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Distribution Patterns and Selected Stock Parameters of Pelagic Redfish
"Oceanic *Sebastes mentella*" in the NAFO and NEAFC Convention Areas

by

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Abstract

Most recent distribution patterns and selected biological parameters of "oceanic *S. mentella*" derived from international surveys and the German commercial fleets classify the stock as highly migratory. The pelagic redfish aggregations of "oceanic *S. mentella*" discovered recently in the NAFO Div. 1F in 1999 and 2000 are considered as a part of that stock which is mainly distributed in the NEAFC Convention Area where it is currently managed as a single stock unit. Based on the 1999 international survey results not less than one third of that stock (minimum estimate) was found distributed in the NAFO Div. 1F. In addition, the high similarity in biological parameters like size composition and maturity does not suggest that the pelagic redfish "oceanic *S. mentella*" distributed across the NEAFC and NAFO Conventions Areas might belong to separate stocks.

The supported hypothesis that the recently discovered pelagic redfish concentrations in the NAFO Div. 1F consist mainly of fish emigrated from the NEAFC "oceanic *S. mentella*" stock requires a joint NAFO/NEAFC management without additional catch options in excess of the NEAFC agreements. The mandatory use of a 130 mm mesh inside the NAFO Regulatory Area is considered ineffective in protecting juveniles during the pelagic redfish fishery and could be reduced to the 100 mm mesh regulation in order to avoid unnecessary investments.

Introduction

A pelagic stock of deep sea redfish (*Sebastes mentella*) with main distribution of adult fish in the open Irminger Sea was defined by the ICES Study Group on Redfish Stocks in 1992 (ICES 1992) and named "oceanic *S. mentella*" opposed to *S. mentella* on the shelves which then was named "deep-sea *S. mentella*". The spawning (larval extrusion) area of "oceanic *S. mentella*" is to the West of the Reykjanes Ridge in the open Irminger Sea, geographically overlapping the spawning areas of the deep-sea *S. mentella* on the continental shelves inside the Greenland and Icelandic EEZs. The location of the nursery areas is not known exactly but the pelagic fry drifts towards Greenland, and it is indicated that nursery areas are along the coast of East Greenland (Magnússon and Magnússon, 1995; Stransky, 2000). Feeding and copulation areas are located mainly in the international parts of the Irminger Sea as well as in the national EEZ of Greenland. The status of "oceanic *S. mentella*" as a separate stock, however, remains unclear and was subject of some controversy over the past (e.g. ICES 1992, 1993 and 1998a). The existence of a 'pelagic deep-sea' *S. mentella* in the Irminger Sea below 500 m of depth, as proposed by Icelandic scientists, also remains uncertain (ICES 1998a). Recent investigations indicate migration of juvenile *S. mentella* from the East Greenland shelf into the Irminger Sea in water depths above and below 500 m (Stransky, 2000).

Russian trawlers started fishing "oceanic *S. mentella*" in 1982. Vessels from Bulgaria, the former GDR and Poland joined those from Russia in 1984. Total catches increased from 60,600 t in 1982 to 105 000 t. in 1986. Since 1987, the

total landings decreased to a minimum in 1991 of 25 000 t. The main reason for this decrease was a reduction in fishing effort, especially by the Russian fleet. Since 1989, the number of countries, participating in the pelagic *S. mentella* fishery gradually increased. As a consequence, total catches have also increased and reached the historically highest level in 1996 at 180 000 t. In 1998 and 1999, the estimate of the ICES North-Western Working Group of the catch has been between 110 000 and 120 000 t, respectively (ICES 1998b, 1999, 2000). In the period 1982–1992, the fishery was carried out mainly from April to August. Since 1993, the fishing season was prolonged considerably and covers the periods from March to December. The peak seasons are, however the second and third quarters. The fleets participating in this fishery have continued to develop their fishing technology, and most trawlers now use large pelagic trawls ("Gloria"-type) with vertical openings of 80–150 m. The vessels have operated in 1998 and 1999 at a depth range of 200 to 950 m, but mainly deeper than 600 m during the spawning season in the second quarter (ICES 2000). The German fishery is believed to be a good indicator for various stock parameters since it operated during most seasons all over the distribution area of "oceanic *S. mentella*".

Material and Methods

Hydro-acoustic surveys

From the onset of the commercial fishery on oceanic redfish in 1982, the former Soviet Union (later Russia) conducted acoustic surveys in the Irminger Sea. Iceland started with a pilot acoustic survey in 1991 (Magnússon *et al.* 1992a) and conducted a survey in 1992, which was intended to be carried out in cooperation with Russia in 1992 but finally presented as separate surveys (Magnússon *et al.* 1992b). The 1992 surveys proved the need for a wider area coverage (ICES 1994), thus Iceland and Norway carried out a survey in 1994 (Magnússon *et al.* 1994), followed by surveys in 1996 (Magnússon *et al.* 1996) and 1999 (Sigurdsson *et al.* 1999) with participation of Iceland, Russia and Germany. Beside these international surveys, Russia conducted surveys in 1993 (Shibanov *et al.* 1994), in 1995 (Shibanov *et al.* 1996, Pedchenko *et al.* 1997) and 1997 (Melnikov *et al.* 1998). Icelandic scientists conducted a survey in 1998 to map the deeper layer redfish distribution patterns below 500 m depth (Sigurdsson and Reynisson 1998). The most recent international hydro-acoustic survey in June/July 1999 also provided an expanded vertical coverage of the survey area, i.e. redfish below 500 m depth were assessed by an experimental trawl-acoustic method. Details of the survey settings and methods are given in ICES 1999b and Sigurdsson *et al.* 1999. An overview of the available survey information is given in Table 1. The 1999 abundance and biomass estimates split into the NAFO and NEAFC areas by depth zones above and below 500 m are given in Table 2. Presented length compositions of the "oceanic *S. mentella*" listed in Table 3 are based on measurements with the precision of cm below. The proportion of mature males and females is derived from visual inspections of the gonads. Maturity stages were noted according to the agreed description given by the ICES Study Group on Redfish Stocks (ICES 1993).

Sampling of commercial catches of the German fleet

For the period 1995-2000, data on commercial catches, effort (hours fished) and positions were derived from official logbook statistics. The data values are aggregated by year and quarter as well as the NEAFC and NAFO areas. Unstandardised mean CPUE (kg/h) are calculated on a haul-by-haul basis. The majority of vessels were equipped with Gloria-type pelagic trawls with a vertical net opening of 120 m and a mesh size of 100-140 mm in the cod end. Towing speed varied between 2.8 and 3.8 knots.

Length frequencies of the catches were derived from measurements conducted directly on board of commercial trawlers. The total body length was measured to cm below. Length compositions of the catches by year and quarter were determined by aggregation of samples being raised to catches or landings according to sample weights.

Results

Geographical distribution patterns of "oceanic *S. mentella*"

It must be noted that none of the consistent international June/July surveys of the past decade has succeeded in identifying the distribution boundaries of "oceanic *S. mentella*". However, the overall distribution of oceanic redfish above 500 m depth has been relatively stable over the past decade (Fig. 1a and b) with the exceptions in 1997 and 1999. During the last decade, higher concentrations were repeatedly located in the NEAFC region south and southeast off Greenland along the Greenland EEZ at 57-62°N with a decreasing trend to the west. However,

especially the 1999 records display a major change in the distribution patterns when there was a major southwestern move of the stock observed. In 1999, there were very few redfish encountered in the traditional distribution area along the Greenland EEZ off East Greenland but highest concentrations were observed in the NAFO Regulatory Area (Div. 1F). One third of the stock in numbers and biomass was found in the NAFO Division 1F, respectively (Table 2). However, these survey estimates should be interpreted as underestimated due to the limited area coverage southwest of Greenland. Information on redfish distribution below 500 m has become available only since a few years. The Russian survey in 1997, the Icelandic survey in 1998 (Sigurdsson and Reynisson 1998) and the international survey in 1999 showed high concentrations of “oceanic *S. mentella*” west off the Reykjanes Ridge between 61-62°N (Fig. 1b). Below 500 m depth there is a clear decreasing trend in abundance evident from east to southwest.

The geographical effort distribution of the German commercial fleets fishing for “oceanic redfish” is illustrated in Figures 2a-d and 3 a-d for the periods 1995-1999 and 2000, respectively. There are also catch and effort values broken down by area and quarter given in Table 3 and illustrated in Figures 4-6. Both sources of information reveal that there have been only negligible commercial activities targeting “oceanic redfish” in the NAFO Regulatory Area before 2000 but that the German fleets have been working significantly in NAFO Div. 1F for the first time during the second half of 2000. One third of the annual effort (4 120 hours) and catch (4 500 t) was taken in NAFO Div. 1F in international waters (NAFO Regulatory Area) as well as the Greenland EEZ. The Figures 2a-d and 3a-d also indicate the seasonal pattern of the fishery, which starts in the north-eastern Irminger Sea close to the Icelandic EEZ at depths beyond 500 m and moves into south-western direction along the Greenland EEZ fishing at depths above 500 m at later seasons. In addition to the generally decreasing trend in the CPUE it is shown that the observed catch rates during the third and fourth quarter in 2000 in the NAFO Div. 1F were similar to those recorded recently in the NEAFC area (Fig. 6).

Biological parameters of oceanic “*S. mentella*”

Length frequencies of the redfish stock as observed during the 1999 June-July international hydroacoustic survey are illustrated in Figure 7 and listed in Table 4 for both the NAFO Div. 1F and the NEAFC area and the depth zones above and below 500 m. In both areas the most frequent length groups were 34-36 cm above 500 m depth with bigger fish being distributed predominantly in the NEAFC area below 500 m. There are also no differences observed in the size composition of the German catches taken in the third and fourth quarters in 2000 in both the NAFO and NEAFC areas at depths less than 500 m (Fig. 8). However, redfish taken in the second quarter in 2000 in the NEAFC area were significantly bigger since the fishery targeted the female spawning concentrations below 500 m depth at that time.

The similarity in size compositions of survey and commercial catches illustrates that there are very few juveniles distributed in the fishing grounds. The percentage of immature fish in all catches is significantly lower than 20 %. Recruits have been indicated to be originated from the East Greenland continental shelves and to recruit to the “oceanic *S. mentella*” stock when they almost reached maturity at lengths of 28-30 cm (Stransky, 2000).

Discussion and Conclusions

Most recent distribution patterns of “oceanic *S. mentella*” derived from international surveys and the German commercial fleet activities classify the stock as highly migratory and do support the assessment of the NAFO Scientific Council, i.e. the “oceanic *S. mentella*” observed in the NAFO Div. 1F in 1999 and 2000 are considered as a part of the stock which is distributed in the NEAFC Convention Area where it is currently managed as a single stock unit (NAFO, 2000). Based on the 1999 international survey results not less than one third of that stock (minimum estimate) was found distributed in the NAFO Div. 1F where it never before was indicated to occur with high abundance by the limited survey information. The movement of the stock into the NAFO Convention Area is especially demonstrated by the simultaneous decrease in abundance in its traditional distribution area off Southeast Greenland along the EEZ. In addition, the high similarity in biological parameters like size composition and maturity does not suggest that the pelagic redfish “oceanic *S. mentella*” distributed across the NEAFC and NAFO Conventions Areas might belong to separate stocks. During the past two decades of fishing, the international and German commercial trawlers operated close to but never before 2000 significantly inside the NAFO Convention Area. Limited data do not allow any conclusions related to the questions whether the indicated movement of the redfish is an accidental effect or part of changes in regular distribution patterns (migrations).

The supported hypothesis that the recently discovered pelagic redfish concentrations in the NAFO Div. 1F consist mainly of fish emigrated from the NEAFC “oceanic *S. mentella*” stock requires a joint NAFO/NEAFC management without additional catch options in excess of the NEAFC agreements.

Considering both the continued low presence of juveniles (<20%) on the fishing grounds and the generally poor size selection of the spiny redfish by pelagic trawls, the fishery in the NEAFC regulatory area and the Greenland EEZ is conducted with a 100 mm diamond mesh. Thus, the mandatory use of a 130 mm mesh inside the NAFO Regulatory Area is considered ineffective in protecting juveniles during the pelagic redfish fishery and could be reduced to the 100 mm mesh regulation in order to avoid unnecessary investments.

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Table 1. Available information on surveys for oceanic redfish 1982-1999.

Country	Date	Depth of hydroacoustic measurements	Distribution maps
Russia	1982-1991	?	?
Iceland	June 1991	10-550 m	x (area incomplete)
Russia	May-July 1992	100-350 m	x
Iceland	June/July 1992	<500 m	x
Russia	May-July 1992	<500 m	x
Russia	June/July 1993	70-700 m (?)	x
International	June/July 1994	<500m	x
Russia	June/July 1995	150-850m	x
International	June/July 1996	<500m	x
Russia	June/July 1997	0-900m	x
Iceland	May 1998	0-800m	x (area incomplete)
International	June/July 1999	0-950m	x

Table 2. Abundance and biomass of oceanic redfish (*S. mentella*) in NAFO Div. 1F and NEAFC by areas (Regulatory Areas and EEZs) above and below 500 m depth, derived from the 1999 international hydroacoustic survey.

	NAFO		NEAFC			Sum
	NRA	Greenland EEZ	NRA	Greenland EEZ	Iceland EEZ	
Abundance (*1000 indiv.)						
<500 m	290947	248909	394935	230102	1106	1166000
Ratio	0.25	0.21	0.20	0.34	0.00	1
>500 m	29348	44660	367488	117392	79112	638000
Ratio	0.05	0.07	0.58	0.18	0.12	1
Sum	320295	293569	762423	347494	80218	1804000
Ratio	0.18	0.16	0.42	0.19	0.04	0.99
Biomass (tonnes)						
<500 m	148717	127230	201871	117617	565	596000
Ratio	0.25	0.21	0.20	0.34	0.00	1
>500 m	22862	34790	286272	91448	61628	497000
Ratio	0.05	0.07	0.58	0.18	0.12	1
Sum	171579	162020	488143	209065	62193	1093000
Ratio	0.16	0.15	0.45	0.19	0.06	1

Table 3. Catch, Effort and CPUE as observed in the German fishery for oceanic redfish in the NEAFC and NAFO areas, 1995-2000*. *) provisional.

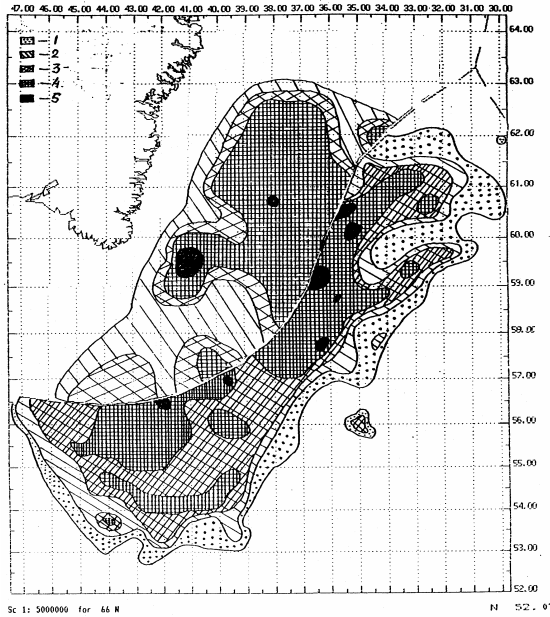
Year	Quarter	Total			NEAFC			NAFO		
		Catch (t)	Effort (h)	CPUE (kg/h)	Catch (t)	Effort (h)	CPUE (kg/h)	Catch (t)	Effort (h)	CPUE (kg/h)
1995	1	1072	817	1392	1072	817	1392	0	0	
1995	2	10333	5782	2552	10333	5782	2552	0	0	
1995	3	4981	4637	2292	4981	4637	2292	0	0	
1995	4	2513	3011	855	2513	3011	855	0	0	
1995		18900	14247	2055	18900	14247	2055	0	0	
1996	1	533	1444	434	533	1444	434	0	0	
1996	2	9604	8591	1253	9604	8591	1253	0	0	
1996	3	9051	5971	1969	9051	5971	1969	0	0	
1996	4	2111	2449	1006	2111	2449	1006	0	0	
1996		21299	18455	1452	21299	18455	1452	0	0	
1997	1	91	116	825	91	116	825	0	0	
1997	2	6153	7286	877	6153	7286	877	0	0	
1997	3	9853	7921	1468	9853	7921	1468	0	0	
1997	4	4344	3254	1626	4344	3254	1626	0	0	
1997		20446	18578	1310	20446	18578	1310	0	0	
1998	1	4	209	19	4	209	19	0	0	
1998	2	5889	6510	938	5889	6510	938	0	0	
1998	3	9578	6769	1629	9578	6769	1629	0	0	
1998	4	2575	2352	1251	2575	2352	1251	0	0	
1998		18046	15839	1301	18046	15839	1301	0	0	
1999	1	0	0		0	0		0	0	
1999	2	8472	8051	1072	8472	8051	1072	0	0	
1999	3	6823	7830	924	6669	7599	931	154	231	663
1999	4	1192	1817	673	1192	1817	673	0	0	
1999		16487	17698	968	16333	17467	972	154	231	663
2000	1	0	0		0	0		0	0	
2000	2	6728	6984	987	6728	6984	987	0	0	
2000	3	5284	5224	1150	1292	1680	819	3992	3544	1286
2000	4	486	579	871	3	5	619	483	574	878
2000		12498	12787	1050	8023	8669	955	4475	4118	1231

Table 4. Length distribution of oceanic redfish (*S. mentella*) in NAFO area 1F and NEAFC above and below 500 m depth, derived from the 1999 international hydroacoustic survey.

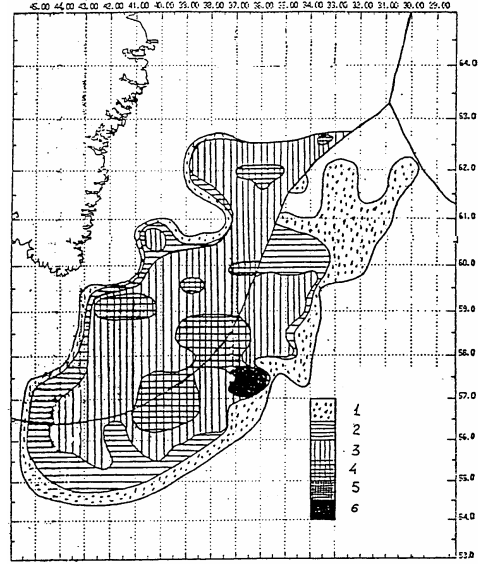
Length (cm)	NAFO <500m	NAFO >500m	NEAFC <500m	NEAFC >500m	Sum
20.5	0	0	0	161	161
21.5	0	0	0	0	0
22.5	293	236	0	0	529
23.5	586	0	433	264	1283
24.5	1466	236	216	264	2182
25.5	3129	236	2921	953	7239
26.5	9968	987	7877	851	19683
27.5	15737	847	9582	2963	29129
28.5	25902	2422	14236	5763	48323
29.5	26878	2776	16128	4972	50754
30.5	17789	3130	17541	9387	47847
31.5	7137	2283	18267	7889	35576
32.5	23664	3689	25191	11820	64364
33.5	47526	6573	51426	16029	121554
34.5	89579	11043	76969	27495	205086
35.5	93796	13071	99711	29035	235613
36.5	80502	9897	92251	23875	206525
37.5	56447	6563	67229	28905	159144
38.5	35797	5801	47253	29578	118429
39.5	18877	1973	29073	34254	84177
40.5	5283	354	14271	43054	62962
41.5	3032	1147	6256	47173	57608
42.5	1663	493	1055	54344	57555
43.5	0	493	1165	54797	56455
44.5	0	236	949	50958	52143
45.5	0	118	732	38816	39666
46.5	0	0	216	19618	19834
47.5	0	0	0	13755	13755
48.5	0	0	0	4706	4706
49.5	0	0	0	1393	1393
50.5	0	0	0	161	161
51.5	0	0	0	0	0
52.5	0	0	0	161	161
53.5	0	0	0	0	0
54.5	0	0	0	0	0
55.5	0	0	0	0	0
Sum	565053	74605	600947	563395	1803997
Mean length	34.5	34.8	35.2	40.2	36.5

Table 5. Size Composition of oceanic redfish in the German catch 2000 by area and quarter.

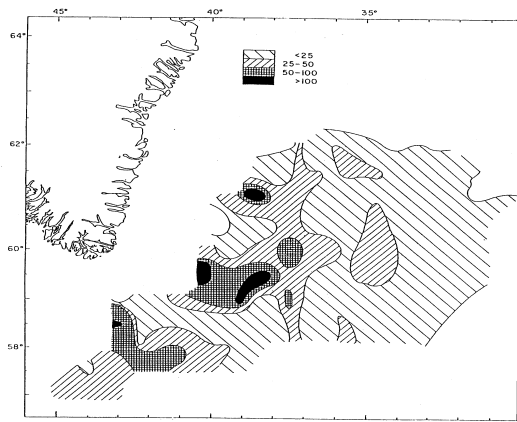
Length (cm)	NEAFC 2nd Q	NEAFC 3rd Q	NAFO 3rd Q	NAFO 4th Q	Total
20,5	0	0	0	0	0
21,5	0	0	3464	419	3883
22,5	0	0	6928	838	7766
23,5	0	1633	28576	3457	33666
24,5	0	0	39833	4820	44653
25,5	0	1633	44163	5343	51139
26,5	435	0	48493	5867	54795
27,5	1459	6534	69275	8382	85650
28,5	5879	26134	105645	12782	150440
29,5	14312	24501	182714	22107	243634
30,5	26098	47368	211290	25564	310320
31,5	43244	47368	282298	34156	407066
32,5	74282	96369	443363	53643	667657
33,5	122451	187838	693621	83923	1087833
34,5	234912	307075	1089357	131803	1763147
35,5	361656	375676	1214919	146995	2099246
36,5	432655	437745	1205393	145843	2221636
37,5	539699	421411	1088491	131699	2181300
38,5	632671	313608	685827	82980	1715086
39,5	792669	171504	419117	50710	1434000
40,5	998747	50635	142015	17183	1208580
41,5	1087775	16334	55420	6705	1166234
42,5	1036000	6534	19917	2410	1064861
43,5	928492	6534	4330	524	939880
44,5	658656	0	0	0	658656
45,5	333776	0	866	105	334747
46,5	137956	1633	866	105	140560
47,5	48127	0	0	0	48127
48,5	3339	0	0	0	3339
49,5	1375	0	0	0	1375
50,5	0	0	0	0	0
Summe	8516665	2548067	8086181	978363	20129276
kg	6728000	1292000	3992000	483000	12495000
mean	40,6	36,1	35,3	35,3	37,6



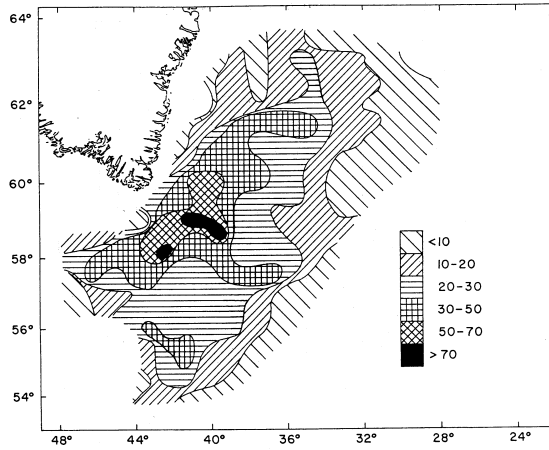
Russian survey May-July 1992



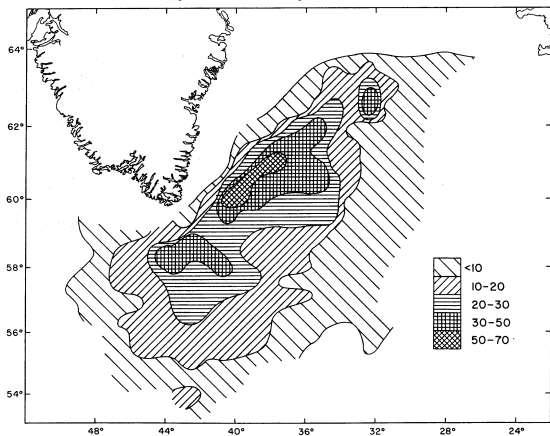
Russian survey June/July 1993



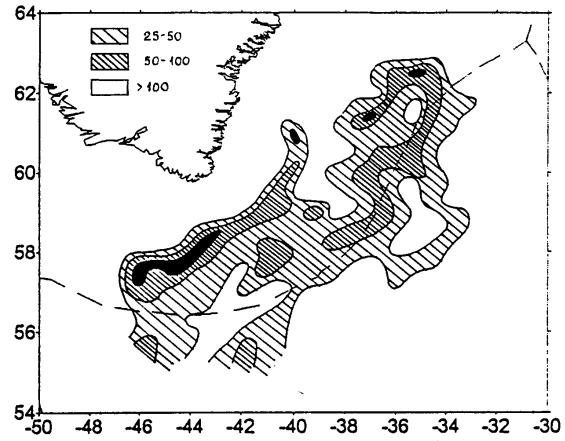
Icelandic survey June/July 1992



International survey June/July 1994



International survey June/July 1996



Russian survey June/July 1995

Fig. 1a. Geographical distribution patterns of “oceanic *S. mentella*” above 500 m depth as observed in June hydro-acoustic surveys, 1992-1996.

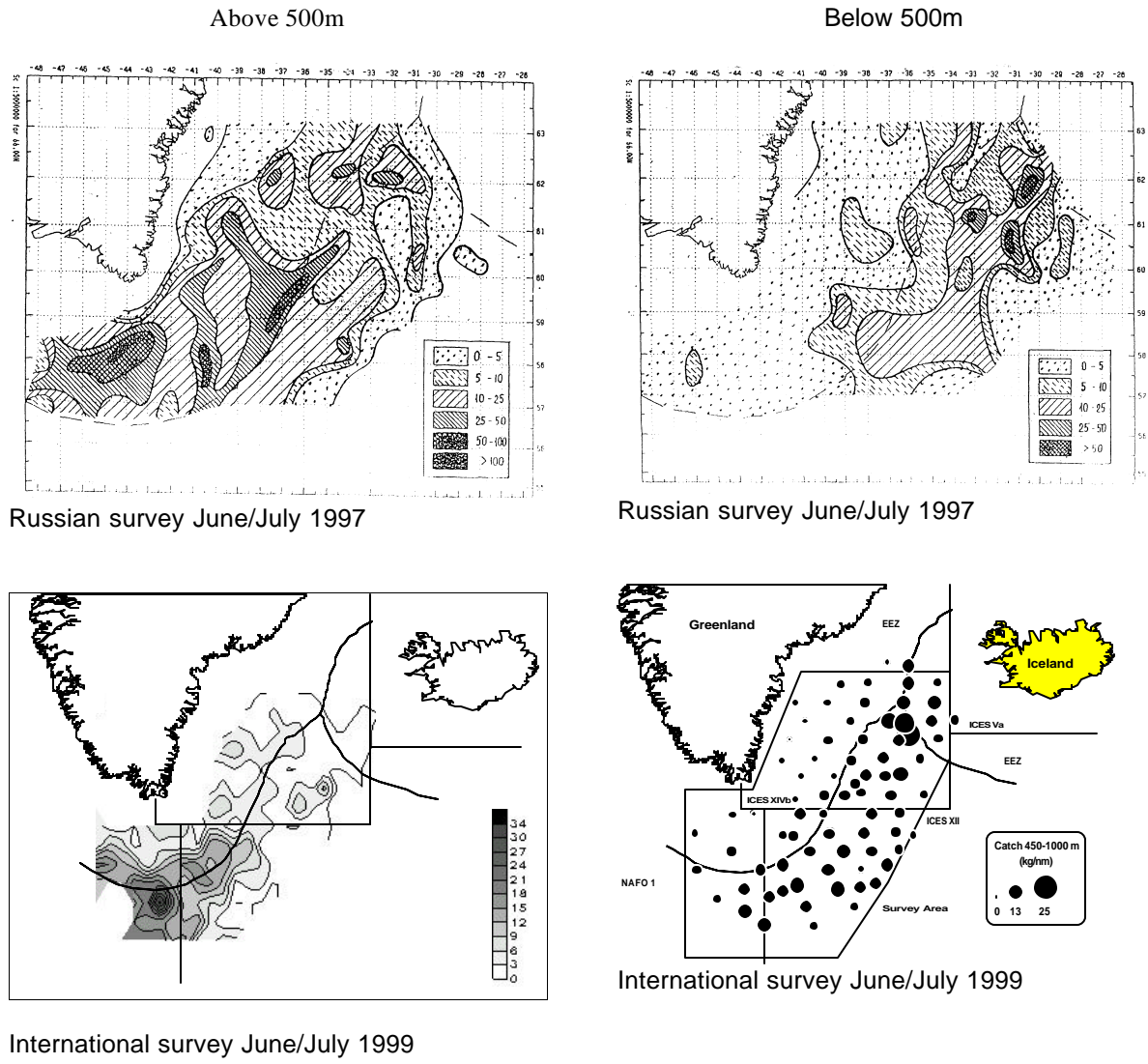


Fig. 1b. Geographical distribution patterns of “oceanic *S. mentella*” above and below 500 m depth as observed in June hydro-acoustic suveys, 1997 and 1999.

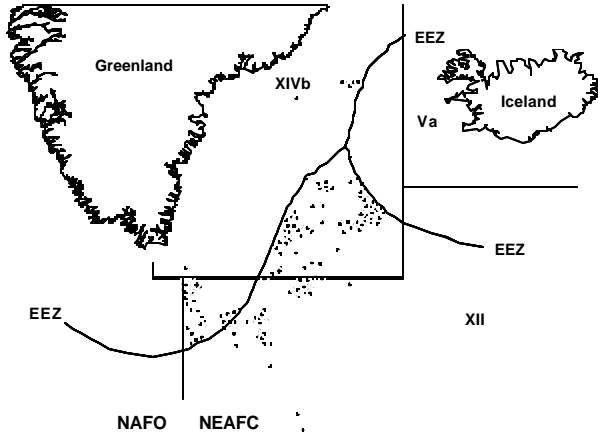


Fig. 2a. German fleet's effort distribution, 1st quarters 1995-1999.

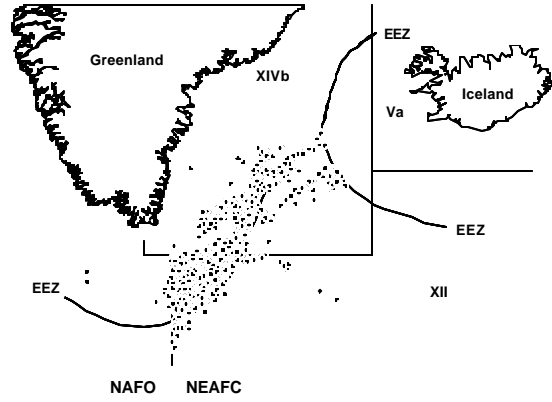


Fig. 2c. German fleet's effort distribution, 3rd quarters 1995-1999.

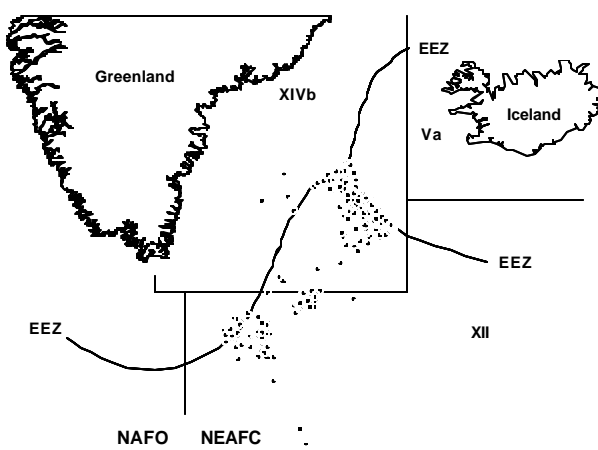


Fig. 2b. German fleet's effort distribution, 2nd quarters 1995-1999.

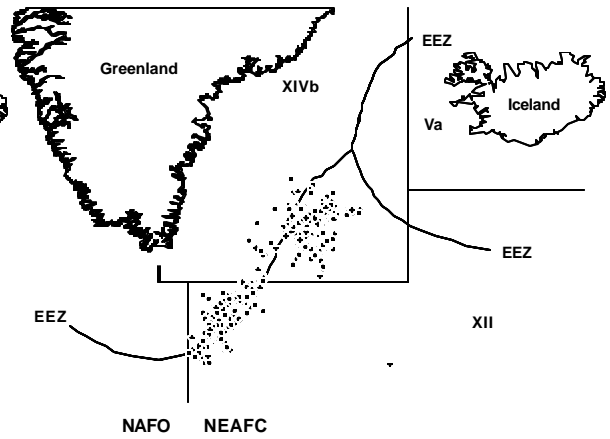


Fig. 2d. German fleet's effort distribution, 4th quarters 1995-1999.

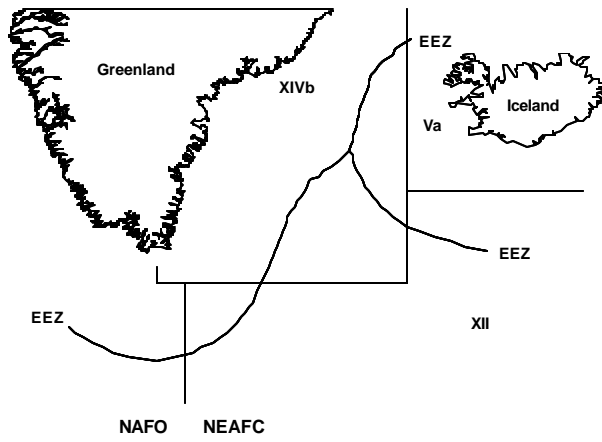


Fig. 3a. German fleet's effort distribution, 1st quarter 2000.

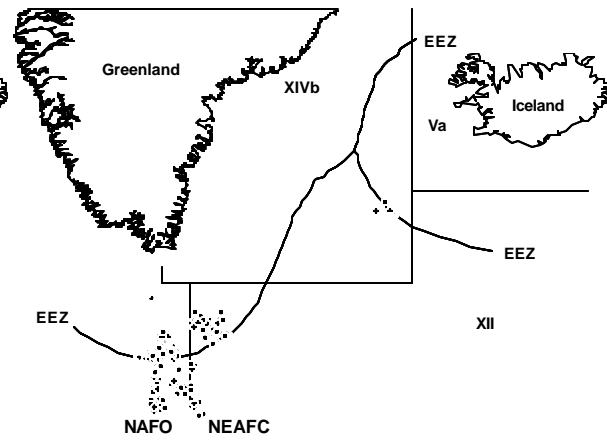


Fig. 3c. German fleet's effort distribution, 3rd quarter 2000.

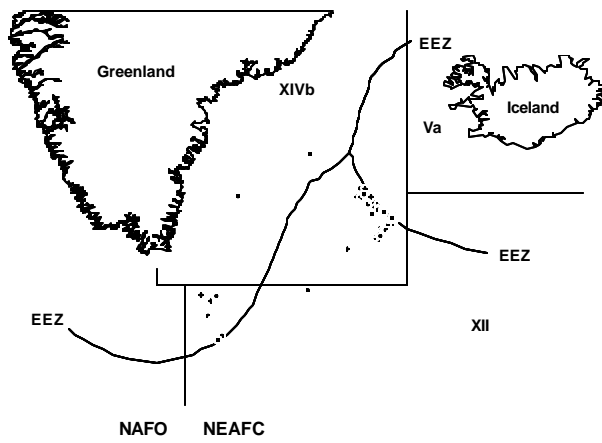


Fig. 3b. German fleet's effort distribution, 2nd quarter 2000.

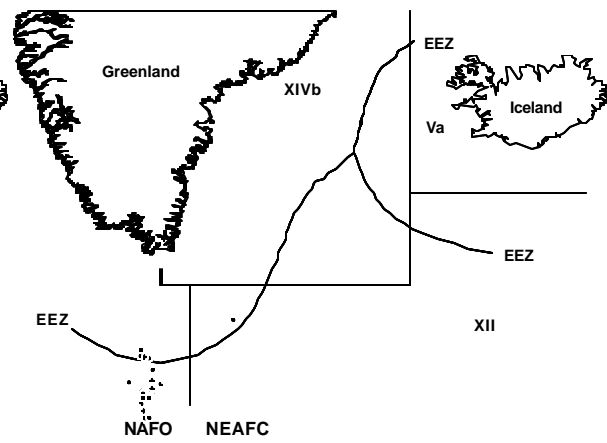


Fig. 3d. German fleet's effort distribution, 4th quarter 2000.

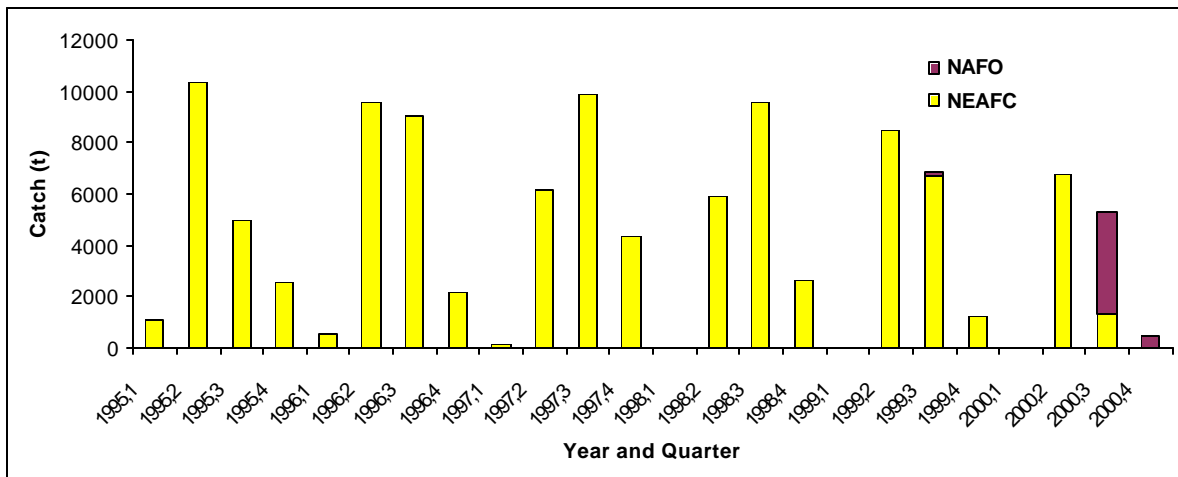


Fig. 4. German catches of oceanic redfish by area and quarter, 1995-2000 (Tab. 4).

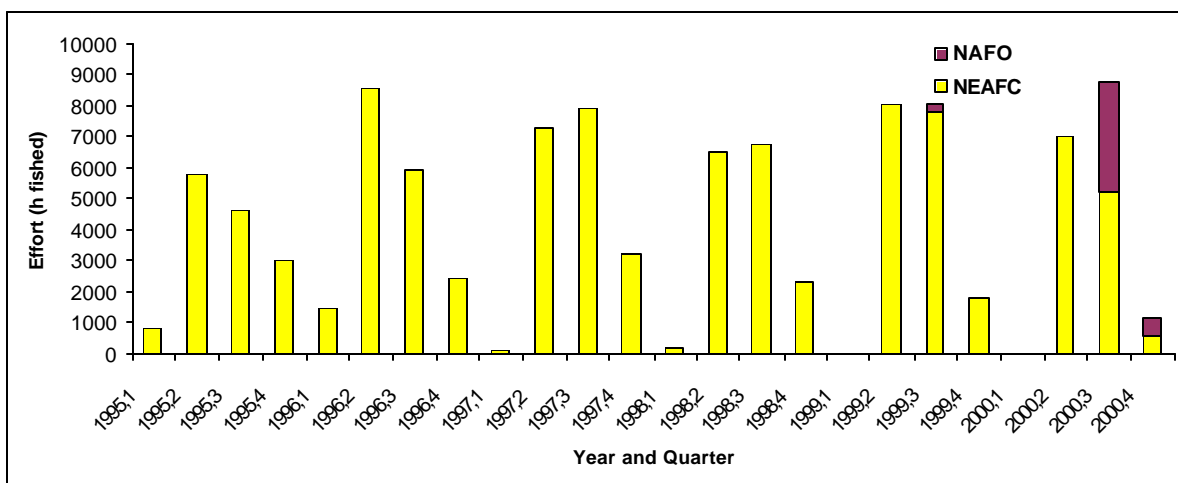


Fig. 5. German trawl effort directed towards oceanic redfish by area and quarter, 1995-2000 (Tab. 4).

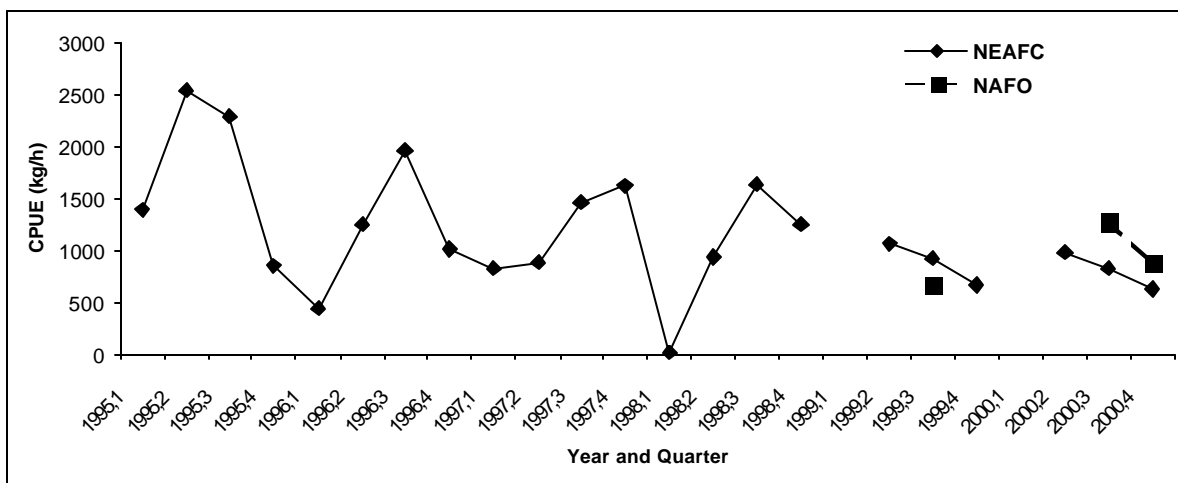


Fig. 6. German catch-per-unit of effort (CPUE) for oceanic redfish by area and quarter, 1995-2000 (Tab. 4).

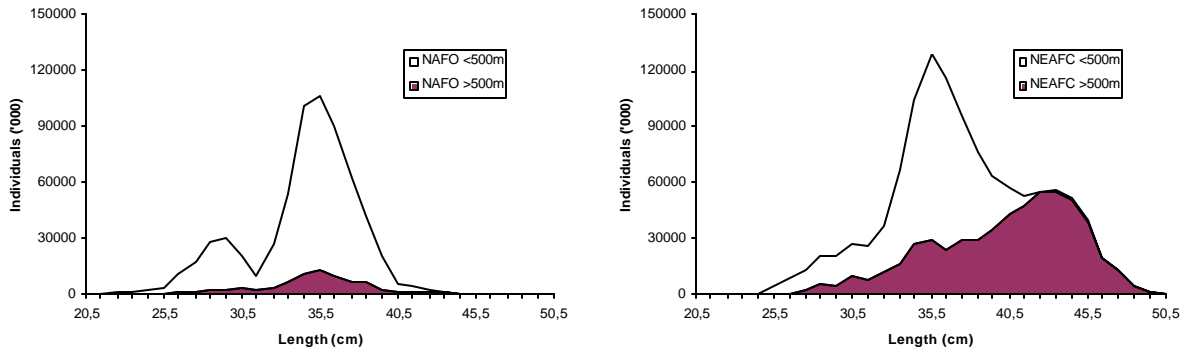


Fig.7. Length distribution of oceanic redfish (*S. mentella*) in NAFO area 1F and NEAFC above and below 500 m depth, derived from the 1999 international hydroacoustic survey.

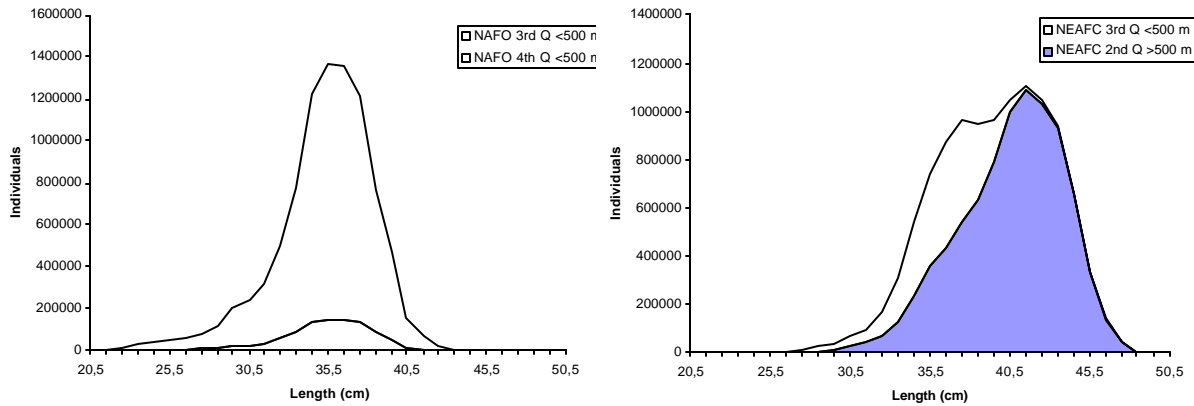


Fig. 8. Size composition of oceanic redfish in the German catch 2000 by area and quarter or depth (Tab. 5).

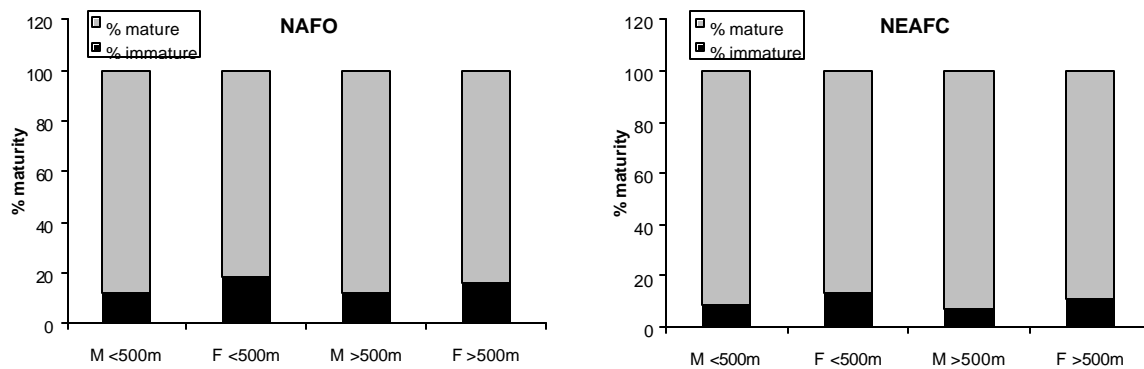


Fig. 9. Maturity of oceanic redfish (*S. mentella*) in NAFO area 1F and NEAFC above and below 500 m depth, derived from the 1999 international hydroacoustic survey (M: males, F: females).