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A Report on the Deliberations of the North-Western Working Group as it Pertains to Stock Structure, Distribution and State of the *Sebastes mentella* in ICES Sub-areas V, XII and XIV and the NAFO Convention Area

by

F. Gonzalez
Instituto Español de Oceanografía (Vigo) Spain

and

D. Power
Northwest Atlantic Fisheries Centre, St. John's, NF, Canada

Introduction

The ICES North-Western Working Group (NWWG) meeting took place from 28 April to 8 May 2002 in Copenhagen. The present report focuses on the stock structure, distribution and state of the stock of *Sebastes mentella*, analyzed in the NWWG 2002 of ICES.

Stock structure of S. mentella in ICES Sub-areas V, XII and XIV and the NAFO Convention Area.

During recent years, the existence of more than one stock of *S. mentella* in the area was discussed. Historically *S. mentella* was fished on the shelves and banks of the Faroe Islands, Iceland and East Greenland and was considered as one stock. With the start of a new pelagic fishery in the open Irminger Sea in 1982, a new stock was defined for management purposes for *S. mentella* inhabiting the Irminger Sea. In 1992, the Study Group on Redfish Stocks distinguished between these types as deep-sea *S. mentella* (inhabiting the shelf and bank areas as noted above) and oceanic *S. mentella* (inhabiting shallower pelagic layers over great depths in the Irminger Sea). In the early 90's, the pelagic fishery in the open Irminger Sea moved to deeper layers beyond 500 m. Some researchers considered that some of the fish caught pelagically deeper than 500 m were different to those living shallower than 500 m and resembled the deep-sea *S. mentella* living on the shelves. This component living deeper than 500 m has been called "pelagic deep-sea *S. mentell*". It is not known if these three components are more than one stock and different hypotheses have been put forward:

- A **single stock hypothesis:** All *S. mentella* in the area from the Faroe Islands to the Grand Banks constitute one stock, segregated according to age/size.

- A **two stock hypothesis:** *S. mentella* living on the shelves (deep-sea *S. mentella*) and that living in deeper pelagic waters of Irminger Sea (pelagic deep-sea *S. mentella*) constitute one stock unit which is separated from the oceanic *S. mentella* living in upper layers of the Irminger Sea.

- A **three stock hypothesis:** The described components constitute a distinct stock.

New information was presented at the 2002 NWWG meeting that supports the one stock theory. One paper focused on analysis of genetic material and a second (NAFO SCR Doc. 02/15) covered a variety of analyses of biological characteristics and composition of parasite fauna. In addition, information on genetic structure of the species was also the issue of a newly published article (Roques *et. al.,* 2002), concluding that there is a lack of genetic

differences and lack of genetic isolation by geographic distance among samples from the Faroe Islands to the Grand Banks.

There was also information available from an ICES paper (Joensen, 2001), based on chemometry of the fatty acid profile in selected tissues that supports a multi-stock theory.

Based on the available information and information described in previous working group reports and published articles, the NWWG concluded that there are still uncertainties in the stock structure of *S. mentella* in ICES Sub-areas V, XII and XIV and the NAFO Convention Area (see Fig. 1). However, in the data available to the NWWG, all information supports that the fishery in the NAFO Convention Area is from the same stock as fished in western part of ICES Sub-area XII.

Distribution of the resource

Trawl-Acoustic Surveys

Limited information is available for describing the distribution of the stock(s) in the area throughout the year and the new information from the international trawl-acoustic survey in 2001 does not add much to the current knowledge. The NWWG considered that information from the various acoustic estimates in recent years only describes the distribution at one time of the year.

Description of the fishery

The pelagic *Sebastes mentella* fishery in ICES Sub-areas XII and XIV and NAFO Convention Area shows a persistent seasonal pattern in the last three years in terms of its geographical and depth distribution. The main fishing season occurs in the second and third quarter of each year. In the second quarter, the fishery takes place in Sub-area XIV between the Greenland EEZ and the Reyjanes Ridge, deeper than 500 m. in an area east of 32°W and north of 61°N. In the third quarter, the fleet moves about 400-500 nautical miles towards the southern part of the area within Sub-area XII as well as in the NAFO Convention Area to areas west of 36°W and south of 60°N, both outside and inside the Greenland EEZ, and the depth of hauls is shallower than 500 meters. Although the fish in all seasons are sexually mature, the mean length in the second half of the year, in Sub-area XII and in NAFO Convention Area is about 8 cm shorter than in the first half of the year in Sub-area XIV (Fig. 2). However, it is important to note that the described fishing pattern has changed significantly to the period prior to 1996 mainly in terms of area and depth expansion, based on the overview of five nations (Germany, Greenland, Iceland, Norway and Russia) which represent about 70% of the total catch in recent years (Fig. 3). The NWWG considered that the reasons for such changes do not necessarily reflect stock changes only but might also be due to commercial considerations. The NWWG considered that information from the fishery of various nations cannot be used alone as a description of the distribution.

These sources are thus not considered adequate to describe the seasonal distribution of the various components.

Landings and CPUE

A Working Group estimate of catches in 2001 is estimated to be about 118 000 t, which was similar to the total catches observed since 1997. In 1995 and 1996, the catches amounted 176 000 and 180 000 tons, respectively, representing the highest catches on record (Table 1). In 2000, considerable amounts of the catches were taken in NAFO Div. 1F (10 815 tons), as observed in this magnitude for the first time. In 2001, about 200 tons of pelagic S. mentella were caught in NAFO Div. 2H, about 1 284 tons in NAFO Div. 2J and about 5 300 tons in NAFO Div. 1F.

The trend in CPUE from different fleets in depths shallower than 500 m (Fig. 4) indicates a steep downward trend since 1995 and the acoustic estimate from the surveys (described below) confirms these changes. In recent years, there is no clear signal in CPUE, but it should be noted that CPUE has decreased between 2000 to 2001 for most indices, both shallower and deeper than 500 m (Fig. 5). Information from Russia does, however, not confirm the above status.

In Figure 6, the standardized CPUE, derived from a GLM CPUE model-incorporating data from Germany (1995-2001), Iceland (1995-2001), Greenland (1999-2001) and Norway (1995-2001) is given. The model takes into account year, month, vessel and area (ICES statistical square). The model shows that the index did decrease until 1997 and increased thereafter until 2000 and decreased by about 15% in 2001.

There were no diagnostics presented for the standardized CPUE except for the error bars around the year coefficients.

Trawl-Acoustic Survey

EU-Germany, Iceland, Russia and Norway carried out an ICES coordinated trawl-acoustic survey in June/July 2001 (NAFO SCR Doc. 01/161). Five vessels participated and over 420.000 sq. naut. Miles were covered. The stock size measured with the acoustic instruments was assessed to be about 716 000 tons at depths down to the deep-scattering layer (to about 350 m.), with redfish having a mean length of 34.6 cm. Highest concentrations of redfish were in the southwest part of the area covered. The redfish was also mixed with the deep scattering layer.

In 2001, as well as in 1999, the stock shallower than 500 m was observed more southwesterly and deeper than it has been during former acoustic surveys in the last decade. During the same period, a gradual increase in temperature in the observation area has been observed. This may have influenced the distribution pattern of the redfish in June-July as the highest concentrations were found in the colder, i.e. southwestern part of the survey area. In June/July 2001, about half of the total acoustically estimated stock biomass was found in the NAFO Convention Area shallower than 500 m omitting the Canadian EEZ.

Since 1994, the results of the acoustic estimate show a drastic decreasing trend (Table 2). The estimate was only 0.7 million tons in 2001, compared with 2.2 and 1.6 and 0.6 million tons in 1994, 1996 and 1999, respectively. This represents a reduction of about 1.5 million tons in the period. During the same period, the total catch has been about 800 000 tons. Therefore, the catch alone cannot explain the changes in the stock estimate. During the same period, the fishery has also developed towards greater depth and towards bigger fish, and in recent years, the majority of the catch has been caught at depths deeper than 500 m. Thus, the NWWG considers acoustic estimates cannot be considered accurate measures of relative changes in stock size of the upper layer fish, as availability may have changed during the surveyed period. Information suggests that fish inhabiting the upper layer may have migrated out of the surveyed area, both horizontally and vertically (deeper).

A decreasing trend in the proportion of females was observed during the last decade, but whether it is related to overexploitation of the females is not known. Recruits with a peak length about 26-27 cm were recorded, particularly in the western most area of the investigation, the western part of NAFO Div. 1F but also in the eastern parts of Div. 2H and 2J.

Trawl estimate

In addition to the acoustic measurements, an attempt was made to estimate the redfish in and below the deep scattering layer. This was done, by correlating catches and acoustic values at depths between 100 and 450 m. The obtained correlation was used to transfer the trawl data at greater depths to acoustic values and subsequently to an abundance and biomass estimate. Standardized trawl hauls were carried out at different depth intervals (three depth intervals in hauls deeper than 500 m and 2 depth intervals in shallower hauls), evenly distributed over the survey area. Data for the correlation calculations between trawl catches and the acoustic results were obtained during trawling only. In addition, scrutinized acoustic values were only taken from exactly the same position and depth range as covered by the trawl. The NWWG considered that the low correlation between catch and the acoustic values used for the abundance estimation make the method questionable and also the assumption that the catchability of the trawl is the same, regardless of the trawling depth. Estimates based on above described calculations both above and below 500 m depth, must be considered as a very rough measure with high uncertainty as the applicability of the method can only be verified after replicate measurements.

Figure 7 shows the pelagic redfish *S. mentella* survey catches from the June/July 2001 trawl acoustic survey. A total of approximately 1.075.000 tons were estimated to be at depths between 0 and 500 m. and about 1.056.000 tons below 500 m. depth. Below 500 m., the densest concentrations were found in the northeastern part of the area and

hydrographic observations indicated that this concentrations were associated with eddies and fronts. The average length of the fish caught below 500 m. was 38.3 cm.

The NWWG considered that the estimated abundance derived from the trawl data should be treated with great caution and they cannot be combined with the acoustic results. In June/July 2001, one third of the biomass obtained with the trawl method of about 2 million tons was found in the NAFO Convention Area outside the Canadian EEZ.

State of the stock

Table 2 shows available survey estimates of stock size by acoustic and trawls. Acoustic biomass estimates have been relatively stable during 1991 to 1995, but they have declined substantially since from 2.48 million tons in 1995 to 0.72 million tons in 2001. The acoustic estimates from the last three surveys are considered minimum biomass because trawl sets during those surveys have shown that there was considerable redfish biomass deeper than the depths where redfish can be estimated acoustically. However the proportion of fish above and below 500 m is not known to be stable over years. The NWWG considered that these possible changes in the depth distribution above and below 500 m combined with the differences in geographic coverage in different years mean that the acoustic biomass series cannot be interpreted as a consistent series showing relative changes in stock size.

The NWWG considered the following: Adding the trawl biomass estimate below 500 m to the acoustic estimates (1.8 million tons) or adding the two trawl biomass estimates (above and below 500 m) together (2.1 million tons) indicates that the biomass down to depth of 1 000 m in 2001 is probably in the order of 2 million tons, distributed also in large portions of the NAFO Convention Area.

Given the technical, seasonal, geographical and depth changes of the fishing activities, the NWWG considered that the relevance of the unstandardized national CPUE series as indicator of stock abundance remains difficult to assess. However, from the standardised CPUE series, the NWWG stated that it could be concluded that the pelagic redfish CPUE remained stable since 1995 for all fishing areas as well as separated above and below 500 m depth. The models do not indicate significant stock reductions since 1995.

In previous years, the NWWG considered that the acoustic surveys were representing the shallower than 500 m component of the pelagic. The decline in the acoustic estimates (1.5 million tons) since the mid-1990s is not explained solely by the catches over that time period (800 000 tons) and therefore the NWWG no longer considers the decline in the estimates to represent only stock decline, but also changes in availability of the *S. mentella* to the acoustic instruments. The decline in the time series has been the basis for the advice in past assessments. The assessment of the current state of the stock and basis of the advice is based on trends in standardized CPUE indices and a trawl biomass estimator that is based on a novice approach that is highly uncertain.

The NNWG concluded that taking into account the uncertainty in stock indicators, it is not known if the exploitation rate generated by recent catches is above or below the 5% exploitation rate.

Reference Points

The NWWG considered that the former proposed MBAL biomass (minimum biologically acceptable level) reference of 1.5 million tons is considered inappropriate as it was derived from a production model disregarding the increased knowledge about the stock distribution and expanded fishing grounds. None of the available data series are considered appropriate to develop reference points (ASPIC models were run with various conditions without success).

Management considerations

The NWWG considered that catch rates shallower than 500 m remained steady but low, and deeper than 500 m remained steady. The main new feature of the fishery was an increasingly clear distinction between two widely separated grounds fished at different seasons and different depths. In 2000 and 2001, the more southwesterly fishing ground extended into the NAFO Convention Area. The parameters analysed so far do suggest, however, that the newly discovered aggregations in the NAFO Convention Area do not form a separate stock component. The 1999

and 2001 surveys indicated that about one third of the stock is distributed in the NAFO Convention Area based on the trawl catches.

The genetic structure of the pelagic and demersal stocks of deep-sea redfish (*S. mentella*) in the North Atlantic, remains poorly known.

Given this pattern of seasonally localised fishing, a seasonal or geographic dimension for management of the fishery on the different grounds could be considered from a management perspective.

The recent exploitation level seems not to cause stock size reduction.

References

Joensen, H., Grahl-Nielsen, O. (2001). Discrimination among species and stocks of redfish and herring by chemometry of the fatty acid profile in selected tissues. ICES CM 2001/J:22

Roques, S. Sévigny, J.-M. and Bernatchez, L. 2002. Genetic structure of deep-water redfish, Sebastes mentella, populations across the North Atlantic. Marine Biology (2002) 140: 297-307.

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Thorsteinn Sigurdsson et al.(2001). Draft report on the Join German/Icelandic/Norwegian/Russian Trawl Acoustic Survey on Pelagic Redfish in the Irminger Sea and Adjacent Waters in June / July 2001. *NAFO SCR Doc. 01/161*. Serial N. 4555

Table. 1. Pelagic *S. mentella*. Landings (in tons) by area as used by the Working Group. Due to the lack of area reportings for some countries, the exact share in Sub-areas XII and XIV is just approximate in latest years.

Year	Va	Vb	VI	XII	XIV	NAFO 1F	NAFO 2H	NAFO 2J	Total
1982	0	0	0	39,783	20,798				60,581
1983	0	0	0	60,079	155				60,234
1984	0	0	0	60,643	4,189				64,832
1985	0	0	0	17,300	54,371				71,671
1986	0	0	0	24,131	80,976				105,107
1987	0	0	0	2,948	88,221				91,169
1988	0	0	0	9,772	81,647				91,419
1989	0	0	0	17,233	21,551				38,784
1990	0	0	0	7,039	24,477	385			31,901
1991	0	0	0	10,061	17,089	458			27,608
1992	1,968	0	0	23,249	40,745				65,962
1993	2,603	0	0	72,529	40,703				115,835
1994	15,472	0	0	94,189	39,028				148,689
1995	1,543	0	0	132,039	42,260				175,842
1996	4,744	0	0	42,603	132,975				180,322
1997	15,301	0	0	19,822	87,812				122,935
1998	40,612	0	0	22,446	53,910				116,968
1999	36,524	0	0	24,085	48,521	534			109,665
2000	44,677	0	0	19,862	50,722	10,815			126,076
2001[1]	28,139	0	0	28,957	53,753	5,299	208	1,284	117,649

1) Provisional data

Table 2. Pelagic redfish *S. mentella*. Time series of survey results, areas covered, hydro-acoustic abundance and biomass estimates shallower and deeper than 500 m (based on standardized trawl catches converted into hydro-acoustic estimates derived from linear regression models).

Year	Area covered (1000 NM^2)	Acoustic estimates < 500 m (10^6 ind.)	Acoustic estimates < 500 m (1000 t)	Trawl estimates < 500 m (10^6 ind.)	Trawl estimates < 500 m (1000 t)	Trawl estimates > 500 m (10^6 ind.)	Trawl estimates > 500 m (1000 t)
1991	105	3498	2235				
1992	190	3404	2165				
1993	121	4186	2556				
1994	190	3496	2190				
1995	168	4091	2481				
1996	253	2594	1576				
1997	158	2380	1225				
1999	296	1165	614			638	497
2001	420	1370	716	1955	1075	1446	1057

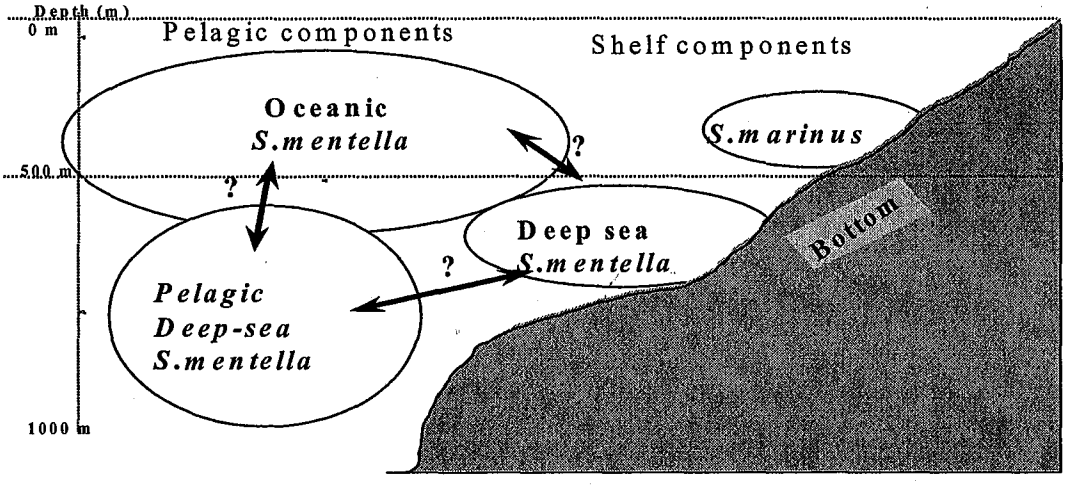

Fig. 1. Schematical representation of the possible relationship between different stocks of redfish in the Irminger Sea and adjacent waters

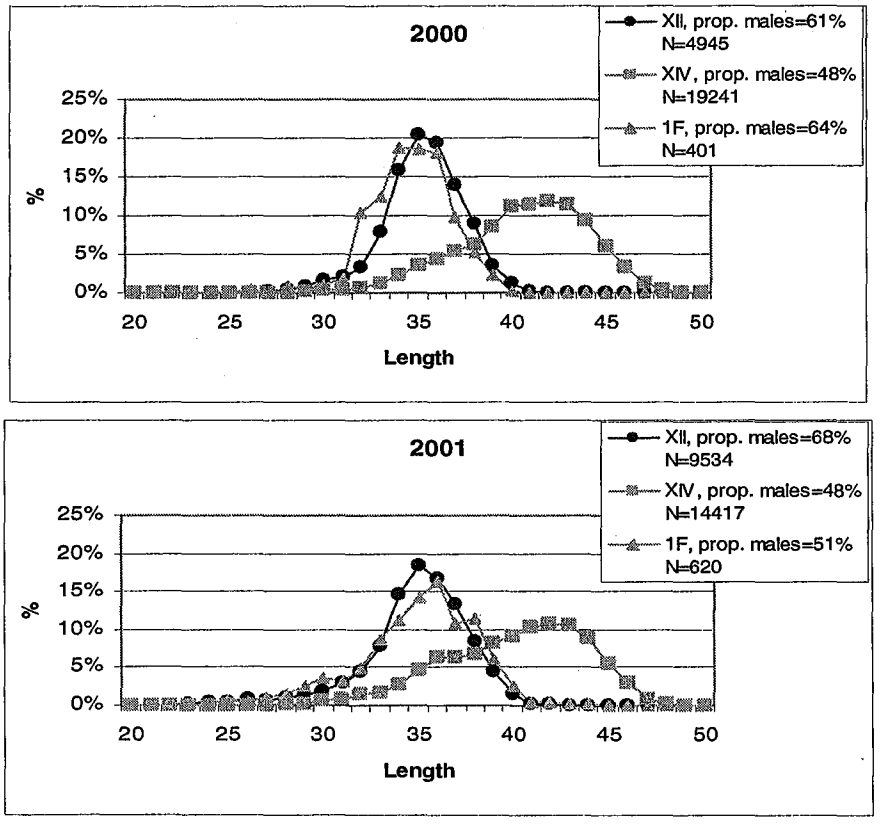

Fig. 2. Length distribution of the Spanish oceanic redfish fishery in ICES Div. XII, XIV and in NAFO Div. 1F in the year 2000 and 2001. The proportion of males is also given.

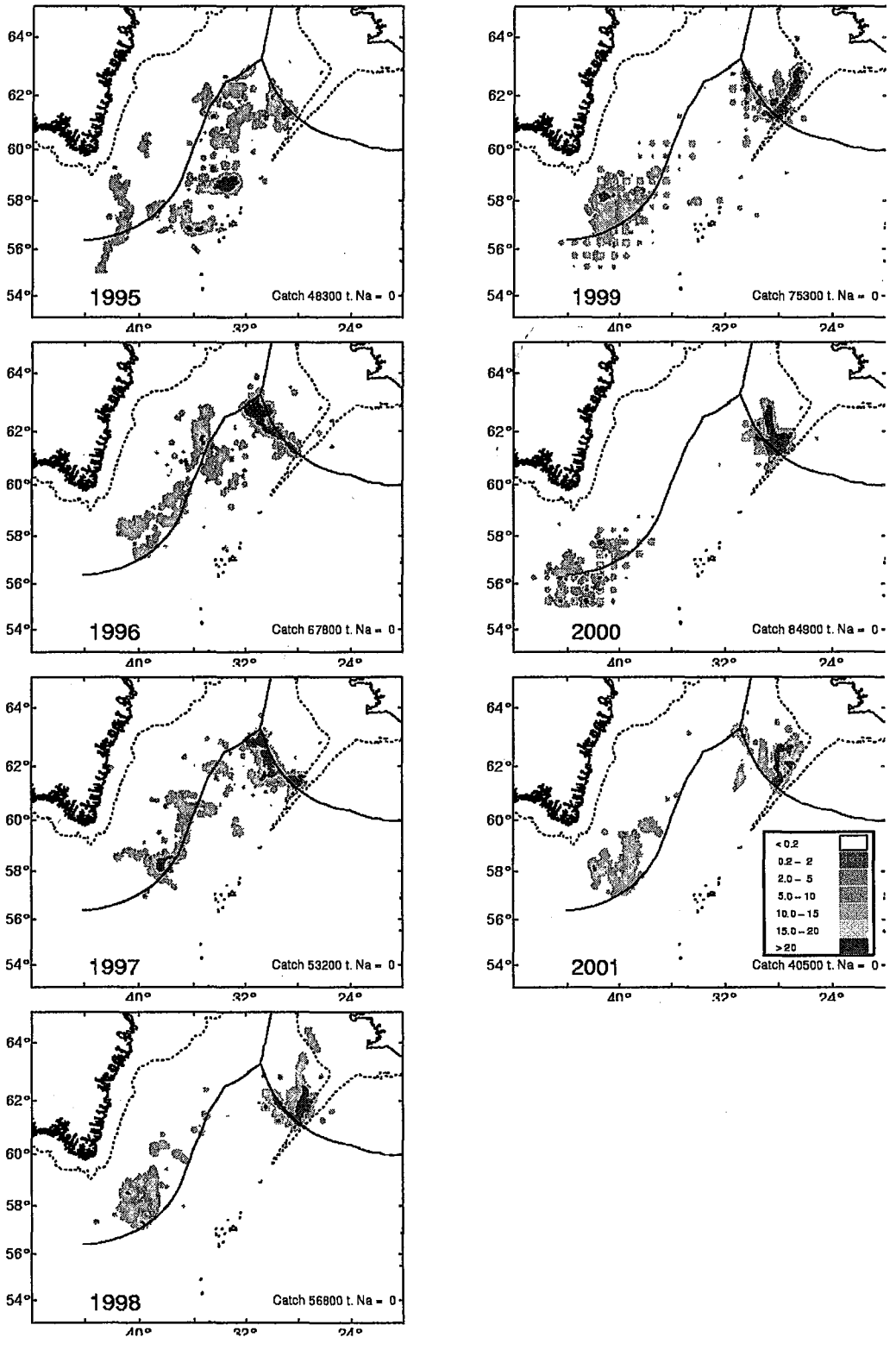

Fig. 3. Fishing areas of the pelagic redfish by year from 1995-2001. Data from Germany (1995-2001), Norway (1995-2001) Greenland (1999-2001), Russia (1999-2000) and Iceland (1995-2001). The scale given on the pictures indicates the catches in tons per square nautical mile.

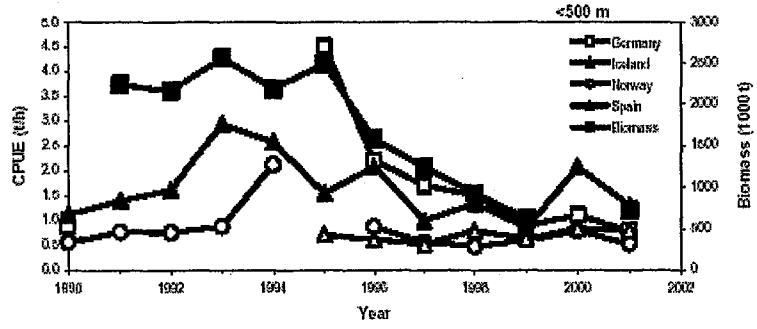

Fig. 4. Trends in CPUE of pelagic *S. mentella* in the Irminger Sea shallower than 500 m and estimated acoustic biomass from the surveys.

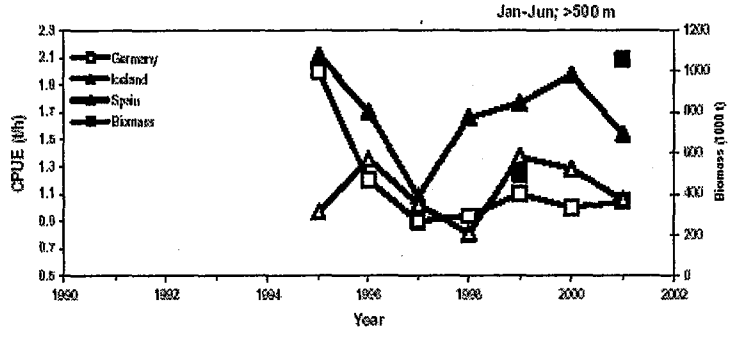

Fig. 5. Trends in CPUE of pelagic *S. mentella* in the Irminger Sea deeper than 500 m with estimated trawl biomass from surveys.

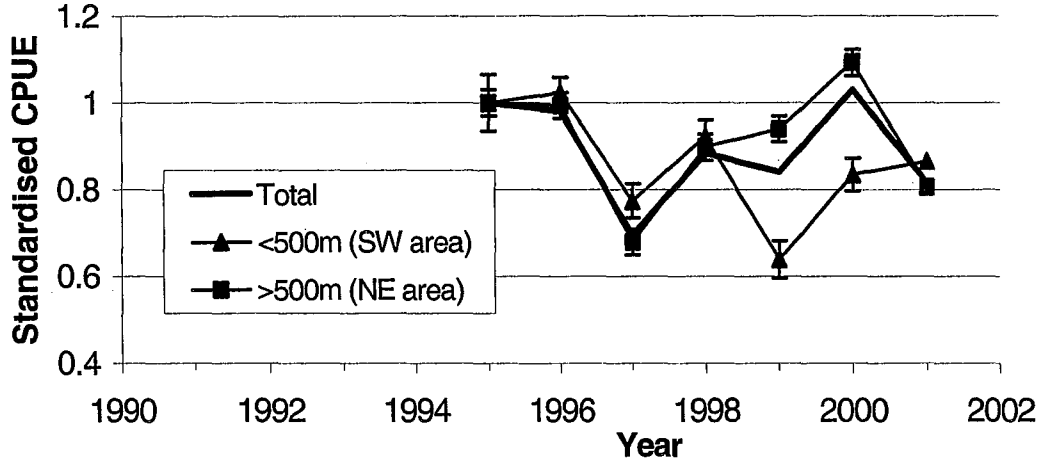

Fig. 6. Standardized CPUE, as calculated by using data from Germany (1995-2001), Iceland (1995-2001), Greenland (1999-2001) and Norway (1995-2001) in the GLM model, divided by depths shallower (south-western area) and deeper than 500 m (north-eastern area) and both depth layers (areas) combined (Total).

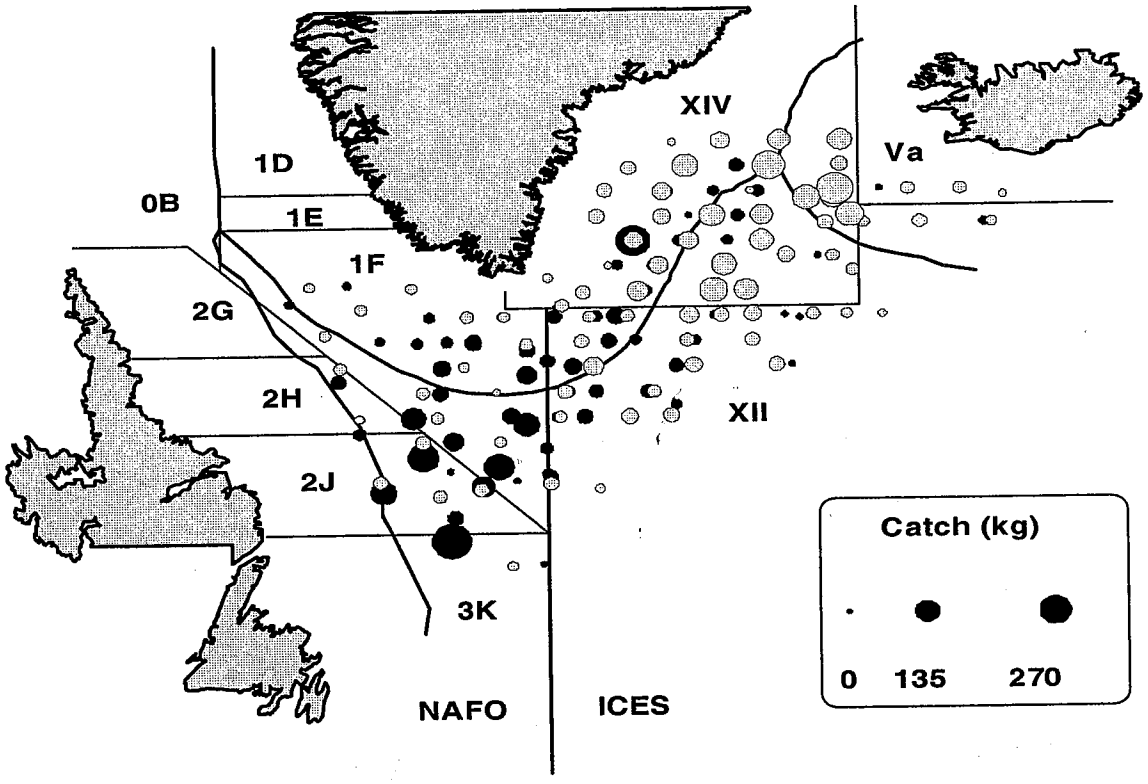

Fig. 7. Pelagic redfish *S. mentella*. Survey catches in June/July 2001 shallower than 500 m depth (black) and deeper than 500 m depth (grey).