

The fishery for pelagic redfish (*Sebastes mentella*) in the Irminger Sea and adjacent waters

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This paper describes the pelagic fishery for deep-sea redfish, *Sebastes mentella*, in the Irminger Sea and adjacent waters, from the start of commercial exploitation of the resource in 1982. The information prior to 1990 is mostly based on ICES reports and unpublished data, but from 1990, logbook data from a joint database on a haul-by-haul basis from the Faroe Islands, Germany, Greenland, Iceland, Norway, and Russia are used to describe the fishery. The nations listed are the main ones operating on the resource, catching about 80% of the total reported catches in recent years. The logbook data include *inter alia* information on positions, catch, and trawling time. Additionally, some nations also include information on gear type and size of gear used, and in some cases also trawling depth. Length distributions of commercial catches from various fleets for the whole period have also been collected, and are shown along with information on the mean lengths in the catches for the whole period. The paper therefore provides a detailed overview of the fishery in terms of area, season, depth, and size composition of the catches from the start of the pelagic fishery to the present, allowing better understanding of the behaviour of the fishery and, in turn, providing improved background for assessment of the resource in the future.

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Introduction

Since 1949, pelagic redfish have been known to live in the Irminger Sea (Tåning, 1949). By use of midwater trawls, hooks, and longlines it was shown that *Sebastes mentella* inhabited the area throughout the year (Sakharov, 1964; Jones, 1968). In 1977, Freytag and Mohr (1977) reported on fishable concentration from catch trials conducted in the north Irminger Sea over the Reykjanes Ridge, in April 1977. The highest catch rates were 2–3 t h⁻¹ during daylight at depths of 330–360 m, and catches comprised mainly females (>90%) in spawning or postspawning condition. Magnússon (1977) also reported on fishable concentrations in that year within the Iceland and Greenland EEZ at latitudes between 62°N and 63°30' N. However, his

catches were much smaller. In 1980, commercial concentrations were detected in the central parts of the Irminger Sea by Soviet scouting vessels (Noskov *et al.*, 1984; Shibano *et al.*, 1984; Pavlov *et al.*, 1989). As a result of those findings, the USSR carried out a research expedition in 1981, the results of which supported the view that commercial fishing could be conducted between spring and summer (Pavlov *et al.*, 1989). In the following year, the USSR and Poland started a commercial fishery on these concentrations and landings exceeded 61 000 t, of which the Soviet portion was 60 000 t (Anon., 2003a). In the years following, more nations took part in the fishery, and landings rose correspondingly to about 105 000 t in 1986, but declined thereafter to just 25 000 t in 1991, owing to a reduction in fishing effort by the former USSR fleet. The main fishing months in

the 1980s were from April to August, and redfish were caught at depths <500 m, mostly between 150 and 400 m.

From 1992 to 1996 landings increased rapidly and reached 180 000 t in 1996 (Table 1). The main reason for this increase was the participation of more nations and vessels in the fishery, technical improvements, including considerable enlargement of the gear, and expansion of the fishery both horizontally into the northwestern Atlantic and vertically down to 1000 m (Anon., 1998). Since 1997, landings have been stable at around 120 000–130 000 t. The fishery has been regulated through total allowable catches (TACs) set by the North-East Atlantic Fisheries Commission (NEAFC) since 1996. This management also covers the Regulatory Area of the Northwest Atlantic Fisheries Organization (NAFO), from which significant landings were reported since 2000. The fleets participating in this fishery have constantly developed their fishing technology, and most trawlers now use large pelagic trawls (“Gloria”-type), with vertical openings between 80 and 150 m.

During the past decade, questions have been raised whether this pelagic redfish fishery exploits one or more stocks that inhabit the Irminger Sea and adjacent waters. The main questions are the extent to which the larger fish, caught at depths >600 m in spring and early summer, are related to the fish taken farther south in the Irminger Sea at depths shallower than 400 m, and also about the unknown relationship between the pelagic and the demersal

redfish caught over the continental shelves of East Greenland—Iceland and the Faroe Islands (Anon., 1998, 2003a).

The main objective of the work presented here was to establish a database for the pelagic redfish fisheries in the Irminger Sea and adjacent waters, one which can be used to strengthen the foundation for the assessment of the resource. Taking the uncertainty in stock structures of redfish into account (Anon., 2004a), detailed information on exploitation activities of the main fishing fleets is considered an important step forward in improving assessment of the stock or its possible stock components as well as the derived management advice to support sustainable exploitation. Another objective is to gather into one document an overview of the fishery since it began in the early 1980s, because it is very unusual to have the opportunity to monitor a fishery on an apparently virgin stock. Following the development of the fishery could result in better understanding of the reaction of the stock to exploitation.

The pelagic fishery for redfish in the Irminger Sea and adjacent waters is a multinational one, with vessels from up to 15 different nations (Anon., 2003a). Germany, Iceland, and Russia have been the major participating nations in the fishery during the past decade, and the Faroe Islands, Norway, and Greenland have also participated for many years. These nations have, on average, reported about 80% of the total reported landings since 1998. Here we present results of the multinational pelagic redfish fishery in the Irminger Sea and adjacent waters since the fishery

Table 1. Pelagic *S. mentella* landings (in tonnes) in ICES Division Va and Subareas XII and XIV, and NAFO Divisions 1F, 2H, and 2J (after Anon., 2004a).

Year	Va	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	Total
1981	0	0	0				0
1982	0	39 783	20 798				60 581
1983	0	60 079	155				60 234
1984	0	60 643	4 189				64 832
1985	0	17 300	54 371				71 671
1986	0	24 131	80 976				105 107
1987	0	2 948	88 221				91 169
1988	0	9 772	81 647				91 419
1989	0	17 233	21 551				38 784
1990	0	7 039	24 477	385			31 901
1991	0	10 061	17 089	458			27 608
1992	1.968	23 249	40 745				65 962
1993	2.603	72 529	40 703				115 835
1994	15.472	94 189	39 028				148 689
1995	1.543	132 039	42 260				175 842
1996	4.744	42 603	132 975				180 322
1997	15.301	19 822	87 812				122 935
1998	40.612	22 446	53 910				116 968
1999	36.524	24 085	48 521	534			109 665
2000	44.677	19 862	50 722	10 815			126 076
2001	28.148	31 751	62 148	5 299	1 284	208	128 838
2002	37.279	23 844	66 133	7 514			134 770
2003	46.676	24 091	57 921	17 635	4 128	325	150 766

was commenced in the early 1980s. The results are based on data obtained from logbooks of most of the vessels participating in the fishery, data published mainly in various ICES assessment reports and ICES CM reports (so-called “grey literature”), and unpublished data, such as personal letters from captains of vessels who participated in the fishery in the 1980s and early 1990s. The data have been collected by scientists, observers, and fishers of many nations. The objective is to give an overview of the fishery in terms of geographical location, depth, and season, as well as the size composition of the catches.

Material and methods

The material consists of published and unpublished information on fishery-related information. Prior to 1990, the information is based entirely on various reports submitted to scientific working group meetings of ICES (e.g. Reports of the North-Western Working Group). The data for the earliest years of the fishery are incomplete, but it is believed that Soviet and German activities in the 1980s do describe the fishery in a representative manner. Information on the activity of the Soviet fleet are available as working documents presented to ICES working group meetings, but also in ICES CM reports (Pavlov *et al.*, 1989; Nagel, 1990; Shibano *et al.*, 1984, 1996). Only limited information from the German fleet is available as reports (Nagel, 1990). Therefore, personal letters and compiled information from the industry are used as basic information. Since 1990, data from some of the fleets participating in the fishery are available in electronic format, but additional information obtained from various reports was also used (Sigurðsson, 2003; Sigurðsson and Reynisson, 1998; Sigurðsson and Þórarinnsson, 1998). An overview of data available in electronic format is given in Table 2. Since 1990, electronic data, stored in a joint database, consist of information on single tows (or data from different fleets and vessel types by week) for the most important fleets participating in the fishery. The available data include information on catches, trawl duration, and geographical positions, representing 80% of the total

Table 2. Available data on electronic format included in the joint database.

Nation	Period	Number of hauls	Catch (t)
Faroese	1995–2003	2 160	31 568
Germany	1995–2003	8 659	141 559
Iceland*	1989–2003	21 815	444 200
Norway	1990–2003	3 783	57 269
Russia	1997–2003	15 109	210 415
Grand total		51 526	885 020

*Including the Greenland data, 1999–2003, because there is only one Greenland vessel.

reported landings in some years. In the database, the aggregation level is individual hauls, but information on individual vessels has been coded to disable individual vessel identification.

The fishery

1982–1991

The former USSR commenced commercial exploitation of pelagic redfish in 1982 and was later joined by (East) Germany, Bulgaria (data not available), and Iceland. Between 1982 and 1988, total annual landings varied between 60 000 and 105 000 t (Table 1). During this period, the USSR was the main nation fishing for the species, and annually landed between 60 000 and 85 000 t. From 1989 to 1991, the total annual landings decreased to about 30 000 t, mainly because of decreased effort by the Soviet and East German fleet.

The fishing activity of the Soviet and East German fleets during this period can be put into three categories: on spawning and prespawning schools in the area west of the Reykjanes Ridge from early April until mid-May; on postspawning fish from late May to mid-June; and on feeding fish from mid-July to the end of the fishing season in August. The areas with highest catch rates of the Soviet fleet were usually in international waters in an area covered by the coordinates 59°N–62°N and 30°W–35°W (Figure 1) and at depths <500 m (Figure 2). The geographical operational location of the East German fishery from 1988 to 1990 was similar to that of the Soviet fishery (Figure 3). Their fishery was conducted mostly at depths of 80–400 m, in deeper water in spring than in summer. At night, the operating depth was usually 80–150 m, and by day 150–250 m, related to the daily vertical movement of redfish. Fish concentrations were most dense at temperatures of 5–6°C.

Most redfish caught by the Soviet fleet from 1982 to 1991 ranged between 33 and 37 cm (Figure 4), with a mean total length of 34.5–36.4 cm (Table 3). The mean length of males was less than females (Table 3). The mean length of the redfish caught by East Germany and Iceland was similar (Table 3). There was also a seasonal difference in the mean length of redfish, slightly larger fish being caught in spring than in summer. This lower mean length in summer was likely due to the greater proportion of males in the catches then, but also perhaps the result of fishing more in shallower water.

1992–1995

In the early 1990s, more nations started to participate in the fishery, and as a consequence the total annual landings increased rapidly, peaking at 175 000 t in 1995. Moreover, the fleet started targeting redfish deeper, at 600–800 m. For instance, the mean depth of trawl of the Icelandic fleet increased from 270 m in 1991 to 600 m in 1994; the same occurred with other national fleets. The increased effort deeper was conducted both within and outside of the

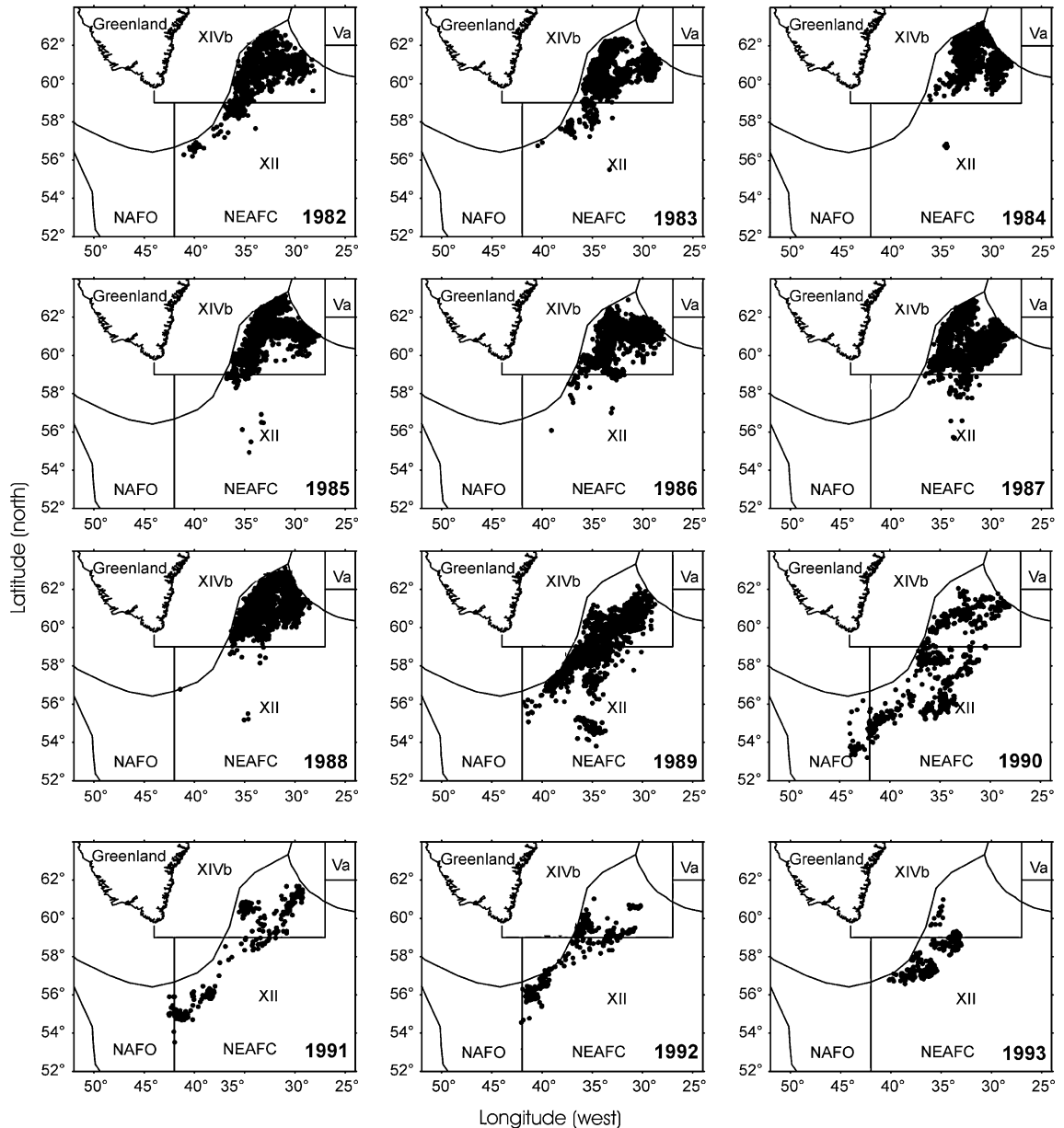


Figure 1. Location of the Soviet Russian fleet fishing *S. mentella* in the Irminger Sea, 1982–1993. ICES statistical areas (Va, XII and XIV), border between regulatory areas (Northwest Atlantic Fisheries Organization and North East Atlantic Fisheries Commission) and national exclusive economic zones are also shown.

Icelandic EEZ in April and May (Figure 5). However, the pelagic fishery within the Icelandic EEZ was only conducted by Iceland. Redfish caught shallower than 500–600 m there were on average about 7 cm larger than the fish caught at depths between 150 and 400 m in the period 1982–1991. The aggregations of fish in deeper water diminished in May, as the fish moved north into the Icelandic EEZ, and the fleet moved towards the southwest. For the rest of the fishing season, the fleet fished in the NEAFC Regulatory Area, delimited by the coordinates

57–58°30'N and 32–36°W (Figure 5). During this period the length of the fishing season increased; in 1995 it extended from March to December, whereas in the period 1982–1991, it did not extend outside the months of April to August.

Since 1996

Total reported annual landings averaged 132 000 t from 1996 to 2003, the minimum being the 110 000 t taken in 1999 and the maximum being the 180 000 t caught in

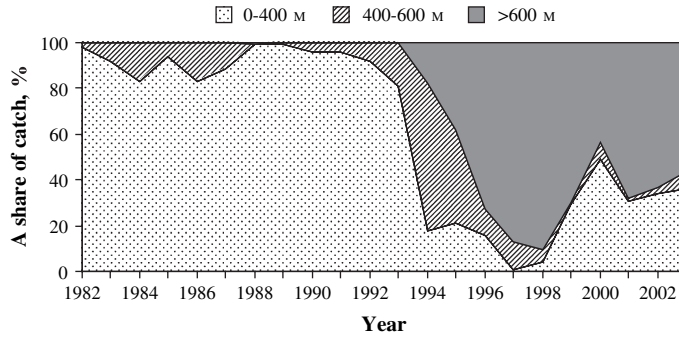


Figure 2. Catch of *S. mentella* in the Irminger Sea by Soviet/Russian vessels at different depth intervals since 1982.

1996. In the same period the fishery changed considerably, and it was conducted in two distinct areas. In the early months of each fishing season, usually from early April until June, the fishery was conducted east of 32°W and

north of 61°N (Figure 6). On average, 69% of the total annual reported landings were caught in this area at that time of year. In July and August, the fleet moved to south of 60°N and west of 36°W, where the fishery continued until the end of the season in October (Figure 6). There was no or little fishing activity from November until late March/early April, when the next fishing season started.

Recently, the summer and the autumn fishery have also extended farther southwest or to the area south of Cape Farwell, Greenland, between 55°N and 59°N, and between 39°W and 44°W (Figure 7). In that area the fishing depth was mainly between 150 and 350 m, and the size of redfish caught was similar to those caught from 1982 to 1991.

The lengths of the fish caught by all five operating nations show two distinct peaks (Figure 8). The redfish caught in the northeastern part of the fishing area from April to June were on average larger (with a peak of 40–42 cm) than those caught later in the fishing season to the southwest (with a peak of 33–38 cm). The apparent changes in the length distributions are not as clear in the mean lengths (Table 3), although the mean length in recent years has been significantly (*t*-test, $p < 0.001$) larger than at the start of the fishery. This may be because more fish have recently been caught in the northeastern part of the fishing ground than in the southwestern part.

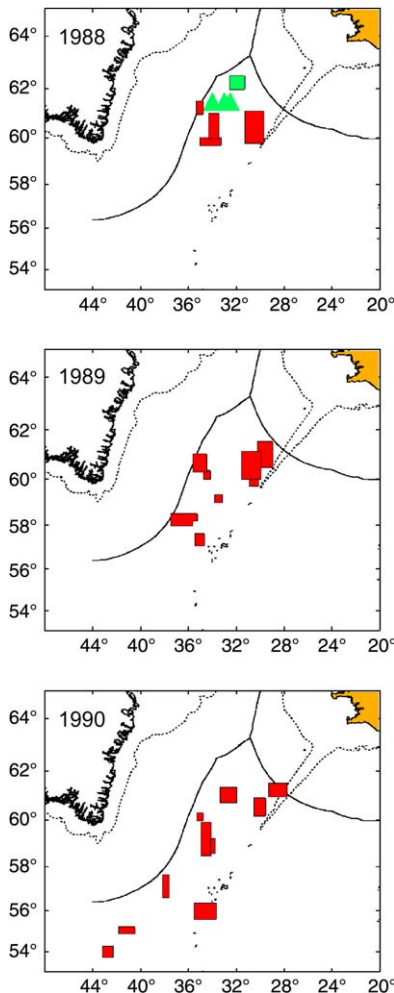


Figure 3. Fishing areas of the East German fleet, 1988–1990. Red indicates the most important fishing grounds and green the area with lower catch rates. Based on unpublished data.

Discussion

Since the Soviet fishery commenced in 1982, the pelagic redfish fishery in the Irminger Sea and adjacent waters has changed considerably. In its first decade the main fishing grounds were in the central Irminger Sea close to the Icelandic and Greenland EEZ, at depths from 150 to 400 m. The fishing season usually started in April and lasted until the end of August. In the early 1990s, more nations took part, and annual landings increased. Fishing areas changed, and two distinct fishing areas emerged. Trawling also took place deeper and the fishing season lengthened. Most fishing was in the northwestern Irminger Sea, within and outside the Icelandic EEZ, at depths from 600 to 900 m, and the fishing season usually started at the beginning of April and ended in June. Fish caught then were larger than fish caught in

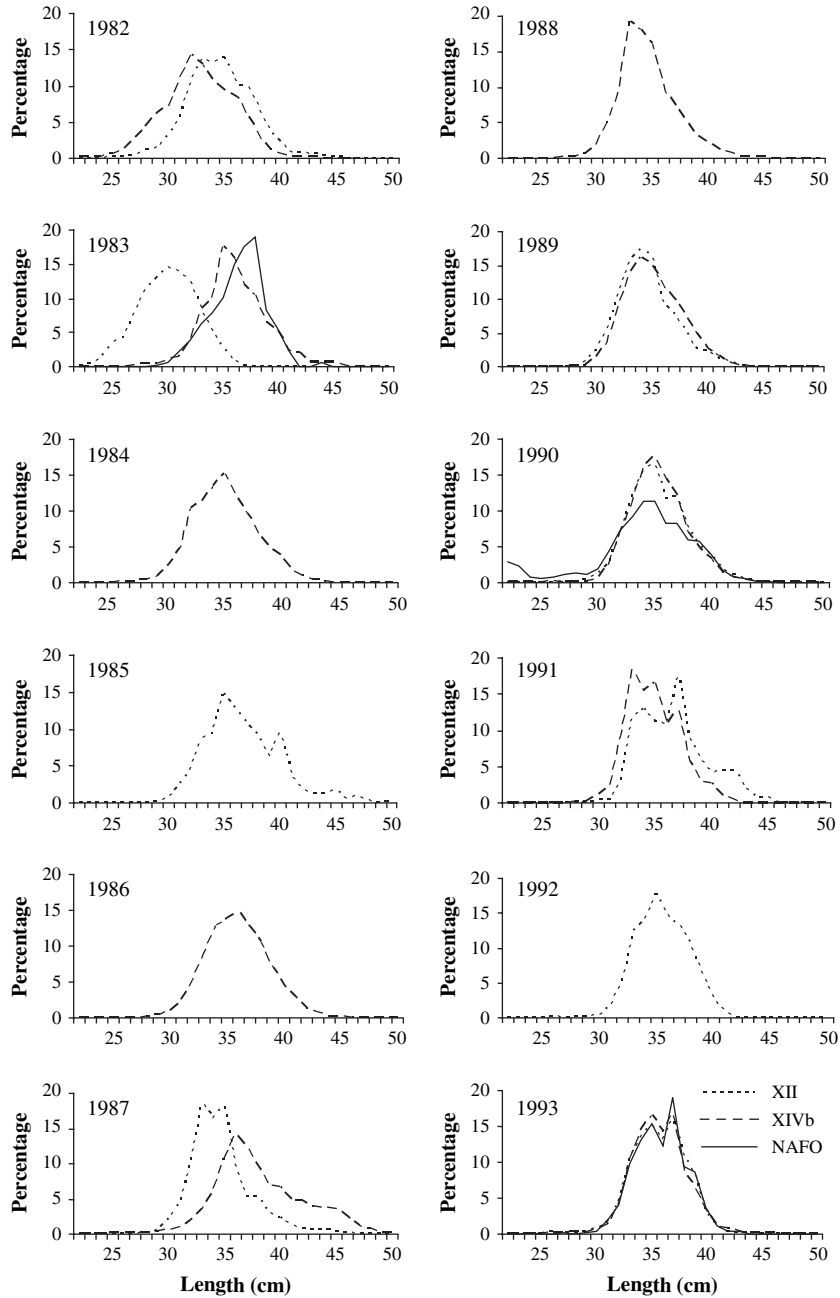


Figure 4. Length distribution of redfish in Soviet/Russian catches, 1982–1993, by ICES statistical areas and within NAFO regulatory area.

the upper layers in the first decade of the fishery. In June/July each year, the fleet moved southwest to south and southeast of Cape Farwell, Greenland. Trawling then took place at depths from 150 to 400 m, and the fish caught were smaller than the fish caught in deeper layers in the northwest of the main fishing area.

Comparing the mean lengths in Soviet/Russian catches by periods (April–June and August–October), representing

the two fishing areas, redfish caught in the northeast (April–June) were on average >5 cm larger than in the southwest (August–October; Table 4). This difference in mean length each year was not observed in the 1980s, when there was no fishing deeper than 500 m and there were no obvious spatial or depth differences. The mean lengths given in Table 4 are given by year, so they are weighted by the catches from different ICES Subdivisions.

Table 3. Mean lengths of redfish in the catches made by nations participating in the pelagic redfish fishery, USSR/Russia, Iceland, Germany, and the former German Democratic Republic (GDR; East Germany). Mean lengths are weighted by catches in different areas. Information is based on various sources (Pavlov *et al.*, 1989; Nagel, 1990; Shibanov and Melnikov, 2001; Melnikov, 2003; Rätz *et al.*, 2003; Sigurðsson, 2003).

Year	USSR/Russia, males	USSR/Russia, females	USSR/Russia, both sexes	Iceland, both sexes	Germany, both sexes	GDR, males	GDR, females
1981	34.4	36.0	35.0				
1982	34.8	36.9	36.4				
1983	34.4	36.6	36.2			33.9	36.8
1984	33.7	35.6	35.0			35.3	38.0
1985	35.0	36.2	36.0			34.3	36.5
1986	34.4	36.3	35.7			34.7	36.7
1987	34.4	36.0	35.5			35.5	36.9
1988	33.8	35.4	34.7			34.1	36.5
1989	34.5	36.1	35.6			33.8	36.3
1990	35.1	34.7	34.8	35.9			
1991	34.7	36.1	35.6		34.8		
1992	36.2	35.2	35.7	38.1			
1993	35.3	35.6	35.5		35.6		
1994	34.8	35.7	35.2	37.3	36.1		
1995	35.6	36.8	36.0	36.5	36.3		
1996	35.1	36.4	35.7	37.8	38.7		
1997	38.0	38.2	38.1	38.9	37.1		
1998	37.1	38.0	37.7	40.8	37.3		
1999	38.7	39.3	39.1	39.5	37.8		
2000	36.5	37.9	37.1	40.6	38.4		
2001	39.9	40.9	40.4	40.2	37.4		
2002	37.6	39.1	38.3	39.4	38.0		
2003	37.8	38.1	37.9				

As the effort on different fishing grounds varies, and there are differences between the size of the fish in each area, changes in mean length between areas are not immediately obvious. Such a way of presenting the data therefore ameliorates the changes that may have occurred in terms of fish size over the past 10 years. Since the fishery started, virtually only sexually mature fish have been exploited in all areas (Anon., 1998, 2003a). Indications of recruitment of immature pelagic redfish from the East Greenland shelves into the Irminger Sea have, however, been recorded, on the basis of survey data (Stransky, 2000).

Several international and national acoustic surveys have been conducted to map the distribution and to estimate stock size of redfish (Melnikov *et al.*, 1988; Pavlov *et al.*, 1989; Magnússon *et al.*, 1992, 1994, 1996; Shibanov *et al.*, 1996; Anon., 1999, 2001, 2003b). Such surveys have usually been conducted bi-annually in June and July at the same time as the fishery has been operating, and have been ongoing. In general, there is concurrence between the distribution of pelagic redfish during the survey with that of the fleet at the same time. It is always difficult to use fishery-related data to describe behaviour or migration routes. However, by comparing the distribution of the fleet with the survey results, it can be concluded that at least during summer, the fishery is

conducted in areas where the main concentration of redfish are found.

Although variable, the available commercial series of catch rate (cpue) has remained stable since 1995 (Anon., 2004b). It is, however, not known to what extent the cpue series reflects changes in the stock status of pelagic redfish. Owing to the nature of a fishery that targets redfish aggregations associated with fronts and eddies (Pavlov *et al.*, 1989; Nagel, 1990; Sigurðsson and Reynisson, 1998), a commercial fishery cpue does not necessarily indicate the real status of the stock or stocks. As a consequence, cpue can be relatively stable even when the stock size is diminishing. Nevertheless, this database has been the basis for the advice given by ICES from 1995 to 2004 (Anon., 2003a). In autumn 2004, ICES decided to abandon the cpue series as a basis for its advice for reasons similar to those given above, and to base their advice on the results from the international surveys (Anon., 2004a).

Since the fishery started, the number of nations participating in the pelagic redfish fishery, and hence the number of vessels, has increased. Although the total number of vessels involved in the fishery over the years is not known with accuracy, it is not unrealistic to infer that the number participating in the fishery each year was close to 100, at least in recent years. The officially reported number of vessels in

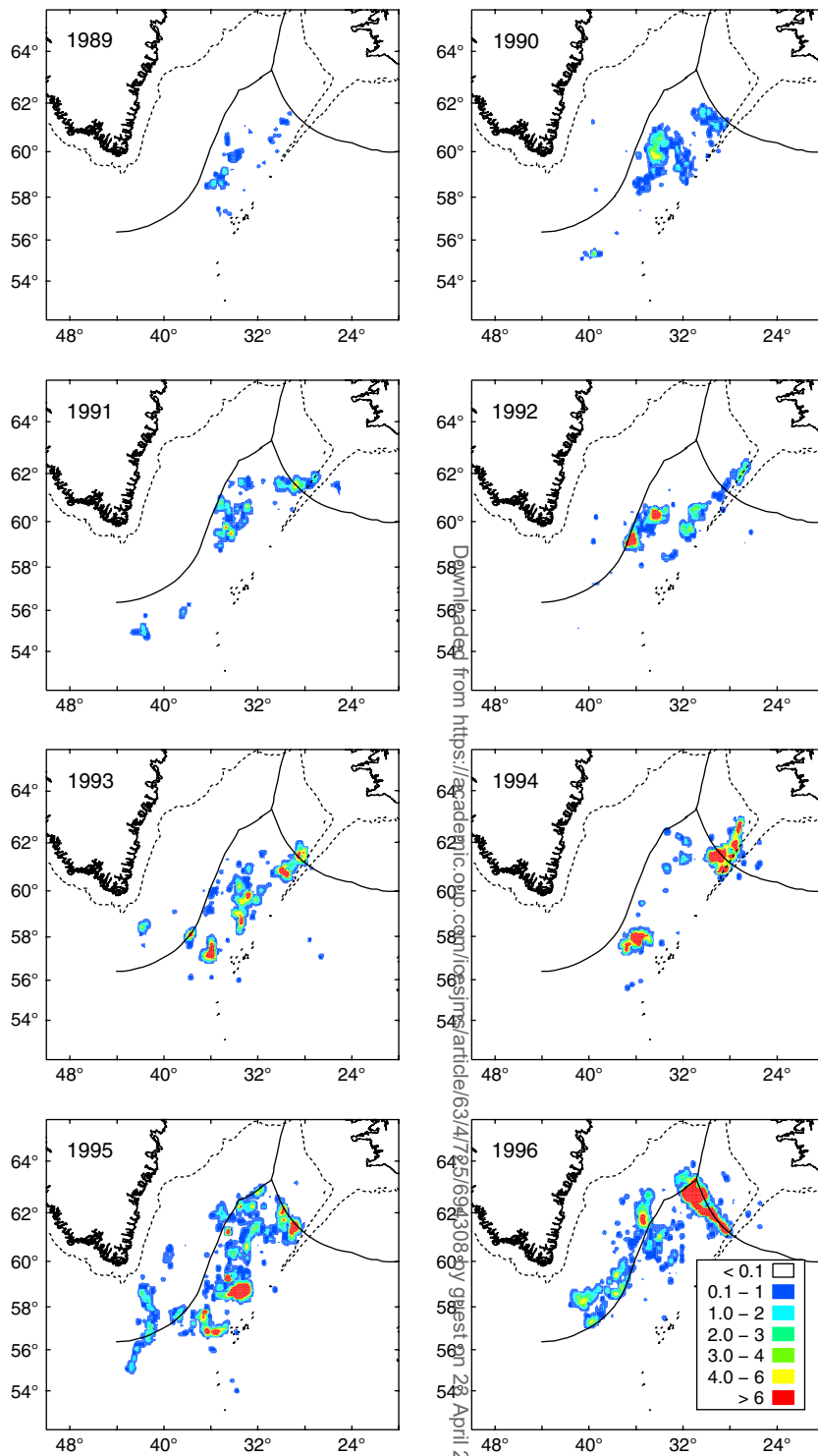


Figure 5. Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters, 1989–1996. Data are from Germany (1995–1996), Norway (1990–1996), the Faroe Islands (1995–1996), and Iceland (1989–1996). The scale given is tonnes per square nautical mile.

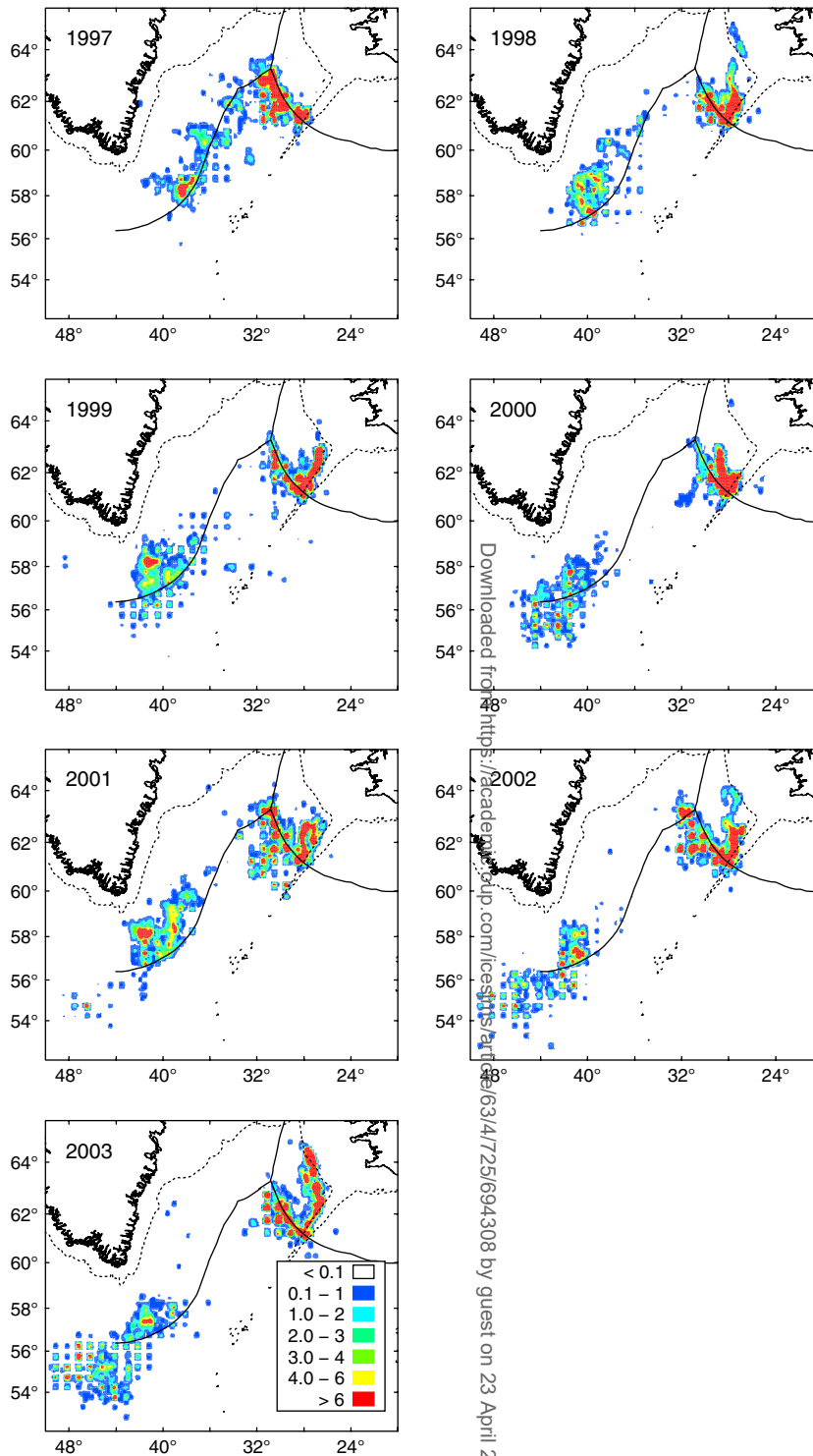


Figure 6. Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters, 1997–2003. Data are from Germany (1997–2003), Norway (1997–2003), Greenland (1999–2003), Russia (1997–2003), the Faroe Islands (1997–2003), and Iceland (1997–2003). The scale given is tonnes per square nautical mile.

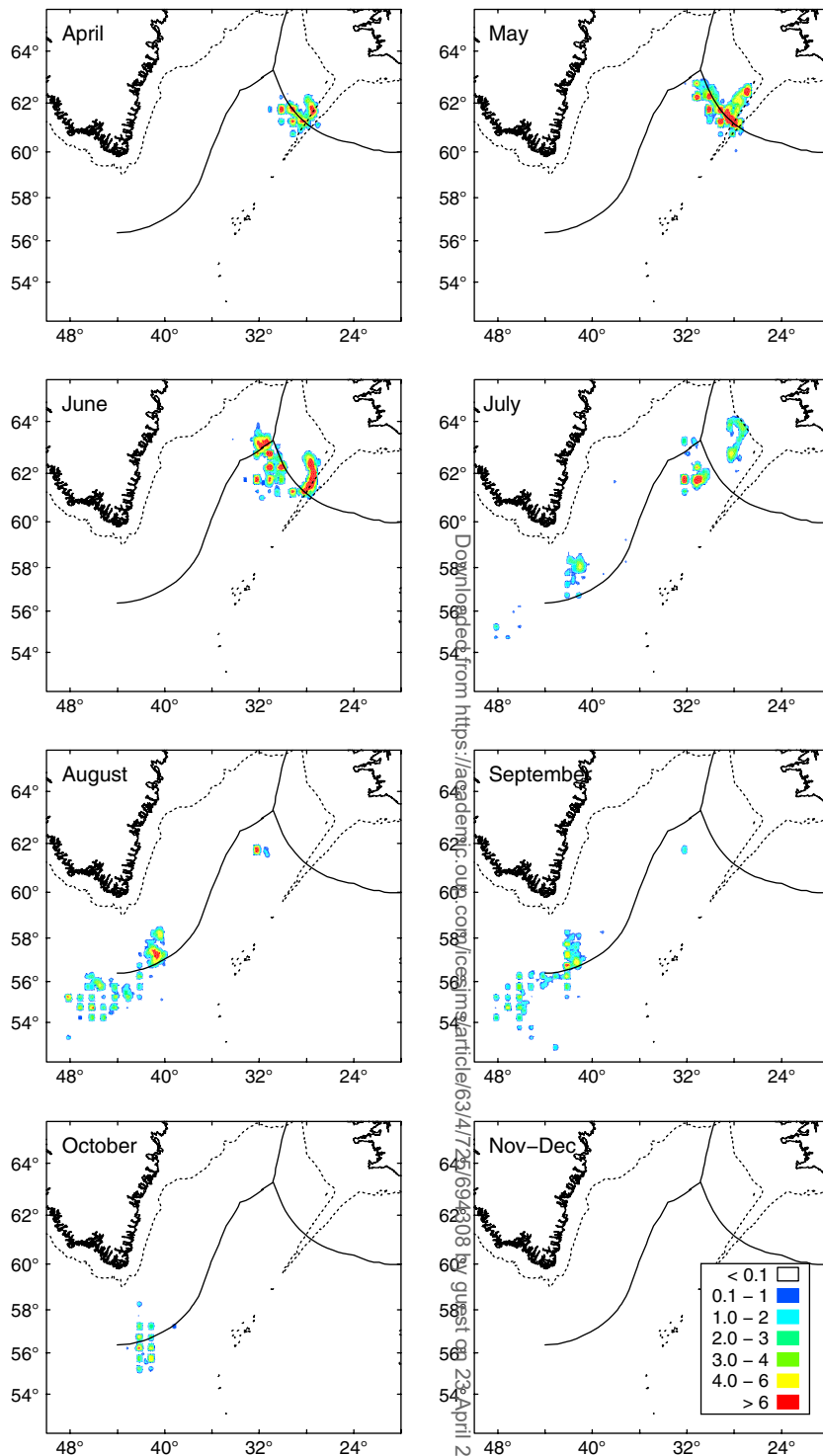


Figure 7. Fishing areas and total catch of pelagic redfish (*S. mentella*) by month in 2002 derived from catch statistics provided by Germany, Norway, Iceland, and Greenland. The scale for the catch is tonnes per square nautical mile.

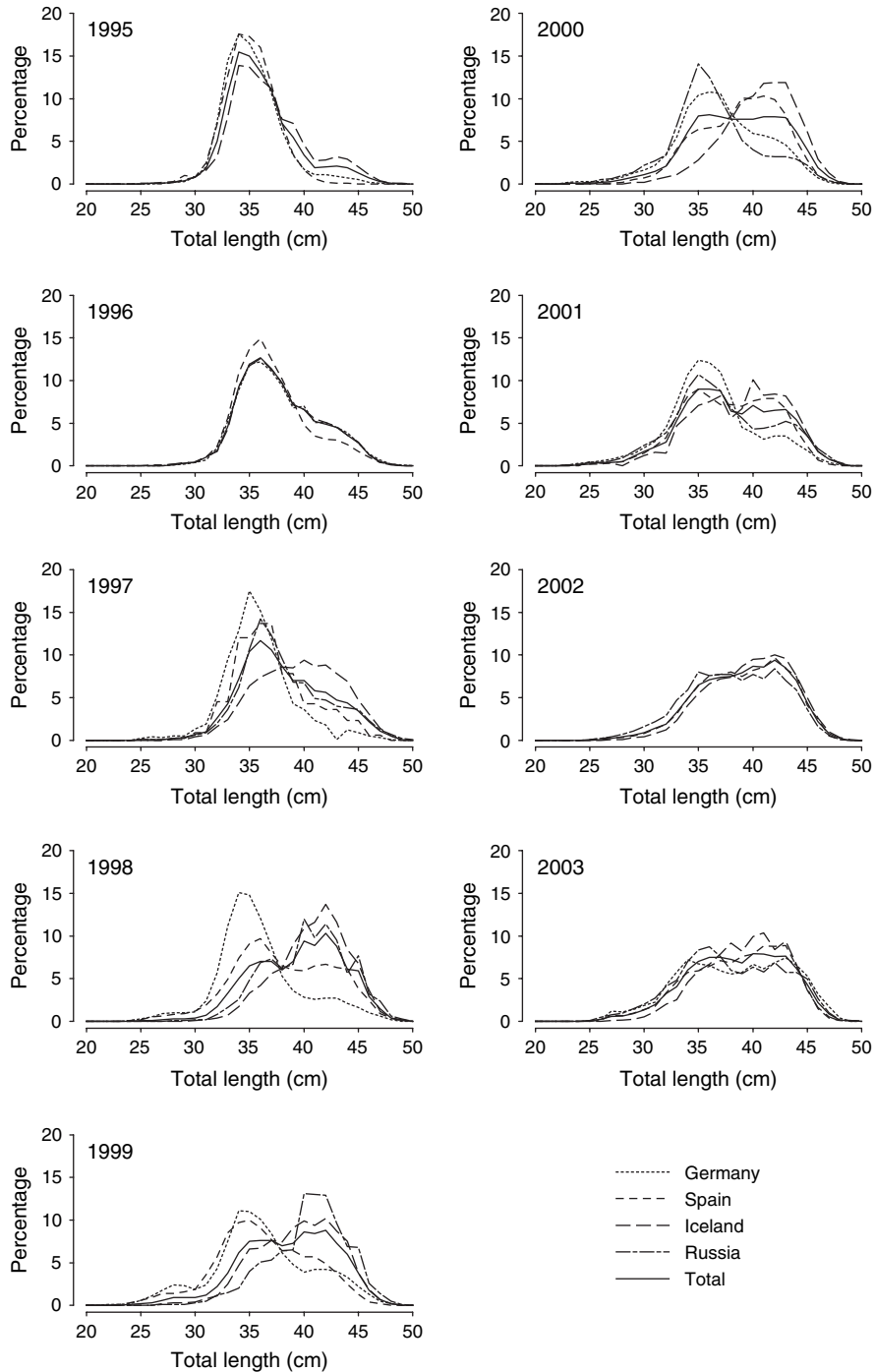


Figure 8. Length distribution of pelagic redfish catches, 1995–2003 by nations (based on data from Anon., 2004b).

2002 was 81 (Anon., 2003a). However, official figures do not take into account vessels from nations that do not report their vessels and catches. Total estimated catches are therefore also likely to be underestimated.

As the numbers of vessels and nations involved in the fishery for pelagic redfish are quite high, it is important to gather fishery-related information from as many as possible to have an acceptable overview of the fishery in terms

Table 4. Average length of *S. mentella* in Soviet/Russian catches, April–June and August–October.

Period	April–June (cm)	August–October (cm)	Difference (cm)
1982–1991	35.7	35.8	0.1
1998–2004	39.5	34.3	5.2

of area, season, and catch quanta. As the nations who catch most redfish are included in the joint database, the database is therefore considered to describe the fishery of the pelagic redfish in a representative manner.

Acknowledgements

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