

18 Redfish in subareas 5, 6, 12 and 14

This chapter deals with fisheries directed to *Sebastes* species in subareas 5, 6, 12 and 14 (sections and 18.7), and the abundance and distribution of juveniles (Section 18.2.1), among other issues.

The “Workshop on Redfish Stock Structure” (WKREDS, 22–23 January 2009, Copenhagen, Denmark; ICES 2009) reviewed the stock structure of *Sebastes mentella* in the Irminger Sea and adjacent waters. ACOM concluded, based on the outcome of the WKREDS meeting, that there are three biological stocks of *S. mentella* in the Irminger Sea and adjacent waters:

- a ‘Deep Pelagic’ stock (NAFO 1–2, ICES 5, 12, 14 >500 m) – primarily pelagic habitats, and including demersal habitats west of the Faeroe Islands;
- a ‘Shallow Pelagic’ stock (NAFO 1–2, ICES 5, 12, 14 <500 m) – extends to ICES 1 and 2, but primarily pelagic habitats, and includes demersal habitats east of the Faeroe Islands;
- an ‘Icelandic Slope’ stock (ICES 5.a, 14) – primarily demersal habitats.

This conclusion is primarily based on genetic information, i.e. microsatellite information, and supported by analysis of allozymes, fatty acids and other biological information on stock structure, such as some parasite patterns. The Russian Federation maintains the point of view that there is only one stock of *S. mentella* in the pelagic waters of the Irminger Sea. Accordingly, the Russian Federation presented alternative approaches to stock assessment as well as environmental influence on stock dynamics. Briefly, it is claimed that the current survey-based assessment does not adequately reflect stock status and that environmental factors – temperature causes major distributional changes of redfish – affect stock status more than fisheries and the use of the current management areas is rejected (see WD22, WD23 and Annex 7). The other NWWG members did not agree with the Russian Federation’s view on stock structure and did not consider the presented assessment approach sufficiently documented.

The adult redfish on the Greenland shelf has traditionally been attributed to several stocks, and there remains the need to investigate the affinity of adult *S. mentella* in this region. Recent studies confirm the connectivity between *S. mentella* in East-Greenland and other areas (Saha *et al.*, 2016). Further studies are needed to understand e.g. the connection between the slope stocks in both East-Greenland, Iceland and the Faroe Islands.

ICES past advice for *S. mentella* fisheries was provided for two distinct management units, i.e. a demersal unit on the continental shelves and slopes and pelagic unit in the Irminger Sea and adjacent waters. However, based on the new stock identification information, ICES recommended three potential management units that are geographic proxies for biological stocks that were partly defined by depth and whose boundaries are based on the spatial distribution pattern of the fishery to minimize mixed stock catches (Figure 18.1.1):

- Management Unit in the northeast Irminger Sea: ICES subareas 5.a, 12, and 14.
- Management Unit in the southwest Irminger Sea: NAFO Areas 1 and 2, ICES subareas 5.b, 12 and 14.
- Management Unit on the Icelandic slope: ICES subareas 5.a and 14, and to the north and east of the boundary proposed in the MU in the northeast Irminger Sea.

The pelagic fishery in the Irminger Sea and adjacent waters shows a clear distinction between two widely separated grounds fished at different seasons and depths. Spatial analysis of the pelagic fishery catch and effort by depth, inside and outside the boundaries proposed for the management units in the northeast Irminger Sea, indicate that the boundaries effectively delineate the pelagic fishery in the northeast Irminger Sea from the pelagic fishery in the southwest Irminger Sea, with a small portion of mixed-stock catches. In the last decade the majority (more

than 90%) of the catches have been taken in the northeast Irminger Sea. The northeastern fisheries on the pelagic *S. mentella* occur at the start of the fishing season at depths below 500 m and overlap to some extent with demersal fisheries on the continental slopes of Iceland (Sigurdsson *et al.*, 2006).

A schematic illustration of the relationship between the management units and biological stocks is given in Figure 18.1.2.

For the above mentioned reasons, the group now provides advice for the following *Sebastes* units:

- the *S. norvegicus* on the continental shelves of ICES divisions 5.a, 5.b and subareas 6 and 14 (Section 19);
- the demersal *S. mentella* on the Icelandic slope (Section 20);
- the shallow and deep pelagic *S. mentella* units in the Irminger Sea and adjacent waters (sections 21 and 22, respectively);
- the Greenland shelf *S. mentella* (Section 23).

18.1 Environmental and ecosystem information

Species of the genus *Sebastes* are common and widely distributed in the North Atlantic. They are found off the coast of Great Britain, along Norway and Spitzbergen, in the Barents Sea, off the Faroe Islands, Iceland, East and West Greenland, and along the east coast of North America from Baffin Island to Cape Cod. All *Sebastes* species are viviparous. Copulation occurs in autumn–early winter and larvae extrusion takes place in late winter–late spring/early summer. Little is known about the copulation areas.

The increase of water temperature in the Irminger Sea may have an effect on spatial and vertical distribution of *S. mentella* in the feeding area (Pedchenko, 2005). The abundance and distribution of pelagic *S. mentella* in relation to oceanographic conditions were analyzed in a special multi-stage workshop (ICES, 2012). Based on 20 years of survey data, the results reveal the average relation of pelagic 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 Subpolar Gyre (SPG) circulation and the North Atlantic Oscillation (NAO). The fish avoid waters mainly associated with the ICW (>4.5°C and >34.94) in the northeastern Irminger Sea, which may cause displacement of the fish towards the southwest, where fresher and colder water occurs.

Results based on international redfish survey data suggest that the interannual distribution of fish above 500 m will shift in a southwest/northeast direction depending on integrated oceanographic conditions (ICES, 2012).

18.2 Environmental drivers of productivity

18.2.1 Abundance and distribution of 0 group and juvenile redfish

Available data on the distribution of juvenile *S. norvegicus* indicate that the nursery grounds are located in Icelandic and Greenland waters. No nursery grounds have been found in Faroese waters. Studies indicate that considerable amounts of juvenile *S. norvegicus* off East Greenland are mixed with juvenile *S. mentella* (Magnússon *et al.*, 1988; 1990, ICES CM 1998/G:3). The 1983 Redfish Study Group report (ICES CM 1983/G:3) and Magnússon and Jóhannesson (1997) describe the distribution of 0-group *S. norvegicus* off East Greenland. The nursery areas for *S. norvegicus*

in Icelandic waters are found all around Iceland but are mainly located west and north of the island at depths between 50 and 350 m (ICES CM 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). As they grow, the juveniles migrate along the north coast towards the most important fishing areas off the west coast.

Indices for 0-group redfish in the Irminger Sea and at East Greenland areas were available from the Icelandic 0-group surveys from 1970–1995. Thereafter, the survey was discontinued. Above average year class strengths were observed in 1972, 1973–1974, 1985–1991, and in 1995.

There are very few juvenile demersal *S. mentella* in Icelandic waters (see Section 20), and the main nursery area for this species is located off East Greenland (Magnússon *et al.*, 1988, Saborido-Rey *et al.*, 2004). Abundance and biomass indices of redfish smaller than 17 cm from the German annual groundfish survey, conducted on the continental shelf and slope of West and East Greenland down to 400 m, show that juveniles were abundant in 1993 and 1995–1998 (Figure 18.2.1). The 1999–2006 survey results indicate low abundance and were similar to those observed in the late 1980s. Since 2008, the survey index has been very low and was in 2013–2016 the lowest value recorded since 1982. Juvenile redfish were only classified to the genus *Sebastes* spp., as identification of small specimens to species level is difficult due to very similar morphological features. Observations on length distributions of *S. mentella* fished deeper than 400 m indicate that a part of the juvenile *S. mentella* on the East Greenland shelf migrates into deeper shelf areas and into the pelagic zone in the Irminger Sea and adjacent waters (Stransky, 2000), with unknown shares.

18.3 Ecosystem considerations

Information on the ecosystems around the Faroe Islands is given in Section 2, in Icelandic waters in Section 7 and Greenland waters in Section 13.

Analysis of the oceanographic situation in the Irminger Sea during the 2013 international survey and long-term data including 2003, allows the following conclusions:

Strong positive anomalies of temperature observed in the upper layer of the Irminger Sea with a maximum in 1998 are related to an overall warming of water in the Irminger Sea and adjacent areas in 1994–2013. These changes were also observed in the Irminger Current above the Reykjanes Ridge (Pedchenko, 2000), off Iceland (Malmberg *et al.*, 2001) and in the Labrador Sea water (Mortensen and Valdimarsson, 1999). Thus, temperature and salinity in the Irminger Current have increased since 1997 to the highest values seen for decades.

The 2003 survey detected high temperature anomalies within the 0–200 m layer in the Irminger Sea and adjacent waters. At 200–500 m depth and deeper waters, positive anomalies were observed in most of the surveyed area. However, increasing temperature as compared to the survey in June–July 2001 was detected only north of 60°N in the flow of the Irminger Current above the Reykjanes Ridge and the northwestern part of the Irminger Sea. These changes in oceanographic conditions might have an effect on the seasonal distribution of redfish and its aggregations in the layer shallower than 500 m in the survey area (ICES, 2003).

In June/July 2005 and 2007, water temperature in the shallower layer (0–500 m) of the Irminger Sea was higher than normal (ICES, 2005; ICES, 2007). As in the surveys 1999–2003, the redfish were aggregating in the southwestern part of the survey area, partly influenced by these hydrographic conditions. Favourable conditions for aggregation of redfish in an acoustic layer have been marked only in the southwestern part of the survey area with temperatures between 3.6–4.5°C, as confirmed by the survey results obtained in 2009 (ICES, 2009b). The hydrography in the survey of June/July 2013 shows 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, 2013a).

18.4 Description of fisheries

There are three species of commercially exploited redfish in ICES subareas 5, 6, 12, and 14: *S. norvegicus* (in publication both names *S. norvegicus* and *S. marinus* can be found, but according to Fernholm and Wheeler (1983) the first name is the correct name), *S. mentella* and *S. viviparus*.

S. viviparus has only been of a minor commercial value in Icelandic waters and it is exploited in two small areas south of Iceland at depths of 150–250 m. The landings of *S. viviparus* decreased from 1160 t in 1997 to 2–9 t in 2003–2006 (Table 18.4.1) due to decreased commercial interest in this species. The landings in 2009 amounted to 37 t, more than a twofold increase in comparison with 2008. After a directed fishery developed in 2010, with a total catch of 2600 t, the MRI (now MFRI) advised on a 1500 t TAC for the 2012–2013 fishing year. Annual catches 2012–2015 were about 500 t but have since then decreased and were 117 t in 2018.

The group has in the past included the fraction of *S. mentella* that are caught with pelagic trawls above the western, south-western and southern continental slope of Iceland as part of the landing statistics of the demersal *S. mentella*. This practice has been in accordance with Icelandic legislation, where captains are obligated to report their *S. mentella* catch as either "pelagic redfish" or as "demersal redfish/Icelandic slope *S. mentella*" depending in which fishing area they fish. According to this legislation, all catch outside the Icelandic EEZ and west of the 'redfish line' (red line shown in Figure 18.1.1, which is drawn approximately over the 1000 m isoclines within the Icelandic EEZ) shall be reported as pelagic *S. mentella*. All fish caught east of the 'redfish line' shall be reported as Icelandic slope *S. mentella*. Most of the catches since 1991 have been taken by bottom trawlers along the shelf west, southwest, and southeast of Iceland at depths between 500 and 800 m. The Group accepts this praxis as a pragmatic management measure but notes that there is no biological information that could support this catch allocation.

As the Review Group in 2005 noted that this issue needed more elaboration, detailed portrayals of the geographical, vertical, and seasonal distribution of the Icelandic slope *S. mentella* fisheries with different gears are presented here, as done previously (see below). Quantitative information on the fractions of the pelagic catches of Icelandic slope *S. mentella* is given in chapter 20. The proportion of the total Icelandic slope *S. mentella* catches taken by pelagic trawls has ranged since 1991 between 0% and 44% (Table 20.3.2) and is on average 15%. With exception of 2007, no Icelandic slope *S. mentella* has been caught with pelagic trawls since 2004. The geographic distribution of the Icelandic fishery for *S. mentella* since 1991 was in general close to the redfish line, off South Iceland, and has expanded into the NAFO Convention Area since 2003 (Figure 18.4.1). The pelagic catches of Icelandic slope *S. mentella* were taken in similar areas and depths as the bottom trawl catches (Figure 18.4.2). The vertical and horizontal distribution of the pelagic catches focused, however, on smaller areas and shallower depth layers than the bottom trawl catches. The seasonal distribution by depth (Figure 18.4.3) shows that the pelagic catches of Icelandic slope *S. mentella* were in general taken in autumn and overlapped in June with the traditional pelagic fishery only in 2003 and 2007. The bottom trawl catches of the Icelandic slope *S. mentella* were mainly taken in the first quarter of the year and during autumn/winter. The length distributions of the Icelandic slope *S. mentella* catches in Iceland by gear and area are given in Figure 18.4.4. During 1994–1999 and in 2003, the fish taken with pelagic trawls were considerably larger than the fish caught with bottom trawls, but they were of similar length during 2000–2002. The fish caught in the north-eastern area were on average about 5 cm larger than those caught in the south-western area. The length distribution also shows that the fish caught in north-east area since 2011 is smaller than during the period 1998–2010 and have now a size similar to that registered in the beginning of the fishery.

18.5 Russian pelagic *S. mentella* fishery

Russia's position regarding the structure of redfish stock in the Irminger Sea remains unchanged and it has been expressed in previous reports (ICES, 2009a; ICES, 2013b; Makhrov *et al.*, 2011; Zelenina *et al.*, 2011; see also Annex 7 in NWWG 2019 report). The Russian Federation still maintains its point of view that there is only one stock of beaked redfish *S. mentella* in the pelagic waters of the Irminger Sea and that is why no split catches information about the fisheries is presented to the NWWG. Russia reiterates its standpoint that studies of the redfish stock structure should be continued (Artamonova *et al.*, 2013) with the aim of developing agreed recommendations using all available scientific and fisheries data as a basis.

The Russian fishery in 2020 is described in WD02. In 2020, the Russian fishery was conducted from April to October in ICES Subareas 12 and 14 and NAFO Division 1F.

18.6 Biological sampling

Biological samples are taken both in national and international surveys and from the commercial catches. They consist of length measurements, otolith collection, stomach contents, sex and maturity stages. The following samples were taken by several nations during 2020:

Country	Area	No. of samples	No. of fish measured
Russia	14	150	4 400
Russia	12	300	11 216
Russia	NAFO 1F	570	24 488

18.7 Demersal *S. mentella* in 5b and 6

18.7.1 Demersal *S. mentella* in 5b

18.7.1.1 Surveys

The Faroese spring and summer surveys in Division 5.b are mainly designed for species inhabiting depths down to 500 m and do not cover the vertical distribution of demersal *S. mentella* fully. Therefore, the surveys are not used to evaluate the stock status.

18.7.1.2 Fisheries

In Division 5.b, landings gradually decreased from 15 000 t in 1986 to about 5000 t in 2001 (Table 18.6.1). Between 2002 and 2011 annual landings varied between 1100 and 4000 t. In 2012, landings decreased drastically from 1126 t in 2011 to 263 t but has since then increased and were 432 t in 2020.

Length distributions from the landings in 2001–2018 indicate that the fish caught in 5.b in 2018 are between 35–50 cm and the mode of the distribution is around 42 cm (Figure 18.7.1).

Non-standardized CPUE indices in Division 5.b were obtained from the Faroese otter board (OB) trawlers (> 1000 HP) towing deeper than 450 m and where demersal *S. mentella* composed at least 70% of the total catch in each tow. The OB trawlers have in recent years landed about 50% of the total demersal *S. mentella* landings from 5b. CPUE decreased from 500 kg/hour in 1991 to 300 kg/hour in 1993 and remained at that level until 2013, when it reached a historical low (Figure 18.7.2). The CPUE has since remained at that level. Data for 2018–2020 were not available.

Fishing effort has decreased since the beginning of the time series and has remained very low since 2008.

18.7.2 Demersal *S. mentella* in 6

18.7.2.1 Fisheries

In Subarea 6, the annual landings varied between 200 t and 1100 t in 1978–2000 (Table 18.6.1). The landings from 6 in 2004 were negligible (6 t), the lowest recorded since 1978. They increased again to 111 t in 2005 and 179 t in 2006. The reported landings in 2008 were 50 t and no catches have been taken since 2009.

18.8 Regulations (TAC, effort control, area closure, mesh size etc.)

Management of redfish differs between stock units and is described in sections 19.14 for *S. norvegicus*, Section 20.7 for Icelandic slope *S. mentella*, Section 21.10 for shallow pelagic *S. mentella*, Section 22.10 for deep pelagic *S. mentella*, and Section 23 for Greenland slope *S. mentella*.

The allocation of Icelandic *S. mentella* catches to the pelagic and demersal management unit has been based on the “redfish line” (see Section 18.4).

18.9 Mixed fisheries, capacity, and effort

The official statistics reported to ICES do not divide catch by species/stocks, and since the Review Group in 2005 recommended that “multispecies catch tables are not relevant to management of redfish resources”, these data are not given here and the best estimates on the landings by species/stock unit are given in the relevant chapters. 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 faced problems in obtaining catch data, especially with respect to pelagic *S. mentella*. Detailed descriptions of the fisheries are given in the respective sections: *S. norvegicus* in Section 19.3, Icelandic slope *S. mentella* in Section 20.3, shallow pelagic *S. mentella* in Section 21.2, deep pelagic *S. mentella* in Section 22.2 and Greenland slope *S. mentella* in Section 23.3.

Information from various sources is used to split demersal landings into two redfish species, *S. norvegicus* and *S. mentella* (see stock annexes for Icelandic slope *S. mentella* and *S. norvegicus*). In Division 5.a, if no direct information is available on the catches for a given vessel, the landings are allocated based on logbooks and samples from the fishery. According to the proportion of biological samples from each cell (one fourth of ICES statistical square), the unknown catches within that cell are split accordingly and raised to the landings of a given vessel. For other areas, samples from the landings are used as basis for dividing the demersal redfish catches between *S. norvegicus* and *S. mentella*.

18.10 References

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18.11 Tables

Table 18.4.1. Landings of *S. viviparus* in Division 5.a 1996–2020.

Year	Landings (t)
1996	22
1997	1159
1998	994
1999	498
2000	227
2001	21
2002	20
2003	3
2004	2
2005	4
2006	9
2007	24
2008	15
2009	37
2010	2602
2011	1427
2012	535
2013	532
2014	550
2015	468
2016	234
2017	161
2018	117
2019	143
2020	118

Table 18.6.1. Nominal landings (tonnes) of demersal *S. mentella* 1978–2020 in ICES divisions 5.b and 6.

Year	5.b	6
1978	7767	18
1979	7869	819
1980	5119	1109
1981	4607	1008
1982	7631	626
1983	5990	396
1984	7704	609
1985	10560	247
1986	15176	242
1987	11395	478
1988	10488	590
1989	10928	424
1990	9330	348
1991	12897	273
1992	12533	134
1993	7801	346
1994	6899	642
1995	5670	536
1996	5337	1048
1997	4558	419
1998	4089	298
1999	5294	243
2000	4841	885
2001	4696	36
2002	2552	20
2003	2114	197
2004	3931	6
2005	1593	111
2006	3421	179

Year	5.b	6
2007	1376	1
2008	750	50
2009	1077	0
2010	1202	0
2011	1126	0
2012	263	0
2013	398	0
2014	370	0
2015	537	0
2016	717	0
2017	372	0
2018	521	0
2019	646	0
2020 ¹⁾	432	0

1) Provisional

18.12 Figures

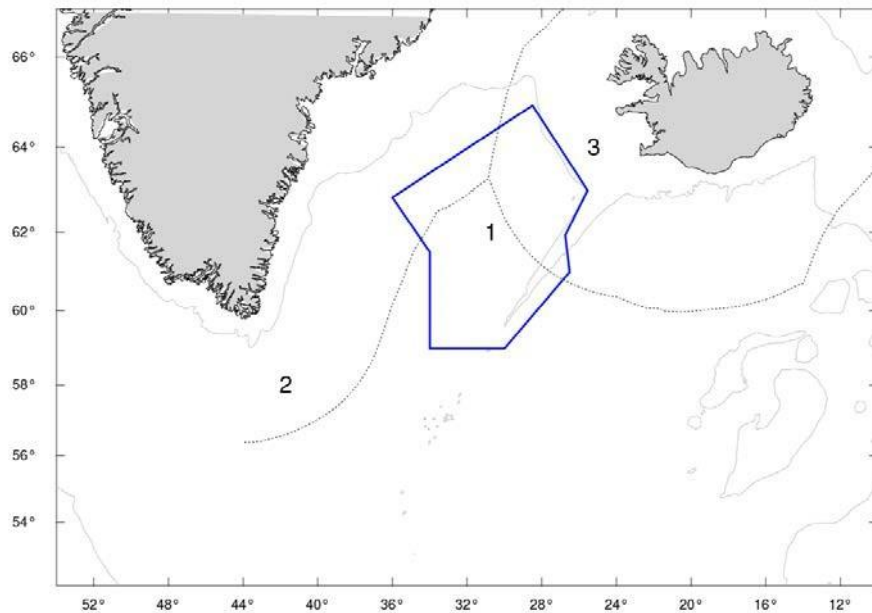


Figure 18.1.1 Potential management unit boundaries. The polygon bounded by blue lines, i.e., 1, indicates the region for the ‘deep pelagic’ management unit in the northwest Irminger Sea, 2 is the “shallow pelagic” management unit in the southwest Irminger Sea, and 3 is the Icelandic slope management unit.

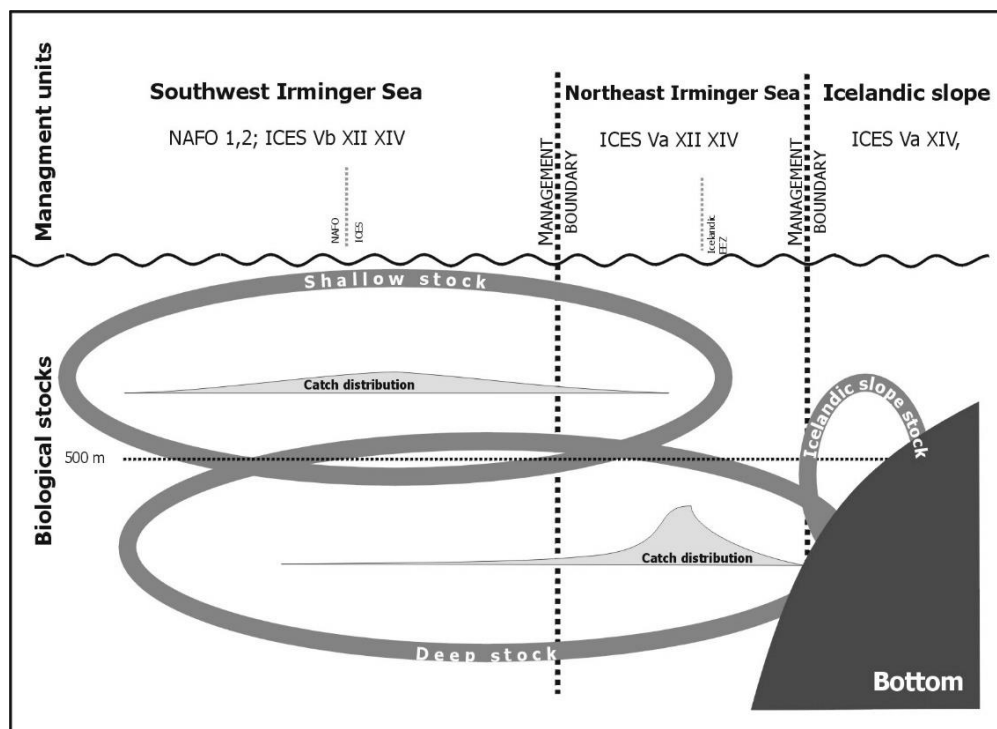


Figure 18.1.2 Schematic representation of biological stocks and potential management units of *S. mentella* in the Irminger Sea and adjacent waters. The management units are shown in Figure 18.1.1. Included is a schematic representation of the geographical catch distribution in recent years. Note that the shallow pelagic stock includes demersal *S. mentella* east of the Faroe Islands and the deep pelagic stock includes demersal *S. mentella* west of the Faroe Islands.

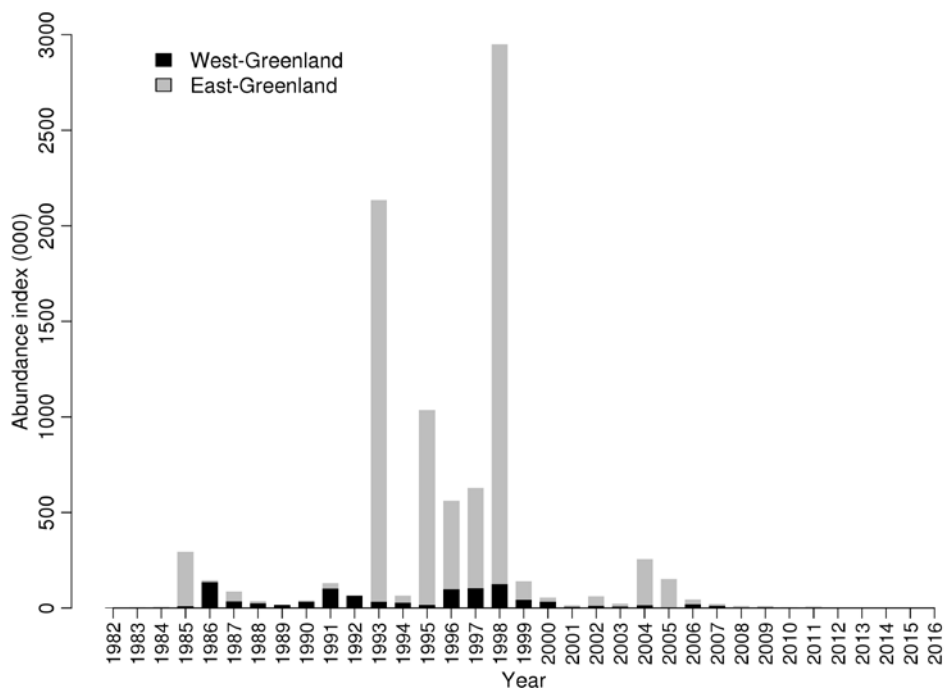


Figure 18.2.1 Survey abundance indices of *Sebastes spp.* (<17 cm) for East and West Greenland from the German ground-fish survey 1982–2016. No data were available in 2017–2020.

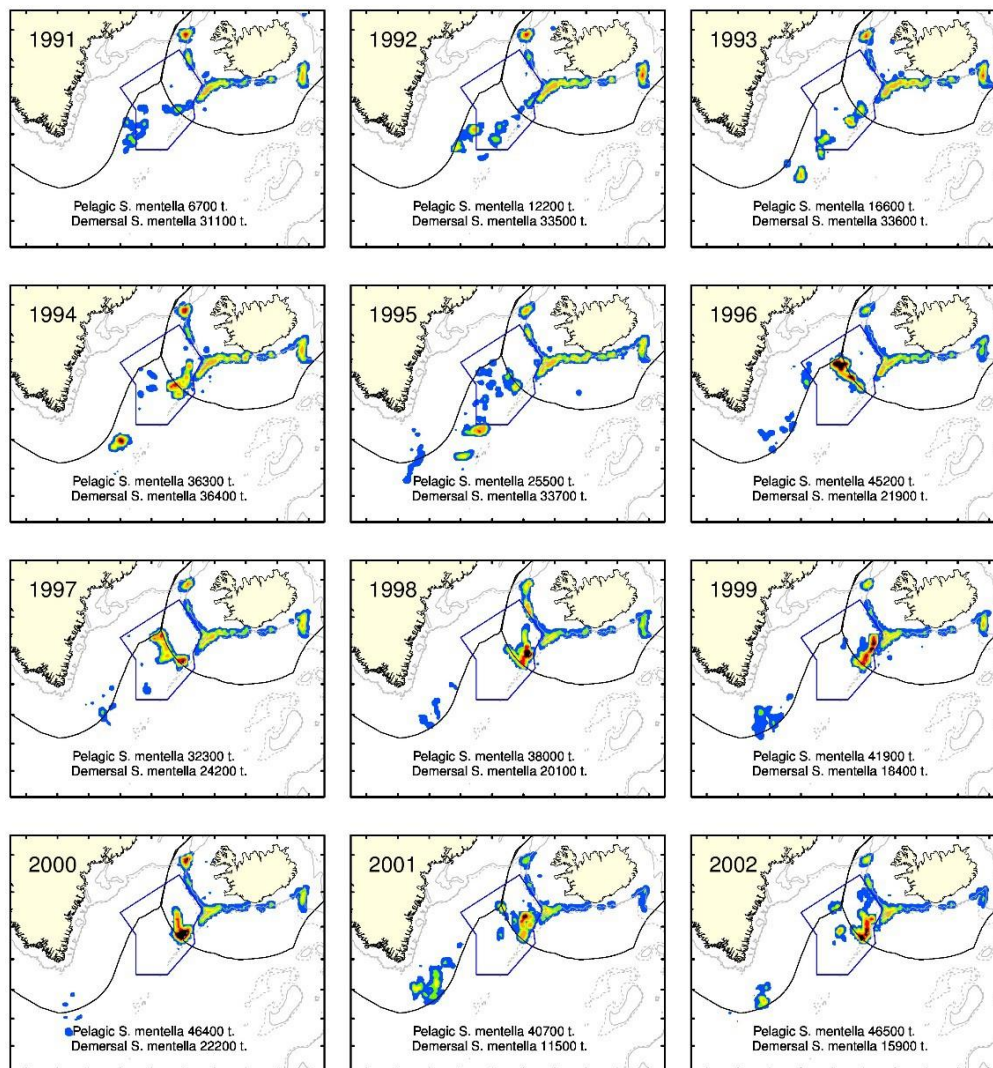


Figure 18.4.1 Geographical distribution of the Icelandic catches of *S. mentella* 1991–2002. The colour scale indicates catches (tonnes per NM2). Not updated for 2019–2020.

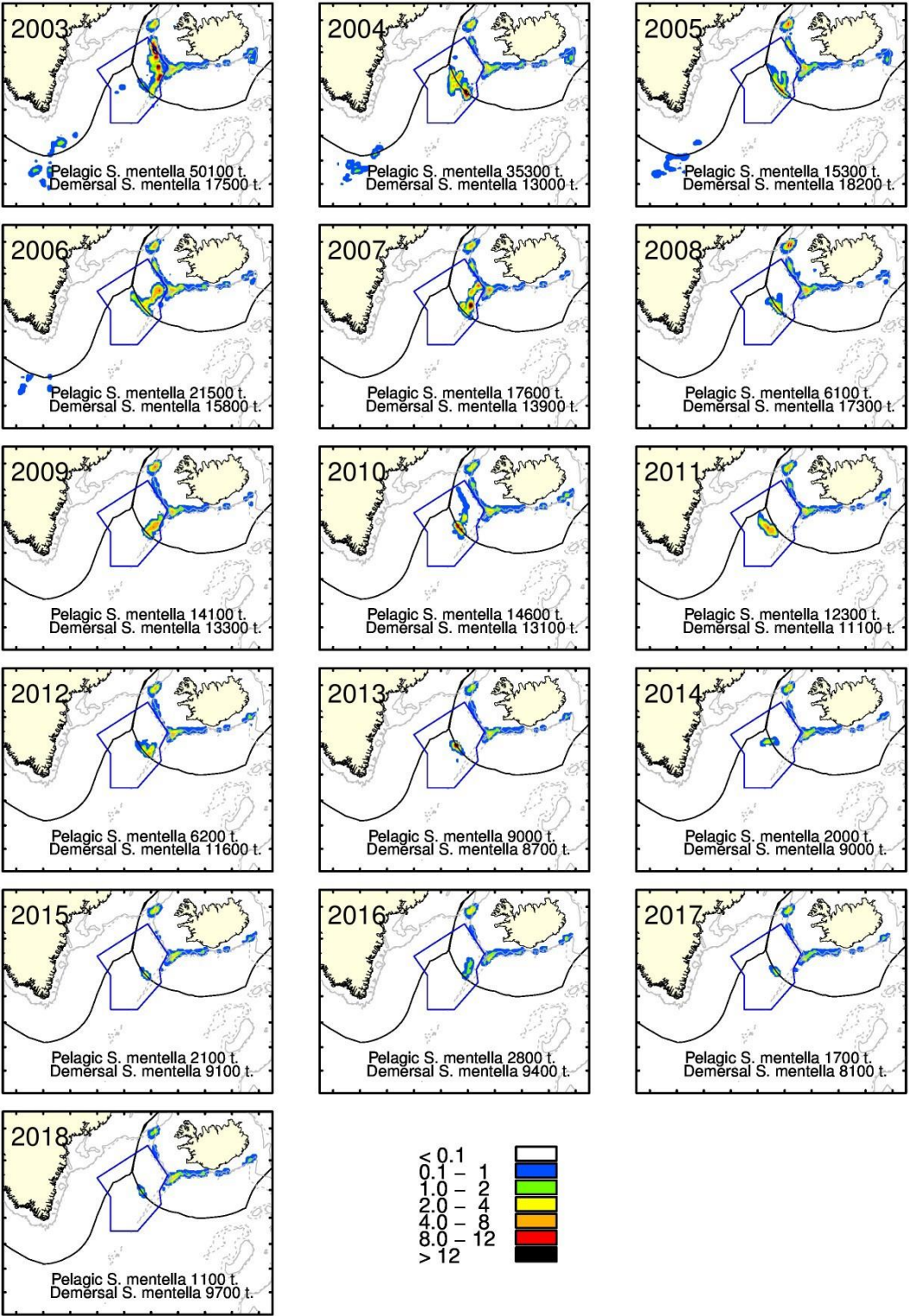


Figure 18.4.1 *cont.* Geographical distribution of the Icelandic catches of *S. mentella* 2003–2018. The colour scale indicates catches (tonnes per NM²). Not updated for 2019–2020.

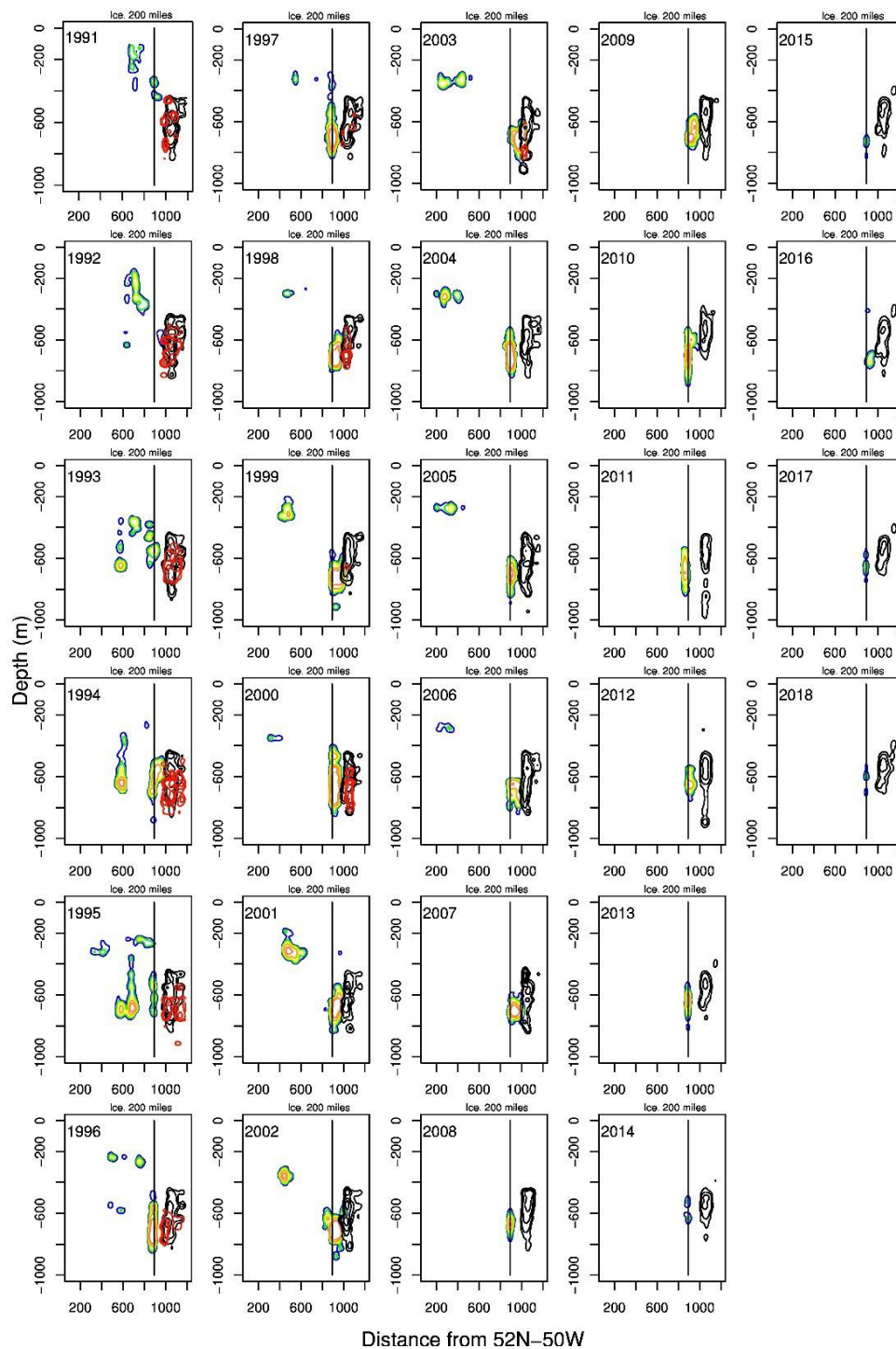


Figure 18.4.2 Distance-depth plot for Icelandic *S. mentella* catches, where distance (in NM) from a fixed position (52°N 50°W) is given. The contour lines indicate catches in a given area and distance. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls. Not updated for 2019-2020.

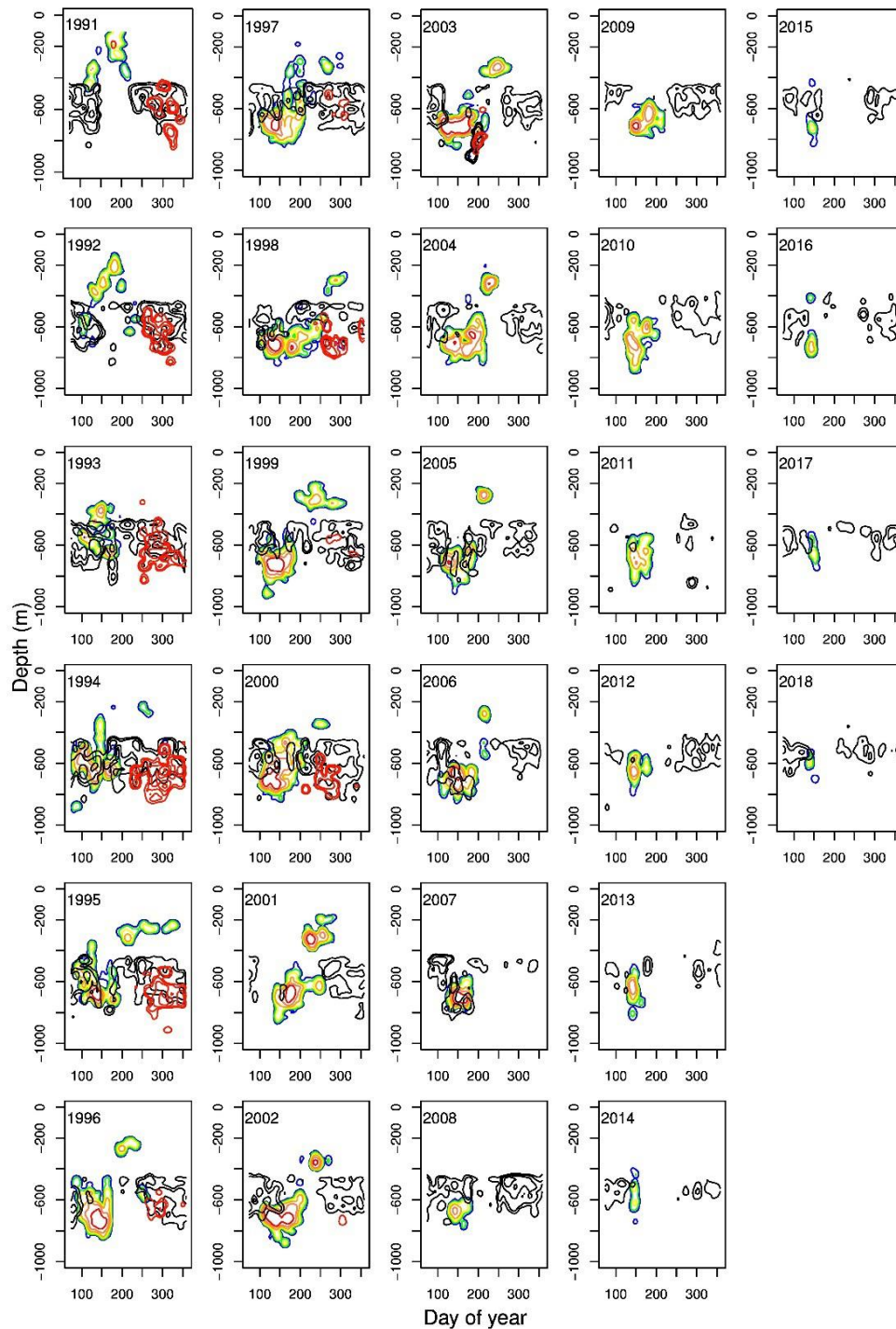


Figure 18.4.3 Depth-time plot for Icelandic *S. mentella* catches 1991–2016 where the y-axis is depth, the x-axis is day of the year and the colour indicates the catches. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls. Not updated for 2019–2020.

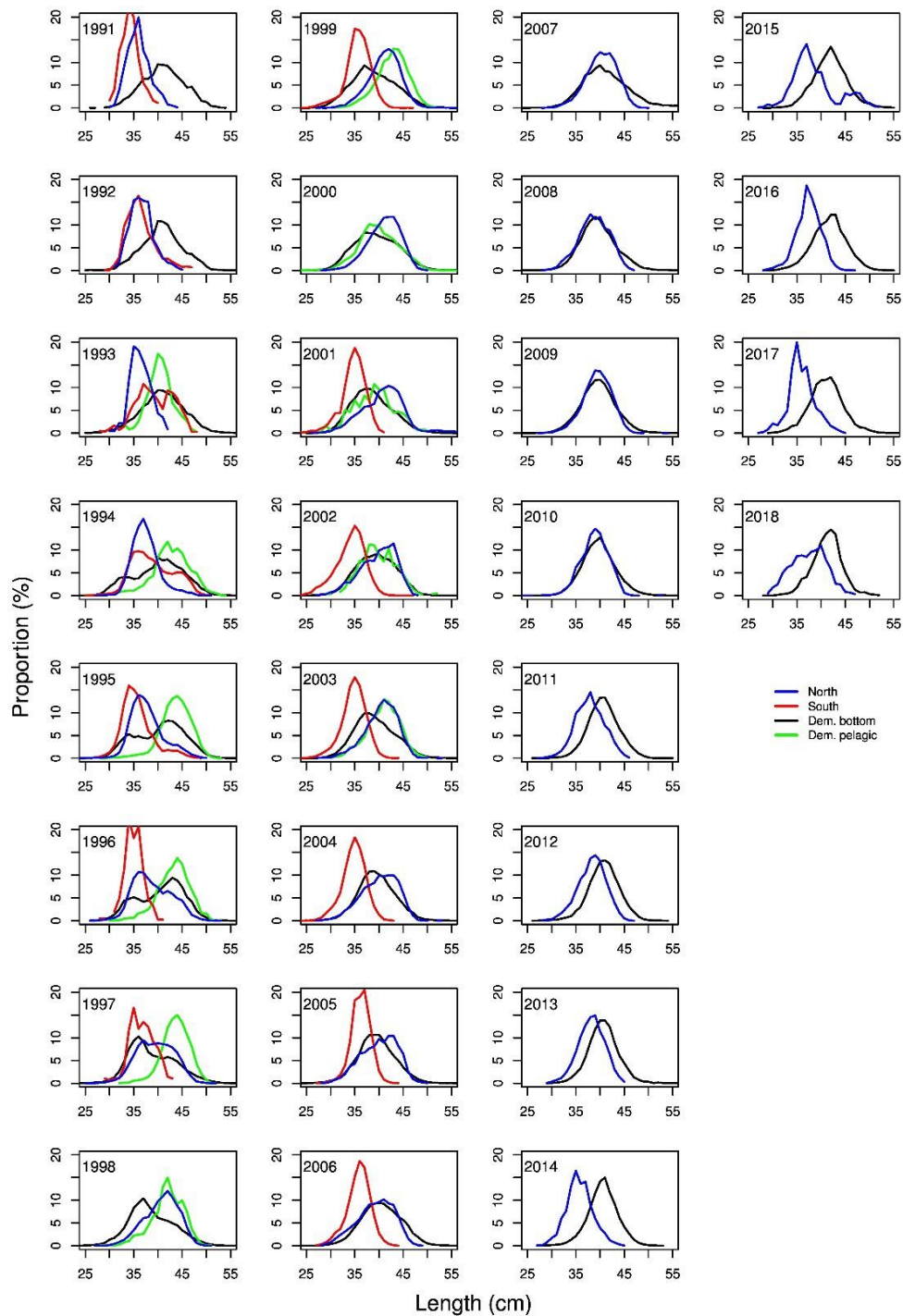


Figure 18.4.4 Length distributions from different Icelandic *S. mentella* fisheries, 1991–2018. The blue lines represent the fishery on pelagic *S. mentella* in the northeastern area, the red lines the pelagic fishery in the southwestern area, the black lines indicate bottom trawl catches of demersal *S. mentella*, and the green lines represent catches of demersal *S. mentella* taken with pelagic trawls. Not updated for 2019–2020.

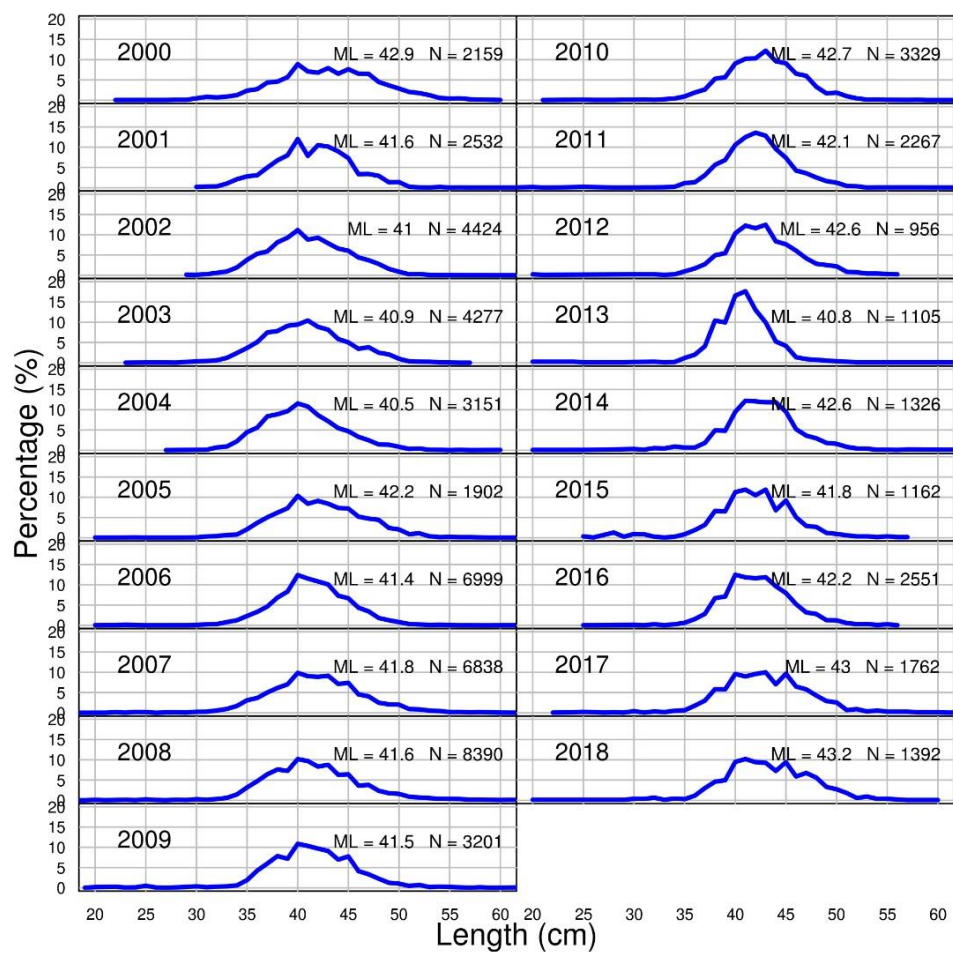


Figure 18.7.1 Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division 5.b 2000–2018. Not updated for 2019 and 2020.

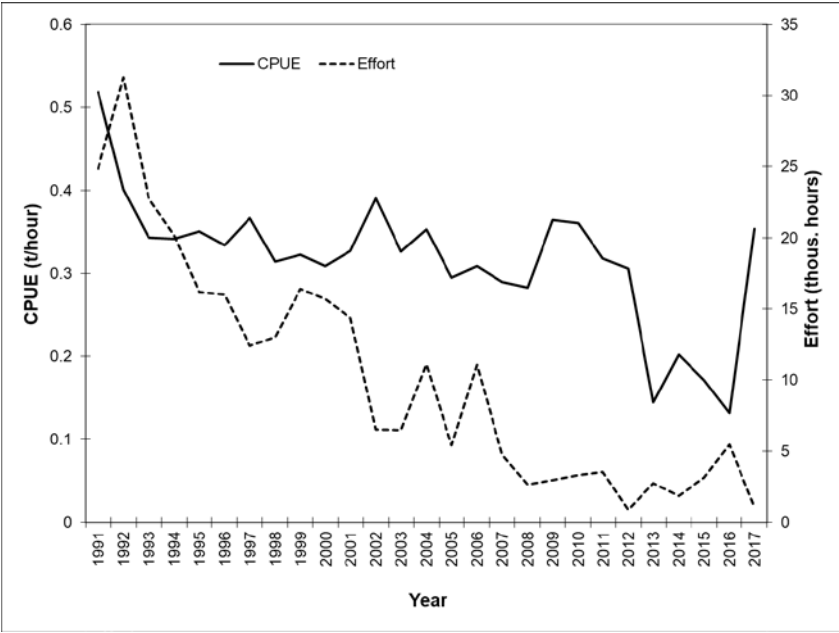


Figure 18.7.2 Demersal *S. mentella*, CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese CUBA fleet 1991–2017 and where 70% of the total catch was demersal *S. mentella*. Not updated for 2018–2020.