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A Revised Assessment of Beaked Redfish (*Sebastes mentella and Sebastes fasciatus*) in NAFO Division 3M Using the Original EU Survey Indices Converted to the New RV Vizconde de Eza Units

by

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Abstract

The 3M beaked redfish stock is regarded as a management unit composed of two populations from two very similar species (*Sebastes mentella* and *Sebastes fasciatus*). In June 2003 a new Spanish research vessel, the *RV Vizconde de Eza* (VE) replaced the *RV Cornide de Saavedra* (CS) that had carried out so far the EU survey series with the exception of the years of 1989 and 1990. In order to preserve the full use of the 1988-2002 survey indices available for beaked redfish, the original time series were converted to the new *RV* units. An Extended Survivor Analysis (Shepherd, 1999) was performed using the previous XSA framework and the revised EU survey abundance's at age as the tuning input file. In order to evaluate the effect of the conversion of the original 1989-02 survey abundance at age matrix to the new *RV* units the original 2003 XSA results are compared with the results of the present analysis. The update of the survey abundance at age tuning matrix kept the general trends of either biomasses and fishing mortality, but re-scaled each stock parameter to a new dimension that has proven to have a much better fit to both survey and commercial data. Very high fishing mortalities until 1996 forced a rapid and steep decline of abundance, biomass and female spawning biomass of the 3M beaked redfish stock. From 1997 onwards, low fishing mortalities allowed a slow but continuous growth of both 4+ Biomass and female SSB. Abundance was kept stable at a low level from 1996 to 2001, increasing afterwards with the recruitment of the above average 1998-00 year classes to the 4+ stock. Medium term trajectories of female spawning stock biomass under a gradient of $F_{statusquo}$ percentages were obtained. Despite the re-scaling of the results between the 2003 and 2005 XSA's due to the conversion of the tuning survey data in accordance to the new *RV* units, the present $Mterm$ trajectories of female spawning biomass and yield under a low fishing mortality regime confirm the advice from the 2003 assessment that the prevail of stock recovery on a foreseeable future is dependent of an average medium term catch level of 5,000 tons.

Introduction

There are three stocks of redfish in NAFO Division 3M: deep-sea redfish (*Sebastes mentella*) with a maximum abundance at depths greater than 300m, golden redfish (*Sebastes marinus*) and Acadian redfish (*Sebastes fasciatus*) preferring shallower waters of less than 400m. Due to their external resemblance *S. mentella* and *S. fasciatus* are commonly designated as beaked redfish. The identity of the Flemish Cap beaked redfish populations is supported by recent morphometric studies (Saborido Rey, 1998).

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

Flemish Cap beaked redfish are long living species presenting slow growth, slow maturation and a long recruitment process to the bottom, extending to lengths up to 30-32cm. The *S. mentella* and *S. fasciatus populations* have similar length growth, namely females, up to 20 years of age (Saborido Rey, 2001). Redfish are viviparous with the larvae eclosion occurring right before or after birth. Mean length of female first maturation varies from 26,5cm (at age 8) for Acadian redfish to 30.1cm (at age 10) for deep-sea redfish (Saborido Rey, *pers. comm.* 2000). Spawning on Flemish Cap occurs through February till the first half of April for deep-sea redfish while for Acadian redfish spawning reach its maximum in July – August (Saborido Rey, 1994).

The present assessment uses an Extended Survivor Analysis (XSA) to tune the terminal fishing mortalities at age with the 1989-04 EU survey abundance's at age, converted to the new Spanish RV Vizconde de Eza units. With the survivors at the beginning of 2005 and recruitment randomly re-sampled from the 2000-2004 geometric mean, medium term projections were made for a range of $F_{statusquo}$ multipliers.

Description of the fishery

The 3M redfish stocks have been exploited over the past both by pelagic and bottom trawl. Due to the similarity of their external morphology the commercial catches of 3M redfish are reported together. The majority of the bottom commercial catches are composed of beaked redfish. The species composition of the pelagic redfish catches, which dominated the fishery in the early nineties, remains unknown. However, taking into account that from survey results, *S.mentella* and *S.fasciatus* together represent the major proportion of the abundance and biomass of 3M redfish, it is assumed that these pelagic catches were also dominated by beaked redfish.

The redfish fishery on Division 3M increased from 20,000 tons in 1985 to 81,000 tons in 1990, falling continuously since then till 1998-99, when a minimum catch around 1,000 tons has been recorded most as by-catch of the Greenland halibut fishery (Table 1a, Fig. 1a). The drop of the 3M redfish catches from 1990 onwards is related with the quick decline of the stock biomass followed by an abrupt decline of fishing effort deployed in this fishery.

The relative increase of the catch on 2000-02 (3,700-2,900 tons respectively) reflected an increase of the fishing effort directed to 3M redfish, pursued by EU- Portugal and Russia fleets. However in 2003 Russian catch fall by 90% and the overall catch didn't reach 2,000 tons. With 1100 tons recorded, EU-Portugal was responsible for more than half of 2003 catch. In 2004 catch raised again near 3,000 tons and Portugal consolidate its major role in the present fishery with 2,600 tons, while Russia records a catch near zero (Table 1a, Fig. 1a).

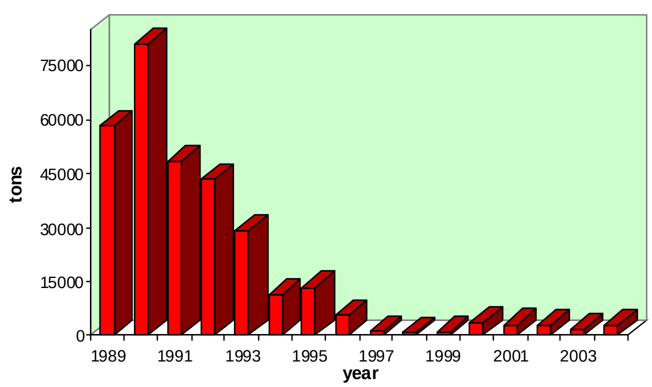


Fig. 1a: STACFIS estimates of commercial catch.

The boom in 1993 and further settlement of a shrimp fishery in Flemish Cap lead to high levels of redfish by-catch in 1993-94. From 1995 onwards by-catch in weight fell to apparent low levels but since 2001 increase again, reaching 1006 tons in 2003. That increase does not reflect any recent expansion of the 3M shrimp fishery and could be supported by one (or more) above average year classes occurring at the turn of the decade (Ávila de Melo *et al*., 2004). On 2004 by-catch in weight dropped more than 50% (471 tons), suggesting that those year classes are now in the commercial fishery (Table 1b).

Translated to numbers by-catch increased from an average 3.4 millions of redfish (1999-00) to 21.9 millions (2001-03), decreasing to an intermediate level of 9.9 million fish in 2004. In 2001-2003 the redfish by-catch in numbers from the Flemish Cap shrimp fishery justified 78% of the total catch. In 2004 represented 44%, same as previously (1999-00) (Table 1c, Fig. 1b).

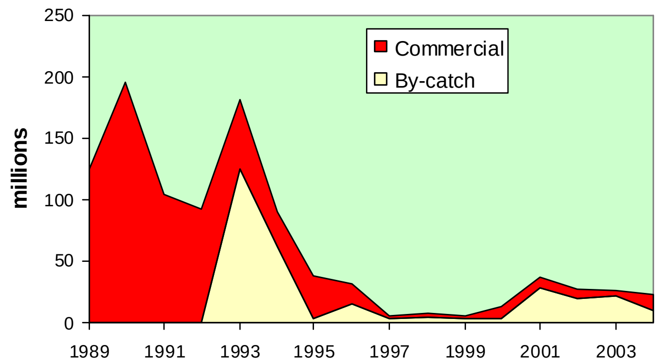


Fig. 1b: Commercial catch and by-catch in numbers

Research survey series

Bottom trawl survey biomass for Div. 3M redfish present large inter-annual variability, too drastic to be only explained by changes in stock abundance from one year to the next. These fluctuations are caused not only by vertical migrations of redfish, all species with both demersal and pelagic behaviour, but also by a wide and variable distribution within the division, as pointed out by the beaked redfish commercial catches from the north eastern slopes of Flemish Pass, near the border of Div. 3M with Div. 3L.

There are two survey series providing bottom biomass indices as well as length and age structure of the Flemish Cap redfish stocks: one series from Russia (1983-93; 1995-96 and 2001-02) and the other one from the European Union/Spain and Portugal (1988-04). An earlier bottom trawl survey series has been carried out by Canada from 1979 till 1985. This series was discontinued since then, despite an isolated Canadian bottom trawl survey conducted again on 1996.

For reasons explained in previous assessments (Ávila de Melo *et al*, 2003) the EU survey series is the only source of survey data used in the input files of the assessment framework.

EU series

The EU survey has been conducted annually in June-July since 1988 as a bottom trawl survey, down to the 731m-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. During the 1988 and 1989 surveys only golden redfish has been separated from the rest of the redfish catches. Since 1990, juvenile redfish (less than 21cm) has also been separated as an independent category, and 1992 forward all the 3 species and juveniles were separated in each haul catch prior to sampling procedures. However, with the continuation of these surveys, the skill to identify redfish smaller than 21 cm increased. The juvenile redfish that has been identified is directly allocated in its species catch, contributing to the decreasing of the proportion of small redfish classified as juvenile over the most recent years. At present the juvenile category includes unidentified redfish less than 16cm.

Conversion of the original EU survey indices to the new RV units (from Troncoso and Casas, 2005)

In June 2003 a new Spanish research vessel, the *RV Vizconde de Eza* (VE) replaced the *RV Cornide de Saavedra* (CS) that had carried out so far the EU survey series with the exception of the years of 1989 and 1990. In order to preserve the full use of the 1988-02 survey indices available for several target species, the original time series needed to be converted to the new RV units.

During 2003 and 2004 Flemish Cap surveys, 130 pairs of parallel hauls (selected at random from the annual coverage of the bank) were performed simultaneously by the two vessels, at depths less than 730m. Those pairs of parallel hauls were distributed over the swept area trying in one hand to maximize the sampled area and on the other to guarantee a large enough number of hauls with acceptable catches of all target species, namely the ones from severely depleted stocks (cod and American plaice). Both vessels were fishing with the same gear, a Lofoten trawl gear with 35mm mesh size at the codend, which remained unchanged throughout the series.

For each target species the straight comparison of the catch within each pair of parallel hauls is based on the assumption that the number of fish on the bottoms swept by each one of the two vessels is the same. The pairs of hauls with zero catch for one of the vessels, or with large differences on the length distribution that would suggest large differences on the density of fish on each swept bottom, were discarded of the calibration analysis. The calibration between the old and the new research vessel allowed the computation of the conversion factors for redfish (regardless the species) and juveniles (lengths < 16cm), based on the redfish catch of 97 valid pairs of parallel hauls.

The first step of the conversion framework was the adjustment of a multiplicative model (Robson, 1966) to the pairs of observed CPUE's, in order to establish a relation between the CPUE of the two boats:

$$CPUE_{ij} = e^{\mu + t_i + h_j + \varepsilon_{ij}}$$

were t_i is the effect of vessel i , i =1, 2; h_j is the effect of haul j , j =1,..., μ is a parameter of the model and ε is the model error.

The model is log transformed

$$\ln(CPUE_{ij}) = \mu + t_i + h_j + \varepsilon_{ij}$$

assuming that $\sum_{i=1}^{2} t_i = 0 \Rightarrow t_1 = t = -t_2$

A Correction Factor (CF) is estimated through the expression (Sissenwine and Bowman, 1978):

$$CF = \frac{CPUE_2}{CPUE_1} = e^{-2t(1+0.5s^2)}$$

where s^2 is the variance associated with t .

The CF's obtained with this model for redfish and juveniles were used to convert the original *RV Cornide de Saavedra* mean catch and biomass for beaked redfish (1988-91), *S. mentella* (1992-02), *S. fasciatus* (1992-02) and juveniles (1990-02) so that each former time series could be comparable with the correspondent new indices obtained since 2003 with the *RV Visconde de Eza.*

Besides the conversion of survey biomass with the Robson correction factor, the original 1989-02 survey abundance length distributions of each redfish category need also to be converted for assessment purposes. A correction factor is obtained for each *cm* length group by the fitness of the Warren multiplicative model (1997) to the observed catch ratios at length for the pairs of valid parallel hauls already used in the fitness of the Robson model:

$$Ratio = \alpha l^{\beta} e^{\delta l}$$

where

$$Ratio = \frac{RV\ Vizconde\ de\ Eza\ (number\ caught)}{RV\ Cornide\ de\ Saavedra(number\ caught)}$$ by *cm* length group,

l is the *cm* length group and α, β and δ are the model parameters

The fitness was made through linear regression of the log transformed Warren model. Due to the low redfish catch at the right tail of the length distributions the observed catch ratios at length for those large sizes are scattered. In order to avoid a poorer fit, an upper limit of the redfish length distribution was set, fixing a length range for the observed catch ratios to be included in the regression of the Warren model. That limit for redfish was fixed subjectively at 38cm, so that the catch ratio for lengths 39cm and larger is an average of the observed catch ratios from those sizes. As for the juvenile length distributions, sizes greater than 15cm are converted using the length correction factors of the redfish category.

In order to adjust on each year of the time series the Warren transformed survey abundance at length to the Robson transformed survey biomass the converted length distributions were finally weighted by an annual factor given by the ratio between the Robson swept area biomass and the Warren SOP biomass

$$WeightingFactor = \frac{SweptBiomass_{Robson}}{SOPBiomass_{Warren}}$$ where

$$SOPBiomass_{Warren} = \sum_{l} Warren_{absolutefrequency_l}\, a\, l^{b}$$

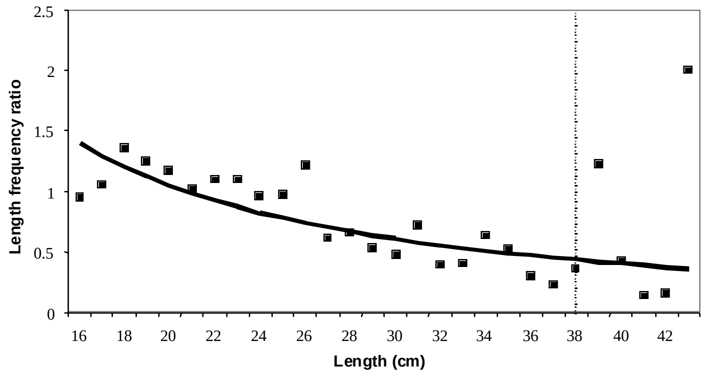
and l is the mid point of the length group, a and b the parameters of the annual survey length weight relationship.

The results of the Robson fit shown that the new *RV Vizconde de Eza* is 12% more efficient than the former *RV Cornide de Saavedra* as regards redfish and this difference is raised to 44% if only the smaller sizes up to 15cm are considered:

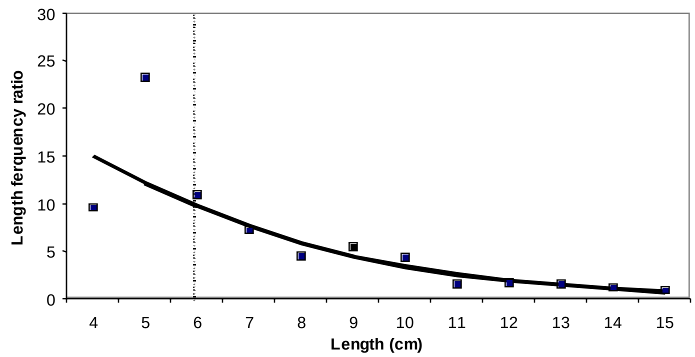
Robson parameters (Troncoso and Casas, 2005)					
	t	S	S^2	2t(1+0.5*s2)	**CF**
redfish	-0.05715	0.05512	0.00304	-0.11447	**1.12128**
juveniles	-0.18408	0.04179	0.00175	-0.36849	**1.44555**

The Warren fit to the observed length frequency ratios for redfish confirms the decrease of efficiency of the new vessel against the old one when moving from smaller to larger sizes. This model presented a better fitness when adjusted to juveniles within 6-15cm length range.

Warren parameters (Troncoso and Casas, 2005)				Length range		
	α	β	δ	valid hauls	adjusted	n hauls
redfish	3.5416	-0.0097	-1.1008	16-43	16-38	97
juveniles	5.7601	-0.1286	-1.4613	6-15	6-15	85



Warren fit for redfish (Troncoso and Casas, 2005)



Warren fit for juveniles (Troncoso and Casas, 2005)

Commercial and survey data

Length weight relationships from EU survey and commercial catch

Annual length weight relationships for *S. mentella* and *S. fasciatus* (1992-04) and for the two species combined (1988-04) were revised (Troncoso and Casas *pers. comm.*, 2005) (Table 2a). In each category all pairs of length-weight observations from the sampling of the survey catch were included in the fit, regardless sex and size. *S. mentella* and *S. fasciatus* length weight relationships were used to get the survey *SOP* biomass and *SSB* for each species since 1992. *Sebastes sp*. length weight relationships were used to get the 1988-91 survey *SOP* biomass and *SSB* for beaked redfish, as well as the stock and mature female weights at age for the whole period.

Length weight relationships from the Portuguese commercial catch were available for 1998-04 (Table 2b: Alpoim and Vargas, 2004 and Vargas *et al*, 2005).

Length composition of the commercial catch and by-catch

Most of the commercial length sampling data available for the 3M redfish came, since 1989, from the Portuguese fisheries and has been annually included in the Portuguese research reports on NAFO SCS Document series. Most of these data referred to beaked redfish, and, taking into account that the majority of the length sampling was from depths greater than 400m, they should represent *S. mentella* catches. Length sampling data from Russia, Japan and Spain were also available for several years and used to estimate the length composition of the commercial catches for those fleets and time periods. The annual length composition of the Portuguese trawl catch was applied to the rest of the commercial catches (Vargas *et al*, 2005). The 1998-2004 3M beaked redfish commercial length weight relationships from the Portuguese commercial catch (Table 2b: Alpoim and Vargas, 2004 and Vargas *et al*, 2005) were used to compute the mean weights of all commercial catches and correspondent catch numbers at length.

Modal lengths of the annual commercial catch gradually shift towards larger sizes from 1996 to 1999 and were kept within 27-30cm the next coming years, 2000-03 (Table 3a). Mean length in the catch generally increased to a higher level, being in 2003 again above the maturity L_{50} of *S. mentella* females (Saborido-Rey pers. comm., 2000). However in 2004, the most abundant length groups were pulled back to smaller sizes, 20-23cm, and mean length drop almost 6cm, to a minimum of 24.4cm (Table 3a, Fig. 2). From the 2004 age-length key and mean lengths at age, this dramatic shift reflects the recruitment process to the commercial fishery of the above average 1998 year class, as well as of the following 1999 year class, after supporting over 2001-03 the increase of the redfish by-catch in numbers in the 3M shrimp fishery.

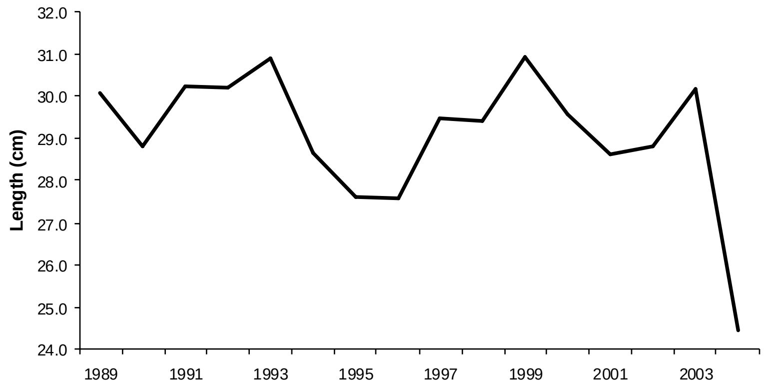


Fig. 2: Mean length in the commercial catch, 1989-2004

Redfish by-catch proportion in weight of the shrimp catch and redfish by-catch in numbers at length for the 3M shrimp fishery were available since 1993 on an annual basis, based on data collected on board of Norwegian (1993-98) and Canadian (1993-97; 1999-04) vessels (Kulka, 1999 and *pers. comm.*, 2000-05; Firth, *pers. comm.* 2004-05). The EU survey length weight relationships (Table 2a: Troncoso and Casas, *pers. comm.* 2005) were used to compute the mean weights of the by-catch and correspondent by-catch numbers at length. To abide the by-catch in numbers at length to the total by-catch in weight, the absolute length frequencies of the redfish by-catch for 2003 and 2004 were re-calculated as in previous assessments (Ávila de Melo *et al*. 2003). Length composition of redfish by-catch in the 3M shrimp fishery is presented on Table 3b.

The sum of the absolute length compositions of the 1989-2004 commercial catch with the absolute length compositions of the 1993-04 by-catch is the 3M redfish catch at length input of this assessment (Table 3c).

Beaked redfish survey abundance at length

Each of the redfish categories included in the beaked redfish assemblage had their own survey abundance at length original series (beaked redfish including juveniles, 1988-99; beaked redfish, 1990-91; *S. mentella*, 1992-02; *S. fasciatus*, 1992-02 and juveniles, 1990-02) converted to the new RV units using the conversion framework summarized above. The transformed *S. mentella*, *S. fasciatus* and juvenile survey abundance at length series were then updated with the 2003 and 2004 *RV Vizconde de Eza* length distributions. Finally the length distributions from all redfish categories were combined, as in previous assessments (Ávila de Melo *et al*., 2003), in order to give for beaked redfish a single 1988-04 survey abundance at length series (Table 4) and a single 1988-04 survey female spawning abundance at length series.

Comparison of original and converted EU survey series, 1988-02

Survey biomass and female spawning biomass were calculated as sums of products of survey abundance and mature female abundance at length times mean weight at length. In the 1988-89 beaked redfish survey biomass, SSB and abundance was derived directly from the 1988-89 beaked redfish survey length distributions. In 1990-91 the length distributions of juveniles up to 21cm assigned as juvenile beaked redfish, were incorporated to the beaked redfish survey length distributions. From 1992 onwards *S.mentella* and *S. fasciatus* survey abundance at length, female spawning abundance at length, biomass and SSB at length are first calculated for each species separately (with the juveniles assigned to each species included in the respective length distributions) and then summed up to give the correspondent beaked redfish survey indices. On former assessments the original survey length distributions were not abide to the swept area biomass, which resulted on a 1988-02 *SOP* biomass 6% higher on average than the original swept area biomass. In this assessment, due to the abundance at length adjustment made in the conversion framework, the SOP biomass from the new survey abundance at length series corresponds to the swept area biomass.

The comparison of original and converted 1988-02 survey series as regards juvenile, female spawning and stock biomass is presented on Table 5a and Fig. 3a,b and c. In order to compare original and converted survey series as regards juvenile biomass an annual beaked juvenile proportion was calculated within each series, as the ratio between the *SOP* biomass of beaked redfish up to 21cm length and the *SOP* biomass of beaked plus golden redfish up the same limit. These proportions were applied to the correspondent juvenile swept area biomass from each survey series. A similar procedure was used to get within each series an SSB proportion (= *SOP SSB*/*SOP biomass*) to apply to the swept area biomass, in order to get an original and converted female spawning biomass. As expected the converted 1990-02 beaked redfish juvenile biomass is on average 45% higher than the original survey series while *SSB* is on average 12% lower. Combination of those two biases resulted on a converted stock biomass 17% higher than the original survey biomass series.

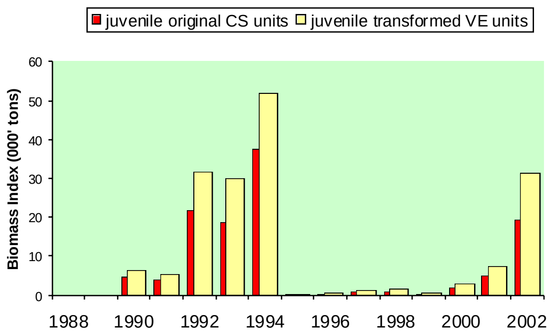


Fig. 3a: 3M beaked redfish juvenile biomass in original CS and transformed VE units (1990/2002)

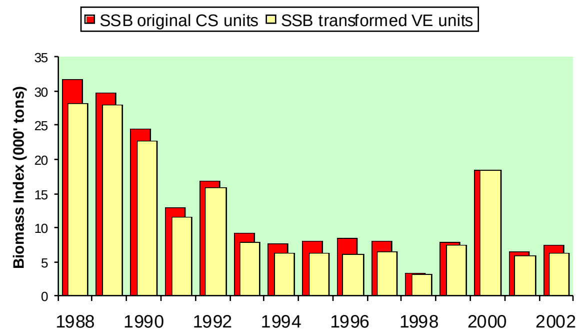


Fig. 3b: 3M beaked redfish female spawning biomass in original Cs and transformed VE units (1988/2002)

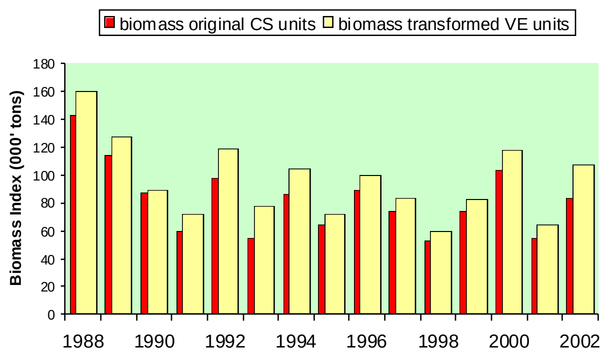


Fig. 3c: 3M Beaked redfish stock biomass in original CS and transformed VE units (1988/2002)

Survey biomass and abundance in ***RV Vizconde de Eza*** **units, 1988-04**

The more recent period of 1988-04 covered by EU surveys, started with a continuous decline of bottom biomass till 1991, followed by a period of biomass fluctuation with no apparent trend between 1992 and 1996. A further decline occurred in 1997 and 1998, when the lowest biomass index was recorded (Table 5b, Fig. 4a). Survey bottom biomass increased in 1999 and 2000 to the former level of 1992. However between 2001-04 this index returned to wide oscillations that culminate with a 2.4 fold from 2003 to 2004, reaching last year the biomass level of the beginning of the EU survey series (Casas and Troncoso, 2005). The wide oscillations in biomass survey indices can be induced by temporal changes on the length/age structure of the beaked redfish concentration near the bottom, with alternate smaller-higher proportions of large juveniles-young adults (25-35cm generally speaking), as well as on the distribution of this component in and out of the survey swept area of the Flemish Cap bank.

Female survey *SSB* index presents less noise inter annually, declining till 1994 and being kept at low level most of the years since then, despite an isolated peak in 2000, 2-3 higher than survey *SSB* on the neighbouring years (Table 5b, Fig. 4a). The same predictable behaviour is observed on survey abundance. After falling by half from the 1988-89 level, reaching in 1990 the minimum of the series, the index was pushed up to a peak in 1992 by the strong 1990-year class, recruiting then to the survey gear. Abundance declined afterwards till 1998, but presents a steady increase since then driven by one or two above average cohorts from the turn of the decade. On 2004 survey abundance was at an historical maximum, well above the level at the beginning of the series. The EU survey indices suggest that despite the apparent recovery of the Flemish Cap beaked redfish, the population is now dominated by young fish with an age/length structure much narrower than on the late 1980's, shifted towards small lengths/young ages when compared to the population structure 16-17 years ago.

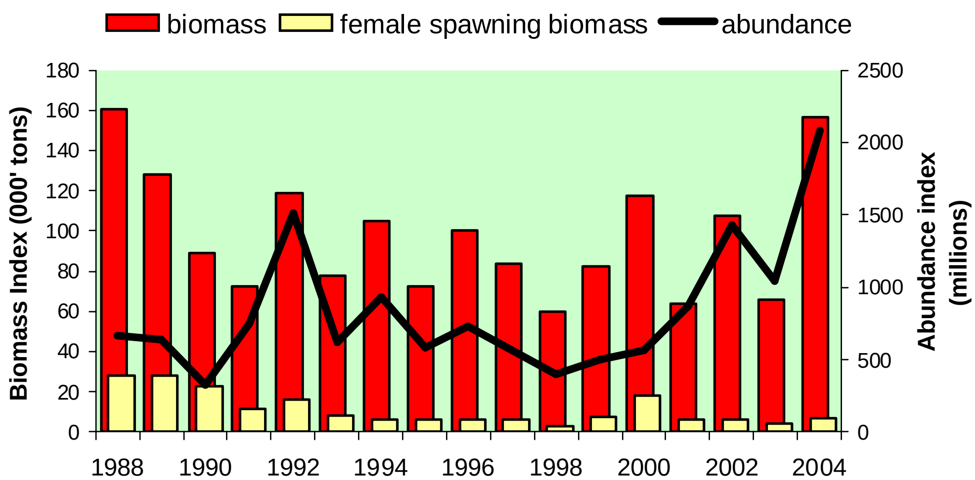


Fig. 4a: 3M Beaked redfish biomass, female spawning biomass and abundance (EU survey, 1988-04)

The 1989-04 EU survey biomass index for 3M beaked redfish is also presented as the mean catch per tow and associated standard errors, converted to *RV Vizconde de Eza* units with the Robson correction factors for redfish and juveniles (Table 5c, Fig. 4b). From 1992 onwards this mean catch is the sum of the mean catch per tow for *S. mentella*, *S. fasciatus* (Casas and Troncoso, 2005) and beaked redfish juveniles. The mean catch per tow for beaked redfish juveniles is estimated with the proportion of beaked redfish found in the sum of products biomass for small redfish up to 21cm length, applied to the juvenile mean catch per tow. The standard error of the beaked redfish mean catch per tow is given by the square root of the sum of squares of the standard errors associated to each mean catch per tow category.

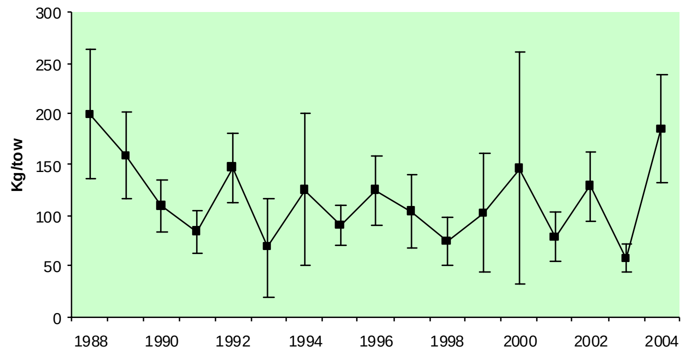


Fig. 4b: mean catch per tow for 3M beaked refish (EU survey, 1988-2004) with associated +/- 2se

Age composition of the beaked redfish survey stock and mature female beaked redfish stock

The EU survey abundance at age for the 1989-04 3M beaked redfish stock and mature female component (Table 6ab) were obtained using the *S.mentella* age length keys from the 1990-2004 EU surveys, with both sexes combined. Dr. Fran Saborido-Rey (Instituto de Investigaciones Marinas,Vigo, Spain) has carried out age reading of 3M redfish otoliths since 1990 (Saborido-Rey, 1994). Due to the fact that the 1989 *S.mentella* age length key was based on scale readings, the 1990 *S. mentella* age length key was also used in 1989. The ageing criteria of 3M redfish otoliths have been first revised in 1995 (Saborido-Rey, 1995) and 1998 (Saborido Rey *pers. comm.*, 1998) and survey age length keys were then standardized accordingly. The purpose of these revisions was to get a clearer consistence on the tracking of the 1990 cohort, a strong year class showed a density dependent growth (Saborido-Rey, 2001). Due to the scarcity of redfish larger than 40cm either in the survey and commercial catch a plus group was considered at age 19.

Age composition of the catches

Age composition of the total catches, including the redfish by-catch on the 3M shrimp fishery, was also obtained using the same *S.mentella* age length keys from the 1990-04 EU surveys (Table 8a). The shift of the relative age composition of the catch towards the smallest age groups (1-3) from the early (1989-91) to the most recent years (2002-04) of the assessment is illustrated in Fig. 5.

Mean weights at age

The annual beaked redfish length weight relationships from EU survey (Table 2a) were used to calculate the mean weights at age in the 3M beaked redfish stock and female spawning stock 3M (Table 7ab), while the length weight relationships from the Portuguese commercial catch (Table 2b) were used to calculate mean weights at age in the redfish total catch (commercial plus by-catch) (Table 8b).

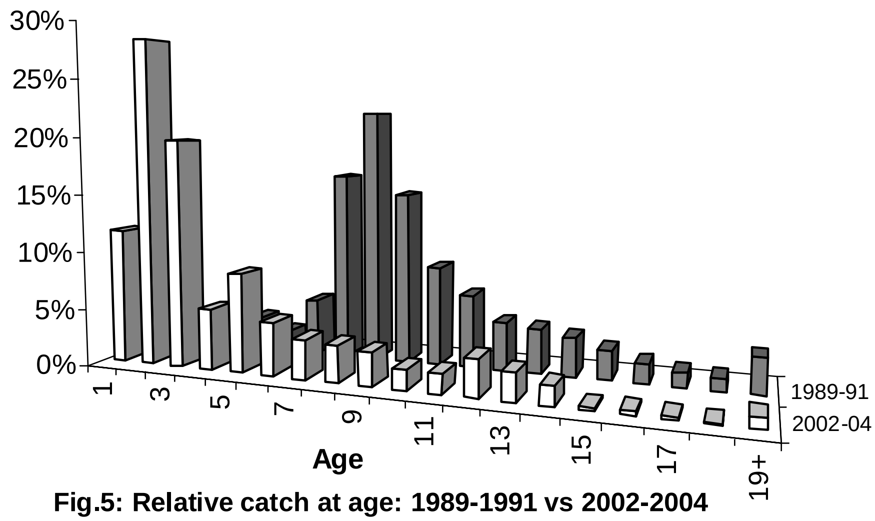


Fig.5: Relative catch at age: 1989-1991 vs 2002-2004

Maturity ogive

An observed maturity ogive for 3M beaked redfish was calculated as the mean proportion of mature females in the survey stock abundance at age (Table 6c) and used in VPA based methods to get female spawning biomass estimates. At each age this mean proportion is given by the ratio between the 1989-02 sum of survey mature females and the correspondent total survey stock abundance.

XSA Assessment

The wide inter annual fluctuations of the 3M beaked redfish survey abundance at age have been considered a strong handicap on the performance of VPA tuning methods such as the Extended Survivor Analysis (XSA) (Shepherd 1999), due to its reflection on the high variability through ages, years and cohorts of the catchabilities that relate survey with VPA abundance. Nevertheless the existence of the EU survey time series of abundance at age indices urged the authors to frame the 3M beaked redfish assessment with an Extended Survivors Analysis since 2000 (Ávila de Melo *et al*., 2000).

The XSA program used was based in the algorithm implemented by Shepherd (1999) and is included in the Lowestoft VPA Suite (Darby and Flatman, 1994). The model algorithms are presented in Appendix 8 of the respective user guide (Darby and Flatman, 1994) and have been summarized and adapted to this case study next in last assessment (Ávila de Melo *et al*., 2003).

Input files

The input files for XSA analysis are presented in Table 9. Natural mortality was assumed constant at 0.1. The proportion of mature females at age is the one observed on the 1989-04 period (Table 6c) and the month with a peak of spawning for 3M *Sebastes mentella*, February (Saborido-Rey, 1994), was the one adopted to the estimate of the proportion of F and M before spawning. The first age group considered was age 4 (the first age in the catch at age matrix with catches assigned every year) and age 18 was the last true age (from age 19 onwards both survey and commercial sampling data are scarce and so a plus group on age 19 has been considered). Landings were given by the 4+ SOP of the catch at age x commercial weight at age matrices.

The present Extended Survivor Analysis used as the tuning file the 1989-04 EU survey abundance at age matrix, with the 1989-02 indices already converted into the new *RV Vizconde de Eza* units.

The framework

In order to give a full use and equal importance to the fourteen years of input data, namely the former ones till 1993 when a full-scale redfish fishery occurred on Flemish Cap, no tapered time weighting was applied. Despite its (very) low level when compared to the first half of the 1990's catches have not been stable through the recent years preceding the last year of this assessment and fishing mortalities at age on the terminal year were not shrunken towards a mean. Population of the recruiting ages (4 - 5) at the end of the final year were not shrunk to a population mean either.

A first run with catchability dependent of year-class strength on all ages till the penultimate true age (17) showed all ages with high regression standard errors, most of them with high *t* values of the slope as well. However the regression statistics of catchability for the younger ages considered (4 and 5) present *t* values of the slopes, that linearly relate the log abundance at age with the log survey index at age, not differing significantly from 1 (*Student's t* test with 14 degrees of freedom = No. points – 2, significance level of 0.05). This lack of a significant trend on the younger ages regression slopes led us to accept catchability independent with respect to year class strength and time through all the age spectrum of the assessment.

Exploratory runs have shown that fixing catchability only since age 17 (not reducing the number of true ages involved) and keeping the minimum standard error of the *log* catchability on the last true age (18) at 0.5 (in order to avoid overweight of the cohort's terminal population estimates by the last true age) improved the fitness of the model to the data.

On this assessment the XSA framework remains unchanged: no recruiting ages with catchability dependent of year-class strength, constant catchability just at the penultimate age and a minimum standard error of the *log* catchability for the last true age of 0.5.

Diagnostics

The diagnostics of the 2005 XSA are presented on Table 10. Extended Survivor Analysis converged after 56 iterations, a much faster process than on 2003, when XSA took 964 iterations to converge. So 2005 XSA shows a much better fit of the model to the revised survey data: the actual tuning with the 1989-04 EU survey abundance's at age expressed in the new *RV* units lead to a higher level of terminal F 's that pushed the model to a quick convergence. Survey catchability at age present a steep decline till age 11, followed by relative stability and a final small increase on older ages, again associated to high standard errors on most ages (Table 10/ Mean *log* catchability and standard errors for ages with catchability independent of year class strength and constant w.r.t. time, Fig. 6a).

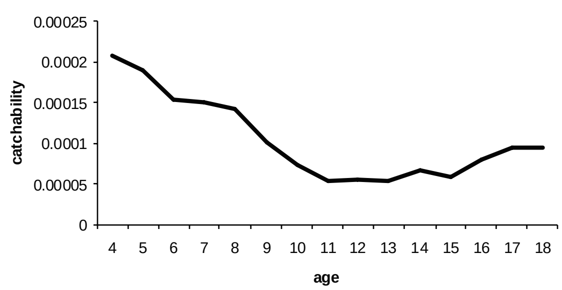


Fig.6a: catchability-at-age, 2005XSA

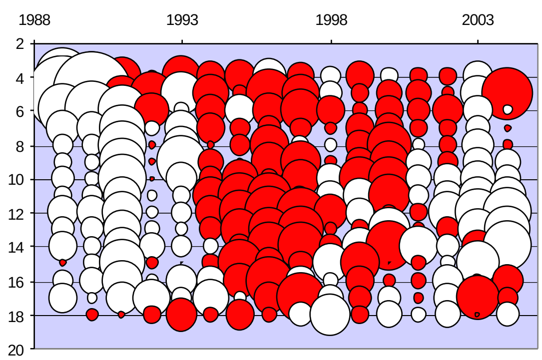


Fig. 6b: Eu survey log q residuals,1989-04

The $\log q$ residuals continue to present a clear pattern of year effects (Table 10/*log* catchability residuals; Fig. 6b). Most of the $\log q$ residuals were positive during the intermediate years of 1994 to 2000, while on the former (1989-91) and last (2003-04) years of the interval most ages had negative residuals. The higher residuals were negative and related to the size of the 1984 and 1985 cohorts on 1989 and 1990 (Table 10/*log* catchability residuals; Fig. 6b). Trends on catchability through the age spectrum never reaching a stage of apparent stability, together with temporal changes on beaked redfish concentration near the bottom of the survey swept area (amplifying the noise on the *log* catchabilities at age and introducing strong year effects) contributed to both high errors and residual patterns that are distinctive of the survey catchability at age of the Flemish Cap beaked redfish.

Retrospective Analysis

A 2005-03 retrospective analysis was carried out in order to determine the bias on the biomass, female spawning stock biomass (SSB), fishing mortality (mean F: ages 6-16) and recruitment (age 4) estimates from consecutive assessments back in time (Table 11 and Fig. 7). This retrospective analysis was confined to the most recent years preserving at the maximum extent the presence of the above average cohorts that drive the biomass trends, namely the 1990 and 1989-year classes and more recently the 1998 cohort. The retrospective XSA present an over bias pattern on 4+ Biomass, female SSB and recruitment and an under bias pattern on fishing mortality. Mean F's from the updated 2004 and 2003 XSA's appeared close estimated and the major gap occurred between the 2005 and 2004 assessments. On the contrary recruitment at age 4 estimates are more consistent between the last two assessments (2005-04), with the 2003 series clearly above. The combination of these two biases influenced the 4+ Biomass and female SSB over bias patterns, with fishing mortality bias more reflected on the SSB retrospective pattern, and recruitment bias visible on 4+ biomass estimates.

From the possible causes of retrospective patterns – patterns of misreporting, patterns in catchability or misspecification of natural mortality (Sinclair *et al*., 1990) – the year patterns in catchability, translated in high positive or negative *log* catchability residuals through most of the ages on several years, can be the main cause of bias in a redfish assessment. In long living stocks, with a large number of ages and survivors at the end of the terminal year included in the assessment, the patterns in catchability can be reflected on the patterns of the retrospective size of survivors and of their cohorts size, extended till recruitment.

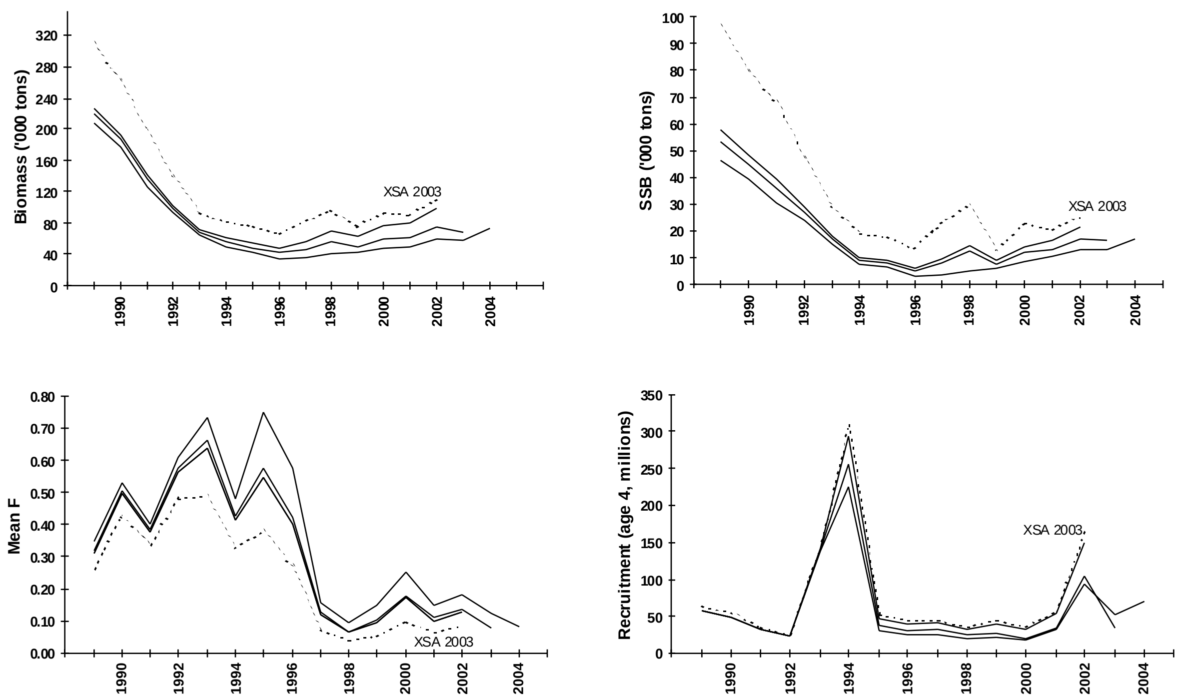


Fig. 7: Retrospective analysis 2004-02 and 2003 XSA (original 2003 XSA on dotted line)

In order to evaluate the effect of the conversion of the original 1989-02 survey abundance at age matrix to the new *RV* units the original 2003 XSA results are compared with the results of the present analysis. The update of the survey abundance at age tuning matrix, according to the conversion of the 1989-02 survey abundance at length to the new *RV* units, kept the general trends of either biomasses and fishing mortality, but re-scaled each stock parameter to a new dimension that has proven to have a much better fit to both survey and commercial data: less efficiency catching sizes greater than 26cm $\rightarrow$ lower survey abundance for age 8 and older $\rightarrow$ higher terminal F 's $\rightarrow$ lower XSA 4+ Biomass and female SSB. At the beginning of 2002 the 4+ Biomass and female SSB by the updated 2003 XSA were 11% and 16% lower than the original 2003 XSA results.

The bad diagnostics of the XSA seem related both with redfish own biology and unpredicted changes of its spatial distribution, together with a drop on fishing mortality to a level much lower than the one from the first half of the 1990's, when a direct fishery was responsible for most of the commercial catch. But despite the high standard errors associated to the average catchability at age, the year patterns in catchability residuals, and the retrospective patterns on stock parameters, the 2005 XSA should also be regarded as the closest picture one can get of the actual 3M beaked redfish stock size.

Results

Very high fishing mortalities until 1996 forced a rapid and steep decline of abundance, biomass and female spawning biomass of the 3M beaked redfish stock. From 1997 onwards, low fishing mortalities allowed a slow but continuous growth of both 4+ Biomass and female SSB. Abundance was kept stable at a low level from 1996 to 2001, increasing afterwards with the recruitment of the above average 1998-00 year classes to the 4+stock (Table12, Fig 8a and b).

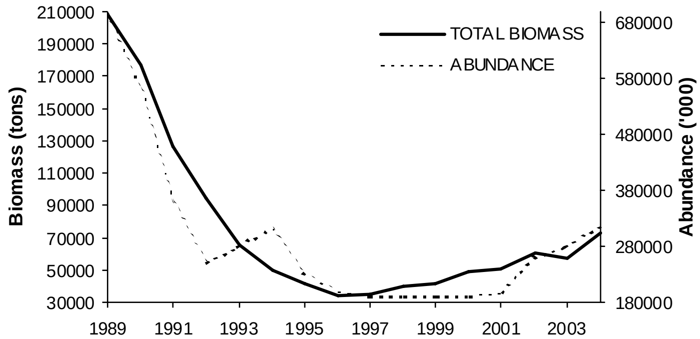


Fig. 8a : 4+Biomass vs 4+Abundance from XSA

Fig. 8b: SSB vs FBar from XSA

There was a general increase of the stock reproductive potential from 1992 to 1998 (Fig. 9a). Despite the decline from the 1998 peak the reproductive potential of the stock at the turn of the decade was kept at high level when compared to the former 1989-97 interval. In 2004 female spawning stock biomass was still far away from a SSB level of 40,000 tons, beyond which two consecutive above average recruitments were observed, from the 1989 and 1990 year classes (Fig. 9b). However the appearance in 1998 of the first abundant year class after 1990, suggest that above average recruitments can be expected at much lower SSB levels. All points in the reproductive potential and SR plots are comparable since all year classes included had already passed through the shrimp fishery during their early life stage, and so all of them have been depressed by the by-catch mortality over the pre-recruited ages.

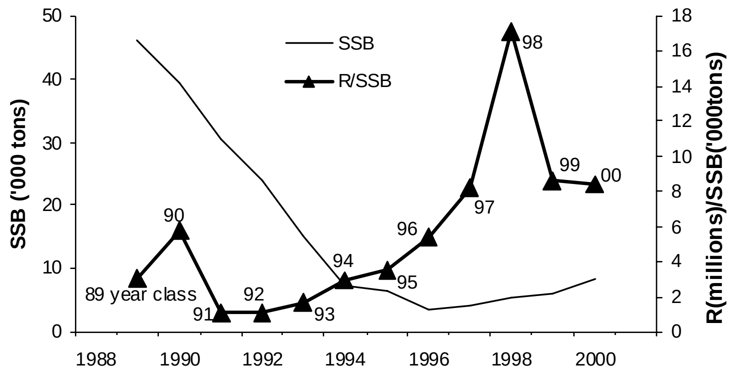


Fig. 9a: Recruitment/SSB from XSA
recruits at age 4 four years later than SSB

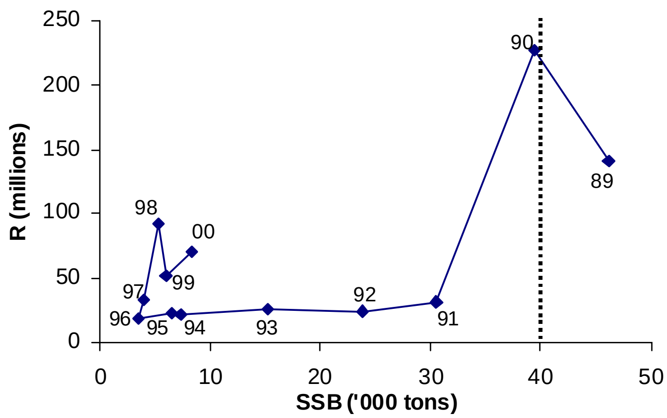


Fig. 9b: SR plot from XSA

Stock projections

Medium term trajectories of female spawning stock biomass under a gradient of $F_{statusquo}$ percentages were obtained with a program of the CEFAS laboratory (Lowestoft/UK), first applied to a NAFO stock in 2000 (Mahe and Darby, 2000). This *Mterm* algorithm use an initial population at age abide to a measure of uncertainty and bootstraps recruitment from the third to the tenth year of the projection. The program has been upgraded to allow projections for long living stocks with a large number of ages included in the analytical assessment (Smith and Darby, *pers. comm.* 2001). The input data are aggregated in two categories of files:

a. A *.srr* file (Table 13), adopting as stock recruitment relationship a random recruitment around the geo-mean of the 2000-04 recruitments (numbers at age 4, from the XSA). The first age at the beginning of each year is given by the re-sampling of the *log* residuals of the 1989-04 recruitments, with the 1993 and 1994 recruitments (from the strong 1989 and 1990 year classes) lowered to the geo-mean recruitment of the adjacent years, 1992 and 1995. This means that the *Mterm* projections are not considering the occurrence of peaks in recruitment equal to the ones from 1989 and 1990 year-classes.

b. A *.sen* sensitivity file (Table 14) including the usual vectors needed to forward projections but with uncertainty associated to the population at age at the beginning of the first year of the projection (2005). The XSA survivors at age by the end of 2004, plus a recruitment given by the geo-mean of the 2000-04 numbers at age 4 are the starting population at age at the beginning of 2005 (the same level of recruitment is assumed for the second year of each projection). Being the internal and external standard errors from XSA diagnostics (Table 10/ Terminal year survivor and F estimates) two measures of the uncertainty around the survivor estimate for each age, their average was adopted as the coefficients of variation associated with the starting population at age. These CV's were used to bootstrap the initial population at age.

Exploratory *Mterm* projections were made from 100% $F_{statusquo}$ ($= Fbar_{2004}$, average fishing mortality for ages 6 to 16), descending -10% $F_{statusquo}$ steps down. The goal was to find a *Fbar* level for next ten years that would allow female spawning biomass to reach a target of 40,000 tons with a 50% probability. Those exploratory *Mterm* runs ended on a 50% reduction of the actual level of fishing mortality if a magnitude of female spawning biomass like the one that produced the most abundant recruitments is to be reached till 2014 (Table 15, Fig. 10).

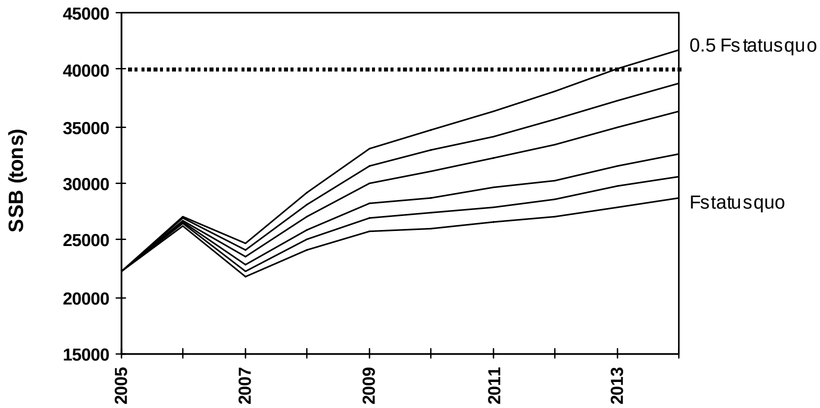


Fig. 10: SSB 50th %ile profiles for a range of $F_{statusquo}$ multipliers

Once a medium term level for fishing mortality is found, a final *Mterm* run with 0.5 $F_{statusquo}$ allowed the setting of 50% and 80% confidence limits for SSB and yield trajectories till 2014 (Table 16a and b, Fig.11a and b). A 50% reduction on $F_{statuquo}$ will keep through 2006-14 catches anchored between average 50% confidence limits of 4,600-5,600 tons, but at the same time will allow a consistent SSB growth till a 2014 level within 38,000 tons and 47,000 tons. This projection is obviously dependent on the maintenance of the average stock productivity observed over the last 16 years (even ignoring the strongest recruitments), namely if above average year-classes similar to the ones from 1998 and 2000 continue to occur in the future and are allowed to reach age 4 still as strong recruitments.

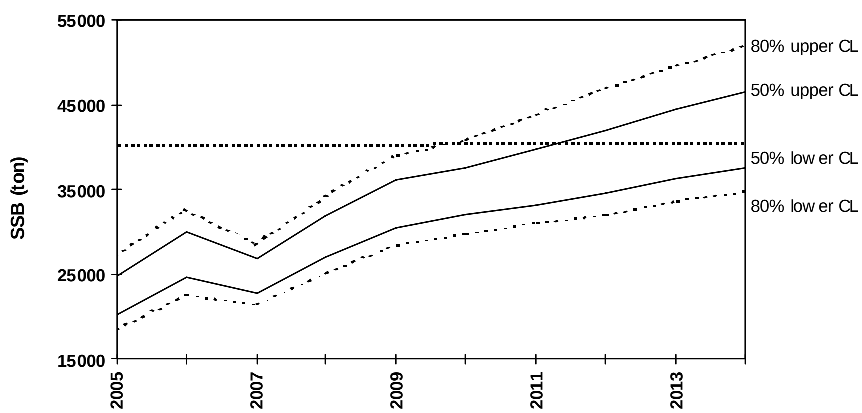


Fig. 11a: Mterm 80% and 50% CL for SSB under a 0.5 $F_{statusquo}$ regime

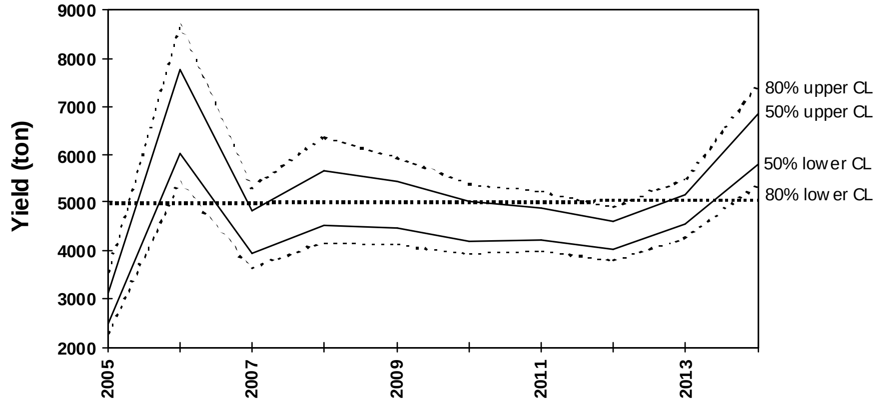


Fig. 11b: Mterm 80% and 50% CL for Yield under a 0.5 $F_{statusquo}$ regime

Despite the re-scaling of the results between the 2003 and 2005 XSA's due to the conversion of the tuning survey data in accordance to the new *RV* units, the present *Mterm* trajectories of female spawning biomass and yield under a low fishing mortality regime confirm the advice from the 2003 assessment that the prevail of stock recovery on a foreseeable future is dependent of an average medium term catch level of 5,000 tons.

Status of the 3M beaked redfish stock

The 3M beaked redfish stock experienced a steep decline from the 1989 till 1996. High commercial catches, at an historical maximum level between 1989 and 1993, lead to fishing mortalities at the top through the first half of the 1990's. Between 1995 and 1997 fishing mortality dropped and since then has been kept at a low level that allowed the survival and growth of the remainders from all cohorts. But the 1993-94 high by-catches in numbers at age 4 depressed too early the most abundant cohorts (1989 and 1990), reducing their contribution to stock recovery. The 4+ Biomass is increasing since 1997 but slowly. A similar pattern of growth is observed on female spawning biomass, also recovering from the 1996 minimum and being still well below the level at the first years of the assessment. Female survivors from the abundant 1990-year class and from younger cohorts, progressively reaching maturity over recent years, support this SSB recovery. The prospective of a no return increase of both 4+ Biomass and female SSB seems to consolidate under the present low exploitation regime: the stock reproductive potential has increased through the nineties compensating the SSB decline and sustaining a 2000-04 average recruitment at age 4 above the level of the overall 1989-04 average, most abundant recruitments from 1989-90 year-classes included. However an SSB approaching a target of 40,000 tons, lower limit of a magnitude corresponding to the most abundant recruitments at age 4, will not be foreseen in the short term, even keeping a low level of exploitation and assuring a high rate of survival of the above average 1998-00 year classes. The present assessment confirms previous recommendations that catches should not go beyond 5,000 tons on the next coming years in order to preserve a fair probability of a medium term SSB at a target level that in a recent past has generated the highest recruitments.

By-catch mortality continued to hammer the survival of pre-recruits and its absolute impact increases with year-class strength. That is illustrated by the sudden jump to a high level of redfish by-catch between 2000 and 2001, kept in the following years of 2002-03. The actual sorting grades are ineffective to avoid large amounts of by-catch of small redfish sizes up to 14cm. The availability to shrimp trawlers of the above average 1998, 1999 and 2000-year classes determined the level of survival by the end of their early life stage preceding recruitment and conditioned the actual rate of medium term stock recovery. Keeping catch and fishing mortality at low level can only be effective if measures to drastically reduce by-catch of very small redfish are implemented.

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Table 1a: 3M Redfish nominal catches (ton) by country, 1989-2004.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000 (a)	2001 (a)	2002 (a)	2003 (a)	2004 (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	210
SUN/RUS	13937	34581	24661	2937	2035	2980	3560	52		25	92	1808	1292	1155	115	5
LVA				7441	5099	94	304									
LTU					2128								10	10	1	2
EST						47						632	167	5	23	61
E-SP	213	2007	6324	3647	100	610	0	0	252	196	409	433	157	499	633	327
E PRT	13012	11665	3787	3198	4781	5630	1282	332	83	259	96	916	1589	1512	1091	2501
EU	13225	13672	10111	6845	4881	6240	1282	332	335	455	505	1349	1746	2011	1724	2828
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	1961	3106
STCAFIS Estimates of commercial catches from various sources																
Total	**58100**	**81000**	**48500**	**43300**	**29000**	**11300**	**13500**	**5789**	**1300**	**971**	**1068**	**3658**	**3224**	**2934**	**1881**	**2923**

(a) Provisional

Table 1b: Redfish by-catch in weight (ton) from the 3M shrimp fishery, 1993-2004.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
By-catch in weight (ton) (b)	11970	5903	374	550	157	191	96	106	738	767	1006	471

(b) Kulka, D. and J. Firth pers. comm.

Table 1c: 3M Redfish catch in numbers(millions), 1989-2004.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Comm.	125.3	196.3	104.2	92.9	57.3	27.5	34.9	15.5	3.0	2.2	2.3	9.7	8.5	7.4	4.6	12.0
By-catch					124.5	62.9	4.0	15.2	3.2	5.2	3.8	3.2	29.1	19.8	21.9	9.9
Total	125.3	196.3	104.2	92.9	181.8	90.4	39.0	30.7	6.2	7.4	6.0	12.9	37.6	27.2	26.4	21.9

Table 2a: Length weight relationships for 3M beaked redfish from EU survey (Troncoso and Casas, *pers. comm*. 2005)

	S. mentella		*S. fasciatus*		*Sebastes sp.*	
Year	a	b	a	b	a	b
1988					0.058	2.593
1989					0.022	2.867
1990					0.018	2.928
1991					0.027	2.814
1992	0.019	2.911	0.027	2.841	0.030	2.788
1993	0.013	3.021	0.028	2.824	0.017	2.965
1994	0.017	2.960	0.020	2.927	0.021	2.896
1995	0.011	3.073	0.016	3.001	0.013	3.034
1996	0.017	2.948	0.023	2.876	0.021	2.890
1997	0.014	2.999	0.019	2.960	0.015	3.001
1998	0.013	3.025	0.019	2.944	0.014	3.019
1999	0.014	2.994	0.020	2.910	0.018	2.928
2000	0.018	2.938	0.025	2.853	0.022	2.874
2001	0.012	3.043	0.017	2.978	0.015	3.008
2002	0.012	3.054	0.018	2.967	0.014	3.026
2003	0.011	3.069	0.009	3.151	0.012	3.055
2004	0.014	2.999	0.017	2.977	0.012	3.074

Table 2b: Length weight relationships
for 3M beaked redfish from commercial catch
(Alpoim,2004; Vargas 2005)

Year	a	b
1998	0.0390	2.7401
1999	0.0466	2.6807
2000	0.0095	3.1110
2001	0.0243	2.8695
2002	0.0433	2.7031
2003	0.0202	2.9025
2004	0.0133	3.0312

Table 3a: Length composition (absolute frequencies in'000s) of the 3M redfish commercial catch, 1989-2004.

Length	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
10	2.7				1.0	0.0								0.5		0.0
11														0.3		1.1
12	2.7				1.0	0.0						8.2		0.8		
13	10.9				8.9	0.5						16.4		1.3		4.0
14	25.3	4.0			112.0	11.1						0.7		2.1		12.2
15	8.2	72.8			378.4	41.2				2.1		8.9	4.1	4.0		43.4
16	29.7	190.1			421.9	123.1	0.2	19.9				1.1	3.8	9.5		215.3
17	59.5	723.7			160.1	363.5		19.9	0.7	1.6		8.5	20.5	22.7	5.8	370.8
18	29.7	2489.4	155.7		96.8	783.3	118.0	19.9		0.8		25.2	57.7	45.6	5.8	483.9
19	10.9	5774.0	646.6	63.7	124.5	956.9	265.3	66.5	6.1	8.3	0.9	38.8	41.5	89.9	0.0	639.5
20	111.3	6179.2	1330.6	322.1	138.7	465.5	1142.1	360.0	7.5	13.0	1.8	66.5	42.9	147.9	0.0	**1229.3**
21	382.8	2904.1	1234.1	1696.9	313.3	478.5	2873.8	964.0	14.4	28.1	0.9	52.3	62.9	153.4	1.7	**1619.4**
22	1148.8	1205.0	1178.6	2843.3	929.5	555.8	5894.6	**2215.2**	40.6	51.9	1.7	118.5	116.9	150.0	3.8	**1605.7**
23	3765.8	1926.9	944.5	2172.5	1815.0	680.0	5714.6	**1640.8**	103.6	93.8	0.9	122.6	197.4	171.9	30.4	**1022.7**
24	**8408.1**	5526.3	1696.9	1343.0	3231.7	1308.5	1691.5	**1323.8**	**263.1**	115.9	9.3	242.1	277.5	283.5	89.4	898.0
25	**14732.5**	11931.9	3737.0	2523.4	3028.7	1857.1	1157.3	785.0	**325.1**	**222.0**	113.3	347.0	450.0	422.2	261.9	745.9
26	**14792.8**	**19979.1**	6292.3	**7914.4**	3206.0	1862.9	793.4	512.8	**310.3**	**222.8**	107.9	740.6	890.1	522.5	362.7	566.1
27	11147.8	**25687.7**	**10368.2**	**12158.9**	3141.1	1656.1	952.7	739.7	197.6	**206.6**	**211.7**	**1304.8**	**1241.2**	693.3	**516.4**	578.5
28	7059.0	**26047.2**	**12852.1**	**12255.9**	**3856.9**	**2266.7**	1184.8	757.7	169.0	172.9	**294.1**	**1630.6**	**1450.9**	**882.6**	**535.3**	524.8
29	5773.1	**20112.8**	**15100.5**	**8785.7**	**3383.4**	**2403.7**	**1476.5**	855.3	209.8	168.0	**295.8**	**1413.1**	**1195.1**	**880.7**	**588.5**	411.1
30	7424.5	15200.1	**13055.9**	7423.3	**5042.0**	**2585.5**	**1506.1**	899.2	247.7	162.2	**194.6**	956.8	997.1	**854.1**	474.9	363.5
31	6971.9	10134.2	7456.3	5299.9	**4419.3**	**2347.1**	**1257.2**	953.8	222.6	172.0	**202.5**	659.3	537.5	661.2	389.5	281.4
32	7393.0	8307.9	7053.6	4685.2	**3478.5**	**2040.4**	**1303.7**	890.6	248.1	156.8	**236.8**	460.1	338.5	490.3	359.2	284.8
33	7029.6	6551.3	3519.4	4146.4	**3592.4**	1353.0	1218.7	688.7	268.1	112.1	171.5	352.6	209.2	394.5	331.0	292.7
34	6926.7	6397.1	3890.6	4362.3	2951.2	864.8	1007.6	671.5	106.9	73.8	82.4	317.7	145.8	237.0	258.3	167.9
35	6519.6	5485.6	3101.3	4401.5	3170.5	923.9	1035.2	281.3	76.0	53.7	139.6	203.4	77.0	117.0	200.1	73.7
36	4919.6	4397.8	2620.2	3178.2	2782.4	578.6	1041.4	197.6	42.5	46.5	75.3	159.5	38.0	76.0	93.8	56.5
37	4080.3	3046.7	2393.5	2380.8	2661.2	328.9	915.2	219.8	23.7	45.9	65.9	149.8	31.3	24.8	47.4	46.3
38	2441.1	2206.1	1672.4	1584.2	1472.3	281.8	749.1	103.1	27.1	33.1	8.5	127.1	36.6	19.5	16.3	49.2
39	1566.2	1557.2	1748.2	1269.4	1263.0	141.6	488.4	125.5	11.1	28.9	28.7	54.8	16.8	14.7	7.9	33.8
40	946.5	769.2	1024.1	890.1	665.8	92.8	468.6	45.0	3.4	16.0	1.9	34.9	10.2	7.7	2.4	33.2
41	504.3	580.8	640.3	533.2	376.1	72.4	345.9	38.1	11.8	10.9	4.3	24.2	4.5	1.5	0.4	44.5
42	341.3	344.7	200.6	213.2	325.2	23.8	164.0	45.7	5.1	8.0	0.6	15.9	6.1	2.0	0.3	15.0
43	288.9	263.8	283.1	250.5	142.5	14.1	68.7	18.4	1.4	3.1	1.4	21.4	3.0	5.0	2.3	19.1
44	135.0	130.2	19.2	181.6	425.0	24.6	50.0	2.7	6.4	1.9	0.3	14.4	1.6			12.7
45	142.8	72.8	14.0	41.5	52.4	15.1	34.2	2.1	1.4	0.3	1.9	2.7	0.7		1.2	6.4
46	74.8	32.3	8.2	9.2	42.7		7.1	3.5	1.4	0.5		7.0	1.1			5.1
47	46.4	16.2	0.0	0.0	34.8		19.0	1.0	1.4		0.3	3.7	0.4			0.0
48	28.0	12.1	7.8	18.3	60.8		4.3			0.2			0.8			0.8
49	3.5	12.1								0.1						
50	10.5	4.0						26.6								
51	3.5	12.1														
52	3.5															
53	7.0	16.2														
54		8.1														
55		4.0														
56																
57																
58		4.0														
59																
60																
61									11.2							
mean weight (g)	464	413	465	466	506	411	386	374	438	435	474	377	379	397	410	243
mean length (cm)	30.1	28.8	30.2	30.2	30.9	28.6	27.6	27.6	29.5	29.4	30.9	29.6	28.6	28.8	30.2	24.4

Table 3b: Length composition (absolute frequencies in'000s) of the redfish by-catch in the 3M shrimp fishery, 1993-2004.

Length	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5								3.5	9.5	9.9	55.4	13.7
6				146.9	1.4	3.4	14.7	4.9	199.7	59.9	246.4	95.4
7			4.8	4305.9	105.5	108.9	114.9	58.6	534.1	380.9	601.4	182.4
8			6.6	2411.5	126.8	247.6	550.3	122.5	1486.2	668.5	1130.7	241.9
9			5.0	210.9	71.0	40.2	811.9	55.5	4217.9	537.8	1432.3	355.3
10			3.3	416.1	257.9	44.6	845.5	193.0	6536.5	878.2	1453.7	593.2
11			14.7	1056.2	568.6	391.1	390.2	592.7	6274.9	1607.0	913.2	1054.0
12	2.1	18.6	36.1	841.1	512.2	1830.3	313.4	1005.8	4996.0	2985.1	1368.1	1495.4
13	24.2	337.5	34.1	458.9	163.6	1721.2	286.1	750.0	2125.6	5086.0	2741.0	1224.6
14	216.8	974.9	63.7	487.6	120.3	339.5	96.9	180.8	746.2	4070.2	2546.2	1081.7
15	1878.3	2217.0	246.7	731.3	119.1	60.7	90.4	84.4	527.3	1771.3	1885.9	978.6
16	7514.7	7246.7	430.1	1692.8	646.8	115.7	86.1	48.6	517.8	795.2	1993.9	795.9
17	29324.9	17332.6	758.0	1161.9	183.7	83.5	61.6	16.0	432.4	376.7	2506.7	635.2
18	47383.4	21047.3	986.6	737.8	61.1	31.4	41.3	10.1	281.7	254.9	1745.5	351.5
19	30056.1	11017.7	821.1	377.0	61.7	26.0	38.7	8.7	104.2	153.1	657.3	261.8
20	6743.3	2316.0	427.4	67.6	77.6	6.1	12.6	10.0	46.7	78.1	224.4	232.9
21	992.0	317.9	127.3	93.7	60.1	11.0	6.5	3.9	28.4	36.1	181.3	177.1
22	359.5	113.5	27.0	4.6	41.3	13.0	7.1	2.0	25.7	19.7	89.3	75.2
23	0.9		6.9		22.2	7.8	5.3	1.8	13.1	12.5	49.7	26.4
24			2.2		10.4	19.5	1.7	1.8	10.4	6.1	18.2	12.1
25			4.2		3.3	15.2	4.3		4.2	2.9	10.6	7.0
26			4.5		0.6	20.3		1.8	1.3	2.0	1.4	3.0
27			3.9			10.1	2.7		1.1	0.4	0.6	1.1
28			6.9			1.0			1.9	0.9	0.7	0.5
29			6.4			1.0			0.2	0.3	0.1	0.2
30			2.4						0.4	0.3		
31			0.5							0.3		0.5
32						1.0			0.2	0.6		
33												
34						1.0						0.1
mean weight (g)	96	94	93	36	49	37	25	34	25	39	46	48
mean length (cm)	18.5	18.1	18.3	11.9	14.0	13.1	11.2	12.5	11.5	13.4	14.2	14.1

Table 3c: Length composition (absolute frequencies in'000s) of the 3M redfish total annual catch, 1989-2004.

Length	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5												3.5	9.5	9.9	55.4	13.7
6								146.9	1.4	3.4	14.7	4.9	199.7	59.9	246.4	95.4
7							4.8	4305.9	105.5	108.9	114.9	58.6	534.1	380.9	601.4	182.4
8							6.6	2411.5	126.8	247.6	550.3	122.5	1486.2	668.5	1130.7	241.9
9							5.0	210.9	71.0	40.2	811.9	55.5	4217.9	537.8	1432.3	355.3
10	2.7				1.0		3.3	416.1	257.9	44.6	845.5	193.0	6536.5	878.7	1453.7	593.2
11	0.0						14.7	1056.2	568.6	391.1	390.2	592.7	6274.9	1607.2	913.2	1055.0
12	2.7				3.2	18.6	36.1	841.1	512.2	1830.3	313.4	1014.0	4996.0	2985.9	1368.1	1495.4
13	10.9				33.0	338.0	34.1	458.9	163.6	1721.2	286.1	766.3	2125.6	5087.3	2741.0	1228.6
14	25.3	4.0			328.8	986.0	63.7	487.6	120.3	339.5	96.9	181.5	746.2	4072.3	2546.2	1093.9
15	8.2	72.8			2256.8	2258.2	246.7	731.3	119.1	62.7	90.4	93.3	531.4	1775.2	1885.9	1022.0
16	29.7	190.1			7936.7	7369.8	430.3	1712.7	646.8	115.7	86.1	49.7	521.5	804.7	1993.9	1011.2
17	59.5	723.7			29485.0	17696.1	758.0	1181.9	184.3	85.1	61.6	24.6	452.8	399.4	2512.5	1006.0
18	29.7	2489.4	155.7		47480.3	21830.6	1104.6	757.7	61.1	32.2	41.3	35.3	339.3	300.5	1751.4	835.4
19	10.9	5774.0	646.6	63.7	30180.6	11974.6	1086.4	443.5	67.9	34.3	39.5	47.5	145.7	243.0	657.3	901.3
20	111.3	6179.2	1330.6	322.1	6882.0	2781.6	1569.5	427.6	85.1	19.1	14.4	76.5	89.6	226.0	224.4	1462.2
21	382.8	2904.1	1234.1	1696.9	1305.3	796.4	3001.1	1057.7	74.6	39.1	7.4	56.3	91.3	189.5	183.0	1796.5
22	1148.8	1205.0	1178.6	2843.3	1289.0	669.4	5921.6	2219.8	81.9	64.9	8.8	120.5	142.6	169.7	93.2	1680.9
23	3765.8	1926.9	944.5	2172.5	1815.9	680.0	5721.5	1640.8	125.7	101.5	6.1	124.4	210.5	184.4	80.1	1049.2
24	8408.1	5526.3	1696.9	1343.0	3231.7	1308.5	1693.7	1323.8	273.4	135.4	11.0	243.9	287.9	289.7	107.6	910.0
25	14732.5	11931.9	3737.0	2523.4	3028.7	1857.1	1161.6	785.0	328.4	237.2	117.7	347.0	454.2	425.0	272.5	752.9
26	14792.8	19979.1	6292.3	7914.4	3206.0	1862.9	797.9	512.8	310.9	243.0	107.9	742.5	891.3	524.5	364.1	569.1
27	11147.8	25687.7	10368.2	12158.9	3141.1	1656.1	956.6	739.7	197.6	216.8	214.3	1304.8	1242.4	693.8	517.0	579.5
28	7059.0	26047.2	12852.1	12255.9	3856.9	2266.7	1191.6	757.7	169.0	173.9	294.1	1630.6	1452.8	883.5	536.0	525.2
29	5773.1	20112.8	15100.5	8785.7	3383.4	2403.7	1482.9	855.3	209.8	169.0	295.8	1413.1	1195.3	880.9	588.6	411.3
30	7424.5	15200.1	13055.9	7423.3	5042.0	2585.5	1508.6	899.2	247.7	162.2	194.6	956.8	997.5	854.4	474.9	363.5
31	6971.9	10134.2	7456.3	5299.9	4419.3	2347.1	1257.7	953.8	222.6	172.0	202.5	659.3	537.5	661.5	389.5	281.9
32	7393.0	8307.9	7053.6	4685.2	3478.5	2040.4	1303.7	890.6	248.1	157.8	236.8	460.1	338.7	490.9	359.2	284.8
33	7029.6	6551.3	3519.4	4146.4	3592.4	1353.0	1218.7	688.7	268.1	112.1	171.5	352.6	209.2	394.5	331.0	292.7
34	6926.7	6397.1	3890.6	4362.3	2951.2	864.8	1007.6	671.5	106.9	74.9	82.4	317.7	145.8	237.0	258.3	168.0
35	6519.6	5485.6	3101.3	4401.5	3170.5	923.9	1035.2	281.3	76.0	53.7	139.6	203.4	77.0	117.0	200.1	73.7
36	4919.6	4397.8	2620.2	3178.2	2782.4	578.6	1041.4	197.6	42.5	46.5	75.3	159.5	38.0	76.0	93.8	56.5
37	4080.3	3046.7	2393.5	2380.8	2661.2	328.9	915.2	219.8	23.7	45.9	65.9	149.8	31.3	24.8	47.4	46.3
38	2441.1	2206.1	1672.4	1584.2	1472.3	281.8	749.1	103.1	27.1	33.1	8.5	127.1	36.6	19.5	16.3	49.2
39	1566.2	1557.2	1748.2	1269.4	1263.0	141.6	488.4	125.5	11.1	28.9	28.7	54.8	16.8	14.7	7.9	33.8
40	946.5	769.2	1024.1	890.1	665.8	92.8	468.6	45.0	3.4	16.0	1.9	34.9	10.2	7.7	2.4	33.2
41	504.3	580.8	640.3	533.2	376.1	72.4	345.9	38.1	11.8	10.9	4.3	24.2	4.5	1.5	0.4	44.5
42	341.3	344.7	200.6	213.2	325.2	23.8	164.0	45.7	5.1	8.0	0.6	15.9	6.1	2.0	0.3	15.0
43	288.9	263.8	283.1	250.5	142.5	14.1	68.7	18.4	1.4	3.1	1.4	21.4	3.0	5.0	2.3	19.1
44	135.0	130.2	19.2	181.6	425.0	24.6	50.0	2.7	6.4	1.9	0.3	14.4	1.6			12.7
45	142.8	72.8	14.0	41.5	52.4	15.1	34.2	2.1	1.4	0.3	1.9	2.7	0.7		1.2	6.4
46	74.8	32.3	8.2	9.2	42.7		7.1	3.5	1.4	0.5	0.0	7.0	1.1			5.1
47	46.4	16.2	0.0	0.0	34.8		19.0	1.0	1.4		0.3	3.7	0.4			
48	28.0	12.1	7.8	18.3	60.8		4.3			0.2			0.8			0.8
49	3.5	12.1								0.1						
50	10.5	4.0						26.6								
51	3.5	12.1														
52	3.5	0.0														
53	7.0	16.2														
54		8.1														
55		4.0														
56																
57																
58		4.0														
59																
60																
61									11.2							
number ('000)	125310	196321	104246	92949	181803	90442	38979	30697	6180	7385	6037	12864	37623	27185	26441	22655
weight (ton)	58100	81000	48500	43300	40970	17203	13874	6339	1457	1162	1164	3764	3962	3701	2887	3577

Table 4: 3M beaked redfish abundance at length ('000s) from EU bottom trawl survey series (1988-02 by RV Cornide Saavedra (CS), 2003-04 by RV Vizconde de Eza (VE); former period converted to new RV units).

Length (cm)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5											2868.4						
6		72.7	238.5	1042.4				143.7			956.1			454.7	1091.1	779.0	
7	1203.2	160.0	1951.5	39643.8	4931.2	1102.2		30.6	2452.7		695.4	290.8		1240.1	9720.3	6940.3	286.4
8	8538.2	1890.5	15438.6	194701.1	117560.8	3159.7		594.5	12310.0	1359.2	3389.5	2416.6	1883.3	18643.0	14580.5	10410.4	12530.6
9	8327.1	2006.8	11860.8	90135.2	75875.3	1763.5		1816.1	6548.0	2886.6	6047.6	12419.6	6848.3	152327.0	44733.4	31939.5	69455.1
10	7081.7	2893.9	845.7	9088.4	57005.1	7812.5	273.5	1889.0	867.1	1614.9	1573.1	8839.7	5242.4	246451.4	53017.1	37817.6	181227.7
11	20337.5	8434.5	412.0	17232.2	332036.8	36152.7	1572.5	3397.2	1762.4	4312.5	2625.6	3052.4	4411.9	29299.8	52316.7	37321.8	178291.9
12	39345.2	20228.1	390.3	18877.3	381332.3	46734.0	2665.5	9269.3	5827.3	12810.3	13751.1	2976.0	15578.6	9423.9	115720.2	82575.4	306318.4
13	27472.0	21580.6	1062.5	5792.3	90011.6	29392.5	5208.7	4665.7	5993.1	14318.4	22306.7	4850.6	30605.4	16453.6	247641.6	176145.8	217458.9
14	4000.0	46258.6	1864.8	1176.9	16174.5	79964.1	25337.8	4768.2	8609.0	7064.3	11124.1	4639.0	18859.8	19286.1	292526.8	206425.3	109488.7
15	802.1	87282.1	2527.3	1707.6	27540.1	165018.9	58046.2	9835.1	16820.4	13160.7	14503.9	19441.8	6447.1	31061.3	99677.4	77232.6	59670.8
16	1034.3	71271.1	6765.2	8177.7	41045.4	138724.1	130198.0	24357.0	14378.5	23772.7	29969.1	39113.7	4277.4	71951.2	73452.6	105506.2	93026.6
17	1498.7	22118.6	15551.6	25999.3	9939.0	29763.2	219434.8	64809.0	23877.5	29709.6	20988.3	26096.6	8269.8	56570.1	59347.5	89286.3	130186.2
18	1139.8	3664.6	17572.8	47125.3	7593.5	9244.8	230201.9	110934.2	54207.5	30013.0	13413.8	32860.5	19780.7	22593.9	72238.9	40676.8	155257.3
19	4031.6	2166.8	10349.1	74339.8	14615.4	4969.8	121884.3	144384.4	108902.2	36047.1	14028.7	29489.4	27897.8	12501.0	74282.7	28248.9	179365.8
20	7430.0	3097.5	2514.3	83900.8	24467.2	3327.6	33878.7	100682.4	153048.2	68928.2	13962.2	20335.0	29189.8	18149.1	55460.7	22777.9	156665.1
21	16559.2	4479.0	1078.1	40481.0	46503.7	3305.7	16450.3	38742.3	135157.7	101922.9	18530.1	14731.3	24042.1	24890.3	28013.0	18750.6	86580.5
22	33994.4	9816.0	3010.8	10577.2	70167.2	5125.0	8472.3	9862.8	83283.0	98255.8	33310.3	17527.7	21180.7	25754.4	23745.2	12634.8	48014.8
23	68368.7	18570.3	10027.7	3746.4	51568.3	7221.8	7631.7	3978.4	37901.8	62654.8	56318.6	29377.7	18209.0	17297.5	19916.0	8312.6	29275.0
24	102943.5	33228.8	13236.3	3852.3	23846.7	8077.8	9824.2	3261.5	17322.4	24171.3	57007.5	61584.9	29389.4	15498.5	21186.0	7521.2	18368.8
25	108959.3	50664.9	28825.2	7718.7	10048.9	5811.5	11309.5	3704.1	7875.0	9733.2	33609.5	75416.7	54136.7	14733.7	16262.9	7312.5	11706.7
26	79513.7	60422.7	42888.3	9637.3	12417.1	5431.4	9940.7	4600.5	4102.0	5921.3	14895.1	57490.4	76084.8	18293.2	14694.9	7560.8	11260.4
27	33899.4	49923.2	41939.4	9637.3	16818.8	4255.8	6970.9	4264.7	5830.5	4279.7	5806.6	20105.6	78418.4	17464.5	13792.8	7875.4	8279.8
28	13962.9	31600.1	28901.7	8406.2	18154.2	4326.5	8135.2	4642.4	4150.0	3998.2	2709.5	6614.1	54136.8	13150.9	12150.3	6742.2	7280.5
29	6817.9	17450.6	16286.7	5838.0	12743.4	3066.5	6924.6	4693.8	4324.7	2789.9	1258.1	2472.3	21494.1	7231.8	9235.0	4987.9	5203.7
30	9150.3	10746.7	9819.2	4831.9	11008.9	2882.3	4765.1	4492.7	2995.0	3195.4	828.0	804.4	4582.4	5002.6	5643.1	3945.1	3753.0
31	7567.2	8245.4	7208.6	3508.1	7556.6	2362.4	3994.7	3478.8	2489.4	1977.1	959.3	700.8	1714.7	1439.0	2209.9	2264.4	2651.0
32	8886.4	9234.3	6686.5	3031.5	4865.7	1882.2	3610.8	2792.2	2279.5	1514.1	762.4	652.5	890.0	781.6	817.9	1555.7	1835.3
33	8569.8	6907.5	5709.6	3283.0	4449.9	2011.5	2462.6	2304.2	2050.3	1291.5	618.6	469.8	1120.4	336.7	571.6	755.7	1132.0
34	7451.1	6529.4	6332.8	3283.0	4275.9	1660.1	1613.2	1897.0	1409.5	981.1	517.4	401.5	578.0	404.7	286.2	639.4	762.4
35	5646.4	6544.0	4311.7	2568.2	3486.2	1535.6	1468.4	1591.1	947.9	590.1	292.6	347.3	381.7	199.1	121.9	171.2	323.2
36	4928.7	5409.7	3974.8	2290.2	2635.0	1517.5	1039.2	1440.5	757.2	544.3	309.9	221.1	387.6	160.6	113.4	207.2	156.7
37	3630.6	3911.8	3065.3	1813.6	2013.9	1425.3	589.8	1205.4	568.0	304.7	193.7	133.7	357.3	66.9	67.7	135.2	107.7
38	3166.2	2501.3	2223.2	1482.7	1619.8	904.4	548.6	717.1	401.7	211.5	142.0	81.5	66.6	80.3	54.2	117.1	97.9
39	3092.3	4144.5	2425.3	1734.2	2156.1	1392.1	519.6	932.3	471.0	211.5	167.9	77.9	130.8	66.9	27.1	117.1	
40	2089.7	2908.4	1633.7	1085.5	1410.2	830.9	379.2	492.8	266.4	143.0	64.6	39.1	87.2	26.8	13.5	45.1	
41	1498.7	1192.5	842.1	476.6	586.0	378.3	224.7	432.7	243.2	124.4	77.5	26.0	43.6	53.5	13.5	9.0	9.8
42	664.9	741.7	421.1	370.7	426.1	361.8	84.3	312.5	162.1	37.3	25.8	26.0		13.4	13.5	9.0	
43	253.3	290.8	252.6	172.1	165.3	103.4	28.1	156.3	69.5		64.6	13.0	29.1	40.1	13.5		
44	84.4	87.3	50.5	53.0	165.3	168.0	28.1	36.1	23.2	24.9	25.8		14.5			9.0	
45	84.4	87.3	67.4	53.0	45.1	25.8	28.1	36.1	23.2		12.9	26.0					
46		58.2	16.8	53.0	30.1	25.8		36.1			12.9						9.8
47			33.7	13.2		25.8		12.0									
48						38.8			11.6								
total	664024.6	638822.7	330614.1	748937.8	1509292.4	623283.6	935745.9	581692.4	730719.4	570875.7	400724.8	496162.8	566768.2	869393.4	1434770.6	1045762.3	2086038.4

Table 5a: 3M beaked redfish survey biomass indices ('000 ton) from the RV Cornide Saavedra 1988-2002 interval, in original units and transformed to the new RV Vizconde Eza units.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
juvenile biomass CS units			4.6	3.8	22.0	18.8	37.5	0.2	0.3	0.8	1.0	0.3	2.0	5.1	19.2
juvenile biomass VE units			6.3	5.5	31.7	30.0	51.9	0.3	0.4	1.1	1.5	0.4	2.9	7.4	31.4
spawning biomass CS units	31.8	29.7	24.4	13.0	16.9	9.3	7.7	8.0	8.5	8.1	3.4	7.8	18.4	6.6	7.4
spawning biomass VE units	28.2	28.0	22.7	11.6	16.0	7.9	6.4	6.3	6.1	6.4	3.2	7.5	18.4	6.0	6.4
biomass CS units	143.0	113.7	87.6	59.3	97.6	55.1	87.0	64.5	89.2	74.3	52.8	73.5	104.1	55.2	83.4
biomass VE units	160.4	127.8	89.1	72.3	118.9	77.7	104.7	72.5	100.2	83.7	59.7	82.5	117.7	64.0	107.2

Table 5b: 3M beaked redfish abundance, stock and female spwanning biomass ('000 tons) from EU bottom trawl survey series (1988-02 by RV Cornide Saavedra (CS), 2003-04 by RV Vizconde de Eza (VE); former period converted to new RV units.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
abundance (millions)	664	639	331	749	1509	623	936	582	731	571	401	496	567	869	1435	1046	2086
biomass ('000 ton)	160	128	89	72	119	78	105	73	100	84	60	82	118	64	107	66	157
spawning biomass ('000 ton)	28	28	23	12	16	8	6	6	6	6	3	8	18	6	6	4	7
ssb proportion	18%	22%	25%	16%	13%	10%	6%	9%	6%	8%	5%	9%	16%	9%	6%	7%	5%

Table 5c: 3M beaked redfish survey mean catch per tow from EU bottom trawl survey series (1988-02 by RV Cornide Saavedra (CS), 2003-04 by RV Vizconde de Eza (VE); former period convert to new RV units).

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
mean weight per tow (Kg/tow	199.4	158.9	109.2	84.6	147.0	68.2	125.3	90.1	124.5	103.9	74.1	102.5	146.3	79.1	128.5	57.2	185.2
SE	31.8	21.2	12.6	10.4	17.3	24.2	37.7	9.7	17.2	18.4	11.7	29.6	56.9	12.2	17.3	7.2	26.4
CV	0.16	0.13	0.12	0.12	0.12	0.36	0.30	0.11	0.14	0.18	0.16	0.29	0.39	0.15	0.13	0.13	0.14

Table 6a: Stock abundance at age (' 000) of 3M beaked redfish from EU surveys, 1989-04.

year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+	Total
1989	4130	53137	219406	19357	8071	35188	89946	89433	43605	21698	12392	7202	6537	5939	5301	3013	2467	2189	9812	638823
1990	29489	2710	33397	24565	2605	17585	56217	67444	36082	18378	10186	5630	5333	4816	4009	2318	1851	1730	6269	330614
1991	325523	51145	5421	154995	127962	17655	20481	13300	8086	4187	3884	3393	3014	2479	952	1514	1139	653	3155	748938
1992	198367	866124	59802	58014	144968	71881	30456	26346	16857	9630	6011	4452	4062	3082	2852	2072	1258	1028	2031	1509292
1993	6025	151086	90620	306049	10455	21648	10476	6426	2189	2996	2596	2453	1910	2000	1589	859	874	1414	1619	623284
1994	0	20065	76102	677611	79504	22080	22594	11375	7515	4950	3935	2808	2105	1122	1257	657	482	616	968	935746
1995	2585	18672	63686	114762	332114	8381	8942	8765	4706	3963	4073	2322	1642	1441	1536	1045	605	732	1721	581692
1996	21311	18163	34710	25262	190134	402615	11731	8653	5698	2783	2035	1950	991	1117	886	659	453	436	1132	730719
1997	5861	28568	34939	86326	96940	78135	222658	4967	3731	2768	1494	1269	689	837	236	298	368	124	667	570876
1998	15530	38427	62957	35093	32524	52330	30121	125511	3903	486	396	1990	257	249	77	156	343	28	347	400725
1999	23967	12166	50006	79605	45976	38126	46333	39046	151887	5871	257	337	858	110	246	253	201	435	481	496163
2000	13974	54195	27539	32860	61731	46285	47381	71096	35736	169492	2949	463	158	1548	152	81	83	52	992	566768
2001	419116	55177	121788	86078	52309	42284	29268	20323	8954	5122	26935	853	304	174	198	156	57	64	234	869393
2002	123142	480414	394558	235867	61369	46106	30279	22076	17766	4899	3033	13969	580	164	241	81	60	23	143	1434771
2003	87887	395055	335930	65241	84103	24769	14624	10827	6967	3974	2233	1323	11068	465	53	248	274	52	669	1045762
2004	263500	762669	301354	144943	430177	104125	34401	17198	8319	4654	2365	1301	1182	8772	72	230	248	39	490	2086038
Total	1540407	3007774	1912213	2146627	1760943	1029194	705908	542786	362000	265852	84773	51714	40691	34314	19659	13640	10764	9616	30729	

Table 6b: Mature female abundance at age (' 000) of 3M beaked redfish from EU surveys, 1989-04.

year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+	Total
1989				43	156	1545	7734	11709	7329	4218	3366	2593	2910	2829	2722	1561	1440	1231	7823	59210
1990				13	59	840	5392	9830	6743	3922	2988	2245	2655	2529	2300	1346	1110	1020	4432	47425
1991				55	493	820	2102	2501	2086	1443	1634	1658	1619	1448	596	1054	769	446	2437	21161
1992				18	1610	1817	2280	4334	4320	3147	2222	1829	1981	1668	1644	1413	818	811	1614	31525
1993					121	995	925	1009	463	779	778	761	707	834	676	942	598	983	1068	11638
1994				19	247	1006	1912	1682	1508	1510	1247	900	674	478	515	344	302	405	665	13413
1995				86	418	360	910	1343	1005	1105	1269	720	525	523	568	498	296	425	1344	11394
1996					1297	2557	1505	1754	1528	980	852	893	521	593	492	394	291	283	793	14731
1997					147	2720	6144	2287	1841	1263	705	605	333	403	113	157	201	67	428	17415
1998					133	924	1560	5282	785	120	119	647	86	96	26	61	155	9	231	10234
1999					155	1129	3118	4737	15007	1341	102	153	340	41	101	99	103	199	307	26931
2000					335	1052	3056	10012	9198	29716	1352	162	97	638	83	55	60	34	615	56465
2001					554	1329	2140	2777	1922	1815	6695	335	108	65	71	57	20	24	175	18089
2002				230	463	1547	1933	2574	3161	1826	1136	5364	308	82	113	28	26	9	62	18864
2003				9	326	676	1012	1258	1342	1114	913	647	3199	281	36	173	156	39	502	11683
2004				41	1431	2676	3028	2990	2112	1528	1100	749	785	3754	57	161	165	31	333	20942
Total				515	7946	21995	44752	66078	60350	55829	26476	20261	16848	16261	10112	8342	6509	6017	22828	

Table 6c: maturity ogive at age for 3M beaked reddish as the average proportion of mature females at age, from the EU survey abundance at age 1989-04.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
Ogive				0.0002398	0.0045124	0.0213713	0.0633968	0.1217387	0.1667127	0.2100009	0.3123139	0.3917875	0.4140425	0.4738957	0.5143753	0.6116158	0.6047323	0.6257309	0.7428962

Table 7a: Weights at age of the 3M beaked redfish stock (Kg) from EU surveys, 1989-04.

year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1989	0.012	0.032	0.060	0.100	0.164	0.205	0.248	0.284	0.317	0.349	0.431	0.511	0.563	0.586	0.631	0.643	0.706	0.703	0.880
1990	0.011	0.028	0.082	0.097	0.171	0.212	0.261	0.299	0.331	0.361	0.443	0.524	0.582	0.602	0.652	0.668	0.731	0.727	0.920
1991	0.012	0.029	0.067	0.109	0.135	0.214	0.276	0.337	0.385	0.465	0.515	0.569	0.616	0.649	0.700	0.779	0.764	0.794	0.892
1992	0.013	0.032	0.070	0.096	0.171	0.208	0.292	0.354	0.396	0.452	0.525	0.571	0.635	0.680	0.704	0.807	0.769	0.879	0.933
1993	0.010	0.034	0.051	0.066	0.156	0.212	0.287	0.365	0.395	0.434	0.513	0.554	0.624	0.687	0.714	0.871	0.853	0.867	1.101
1994	0.000	0.045	0.076	0.090	0.130	0.226	0.276	0.348	0.395	0.464	0.493	0.530	0.549	0.673	0.659	0.719	0.816	0.852	0.912
1995	0.011	0.027	0.071	0.102	0.113	0.217	0.288	0.357	0.405	0.456	0.514	0.546	0.632	0.702	0.726	0.812	0.822	0.869	1.067
1996	0.011	0.036	0.062	0.079	0.138	0.141	0.270	0.328	0.384	0.443	0.480	0.533	0.580	0.600	0.649	0.697	0.756	0.794	0.956
1997	0.013	0.031	0.059	0.090	0.127	0.190	0.174	0.355	0.406	0.466	0.505	0.573	0.609	0.621	0.682	0.746	0.787	0.759	0.933
1998	0.010	0.034	0.062	0.089	0.138	0.181	0.229	0.222	0.371	0.422	0.490	0.550	0.624	0.687	0.714	0.809	0.832	0.729	1.103
1999	0.014	0.033	0.064	0.087	0.121	0.176	0.223	0.260	0.246	0.323	0.473	0.564	0.513	0.552	0.541	0.552	0.642	0.615	0.766
2000	0.016	0.037	0.060	0.097	0.132	0.174	0.234	0.285	0.329	0.297	0.418	0.528	0.668	0.564	0.497	0.673	0.718	0.718	0.750
2001	0.015	0.028	0.062	0.085	0.140	0.179	0.238	0.297	0.328	0.384	0.340	0.516	0.598	0.663	0.668	0.616	0.771	0.853	1.010
2002	0.013	0.034	0.052	0.101	0.132	0.184	0.227	0.282	0.323	0.390	0.408	0.398	0.561	0.595	0.629	0.719	0.644	0.894	0.952
2003	0.012	0.034	0.054	0.076	0.109	0.161	0.217	0.264	0.321	0.355	0.413	0.462	0.351	0.558	0.584	0.638	0.509	0.694	0.754
2004	0.015	0.030	0.066	0.094	0.120	0.163	0.221	0.278	0.343	0.378	0.444	0.498	0.553	0.426	0.635	0.684	0.541	0.756	0.755
mean	0.012	0.033	0.064	0.091	0.137	0.190	0.248	0.307	0.355	0.402	0.463	0.527	0.579	0.615	0.649	0.715	0.729	0.781	0.918

Table 7b: Weights at age of the 3M mature female beaked redfish stock (Kg) from EU surveys, 1989-04.

year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1989				0.157	0.174	0.220	0.267	0.306	0.337	0.376	0.461	0.541	0.575	0.596	0.636	0.647	0.728	0.725	0.886
1990				0.160	0.181	0.228	0.283	0.323	0.352	0.390	0.474	0.553	0.594	0.615	0.658	0.671	0.749	0.746	0.926
1991				0.151	0.163	0.251	0.304	0.354	0.406	0.473	0.528	0.585	0.629	0.661	0.712	0.791	0.778	0.809	0.908
1992				0.157	0.185	0.225	0.310	0.372	0.412	0.459	0.534	0.593	0.656	0.706	0.732	0.828	0.800	0.889	0.947
1993					0.183	0.226	0.288	0.375	0.411	0.438	0.518	0.558	0.645	0.705	0.728	0.929	0.865	0.875	1.156
1994				0.153	0.169	0.244	0.286	0.357	0.402	0.470	0.502	0.539	0.569	0.702	0.684	0.750	0.824	0.874	0.952
1995				0.153	0.157	0.226	0.296	0.366	0.412	0.459	0.516	0.546	0.638	0.723	0.740	0.837	0.854	0.889	1.079
1996					0.176	0.187	0.281	0.337	0.389	0.449	0.483	0.536	0.583	0.606	0.658	0.702	0.757	0.799	0.959
1997					0.188	0.226	0.240	0.358	0.410	0.465	0.503	0.576	0.612	0.625	0.684	0.747	0.790	0.768	0.957
1998					0.159	0.195	0.266	0.243	0.384	0.436	0.493	0.554	0.626	0.707	0.712	0.815	0.844	0.729	1.128
1999					0.152	0.193	0.238	0.277	0.264	0.341	0.464	0.572	0.514	0.542	0.534	0.544	0.673	0.643	0.778
2000					0.162	0.192	0.270	0.304	0.344	0.327	0.424	0.519	0.681	0.574	0.494	0.695	0.724	0.728	0.770
2001					0.165	0.191	0.246	0.306	0.344	0.390	0.374	0.514	0.602	0.665	0.667	0.622	0.776	0.853	1.035
2002				0.151	0.174	0.209	0.238	0.305	0.340	0.399	0.453	0.408	0.557	0.587	0.616	0.715	0.643	0.888	0.968
2003				0.138	0.148	0.188	0.234	0.274	0.334	0.378	0.432	0.476	0.398	0.560	0.584	0.651	0.524	0.694	0.778
2004				0.149	0.160	0.195	0.243	0.288	0.352	0.399	0.466	0.518	0.566	0.460	0.635	0.675	0.550	0.756	0.718
mean				0.152	0.168	0.212	0.268	0.322	0.368	0.416	0.477	0.537	0.590	0.627	0.655	0.726	0.742	0.792	0.934

Table 8a: Catch in numbers at age (' 000) of 3M redfish, 1989-04, including redfish by-catch in the shrimp fishery.

year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1989	0	16	136	444	1057	7890	22978	24054	14508	9716	8792	6213	6366	5883	5199	2965	2122	1969	5003
1990	0	0	5996	10382	2773	5860	28741	47007	32291	18415	11643	6614	5940	5430	4449	2543	1888	1788	4562
1991	0	0	0	1229	3592	6929	18141	22725	16867	8491	6503	4808	3967	2888	1102	1648	1270	780	3305
1992	0	0	0	237	5234	7018	16988	18149	11681	7422	5608	4455	4286	3302	2952	1953	1189	746	1730
1993	0	308	3913	111450	11241	7987	6706	6787	3112	4903	4776	4538	3442	3692	3060	1452	1120	1718	1599
1994	0	759	5174	54165	6617	2876	4296	3376	3077	2788	2150	1523	1111	612	728	320	219	269	384
1995	16	84	979	2770	13324	5399	1889	2423	1554	1471	1869	1137	966	927	1070	833	482	548	1239
1996	7075	2966	2288	1632	3546	4635	1402	1399	1431	983	767	733	393	404	283	202	135	133	289
1997	563	1216	490	692	144	595	800	272	285	322	219	194	98	119	27	28	30	10	76
1998	445	3678	810	109	59	109	285	706	422	69	76	355	45	50	12	33	66	4	52
1999	2337	998	228	151	43	16	70	258	593	367	81	114	263	39	78	79	69	105	147
2000	438	2408	258	102	159	232	417	1023	1393	4145	647	179	75	644	64	39	35	41	569
2001	12984	13397	1805	828	337	387	842	1303	870	858	3232	381	116	61	65	59	19	29	61
2002	2536	10606	5543	1280	309	464	559	877	1044	555	678	1910	360	116	167	61	53	10	57
2003	4920	6570	6494	1712	1946	281	391	546	565	423	365	311	1222	214	22	102	69	23	266
2004	1482	4518	3022	1025	4259	2730	1631	1001	588	367	256	188	224	902	16	70	41	14	322
total	32796	47524	37134	188208	54641	53407	106135	131904	90281	61293	47662	33653	28875	25283	19295	12386	8804	8187	19661

Table 8b: Weights at age in the catch and by catch (Kg) of 3M redfish, 1989-04.

year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1989		0.043	0.099	0.174	0.208	0.251	0.293	0.344	0.401	0.453	0.535	0.597	0.644	0.668	0.712	0.729	0.783	0.794	1.005
1990			0.130	0.144	0.183	0.258	0.318	0.364	0.401	0.434	0.508	0.579	0.639	0.658	0.709	0.726	0.773	0.768	1.006
1991				0.147	0.182	0.287	0.347	0.401	0.439	0.511	0.558	0.616	0.672	0.721	0.772	0.853	0.833	0.867	0.964
1992				0.157	0.197	0.269	0.337	0.389	0.437	0.503	0.584	0.626	0.693	0.732	0.750	0.850	0.803	0.933	1.017
1993		0.066	0.093	0.114	0.156	0.250	0.323	0.405	0.442	0.474	0.547	0.588	0.654	0.716	0.740	0.883	0.856	0.870	1.170
1994		0.057	0.098	0.109	0.147	0.264	0.312	0.389	0.436	0.500	0.533	0.572	0.601	0.703	0.694	0.726	0.832	0.855	0.923
1995	0.014	0.041	0.086	0.164	0.184	0.239	0.327	0.397	0.442	0.495	0.552	0.583	0.665	0.725	0.751	0.829	0.835	0.873	1.050
1996	0.011	0.037	0.078	0.093	0.184	0.209	0.316	0.378	0.441	0.498	0.532	0.590	0.635	0.650	0.705	0.747	0.806	0.845	1.075
1997	0.019	0.037	0.074	0.092	0.153	0.266	0.284	0.394	0.442	0.507	0.548	0.595	0.621	0.626	0.672	0.761	0.793	0.741	1.291
1998	0.014	0.043	0.058	0.107	0.165	0.213	0.318	0.295	0.427	0.480	0.519	0.572	0.639	0.712	0.728	0.827	0.839	0.745	1.026
1999	0.020	0.040	0.072	0.101	0.140	0.201	0.325	0.364	0.351	0.433	0.509	0.597	0.553	0.580	0.568	0.583	0.671	0.612	0.737
2000	0.010	0.025	0.045	0.071	0.122	0.167	0.234	0.283	0.348	0.330	0.441	0.520	0.657	0.558	0.496	0.659	0.720	0.763	0.801
2001	0.017	0.032	0.063	0.097	0.148	0.211	0.269	0.322	0.361	0.411	0.404	0.537	0.611	0.674	0.674	0.617	0.797	0.860	0.989
2002	0.018	0.045	0.067	0.115	0.167	0.229	0.266	0.328	0.359	0.423	0.492	0.450	0.577	0.600	0.622	0.704	0.643	0.866	0.876
2003	0.013	0.038	0.066	0.085	0.107	0.190	0.253	0.288	0.341	0.384	0.454	0.500	0.409	0.584	0.587	0.633	0.550	0.692	0.664
2004	0.012	0.032	0.062	0.091	0.132	0.174	0.222	0.272	0.338	0.378	0.453	0.510	0.553	0.441	0.610	0.679	0.569	0.724	0.925
mean	0.015	0.041	0.078	0.116	0.161	0.230	0.297	0.351	0.400	0.451	0.511	0.565	0.614	0.647	0.675	0.738	0.756	0.800	0.970

Table 9: Input files for 2005 XSA assessment.

REDFISH NAFO DIVISION 3M INDEX OF INPUT FILES 2005

1
red3mla.txt
red3mcn.txt
red3mcw.txt
red3msw.txt
red3mnm.txt
red3mmo.txt
red3mpf.txt
red3mpm.txt
red3mfo.txt
red3mfn.txt
red3mtun.txt

REDFISH NAFO 3M LANDINGS tons

1	1
1989	2004
4	19
5	
58086	
80223	
48500	
43300	
43090	
17660	
13879	
6101	
1408	
1011	
1095	
3664	
3327	
3061	
2273	
3223	

REDFISH NAFO 3M CATCH NUMBERS thousands

1	2														
1989	2004														
4	19														
1															
444	1057	7890	22978	24054	14508	9716	8792	6213	6366	5883	5199	2965	2122	1969	5003
10382	2773	5860	28741	47007	32291	18415	11643	6614	5940	5430	4449	2543	1888	1788	4562
1229	3592	6929	18141	22725	16867	8491	6503	4808	3967	2888	1102	1648	1270	780	3305
237	5234	7018	16988	18149	11681	7422	5608	4455	4286	3302	2952	1953	1189	746	1730
111450	11241	7987	6706	6787	3112	4903	4776	4538	3442	3692	3060	1452	1120	1718	1599
54165	6617	2876	4296	3376	3077	2788	2150	1523	1111	612	728	320	219	269	384
2770	13324	5399	1889	2423	1554	1471	1869	1137	966	927	1070	833	482	548	1239
1632	3546	4635	1402	1399	1431	983	767	733	393	404	283	202	135	133	289
692	144	595	800	272	285	322	219	194	98	119	27	28	30	10	76
109	59	109	285	706	422	69	76	355	45	50	12	33	66	4	52
151	43	16	70	258	593	367	81	114	263	39	78	79	69	105	147
102	159	232	417	1023	1393	4145	647	179	75	644	64	39	35	41	569
828	337	387	842	1303	870	858	3232	381	116	61	65	59	19	29	61
1280	309	464	559	877	1044	555	678	1910	360	116	167	61	53	10	57
1712	1946	281	391	546	565	423	365	311	1222	214	22	102	69	23	266
1025	4259	2730	1631	1001	588	367	256	188	224	902	16	70	41	14	322

REDFISH NAFO 3M CATCH WEIGHT AT AGE kg

1	3														
1989	2004														
4	19														
1															
0.174	0.208	0.251	0.293	0.344	0.401	0.453	0.535	0.597	0.644	0.668	0.712	0.729	0.783	0.794	1.005
0.144	0.183	0.258	0.318	0.364	0.401	0.434	0.508	0.579	0.639	0.658	0.709	0.726	0.773	0.768	1.006
0.147	0.182	0.287	0.347	0.401	0.439	0.511	0.558	0.616	0.672	0.721	0.772	0.853	0.833	0.867	0.964
0.157	0.197	0.269	0.337	0.389	0.437	0.503	0.584	0.626	0.693	0.732	0.750	0.850	0.803	0.933	1.017
0.114	0.156	0.250	0.323	0.405	0.442	0.474	0.547	0.588	0.654	0.716	0.740	0.883	0.856	0.870	1.170
0.109	0.147	0.264	0.312	0.389	0.436	0.500	0.533	0.572	0.601	0.703	0.694	0.726	0.832	0.855	0.923
0.164	0.184	0.239	0.327	0.397	0.442	0.495	0.552	0.583	0.665	0.725	0.751	0.829	0.835	0.873	1.050
0.093	0.184	0.209	0.316	0.378	0.441	0.498	0.532	0.590	0.635	0.650	0.705	0.747	0.806	0.845	1.075
0.092	0.153	0.266	0.284	0.394	0.442	0.507	0.548	0.595	0.621	0.626	0.672	0.761	0.793	0.741	1.291
0.107	0.165	0.213	0.318	0.295	0.427	0.480	0.519	0.572	0.639	0.712	0.728	0.827	0.839	0.745	1.026
0.101	0.140	0.201	0.325	0.364	0.351	0.433	0.509	0.597	0.553	0.580	0.568	0.583	0.671	0.612	0.737
0.071	0.122	0.167	0.234	0.283	0.348	0.330	0.441	0.520	0.657	0.558	0.496	0.659	0.720	0.763	0.801
0.097	0.148	0.211	0.269	0.322	0.361	0.411	0.404	0.537	0.611	0.674	0.674	0.617	0.797	0.860	0.989
0.115	0.167	0.229	0.266	0.328	0.359	0.423	0.492	0.450	0.577	0.600	0.622	0.704	0.643	0.866	0.876
0.085	0.107	0.190	0.253	0.288	0.341	0.384	0.454	0.500	0.409	0.584	0.587	0.633	0.550	0.692	0.664
0.091	0.132	0.174	0.222	0.272	0.338	0.378	0.453	0.510	0.553	0.441	0.610	0.679	0.569	0.724	0.925

Table 9: Input files for 2005 XSA assessment (cont.).

REDFISH NAFO 3M STOCK WEIGHT AT AGE kg

1	4														
1989	2004														
4	19														
1															
0.100	0.164	0.205	0.248	0.284	0.317	0.349	0.431	0.511	0.563	0.586	0.631	0.643	0.706	0.703	0.880
0.097	0.171	0.212	0.261	0.299	0.331	0.361	0.443	0.524	0.582	0.602	0.652	0.668	0.731	0.727	0.920
0.109	0.135	0.214	0.276	0.337	0.385	0.465	0.515	0.569	0.616	0.649	0.700	0.779	0.764	0.794	0.892
0.096	0.171	0.208	0.292	0.354	0.396	0.452	0.525	0.571	0.635	0.680	0.704	0.807	0.769	0.879	0.933
0.066	0.156	0.212	0.287	0.365	0.395	0.434	0.513	0.554	0.624	0.687	0.714	0.871	0.853	0.867	1.101
0.090	0.130	0.226	0.276	0.348	0.395	0.464	0.493	0.530	0.549	0.673	0.659	0.719	0.816	0.852	0.912
0.102	0.113	0.217	0.288	0.357	0.405	0.456	0.514	0.546	0.632	0.702	0.726	0.812	0.822	0.869	1.067
0.079	0.138	0.141	0.270	0.328	0.384	0.443	0.480	0.533	0.580	0.600	0.649	0.697	0.756	0.794	0.956
0.090	0.127	0.190	0.174	0.355	0.406	0.466	0.505	0.573	0.609	0.621	0.682	0.746	0.787	0.759	0.933
0.089	0.138	0.181	0.229	0.222	0.371	0.422	0.490	0.550	0.624	0.687	0.714	0.809	0.832	0.729	1.103
0.087	0.121	0.176	0.223	0.260	0.246	0.323	0.473	0.564	0.513	0.552	0.541	0.552	0.642	0.615	0.766
0.097	0.132	0.174	0.234	0.285	0.329	0.297	0.418	0.528	0.668	0.564	0.497	0.673	0.718	0.718	0.750
0.085	0.140	0.179	0.238	0.297	0.328	0.384	0.340	0.516	0.598	0.663	0.668	0.616	0.771	0.853	1.010
0.101	0.132	0.184	0.227	0.282	0.323	0.390	0.408	0.398	0.561	0.595	0.629	0.719	0.644	0.894	0.952
0.076	0.109	0.161	0.217	0.264	0.321	0.355	0.413	0.462	0.351	0.558	0.584	0.638	0.509	0.694	0.754
0.094	0.120	0.163	0.221	0.278	0.343	0.378	0.444	0.498	0.553	0.426	0.635	0.684	0.541	0.756	0.755

REDFISH NAFO 3M NATURAL MORTALITY

1	5														
1989	2004														
4	19														
2															
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

REDFISH NAFO 3M PROPORTION MATURE AT AGE

1	6														
1989	2004														
4	19														
2															
0.0002	0.0045	0.0214	0.0634	0.1217	0.1667	0.2100	0.3123	0.3918	0.4140	0.4739	0.5144	0.6116	0.6047	0.6257	0.7429

REDFISH NAFO 3M F ON OLDEST AGE GROUP BY YEAR

1	9
1989	2004
4	19
5	
0.1518	
0.1703	
0.1128	
0.1287	
0.3774	
0.0843	
0.2133	
0.0521	
0.0039	
0.0022	
0.0524	
0.0393	
0.0424	
0.0232	
0.0232	
0.0232	

REDFISH NAFO 3M PROPORTION OF F BEFORE SPAWNING

1	7
1989	2004
4	19
3	
0.08	

REDFISH NAFO 3M PROPORTION OF M BEFORE SPAWNING

1	8
1989	2004
4	19
3	
0.08	

REDFISH NAFO 3M F AT AGE IN LAST YEAR

1	10														
1989	2004														
4	19														
2															
0.0079	0.0069	0.0186	0.021	0.0471	0.0533	0.0324	0.0452	0.0256	0.179	0.1807	0.2963	0.0768	0.1338	0.0232	0.0232

Table 9: Input files for 2005 XSA assessment (cont.).

REDFISH NAFO 3M SURVEY TUNNING DATA

101

EU BOTTOM TRAWL SURVEY

1989	2004															
1	1	0.5	0.6													
4	19															
10555	19357	8071	35188	89946	89433	43605	21698	12392	7202	6537	5939	5301	3013	2467	2189	9812
10555	24565	2605	17585	56217	67444	36082	18378	10186	5630	5333	4816	4009	2318	1851	1730	6269
10555	154995	127962	17655	20481	13300	8086	4187	3884	3393	3014	2479	952	1514	1139	653	3155
10555	58014	144968	71881	30456	26346	16857	9630	6011	4452	4062	3082	2852	2072	1258	1028	2031
10555	306049	10455	21648	10476	6426	2189	2996	2596	2453	1910	2000	1589	859	874	1414	1619
10555	677611	79504	22080	22594	11375	7515	4950	3935	2808	2105	1122	1257	657	482	616	968
10555	114762	332114	8381	8942	8765	4706	3963	4073	2322	1642	1441	1536	1045	605	732	1721
10555	25262	190134	402615	11731	8653	5698	2783	2035	1950	991	1117	886	659	453	436	1132
10555	86326	96940	78135	222658	4967	3731	2768	1494	1269	689	837	236	298	368	124	667
10555	35093	32524	52330	30121	125511	3903	486	396	1990	257	249	77	156	343	28	347
10555	79605	45976	38126	46333	39046	151887	5871	257	337	858	110	246	253	201	435	481
10555	32860	61731	46285	47381	71096	35736	169492	2949	463	158	1548	152	81	83	52	992
10555	86078	52309	42284	29268	20323	8954	5122	26935	853	304	174	198	156	57	64	234
10555	235867	61369	46106	30279	22076	17766	4899	3033	13969	580	164	241	81	60	23	143
10555	65241	84103	24769	14624	10827	6967	3974	2233	1323	11068	465	53	248	274	52	669
10555	144943	430177	104125	34401	17198	8319	4654	2365	1301	1182	8772	72	230	248	39	490

Table 10: Extended Survivor Analysis diagnostics for 2005 (Lowestoft VPA Version 3.1)

REDFISH NAFO DIVISION 3M INDEX OF INPUT FILES 2005
CPUE data from file red3mtun.txt

Catch data for 16 years. 1989 to 2004. Ages 4 to 19.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU BOTTOM TRAWL SURV	1989	2004	4	18	0.5	0.6

Time series weights :
Tapered time weighting not applied

Catchability analysis :
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 17

Terminal population estimation :
Final estimates not shrunk towards mean F
Minimum standard error for population
estimates derived from each fleet = .500
Prior weighting not applied

Tuning converged after 56 iterations

Regression weights

Regression weights	1	1	1	1	1	1	1	1	1	1					
AGE	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Taper weighted geometric mean of the VPA populations:	43400	33400	28400	23100	18200	13200	9470	6910	4710	3110	2080	1090	790	548	367
Standard error of the weighted Log(VPA populations) :	0.7204	0.6269	0.7707	0.9281	1.0487	1.1266	1.1989	1.2708	1.3838	1.5398	1.6334	1.5048	1.4342	1.4647	1.5069

Log catchability residuals.
Fleet : EU BOTTOM TRAWL SURV

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4	-1.83	-1.26	0.84	0.14	1.05	0.53	0.63	-0.68	0.49	-0.23	0.52	-0.18	0.26	0.22	-0.49	0
5	-2.83	-3.61	0.76	1.1	-0.95	0.92	0.19	1.45	0.89	-0.28	0.23	0.46	0.49	0.13	-0.61	1.66
6	-1.46	-1.68	-1.27	0.72	-0.12	0.67	-0.51	0.75	0.96	0.59	0.19	0.55	0.41	0.7	-0.46	-0.05
7	-0.61	-0.58	-1.11	-0.11	-0.66	0.55	0.32	0.37	0.31	0.15	0.59	0.55	0.26	0.23	-0.29	0.04
8	-0.22	-0.21	-1.31	0.04	-0.81	0.05	0.28	0.99	-0.16	-0.09	0.59	1.23	-0.08	0.21	-0.6	0.1
9	-0.19	-0.14	-1.2	0.04	-1.39	0.42	-0.02	0.82	0.96	0.12	0.52	0.99	-0.35	0.29	-0.47	-0.39
10	-0.27	-0.13	-1.27	0.03	-0.53	0.36	0.86	0.24	0.93	-0.5	1.11	1.11	-0.41	-0.45	-0.7	-0.38
11	-0.2	-0.24	-0.74	-0.04	-0.17	0.83	1.33	1.28	0.23	-0.46	-0.65	1.09	-0.26	-0.44	-0.78	-0.77
12	-0.51	-0.58	-0.87	-0.07	-0.21	0.65	1.1	1.6	1.37	0.74	-0.47	0.18	0.24	-0.82	-1.15	-1.22
13	-0.29	-0.31	-0.72	-0.14	-0.07	0.34	0.94	1.07	1.28	0.11	0.24	-0.99	0.14	0.41	-0.9	-1.1
14	-0.5	-0.17	-0.78	-0.37	-0.21	-0.14	0.39	1.26	1.26	0.39	-0.74	1.41	-0.91	-0.28	0.62	-1.22
15	0.06	-0.18	-1.16	0.13	0.01	0.23	1.31	0.6	0.36	-0.72	0.97	0.01	0.2	-0.11	-0.97	-0.73
16	-0.24	-0.34	-0.89	-0.1	-0.52	-0.42	0.71	1.44	-0.49	-0.11	0.54	0.14	0.16	-0.58	0.11	0.61
17	-0.43	-0.04	-0.52	-0.77	-0.25	-0.72	-0.1	0.62	1.38	-0.34	0.4	-0.31	0.1	-0.42	1.09	0.3
18	0	0.15	0.04	0.23	0.64	0.19	0.52	0.18	-0.31	-0.92	0.22	-0.34	-0.11	-0.39	0.03	-0.29

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Mean Log q	-8.4831	-8.5722	-8.7803	-8.8053	-8.8685	-9.1874	-9.5333	-9.8437	-9.804	-9.8244	-9.612	-9.7357	-9.4495	-9.2609	-9.2609
S.E(Log q)	0.7681	1.4429	0.8495	0.5115	0.6231	0.6863	0.7062	0.7345	0.8871	0.7187	0.8113	0.6655	0.5948	0.6202	0.3811

Table 10: Extended Survivor Analysis diagnostics for 2005 (Lowestoft VPA Version 3.1) (cont)

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	NoPts	Regs.e	MeanQ
4	0.89	0.452	8.73	0.53	16	0.7	-8.48
5	7.83	-1.533	-4.03	0	16	10.83	-8.57
6	2.06	-1.976	7.22	0.2	16	1.6	-8.78
7	1.42	-2.362	8.29	0.7	16	0.63	-8.81
8	1.33	-1.701	8.56	0.66	16	0.78	-8.87
9	1.25	-1.313	9.11	0.66	16	0.84	-9.19
10	1.16	-0.884	9.59	0.69	16	0.82	-9.53
11	1.28	-1.538	10.13	0.68	16	0.9	-9.84
12	1.8	-3.58	10.88	0.59	16	1.19	-9.8
13	1.39	-2.784	10.51	0.79	16	0.83	-9.82
14	1.35	-2.269	10.3	0.75	16	0.97	-9.61
15	1.01	-0.068	9.76	0.83	16	0.69	-9.74
16	1.24	-1.991	10.12	0.83	16	0.68	-9.45
17	1.34	-2.765	10.25	0.83	16	0.69	-9.26
18	0.85	3.613	8.77	0.98	16	0.24	-9.27

Terminal year survivor and F summaries :

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	63003	0.792	0	0	1	1	0.015

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	37352	0.699	0.899	1.29	2	1	0.103

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	63342	0.546	0.19	0.35	3	1	0.04

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	19270	0.379	0.137	0.36	4	1	0.077

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	9629	0.327	0.172	0.53	5	1	0.094

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	10677	0.297	0.193	0.65	6	1	0.051

Table 10: Extended Survivor Analysis diagnostics for 2005 (Lowestoft VPA Version 3.1) (cont)

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	8326	0.275	0.141	0.51	7	1	0.041

Age 11 Catchability constant w.r.t. time and dependent on age
Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	8647	0.259	0.193	0.74	8	1	0.028

Age 12 Catchability constant w.r.t. time and dependent on age
Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	7168	0.25	0.278	1.11	9	1	0.025

Age 13 Catchability constant w.r.t. time and dependent on age
Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	5845	0.239	0.255	1.07	10	1	0.036

Age 14 Catchability constant w.r.t. time and dependent on age
Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	39885	0.229	0.221	0.97	11	1	0.021

Age 15 Catchability constant w.r.t. time and dependent on age
Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	222	0.324	0.199	0.61	12	1	0.066

Age 16 Catchability constant w.r.t. time and dependent on age
Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	118	0.266	0.193	0.73	13	1	0.447

Age 17 Catchability constant w.r.t. time and dependent on age
Year class = 1987

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	158	0.259	0.145	0.56	14	1	0.221

Age 18 Catchability constant w.r.t. time and age (fixed at the value for age) 17
Year class = 1986

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	44	0.306	0.155	0.51	15	1	0.263

Table 11: Retrospective analysis 2005-03 and original 2003 XSA

Biomass

XSA	2005	2004	2003	2003 orig.
1989	208	220	227	309
1990	178	187	193	262
1991	127	137	142	199
1992	94	100	103	139
1993	65	69	71	95
1994	50	56	61	82
1995	42	49	55	77
1996	34	42	49	67
1997	35	47	57	83
1998	40	57	69	97
1999	42	51	63	74
2000	48	61	76	94
2001	51	62	80	92
2002	61	74	99	111
2003	58	69		
2004	73			

SSB

XSA	2005	2004	2003	2003 orig.
1989	46	53	57	97
1990	39	45	48	80
1991	30	36	39	68
1992	24	27	29	47
1993	15	17	18	30
1994	7	9	10	19
1995	7	8	9	18
1996	4	5	6	14
1997	4	8	10	23
1998	5	12	15	30
1999	6	8	9	13
2000	8	12	14	23
2001	11	13	16	20
2002	13	17	21	25
2003	13	17		
2004	17			

FBAR

XSA	2005	2004	2003	2003 orig.
1989	0.35	0.32	0.31	0.26
1990	0.53	0.51	0.49	0.43
1991	0.40	0.39	0.38	0.34
1992	0.61	0.58	0.56	0.48
1993	0.73	0.66	0.64	0.49
1994	0.48	0.43	0.42	0.33
1995	0.75	0.58	0.55	0.38
1996	0.58	0.42	0.40	0.27
1997	0.16	0.13	0.12	0.08
1998	0.09	0.07	0.07	0.04
1999	0.15	0.10	0.10	0.06
2000	0.25	0.18	0.17	0.10
2001	0.15	0.11	0.10	0.07
2002	0.18	0.14	0.13	0.09
2003	0.12	0.08		
2004	0.08			

REC

XSA	2005	2004	2003	2003 orig.
1989	59	59	59	66
1990	48	49	49	55
1991	33	33	33	36
1992	24	24	25	26
1993	140	142	142	141
1994	226	255	293	308
1995	31	38	46	52
1996	25	31	40	45
1997	26	32	41	44
1998	21	26	32	36
1999	23	28	40	44
2000	19	20	33	36
2001	33	34	54	55
2002	93	105	150	165
2003	52	35		
2004	71			

Table 12: Extended Survivor Analysis results for 2005 (Lowestoft version 3.1)

Run title : REDFISH NAFO DIVISION 3M INDEX OF INPUT FILES 2005

Terminal Fs derived using XSA (Without F shrinkage)

(Table 8) Fishing mortality (F) at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR **-**
AGE																	
4	0.008	0.2565	0.0398	0.0102	1.8051	0.2896	0.0977	0.0707	0.0285	0.0053	0.0069	0.0056	0.027	0.0146	0.035	0.0154	0.0217
5	0.0154	0.0569	0.1186	0.2122	0.7747	0.4055	0.0958	0.1568	0.0072	0.0027	0.0023	0.0081	0.0208	0.0114	0.0251	0.103	0.0465
6	0.0841	0.0999	0.1765	0.3172	0.5086	0.4017	0.5995	0.0394	0.032	0.006	0.0008	0.0141	0.0222	0.0326	0.0115	0.0402	0.0281
7	0.2158	0.4358	0.4453	0.7402	0.5011	0.501	0.4445	0.2688	0.0077	0.0174	0.0043	0.0239	0.0585	0.0365	0.0313	0.0774	0.0484
8	0.3114	0.7864	0.6487	0.9682	0.6619	0.4493	0.5198	0.6128	0.0684	0.0076	0.0177	0.0722	0.0873	0.0719	0.041	0.0943	0.0691
9	0.2904	0.7811	0.6427	0.7312	0.3703	0.6352	0.3405	0.5887	0.2112	0.1294	0.0071	0.1125	0.073	0.0842	0.0545	0.0511	0.0633
10	0.2553	0.64	0.4217	0.577	0.6929	0.5866	0.6328	0.3335	0.2223	0.065	0.1425	0.0564	0.0845	0.0549	0.0401	0.0411	0.0454
11	0.3181	0.4863	0.4306	0.4827	0.8101	0.6623	0.8944	0.7108	0.1025	0.0671	0.0911	0.3544	0.0513	0.0802	0.0419	0.0278	0.0499
12	0.2954	0.373	0.3367	0.5233	0.8093	0.5796	0.7963	0.9853	0.3418	0.215	0.1223	0.2653	0.324	0.035	0.0432	0.0246	0.0343
13	0.4046	0.4512	0.3562	0.5014	0.8847	0.4113	0.7997	0.6255	0.2851	0.1103	0.2186	0.0994	0.2454	0.5102	0.0255	0.0358	0.1905
14	0.4107	0.635	0.3658	0.5002	0.9671	0.3278	0.6334	0.835	0.3437	0.2058	0.1185	1.0826	0.0986	0.3674	0.5749	0.0213	0.3212
15	0.6148	0.5524	0.2218	0.6911	1.093	0.4389	1.3841	0.3542	0.1013	0.0468	0.5008	0.2589	0.2456	0.3764	0.0977	0.0664	0.1801
16	0.6135	0.6144	0.3593	0.6665	0.7795	0.2603	1.1936	0.9784	0.0476	0.1556	0.4285	0.445	0.3582	0.3407	0.3688	0.4475	0.3857
17	0.5374	0.9064	0.6318	0.4227	0.9173	0.2191	0.6832	0.5306	0.3181	0.1358	0.4926	0.3037	0.3592	0.5579	0.7083	0.2208	0.4957
18	0.8371	1.0864	1.1196	0.8486	1.8336	0.5089	1.1312	0.3551	0.059	0.0568	0.2953	0.5413	0.393	0.2896	0.4436	0.2628	0.332
+gp	0.8371	1.0864	1.1196	0.8486	1.8336	0.5089	1.1312	0.3551	0.059	0.0568	0.2953	0.5413	0.393	0.2896	0.4436	0.2628	
0 FBAR 6-16	0.3467	0.5323	0.4005	0.609	0.7344	0.4777	0.749	0.5757	0.1603	0.0933	0.1502	0.2532	0.1499	0.1809	0.121	0.0843	

(Table 9) Relative F at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	MEAN **-**
AGE																	
4	0.023	0.4818	0.0994	0.0168	2.4579	0.6063	0.1304	0.1228	0.178	0.0573	0.0462	0.0222	0.1803	0.0809	0.2891	0.1822	0.1841
5	0.0444	0.107	0.296	0.3484	1.0549	0.849	0.1279	0.2724	0.0447	0.0293	0.0156	0.0321	0.139	0.0628	0.2074	1.2214	0.4972
6	0.2426	0.1876	0.4407	0.5208	0.6925	0.841	0.8005	0.0684	0.1996	0.0647	0.0055	0.0556	0.1482	0.18	0.0955	0.4766	0.2507
7	0.6224	0.8186	1.1119	1.2155	0.6823	1.0488	0.5935	0.4669	0.048	0.1861	0.0287	0.0945	0.3905	0.2018	0.2589	0.9185	0.4597
8	0.8982	1.4774	1.6198	1.5898	0.9012	0.9407	0.694	1.0645	0.4267	0.0811	0.1177	0.2854	0.5823	0.3975	0.3387	1.1185	0.6182
9	0.8376	1.4674	1.6047	1.2006	0.5043	1.3299	0.4546	1.0226	1.3173	1.3877	0.0471	0.4444	0.4872	0.4655	0.4509	0.6056	0.5073
10	0.7362	1.2023	1.053	0.9475	0.9435	1.2281	0.8449	0.5793	1.3866	0.6968	0.9487	0.2228	0.564	0.3034	0.3318	0.4872	0.3741
11	0.9173	0.9136	1.0752	0.7926	1.1031	1.3867	1.1942	1.2347	0.6395	0.7199	0.6068	1.3998	0.3422	0.4432	0.3462	0.3294	0.3729
12	0.852	0.7007	0.8406	0.8593	1.102	1.2135	1.0632	1.7116	2.1317	2.305	0.8144	1.0481	2.1618	0.1933	0.3574	0.2923	0.281
13	1.1668	0.8476	0.8894	0.8234	1.2046	0.8612	1.0677	1.0866	1.778	1.1828	1.4555	0.3926	1.6375	2.8203	0.2107	0.4247	1.1519
14	1.1844	1.1929	0.9135	0.8214	1.3169	0.6862	0.8457	1.4505	2.1438	2.2064	0.7887	4.2764	0.6581	2.0308	4.7533	0.2525	2.3455
15	1.773	1.0376	0.554	1.1348	1.4882	0.919	1.848	0.6153	0.6321	0.5017	3.334	1.0226	1.6387	2.0805	0.8074	0.7871	1.225
16	1.7695	1.1543	0.8972	1.0944	1.0614	0.545	1.5936	1.6996	0.2968	1.6679	2.853	1.7578	2.3896	1.8836	3.0493	5.3076	3.4135
17	1.5499	1.7026	1.5777	0.6941	1.2491	0.4587	0.9121	0.9217	1.9842	1.4559	3.2796	1.1998	2.3966	3.0841	5.856	2.6194	3.8532
18	2.4142	2.0409	2.7957	1.3934	2.4967	1.0655	1.5103	0.6168	0.368	0.6087	1.9662	2.1383	2.6223	1.6007	3.6673	3.1171	2.795
+gp	2.4142	2.0409	2.7957	1.3934	2.4967	1.0655	1.5103	0.6168	0.368	0.6087	1.9662	2.1383	2.6223	1.6007	3.6673	3.1171	
0 REFMEAN	0.3467	0.5323	0.4005	0.609	0.7344	0.4777	0.749	0.5757	0.1603	0.0933	0.1502	0.2532	0.1499	0.1809	0.121	0.0843	

Table 12: Extended Survivor Analysis results for 2005 (Lowestoft version 3.1). (cont.)

(Table 10) Stock number at age (start of year) Numbers*10**-3

YEAR / AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 89-**	AMST 89-**
4	58679	48243	33099	24471	140226	226453	31294	25140	25859	21482	22964	19094	32652	92614	52369	70706	0	41313	57305
5	72737	52673	33777	28781	21917	20867	153380	25681	21195	22740	19334	20635	17180	28757	82583	45757	63003	30622	38547
6	102825	64810	45023	27146	21063	9139	12587	126110	19864	19041	20520	17453	18520	15225	25726	72873	37352	26730	37095
7	124452	85535	53068	34147	17887	11461	5533	6253	109700	17408	17126	18552	15572	16390	13335	23011	63342	24012	38077
8	94492	90751	50056	30762	14738	9806	6284	3210	4325	98499	15480	15429	16390	13289	14298	11694	19270	19089	33108
9	60513	62619	37401	23676	10570	6880	5661	3381	1574	3654	88454	13762	12988	13590	11190	12418	9629	13360	24623
10	45339	40954	25944	17797	10312	6604	3298	3644	1698	1153	2905	79473	11127	10924	11304	9588	10677	9342	18655
11	33926	31782	19540	15398	9043	4666	3324	1585	2362	1230	978	2280	67967	9252	9357	9826	8326	6594	14524
12	25537	22334	17683	11494	8598	3640	2177	1230	704	1929	1041	807	1447	58425	7727	8119	8647	4374	11218
13	20113	17197	13917	11426	6163	3463	1845	888	415	453	1408	833	560	947	51048	6696	7168	2412	5688
14	18364	12144	9910	8819	6262	2302	2077	750	430	283	367	1024	683	397	514	45028	5845	1848	4558
15	11902	11020	5823	6220	4839	2154	1501	997	295	276	208	295	314	560	249	262	39885	1347	3314
16	6797	5824	5740	4220	2820	1468	1257	340	633	241	238	114	206	222	348	204	222	922	2151
17	5366	3330	2850	3626	1961	1170	1024	345	116	546	186	140	66	130	143	218	118	645	1490
18	3651	2837	1217	1371	2150	709	851	468	183	76	432	103	94	42	67	64	158	470	1013
+gp	9208	7171	5109	3156	1971	1007	1905	1013	1393	990	603	1424	197	238	777	1461	1061		
0 TOTAL	693900	559224	360156	252510	280520	311789	233996	201036	190747	190001	192244	191420	195963	261002	281036	317924	274704		

(Table 11) Spawning stock number at age (spawning time) Numbers*10**-3

YEAR / AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4	12	9	7	5	24	44	6	5	5	4	5	4	6	18	10	14
5	324	234	149	126	92	90	679	113	95	101	86	92	77	128	368	203
6	2168	1365	942	562	429	188	255	2669	421	404	436	370	392	322	546	1542
7	7693	5195	3221	2024	1081	693	336	385	6895	1093	1077	1165	975	1028	837	1438
8	11127	10288	5738	3437	1688	1142	728	369	519	11885	1866	1852	1965	1595	1721	1401
9	9777	9728	5875	3693	1697	1081	911	533	256	598	14620	2255	2135	2232	1842	2045
10	9254	8106	5225	3540	2032	1313	653	739	348	239	598	16482	2302	2266	2347	1991
11	10246	9471	5849	4590	2626	1371	959	464	726	379	301	687	20971	2848	2889	3037
12	9694	8426	6690	4284	3132	1351	794	442	266	737	401	307	548	22645	2993	3150
13	7997	6812	5555	4508	2358	1376	711	347	167	184	568	340	226	373	20923	2742
14	8354	5426	4524	3983	2725	1054	928	330	197	131	171	441	318	181	231	21133
15	5782	5381	2919	3003	2263	1061	686	495	149	140	102	147	157	277	126	133
16	3927	3364	3384	2428	1607	872	693	191	383	144	140	67	121	131	205	119
17	3084	1858	1626	2103	1093	690	581	198	68	324	108	82	39	75	81	128
18	2119	1614	691	795	1152	423	482	282	113	47	262	61	56	25	40	39
+gp	6347	4845	3443	2173	1255	713	1282	726	1022	726	434	1005	140	171	553	1054

Table 12: Extended Survivor Analysis results for 2005 (Lowestoft version 3.1). (cont.)

(Table 12) Stock biomass at age (start of year) Tonnes

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE																
4	5868	4680	3608	2349	9255	20381	3192	1986	2327	1912	1998	1852	2775	9354	3980	6646
5	11929	9007	4560	4921	3419	2713	17332	3544	2692	3138	2339	2724	2405	3796	9002	5491
6	21079	13740	9635	5646	4465	2065	2731	17781	3774	3447	3611	3037	3315	2801	4142	11878
7	30864	22325	14647	9971	5133	3163	1594	1688	19088	3986	3819	4341	3706	3721	2894	5085
8	26836	27135	16869	10890	5379	3412	2243	1053	1535	21867	4025	4397	4868	3747	3775	3251
9	19183	20727	14399	9376	4175	2717	2293	1298	639	1356	21760	4528	4260	4390	3592	4260
10	15823	14784	12064	8044	4475	3064	1504	1614	791	486	938	23603	4273	4261	4013	3624
11	14622	14079	10063	8084	4639	2301	1708	761	1193	603	462	953	23109	3775	3864	4363
12	13049	11703	10061	6563	4763	1929	1189	655	404	1061	587	426	747	23253	3570	4043
13	11324	10008	8573	7256	3846	1901	1166	515	253	283	722	557	335	531	17918	3703
14	10761	7310	6431	5997	4302	1549	1458	450	267	194	203	577	453	236	287	19182
15	7510	7185	4076	4379	3455	1420	1090	647	201	197	113	147	210	352	145	166
16	4371	3890	4471	3406	2456	1055	1020	237	472	195	132	77	127	160	222	140
17	3788	2434	2178	2788	1673	955	841	261	91	455	120	101	51	84	73	118
18	2566	2062	967	1205	1864	604	739	371	139	56	265	74	80	37	47	48
+gp	8103	6598	4557	2945	2170	919	2032	968	1300	1091	462	1068	199	226	586	1103
0 TOTALBIO	207677	177668	127159	93820	65471	50149	42133	33832	35167	40326	41556	48462	50912	60724	58109	73101

(Table 13) Spawning stock biomass at age (spawning time) Tonnes

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE																
4	1	1	1	0	2	4	1	0	0	0	0	0	1	2	1	1
5	53	40	20	22	14	12	77	16	12	14	10	12	11	17	40	24
6	445	289	202	117	91	42	55	376	80	73	77	64	70	59	88	251
7	1908	1356	889	591	310	191	97	104	1200	250	240	273	232	233	182	318
8	3160	3076	1934	1217	616	397	260	121	184	2638	485	528	584	450	454	390
9	3099	3220	2262	1462	670	427	369	205	104	222	3596	742	700	721	591	702
10	3230	2926	2430	1600	882	609	298	327	162	101	193	4895	884	884	833	753
11	4416	4196	3012	2410	1347	676	493	223	367	186	142	287	7130	1162	1193	1349
12	4954	4415	3807	2446	1735	716	434	235	153	405	226	162	283	9013	1383	1568
13	4503	3965	3422	2863	1471	756	449	201	102	115	291	227	135	209	7344	1516
14	4896	3267	2936	2709	1872	710	652	198	122	90	94	249	211	108	129	9002
15	3648	3508	2043	2114	1616	699	498	321	102	100	55	73	105	174	74	84
16	2525	2247	2636	1959	1400	627	563	133	286	117	77	45	75	94	131	82
17	2177	1358	1242	1617	932	563	478	150	53	270	69	59	30	48	41	69
18	1490	1174	549	699	999	360	419	224	86	34	161	44	48	23	28	29
+gp	5585	4458	3071	2028	1381	650	1368	694	953	801	332	754	142	163	417	796
0 TOTSPBIO	46089	39495	30455	23854	15340	7439	6509	3529	3965	5417	6051	8414	10640	13360	12928	16935

Table 12: Extended Survivor Analysis results for 2005 (Lowestoft version 3.1). (cont.)

(Table 16) Summary (without SOP correction)

	RECRUITS Age4	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR6-16	ABUNDANCE
1989	58679	207677	46089	58086	1.2603	0.3467	693900
1990	48243	177668	39495	80223	2.0312	0.5323	559224
1991	33099	127159	30455	48500	1.5925	0.4005	360156
1992	24471	93820	23854	43300	1.8152	0.609	252510
1993	140226	65471	15340	43090	2.8091	0.7344	280520
1994	226453	50149	7439	17660	2.3739	0.4777	311789
1995	31294	42133	6509	13879	2.1324	0.749	233996
1996	25140	33832	3529	6101	1.7289	0.5757	201036
1997	25859	35167	3965	1408	0.3551	0.1603	190747
1998	21482	40326	5417	1011	0.1866	0.0933	190001
1999	22964	41556	6051	1095	0.181	0.1502	192244
2000	19094	48462	8414	3664	0.4354	0.2532	191420
2001	32652	50912	10640	3327	0.3127	0.1499	195963
2002	92614	60724	13360	3061	0.2291	0.1809	261002
2003	52369	58109	12928	2273	0.1758	0.121	281036
2004	70706	73101	16935	3223	0.1903	0.0843	317924
Arith. Mean	57834	75392	15651	20619	1.1131	0.3511	
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 13: The .srr file used in the Mterm projections from the 2005XSA

```
5               Nparams
5               Geometric mean model
46.345          2000-2004 age 4 XSA geomean in millions
0.00000E+000
0.00000E+000
0
0.00000E+000
16              Ndata
-0.1763         Residuals
0.2360
0.0401
-0.3366
-0.6386
-0.5081
-0.5081
-0.3927
-0.6117
-0.5835
-0.7689
-0.7022
-0.8867
-0.3502
0.6923
0.1222
0.4224
0               No extra data
```

Table 14: An explanation of the .sen file input data with an exploitation pattern corresponding to F*statusquo*

$N_{4,2005} = N_{4,2006}$ = 2000-04 geomean recruitment

Name	Value	C.V.	Name	Value	C.V.	Name	Value	C.V.	Name	Value	C.V.
Population at age in 2005			Exploitation pattern (H - Human consumption)			Exploitation pattern (D - Discards)			Exploitation pattern (I - Industrials)		
N4	46345	0.80	sH4	0.0092	0.00	sD4	0.00	0.00	sI4	0.00	0.00
N5	63003	0.80	sH5	0.0618	0.00	sD5	0.00	0.00	sI5	0.00	0.00
N6	37352	0.37	sH6	0.0241	0.00	sD6	0.00	0.00	sI6	0.00	0.00
N7	63342	0.26	sH7	0.0464	0.00	sD7	0.00	0.00	sI7	0.00	0.00
N8	19270	0.25	sH8	0.0566	0.00	sD8	0.00	0.00	sI8	0.00	0.00
N9	9629	0.25	sH9	0.0307	0.00	sD9	0.00	0.00	sI9	0.00	0.00
N10	10677	0.21	sH10	0.0247	0.00	sD10	0.00	0.00	sI10	0.00	0.00
N11	8326	0.23	sH11	0.0167	0.00	sD11	0.00	0.00	sI11	0.00	0.00
N12	8647	0.27	sH12	0.0148	0.00	sD12	0.00	0.00	sI12	0.00	0.00
N13	7168	0.25	sH13	0.0215	0.00	sD13	0.00	0.00	sI13	0.00	0.00
N14	5845	0.23	sH14	0.0128	0.00	sD14	0.00	0.00	sI14	0.00	0.00
N15	39885	0.26	sH15	0.0398	0.00	sD15	0.00	0.00	sI15	0.00	0.00
N16	222	0.23	sH16	0.2685	0.00	sD16	0.00	0.00	sI16	0.00	0.00
N17	118	0.20	sH17	0.1325	0.00	sD17	0.00	0.00	sI17	0.00	0.00
N18	158	0.23	sH18	0.1577	0.00	sD18	0.00	0.00	sI18	0.00	0.00
N19	1061	0.23	sH19	0.1577	0.00	sD19	0.00	0.00	sI19	0.00	0.00
Stock weight at age			Catch weight at age (H - Human consumption)			Catch weight at age (D - Discards)			Catch weight at age (I - Industrials)		
WS4	0.090	0.00	WH4	0.097	0.00	WD4	0.00	0.00	WI4	0.00	0.00
WS5	0.120	0.00	WH5	0.135	0.00	WD5	0.00	0.00	WI5	0.00	0.00
WS6	0.169	0.00	WH6	0.197	0.00	WD6	0.00	0.00	WI6	0.00	0.00
WS7	0.221	0.00	WH7	0.247	0.00	WD7	0.00	0.00	WI7	0.00	0.00
WS8	0.274	0.00	WH8	0.296	0.00	WD8	0.00	0.00	WI8	0.00	0.00
WS9	0.329	0.00	WH9	0.346	0.00	WD9	0.00	0.00	WI9	0.00	0.00
WS10	0.375	0.00	WH10	0.395	0.00	WD10	0.00	0.00	WI10	0.00	0.00
WS11	0.421	0.00	WH11	0.467	0.00	WD11	0.00	0.00	WI11	0.00	0.00
WS12	0.453	0.00	WH12	0.487	0.00	WD12	0.00	0.00	WI12	0.00	0.00
WS13	0.488	0.00	WH13	0.513	0.00	WD13	0.00	0.00	WI13	0.00	0.00
WS14	0.527	0.00	WH14	0.542	0.00	WD14	0.00	0.00	WI14	0.00	0.00
WS15	0.616	0.00	WH15	0.606	0.00	WD15	0.00	0.00	WI15	0.00	0.00
WS16	0.680	0.00	WH16	0.672	0.00	WD16	0.00	0.00	WI16	0.00	0.00
WS17	0.565	0.00	WH17	0.588	0.00	WD17	0.00	0.00	WI17	0.00	0.00
WS18	0.781	0.00	WH18	0.760	0.00	WD18	0.00	0.00	WI18	0.00	0.00
WS19	0.820	0.00	WH19	0.822	0.00	WD19	0.00	0.00	WI19	0.00	0.00
Natural mortality at age			Maturity								
M4	0.1	0.00	MT4	0.000	0.00						
M5	0.1	0.00	MT5	0.005	0.00						
M6	0.1	0.00	MT6	0.021	0.00						
M7	0.1	0.00	MT7	0.063	0.00						
M8	0.1	0.00	MT8	0.122	0.00						
M9	0.1	0.00	MT9	0.167	0.00						
M10	0.1	0.00	MT10	0.210	0.00						
M11	0.1	0.00	MT11	0.312	0.00						
M12	0.1	0.00	MT12	0.392	0.00						
M13	0.1	0.00	MT13	0.414	0.00						
M14	0.1	0.00	MT14	0.474	0.00						
M15	0.1	0.00	MT15	0.514	0.00						
M16	0.1	0.00	MT16	0.612	0.00						
M17	0.1	0.00	MT17	0.605	0.00						
M18	0.1	0.00	MT18	0.626	0.00						
M19	0.1	0.00	MT19	0.743	0.00						
Natural mortality multiplier in year			Effort multiplier in year (H - Human consumption)								
K2004	1	0.0	HF2004	1.0	0.0						
K2005	1	0.0	HF2005	1.0	0.0						
K2006	1	0.0	HF2006	1.0	0.0						

Table 15: SSB 50th %ile profiles for a range of *Fstaus quo* multipliers

Year	**Fstquo**	**0.9Fstquo**	**0.8Fstquo**	**0.7Fstquo**	**0.6Fstquo**	**0.5Fstquo**
2005	22351	22351	22351	22351	22351	22351
2006	26248	26406	26570	26746	26920	27088
2007	21775	22332	22873	23510	24119	24752
2008	24137	25007	25897	27060	28086	29150
2009	25782	26916	28152	30064	31497	33017
2010	26054	27358	28788	31099	32826	34703
2011	26510	27937	29560	32217	34179	36304
2012	27083	28650	30332	33484	35646	38171
2013	27999	29664	31514	34933	37302	40009
2014	28708	30541	32578	36262	38832	41733

Table 16a: Mterm 80% and 50% CL for SSB under a 0.5 Fstatusquo regime

	0.8		0.5	
Year	lower CL	upper CL	lower CL	upper CL
2005	18520	27149	20152	24800
2006	22572	32725	24546	29988
2007	21465	28556	22848	26775
2008	25205	34293	26953	31830
2009	28433	39052	30539	36084
2010	29815	40970	31977	37678
2011	31065	43853	33215	39835
2012	32041	47072	34599	42119
2013	33628	49714	36303	44401
2014	34752	52017	**37639**	**46535**

Table 16b: Mterm 80% and 50% CL for Yield under a 0.5 Fstatusquo regime

	0.8		0.5	
Year	lower CL	upper CL	lower CL	upper CL
2005	2285	3561	2491	3120
2006	5407	8666	**6006**	**7784**
2007	3662	5313	**3943**	**4825**
2008	4164	6381	4541	5655
2009	4125	5954	4456	5430
2010	3957	5390	4219	4998
2011	3998	5237	4232	4876
2012	3820	4902	4030	4629
2013	4283	5507	4552	5183
2014	5378	7424	5785	6868