Northwest Atlantic Fisheries Organization

Serial No. N1957 NAFO SCR Doc. 91/73

SCIENTIFIC COUNCIL MEETING - JUNE 1991

NAFO Subarea 1 Golden and Beaked Redfish: Spatial Distribution Pattern, Survey Abundance and Biomass Estimates in 1982-90 and Length Frequency in 1990

by

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Abstract

During 1982-90, trends in abundance and biomass indices derived from an annual groundfish survey reveal a major decline for the golden redfish (Sebastes marinus L.) although the values are highly variable. On the contrary, the estimates of the beaked redfish (Sebastes mentella T.) show no definte trends. A very low precision in abundance and biomass estimates is determined pointing to an enormous variability in catches. This seems to be due to the inappropriate survey design adjusted to the assessment of cod and the pelagic occurrence of redfish.

Both redfish species are caught throughout the survey area but no persistent spatial distribution patterns are found. In 1990, the golden redfish (Sebastes marinus) is indicated to be mainly distributed in the southern strata, whereas the beaked redfish (Sebastes mentella) predominantly occurred in the northern strata. The analyses of the length distributions underlines the importance of the northern strata as nursery areas.

Introduction

In 1982, an annual groundfish survey is established by the Federal Republic of Germany in order to assess abundance, biomass and stock structure for cod in NAFO Divisions 1B-1F. A provisional analysis of the changes in the fish community off West Greenland (Rätz, 1991) reveals the important rank of both species golden redfish (Sebastes marinus L.) and beaked redfish (Sebastes mentella T.) in the ecosystem. On this account, an approach is taken here to analyse the spatial distribution pattern of abundance and biomass estimates in 1982-90 as well length structures in 1990 for both species. The reliability of the abundance and biomass values is evaluated as the survey is desinged primarily for the estimation of cod stock and does not sufficiently cover the depth range of the golden and beaked redfish (Messtorff and Cornus, 1989).

Materials and Methods

The analyses are based on the data collected during 1982-90. The annual groundfish survey established by the Federal Republic of Germany covers the continental shelf and slope off West Greenland (south of 67° north latitude) outside the 3 mile limit to the 600m isobath. The stratified random survey is designed for cod. On account to favourable weather and ice conditions, the late autumn is chosen as survey time. The survey area is divided into 4 geographic strata (Fig. 1). Each of the geographic strata is splitted into 3 depth zones ranging from 0-200m, 201-400m and 401-600m. Strata names, geographic boundaries, depth ranges and strata areas are specified in Table 1.

The survey is carried out by th R/V Walther Herwig throughout the time series except for 1984, when the R/V Anton Dohrn is used. The standard trawl is a 140-feet bottom trawl rigged with a heavy ground gear and equipped with a small mesh liner (30mm) inside the cod end. Catches are identified to species, counted and weighted. The fishes are measured to total length (cm below). However, the identification of small redfish (<10cm below) is difficult and may result in sampling bias. During the survey in 1990, 1,065 individuals of the golden redfish (Sebastes marinus) and 3,126 individuals of the beaked redfish (Sebastes mentella) are measured.

Stratified abundance and biomass estimates (Saville, 1977) are derived from mean catches applying the 'swepth area' method. The coefficient of catchability taken to be 1.0 for all species. Consequently, the estimates are merely indices of abundance and biomass. The gear parameters are listed in Table 2. The respective confidence intervals are given at the 95 % level of significance in per cent of the stratified mean. In case of any net damage or hang up before 15 minutes towing time, the haul is designated as invalid. Strata including less than 5 valid sets are rejected from the evaluation. These restrictions cause the differences between the calculated values and the estimates given by Messtorff and Cornus (1989).

During the period 1982-90, 1,071 successful hauls are carried out. The numbers of valid sets per stratum are listed in Table 3. The main feature of this table is the predominance of hauls allocated to the shallow strata 1.1, 2.1, 3.1 and 4.1 ranging from 0-200m depth. Significantly lower numbers of hauls are carried out in the strata 1.2, 2.2, 3.2 and 4.2 (201-400m), especially in the southern strata 3.2 and 4.2 characterized by extremely rough trawling grounds. The deepest strata 1.3, 2.3, 3.3 and 4.3 (401-600m) are inadequately covered with hauls.

Results

Trends in survey abundance and biomass estimates for the golden redfish (Sebastes marinus) are illustrated in Figure 2. During 1982-83, a major decline in abundance and biomass is observed. Abundance indices decrease from 134 millions to 33 millions and biomass indices decrease from 56 thousand tonnes to 14 thousand tonnes. The following period 1984-1988 is characterized by abundance values varying among 15 millions and 65 millions and biomass estimates varying among 6.8 thousand tonnes and 19.7 thousand tonnes. In 1988-90, a second drastic decrease in abundance and biomass values is determined. The recent abundance and biomass estimates in 1990 amount to 6 millions and 2.5 thousand tonnes, respectively. The 95% confidence intervals are high (30-110%) and show a pronounced interannual variability.

In order to analyse the spatial distribution pattern of the golden redfish (Sebastes marinus), the Figures 3-5 illustrate the trends in survey abundance estimates per stratum in 1982-90. The calculated indices for the shallow strata 1.1, 2.1, 3.1 and 4.1 (0-200m) vary over a wide range (Fig .3). The outstanding estimate in 1982 amounting to 88 millions is the maximum value on record. None of the strata show a clear trend but the estimates of the southern stratum 4.1 are on a very low level throughout the total time series. Apart from the maximum value amounting to 30 millions, the abundance indices of the strata 1.2, 2.2, and 3.2 (201-400m) vary among the same order of magnitude as observed for the shallow strata and lack definite trends as well (Fig. 4). During 1982-89, no estimates are calculated for the southern stratum 4.2 due to the very low number of hauls carried out in this area (Tab. 3). Low abundance estimates are calculated for the northern stratum 1.3 (401-600m) except for the year 1988, when the abundance index amounts to 6 millions (Fig. 5). No assessments have been carried out for the remaining strata 2.3, 3.3 and 4.3 as they are inadequately covered with hauls.

The length frequency for the golden redfish (Sebastes marinus) in 1990 is illustrated in Figure 6. The length frequency is splitted

into the geographic strata 1-4. The frequencies are raised to abundance indices per stratum. The total length distribution ranges from 6.5 to 50.5 cm. Comparing the frequencies of the strata, the golden redfish (Sebastes marinus) seems to be mainly distributed in the southern stratum 4. However, the main feature of the figure 6 is the predominance of the small individuals in the northern strata 1 and 2. The proportion of small individuals decreases with decreasing latitude. Three distinct peaks at 8.5, 12.5 and 17.5 cm are observed for the small fish in the northern stratum 1. The larger fish show now pronounced peaks in their size distributons. The length frequency of the larger fish in the southern stratum 4 seems to be normal distributed with a maximum value at 31.5 cm.

Abundance and biomass estimates of the beaked redfish (Sebastes mentella) are shown in Figure 7. During the period 1982-90, both abundance and biomass indices lack definite trends. The outstanding abundance estimate in 1987, amounting to 152 millions, points to the occurrence of small fish in enormous numbers. The remaining abundance indices range from 3 millions to 34 millions and the biomass estimates from 1 thousand to 10.5 thousand tonnes. The respective 95% confidence intervals are large and exceed even 117% of the stratified mean.

The Figures 8-10 illustrate the trends in abundance for the beaked redfish (Sebastes mentella) splitted up into the individual strata. The northern stratum 1.1 is the only stratum in the 0-200m depth zone showing remarkable abundance values. During 1986-87, a pronounced increase in abundance up to 12 millions is observed while the index drops to 3 millions in 1988. The abundance values of the remaining years vary among 0 and 6 millions (Fig. 8). The estimates of the strata 1.2, 2.2 and 3.2 (201-400m) also point to a northern distribution of the beaked redfish (Sebastes mentella) although no clear trends are identifiable. In 1987, the highest redfish abundance index of the survey is observed in the northern stratum 1.2 amounting to 127 millions (Fig.9). Again no trend is estimated for the southern stratum 4.2 due to the very low number of valid hauls. As already mentioned, the numbers of hauls carried out in the very deep strata 2.3, 3.3 and 4.3 are insufficient for assessment purposes (Tab. 3). During 1982-90, the northern stratum 1.3 (401-600m) shows an increasing trend in abundance to 16 millions (Fig 10).

Figure 11 illustrates the length frequency for the beaked redfish (Sebastes mentella) in 1990 splitted into the geographic strata 1-4. The frequency distributions are raised to the respective abundance indices of the strata. The total size composition ranges from 5.5 to 43.5 cm. Only the northern stratum 1 and the southern stratum 4 show high frequencies, whereas the remaining strata 2 and 3 are characterized by negligible values. Comparing the frequencies in stratum 1 and 4, Figure 11 indicates the northern distribution of the beaked redfish (Sebastes mentella). Both length frequencies of stratum 1 and 4 cover different ranges in total length. The great majority of the individuals of the northern stratum 1 are small (9.5-21.5 cm). The length frequency seems to be normal distributed with a peak at 15.5 cm. On the contrary, most of the individuals of the southern stratum 4 are medium sized and range from 21.5 to 24.5 cm.

Discussion

During the period 1982-90, the survey abundance and biomass estimates of the golden redfish (Sebastes marinus) show a major decrease although the values vary over a wide range. Correspondigly, the biomass estimates derived from by-catches collected during a shrimp survey (Pedersen and Kanneworf, 1991) and estimates of the bottom trawl survey carried out jointly by the Japan Marine Fishery Resource Research Center and the Greenland Fisheries Research Institute in 1987-89 decrease but differ in magnitude (Yamada et al., 1988; Yatsu and Jorgensen, 1989 a; Jorgensen and Akimoto, 1990). The calculated abundance and biomass values of the joint survey are significantly lower although a larger area is covered (NAFO Subdiv. 1A and depth zone 600-1000m

included). This fact underlines that the abundance and biomass estimates derived from a bottom trawl survey are merely indices due to the unknown catchability coefficients of the different gears. This is also true of the comparison of East Greenland survey results characterized by a much higher abundance of both redfish species (Yatsu and Jorgensen, 1988 and 1989 b; Rätz, 1990). No definite trends in abundance or biomass estimates are derivable from survey results for the beaked redfish (Sebastes mentella).

A very low precision in abundance and biomass estimates is achieved for both redfish species indicating an enormous variability in catches. As the redfish species are known to be mainly distributed in the 200-600m depth zones, the very huge confidence intervals and their pronounced interannual variability could be due to the inappropriate survey design (haul distribution mainly covers the 0-200m depth zone) and their pelagic occurrence. A check of the respective within strata abundance indices reveals a general lack of clear persistent trends in spatial distribution pattern.

Comparing the length frequencies of the four geograhic strata as observed in 1990 and raised to respective strata abundance, the golden redfish (Sebastes marinus) seems to be mainly distributed in the southern strata contributing 41% to the total abundance. In 1990, the beaked redfish (Sebastes mentella) is contrarily concentrated in the northern strata (85% of the total abundance). Distinct differences between size composition of the geographic strata are found for both species pointing to the importance of the northern strata as nursery areas and a gradual migration directed to the south. Similar results are reported by Atkinson (1987), by Messtorff and Cornus (1990) for both redfish species and by Yamada et al. (1988) regarding the beaked redfish (Sebastes mentella) only. The increase in length with decreasing latitude is even supported by analyses of redfish by-catch data in the shrimp fishery (Pedersen and Kanneworff, 1991). The length distributions of both redfish species as given in this paper and those caught off East Greenland in 1988 cover the identical ranges (Yatsu and Jorgensen, 1989).

Acknowledgements

This study was supported by the Federal Ministry of Research and Technology (03F 0579A), FRG. I am indepted to Mr. F. Köster for comments on the text.

References

Atkinson, D. B. 1987. The Distribution and Abundance of Redfish (Sebastes marinus and S. mentella) in Davis Strait (NAFO Subarea 0+1) NAFO SCR Doc. 87/38

Jorgensen, O. and K. Akimoto 1990. Results of a Random Bottom Trawl Survey in NAFO Subarea 1 in 1989. NAFO SCR Doc. 90/39, Ser. No. N1756: 1-14

Messtorff, J. and H.-P. Cornus 1989. Survey Biomass and Abundance Estimates for Redfish (Sebastes marinus and S. mentella) off West Greenland (NAFO Subarea 1), 1982-88, and off East Greenland ICES Div. XIVb), 1980-88. NAFO SCR Doc. Ser. No. N1630: 1-12

Pedersen, S. A. and P. Kanneworff 1991. Survey Biomass of Redfish (Sebastes spp.) off West Greenland (NAFO Subareas 0+1), July-August 1988, 1989 and 1990. NAFO SCR Doc. 91/46, Ser. No. N1929: 1-11

Rätz, H.-J. 1990. Reliability of Aundance Estimates derived from Groundfish Surveys Conducted off East Greenland. ICES C.M. 1990, G:61: 1-25

Rätz, H.-J. 1991. Notes of the Changes and Structures in the Ichthyofauna off West Greenland. NAFO SCR Doc. (announced for the NAFO Scientific Council Meeting 1991): 1-20

Saville, A. 1977. Survey methods of appraising fishery resources. FAO Fish. Tech. Pap. 171: 1-76

Yamada, H., K. Okada and O. Jorgensen, 1988. West Greenland Groundfish Biomass Estimated from a Stratified-random Trawl Survey in 1987. NAFO SCR Doc. 88/31, Ser. No. N1469: 1-6

Yatsu, A. and O. Jorgensen, 1988. Distribution and Size Composition of Redfish, Sebastes marinus (L.) and Sebastes mentella (Travis), from a Bottom Trawl Survey off East Greenland in 1987. ICES C.M. 1988, G:60: 1-14

Yatsu, A. and O. Jorgensen 1989 a. West Greenland Groundfish Biomass Estimated from a Stratified-random Trawl Survey in 1988. NAFO SCR Doc. 89/30, Ser. No. N1607: 1-7

Yatsu, A. and O. Jorgensen 1989 b. Groundfish Biomass Estimates and Biology of Redfish (Sebastes mentella and Sebastes marinus) and Greenland halibut (Reinhardtius hippoglossoides) from a Stratified-random Trawl Survey off East Greenland in 1988. ICES C.M. 1989, G:25: 1-13

Table 1 Specification of the strata.

64°15'N - 67°00'N 50°00'W - 57°00'W
Stratum 1.1 depth 1-200m, area 6,805 nm2
Stratum 1.2 depth 201-400m, area 1,881 nm2
Stratum 1.3 depth 401-600m, area 1,191 nm2

62°30'N - 64°15'N 50°00'W - 55°00'W
Stratum 2.1 depth 1-200m, area 2,350 nm2
Stratum 2.2 depth 201-400m, area 1,018 nm2
Stratum 2.3 depth 401-600m, area 259 nm2

60°45'N - 62°30'N 48°00'W - 53°00'W
Stratum 3.1 depth 1-200m, area 1,938 nm2
Stratum 3.2 depth 201-400m, area 742 nm2
Stratum 3.3 depth 401-600m, area 57 nm2

59°00'N - 60°45'N 44°00'W - 50°00'W
Stratum 4.1 depth 1-200m, area 2,568 nm2
Stratum 4.2 depth 201-400m, area 971 nm2
Stratum 4.3 depth 401-600m, area 353 nm2

Table 2 Gear parameters applied for the 'swept area' method.

Horizontal net opening	22 m
Towing time	30 minutes
Towing speed	4.5 knots

Table 3 Number of valid hauls per stratum, 1982-90.

Stratum	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3
Year												
1982	20	11	4	16	7	2	9	6	0	13	2	0
1983	26	11	4	25	11	0	17	5	0	18	4	0
1984	25	13	13	26	8	2	18	6	1	21	4	1
1985	10	8	3	26	10	1	17	5	0	21	4	0
1986	27	9	7	21	9	3	16	7	1	18	3	0
1987	25	11	8	21	4	1	18	3	0	21	3	2
1988	34	21	9	28	5	1	18	5	2	18	2	1
1989	26	14	5	30	9	1	8	3	0	25	3	0
1990	19	7	7	23	8	0	16	3	0	21	6	1

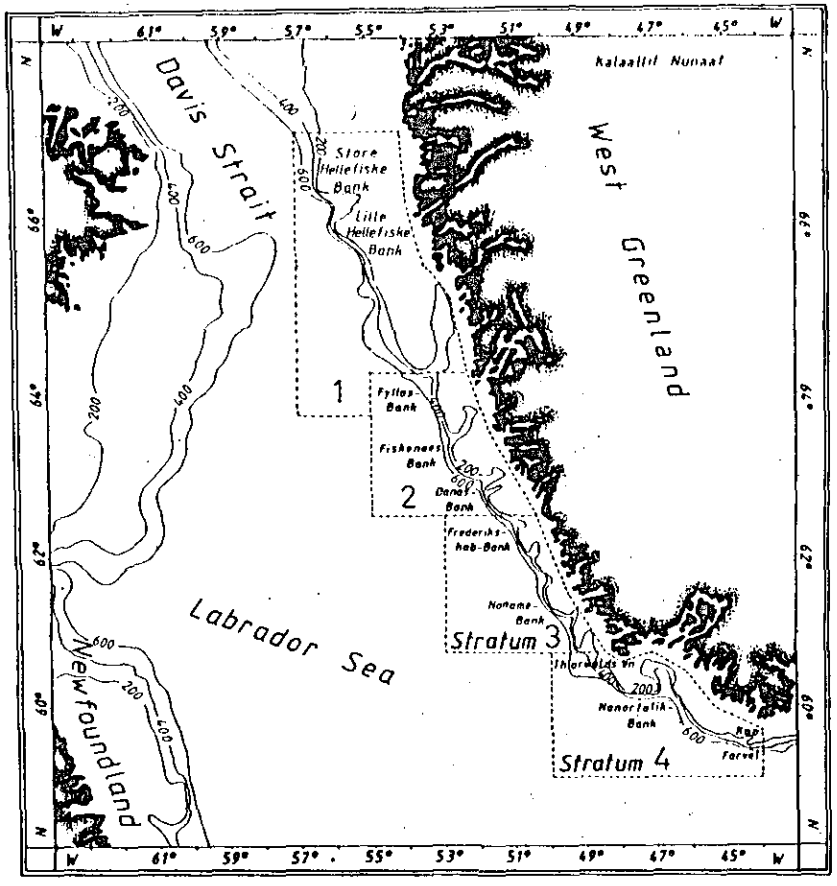

Figure 1 Survey area and stratification scheme as given in Table 1.

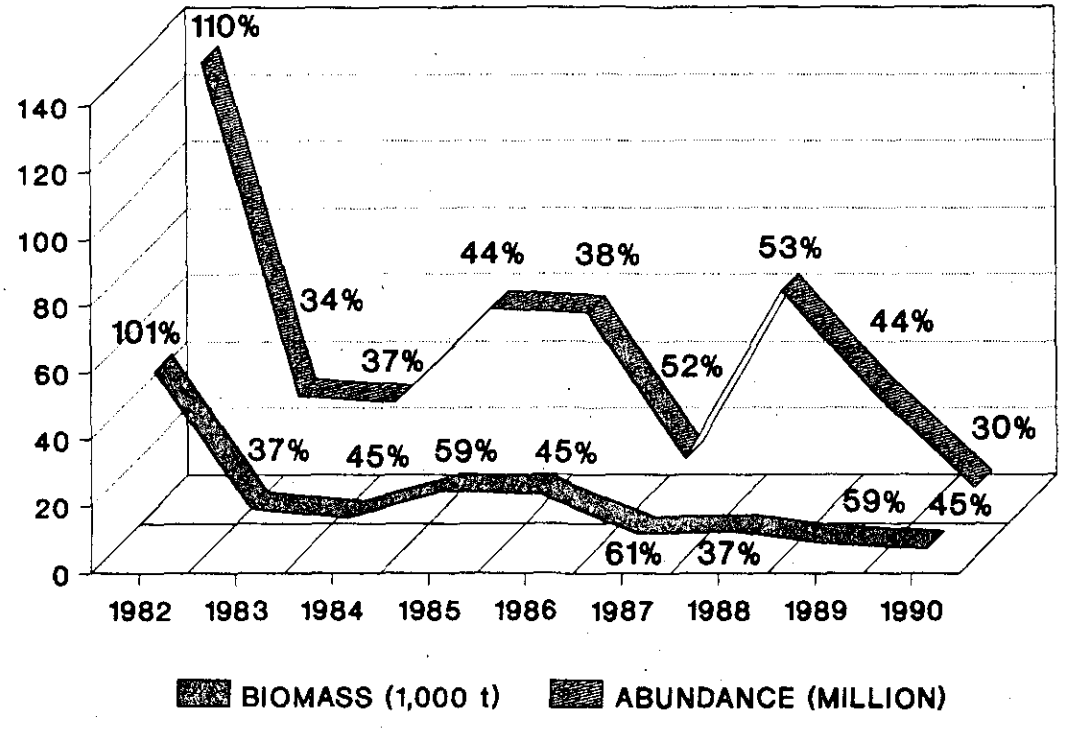

Figure 2 Survey abundance and biomass estimates for golden redfish (Sebastes marinus), 1982-90 and respective confidence intervals in per cent.

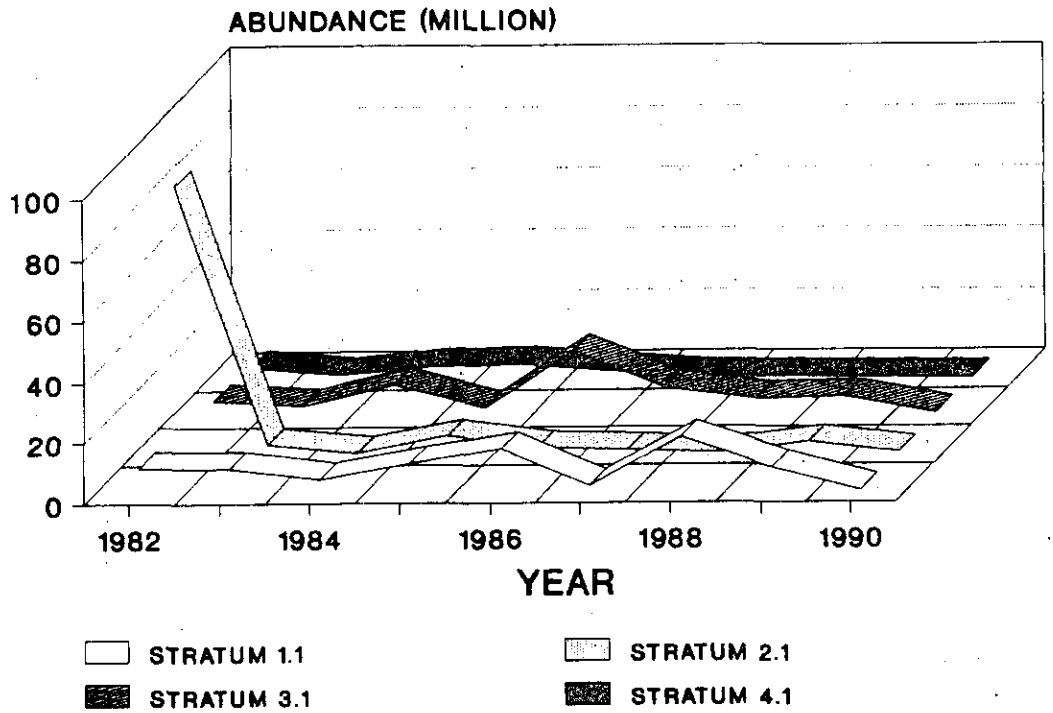

Figure 3 Survey abundance estimates of golden redfish (Sebastes marinus) for strata 1.1, 2.1, 3.1 and 4.1 (0-200m), 1982-90.

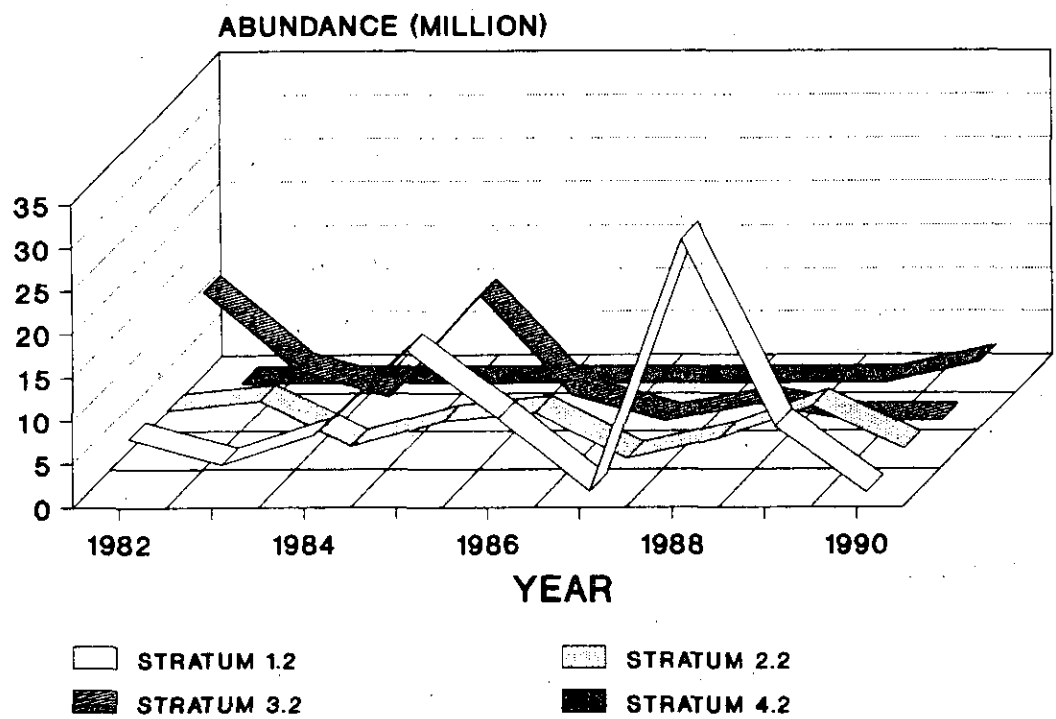

Figure 4 Survey abundance estimates of golden redfish (Sebastes marinus) for strata 1.2, 2.2, 3.2 and 4.2 (201-400m), 1982-90.

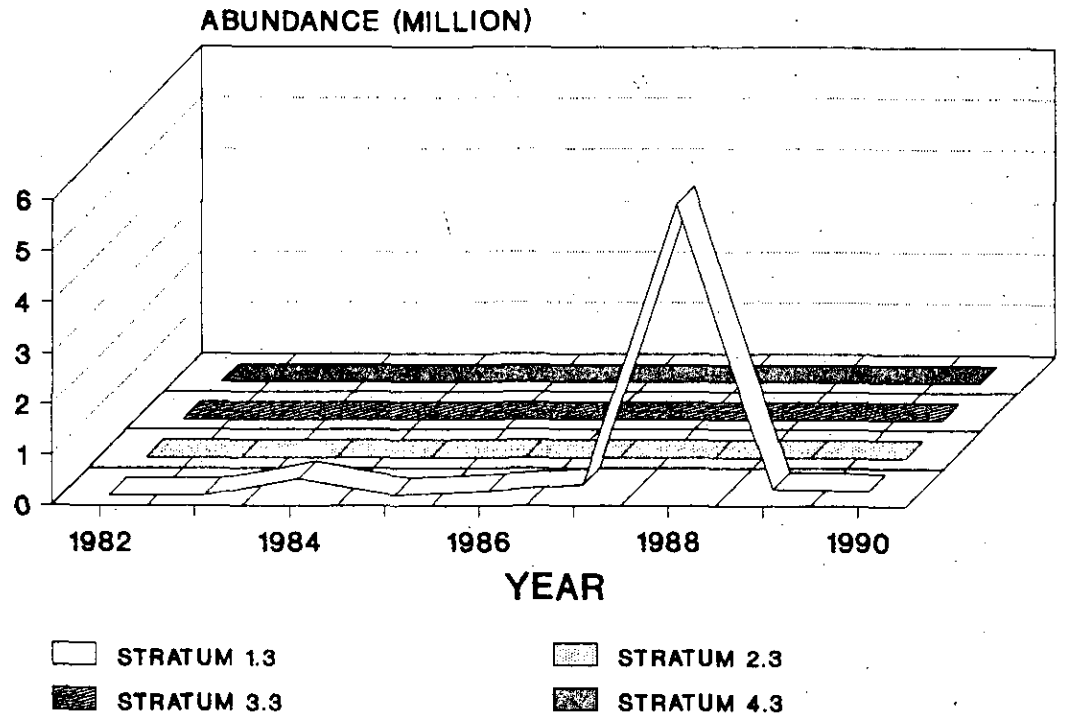

Figure 5 Survey abundance estimates of golden redfish (Sebastes marinus) for strata 1.3, 2.3, 3.3 and 4.3 (401-600m), 1982-90.

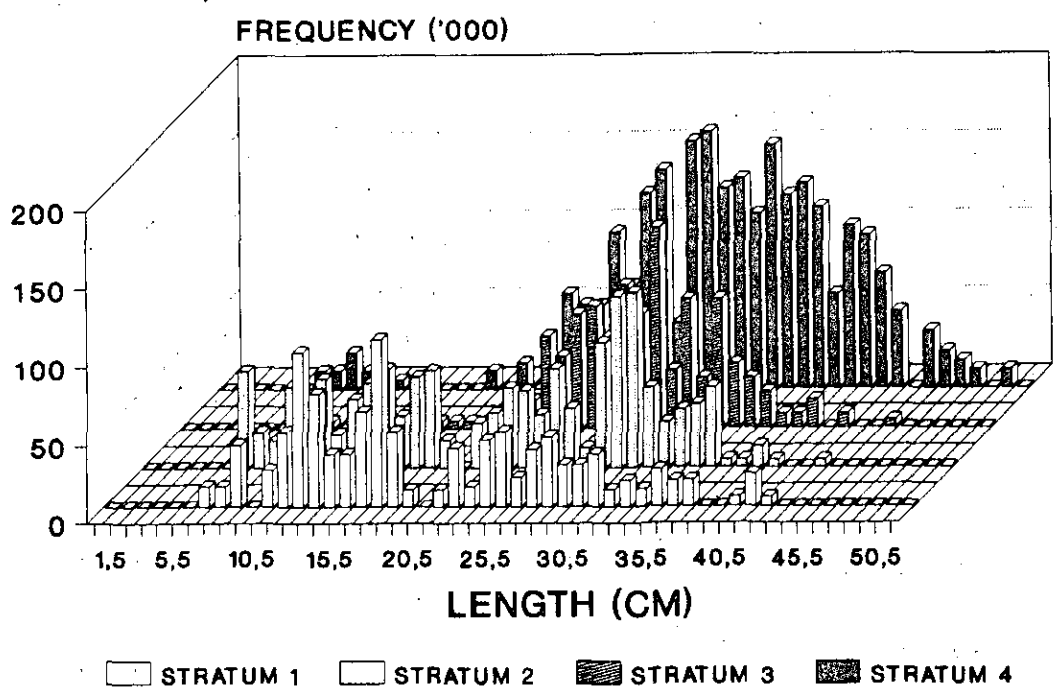

Figure 6 Length frequency of golden redfish (Sebastes marinus) splitted into the geographic strata 1-4 in 1990.

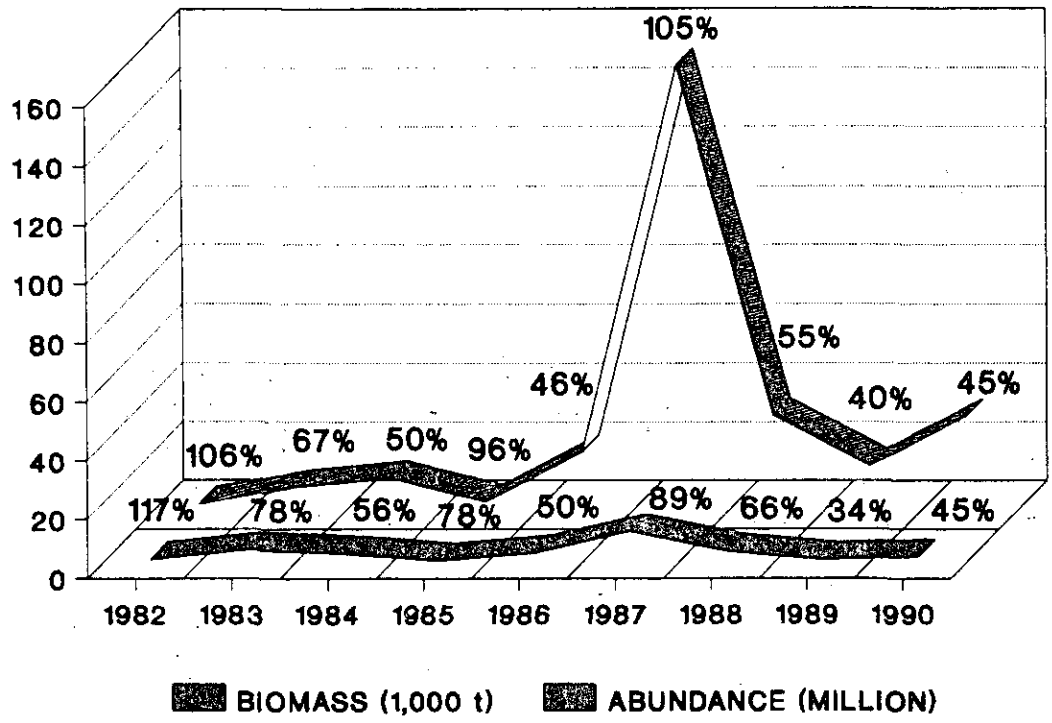

Figure 7 Survey abundance and biomass estimates for the beaked redfish (Sebastes mentella), 1982-90 and respective confidence intervals in per cent.

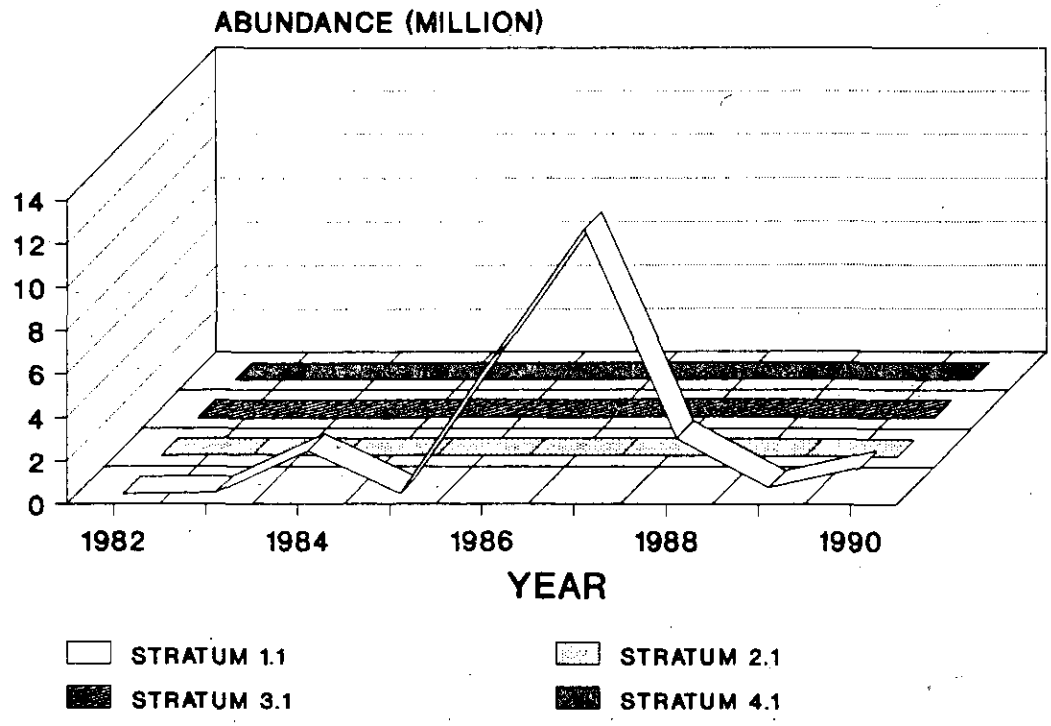

Figure 8 Survey abundance estimates of beaked redfish (Sebastes mentella), for strata 1.1, 2.1, 3.1 and 4.1 (0-200m), 1982-90.

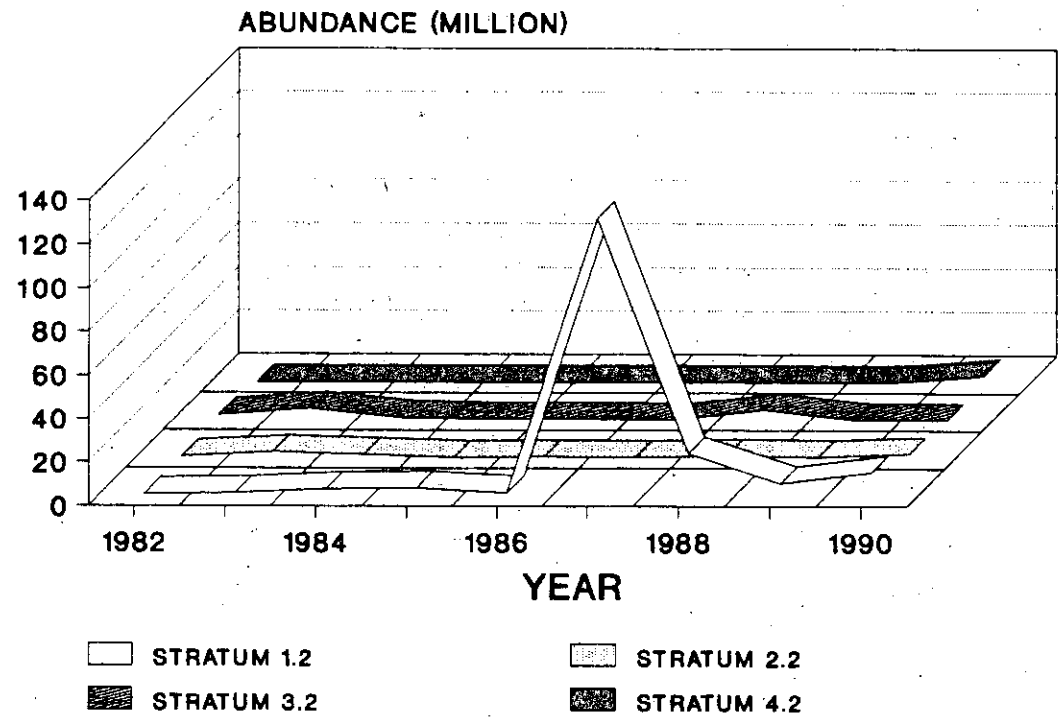

Figure 9 Survey abundance estimates of beaked redfish (Sebastes mentella) for strata 1.2, 2.2, 3.2 and 4.2 (201-400m), 1982-90.

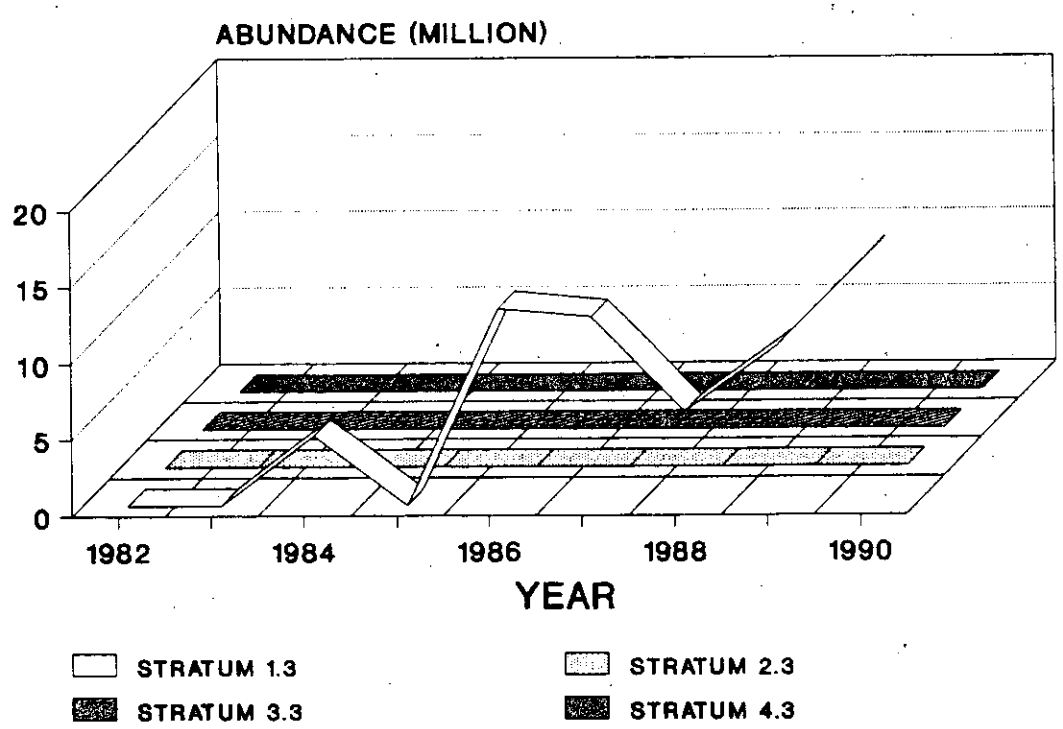

Figure 10 Survey abundance estimates of beaked redfish (Sebastes mentella) for strata 1.3, 2.3, 3.3 and 4.3 (401-600m), 1982-90.

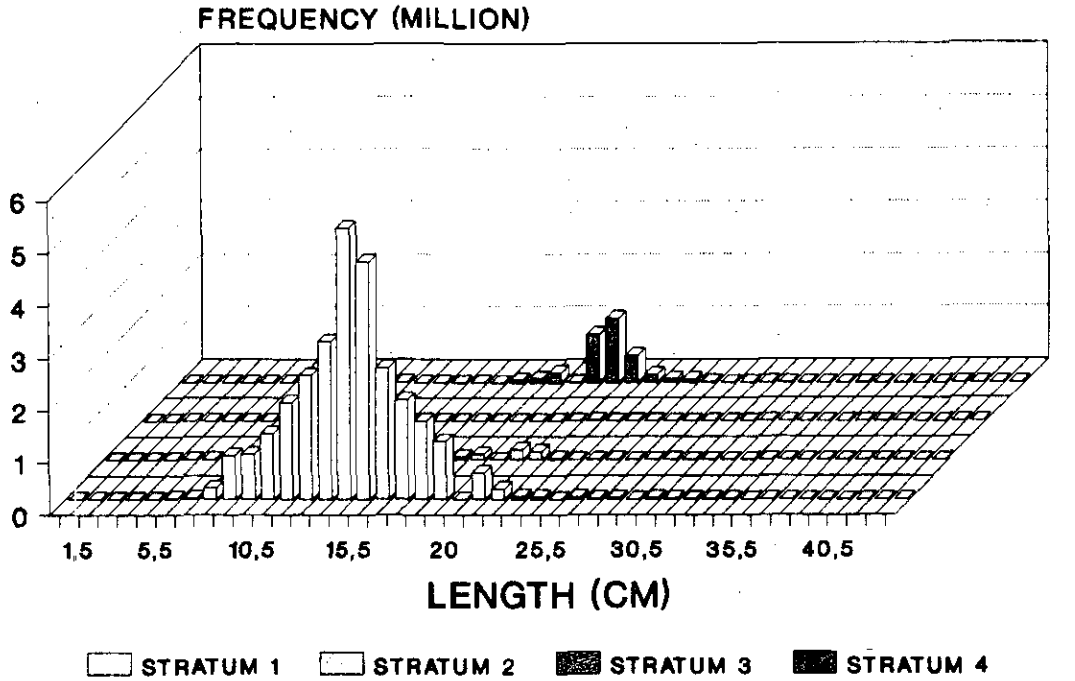

Figure 11 Length frequency of beaked redfish (Sebastes mentella) splitted into the geographic strata 1-4 in 1990.