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Interim Monitoring Report of Beaked Redfish (*Sebastes mentella and S. fasciatus*) in NAFO Division 3M

by

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Abstract

The present report updates for 2003 the most relevant commercial and survey data used in the assessment of the Division 3M beaked redfish stock. From the data presented there are no signs of a change in the status of the 3M beaked redfish stock from 2002 to 2003.

Introduction

The 3M redfish assessment is focused on the beaked redfish stock regarded as a management unit composed of two populations from two very similar species: the Flemish Cap *S. mentella* and *S. fasciatus*. The reason for this approach is the dominance of this group in the whole of the 3M redfish populations, representing the bulk of the redfish bottom biomass survey indices available for the Flemish Cap bank (on average 80% of the redfish survey bottom biomass) and dominating the commercial catch.

In last year assessment (Ávila de Melo *et al*., 2003) an Extended Survivor Analysis (XSA-Shepherd, 1999) was performed using the framework of previous assessments (Ávila de Melo *et al*., 2001). A Logistic Surplus Production Model Including Covariates (ASPIC-Praguer, 1994 and 1995) was also applied. Either XSA or ASPIC analysis pointed out that the 3M beaked redfish stock experienced a steep decline from the second half of the eighties till 1996. Fishing mortality was kept well above F_{msy} over the first half of the assessment period. From 1995 onwards fishing mortality dropped and since 1997 has been kept well below the assumed level of natural mortality. Despite apparent fluctuations biomass and female spawning biomass are generally increasing since 1997 but at slow rates, being still well bellow the level on the first years of the XSA time series (1989-1990). The stock reproductive potential has increased through the nineties compensating the SSB decline and sustaining a 1998-2002 geo-mean recruitment at age 4 identical to the former years of 1989-1993.

Commercial fishery and by-catch data

The redfish fishery on Div. 3M increased from 20,000 tons in 1985 to 81,000 tons in 1990, falling continuously since then till 1998-1999, when a minimum catch around 1,000 tons has been recorded. The increase of the catch to a somewhat higher level on 2000-2002 (3,700-2934 tons respectively) reflected an increase of the fishing effort directed to 3M redfish, with EU- Portugal and Russia consolidating a major role on the actual fishery. However in 2003 Russian catch fall by 90% and the overall catch didn't reach 2,000 tons. With 1,100 tons recorded EU-Portugal is responsible for more than half of 2003 catch, but also well bellow its former 2001-2002 level of 1,500 tons (Table 1a, Fig. 1a).

The boom in 1993 and further settlement of a shrimp fishery in Flemish Cap lead to high levels of redfish by-catch in 1993-1994. From 1995 onwards by-catch in weight fell to apparent low levels but since 2001 is increasing again, reaching 1006 tons in 2003 (Table 1b). This increase does not reflect any recent expansion of the 3M shrimp fishery and could be supported by a couple of above average year classes occurring at the turn of the decade.

Translated to numbers this represents an increase from an annual by-catch level of 3.4 millions of redfish, recorded in 1999-2000, to 21.9 millions in 2001-2003. In 1999-2000 this by-catch represented on average 37% of the total 3M redfish catch in numbers. In 2001-2003 the redfish by-catch in numbers from the Flemish Cap shrimp fishery justified 75% of the total catch (Table 1c, Fig. 1b).

For several years length sampling data from Russia, Japan and Spain were available and used to estimate the length composition of the commercial catches for those fleets and time periods. The 1989-2003 length composition of the Portuguese trawl catch was applied to the rest of the commercial catches. An annual shift of the most abundant length groups in the commercial catch to larger sizes, within the 20-30cm, interval is observed every year since 1996 (Table 2a, Fig. 2a). From previous assessments 1996 was the year when both exploitable and female spawning biomass reached a minimum, beyond which the stock decline was halted by the pursuing of exploitation at low levels, well below natural mortality. Mean length in the catch increased as well, being in 2003 again above the maturity L_{50} of *S. mentella* females (Saborido-Rey, pers. comm., 2000) (Table 2a, Fig. 2b).

The 1993-2003 redfish by-catch in numbers at length for the 3M shrimp fishery was calculated based on data collected on board of Canadian and Norwegian vessels (Kulka, D. and J. Firth, *pers. comm.*, 2000-2004). Despite the apparent stability of the Flemish Cap shrimp fishery, there is a dramatic increase on the magnitude of the by-catch at length for the most abundant length groups, when switching from1999-2000 to 2001-2003 (Table 2b and Fig. 2c).

Furthermore, over the last three years there is also a progression of the modal length groups from smaller (8-13 cm in 2001) to larger sizes (12-18 cm in 2003), suggesting the recent passage of strong cohorts through their pre-recruited ages (Table 2b and Fig. 2d).

Survey data

The EU survey on the Flemish Cap bank has been conducted annually in June-July since 1988 as a bottom trawl survey, down to the 731 m-depth contour. Swept area is divided according the Flemish Cap bank stratification proposed by Doubleday (1981). Half an hour valid hauls were kept around 120 each year, with the number of hauls in each stratum proportional to the respective swept area. Each haul swept the bottom at a constant speed about 3.3-3.5 knots, with the gear performance controlled at most of the tows with SCANMAR equipment.

In June 2003 a new Spanish research vessel, the RV "Vizconde de Eza" (VE), replaced the RV "Cornide de Saavedra" (CS) that has carried out the whole EU survey series, with the exception of the years of 1989 and 1990. From the 114 valid hauls made by the VE to cover the nineteen Flemish Cap strata down to 730 m, 59 were valid calibration hauls made with the CS (Casas, 2004). Both vessels were fishing with the same gear, a Lofoten trawl gear with 35 mm mesh size at the codend, which remained unchanged throughout the series. The calibration between the old and new RV's of the Flemish Cap EU survey will be completed next July 2004 with 10 days of simultaneous and parallel hauls, to consolidate the coverage of the strata of the bank deeper than 250 m.

However, the usefulness of the final results of the calibration as regards the three native species of *Sebastes* should be checked prior to the 2005 assessment. With a wide vertical distribution from the bottom and a strong schooling behaviour, redfish survey data from a calibration campaign might be submitted to several sources of variation much larger than the difference between the fishing efficiency of the two research vessels. The validation of the calibration results will be pursued through sensitivity analysis of a 2004 XSA, with the survey tuning data matrix incorporating each one of the possible 2003 survey abundance at age vectors: one from the raw VE survey abundance at length and the other with this same vector converted to CS units by the adjustment of the Warren model (Warren, 1997). At this stage the 2003 survey results presented are from the RV "Vizconde de Eza", without conversion to RV "Cornide de Saavedra" units (Casas *pers comm*, 2004).

Survey biomass and female spawning biomass were calculated as sums of products, through the survey abundance and mature female abundance at length. The average proportion of each *Sebastes* found in the identified

juveniles up to 21 cm is applied to the length frequencies of unidentified juveniles in order to split them by species. The annual length weight relationships used were for beaked redfish as a whole over the former period of 1988-1991. From 1992 onwards *S.mentella* and *S. fasciatus* survey biomasses were calculated separately with their own annual length-weight relationships (Table 3a and Fig. 3a). All length weight relationships were derived from the sampling of the survey catches.

The 1989-2003 EU survey mean catch per tow of beaked redfish (Table 3a and Fig. 3b), is also presented as the sum of the mean catch per tow for *S. mentella* and *S. fasciatus* separately (Casas *pers comm*, 2004) with the mean catch per tow for beaked redfish juveniles. This mean catch is estimated with the annual proportion of small beaked redfish found in the juvenile biomass (sum of products up to 21 cm length) of the three *Sebastes* species together, applied to the mean catch per tow of juveniles. The overall standard error is given by the square root of the sum of squares of the standard errors of the mean catch per tow for each category.

The more recent period covered by EU surveys (1988-2003), started with a continuous decline of bottom biomass till 1991 followed by a period of biomass fluctuation with no apparent trend from 1992 till 1996. A further decline occurred in 1997 and 1998, when the second lowest biomass was recorded. Survey bottom biomass increased in 1999 and 2000 till 110,000 tons, the highest index observed since 1989. In 2001 biomass fall again to 59,000 tons, increased to 89,000 tons in 2002 and in 2003 returned again to the 2001 level (Table 3a, Fig. 3a).

Survey spawning biomass declined through the first years of EU survey series, staying at low level for most of the years since 1993. Over the more recent period the SSB index experienced large inter-annual variation, from a minimum in 1998 of 3,700 tons to 19,500 tons recorded in 2000, the highest value since 1990. In 2001-2002 the SSB index returned to 7,000-8,000 tons. The female spawning biomass index also declined in 2003: 6,600 tons against 7,700 tons the year before. From 1988 till 1991 female spawners represented between 22% and 28% of the bottom biomass index. Since 1994 this proportion has been oscillating between 9% and 12%, with the exception of 1998 (7%) and 2000 (18%) (Table 3a).

Abundance falls on the first years of EU survey series (1988-1990). The strong 1990 year-class pushed the survey abundance to a maximum in 1992. Abundance declined sharply during the intermediate years, regardless the smaller peaks of 1994 and 1996. The second lowest abundance of the EU survey series is attained in 1998. Afterwards stock abundance increased continuously till 2002, but this increase is not yet reflected on survey biomass and spawning biomass: a couple of recent above average cohorts, probably from 1998 and 2000, have supported this increase at their very young ages (Table 3a, Fig. 3a).

Survey abundance index decline almost 40% in 2003. It is difficult to associate this type of drastic decline with fishing mortality, well bellow the assumed natural mortality since 1997. The wide oscillations in survey bottom biomass with time have been usually induced by changes on the adult redfish concentration near the bottom (fish grater than 30 cm, generally speaking), as well as on the distribution of this component in and out of the survey swept area of the Flemish Cap bank. Those sudden declines and increases are then reflected on switching the sign of survey catchability residuals for several full recruited age groups, within consecutive years. However that was not the case in 2003: from the changes in the survey abundance at length observed between 2002 and 2003 (Table 3b) the segments of the population at length justifying the decline in abundance are the smallest length groups (6-15 cm) and the intermediate ones (21-30 cm), which suffered a 82% and 35% reduction from previous year. Those reductions suggest that year classes after 2000 are much weaker than their predecessors and that immature/young adult beaked redfish was less available to survey gear than in 2002. On the other side beaked redfish from either 16-18 cm lengths and greater than 30cm almost double their survey abundance: in other words, after passing through the critical ages of by-catch mortality, juveniles from the 1998-2000 cohorts confirm their importance in the actual stock, while adult fish survival is kept at a high level.

Conclusion

Despite the observed declines in the EU survey indices, 2003 data on the length structure of the commercial catch and survey abundance suggests stability in the 3M beaked redfish exploitable and spawning stock. The 1998 and 2000 year classes, predicted to be strong in the previous assessment, confirmed their above average magnitude in last EU survey, after being responsible for the raise of the redfish by catch in numbers in the 3M shrimp fishery in 2001-2003.

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Table 1a: 3M Redfish nominal catches (ton) by country, 1989-2003.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000 (a)	2001 (a)	2002 (a)	2003 (a)
CAN			2		10			2				5			
CUB	1765	4195	1772	2303	945										
DDR		4025													
GRL				1		26									
JPN	885	2082	1432	1424	967	488	553	678	212	440	321	31	80	67	98
SUN/RUS	13937	34581	24661	2937	2035	2980	3560	52		25	92	1808	1292	1155	115
LVA				7441	5099	94	304								
LTU					2128								10	10	1
EST						47						632	167	5	23
E PRT	13012	11665	3787	3198	4781	5630	1282	332	83	259	96	916	1589	1512	1113
EU	13225	13672	10111	6845	4881	6240	1282	332	335	455	505	1349	1746	2011	1722
KOR-S	17885	8332	2936	8350	2962										
FAROE IS.				16										0.1	
NORWAY						8	3								
Total	47697	66887	40914	29317	19027	9883	5702	1064	547	920	918	3825	3295	3248	1959
STCAFIS Estimates of commercial catches from various sources.															
Total	**58100**	**81000**	**48500**	**43300**	**29000**	**11300**	**13500**	**5789**	**1300**	**971**	**1068**	**3658**	**3224**	**2934**	

(a) Provisional

Table 1b: Redfish by-catch in weight (ton) from the 3M shrimp fishery, 1993-2003.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
By-catch in weight (ton) (b)	11970	5903	374	550	157	191	96	106	738	767	1006

(b) from Canadian and Norwegian sampling data kindly supllied by D. Kulka and J. Firth (Sci.,Oceans &Envir. Br., Dept. Of Fish. & Oceans, St. John's, Nfld, Can.)

Table 1c: 3M Redfish catch in numbers(millions), 1989-2003.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Comm.	143.3	219.2	116.9	101.7	61.3	29.6	38.5	17.2	3.2	2.5	2.4	9.3	9.2	8.6	4.5
By-catch (b)					118.8	61.8	3.7	15.6	2.9	4.6	3.7	3.1	25.8	18.5	21.3
Total	143.3	219.2	116.9	101.7	180.1	91.4	42.2	32.8	6.1	7.1	6.1	12.4	35.0	27.1	25.8

(b) from Canadian and Norwegian sampling data kindly supllied by D. Kulka and J. Firth (Sci.,Oceans &Envir. Br., Dept. Of Fish. & Oceans, St. John's, Nfld, Canada

Table 3a: EU survey biomass, female ssb and abundance indices, 1989-2003.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
spawning biomass ('000 ton)	43.5	32.3	22.9	15.0	18.1	9.0	7.9	8.7	8.8	8.3	3.7	8.3	19.5	7.0	7.7	6.6
biomass ('000 ton)	195.5	123.4	82.2	68.8	104.5	53.8	89.2	69.6	92.7	75.6	56.5	77.9	110.4	58.9	89.2	59.5
abundance (millions)	731.9	469.6	279.8	536.0	1105.1	491.9	720.4	448.2	614.5	461.4	323.2	413.9	487.5	668.0	880.3	535.5
ssb proportion	22%	26%	28%	22%	17%	17%	9%	12%	10%	11%	6%	11%	18%	12%	9%	11%
mean weight per tow (Kg/tow)	177.9	141.7	96.1	143.4	219.1	52.7	100.7	80.3	111.0	92.4	65.7	91.3	129.7	68.7	103.7	67.0
SE Kg/tow	28.3	18.9	10.8	12.5	20.5	16.7	26.8	8.6	15.3	16.4	10.4	26.4	50.7	10.8	15.0	9.2

Table 3b: Abundance at length ('000) from 2002 and 2003 EU survey

length	6	7	8	9	10	11	12	13	14	15						
2002	71	924	1919	7959	12526	16150	46147	126205	188560	76565						
2003	7	92	192	796	1250	1612	4610	12592	19834	46182	**-82%**					
length	16	17	18													
2002	43706	39809	53010													
2003	107514	104773	55000	**96%**												
length	19	20	21	22	23	24	25	26	27	28	29	30				
2002	55270	43080	23900	21990	18460	20200	16280	15340	14940	13770	10810	6900				
2003	38420	31260	22350	15210	10100	8980	8310	8330	9100	7470	5540	4480	**-35%**			
length	31	32	33	34	35	36	37	38	39	40	41	42	43	44		
2002	2830	1110	790	430	190	190	110	100	30	10	10	10	10			
2003	2840	2360	1160	1740	590	800	610	580	770	50	10	10		10	**98%**	

Table 2a: Relative commercial catch at length (per mile), 1996-2003 (most abundant length groups on **bold**).

Length	1996	1997	1998	1999	2000	2001	2002	2003
10							0.07	
11							0.03	
12					1		0.10	
13					2		0.16	
14					0		0.26	
15			1		1	0.48	0.49	
16	1				0	0.44	1	
17	1	0.23	1		1	2	3	1
18	1		0.36		3	7	6	1
19	4	2	4	0.39	4	5	11	
20	23	3	6	1	7	5	18	
21	62	5	13	0	5	7	19	0.37
22	**143**	14	23	1	12	14	19	1
23	**106**	35	42	0	13	23	22	6
24	86	89	52	4	25	33	37	19
25	51	**110**	**100**	50	36	53	56	57
26	33	**105**	**100**	48	76	**105**	70	78
27	48	67	93	94	**134**	**146**	94	**112**
28	49	57	78	**131**	**168**	**170**	**120**	**116**
29	55	71	75	**131**	**145**	**140**	**120**	**128**
30	58	84	72	86	99	**117**	**117**	**105**
31	61	75	77	90	68	63	91	86
32	57	84	70	**105**	47	40	68	79
33	44	90	50	76	36	25	56	73
34	43	36	33	36	33	17	34	57
35	18	26	24	62	21	9	17	44
36	13	14	21	33	16	5	11	21
37	14	8	20	29	15	4	3	10
38	7	9	15	4	13	4	3	4
39	8	4	13	13	6	2	2	2
40	3	1	7	1	4	1	1	0.51
41	2	4	5	2	2	1	0.20	0.09
42	3	2	4	0	2	1	0.29	0.07
43	1	0.46	1	1	2	0.35	1	1
44	0.18	2	1	0.13	1	0.19		
45	0.13	0.46	0.14	1	0.27	0.08		0.26
46	0.23	0.46	0.23		1	0.13		
47	0.07	0.46			0.39	0.04		
48						0.09		
49								
50	2							
51								
52								
53								
54								
55								
56								
57								
58								
59								
60								
61		4						
mean weight (g)	337	406	395	440	395	357	376	414
mean length (cm)	27.5	29.5	29.4	30.9	29.6	28.6	28.9	30.2

Table 2b: By-catch in numbers ('000s) at length, 1999-2003 (most abundar length groups on **bold**).

Length	1999	2000	2001	2002	2003
5		3	8	9	54
6	14	5	177	56	240
7	111	58	473	355	587
8	**531**	121	**1318**	623	1103
9	**784**	55	**3739**	501	1398
10	**816**	191	**5795**	819	1419
11	377	**588**	**5563**	**1498**	891
12	302	**997**	**4429**	**2784**	**1335**
13	276	**743**	**1884**	**4743**	**2675**
14	93	179	662	**3795**	**2485**
15	87	84	467	**1652**	**1840**
16	83	48	459	742	**1946**
17	59	16	383	351	**2446**
18	40	10	250	238	**1703**
19	37	9	92	143	641
20	12	10	41	73	219
21	6	4	25	34	177
22	7	2	23	18	87
23	5	2	12	12	48
24	2	2	9	6	18
25	4		4	3	10
26		2	1	2	1
27	3		1	0	1
28			2	1	1
29			0	0	0
30			0	0	
31			0	0	
32			0	1	
33					
34					
mean weight	0.026	0.034	0.029	0.042	0.047
mean length	11.2	12.5	11.5	13.4	14.2

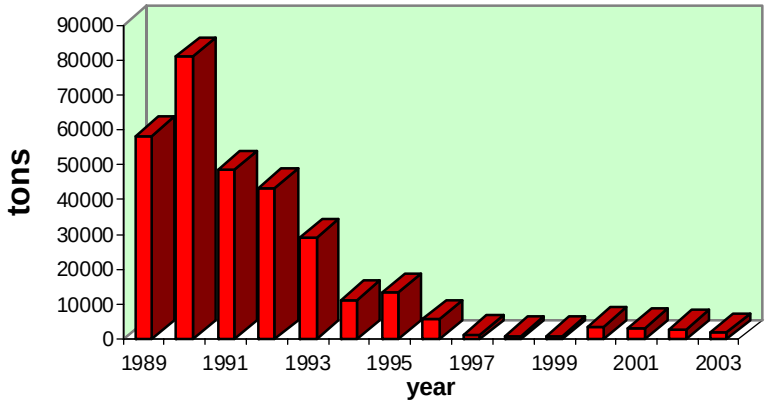

Fig. 1a: STACFIS estimate of commercial catch (2003 from NAFO Circ. letters)

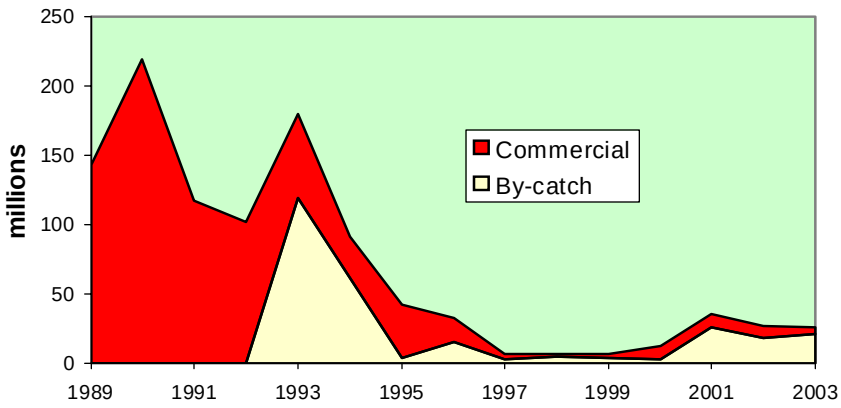

Fig. 1b: Commercial catch and by-catch in numbers

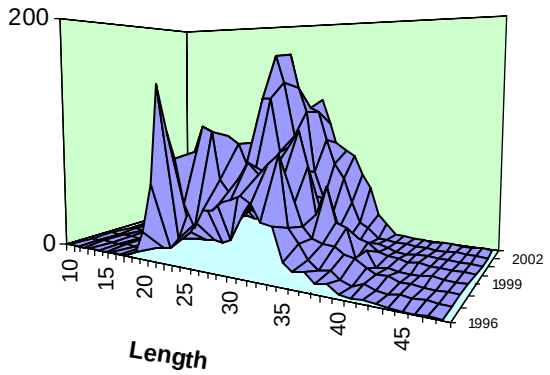

Fig.2a: Relative commercial catch at lenght: 1996-2003

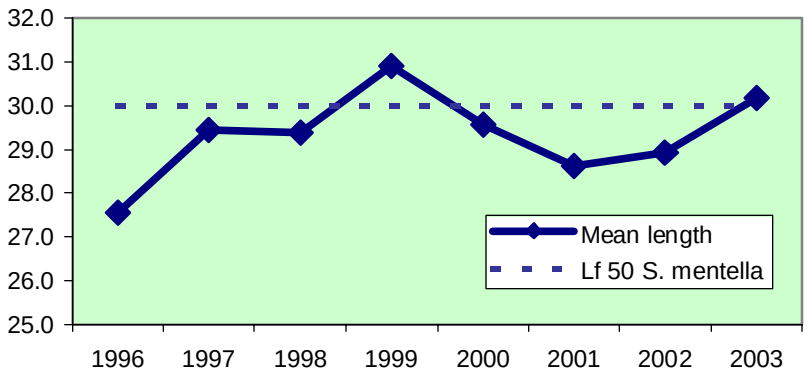

Fig. 2b: Mean length in the commercial catch, 1996-2003

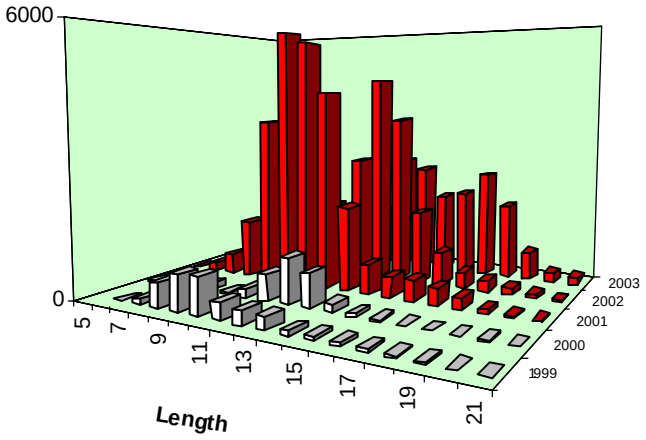

Fig.2c: By-catch in numbers ('000s) at lenght: 1999-2003

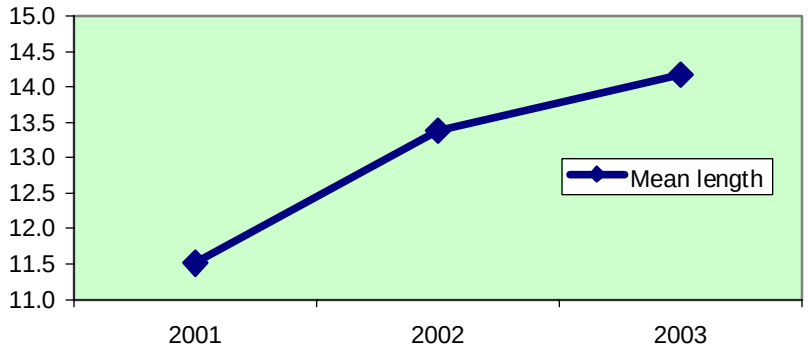

Fig. 2d: Mean length of the by-catch, 2001-2003

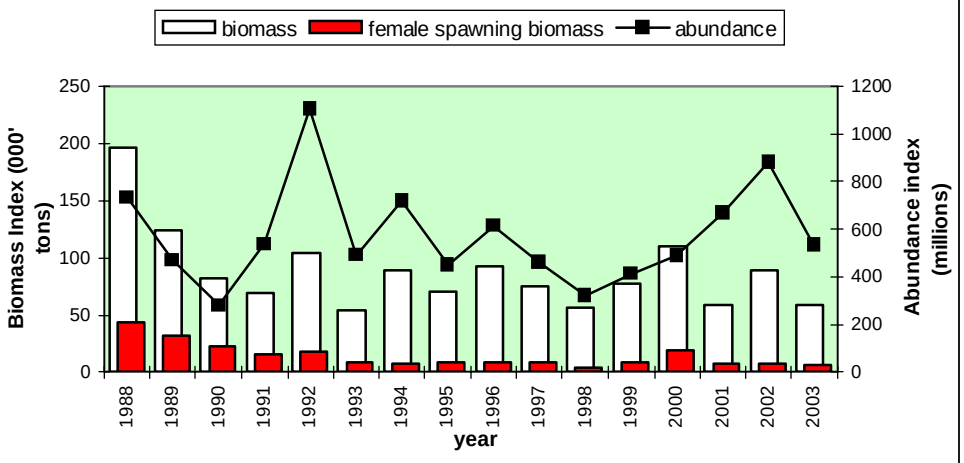

Fig. 3a: 3M Beaked redfish biomass, female spawning biomass and abundance (EU survey, 1988/2003)

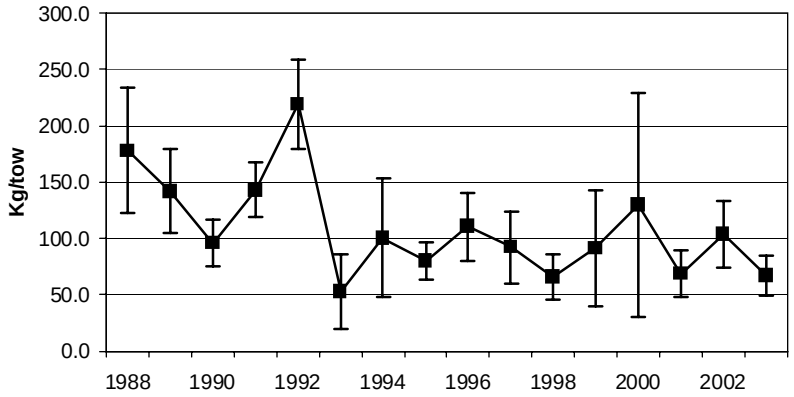

Fig. 3b: mean catch per tow for 3M beaked refish (EU survey, 1988-2003) with upper and lower 95% CI