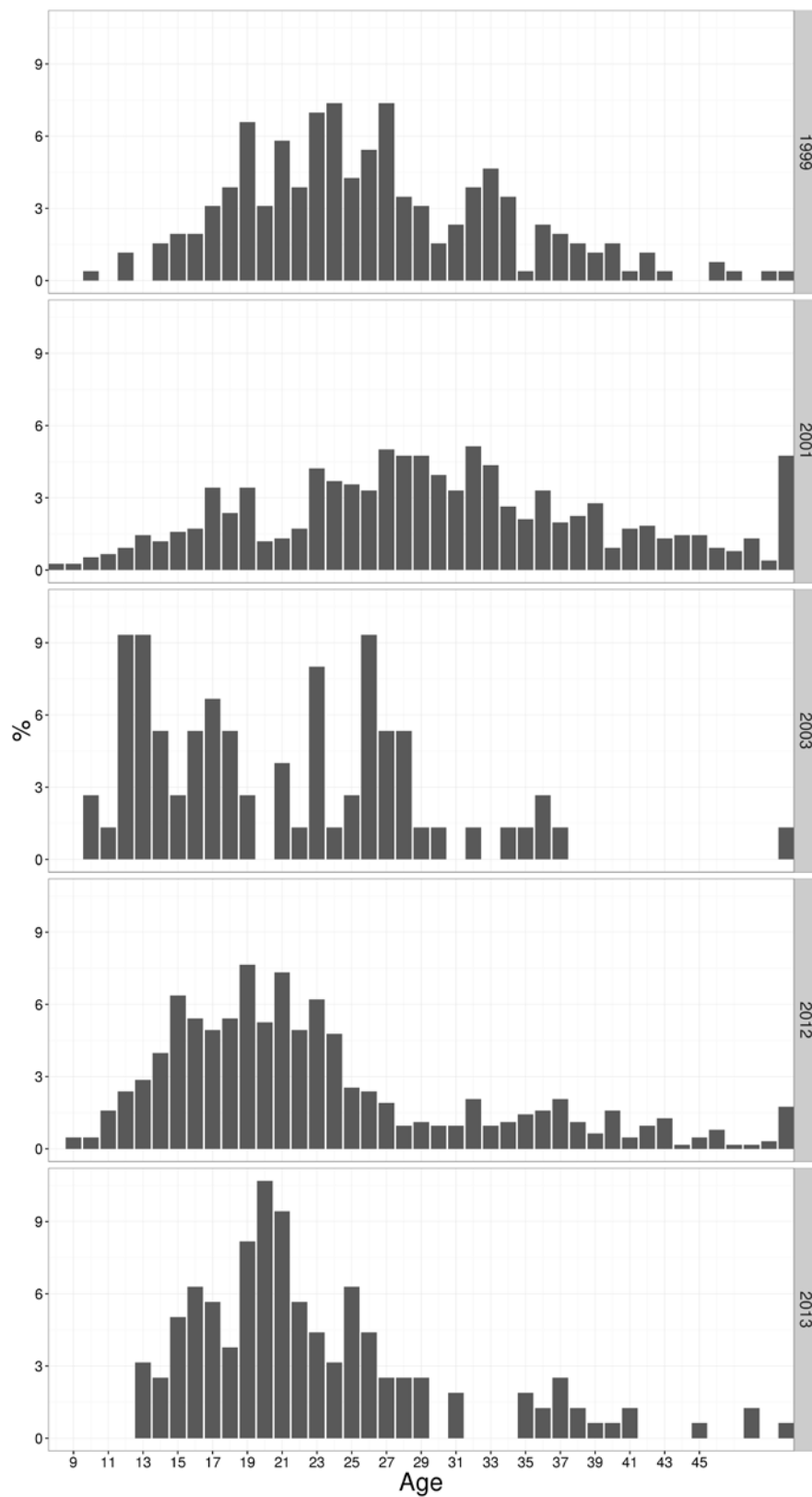


Figure 22.3.2 Age distribution of deep pelagic beaked redfish based on age reading from the Norwegian commercial catch.

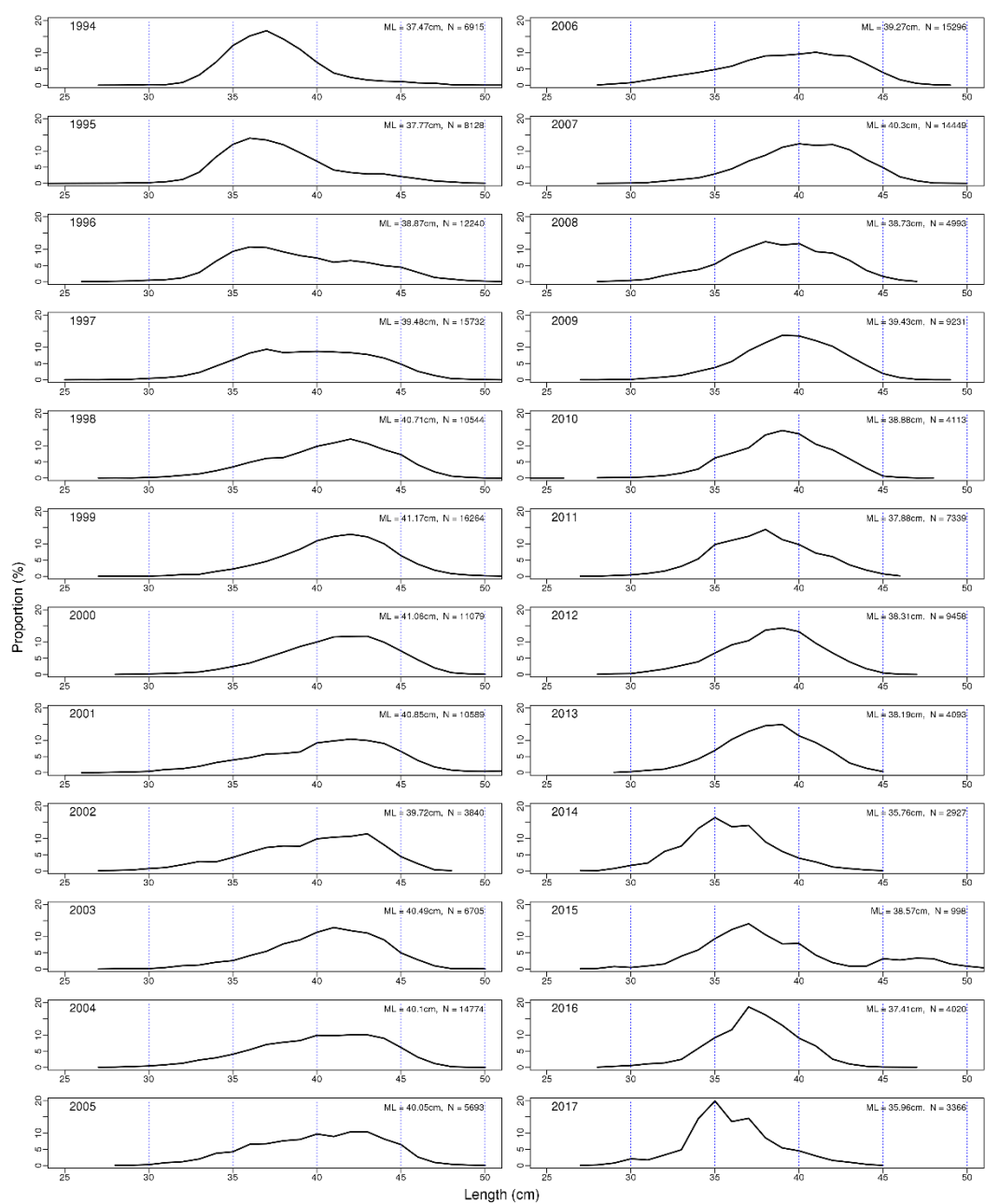


Figure 22.3.3 Length distribution from Icelandic landings of deep pelagic *S. mentella* 1994–2017.

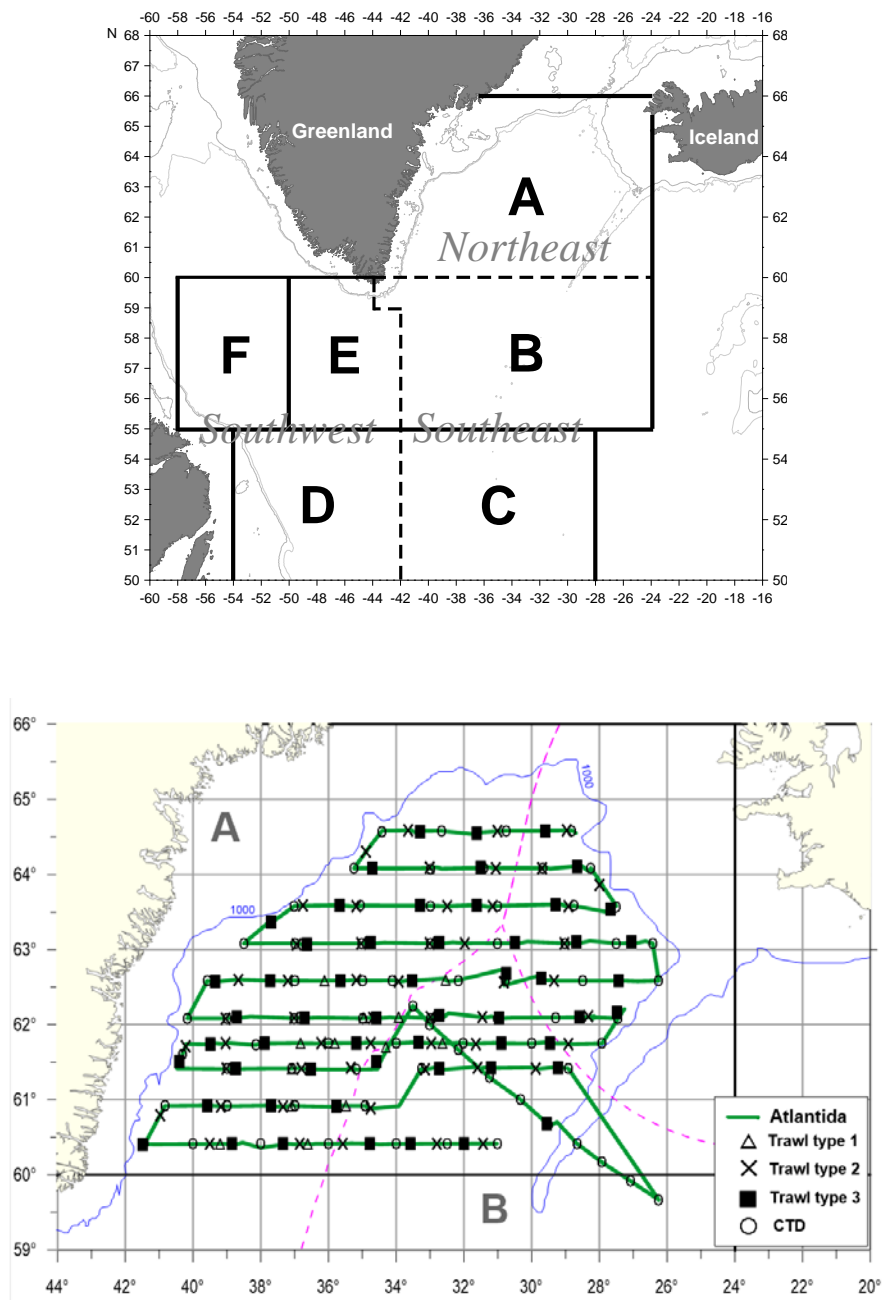


Figure 22.6.1 Upper: Subareas A-F used on international surveys for redfish in the Irminger Sea and adjacent waters, and divisions for biological data (Northeast, Southwest and Southeast; boundaries marked by broken lines). Lower: Cruise tracks and stations taken in the joint international redfish survey in June/July 2018. Only the northeast area (subarea A) was surveyed.

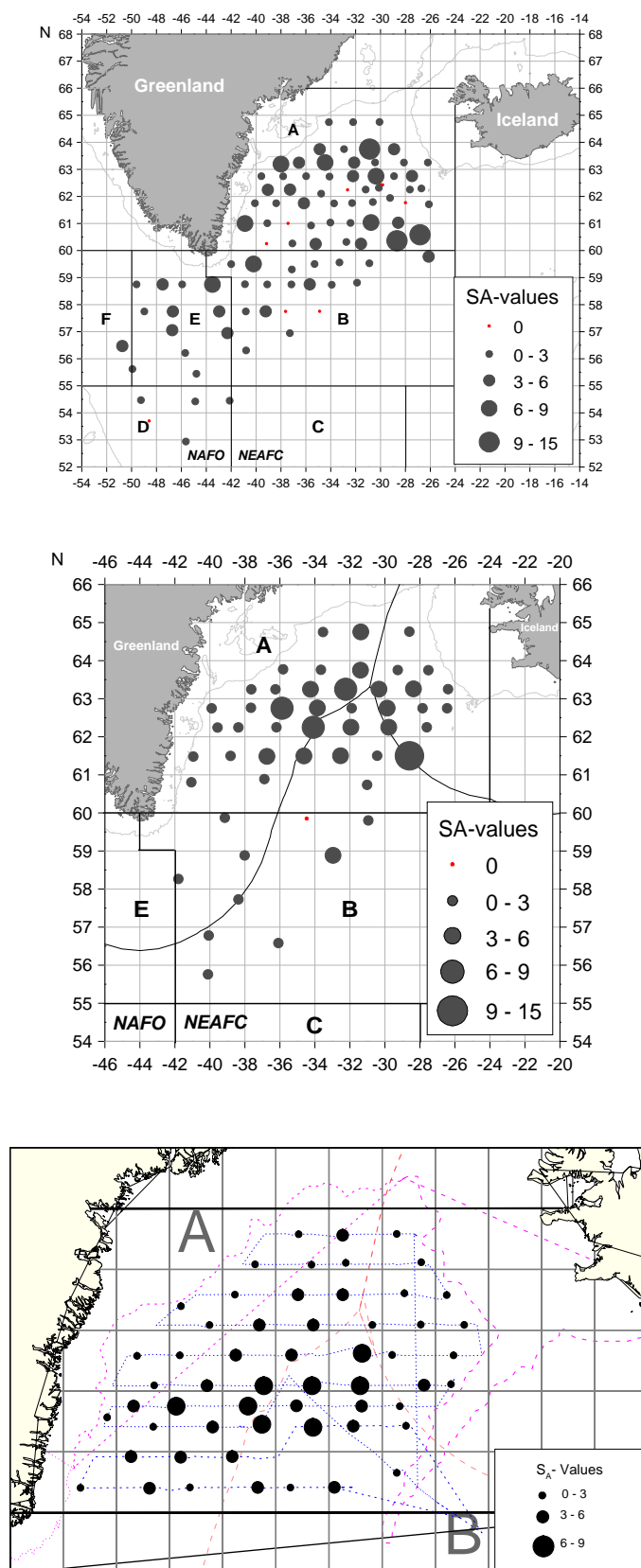


Figure 22.6.2. Redfish trawl estimates deeper than 500 m (type 3 trawls).  $S_A$  values calculated by the trawl method (see WGRS Report, 2013) during the joint international redfish survey in June/July 2013 (top), June/July 2015 (middle) and June/July 2018 (bottom).

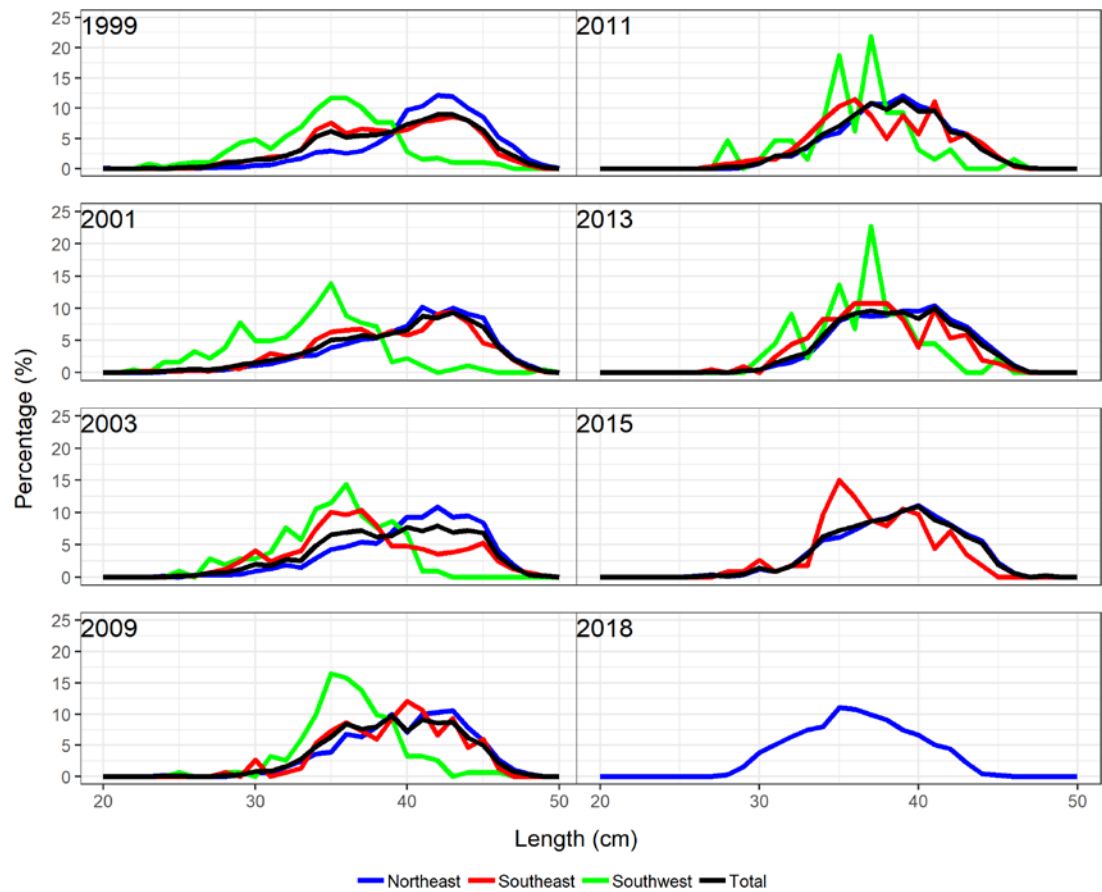
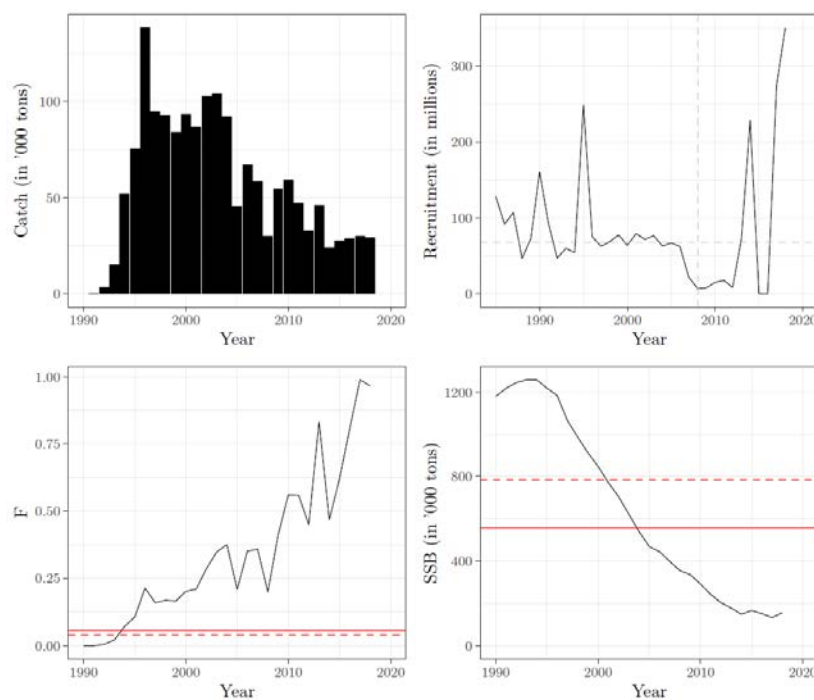


Figure 22.6.3 Length distribution of redfish by geographical areas (see Figure 22.6.1) and total, from fish caught deeper than 500 m 1999–2003 and 2009–2018 (in 2018, the survey only covered the north-east area).



**Figure 22.7.1: Summary of stock assessment agreed by WKDEEPRED, see Table 5.2.2 for a tabulation of results (to be presented as a Category 2 assessment, i.e. with Recruitment, F and SSB on relative, rather than absolute, scale). Recruitment after 2008 is not considered to be reliably estimated and has been replaced by the geometric mean of the estimated recruitment during 1985–2006. SSB and F values after 2006 were recalculated accordingly, so as to match the observed catches in those years.**

