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BYCATCH ESTIMATES OF REDFISH (*Sebastes spp.*) IN THE NORWEGIAN BARENTS SEA SHRIMP FISHERIES DURING 1983-2002

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Abstract

This document provides estimated numbers and weights of the redfish taken as by-catch in the Norwegian shrimp fishery in the Barents Sea during two decades. The results have shown that shrimp trawlers removed significant numbers of juvenile redfish during the beginning of the 80's with a peak during 1985 amounting to about 200 millions individuals. As sorting grids became mandatory in 1993, by-catches of redfish reduced drastically during the 90's. The by-catch of the redfish in relation to the shrimp catches and redfish landings are discussed.

Introduction

In the main offshore shrimp fishing areas *Sebastes mentella* is the dominating redfish species. Some analytical assessments of this stock have been presented (ICES, 1998). Those indicate a fairly high stock from the mid 60-ies to the mid 70-ies, then a significant decrease towards the mid 80-ies, and has remained low since then (less than 25% of the stock size around 1970). Annual landings were above 50.000 tonnes in the period 1974-1985. Since then landings in most years has been below 20.000 tonnes, in 2003 about 3.000 tonnes (ICES, 2004). Since 1997, ACFM has advised to prevent a direct fishery on this stock, and stronger regulations has gradually been introduced in order to rebuild the stock. Several areas have been closed for directed fishing. In the shrimp fisheries sorting grids for reducing by-catch of redfish and other commercial fish species were made mandatory in 1993, in the coastal areas already in 1990. From beginning of year 2000, 10 juveniles per 10 kg of shrimp have been used as criteria for closing areas for the shrimp fishery (ICES, 2002).

The objective of this study is to evaluate the level of by-catches of this species in the Norwegian shrimp fisheries from 1983 to 2002 in the Barents Sea and to compare that level after and before using a sorting grid in shrimp trawls.

Materials and Methods

Data used in this report were obtained from the Institute of Marine Research database that includes shrimp commercial catch statistic, logbook data, and data from surveillance surveys and IMR surveys. Number of the redfish by 1 cm interval taken as by-catch in shrimp trawlers were estimated according to Hylen and Jakobsen (1983) proposed method with a slight modification for extrapolating missing values in some localities. Detail description of the methods were given in Ajiad , Aglen & Nedreaas (2004). All the bycatch estimation was done in SAS using a release version 8.02.

The surveillance surveys have applied the shrimp trawls typical for the commercial fishery and the catches from these surveys have been used as a direct measure of by-catch (per length group) of redfish. The research trawl used before 1994 also had the same mesh size as used in commercial shrimp trawl (35 mm) and the catch data have been used as direct measure of by-catch for the commercial catches where sorting grid was not used (all commercial

catches before 1990 and offshore catches in 1990-1992). For 1993 (and those commercial tows with sorting grid in the years 1990-1992), the research trawl data were converted according to a grid selection curve for redfish fitted to data reported by Isaksen et al. (1990). In 1994 and later years a 20 mm cod end has been used in the research trawl and an additional conversion for the ratio between the redfish selection curve for 20 mm and 35 mm cod ends has been used. Here the assumptions were made that L50(cm)=2.63*mesh size (cm) and L25=0.8*L50 and L75=1.2*L50. Figure 2 shows the resulting mesh selection curves and Figure 2 shows the factors used for converting research trawl catch to commercial trawl catch. To eliminate research trawl data from areas where commercial fishing is unlikely, all research data with less than 1 kg shrimp catch was excluded. Since redfish catch is expressed pr kg shrimp this criteria also reduce some random effects caused by low numbers in the denominator.

Results and Discussion

Table 1 shows the estimated number of redfish by length group caught annually in the shrimp fishery. It is seen that both the total amount and the length compositions varies considerably between years. This is also illustrated in Figure 3. Large variations could be caused by scarce data on catch composition, and a few occasions with large by-catches among the survey data could make strong impact on the annual total. For instance is the estimated by-catch in 1986 surprisingly low compared to the years before and the years after. The more long term trends are, however, rather clear; the by-catches have decreased, and all large redfish disappeared from the catches after the sorting grid was introduced. Figure 4 compares the average over the years 1983-1991 and the average for 1993-2002. 1992 is shown separately and appears as a kind of transition year.

Judging from these results it seems that the sorting grid has been very effective in removing all redfish above 20 cm from the catches. Comparison between the surveillance data and the converted research trawl data should be done to test how good these conversions are.

According to the grid selection curve (identical to Res. tr. 93 in Figure 2) the grid is not able to reduce very much the by-catch of redfish below 10 cm. The observed reduction of these size groups could be partly caused by more closed areas, but presumably it is mainly caused by the reduced abundance of these size groups over the years, as observed both in the 0-group survey (Figure 8) and in the winter bottom trawl survey (Table 2). Decreased abundance most probably contributes to the reduced by-catch of all size groups below 20 cm.

The total by-catch of redfish was about 20.000 tonnes during some years (1984, 1985, 1989). This is high compared to the redfish landings those years. Since 1993 the redfish by-catch has been well below 1000 tonnes. The by-catch rate in this shrimp fishery over the considered period shows a maximum of 0.36 kg redfish per kg shrimp (1989). Compared to many shrimp fisheries around the world even this maximum value is low. The lowest value in this series of estimated redfish by-catch is 2 grams per kg shrimp (1998).

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Table 1. Estimated number (millions) of redfish caught in the shrimp fishery by length group and year. Sum and estimated catch weight (000 tonnes) are given at the bottom rows.

L(cm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
5	0.06	0.00	0.00	0.00	0.00	0.23	1.03	0.08	0.91	0.05	0.00	0.00	0.01	0.00	0.00	0.00	0.07	0.00	0.17	0.00
6	0.53	0.10	0.01	0.10	0.00	1.85	4.56	0.17	1.64	0.64	0.16	0.09	0.12	0.21	0.01	0.00	2.15	0.06	0.30	0.00
7	1.80	0.94	0.21	0.42	0.01	5.97	14.79	2.76	11.44	2.56	0.47	0.24	0.31	1.81	0.40	0.00	2.69	0.15	0.57	0.09
8	5.37	4.64	0.93	0.44	0.02	3.55	28.90	6.24	5.89	2.94	0.41	0.20	0.17	6.81	0.60	0.00	0.83	0.39	0.73	0.45
9	1.70	7.10	2.12	0.09	0.02	1.01	17.81	9.19	1.88	10.42	0.80	0.64	0.05	8.30	2.75	0.07	0.65	1.61	1.91	0.88
10	3.79	9.35	2.80	0.03	0.09	1.42	8.68	7.22	1.11	15.29	1.49	0.53	0.06	2.37	6.40	0.22	0.66	3.96	1.13	0.82
11	0.62	7.96	3.13	0.25	0.08	0.60	5.70	7.50	2.31	10.14	2.81	2.01	0.08	1.71	5.38	0.65	0.44	3.13	1.34	0.31
12	1.64	22.25	10.82	0.28	2.00	0.50	5.47	10.65	2.57	5.56	4.04	3.08	0.06	2.34	3.36	0.72	0.16	2.63	1.35	0.22
13	1.46	20.66	15.24	1.00	1.34	0.52	2.19	5.90	2.88	5.31	2.88	3.92	0.14	0.94	1.71	0.84	0.47	0.43	0.82	0.45
14	2.68	4.11	12.64	1.15	1.78	0.42	2.48	3.18	5.72	3.65	1.83	5.25	0.33	0.16	1.52	0.41	0.41	0.34	0.43	0.55
15	3.07	2.04	6.26	2.39	7.04	0.46	1.80	1.73	5.91	4.76	4.79	3.50	0.41	0.13	1.09	0.18	0.59	0.41	0.71	0.41
16	6.08	0.33	6.63	3.90	23.00	1.57	1.31	0.82	2.31	5.15	0.81	1.84	0.35	0.03	0.28	0.09	0.62	0.69	1.64	0.18
17	15.13	2.74	8.29	2.91	26.45	2.17	6.82	1.08	1.70	4.95	0.51	1.24	0.14	0.02	0.27	0.02	0.34	0.61	1.10	0.11
18	6.60	0.17	0.42	1.33	21.11	4.33	8.92	0.83	0.63	3.52	0.47	0.13	0.02	0.06	0.00	0.00	0.76	0.35	1.34	0.03
19	4.72	2.23	3.05	0.56	7.13	5.65	8.03	13.78	0.41	1.46	0.27	0.04	0.01	0.05	0.00	0.00	0.23	0.36	0.28	0.01
20	3.22	6.55	6.04	0.32	3.43	6.46	4.13	0.68	0.41	0.61	0.11	0.00	0.00	0.11	0.00	0.00	0.09	0.16	0.27	0.00
21	3.23	5.82	5.53	0.11	1.27	2.93	6.21	1.17	0.22	0.30	0.04	0.00	0.00	0.07	0.00	0.00	0.01	0.05	0.00	0.00
22	3.83	3.43	6.79	0.10	2.89	2.15	18.24	0.81	0.17	0.37	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.15	0.00	0.00
23	3.47	3.63	14.78	0.33	1.27	1.38	6.61	0.94	0.26	0.15	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.02	0.00	0.00
24	1.60	4.96	23.90	0.20	1.70	1.12	10.72	1.29	0.50	0.27	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
25	1.54	3.86	23.48	0.29	2.15	0.83	9.19	1.59	0.26	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
>25	18.95	53.87	44.56	1.60	7.41	0.96	24.98	16.22	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	91	167	198	18	110	46	199	94	51	78	22	23	2	25	24	3	11	15	14	5
000T	9.0	17.8	25.5	1.3	8.8	3.3	16.7	6.8	1.3	2.2	0.7	0.7	0.1	0.3	0.4	0.1	0.2	0.4	0.5	0.1

Table 2. Swept are index by length for *S. mentella* in the winter bottom trawl survey 1986-2005.

	Length group (cm)									
Year	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	> 45	Total
1986	81.3	151.9	205.4	87.7	169.2	129.8	87.5	23.6	13.8	951
1987	71.8	25.1	227.4	56.1	34.6	11.4	5.3	1.1	0.1	433
1988	587.0	25.2	132.6	182.1	39.6	50.1	47.9	3.6	0.1	1070
1989	622.9	55.0	28.4	177.1	58.0	9.4	8.0	1.9	0.3	962
1990	323.6	304.5	36.4	55.9	80.2	12.9	12.5	1.5	0.2	830
1991	395.2	448.8	86.2	38.9	95.6	34.8	24.3	2.5	0.2	1123
1992	139.0	366.5	227.1	34.6	55.2	34.4	7.5	1.8	0.5	867
1993	30.8	592.7	320.2	116.3	24.2	25.0	6.3	1.0	+	1117
1994	6.9	258.6	289.4	284.3	51.4	69.8	19.9	1.4	0.1	979
1995	263.7	71.4	637.8	505.8	90.8	68.8	31.3	3.9	0.5	1674
1996	213.1	100.2	191.2	337.6	134.3	41.9	16.6	1.4	0.3	1037
1997[2]	63.2	120.9	24.8	278.2	271.8	70.9	39.8	5.2	0.1	875
1998[2]	1.3	88.2	62.5	101.0	203.2	40.4	12.9	1.1	0.2	511
1999	2.2	6.8	68.2	36.8	167.4	71.3	21.0	3.1	0.1	374
2000	9.0	12.7	39.4	76.8	141.9	97.1	26.6	6.9	1.5	412
2001	9.3	22.5	7.0	54.9	77.4	73.2	9.4	0.6	0.1	254
2002	16.1	7.2	19.1	41.7	103.9	113.7	22.9	1.4	+	326
2003	3.9	3.9	10.0	12.4	70.8	199.8	46.9	6.0	0.3	354
2004	2.2	3.0	6.9	18.5	32.9	86.7	31.8	2.0	0.1	184
2005	-	6.3	7.3	10.7	28.4	153.4	86.6	3.9	0.2	297

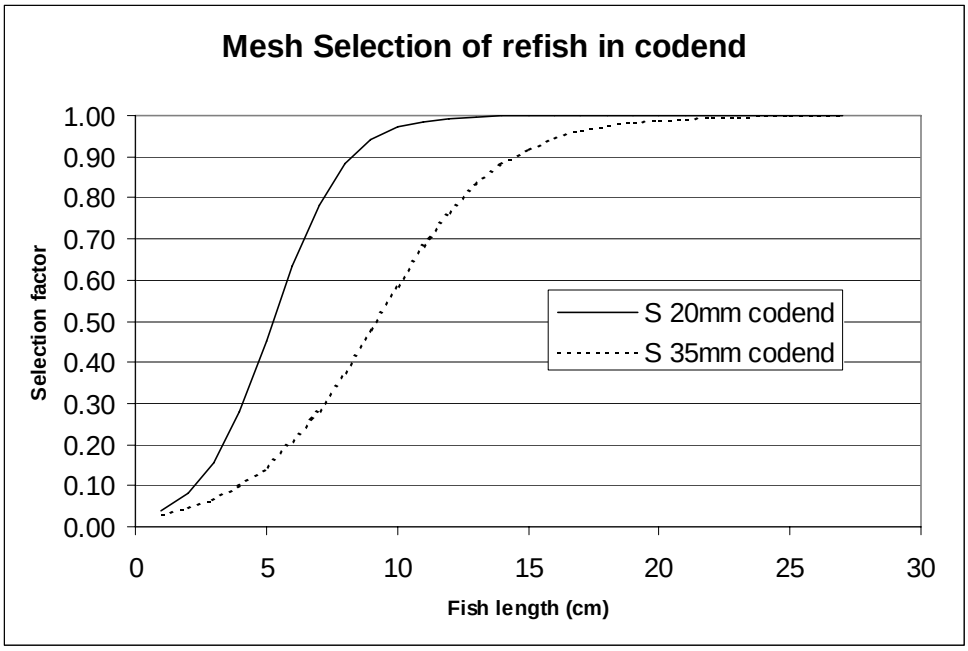

Figure 1. Assumed cod end selection curve for redfish for the research trawl used in 1994 and later (20mm cod end) and for commercial shrimp trawl and research trawl before 1994 (35 mm cod end).

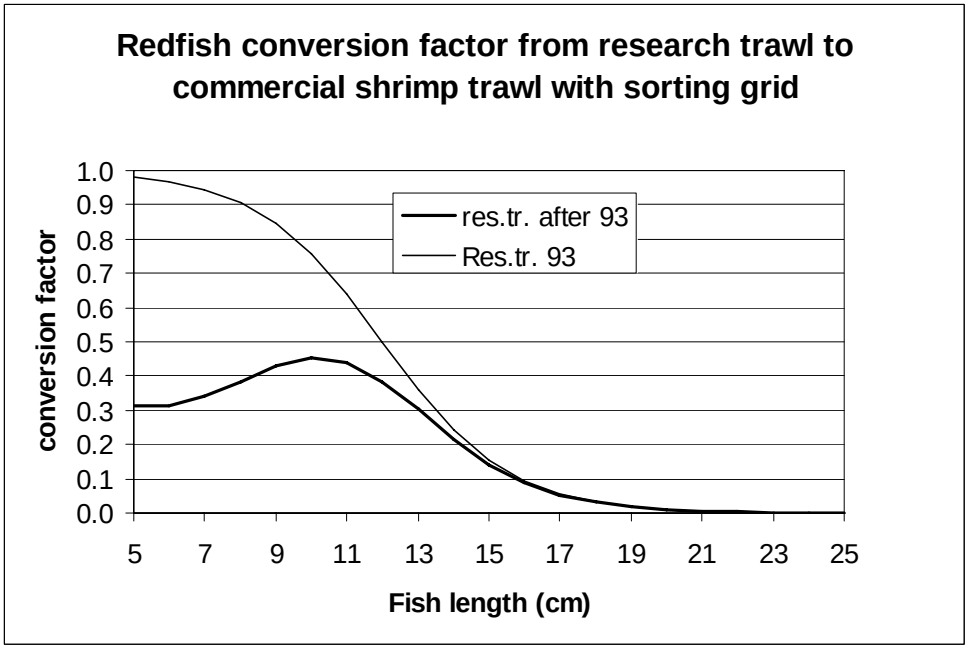

Figure 2. Conversion factors from research trawl to commercial trawl with sorting grid. The curve labelled Res. tr. 93 is fitted to the grid selection data from Isaksen et al. (1990). This was also applied for converting to coastal commercial vessels using sorting grid in the years 1990-1992. No conversion for the catches before 1990.

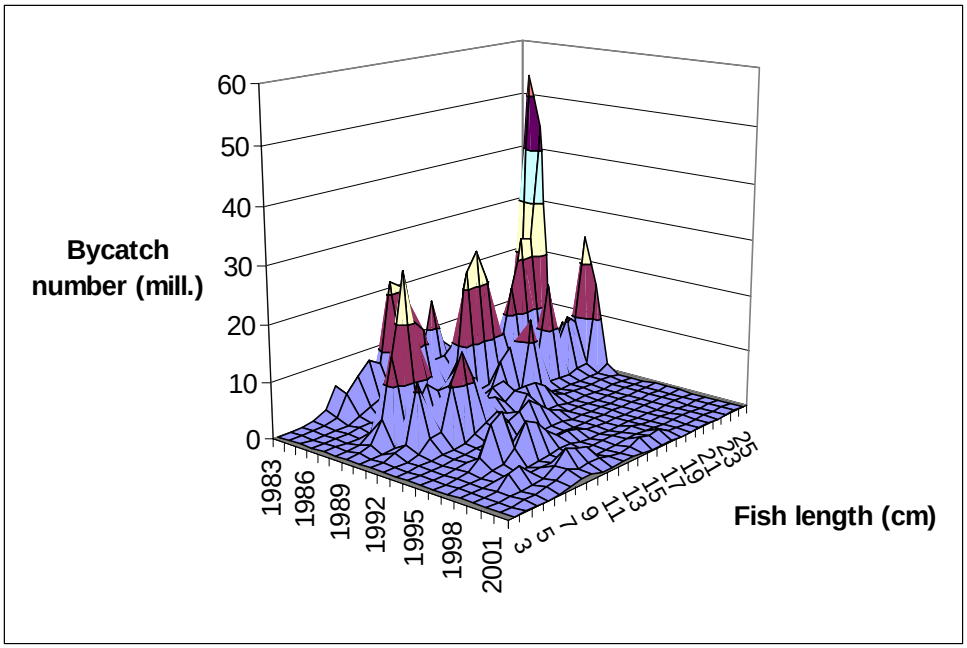

Figure 3. Redfish by-catch by year and length group (same data as Table 1).

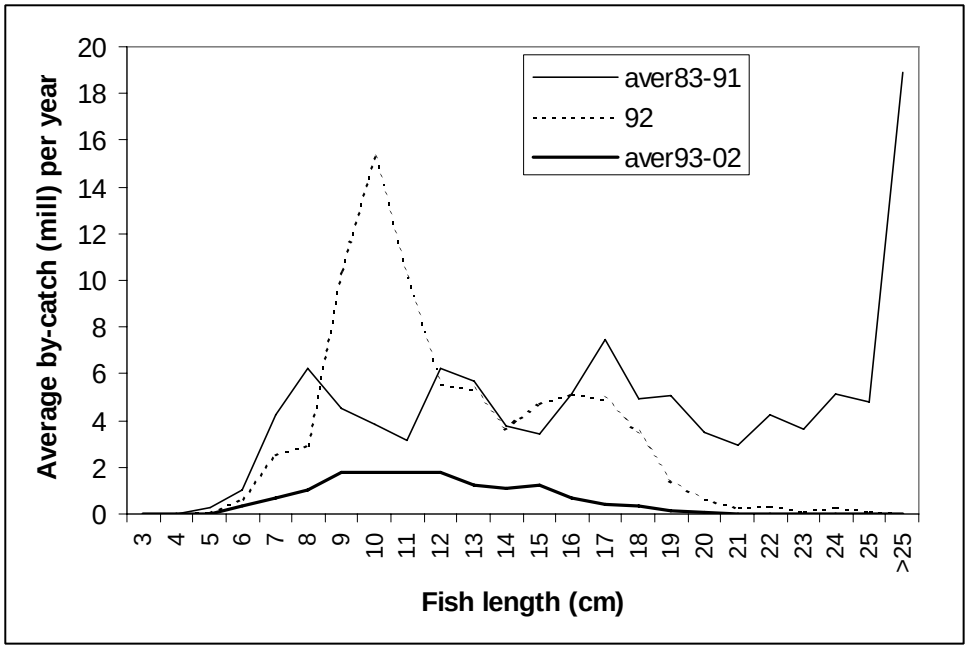

Figure 4. Average by-catch by length group for the periods 1983-1991 and 1993-2002 compared with the single year 1992.

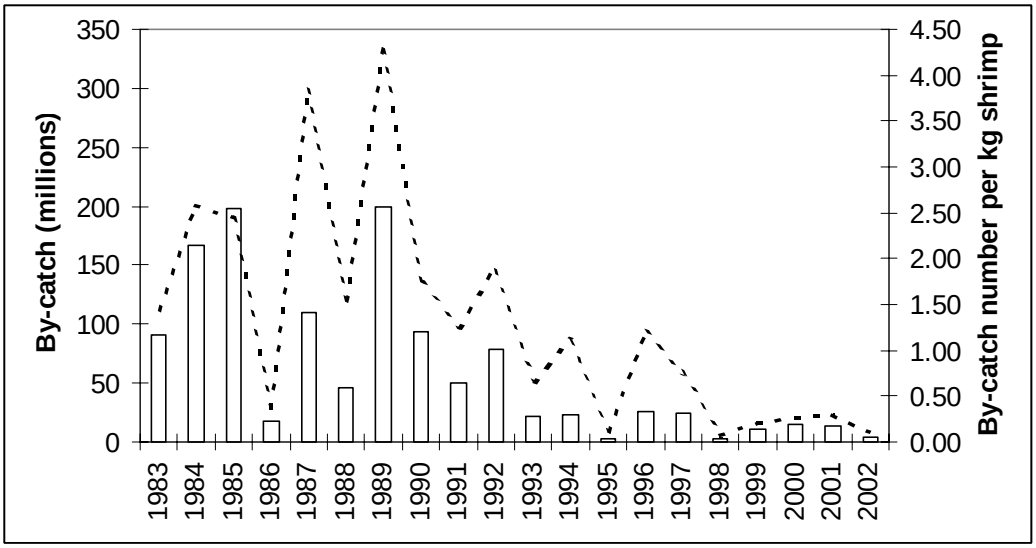

Figure 5. Total number of redfish caught by year in the Norwegian shrimp fishery (columns) and bycatch number per kg shrimp (line).

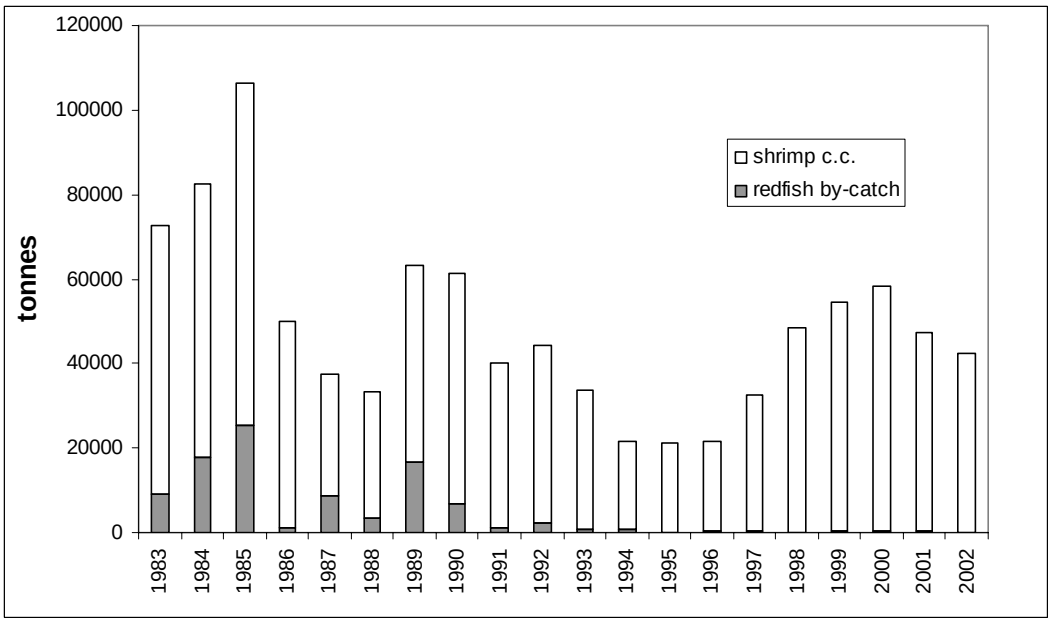

Figure 6. Redfish by-catch compared to commercial catch of shrimp.

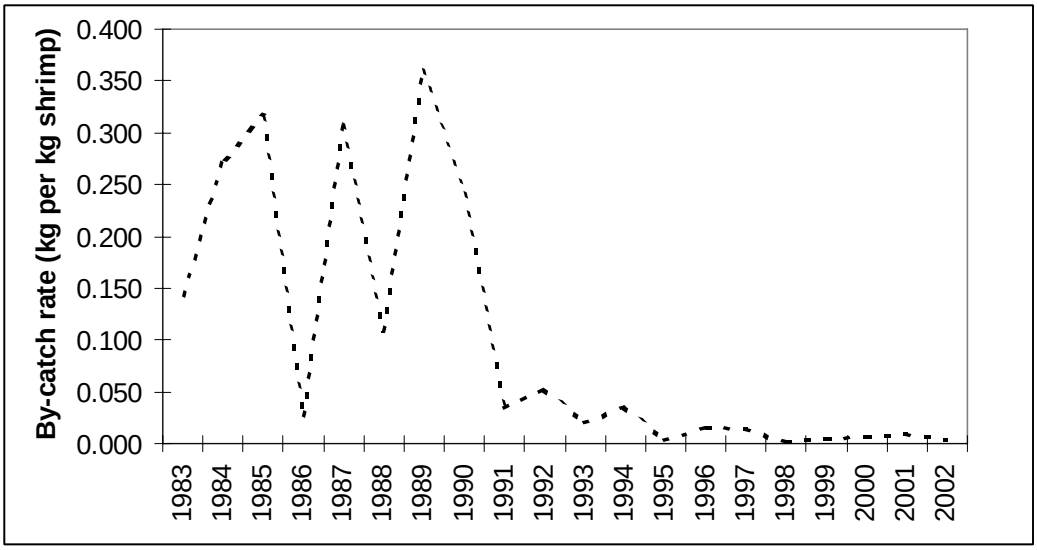

Figure 7. Bycatch rate (kg redfish per kg shrimp).

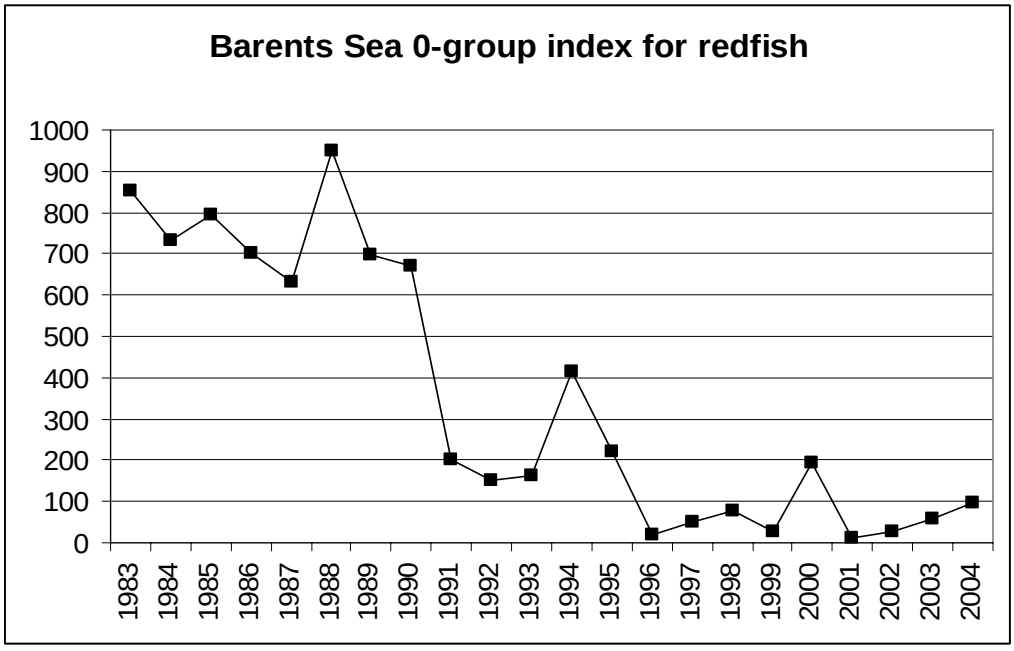

Figure 8. 0-group index of redfish in the Barents Sea.