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An Assessment of Beaked Redfish (*S. mentella and S. fasciatus*) in NAFO Division 3M (*With a Revised Approach to Quantify the Increase on Redfish Natural Mortality Determined by the Increase on Cod Predation Observed Over Recent Years, 2006-2012)*

By

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Abstract

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 reason for this approach is the historical dominance of this group in the 3M redfish commercial catch until 2005. However a new golden redfish fishery (*S. marinus*) started on September 2005 on shallower depths of the Flemish Cap bank above 300m, and the Flemish Cap cod fishery reopened in 2010. These new realities implied a revision of catch estimates, in order to split recent redfish commercial catch and by-catch from the major fleets on Div. 3M into golden (*S. marinus*) and beaked (*S. mentella* and *S. fasciatus*) redfish catches.

An Extended Survivor Analysis (Shepherd, 1999) was used with the same framework of previous assessments and with the tuning of the 1989-2012 EU survey. Survey results suggest that the beaked redfish stock has not been able to hold its growth and sustain an above average level, suffering instead a severe decline on the second half of the 2000's. The most likely hypothesis to justify this unexpected downward trend on stock size is an increase in natural mortality by cod predation. From the sensitive analysis, natural mortality at 0.4 was applied on ages 4-6 through 2006-2010, and extended to ages 7 plus on 2009 and 2010. It has been kept constant through all ages on 2011 and 2012, but with an overall decline to 0.125.This is the highest possible level of natural mortality giving assessment results in line with the recent survey trends and at the same time with key diagnostics very close to the best ones, obtained with the return on 2011-2012 to the "standard" redfish natural mortality of 0.1. A 2013-2009 retrospective XSA was also carried out, being this assessment very much in line with their immediate predecessors (2012-2011).

Above average year classes coupled with low fishing mortalities allowed a rapid growth of biomass and abundance since 2003 that pushed the stock to a 2008-2009 high. Between 2009 and 2011 biomass and abundance of exploitable and 7 plus female stock went down for causes other than fishing. These declines were halted at well above average levels on the terminal year and, at least for biomass, there was some improvement on 2012. The recruitment at age 4 increased from 2002 till 2006 and was kept at a high level until 2009, with 2005 year class as the most abundant year class of the assessment interval. Recruitment to exploitable stock declined since then and is approaching the level of the weak year classes from the 1990's.

Short and medium term stochastic projections were obtained for female spawning stock biomass (SSB) under $F_{statusquo}$, together with SSB and yield medium term probability profiles. As it was documented on the 2011 assessment $F_{0.1}$ is an unacceptable management option at the current beaked redfish stock status. Keeping on 2014 and 2015 fishing mortality at its present low level will sustain on the short term a high level of female spawning biomass. But on the long term it will be natural mortality to determine the future of beaked redfish as a fishery resource.

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 redfish populations is supported by morphometric studies (Saborido Rey, 1998).

The 3M redfish assessment is focused on 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 reason for this approach is the dominance of this group in the 3M redfish commercial catch. During the entire series of EU Flemish Cap surveys (1988-2012) beaked redfish also represents the majority of redfish biomass (78%).

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 old (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).

Description of the fishery

The 3M redfish stocks have been exploited both by pelagic and bottom trawl. Due to the similarity of their external morphology the commercial catches of 3M redfish are reported together. Historically the majority of pelagic and bottom commercial catches from the 3M redfish fisheries are a mixture of *S.mentella* and *S.fasciatus*. The redfish by-catch from the 3M Greenland halibut fishery is 100% *S. mentella.*

The redfish fishery on Division 3M increased from 20,000 tons in 1985 to 81,000 tons in 1990, falling continuously since then till 1998-1999, when a minimum catch around 1,000 tons has been recorded most as by-catch of the Greenland halibut fishery (Table 1a, Fig. 1a). This drop of the 3M redfish catches was related with the quick decline of both stock biomass and fishing effort deployed in this fishery. A discrete increase of catch and fishing effort directed to redfish is observed again during the first half of the 2000's, when Portugal consolidated its major role in the fishery (Table 1a).

From July 2004 to July 2006 Flemish Cap EU survey showed a 3.5 fold increase in bottom biomass of both golden and Acadian redfish (Casas *et al.*, 2007). Cod stock and cod by-catch also went up, and the Flemish Cap cod fishery reopened in 2010. Redfish catch (including by-catch from cod) respond positively to those events and was kept at a relative high level of 6,000-11,000 tons between 2006 and 2012. So, over the most recent years, we have a mixture of redfish by-catch from depths above 300m (a mixture of golden and beaked redfish) with redfish catch bellow 300m (basically beaked redfish), mainly taken by Portuguese bottom trawl and Russian pelagic and bottom trawl fisheries.

This new blend forced a revision of redfish catch estimates, in order to split recent by-catch and catch of the major fleets on the Flemish Cap bank (Portugal, Russia and Spain) into golden and beaked redfish. And at the same time to have the available length sampling for each of the main fleets separated as well.

In order to estimate a proxy of the beaked redfish catch by fleet, a 2005-2012 revision of the logbooks from the monitored vessels has been carried by the national sampling programmes of Portugal, Spain and Russia. For each fleet the observed hauls were assembled by depth intervals (<300m; 300-400m; 400-700m and >700m). The proportion of beaked redfish found in the EU survey redfish catch in weight (excluding juveniles) at each of these intervals was applied to the correspondent commercial redfish observed catch taken from the same depth interval in order to get a beaked redfish catch estimate. The ratio between estimated beaked redfish catch and observed redfish catch for the ensemble of monitored vessels was then applied to the fleet annual catch in order to get a beaked redfish catch estimate for that fleet. This exercise was performed annually for the Portuguese bottom trawl, Spanish bottom trawl and Russian pelagic and bottom trawl.

The 2005-2008 3M redfish catches of Japan were assigned to beaked redfish. The 2005-2009 3M beaked redfish catches from fleets other than Portugal, Spain and Russia were estimated with an average beaked redfish proportion found on the redfish catches of Portugal and Spain on each of those years. With the reopening of the cod fishery in 2010 the Portuguese bottom trawl fleet was allowed to spread more evenly its effort on the bank over a wider depth range, while the Spanish effort maintained its preference to deeper Greenland halibut grounds. That is why on 2010-2012 redfish catches from fleets mentioned above were translated into beaked redfish catches using just the beaked redfish proportion estimated for the Portuguese redfish catches.

No STACFIS catch estimates were available for 2011-2012. Over the previous five years (2006-2010) an average annual bias of 15% plus was recorded between overall SACFIS catch estimate and overall STATLANT nominal catch. In order to mitigate the lack of scientific catch information a 15% surplus was added to the STATLANT catch of each fleet for the last couple of years or, (for 2012 and for the countries with no STATLANT catch available yet) to the catch reported on the “Provisional Catches for December 2012” (NAFO Circ.Letter Ref. No.: GFS/13-070, 11 February 2013). This inflated STALANT catches are included in the present assessment along with the STACFIS catch estimates.

The 1989-2012 redfish nominal catch is presented on Table 1a, STACFIS redfish catch on Table 1b and the beaked redfish catch estimates used in this assessment on Table 1c and Fig. 1a. Finally on Table 1d are tabulated the golden and beaked redfish proportions by depth found in the 2005-2012 EU surveys (Gonzalez, *pers. comm.*,2009-2013) that were used to get the beaked redfish commercial catch estimates by fleet.

The boom in 1993 and further settlement of a shrimp fishery in Flemish Cap lead to high levels of redfish by-catch in 1993-1994. From 1995 onwards by-catch in weight fell to apparent low levels but since 2001 increased again, reaching 1006 tons in 2003. That increase does not reflect any expansion of the 3M shrimp fishery and was supported by the income of above average year classes. From Canadian observer data (Kulka and Firth, *pers. comm.*, 1999-2005) the redfish by-catch on the 3M shrimp fishery declined to 471 ton in 2004 and again to 80 ton in 2005 (Table 1e) due to the fall of the Flemish Cap shrimp fishery (Skúladóttir and Pétursson, 2006).

In 2001-2003 the redfish by-catch in numbers from the Flemish Cap shrimp fishery justified 78% of the total 3M redfish catch. In 2004 represented 44%, and just 15% of the total catch in 2005 (Table 1f, Fig. 1b). From 2006 onwards the beaked redfish catch in the basically from the commercial catch.

Length composition of the commercial catch and by-catch

The 1998-2010 and 2012 3M beaked redfish commercial length weight relationships from the Portuguese commercial catch (Alpoim and Vargas, 2004; Vargas *et al*, 2005 and 2007-2011 and 2013) were used to compute the mean weights of all commercial catches and correspondent catch numbers at length (Table 2a). Due to the small length weight sample size available for 2011 the previous 2010 length weight relationship was applied to the 2011 catch. The 1993-2004 beaked redfish length weight relationships from the EU survey (Table 2b: Troncoso and Casas, *pers. comm.* 2005) were used to compute the mean weights of the by-catch and correspondent by-catch numbers at length.

Length samplings from the Portuguese bottom trawl and from the Russian pelagic and bottom trawl are the major inputs to the length composition of the 3M beaked redfish commercial catch. The Russian beaked redfish length sampling from pelagic trawl is just applied to the Russian beaked redfish pelagic catches. Until 2009 the pelagic catch is near 100% of the Russian catch but for 1996, 1998-1999 and 2003-004. However on recent years this pattern is reversed: no pelagic redfish catch recorded on 2010 and 2012. In 2011 less than half of the Russian redfish catch came from pelagic trawl.

The Portuguese beaked redfish length sampling is applied to the beaked redfish catch of bottom trawl fleets with the exception of the Russian, Spanish and Japanese fleets for the years where respective length sampling data are available for those fleets (Table 3a). In order to overcome the lack of the length sampling of the Portuguese catches on 1993-1994 and of the Russian catches on 1992-1994, for each year and fleet an expected length composition of the commercial catch was derived from the permile length composition of the correspondent EU survey catch, using a “exploitation pattern at length” calculated previously for each commercial trawl gear (Ávila de Melo et al., 2009).

Length structure of the commercial catch show relative stability between 1989 and 2001, with most of the annual mean lengths falling within 27-31cm. Small sizes increase their presence in the commercial catch afterwards, being responsible of annual mean lengths bellow 28cm and wide oscillations in the catch structure at length. Until very recently this presence of small redfish in the commercial catch was the outcome of several recruitment processes from a sequence of abundant year classes. However the severe decline of the commercial mean length between 2009 and 2010 may also reflect a decline on the size of the exploitable stock, as suggested by the EU survey results. The same rational, but on the opposite way, can be justify the recent increases (2011-2012) observed both on mean length of commercial catch and exploitable stock size from EU survey (Table 3b, Fig. 2).

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 from 1993 till 2004, based on data collected on board of Norwegian (1993-1998) and Canadian (1993-1997; 1999-2004) vessels (Kulka, 1999 and *pers. comm.*, 2000-2005; Firth, *pers. comm.* 2004-2005). The sum of the absolute length compositions of the 1989-2013 commercial catch with the absolute length compositions of the 1993-2004 by catch is the 3M redfish catch at length input of this assessment (Table 3c).

Age composition of the catch

Age composition of the total catch was obtained using the *S.mentella* age length keys from the 1990-2007 and 2009-2012 EU surveys (Fran Saborido-Rey and Rosario Petit, *pers. comm.* 1991-2013). No *S.mentella* age length key was available for 2008: a synthetic *S.mentella* age length key was applied both to commercial and survey length compositions (Fran Saborido-Rey, *pers. comm.* 2009). Before 1993 age group 8 was the most abundant in the commercial catch and consecutive 1981-1984 cohorts were the most important when passing through this age. The lack of sorting grades on shrimp trawl at the beginning of the 3M shrimp fishery justified that the most abundant age group in the catch (including redfish by-catch) moved back to age 4 and 5 in 1993-1995, targeting prematurely the above average 1989 and 1990 cohorts. The expansion of the shrimp fishery with sorting grade escape device and the decline of the redfish fishery lead to even younger modal age groups between 1996 and 2004, when age 2 was the most abundant on the redfish catch most of the years (nevertheless 1990 year class dominated again the commercial catch in 2000). The 1999-2002 and 2005 cohorts dominated sequentially the overall catch through most years of the past decade (with the exception of 2005), some of them on several years, first still in the shrimp by-catch and later on in the commercial fishery (Table 3d). The 2006 and 2007 year classes are the most abundant on the 2012 catch.

The length weight relationships from the Portuguese commercial catch (Table 2a) were used to calculate mean weights at age in the redfish catch (commercial plus by-catch) (Table 3e).

Research surveys

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 (1983-1993; 1995-1996 and 2001-2002) and the other one from the European Union/Spain and Portugal (1988-2010). 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 was conducted again on 1996.

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

EU survey

The EU survey has been conducted annually in June-July since 1988 as a bottom trawl survey, down to the 731m-depth contour till 2002, extending to 1400m depth since 2003. Swept area is divided according to the Flemish Cap bank stratification proposed by Doubleday (1981) and revised and extended by Bishop (1994). The survey series used in the assessment is the original one, covering the nineteen strata of the bank till 731m. Half an hour valid hauls were kept around 120 each year. More details regarding the EU survey series, namely its conversion from former *RV Cornide de Saavedra* (CS) to the actual *RV Vizconde de Eza* (VE) units go to the 2005 EU survey report (Troncoso and Casas, 2005) and to the 2005 assessment (Ávila de Melo *et al*, 2005).

Length weight relationships

Annual length weight relationships for *S. mentella* and *S. fasciatus* (1992-2012) and for the two species combined (1988-2012) were available from survey data (Troncoso and Casas *pers. comm.*, 2005-2013) (Table 2b). *S. mentella* and *S. fasciatus* length weight relationships were used to get 1992-2012 *SOP* survey biomass for each redfish species. The *Sebastes sp*. length weight relationships were used to get the 1988-1991 *SOP* survey biomass for beaked redfish.

Survey abundance at length

Each of the redfish categories included in the beaked redfish unit (beaked redfish including juveniles, 1988-1989; beaked redfish, 1990-1991; *S. mentella*, 1992-2002; *S. fasciatus*, 1992-2002 and juveniles, 1990-2002) had their own survey abundance at length original series converted to the new RV units using the conversion framework described in the 2005 assessment (Ávila de Melo *et al*, 2005). The transformed *S. mentella*, *S. fasciatus* and juvenile survey abundance at length series were then linked to with the 2003-2012 *RV Vizconde de Eza* length distributions (Troncoso *pers. comm.*, 2005-2013). For each year and redfish category, abundance at length is re-scaled in order to fit the correspondent swept area survey biomass estimate. Finally the matrices of length distributions from all redfish categories were assembled into one single survey abundance at length series for beaked redfish (Table 5a).

Maturity at length

Gonads of the Flemish Cap beaked redfish species were collected since 1994 though not every year. Maturity ogives at length available and used on previous assessments were from 1994 (*S. fasciatus* and *S. mentella*, Saborido Rey 1994) and 1999 (*S. mentella*, Fran Saborido Rey *pers. comm.*, 2000). New 2011 and 2012 maturity ogives were available for this assessment (Rosario Petit and Fran Saborido Rey *pers. comm.*, 2013) but the analysis of samples from the rest of the years has just began. Preliminary results revealed relevant changes on maturity for the three redfish species with length at maturity (L_{50}) falling on all of them (Table 4 and Figure 3). These data were revised for correcting mistakes and/or misinterpretations. For *S. fasciatus*, estimated L_{50} decreased 12.1 cm, from 30.1cm (1994) to 18cm (2012). For *S. mentella*, estimated L_{50} decreased 9.7cm, from 30.1cm (1994) to 20.4cm (2012). And finally for *S. marinus* estimated L_{50} decreased from 33.8 cm in 1999 to 18.8 cm in 2012, i.e. 15 cm of variation.

Due to the potential impact of these results on the assessment, a thorough analysis is under way in order to complete the historical maturity data series and validate results.

Age composition of the survey stock and a proxy to mature female component

The survey abundance at age for the 1989-2012 3M beaked redfish stock (Table 5b) were obtained using the *S.mentella* age length keys from the 1990-2007 and 2009-2012 surveys (Fran Saborido-Rey and Rosario Petit, *pers. comm.* 1991-2013). No *S.mentella* age length key was available for 2008: a synthetic *S.mentella* age length key was applied both to commercial and survey length compositions (Fran Saborido-Rey, *pers. comm.* 2009). Due to the scarcity of redfish larger than 40cm either in the survey and commercial catch, a plus group was considered at age 19.

As mentioned above, a substantial shift towards smaller lengths as been detected on maturity ogives both for *S. mentella* and *S. fasciatus*, now made available for 2011 and 2012 (Rosario Petit and Fran Saborido-Rey, *pers. comm.* 2013). The use on the last couple of years of these new ogives, instead of the former ones from 1999 (for *S. mentella*) and 1994 (for *S. fasciatus*) that have been used so far to get the female spawners, would lead to a sudden increase on the size of this component perhaps of unrealistic high magnitude (Table 6a, Fig. 4a and 4b). Since most of the biomass and abundance of the beaked redfish female spawning stock has been historically composed of age 7 and older females, until the shift to younger maturity is clarified back in time for the two redfish species involved in the assessment, the female spawning stock shall be represented by the age 7 plus female segment of the beaked redfish stock.

The annual beaked redfish length weight relationships from the survey (Table 2b) were used to calculate the mean weights at age in the 3M beaked redfish stock and 7+ female stock (Table 7a and 7b).

Survey biomass and abundance, 1988-2012

The 1989-2010 survey mean catch per tow for beaked redfish is presented on Table 8a and Fig. 5. Details on the computation of this combined index can be found in 2003 assessment (Ávila de Melo et al, 2003). Survey year class strength at age 4, abundance and biomass for the total stock unit, exploitable and 7+ female stock can be found on Table 8b. Trends of the respective standardized series are at Fig.'s 6a to 6d.

The survey stock biomass and abundance declined on the first years of the survey till 1991, and were kept at low level between 1991 and 2001. A sequence of an above average and a strong year class (2001-2002) lead the stock to a maximum in 2006. But year class strength declined afterwards, and the last cohort entering the exploitable stock (2008 year class in 2012) is near the low level of recruitment at age 4 observed over the 1990's. Until 2010 overall and exploitable stock follow similar trends to recruitment. Stock decline was halted on 2011 and on 2012 the stock showed signs of recovery, namely its exploitable part took off again from its average level. The 7+ female survey indices extended their increase further on till 2009 but fall on 2010 and 2011. Those indices also went up again on 2012 to a level close to the 2009 high.

Despite relatively abundant and abundant year classes on a row (2001-2005) and a low exploitation regime over almost two decades, survey results suggest that the beaked redfish stock has not been able to hold its growth, suffering instead a severe decline on the second half of the 2000's. This unexpected decline on all survey indices related to stock size can only be attributed to mortality other than fishing mortality.

The strong possibility of an important increase on redfish natural mortality is now associated to cod growth on Flemish Cap: not only in terms of abundance but also in terms of individual growth, leading to a consistent increase of cod biomass from 2006 onwards (Gonzalez *et al*, 2012). The main results from on going research on the predator prey relationship between redfish and cod on Flemish Cap are summarized next, including a quantitative approach to redfish consumption by cod, on an annual basis. The quantitative impact of the increase of this consumption on top of beaked redfish natural mortality, from 2006 onwards, will be evaluated further on in the sensitivity analysis of the present assessment.

Impact of cod predation on redfish in Flemish Cap: preliminary results.

In the Flemish Cap demersal community important changes have been observed since early 1990´s. The comparative analysis of survey trends showed that, in addition to fishing and environmental conditions, predation is one of the main drivers in the dynamic of the Flemish Cap demersal community (Pérez-Rodríguez et al. 2011b). The decline of the cod stock (*Gadus morhua*) from 150000 tons in 1989 to collapse in 1995 was followed by shifts in the stock size of other bottom related species. Since 2004 a rapid increase was observed on survey biomass both of golden (*Sebastes marinus*) and Acadian (*Sebastes fasciatus*) redfish stocks. Due to their shallower depth distributions these two redfish species overlap with cod to an extent greater than deep sea redfish (*Sebastes mentella*). Since 2006, the cod stock started to recover, while those two redfish stocks declined sharply. Pérez-Rodríguez et al. (2011a) showed that redfish was an important component in the diet of cod across the period 1993-2008, especially those years when successful recruitment events were observed in redfish stocks.

Previous studies during the early 1980's (Lilly 1985) already pointed out the importance of predation by cod for the dynamics of redfish stocks in the Flemish Cap. More recently Pérez-Rodríguez and Saborido-Rey (2012) found that redfish numbers estimated to be consumed by cod are negatively correlated to beaked redfish abundance since 2006 (evaluated assuming a higher natural mortality on ages 4 - 6 on 2006 - 2008, extended to all age groups on 2009 – 2010, Ávila de Melo *et al.* 2011).

Fish predation is highly determined by proper size frequency between fish population and its prey (Gerking 1994). In the case of cod and redfish in the Flemish Cap, previous analyses suggested that there is a positive relationship between cod and redfish size. Lilly (1980) estimated that the maximum size of preyed redfish was the

35% of cod size. Later on Casas and Paz (1994) found that redfish consumed by cod sized in average the 22.3% of cod size. Redfish continues to be an important prey in the diet of the cod even on older codfish larger than 80 cm. The average size considered by Pérez-Rodríguez and Saborido-Rey (2012) for redfish consumption by the Flemish Cap cod stock as a whole was 25cm.

The numbers of redfish cod consumption (‘000s) between 2006 and 2012 were estimated to be as follows (Alfonso Pérez-Rodríguez *pers. comm.*. 2013):

	2006	2007	2008	2009	2010	2011	2012
Deaths by cod	**28263**	**53207**	**69299**	**149030**	**215836**	**219291**	**192853**

These preliminary results are rough estimates that need to be disaggregated by species. Nevertheless they are a first attempt to evaluate on an annual basis the magnitude of redfish consumption by cod. Therefore they were integrated on the quantitative approach to natural mortality surplus over most recent years, which constitute the sensitivity analysis preceding the 2013 beaked redfish assessment. For practical purposes it was assumed on this analysis that most of those natural deaths came from either one of the two beaked redfish species.

The 2013 XSA Assessment

Wide inter-annual variability can be observed on bottom trawl survey indices for each of the three redfish species existing on the Flemish Cap bank, caused by the scattered occurrence of large schools and changes in redfish availability as regards the vertical opening of the bottom net. When abundance at length survey indices for the two beaked redfish species are lumped together and then turn into survey abundance at age those fluctuations originate annual patterns in the catchabilities that relate survey indices with stock size at age that may print retrospective patterns on the assessment results. Nevertheless, the long EU survey series seems to reflect well the overall dynamic of the beaked redfish stock, rich of contrasting trends over the last 24 years, and so is considered by the authors a valid tool to frame an Extended Survivors Analysis (XSA, Shepherd 1999) despite the above mentioned caveats.

The model runs with an XSA algorithm included in the Lowestoft VPA Suite (Darby and Flatman, 1994). An XSA summary and formulation to this case study can be found in the 2003 assessment (Ávila de Melo *et al.*, 2003).

Input files

The input files for XSA analysis are presented in Table 8. As on previous assessments natural mortality was assumed constant at 0.1 on a standard run for sensitivity analysis (Table 10), but allowed to vary over age and time afterwards in order to select a magnitude of M in line with the most recent stock trends given by the survey . The proportion of 7 plus females at age is the one observed through the 1989-2012 period and is used by the model to get a proxy to spawning stock biomass. The month with a peak of spawning for 3M *Sebastes mentella*, February (Saborido-Rey, 1994), was the one chosen to the estimate 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 the plus group was set at age 19). Landings were given by the *SOP* of the 4+ catch at age and commercial weight at age matrices.

The present Extended Survivor Analysis used as tuning file the 1989-2012 EU survey abundance at age matrix, with the 1989-2002 indices converted into the new *RV Vizconde de Eza* units (Casas *et al.*, 2013).

The framework

The model runs free of any of the available *softener* tools:

- No tapered time weighting, in order to give a full use and equal importance to the twenty four years of input data, namely the former ones till 1993 when a full-scale redfish fishery occurred on Flemish Cap.

- No shrinkage of fishing mortalities at age on the terminal year (catches and stock size indices have not been stable on recent years).
- Fishing mortalities at oldest true age were not shrunk either.
- Survivors at the younger recruited ages were not shrunk to a mean of previous age abundances at the end of last year of the assessment.

A run with catchability independent of year-class strength on all ages till the penultimate true age (17) showed the *t* values for the slopes that linearly relate the log abundance with the log survey index for the recruiting ages (4 and 5) not differing significantly from 1 (*Student's t* test with 22 degrees of freedom = No. points – 2, significance level of 0.05). This lack of a significant trend on the regression slopes for the youngest ages led us to accept catchability independent with respect to year class strength. Catchability was set constant with respect to age only at age 17: after declining until age 11, catchability is relatively stable on older ages (11-17) but assuming a constant q will lead to poorer diagnostics. In order to avoid overweight of the cohort's terminal population estimate by the last true age, the minimum allowable standard error of the *log* catchability on the last true age (18) of was set at 0.5.

In summary, apart the input of annual 7 plus female proportions at age to get a proxy of spawning stock biomass the basics of the 2013 XSA framework remained unchanged from the 2011 assessment (Ávila de Melo *et al*., 2011): no recruiting ages with catchability dependent of year-class strength, constant catchability just at the penultimate age, a minimum standard error of the *log* catchability for the last true age of 0.5 and finally the possibility of a M higher than 0.1 on recent years.

Sensitivity Analysis: adjusting natural mortality towards a better XSA fit to 2006-2012 survey trends.

The rational to "select a best option" for natural mortality in the 2011 XSA was based on the sequential time schedule of decline for different beaked redfish stock components (Ávila de Melo *et al*., 2011). Survey trends shown that recruitment at age 4 and exploitable stock started their decline earlier, on 2006, while the female spawning component started later, on 2009 (Table 8b, Fig. 6a, 6c and 6d). So, when considering a set of runs for a range of M 's higher than the standard value of 0.1, these facts determined the definition of two time/age boxes where natural mortality was allowed to increase: (1) 2006-2010 for ages 4 to 6, and (2) 2009-2010 for ages 7 and older. For years before 2006 M was kept at 0.1.

From the 2011 sensitive analysis (Ávila de Melo *et al*., 2011), carried out for a set of natural mortality options, a natural mortality of 0.4 was adopted for ages 4-6 through 2006-2010, extended to ages 7 on 2009-2010. This was the lowest possible level of natural mortality giving assessment results in line with the 2006-2010 survey declines, and at the same time key diagnostics very close to the best ones, obtained with a higher natural mortality of 0.55.

On the present assessment eleven options regarding 2006-2012 natural mortality will be considered. These options are presented on Table 10. Most of them are follow ups of the 2011 rational, except for the two options presented next. The goodness of fit of the model for each of the M options is given by the sum of squared $\log q_{age}$ residuals for 2006-2012, the most recent period of the assessment interval when the survey indices declined and is assumed that M increased.

Run 1: $M_{2006\text{-}2012} = M_{cod\,2006\text{-}2012} + 0.1$

Natural mortality constant through ages but year dependent over the 2006-2012 interval, just as if the increase by cod predation 2006 onwards would basically impact the natural mortality of the species within the beaked redfish combo on an annual basis.

The estimates of cod consumption in numbers presented above can be used to calculate an extra natural mortality M_{cod} that would be added each year, between 2006 and 2012, to the standard M of 0.1:

1. Run a 1989-2012 XSA with M constant at 0.1, as if cod consumption is kept at the low level assumed to be already included in the standard M. Consider the population N_t at the beginning of each year t as the sum of individuals at age

$$N_t = \sum_{a=4}^{19} N_{a,t}$$

2. Then for each year t of the 2006-2012 interval the number of extra deaths D_t caused by the recent increase on cod consumption would correspond to

$$D_t = N_t - N_t e^{-M_{cod,t}}$$

3. Finally $M_{cod,t} = \ln\left(\frac{N_t}{N_t - D_t}\right)$ is added to the standard natural mortality of 0.1. Results are presented on Table 11.

The expanded natural mortalities are applied at each age and year of the 2006-2012 interval with the same criteria adopted on the 2011 assessment (on the former years 2006-2008 only the younger ages 4 to 6 were considered to be vulnerable to the increase on cod consumption).

Tuning had not converged after 70 iterations and $SS \log q_{age}$ record a maximum well above the runs with other M options (Table 12a, Fig. 7a).

Run 3: $M_{1989\text{-}2012} = 0.1$

Natural mortality constant through ages and over the entire interval, just as if the increase of cod predation 2006 onwards would basically impact golden redfish (*Sebastes marinus*), the species outside the beaked redfish combo.

Tuning converged before 70 iterations, but $SS \log q_{age}$ is the second highest of the sensitivity runs (Table 12a, Fig. 7a).

Run 2 and Run 4 to 6f: from $M_{2011\text{-}2012} = 0.4$ **down to** $M_{2011\text{-}2012} = 0.1$

Between 2010 and 2012 survey biomass and abundance of exploitable and spawning stock increased again along with a general increase of commercial catch from an average level of 4500 tons (2009-2010) to 7500 tons (2011-2012). Diminishing natural mortality, by easing the pressure of cod on redfish, could justify this most recent change of signal from the survey as regards the state of the stock (Table 8b, Fig. 6c and 6d). So one set of options to take into account on the sensitivity analysis is a $M_{2011\text{-}2012}$ somewhere between 0.4 (=previous $M_{2009\text{-}2010}$) and 0.1 (= constant $M_{\geq 2005}$).

A sequence of runs with $M_{2011\text{-}2012}$ falling from 0.4 to 0.1 pointed to 0.1 as the best option for natural mortality on the last couple of years, with a minimum $SS \log q_{age}$ residuals plateau for M between 0.125 and 0.1 (Table 11a, Fig. 7a and 7b).

The XSA_{2013} exploitable and 7 plus female biomass trends from the five natural mortality options between $M_{2006\text{-}2012} = M_{cod2006\text{-}2012} + 0.1$ and $M_{2011\text{-}2012} = 0.125$ are compared with the trends given by the survey and the standard M run, with all series standardized to the respective mean and unit standard deviation. The standardized trends for the runs between $0.200 \geq M_{2011-2012} \geq 0.125$ were very similar and in line with the survey story. The trends of the other three options, $M_{2006-2012} = M_{cod\,2006-2012} + 0.1$, $M_{2006-2012} = 0.40$ and $M_{1989-2012} = 0.1$, ignore what was going on through one of the two intervals to be considered on the last seven years of survey: first decline on 2006-2010, then stability and/or increase on 2011-2012 (Fig. 9a and 9b).

For $M_{2011-2012}$ between 0.125 and 0.1 the lowest natural mortality gave the best tuning. Nevertheless this return to $M = 0.1$ would imply that from 2011 onwards the impact of cod predation on either beaked redfish species would be again accommodated in the standard level assumed by the assessment before the start of the cod boom. This is a hypothesis far from being demonstrated by the ongoing predator-prey research regarding cod-redfish relationship on the Flemish Cap. That is why choosing the “best” XSA_{2013} fit with $M_{2011-2012} = 0.1$ could be an unrealistic light option leaving no room to a remaining extra level of cod pressure. That could only be justified by a clear improvement on the model performance leading to much more robust results. When looking at the key diagnostics of the six “best” XSA_{2013} runs (Table 12b and 12c, Fig. 8a and 8b) that seems not to be the case: $M_{2011-2012}$ going down from 0.125 to 0.1 turns on a minimal improvement on the diagnostics of the assessment.

On this sensitivity analysis, mean *log* catchabilities from the eleven options regarding 2006-2012 natural mortality present a common pattern of year effects on their $\log q_{age}$ residuals. This is illustrated on Fig. 10a and 10b with the $\log q_{age}$ bubble plots for the “worst option”, $M_{2006-2012} = M_{cod\,2006-2012} + 0.1$ against one of the “best options”, the one with a higher $M_{2011-2012} = 0.125$. Positive *log q* residuals dominate during the intermediate years of 1994-2001, while the on the first years, 1989-1993, there is a clear negative pattern, sometimes with very large residuals as it is the case of the 1983-1985 cohorts between 1989 and 1991. From 2002 onwards residuals are smaller on the “best option”, namely on 2011 and 2012, while the marked negative/positive pattern of the former intervals fades away.

Taking into account the results of the sensitivity analysis of the XSA_{2013} assessment, natural mortality at 0.4 was applied on ages 4-6 through 2006-2010, and extended to ages 7 plus on 2009 and 2010. It has been kept constant through all ages on 2011 and 2012, but with an overall decline to 0.125. The full diagnostics outputs for the chosen M option are presented on Table 13.

Retrospective Analysis

A 2013-2009 retrospective XSA was carried out for the patterns and magnitude of bias on the main results of recent assessments back in time (Table 14, Fig. 11). It covers a period of rapid and profound contrast on the dynamics of the stock, driven by year to year increases (and declines) on natural mortality and consecutive declines on recruitment at age 4. As regards exploitable biomass this retro XSA show no retrospective pattern, being this assessment very much in line with their immediate predecessors (2012-2011). Reverse retrospective patterns are observed on the 7 plus female biomass (under estimate) and average (6-16) fishing mortality (over estimate) but with small bias on the sequential estimates of both parameters even on recent years.

Retrospective Analysis is a useful check to consistency of stock trends between consecutive assessments. From the possible causes of retrospective patterns – patterns of catch misreporting, patterns in catchability or misspecification of natural mortality (Sinclair *et al*., 1990) – the last two causes seem to be the most likely causes of bias in this redfish assessment. With emphasis nowadays to changes on natural mortality not properly quantified and integrated in the analytical assessment. However, the adjustment of M over most recent years made by the sensitive analysis preceding the last and present assessment seems to improve both the magnitude and the pattern of retrospective bias.

Final considerations on the diagnostics

An “erratic” pelagic-demersal distribution, associated with schooling and longevity will always doom bottom survey dependent redfish analytical assessments to relatively poor diagnostics and more or less severe retrospective biases. Nevertheless, if the stock unit shows a clear dynamics and an apparently stable bottom-water column distribution, as it is the case for 3M beaked redfish over the 2000’s, the correspondent signals can generate consistent results over time without the help of the XSA statistical facilities commonly used to smooth ugly retrospective patterns. Despite year to year differences and recent changes on natural mortality, the assessment results present a sound retrospective pattern, as regards exploitable biomass, 7 plus female biomass and average fishing mortality. Being so, the final outcome of the 3M beaked redfish assessment turns out to be an acceptable alternative to the usual Scientific Council rule of thumb recommendation around catch averages or to no recommendation at all.

2013 XSA Results

Very high fishing mortalities until 1996 forced a rapid decline of abundance, biomass and female spawning biomass (Table 15, Fig. 12a: *4+ Biomass vs 4+ Abundance and 7plus Fembiomass vs FBar*). With low fishing mortalities since then the stock decline was halted. But the weak 1991-1999 year classes kept the stock size down till 2003, basically sustained by the survival and growth of the existing cohorts. Above average year classes coupled with low fishing mortalities allowed a rapid growth of biomass and abundance since 2003 that pushed the stock to a 2008-2009 high. Between 2009 and 2011 biomass and abundance of exploitable and 7 plus female stock went down for causes other than fishing. These declines were halted at well above average levels on the terminal year and, at least for biomass, there was some improvement on 2012.

The recruitment at age 4 increased from 2002 till 2006 and was kept at a high level until 2009, with 2005 year class as the most abundant year class of the assessment interval (Table 15, Fig. 12b). Recruitment to exploitable stock declined since then and is approaching the level of the weak year classes from the 1990’s.

The reproductive potential of the stock increased steadily from the late 1990’s to 2007, but has felled abruptly and continuously since then (Fig. 12a, *R/SSB plot*). The stock seems to have returned to the low productivity regime of the first half of the 1990’s. But in 2012 the proxy of SSB was kept well above average (see summary table on the bottom of Table 15) and well above the level that originated the high 2001-2006 recruitments (Fig. 12a, *SR plot*). Rather than the return to a low productivity regime, this apparent decline on reproductive potential reflects the actual small size of pre-recruited ages over depressed by cod related high natural mortalities, regardless the strength of the year classes they belong.

Regardless no apparent relationship between the size of the year classes at age 4 and the parental female stock biomass (Fig. 12a, *SR plot*), and the unavoidable negative impact of high M ’s prior the entry of young redfish in the exploitable stock, the main concern as regards the management of this stock is in the short term to keep female spawning stock biomass above the range of SSB’s that generated the good year classes of the 2000’s.

Stock projections

Short and medium term stochastic projections of female spawning stock biomass (SSB) under a gradient of *F status quo* percentages, together with SSB and yield medium term probability profiles under *F status quo*, 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 initial abundance for ages 5 and older, at the beginning of the first year of the projection interval (2013, given by the XSA survivors by the end of 2012) abide to a measure of uncertainty. It bootstraps recruitment (age 4) from the third to the tenth year of the projection (on the first two years of the projection, 2013 and 2014, recruitment is set at the 1989-2010 geomean). 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 were aggregated in two categories of files:

a. *.srr* file (Table 16a), assuming no stock recruitment relationship and with a random recruitment around the geo-mean of the 1989-2010 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 1989-2010 recruitments. The two last recruitments were excluded from average due to greater uncertainty of their estimate by the present XSA.

b. *.sen* sensitivity file (Table 16b), including the usual vectors needed to forward projections, with uncertainty associated to all vectors but natural mortality, which was fixed at 0.125 for all ages and years. Maturity ogive, as the 7 plus female proportions at age, stock and catch weights at age are the last three years averages with associated errors. The XSA survivors at age 5+ coupled with the geomean recruitment at age 4, are the basis to get the starting population at the beginning of 2013 (the same level of recruitment is assumed for 2014). Being the internal and external standard errors from XSA diagnostics (Table 13/ 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. Fishing mortality was kept constant through projections at $F_{statusquo}$, corresponding to the 2010-2012 $\bar{F}_{age}$.

There is a high probability that from 2006 onwards natural mortality has been the major force driving the beaked redfish stock dynamics, at levels above the traditionally 0.1 adopted on the assessment. Between 2010 and 2012 fishing mortality was rather unstable (Table 15, Fig. 12a *Femalebiomass vs FBar*), with an average level slightly below $F_{0.1}$ (from the most recent yield per recruit analysis with natural mortality at 0.1, Joanne Morgan *pers. comm.*, 2011). Nevertheless this average level of fishing mortality didn't put in jeopardy the positive signals given by the stock on the terminal year (halt of the stock decline/return to increase).

It is unpredictable if cod predation on beaked redfish will be kept at the moderate level suggested by the sensitivity analysis of the assessment for the last couple of years, or increase again. Furthermore it is also unpredictable if the actual pressure of cod predation on redfish pre recruited ages will ease in a foreseen future, allowing some recovery from the depressed size that recruitments are entering the exploitable stock. So, despite the availability of medium term stochastic projections, only the results for the next two coming years will be taken into consideration.

As it was documented on last assessment STACFIS Report (NAFO, 2011) $F_{0.1}$ is an unacceptable management option at the current beaked redfish stock status: a $F_{0.1}$ management option is supported by the results of a yield per recruit analysis and will always be dependent on the magnitude of the underlying natural mortality. The yield per recruit analysis assumes that their key input parameters are representative of a long term equilibrium status of the stock. If a $F_{0.1}$ is to be used on short term projections it should be derived from a yield per recruit analysis where key input parameters are at the same time representative of the stock on the long term and can be accepted to fit to the stock at present. This is not the case for beaked redfish nowadays where is very difficult to reconcile the existing gap between the long term and the actual natural mortality or maturity at age within a revisited beaked redfish yield per recruit analysis that will not undermine its principles and end up with a meaningful $F_{0.1}$.

On the short term lowering fishing mortality bellow $F_{statusquo}$ will have little impact on the stock status, while increasing fishing mortality above $F_{statusquo}$ is not a precautionary response to M uncertainty and low income of most recent recruitments. Taking into account these considerations fishing mortality was kept through projections at $F_{statusquo}$, corresponding to the average 2010-2012 $\bar{F}_{age}$.

The results of the *Mterm* projections (Table 17a and 17b, Figures 13a, 13b and 13c) predict that fishing at $F_{statusquo}$ will accommodate on the short term, and with a high probability associated, a 7 plus Female Biomass at a high level beyond 60,000 tons, a level only observed on the first years of the assessment interval. Obviously this high probability holds if the predicted 2014 and 2015 yield is taken from the lowest probability profile of the yield stochastic projections and if the moderate natural mortality assumed to have occurred in 2011-2012 continues in place at present and on the next coming years. Fishing at $F_{statusquo}$ will result on an average annual catch of 8,561 tons in 2014 and 2015.

According to 2011-2012 observed catch data from the Portuguese, Spanish and Russian National Sampling Programmes on board, a beaked redfish annual catch of 8,561 tons would roughly correspond to an overall 3M redfish catch (including the shallower golden redfish catches) of 10,800 tons.

Conclusions

The stock decline on 2009-2011, earlier detected by the EU survey, is halted on 2012 and, in terms of biomass, exploitable and 7 plus female stock shown a reversing trend to moderate increase on last year. With catch at low levels for more than a decade and a half, and after increasing since 2003 due to the income of consecutive good year classes (2001-2006), the stock decline could only reflect the declines foreseen by the survey if natural mortality was allowed to suffer an important increase since 2006, first just over the younger ages and later on covering the full age spectrum. The most likely cause of such sudden shift downwards on the beaked redfish stock size would be depletion by cod. Sensitivity analysis prior to the present assessment point out to a likely reduction of such depletion on the last couple of years, foreseen by a reduction on natural mortality to a level "close to normality". Nevertheless the year class strength at age 4 continues to decline despite female spawning biomass stand still at a high level, suggesting that cod pressure on redfish pre recruited ages is likely to be kept at the high level of the late 2000's.

Keeping on 2014 and 2015 fishing mortality at its present low level will sustain on the short term a high level of female spawning biomass. But on the long term it will be natural mortality to determine the future of beaked redfish as a fishery resource.

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Table 1a: 3M Redfish nominal catches (ton) by country, 1989-2012.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011[1]	2012[2]
CAN			2		10							5											2	
CUB	1765	4195	1772	2303	945						2												875	600
DDR		4025																						
GRL				1		26	4	2		2		11												
JPN	885	2082	1432	1424	967	488	553	678	212	439	320	31	80	67	98	209	483	383	613	603				
SUN/RUS	13937	34581	24661	2937	2035	2980	3560	52		7	108	1864	1281	1155	115	6	1023	849	780	1212	1184	927	1571	1720
UKR															5	3		1						
E-LVA				7441	5099	94	304					13	11			2	48	250			58		71	
E-LTU					2128									10	1		522	397	542			348	478	
E-EST						47	863	13				631	158	5	23	60	1093	1249	728	950	1643	1161	820	
E-SP	213	2007	6324	3647	100	610	165	113	129	262	268	348	272	220	633	266	542	596	533	1225	745	892	339	512
E PRT	13012	11665	3787	3198	4781	5630	1284	281	83	259	97	925	1590	1513	1113	2574	2696	2594	2357	3707	5027	4703	5024	3162
EU																								492
FR-STP										2							10			8			68	69
UK																						1	2	
KOR-S	17885	8332	2936	8350	2962																			
FAROE IS.				16			15	1						6		6				215	1	122	420	148
NORWAY						8																		9
Total	47697	66887	40914	29317	19027	9883	6748	1140	423.8	970.7	795	3828	3392	2976	1988	3126	6417	6319	5553	7920	8658	8154	9670	6712

Table 1b: Redfish commercial catches on Div. 3M from various sources (STACFIS, 1989-2010; based on STALANT, 2011 and 2012).

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total	58100	81000	48500	43300	29000	11300	13500	5789	1300	971	1068	3658	3224	2934	1881	2923	6550	7156	6662	8465	11317	8496	11121	7629

Table 1c: Beaked redfish on Div. 3M commercial catch estimates from various sources (STACFIS, 1989-2010; based on STALANT, 2011 and 2012).

From 2005 onwards also using information on distribution by depth of the EU survey catch (D. Gonzalez pers. comm.) and of the commercial catch of Portugal, Russia (M. Pochtar *pers.comm.*) and Spain (F. Gonzalez *pers. comm.*)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total	58100	81000	48500	43300	29000	11300	13500	5789	1300	971	1068	3658	3224	2934	1881	2923	4148	5997	5149	4277	3656	5410	8994	5910

Table 1d: Percentage of beaked redfish found in the EU survey redfish catch (*excluding juveniles; redfish beyond 700m depth is 100% S. mentella*) (Diana González *pers. comm.*).

<200m	2005	2006	2007	2008	2009	2010	2011	2012	**200-300m**	2005	2006	2007	2008	2009	2010	2011	2012
golden	36.1	51.1	97.9	100.0	100.0	100.0	90.0	96.5	golden	54.5	50.7	32.4	68.3	84.9	68.3	52.9	63.5
beaked	63.9	48.9	2.1	0.0	0.0	0.0	10.0	3.5	beaked	45.5	49.3	67.6	31.7	15.1	31.7	47.1	36.5

300-400m	2005	2006	2007	2008	2009	2010	2011	2012	**400-700m**	2005	2006	2007	2008	2009	2010	2011	2012
golden	18.8	5.9	12.0	28.5	22.0	28.5	3.7	5.5	golden	2.1	5.0	1.3	8.8	0.9	8.8	0.6	0.0
beaked	81.2	94.1	88.0	71.5	78.0	71.5	96.3	94.5	beaked	97.9	95.0	98.7	91.2	99.1	91.2	99.4	100.0

Table 1e: Redfish by-catch in weight (ton) from the 3M shrimp fishery, 1993-2005 (Kulka, D. and J. Firth *pers. comm.*)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
By-catch in weight (ton) [2]	11970	5903	374	550	157	191	96	106	738	767	1006	471	80

Table 1f: 3M Redfish catch in numbers(millions), 1989-2008.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Comm.	125.3	196.3	104.2	94.1	49.2	24.6	34.9	15.5	3.0	2.2	2.3	9.6	8.5	9.1	4.6	12.5	12.5	28.2	16.1	15.3	11.6	24.4	28.8	16.4
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	1.8							
Total	125.3	196.3	104.2	94.1	173.7	87.5	39.0	30.7	6.2	7.4	6.1	12.8	37.6	28.9	26.4	22.4	14.4	28.2	16.1	15.3	11.6	24.4	28.8	16.4

[1] From STATLANT 21A.

[2] From STATLANT 21A and NAFO Circ. Letters.

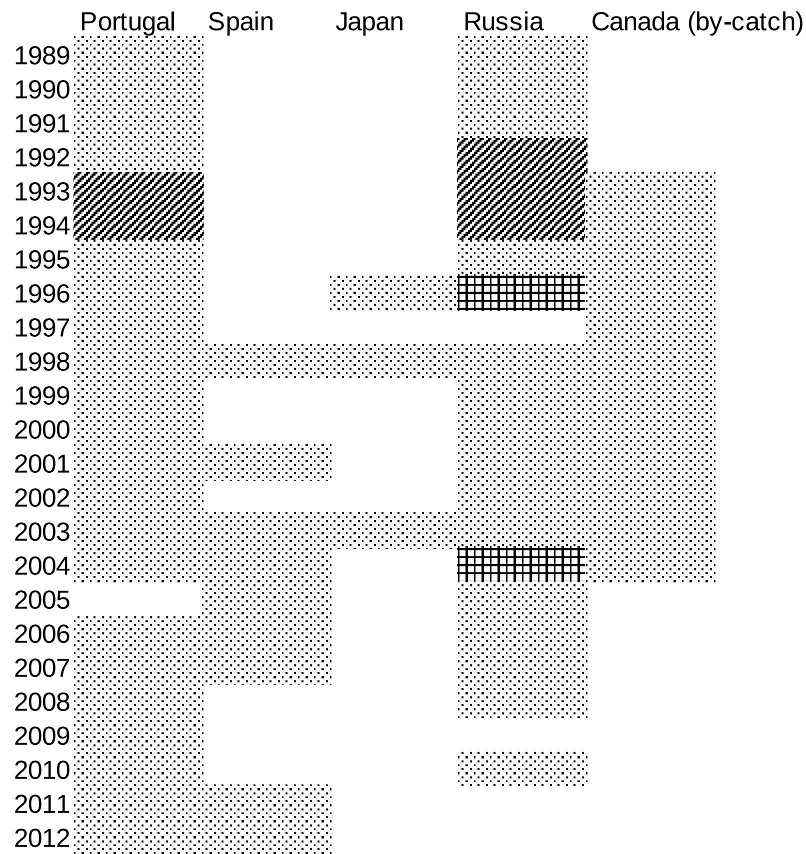
Table 2a: Length weight relationships
for 3M beaked redfish from commercial catch
(Alpoim,2004; Vargas, 2005, 2007-2011 and 2013)

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
2006	0.0096	3.1176
2007	0.0100	3.1018
2008	0.0407	2.6452
2009	0.0120	3.0635
2010	0.0145	2.9911
2011		
2012	0.0323	2.7743

Table 2b: Length weight relationships for 3M beaked redfish from EU survey (Troncoso and Casas, *pers. comm. 2005-2013*)

	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
2005	0.015	2.974	0.012	3.061	0.011	3.088
2006	0.011	3.069	0.012	3.066	0.011	3.088
2007	0.010	3.119	0.016	2.996	0.014	3.026
2008	0.019	2.921	0.016	2.983	0.020	2.902
2009	0.012	3.067	0.016	2.983	0.015	3.004
2010	0.013	3.021	0.024	2.850	0.018	2.925
2011	0.015	2.973	0.023	2.875	0.021	2.893
2012	0.016	2.960	0.024	2.861	0.021	2.886

Table 3a: Availability of length data for commercial catches and by-catch of 3M beaked redfish, 1989-2013



available length data

derived from the length composition of the 1993-1994 beaked redfish EU survey abundance (Portugal)
or
derived from the length composition of the 1992-1994 beaked redfish EU survey abundance (Russia)

assumed as by-catch of Russian Greenland halibut fishery with the same length composition of EU commercial bottom trawl.

Table 3b: Length composition (absolute frequencies in'000s) of the 3M redfish commercial catch, 1989-2012.

Length	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
10	3													10			3	16	12					7
11				1	3									48		1	18	40	41			3	1	9
12	3			1	7							5		220		3	108	86	133		1	9	3	23
13	11				5							11		723		5	381	70	172		5	28	27	36
14	25	4			40	4						1		590		12	509	91	88		5	99	87	69
15	8	73		1	120	15				2		6	4	175		43	474	112	23	6	37	248	209	95
16	30	190		4	167	66		20				1	4	70		203	516	313	18	14	68	341	309	122
17	59	724		3	55	244		20	1	2		6	20	53	6	352	423	436	31	12	102	481	352	162
18	30	2489	156	6	39	607	118	20		1		17	57	84	6	464	285	635	138	47	121	669	586	222
19	11	5774	647	97	54	922	265	66	6	8	1	27	41	144		666	183	1296	433	166	147	912	806	388
20	111	6179	1331	418	71	491	1142	360	8	13	1	50	43	187		**1165**	157	2168	371	381	226	1559	1452	709
21	383	2904	1234	1987	125	427	2874	964	14	28	1	48	63	173	2	**1513**	132	**3104**	658	622	308	**2254**	**2130**	**1038**
22	1149	1205	1179	3834	337	408	5895	**2215**	41	52	2	103	117	166	4	**1512**	159	**3939**	490	1032	535	**3696**	**3198**	**1637**
23	3766	1927	945	3016	668	457	5715	**1641**	104	94	1	112	197	175	30	**961**	216	**3658**	720	794	869	**3261**	**2778**	**1496**
24	8408	5526	1697	1690	1116	701	1691	**1324**	**263**	116	9	206	277	284	89	845	287	**3179**	760	1198	981	1671	1543	755
25	**14733**	**11932**	3737	2468	1159	870	1157	785	**325**	**222**	118	317	451	414	262	720	555	2261	947	787	**1257**	1151	990	533
26	**14793**	**19979**	6292	7519	1577	1020	793	513	**310**	**223**	112	717	891	511	363	571	724	1427	**1471**	**1760**	**1266**	848	821	500
27	**11148**	**25688**	**10368**	**11599**	1701	986	953	740	198	**207**	220	**1322**	**1241**	672	**516**	596	**927**	1181	**1876**	**2050**	**1145**	775	774	389
28	7059	**26047**	**12852**	**11899**	2456	1688	1185	758	169	173	**303**	**1654**	**1450**	**854**	**535**	553	**1057**	1058	**1405**	**2306**	**1086**	886	963	538
29	5773	**20113**	**15100**	8677	2448	**2039**	**1476**	855	210	168	**301**	**1467**	**1193**	**841**	**588**	426	**1111**	779	**1348**	1244	877	870	1115	598
30	7424	**15200**	**13056**	7505	3277	**1987**	**1506**	899	248	162	191	**1036**	996	**814**	475	384	779	619	**1350**	692	590	838	**1802**	1008
31	6972	**10134**	7456	5452	**3846**	**2327**	**1257**	954	223	172	204	677	537	625	390	269	770	444	998	437	596	627	**1886**	**1181**
32	7393	8308	7054	4705	**3974**	**2611**	**1304**	891	248	157	242	451	339	463	359	304	525	353	850	272	434	500	**2230**	**1463**
33	7030	6551	3519	4150	**4831**	1963	1219	689	268	112	169	321	210	366	331	319	543	262	639	311	300	398	**1969**	**1327**
34	6927	6397	3891	4309	**4283**	1347	1008	672	107	74	75	300	146	221	258	204	527	193	463	208	216	234	1018	677
35	6520	5486	3101	4286	**3737**	1154	1035	281	76	54	136	187	77	111	200	111	536	169	312	59	156	181	587	404
36	4920	4398	2620	3104	3474	776	1041	198	43	47	72	151	38	70	94	76	412	124	162	230	88	101	372	282
37	4080	3047	2394	2336	2914	404	915	220	24	46	65	150	31	26	47	53	105	47	33	105	64	57	265	176
38	2441	2206	1672	1582	1753	366	749	103	27	33	7	113	37	18	16	50	25	36	28	158	44	34	222	187
39	1566	1557	1748	1343	2453	328	488	125	11	29	30	56	17	14	8	31	25	15	34	59	14	2	137	87
40	946	769	1024	917	1151	191	469	45	3	16	2	34	10	7	2	33	7	14	5	137	5	4	108	97
41	504	581	640	522	517	105	346	38	12	11	4	26	5	1		41	34	17	16	65	4		50	80
42	341	345	201	214	476	37	164	46	5	8		19	6	2		14		11	6	61	2		**19**	25
43	289	264	283	237	118	10	69	18	1	3	1	25	3	5	2	18		11	3	52	1		**9**	19
44	135	130	19	172	170	9	50	3	6	2		14	2			12		4	8	26	2		20	21
45	143	73	14	39	26	9	34	2	1		2	3	1		1	6		3	3	5	2			0.3
46	75	32	8	9	17		7	4	1	1		10	1			5		4	5	20			2	
47	46	16			17		19	1	1			6						1		7	1			
48	28	12	8	17			4						1			1		1		10				
49	4	12																1	3					
50	11	4						27											8					13
51	4	12																						0.4
52	4																							
53	7	16																1	2					
54		8																						
55		4																						
56																								
57																								
58		4																						
59																								
60																								
61									11															
mean weight (g)	464	413	465	460	590	460	386	374	438	435	471	379	379	321	410	250	331	213	321	279	316	222	312	361
mean length (cm)	30.1	28.8	30.2	30.0	32.9	29.8	27.6	27.6	29.5	29.4	30.9	29.6	28.6	25.6	30.2	24.6	26.6	24.0	27.5	27.6	27.1	24.3	26.9	27.7

Table 3c: Length composition (absolute frequencies in'000s) of the 3M redfish total annual catch, 1989-2012 (including redfish by-catch in the 3M shrimp fishery, 1993-2004).

Length	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
5												3	9	10	55	14								
6								147	1	3	15	5	200	60	246	95								
7							5	4306	105	109	115	59	534	381	601	182								
8							7	2412	127	248	550	123	1486	668	1131	242								
9							5	211	71	40	812	55	4218	538	1432	355								
10	3						3	416	258	45	845	193	6537	888	1454	593	3	16	12					7
11				1	3		15	1056	569	391	390	593	6275	1655	913	1055	18	40	41			3	1	9
12	3			1	9	19	36	841	512	1830	313	1011	4996	3205	1368	1498	108	86	133		1	9	3	23
13	11			0	29	338	34	459	164	1721	286	761	2126	5809	2741	1229	381	70	172		5	28	27	36
14	25	4		0	257	979	64	488	120	340	97	182	746	4660	2546	1093	509	91	88		5	99	87	69
15	8	73		1	1998	2232	247	731	119	63	90	90	531	1946	1886	1022	474	112	23	6	37	248	209	95
16	30	190		4	7682	7312	430	1713	647	116	86	50	522	865	1994	999	516	313	18	14	68	341	309	122
17	59	724		3	29380	17576	758	1182	184	85	62	22	453	430	2513	987	423	436	31	12	102	481	352	162
18	30	2489	156	6	47422	21654	1105	758	61	32	41	27	339	339	1751	815	285	635	138	47	121	669	586	222
19	11	5774	647	97	30110	11939	1086	444	68	34	39	35	146	297	657	927	183	1296	433	166	147	912	806	388
20	111	6179	1331	418	6815	2807	1569	428	85	19	14	60	89	265	224	1398	157	2168	371	381	226	1559	1452	709
21	383	2904	1234	1987	1117	745	3001	1058	75	39	7	52	91	209	183	1690	132	3104	658	622	308	2254	2130	1038
22	1149	1205	1179	3834	697	521	5922	2220	82	65	9	105	142	186	93	1588	159	3939	490	1032	535	3696	3198	1637
23	3766	1927	945	3016	669	457	5722	1641	126	102	6	114	210	187	80	988	216	3658	720	794	869	3261	2778	1496
24	8408	5526	1697	1690	1116	701	1694	1324	273	135	11	208	288	290	108	857	287	3179	760	1198	981	1671	1543	755
25	14733	11932	3737	2468	1159	870	1162	785	328	237	122	317	455	417	272	727	555	2261	947	787	1257	1151	990	533
26	14793	19979	6292	7519	1577	1020	798	513	311	243	112	719	893	513	364	574	724	1427	1471	1760	1266	848	821	500
27	11148	25688	10368	11599	1701	986	957	740	198	217	223	1322	1242	672	517	597	927	1181	1876	2050	1145	775	774	389
28	7059	26047	12852	11899	2456	1688	1192	758	169	174	303	1654	1451	855	536	553	1057	1058	1405	2306	1086	886	963	538
29	5773	20113	15100	8677	2448	2039	1483	855	210	169	301	1467	1194	841	589	426	1111	779	1348	1244	877	870	1115	598
30	7424	15200	13056	7505	3277	1987	1509	899	248	162	191	1036	996	815	475	384	779	619	1350	692	590	838	1802	1008
31	6972	10134	7456	5452	3846	2327	1258	954	223	172	204	677	537	626	390	270	770	444	998	437	596	627	1886	1181
32	7393	8308	7054	4705	3974	2611	1304	891	248	158	242	451	339	464	359	304	525	353	850	272	434	500	2230	1463
33	7030	6551	3519	4150	4831	1963	1219	689	268	112	169	321	210	366	331	319	543	262	639	311	300	398	1969	1327
34	6927	6397	3891	4309	4283	1347	1008	672	107	75	75	300	146	221	258	204	527	193	463	208	216	234	1018	677
35	6520	5486	3101	4286	3737	1154	1035	281	76	54	136	187	77	111	200	111	536	169	312	59	156	181	587	404
36	4920	4398	2620	3104	3474	776	1041	198	43	47	72	151	38	70	94	76	412	124	162	230	88	101	372	282
37	4080	3047	2394	2336	2914	404	915	220	24	46	65	150	31	26	47	53	105	47	33	105	64	57	265	176
38	2441	2206	1672	1582	1753	366	749	103	27	33	7	113	37	18	16	50	25	36	28	158	44	34	222	187
39	1566	1557	1748	1343	2453	328	488	125	11	29	30	56	17	14	8	31	25	15	34	59	14	2	137	87
40	946	769	1024	917	1151	191	469	45	3	16	2	34	10	7	2	33	7	14	5	137	5	4	108	97
41	504	581	640	522	517	105	346	38	12	11	4	26	5	1		41	34	17	16	65	4		50	80
42	341	345	201	214	476	37	164	46	5	8		19	6	2		14		11	6	61	2		19	25
43	289	264	283	237	118	10	69	18	1	3	1	25	3	5	2	18		11	3	52	1		9	19
44	135	130	19	172	170	9	50	3	6	2		14	2			12		4	8	26	2		20	21
45	143	73	14	39	26	9	34	2	1		2	3	1		1	6		3	3	5	2			
46	75	32	8	9	17		7	4	1	1		10	1			5		4	5	20			2	
47	46	16			17		19	1	1			6						1		7	1			
48	28	12	8	17			4						1			1		1		10				
49	4	12																1	3					
50	11	4						27											8					13
51	4	12																						
52	4	0																						
53	7	16																1	2					
54		8																						
55		4																						
56																								
57																								
58		4																						
59																								
60																								
61									11															
number ('000)	125310	196321	104246	94117	173677	87505	38979	30697	6180	7385	6051	12800	37620	28932	26441	22436	12515	28179	16062	15333	11556	22735	28842	16379
weight (ton)	58100	81000	48500	43300	40970	17203	13874	6339	1457	1162	1164	3764	3962	3701	2887	3612	4148	5997	5149	4277	3656	5056	8994	5910

Table 3d: Catch in numbers at age (' 000) of 3M redfish, 1989-2012, including redfish by-catch in the shrimp fishery (1993-2004).

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+	Total	Most abundant year class
1989	0	16	136	444	1057	7890	22978	24054	14508	9716	8792	6213	6366	5883	5199	2965	2122	1969	5003	125310	1981
1990	0	0	5996	10382	2773	5860	28741	47007	32291	18415	11643	6614	5940	5430	4449	2543	1888	1788	4562	196321	1982
1991	0	0	0	1229	3592	6929	18141	22725	16867	8491	6503	4808	3967	2888	1102	1648	1270	780	3305	104246	1983
1992	0	0	0	237	5234	7018	16988	18149	11681	7422	5608	4455	4286	3302	2952	1953	1189	746	1730	92949	1984
1993	0	274	3805	110773	10414	3064	3409	4557	2101	3936	5178	5512	4547	4665	3554	2092	1666	2614	1514	173677	1989
1994	0	755	5135	53804	6411	1630	2399	2522	2550	2819	2521	1956	1459	856	969	460	320	390	551	87505	1990
1995	16	84	979	2770	13324	5399	1889	2423	1554	1471	1869	1137	966	927	1070	833	482	548	1239	38979	1990
1996	7075	2966	2288	1632	3546	4635	1402	1399	1431	983	767	733	393	404	283	202	135	133	289	30697	1995
1997	563	1216	490	692	144	595	800	272	285	322	219	194	98	119	27	28	30	10	76	6180	1995
1998	445	3678	810	109	59	109	285	706	422	69	76	355	45	50	12	33	66	4	52	7385	1996
1999	2337	998	228	151	43	16	70	258	593	367	81	114	263	39	78	79	69	105	147	6037	1998
2000	438	2400	254	89	130	204	387	1018	1436	4211	657	170	71	608	64	38	34	38	558	12804	1990
2001	12984	13397	1805	828	337	386	842	1303	869	856	3229	381	117	62	65	60	19	29	61	37630	1999
2002	2545	11722	6220	1435	350	478	554	854	1009	530	642	1819	337	109	157	57	50	9	54	28932	2000
2003	4920	6570	6494	1712	1946	281	391	546	565	423	365	311	1222	214	22	102	69	23	266	26441	2001
2004	1482	4520	2996	1013	4104	2581	1564	999	611	379	268	203	254	953	19	83	46	19	342	22436	2002
2005	3	1228	891	611	311	683	875	1264	1462	1122	820	860	423	418	1240	126	75	21	84	12515	1996
2006	16	407	617	2031	4853	8382	5584	2388	1250	521	395	242	191	179	198	725	80	9	112	28179	2000
2007	12	345	161	442	782	824	4237	2165	2063	630	784	763	347	322	246	1106	505	32	296	16062	2000
2008	0	5	31	246	723	2619	2553	2934	2426	1095	592	380	226	221	128	120	130	436	467	15333	2000
2009	0	66	163	434	468	1419	1613	1645	1455	1452	741	453	136	304	53	110	35	147	862	11556	2001
2010	0	1118	1097	2735	5422	4200	3570	981	715	1017	1383	557	506	247	70	120	66	42	579	22735	2005
2011	84	435	801	3354	3677	4247	2133	1028	873	1848	1831	2655	684	682	1122	1108	401	372	1511	28849	2005
2012	82	275	270	1224	2037	2027	1458	808	344	251	612	1096	2012	968	636	365	106	47	1767	16385	2007

Table 3e: Weights at age in the catch and by-catch (Kg) of 3M redfish, 1989-2012.

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		0.065	0.094	0.114	0.152	0.248	0.325	0.406	0.444	0.480	0.556	0.595	0.652	0.710	0.737	0.901	0.868	0.885	1.096
1994		0.057	0.098	0.109	0.145	0.267	0.316	0.393	0.436	0.509	0.543	0.583	0.609	0.702	0.691	0.745	0.844	0.868	0.902
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	0.069	0.124	0.167	0.237	0.284	0.349	0.332	0.439	0.518	0.659	0.557	0.492	0.662	0.720	0.761	0.817
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	0.066	0.115	0.165	0.227	0.265	0.328	0.359	0.423	0.491	0.450	0.577	0.601	0.623	0.703	0.643	0.866	0.877
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	0.131	0.174	0.223	0.274	0.338	0.377	0.456	0.513	0.558	0.445	0.610	0.681	0.586	0.724	0.897
2005	0.017	0.042	0.065	0.088	0.114	0.184	0.252	0.294	0.349	0.384	0.476	0.508	0.519	0.638	0.598	0.692	0.693	0.878	0.932
2006	0.015	0.037	0.073	0.102	0.137	0.172	0.215	0.279	0.349	0.400	0.443	0.447	0.537	0.573	0.626	0.460	0.625	0.842	1.024
2007	0.015	0.028	0.050	0.107	0.130	0.146	0.251	0.277	0.354	0.392	0.453	0.493	0.515	0.527	0.538	0.441	0.547	0.701	0.757
2008	0.000	0.058	0.082	0.113	0.135	0.172	0.219	0.260	0.289	0.316	0.360	0.381	0.402	0.489	0.514	0.540	0.563	0.457	0.786
2009	0.000	0.059	0.078	0.155	0.140	0.212	0.233	0.267	0.326	0.351	0.450	0.370	0.538	0.475	0.531	0.506	0.708	0.626	0.566
2010	0.000	0.064	0.094	0.122	0.155	0.180	0.221	0.276	0.310	0.358	0.392	0.442	0.492	0.501	0.530	0.575	0.497	0.529	0.589
2011	0.041	0.057	0.080	0.133	0.152	0.183	0.208	0.299	0.327	0.433	0.430	0.481	0.385	0.455	0.468	0.551	0.597	0.483	0.722
2012	0.040	0.068	0.095	0.138	0.170	0.202	0.244	0.289	0.337	0.396	0.410	0.493	0.506	0.494	0.550	0.607	0.623	0.463	0.673

Table 4: Maturity parameters of the three species of the genus *Sebastes* in Flemish Cap (*S. fasciatus* , *S. mentella* and *S. marinus*) for 1994, 1999, 2011 and 2012.

Year	**1994**			**1999**			**2011**			**2012**			**1994-2012**
Specie	α	β	L_{50} (cm)	α	β	L_{50} (cm)	α	β	L_{50} (cm)	α	β	L_{50} (cm)	ΔL_{50} (cm)
S. fasciatu	-14.43	0.4787	30.1	-19.91	0.7505	26.5	-8.44	0.441	19.1	-20.11	1.1153	18	12.1
S. mentell	-14.43	0.4787	30.1	-10.87	0.3692	29.4	-27.92	1.3561	20.6	-21.8	1.0704	20.4	9.7
S. marinus				-17.72	0.5247	33.8	-11.48	0.5325	21.6	-8.86	0.4703	18.8	15

Table 5a: 3M beaked redfish abundance at length ('000s) from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2012 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	2005	2006	2007	2008	2009	2010	2011	2012
5											2868														
6		73	239	1042				144			956			455	1091	779					136	54	61	71	73
7	1203	160	1952	39644	4931	1102		31	2453		695	291		1240	9720	6940	286	499	304	1547	573	477	544	725	646
8	8538	1890	15439	194701	117561	3160		594	12310	1359	3390	2417	1883	18643	14581	10410	12530	5985	94129	26849	5315	2640	3263	3498	3578
9	8327	2007	11861	90135	75875	1764		1816	6548	2887	6048	12420	6848	152327	44733	31940	69454	8679	410980	214426	4271	5731	6535	7592	7766
10	7082	2894	846	9088	57005	7812	274	1889	867	1615	1573	8840	5242	246451	53017	37818	181225	11172	569937	471628	5446	3386	3861	4517	4589
11	20338	8434	412	17232	332037	36153	1573	3397	1762	4312	2626	3052	4412	29300	52317	37322	178289	47283	83653	269398	21536	5348	6099	7137	7248
12	39345	20228	390	18876	381332	46734	2665	9269	5827	12810	13751	2976	15579	9424	115720	82575	306313	109207	93826	255837	62810	7229	8244	9639	9797
13	27472	21581	1062	5790	90012	29392	5209	4666	5993	14318	22307	4851	30605	16454	247642	176520	217455	305354	168066	460809	135178	7342	7478	8322	8074
14	4000	46259	1865	1174	16174	79964	25338	4768	8609	7064	11124	4639	18860	19286	292527	206474	109487	563721	368890	359968	146220	14300	13152	17863	15660
15	802	87282	2527	1706	27540	165019	58046	9835	16820	13161	14504	19442	6447	31061	99677	63031	59669	496389	570816	235990	109149	37040	23025	35188	36259
16	1034	71271	6765	8180	41045	138724	130198	24357	14379	23773	29969	39114	4277	71951	73453	45579	93021	321931	705419	132602	150419	74563	31410	47556	54358
17	1499	22119	15552	25997	9939	29763	219435	64809	23877	29710	20988	26097	8270	56570	59348	29838	130177	216267	1022160	204730	200256	106859	35142	33445	53159
18	1140	3665	17573	47123	7593	9245	230202	110934	54208	30013	13414	32861	19781	22594	72239	31830	155247	199060	785217	363584	236520	147862	63068	35483	53830
19	4032	2167	10349	74331	14615	4970	121884	144384	108902	36047	14029	29489	27898	12501	74283	37393	179357	182684	502051	489233	195040	182429	88904	55002	45709
20	7430	3097	2514	83897	24467	3328	33879	100682	153048	68928	13962	20335	29190	18149	55461	32007	156658	169721	357550	396759	241170	274446	108084	108351	56535
21	16559	4479	1078	40486	46504	3306	16450	38742	135158	101923	18530	14731	24042	24890	28013	24617	86575	163284	189221	256720	256356	244424	138243	158592	85648
22	33994	9816	3011	10581	70167	5125	8472	9863	83283	98256	33310	17528	21181	25754	23745	16788	48011	179265	120687	144663	241869	209744	150168	160054	170639
23	68369	18570	10028	3744	51568	7222	7632	3978	37902	62655	56319	29378	18209	17298	19916	14445	29273	132897	99934	101176	141913	137275	112686	134422	229288
24	102943	33229	13236	3855	23847	8078	9824	3261	17322	24171	57007	61585	29389	15498	21186	26716	18368	81899	76563	71205	106627	138138	74872	101986	207034
25	108959	50665	28825	7720	10049	5812	11309	3704	7875	9733	33609	75417	54137	14734	16263	52455	11706	41610	57756	42237	61464	93215	61323	58822	138854
26	79514	60423	42888	9638	12417	5431	9941	4600	4102	5921	14895	57490	76085	18293	14695	74506	11260	32227	25060	38613	45511	49136	37645	31084	89036
27	33899	49923	41939	9642	16819	4256	6971	4265	5830	4280	5807	20106	78418	17465	13793	77547	8280	18476	13669	25283	31512	37652	24648	20314	44921
28	13963	31600	28902	8402	18154	4326	8135	4642	4150	3998	2710	6614	54137	13151	12150	53878	7280	12570	8322	13766	20128	19937	16266	12887	24186
29	6818	17451	16287	5836	12743	3066	6925	4694	4325	2790	1258	2472	21494	7232	9235	20825	5204	8890	5071	8331	10536	19353	10922	6369	14517
30	9150	10747	9819	4833	11009	2882	4765	4493	2995	3195	828	804	4582	5003	5643	4343	3753	7874	5648	9541	3737	6364	6414	3902	10679
31	7567	8245	7209	3513	7557	2362	3995	3479	2489	1977	959	701	1715	1439	2210	1384	2651	3273	2393	3284	5765	4025	2468	2551	6786
32	8886	9234	6686	3034	4866	1882	3611	2792	2280	1514	762	652	890	782	818	510	1835	2954	1722	2100	1171	2631	1586	1917	4326
33	8570	6908	5710	3287	4450	2012	2463	2304	2050	1291	619	470	1120	337	572	1097	1132	1085	1340	3374	1034	2360	1450	1031	4062
34	7451	6529	6333	3279	4276	1660	1613	1897	1410	981	517	401	578	405	286	630	762	736	479	909	371	175	572	383	2266
35	5646	6544	4312	2567	3486	1536	1468	1591	948	590	293	347	382	199	122	305	323	310	383	238	312	1587	151	21	721
36	4929	5410	3975	2295	2635	1518	1039	1441	757	544	310	221	388	161	113	363	166	174	192	71	29	563	60	21	693
37	3631	3912	3065	1811	2014	1425	590	1205	568	305	194	134	357	67	68	320	108	29		20	29	249	50	21	322
38	3166	2501	2223	1488	1620	904	549	717	402	212	142	81	67	80	54	58	98	29	96	10	39	46	30	11	
39	3092	4145	2425	1739	2156	1392	520	932	471	212	168	78	131	67	27	131		19			29	46	101		171
40	2090	2908	1634	1079	1410	831	379	493	266	143	65	39	87	27	14	87			95	10	20	1657			
41	1499	1192	842	471	586	378	225	433	243	124	77	26	44	54	14	44	10				10	37		10	
42	665	742	421	367	426	362	84	313	162	37	26	26		13	14						10		10		
43	253	291	253	179	165	103	28	156	69	0	65	13	29	40	14										
44	84	87	51	53	165	168	28	36	23	25	26		15			15									
45	84	87	67	53	45	26	28	36	23		13	26													
46		58	17	53	30	26		36			13						10								
47			34	11		26		12																	
48						39			12																
total	664025	638823	330614	748931	1509292	623284	935746	581692	730719	570876	400725	496163	566768	869393	1434771	1201521	2085973	3325555	6341632	4604910	2442512	1838324	1038539	1068786	1391429

Table 5b: 3M beaked redfish abundance at age ('000s) from EU bottom trawl survey series, 1989-2012.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+	Total	Most abundant year class
1988	18068	94236	10657	19600	28673	105880	172047	106189	37983	18147	11580	7031	6836	6017	5102	2919	2365	2162	8533	541062	1981
1989	4130	53137	219406	19357	8071	35188	89946	89433	43605	21698	12392	7202	6537	5939	5301	3013	2467	2189	9812	638823	1986
1990	29489	2710	33397	24565	2605	17585	56217	67444	36082	18378	10186	5630	5333	4816	4009	2318	1851	1730	6269	330614	1982
1991	325523	51145	5421	154995	127962	17655	20481	13300	8086	4187	3884	3393	3014	2479	952	1514	1139	653	3155	748938	1990
1992	198367	866124	59802	58014	144968	71881	30456	26346	16857	9630	6011	4452	4062	3082	2852	2072	1258	1028	2031	1509292	1990
1993	6025	151086	90620	306049	10455	21648	10476	6426	2189	2996	2596	2453	1910	2000	1589	859	874	1414	1619	623284	1989
1994	0	20065	76102	677611	79504	22080	22594	11375	7515	4950	3935	2808	2105	1122	1257	657	482	616	968	935746	1990
1995	2585	18672	63686	114762	332114	8381	8942	8765	4706	3963	4073	2322	1642	1441	1536	1045	605	732	1721	581692	1990
1996	21311	18163	34710	25262	190134	402615	11731	8653	5698	2783	2035	1950	991	1117	886	659	453	436	1132	730719	1990
1997	5861	28568	34939	86326	96940	78135	222658	4967	3731	2768	1494	1269	689	837	236	298	368	124	667	570876	1990
1998	15530	38427	62957	35093	32524	52330	30121	125511	3903	486	396	1990	257	249	77	156	343	28	347	400725	1990
1999	23967	12166	50006	79605	45976	38126	46333	39046	151887	5871	257	337	858	110	246	253	201	435	481	496163	1990
2000	13974	54195	27539	32860	61731	46285	47381	71096	35736	169492	2949	463	158	1548	152	81	83	52	992	566768	1990
2001	419116	55177	121788	86078	52309	42284	29268	20323	8954	5122	26935	853	304	174	198	156	57	64	234	869393	2000
2002	123142	480414	394558	235867	61369	46106	30279	22076	17766	4899	3033	13969	580	164	241	81	60	23	143	1434771	2000
2003	87887	395055	335930	65241	84103	24769	14624	10827	6967	3974	2233	1323	11068	465	53	248	274	52	669	1045762	2001
2004	263495	762656	301339	144934	430153	104119	34399	17197	8318	4654	2365	1301	1182	8772	72	232	250	42	492	2085973	2002
2005	26335	1244660	652407	425205	292846	467795	123484	47163	20489	10868	4939	3849	1663	655	3050	64	45	21	16	3325555	2003
2006	1075350	1210339	1202363	1528343	752862	373958	133664	38139	11992	3707	2477	1591	980	656	592	4168	212	24	215	6341632	2000
2007	714451	986044	933290	537850	652131	384716	283236	66498	25067	3799	3834	2379	1241	1147	576	6720	1515	14	402	4604910	2005
2008	15741	426790	292064	441539	414437	559582	177908	65953	27153	9725	4177	2316	1392	800	258	157	132	2278	111	2442512	2002
2009	14963	89897	180844	353754	396975	290371	250188	127865	59244	37189	9903	10772	1017	3811	480	752	300	1352	8645	1838324	2004
2010	14325	111084	88995	187503	250123	157413	138615	34940	18552	15351	12900	4018	1728	910	286	310	209	145	1189	1038598	2005
2011	51671	70181	73334	219028	223444	244354	115969	25006	13555	13365	6080	4043	4378	852	2009	790	101	319	310	1068786	2005
2012	44361	98737	82954	131815	202033	313659	292199	139414	29159	6307	13926	9276	10094	6559	2852	1808	265	271	5742	1391429	2005

Table 6a: 3M beaked redfish average mature female proportion at age 1989-2010 *versus* 2011-2012.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
mat 1989-2010	0.000	0.000	0.001	0.003	0.008	0.030	0.092	0.171	0.241	0.283	0.420	0.459	0.548	0.524	0.547	0.641	0.639	0.676	0.755
cv	0.003	0.013	0.031	0.076	0.094	0.107	0.123	0.182	0.196	0.191	0.174	0.167	0.171	0.161	0.168	0.220	0.176	0.210	0.141
mat 2011-2012	0.008	0.046	0.111	0.264	0.341	0.412	0.478	0.576	0.697	0.742	0.739	0.753	0.743	0.777	0.805	0.824	0.994	0.700	0.799
cv	0.009	0.009	0.027	0.031	0.031	0.002	0.005	0.127	0.050	0.005	0.037	0.058	0.030	0.084	0.070	0.013	0.005	0.053	0.102

Table 6b: 3M beaked redfish female abundance at age ('000s, 7+ shaded as a proxy to female spawners) from EU bottom trawl survey series, 1989-2012.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+	Total	Most abundant 7+ year class
1988	7426	38731	4773	9255	13509	49278	79233	50067	18514	8785	5390	3358	3424	3127	2792	1629	1465	1340	6525	185650	1981
1989	2065	26569	110388	11124	4842	17279	40884	40440	19577	9375	5093	3133	3247	3118	2910	1657	1498	1290	7894	140116	1981
1990	14745	1355	16863	12641	1627	8845	25163	30891	16858	8359	4515	2733	2964	2790	2463	1429	1158	1077	4475	104876	1982
1991	162761	25467	2680	77227	64378	8348	8467	5971	3848	1943	1972	1877	1761	1550	624	1079	789	454	2461	32797	1984
1992	99184	433145	29834	26515	65240	31909	11263	11337	8653	4919	2812	2131	2163	1770	1727	1444	843	820	1629	51511	1985
1993	3013	75536	45310	152419	4446	9867	4180	2277	855	1237	995	910	782	888	710	954	608	998	1072	16464	1986
1994	0	9960	37804	332877	35911	9544	9600	4263	3065	2284	1736	1170	852	512	555	370	309	412	677	25805	1987
1995	1364	9184	30311	58038	171358	3357	3760	3222	1878	1724	1673	899	583	555	597	511	303	432	1352	17488	1988
1996	10667	8135	13957	11192	89533	190310	5431	3820	2526	1427	1121	1056	585	654	525	413	300	289	799	18947	1989
1997	2929	13918	15297	35316	42475	42018	114997	3182	2277	1479	808	664	362	435	119	162	207	70	434	125195	1990
1998	7781	18813	28766	15951	15116	24317	15224	64231	1849	219	166	806	97	104	27	63	158	9	232	83187	1990
1999	11867	5907	22444	34776	20289	16229	21186	20879	76625	3474	130	177	423	48	120	118	114	238	325	123858	1992
2000	6997	26900	13141	14841	26784	18291	16839	35548	24305	91444	2220	195	104	718	105	59	64	36	649	172285	1992
2001	209558	26925	55737	38387	23167	18097	12242	8948	5038	3725	16064	451	130	74	81	68	22	25	179	16205	1994
2002	61571	239938	194355	114756	29280	20090	12645	8619	7877	3666	1940	10515	402	103	137	31	30	10	64	46038	1995
2003	43943	193641	118432	17011	45534	21443	29485	31665	16921	7596	2574	1076	19302	321	40	327	154	75	770	110304	1995
2004	131748	381004	144938	69113	207243	52979	17866	8590	4100	2574	1589	1008	999	5639	67	187	217	34	375	43244	1997
2005	13167	620808	311930	201783	139391	213383	66436	30586	11631	6110	3453	2862	1133	566	2249	37	29	13	10	125114	1998
2006	537675	593360	572371	742051	374805	193995	70124	22010	7427	2309	1696	994	694	480	503	2699	157	24	201	109319	1999
2007	357225	493119	444930	243054	301978	179837	153934	41341	18564	3454	3546	2274	1198	1101	544	6043	1376	10	372	233756	2000
2008	7237	213322	142853	191637	168814	269755	107266	44266	18815	7157	3142	1760	1063	611	147	70	55	1777	51	186180	2001
2009	7481	45392	84156	142616	148404	141551	127105	78370	37787	28072	8418	8451	892	3305	420	642	284	1253	7664	302664	2002
2010	7006	54780	40732	78117	94294	67504	80823	25694	14496	12455	10898	3435	1512	804	275	272	179	131	1020	151993	2003
2011	25779	34687	36336	94759	92538	110754	58387	18623	10366	10196	4888	3343	3402	724	1711	582	101	316	302	112943	2004
2012	22081	47175	39054	62513	84699	134605	140674	76986	19677	4647	10102	6799	7362	4749	2186	1484	263	199	4579	279708	2005

Table 6c: 3M beaked redfish annual "maturity ogives" (7+ female proportion at age from the EU survey abundance at age 1988-2012).

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.461	0.471	0.487	0.484	0.465	0.478	0.501	0.520	0.547	0.558	0.619	0.620	0.765
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.455	0.452	0.449	0.432	0.411	0.435	0.497	0.525	0.549	0.550	0.607	0.589	0.805
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.448	0.458	0.467	0.455	0.443	0.485	0.556	0.579	0.614	0.617	0.625	0.622	0.714
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.413	0.449	0.476	0.464	0.508	0.553	0.584	0.625	0.655	0.713	0.693	0.696	0.780
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.370	0.430	0.513	0.511	0.468	0.479	0.532	0.574	0.605	0.697	0.671	0.798	0.802
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.399	0.354	0.391	0.413	0.383	0.371	0.410	0.444	0.447	1.110	0.696	0.706	0.662
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.425	0.375	0.408	0.461	0.441	0.416	0.405	0.456	0.442	0.563	0.642	0.669	0.699
1995	0.000	0.000	0.000	0.000	0.000	0.000	0.421	0.368	0.399	0.435	0.411	0.387	0.355	0.385	0.389	0.489	0.501	0.589	0.786
1996	0.000	0.000	0.000	0.000	0.000	0.000	0.463	0.441	0.443	0.513	0.551	0.542	0.590	0.586	0.592	0.627	0.662	0.662	0.706
1997	0.000	0.000	0.000	0.000	0.000	0.000	0.516	0.640	0.610	0.534	0.541	0.523	0.525	0.519	0.504	0.544	0.562	0.564	0.651
1998	0.000	0.000	0.000	0.000	0.000	0.000	0.505	0.512	0.474	0.452	0.420	0.405	0.378	0.417	0.350	0.403	0.462	0.333	0.669
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.457	0.535	0.504	0.592	0.505	0.526	0.492	0.439	0.487	0.467	0.566	0.547	0.676
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.355	0.500	0.680	0.540	0.753	0.421	0.660	0.464	0.691	0.729	0.765	0.689	0.654
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.073	0.137	0.215	0.354	0.249	0.392	0.355	0.376	0.360	0.365	0.361	0.369	0.749
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.418	0.390	0.443	0.748	0.639	0.753	0.692	0.627	0.567	0.378	0.498	0.433	0.450
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.391	0.346	0.317	0.370	0.454	0.594	0.365	0.696	0.762	0.791	0.796	0.826	0.810
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.519	0.500	0.493	0.553	0.672	0.775	0.845	0.643	0.923	0.803	0.868	0.825	0.762
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.538	0.649	0.568	0.562	0.699	0.744	0.681	0.865	0.737	0.573	0.634	0.615	0.600
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.525	0.577	0.619	0.623	0.685	0.625	0.708	0.732	0.848	0.648	0.740	1.000	0.936
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.543	0.622	0.741	0.909	0.925	0.956	0.966	0.960	0.944	0.899	0.908	0.714	0.925
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.603	0.671	0.693	0.736	0.752	0.760	0.764	0.763	0.570	0.449	0.421	0.780	0.461
2009	0.000	0.000	0.000	0.000	0.000	0.000	0.508	0.613	0.638	0.755	0.850	0.784	0.877	0.867	0.874	0.854	0.947	0.927	0.886
2010	0.000	0.000	0.000	0.000	0.000	0.000	0.583	0.735	0.781	0.811	0.845	0.855	0.875	0.883	0.960	0.877	0.859	0.903	0.858
2011	0.000	0.000	0.000	0.000	0.000	0.000	0.503	0.745	0.765	0.763	0.804	0.827	0.777	0.851	0.852	0.737	1.000	0.989	0.975
2012	0.000	0.000	0.000	0.000	0.000	0.000	0.481	0.552	0.675	0.737	0.725	0.733	0.729	0.724	0.767	0.821	0.992	0.733	0.798

Table 7a: Weights at age of the 3M beaked redfish stock (Kg) from EU surveys, 1988-2012.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1988	0.017	0.040	0.093	0.158	0.185	0.220	0.252	0.282	0.317	0.362	0.456	0.523	0.563	0.583	0.623	0.638	0.696	0.697	0.847
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	0.033	0.050	0.083	0.114	0.182	0.237	0.268	0.310	0.324	0.365	0.425	0.310	0.576	0.584	0.661	0.570	0.694	0.749
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	0.685	0.543	0.756	0.755
2005	0.013	0.041	0.061	0.092	0.119	0.166	0.214	0.273	0.339	0.379	0.459	0.481	0.462	0.591	0.502	0.710	0.724	0.904	0.869
2006	0.014	0.044	0.071	0.088	0.114	0.157	0.215	0.265	0.337	0.401	0.431	0.429	0.492	0.533	0.588	0.422	0.551	0.839	0.773
2007	0.015	0.030	0.058	0.109	0.120	0.137	0.205	0.250	0.314	0.397	0.457	0.520	0.542	0.539	0.523	0.399	0.489	0.730	0.553
2008	0.014	0.043	0.074	0.101	0.130	0.168	0.218	0.275	0.325	0.369	0.415	0.438	0.442	0.492	0.567	0.605	0.591	0.448	0.769
2009	0.015	0.056	0.081	0.117	0.133	0.177	0.190	0.227	0.260	0.319	0.396	0.326	0.543	0.436	0.476	0.501	0.676	0.817	0.532
2010	0.013	0.058	0.095	0.118	0.151	0.182	0.219	0.263	0.290	0.325	0.364	0.387	0.457	0.451	0.622	0.527	0.473	0.518	0.517
2011	0.029	0.061	0.082	0.138	0.156	0.189	0.215	0.293	0.310	0.314	0.363	0.412	0.337	0.447	0.412	0.437	0.582	0.488	0.575
2012	0.026	0.062	0.083	0.120	0.159	0.194	0.225	0.252	0.296	0.350	0.349	0.405	0.447	0.423	0.475	0.485	0.593	0.441	0.485

Table 7b: Weights at age of the 3M mature female beaked redfish stock (Kg) from EU surveys, 1988-2012.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1988	0.017	0.040	0.095	0.158	0.184	0.220	0.252	0.284	0.318	0.362	0.454	0.528	0.569	0.588	0.629	0.643	0.707	0.704	0.853
1989	0.012	0.032	0.060	0.103	0.161	0.203	0.247	0.285	0.315	0.344	0.431	0.527	0.572	0.592	0.634	0.645	0.724	0.718	0.886
1990	0.011	0.028	0.082	0.098	0.167	0.209	0.261	0.302	0.332	0.360	0.444	0.539	0.591	0.611	0.655	0.669	0.744	0.737	0.925
1991	0.012	0.029	0.067	0.109	0.135	0.207	0.275	0.342	0.388	0.468	0.522	0.579	0.625	0.657	0.710	0.789	0.776	0.808	0.906
1992	0.013	0.032	0.070	0.094	0.172	0.206	0.291	0.361	0.400	0.449	0.525	0.584	0.650	0.702	0.727	0.826	0.796	0.889	0.945
1993	0.010	0.034	0.051	0.066	0.156	0.215	0.285	0.370	0.401	0.432	0.511	0.553	0.640	0.702	0.726	0.928	0.864	0.875	1.155
1994	0.000	0.045	0.076	0.090	0.129	0.225	0.274	0.349	0.397	0.464	0.492	0.526	0.550	0.697	0.679	0.738	0.823	0.872	0.948
1995	0.011	0.027	0.072	0.102	0.112	0.217	0.286	0.358	0.408	0.454	0.512	0.541	0.635	0.720	0.738	0.835	0.853	0.888	1.079
1996	0.011	0.035	0.062	0.080	0.138	0.142	0.268	0.329	0.384	0.446	0.481	0.535	0.581	0.603	0.656	0.700	0.755	0.798	0.958
1997	0.013	0.031	0.058	0.089	0.128	0.192	0.177	0.355	0.406	0.464	0.502	0.574	0.608	0.622	0.683	0.747	0.789	0.765	0.955
1998	0.010	0.034	0.061	0.090	0.137	0.182	0.232	0.224	0.368	0.416	0.487	0.546	0.621	0.700	0.712	0.813	0.843	0.729	1.126
1999	0.015	0.033	0.063	0.087	0.120	0.174	0.224	0.262	0.248	0.319	0.462	0.564	0.504	0.539	0.530	0.538	0.662	0.613	0.771
2000	0.016	0.037	0.059	0.097	0.132	0.170	0.242	0.296	0.335	0.312	0.412	0.514	0.680	0.571	0.488	0.693	0.723	0.727	0.766
2001	0.015	0.028	0.062	0.085	0.139	0.179	0.237	0.302	0.337	0.385	0.353	0.510	0.599	0.664	0.665	0.612	0.775	0.853	1.033
2002	0.013	0.034	0.052	0.101	0.130	0.183	0.226	0.285	0.335	0.394	0.435	0.401	0.551	0.581	0.609	0.714	0.643	0.887	0.965
2003	0.012	0.033	0.049	0.084	0.114	0.178	0.233	0.264	0.313	0.332	0.381	0.437	0.320	0.574	0.584	0.670	0.574	0.694	0.775
2004	0.015	0.030	0.065	0.094	0.120	0.164	0.219	0.277	0.345	0.387	0.459	0.512	0.561	0.447	0.635	0.670	0.542	0.756	0.713
2005	0.013	0.041	0.061	0.092	0.118	0.167	0.222	0.273	0.335	0.379	0.472	0.491	0.480	0.582	0.511	0.705	0.716	0.899	0.860
2006	0.014	0.044	0.071	0.089	0.114	0.158	0.216	0.267	0.339	0.403	0.439	0.436	0.505	0.536	0.592	0.432	0.542	0.839	0.788
2007	0.015	0.030	0.057	0.109	0.121	0.138	0.212	0.259	0.332	0.397	0.459	0.521	0.543	0.538	0.523	0.401	0.489	0.730	0.553
2008	0.014	0.043	0.073	0.099	0.131	0.173	0.221	0.276	0.326	0.372	0.419	0.440	0.436	0.475	0.540	0.566	0.540	0.440	0.624
2009	0.015	0.055	0.080	0.118	0.133	0.186	0.200	0.233	0.278	0.322	0.397	0.329	0.548	0.439	0.481	0.504	0.677	0.840	0.543
2010	0.013	0.058	0.094	0.116	0.151	0.188	0.226	0.265	0.291	0.326	0.365	0.389	0.459	0.453	0.627	0.523	0.476	0.518	0.515
2011	0.029	0.061	0.082	0.137	0.155	0.193	0.220	0.294	0.312	0.318	0.367	0.417	0.338	0.450	0.415	0.435	0.582	0.488	0.574
2012	0.026	0.062	0.084	0.118	0.159	0.195	0.230	0.258	0.298	0.350	0.349	0.408	0.451	0.428	0.488	0.500	0.593	0.441	0.498

Table 8a: 3M beaked redfish survey mean catch per tow from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2010 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	2005	2006	2007	2008	2009	2010	2011	2012
mean weight per tow (Kg/tow)	199	159	109	85	147	68	125	90	125	104	74	103	146	78	129	59	185	297	532	279	224	342	178	132	183
SE	32	21	13	10	17	24	38	10	17	18	12	30	57	12	17	7	26	53	79	43	45	92	34	16	23
CV	16%	13%	12%	12%	12%	36%	30%	11%	14%	18%	16%	29%	39%	16%	13%	12%	14%	18%	15%	15%	20%	27%	19%	12%	12%

Table 8b: 3M beaked redfish abundance, stock and female spwanning biomass ('000 tons) from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2010 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	2005	2006	2007	2008	2009	2010	2011	2012
abundance (millions)	664	639	331	749	1509	623	936	582	731	571	401	496	567	869	1435	1202	2086	3326	6342	4605	2443	1838	1039	1069	1391
4+abundance (millions)	541	362	265	367	385	376	840	497	657	502	284	410	471	273	437	227	759	1402	2854	1971	1708	1553	824	874	1165
biomass ('000 ton)	160	128	89	72	119	78	105	73	100	84	60	82	118	64	107	132	157	302	485	386	308	286	162	166	252
4+ biomass ('000 ton)	155	113	86	67	92	45	100	71	101	82	56	81	116	51	69	34	106	209	333	279	264	266	147	159	242
7+ female biomass ('000 ton)	62	50	40	16	24	9	11	9	8	25	20	31	53	15	15	32	14	34	28	59	49	77	41	31	76
7+ female biomass proportion	38%	39%	45%	21%	20%	12%	10%	12%	8%	30%	33%	38%	45%	24%	14%	24%	9%	11%	6%	15%	16%	27%	25%	19%	30%

Table 9: Input files for 2013 XSA assessment.

REDFISH NAFO DIVISION 3M INDEX OF INPUT FILES 2011

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	2012
4	19
5	
58086	
80223	
48500	
43300	
43100	
17664	
13879	
6101	
1408	
1011	
1095	
3665	
3327	
2964	
2273	
3260	
4039	
5936	
5131	
4274	
3639	
5235	
8904	
5864	

REDFISH NAFO 3M CATCH NUMBERS thousands

1	2														
1989	2012														
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
110773	10414	3064	3409	4557	2101	3936	5178	5512	4547	4665	3554	2092	1666	2614	1514
53804	6411	1630	2399	2522	2550	2819	2521	1956	1459	856	969	460	320	390	551
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
89	130	204	387	1018	1436	4211	657	170	71	608	64	38	34	38	558
828	337	386	842	1303	869	856	3229	381	117	62	65	60	19	29	61
1435	350	478	554	854	1009	530	642	1819	337	109	157	57	50	9	54
1712	1946	281	391	546	565	423	365	311	1222	214	22	102	69	23	266
1013	4104	2581	1564	999	611	379	268	203	254	953	19	83	46	19	342
611	311	683	875	1264	1462	1122	820	860	423	418	1240	126	75	21	84
2031	4853	8382	5584	2388	1250	521	395	242	191	179	198	725	80	9	112
442	782	824	4237	2165	2063	630	784	763	347	322	246	1106	505	32	296
246	723	2619	2553	2934	2426	1095	592	380	226	221	128	120	130	436	467
434	468	1419	1613	1645	1455	1452	741	453	136	304	53	110	35	147	862
2735	5422	4200	3570	981	715	1017	1383	557	506	247	70	120	66	42	579
3354	3677	4247	2133	1028	873	1848	1831	2655	684	682	1122	1108	401	372	1511
1224	2037	2027	1458	808	344	251	612	1096	2012	968	636	365	106	47	1767

REDFISH NAFO 3M CATCH WEIGHT AT AGE kg

1	3														
1989	2012														
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	0.152	0.248	0.325	0.406	0.444	0.480	0.556	0.595	0.652	0.710	0.737	0.901	0.868	0.885	1.096
0.109	0.145	0.267	0.316	0.393	0.436	0.509	0.543	0.583	0.609	0.702	0.691	0.745	0.844	0.868	0.902
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
0.069	0.124	0.167	0.237	0.284	0.349	0.332	0.439	0.518	0.659	0.557	0.492	0.662	0.720	0.761	0.817
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	0.165	0.227	0.265	0.328	0.359	0.423	0.491	0.450	0.577	0.601	0.623	0.703	0.643	0.866	0.877
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	0.131	0.174	0.223	0.274	0.338	0.377	0.456	0.513	0.558	0.445	0.610	0.681	0.586	0.724	0.897
0.088	0.114	0.184	0.252	0.294	0.349	0.384	0.476	0.508	0.519	0.638	0.598	0.692	0.693	0.878	0.932
0.102	0.137	0.172	0.215	0.279	0.349	0.400	0.443	0.447	0.537	0.573	0.626	0.460	0.625	0.842	1.024
0.107	0.130	0.146	0.251	0.277	0.354	0.392	0.453	0.493	0.515	0.527	0.538	0.441	0.547	0.701	0.757
0.113	0.135	0.172	0.219	0.260	0.289	0.316	0.360	0.381	0.402	0.489	0.514	0.540	0.563	0.457	0.786
0.155	0.140	0.212	0.233	0.267	0.326	0.351	0.450	0.370	0.538	0.475	0.531	0.506	0.708	0.626	0.566
0.122	0.155	0.180	0.220	0.276	0.310	0.357	0.392	0.442	0.493	0.501	0.530	0.575	0.497	0.529	0.589
0.133	0.152	0.183	0.208	0.299	0.327	0.433	0.430	0.481	0.385	0.455	0.468	0.551	0.597	0.483	0.722
0.138	0.170	0.202	0.244	0.289	0.337	0.396	0.410	0.493	0.506	0.494	0.550	0.607	0.623	0.463	0.673

REDFISH NAFO 3M STOCK WEIGHT AT AGE kg

1	4														
1989	2012														
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	0.685	0.543	0.756	0.755
0.092	0.119	0.166	0.214	0.273	0.339	0.379	0.459	0.481	0.462	0.591	0.502	0.710	0.724	0.904	0.869
0.088	0.114	0.157	0.215	0.265	0.337	0.401	0.431	0.429	0.492	0.533	0.588	0.422	0.551	0.839	0.773
0.109	0.120	0.137	0.205	0.250	0.314	0.397	0.457	0.520	0.542	0.539	0.523	0.399	0.489	0.730	0.553
0.101	0.130	0.168	0.218	0.275	0.325	0.369	0.415	0.438	0.442	0.492	0.567	0.605	0.591	0.448	0.769
0.117	0.133	0.177	0.190	0.227	0.260	0.319	0.396	0.326	0.543	0.436	0.476	0.501	0.676	0.817	0.532
0.118	0.151	0.182	0.219	0.263	0.290	0.325	0.364	0.387	0.457	0.451	0.622	0.527	0.473	0.518	0.517
0.138	0.156	0.189	0.215	0.293	0.310	0.314	0.363	0.412	0.337	0.447	0.412	0.437	0.582	0.488	0.575
0.120	0.159	0.194	0.225	0.252	0.296	0.350	0.349	0.405	0.447	0.423	0.475	0.485	0.593	0.441	0.485

REDFISH NAFO 3M NATURAL MORTALITY (standard run)

1	5														
1989	2012														
4	19														
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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	0.1

REDFISH NAFO 3M PROPORTION FEMALES 7 plus

1	6														
1989	2012														
4	19														
1															
0.000	0.000	0.000	0.455	0.452	0.449	0.432	0.411	0.435	0.497	0.525	0.549	0.550	0.607	0.589	0.805
0.000	0.000	0.000	0.448	0.458	0.467	0.455	0.443	0.485	0.556	0.579	0.614	0.617	0.625	0.622	0.714
0.000	0.000	0.000	0.413	0.449	0.476	0.464	0.508	0.553	0.584	0.625	0.655	0.713	0.693	0.696	0.780
0.000	0.000	0.000	0.370	0.430	0.513	0.511	0.468	0.479	0.532	0.574	0.605	0.697	0.671	0.798	0.802
0.000	0.000	0.000	0.399	0.354	0.391	0.413	0.383	0.371	0.410	0.444	0.447	1.110	0.696	0.706	0.662
0.000	0.000	0.000	0.425	0.375	0.408	0.461	0.441	0.416	0.405	0.456	0.442	0.563	0.642	0.669	0.699
0.000	0.000	0.000	0.421	0.368	0.399	0.435	0.411	0.387	0.355	0.385	0.389	0.489	0.501	0.589	0.786
0.000	0.000	0.000	0.463	0.441	0.443	0.513	0.551	0.542	0.590	0.586	0.592	0.627	0.662	0.662	0.706
0.000	0.000	0.000	0.516	0.640	0.610	0.534	0.541	0.523	0.525	0.519	0.504	0.544	0.562	0.564	0.651
0.000	0.000	0.000	0.505	0.512	0.474	0.452	0.420	0.405	0.378	0.417	0.350	0.403	0.462	0.333	0.669
0.000	0.000	0.000	0.457	0.535	0.504	0.592	0.505	0.526	0.492	0.439	0.487	0.467	0.566	0.547	0.676
0.000	0.000	0.000	0.355	0.500	0.680	0.540	0.753	0.421	0.660	0.464	0.691	0.729	0.765	0.689	0.654
0.000	0.000	0.000	0.418	0.440	0.563	0.727	0.596	0.529	0.429	0.425	0.407	0.439	0.387	0.385	0.766
0.000	0.000	0.000	0.418	0.390	0.443	0.748	0.639	0.753	0.692	0.627	0.567	0.378	0.498	0.433	0.450
0.000	0.000	0.000	0.391	0.346	0.317	0.370	0.454	0.594	0.365	0.696	0.762	0.791	0.796	0.826	0.810
0.000	0.000	0.000	0.519	0.500	0.493	0.553	0.672	0.775	0.845	0.643	0.923	0.803	0.868	0.825	0.762
0.000	0.000	0.000	0.538	0.649	0.568	0.562	0.699	0.744	0.681	0.865	0.737	0.573	0.634	0.615	0.600
0.000	0.000	0.000	0.525	0.577	0.619	0.623	0.685	0.625	0.708	0.732	0.848	0.648	0.740	1.000	0.936
0.000	0.000	0.000	0.543	0.622	0.741	0.909	0.925	0.956	0.966	0.960	0.944	0.899	0.908	0.714	0.925
0.000	0.000	0.000	0.603	0.671	0.693	0.736	0.752	0.760	0.764	0.763	0.570	0.449	0.421	0.780	0.461
0.000	0.000	0.000	0.508	0.613	0.638	0.755	0.850	0.784	0.877	0.867	0.874	0.854	0.947	0.927	0.886
0.000	0.000	0.000	0.583	0.735	0.781	0.811	0.845	0.855	0.875	0.883	0.960	0.877	0.859	0.903	0.858
0.000	0.000	0.000	0.503	0.745	0.765	0.763	0.804	0.827	0.777	0.851	0.852	0.737	1.000	0.989	0.975
0.000	0.000	0.000	0.481	0.552	0.675	0.737	0.725	0.733	0.729	0.724	0.767	0.821	0.992	0.733	0.798

REDFISH NAFO 3M F ON OLDEST AGE GROUP BY YEAR

1 9
1989 2012
4 19
5
0.5757
0.6908
0.74
0.5124
1.6679
0.4997
0.6875
0.2377
0.0425
0.0491
0.1824
0.2984
0.2156
0.1374
0.2693
0.2172
0.4729
0.2613
1.1918
0.0628
0.1695
0.1318
0.1318
0.1318

REDFISH NAFO 3M PROPORTION OF F BEFORE SPAWNING

1 7
1989 2012
4 19
3
0.08

REDFISH NAFO 3M PROPORTION OF M BEFORE SPAWNING

1 8
1989 2012
4 19
3
0.08

REDFISH NAFO 3M F AT AGE IN LAST YEAR

1 10
1989 2012
4 19
2

0.0364	0.058	0.0547	0.0528	0.0155	0.0197	0.0391	0.0761	0.064	0.1405	0.1681	0.0505	0.1432	0.1135	0.1318	0.1318

REDFISH NAFO 3M SURVEY TUNNING DATA

101

EU BOTTOM TRAWL SURVEY

1989 2012
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	144934	430153	104119	34399	17197	8318	4654	2365	1301	1182	8772	72	232	250	42	492
10555	425205	292846	467795	123484	47163	20489	10868	4939	3849	1663	655	3050	64	45	21	16
10555	1528343	752862	373958	133664	38139	11992	3707	2477	1591	980	656	592	4168	212	24	215
10555	537850	652131	384716	283236	66498	25067	3799	3834	2379	1241	1147	576	6720	1515	14	402
10555	441539	414437	559582	177908	65953	27153	9725	4177	2316	1392	800	258	157	132	2278	111
10555	353754	396975	290371	250188	127865	59244	37189	9903	10772	1017	3811	480	752	300	1352	8645
10555	187503	250123	157413	138615	34940	18552	15351	12900	4018	1728	910	286	310	209	145	1189
10555	219028	223444	244354	115969	25006	13555	13365	6080	4043	4378	852	2009	790	101	319	310
10555	131815	202033	313659	292199	139414	29159	6307	13926	9276	10094	6559	2852	1808	265	271	5742

Table 10: An explanation of the eleven M options included in the XSA_{2013} sesitivity analysis

Run 1	Only larger juvenile (beaked) redfish is included on the computation of Mcod (average length 25 cm). M = 0.1+M_{cod} for ages 4 - 6 on 2006 - 2008 and all age groups on 2009 - 2012. M_{cod} is derived from annual redfish cod consumption against XSA redfish abundance of all age groups (standard framework with M=0.1).
Run 2	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2012 (extended XSA_{2011} assessment framework)
Run 3	M is kept constant at 0.10 on all ages and all years (standard XSA assessment framework)
Run 4	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010 (XSA_{2011} assessment framework). M = 0.20 on all age groups on 2011-2012.
Run 5	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010 (XSA_{2011} assessment framework). M = 0.15 on all age groups on 2011-2012.
Run 6a	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010 (XSA_{2011} assessment framework). M = 0.125 on all age groups on 2011-2012.
Run 6b	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010 (XSA_{2011} assessment framework). M = 0.120 on all age groups on 2011-2012.
Run 6c	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010 (XSA_{2011} assessment framework). M = 0.115 on all age groups on 2011-2012.
Run 6d	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010 (XSA_{2011} assessment framework). M = 0.110 on all age groups on 2011-2012.
Run 6e	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010 (XSA_{2011} assessment framework). M = 0.105 on all age groups on 2011-2012.
Run 6f	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010 (XSA_{2011} assessment framework). M = 0.10 on all age groups on 2011-2012.

Table 11: Computation of natural mortality using cod consuption estimates in number, 2006-2012.

standard XSA_{2013} with M=0.1

Table 10	Stock number at age (start of year)			Numbers*10**-3			
YEAR	2006	2007	2008	2009	2010	2011	2012
AGE							
4	68734	66439	101300	134921	88398	71261	41218
5	70523	60261	59696	91426	121669	77384	61289
6	58383	59195	53783	53328	82280	104933	66523
7	48355	44854	52778	46173	46903	70455	90907
8	25729	38442	36555	45327	40245	39044	61722
9	11389	21009	32724	30286	39449	35482	34351
10	7198	9116	17047	27302	26019	35015	31275
11	5166	6017	7649	14383	23323	22576	29925
12	2797	4299	4699	6358	12310	19788	18686
13	2368	2301	3164	3890	5322	10608	15379
14	1402	1961	1752	2648	3391	4334	8948
15	3331	1098	1468	1375	2107	2833	3273
16	11506	2826	760	1206	1194	1840	1496
17	145	9722	1505	573	987	966	611
18	51	55	8316	1238	485	830	493
0 TOTAL	317077	327595	383196	460434	494082	497349	466096

	2006	2007	2008	2009	2010	2011	2012
Deaths by cod	28263	53207	69299	149030	215836	219291	192853
Mcod	0.093	0.177	0.199	0.391	0.574	0.581	0.534
M	**0.193**	**0.277**	**0.299**	**0.491**	**0.674**	**0.681**	**0.634**

Tabela 12a: XSA_{2013} sensitivity analysis I. Sum of squares of survey log catchabilities at age, 2006-2012.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6a	Run 6b	Run 6c	Run 6d	Run 6e	Run 6f
SS log q resiuals$_{2006\text{-}2012}$	101.94	53.43	49.25	46.65	45.39	44.61	44.59	44.49	44.38	44.34	44.24

Tabela 12b: XSA2013 sensitivity analysis II. Diferrence betwwen sirvivors at age internal and external *se*'s.

Run\Ages	6	7	8	9	10	11	12	13	14	15	16	17	SS (se_{int}-se_{ext})
Run 6a	0.05476	0.04203	0.04494	0.01166	0.00336	0.01232	0.00608	0.00068	0.00884	0.00023	0.00036	0.00922	0.01621
Run 6b	0.05570	0.04285	0.04537	0.01166	0.00336	0.01232	0.00608	0.00073	0.00903	0.00026	0.00036	0.00922	0.01641
Run 6c	0.05664	0.04368	0.04623	0.01145	0.00348	0.01232	0.00608	0.00073	0.00903	0.00026	0.00032	0.00941	0.01664
Run 6d	0.05808	0.04452	0.04666	0.01145	0.00360	0.01232	0.00608	0.00078	0.00922	0.00029	0.00029	0.00941	0.01689
Run 6e	0.05905	0.04494	0.04709	0.01124	0.00360	0.01232	0.00608	0.00078	0.00941	0.00029	0.00029	0.00941	0.01704
Run 6f	0.06052	0.04580	0.04796	0.01124	0.00372	0.01232	0.00608	0.00078	0.00941	0.00029	0.00026	0.00960	0.01733

Tabela 12c: XSA2013 sensitivity analysis II. Average se's of log catchabilities at age.

Run\Ages	6	7	8	9	10	11	12	13	14	15	16	17	Av. *se log q*
Run 6a	0.88910	0.62380	0.67580	0.70170	0.74240	0.56850	0.68130	0.55670	0.68920	0.79800	0.80680	0.90360	0.71974
Run 6b	0.88940	0.62420	0.67560	0.70170	0.74260	0.56840	0.68120	0.55600	0.68890	0.79700	0.80590	0.90300	0.71949
Run 6c	0.88970	0.62450	0.67540	0.70160	0.74290	0.56840	0.68100	0.55530	0.68850	0.79590	0.80500	0.90250	0.71923
Run 6d	0.89000	0.62490	0.67520	0.70160	0.74320	0.56830	0.68090	0.55470	0.68810	0.79490	0.80410	0.90190	0.71898
Run 6e	0.89040	0.62520	0.67500	0.70150	0.74350	0.56830	0.68070	0.55400	0.68780	0.79380	0.80320	0.90130	0.71873
Run 6f	0.89070	0.62560	0.67480	0.70140	0.74380	0.56830	0.68060	0.55330	0.68740	0.79280	0.80230	0.90080	0.71848

Table 13: Extended Survivor Analysis summary of diagnostics for 2013 (Lowestoft VPA Version 3.1).

single EU survey, 1989-2012
M=0.1 all ages 1989-2005
M=0.4 ages 4-6 2006-2010 and ages 7+ 2009-2010
M=0.125 all ages 2011-2012

REDFISH NAFO DIVISION 3M INDEX OF INPUT FILES 2013
CPUE data from file red3mtun.txt

Catch data for 24 years. 1989 to 2012. Ages 4 to 19.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU BOTTOM TRAWL SURV	1989	2012	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 66 iterations

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	2005	2006	2007	2008	2009	2010	2011	2012
4	**-1.9**	**-1.25**	**1.04**	0.1	0.9	0.87	0.62	-0.15	0.82	-0.03	0.51	-0.52	0.18	0.5	**-1.27**	-0.76	-0.1	**1.12**	0.28	-0.11	-0.42	-0.42	-0.01	0
5	**-3.08**	**-3.81**	**0.67**	**1.23**	**-1.1**	0.64	0.51	**1.33**	**1.33**	-0.08	0.3	0.32	0.01	-0.08	-0.44	0.71	0	0.72	0.64	0.39	0.15	-0.38	0	0.02
6	-1.9	**-2.11**	**-1.63**	0.51	-0.25	0.29	-0.97	0.96	0.68	0.86	0.22	0.46	0.1	0.04	-0.83	-0.04	0.96	0.6	0.5	0.94	0.48	-0.31	-0.08	0.53
7	-0.96	-0.91	**-1.42**	-0.29	-0.83	0.33	-0.03	0.01	0.65	-0.01	0.98	0.69	0.29	0.03	-0.84	-0.22	0.4	0	0.78	0.12	0.7	0.33	-0.19	0.39
8	-0.38	-0.35	**-1.41**	-0.01	-0.79	-0.03	0.22	0.85	-0.31	0.48	0.66	**1.89**	0.33	0.49	-0.56	-0.24	0.56	-0.33	-0.25	-0.22	0.38	-0.56	-0.8	0.42
9	-0.29	-0.27	**-1.31**	0.01	-1.42	0.37	-0.09	0.87	0.87	0.02	**1.16**	**1.13**	0.46	0.82	-0.1	-0.3	0.52	-0.25	-0.2	-0.62	0.36	-0.75	-0.85	-0.12
10	-0.33	-0.2	**-1.38**	-0.06	-0.58	0.34	0.8	0.21	**1.08**	-0.54	**1.07**	**1.84**	-0.19	0.51	-0.07	0.08	0.58	-0.59	-0.82	-0.58	0.41	-0.15	-0.38	-1.06
11	-0.33	-0.39	-0.93	-0.3	-0.38	0.65	1.21	**1.09**	0.13	-0.37	-0.76	0.96	0.45	-0.28	0.18	-0.19	0.6	-0.47	-0.14	-0.33	-0.02	0.04	-0.51	0.07
12	-0.63	-0.69	-1.02	-0.27	-0.47	0.52	0.94	**1.45**	**1.18**	0.68	-0.3	0.11	0.15	0	-0.92	-0.15	0.56	-0.31	-0.3	-0.45	0.95	-0.47	-0.73	0.14
13	-0.3	-0.35	-0.74	-0.23	-0.14	0.21	0.92	0.92	**1.18**	0.01	0.29	-0.69	0.16	0.38	0.08	-0.74	0.49	-0.43	-0.22	-0.5	-0.82	-0.24	0.08	0.65
14	-0.43	-0.13	-0.75	-0.33	-0.18	0.02	0.3	**1.25**	**1.12**	0.38	-0.73	**1.49**	-0.45	-0.17	0.62	-0.08	-1.23	-0.27	-0.15	-0.54	0.76	-0.56	-0.6	0.65
15	0.26	-0.08	-1.07	0.14	0.09	0.43	**1.59**	0.5	0.38	-0.8	0.98	0.09	0.29	0.53	-0.77	-0.66	-0.72	-0.91	0.11	-1.2	-0.49	**-1.12**	**1.17**	**1.27**
16	-0.1	-0.31	-0.96	-0.21	-0.67	-0.45	0.76	**1.55**	-0.73	-0.19	0.3	-0.07	0.09	-0.65	0.84	0.75	-0.67	-0.59	1.55	-1.27	-0.15	-0.8	0.52	**1.47**
17	-0.19	0.27	-0.33	-0.65	-0.17	-0.57	0.08	0.79	**1.71**	-0.29	0.52	-0.38	0.05	-0.33	**1.15**	**1.61**	0.03	1.51	-1.31	-1.88	-0.13	-0.81	-1.12	0.45
18	0	0.04	-0.03	0.09	0.43	0.17	0.35	0.16	-0.23	-0.63	0.17	-0.46	-0.37	-0.61	-0.11	-0.35	-0.34	0.01	-0.19	-0.75	0.82	-0.37	0.36	0.36

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	-8.3373	-8.296	-8.3312	-8.4674	-8.7525	-9.1294	-9.534	-9.7682	-9.7776	-9.9198	-9.8345	-10.0759	-9.725	-9.8627	-9.8627
S.E(Log q)	0.7699	1.2078	0.8891	0.6238	0.6758	0.7017	0.7424	0.5685	0.6813	0.5567	0.6892	0.798	0.8068	0.9036	0.3891

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	1.04	-0.23	8.23	0.61	24	0.82	-8.34
5	1.2	-0.612	7.8	0.3	24	1.47	-8.3
6	1.05	-0.252	8.22	0.51	24	0.96	-8.33
7	1.11	-0.731	8.27	0.67	24	0.7	-8.47
8	1.36	-1.986	8.31	0.58	24	0.86	-8.75
9	1.38	-2.098	8.94	0.58	24	0.9	-9.13
10	1.24	-1.394	9.59	0.6	24	0.9	-9.53
11	1.18	-1.484	9.92	0.75	24	0.66	-9.77
12	1.53	-3.351	10.4	0.64	24	0.87	-9.78
13	1.23	-2.147	10.32	0.79	24	0.64	-9.92
14	1.22	-1.652	10.27	0.72	24	0.81	-9.83
15	1.09	-0.67	10.32	0.7	24	0.88	-10.08
16	1.19	-1.27	10.23	0.67	24	0.95	-9.73
17	1.63	-3.654	11.91	0.6	24	1.19	-9.86
18	0.92	1.876	9.62	0.96	24	0.33	-9.93
1							

Terminal year survivor and F summaries :

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

Year class = 2008

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	48794	0.786	0	0	1	1	0.023

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
48794	0.79	0	1	0	0.023

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

Year class = 2007

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	69904	0.663	0.016	0.02	2	1	0.027

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
69904	0.66	0.02	2	0.024	0.027

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

Year class = 2006

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	67860	0.535	0.301	0.56	3	1	0.028

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
67860	0.54	0.3	3	0.563	0.028

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

Year class = 2005

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	84092	0.41	0.205	0.5	4	1	0.016

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
84092	0.41	0.2	4	0.499	0.016

Age 8 Catchability constant w.r.t. time and dependent on age
Year class = 2004

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	51436	0.352	0.14	0.4	5	1	0.015

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
51436	0.35	0.14	5	0.398	0.015

Age 9 Catchability constant w.r.t. time and dependent on age
Year class = 2003

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	27073	0.317	0.209	0.66	6	1	0.012

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
27073	0.32	0.21	6	0.659	0.012

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	22542	0.292	0.35	1.2	7	1	0.01

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
22542	0.29	0.35	7	1.198	0.01

Age 11 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	20035	0.261	0.15	0.58	8	1	0.028

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20035	0.26	0.15	8	0.576	0.028

Age 12 Catchability constant w.r.t. time and dependent on age
Year class = 2000

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	12295	0.246	0.168	0.68	9	1	0.08

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12295	0.25	0.17	9	0.682	0.08

Age 13 Catchability constant w.r.t. time and dependent on age
Year class = 1999

Fleet	Estim. Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	8812	0.228	0.202	0.88	10	1	0.194

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8812	0.23	0.2	10	0.885	0.194

Age 14 Catchability constant w.r.t. time and dependent on age
Year class = 1998

Fleet	Estim Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	5330	0.216	0.122	0.56	11	1	0.158

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5330	0.22	0.12	11	0.563	0.158

Age 15 Catchability constant w.r.t. time and dependent on age
Year class = 1997

Fleet	Estim Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	1461	0.213	0.198	0.93	12	1	0.343

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1461	0.21	0.2	12	0.929	0.343

Age 16 Catchability constant w.r.t. time and dependent on age
Year class = 1996

Fleet	Estim Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	489	0.22	0.239	1.09	13	1	0.532

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
489	0.22	0.24	13	1.087	0.532

Age 17 Catchability constant w.r.t. time and dependent on age
Year class = 1995

Fleet	Estim Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	249	0.248	0.152	0.61	14	1	0.337

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
249	0.25	0.15	14	0.614	0.337

Age 18 Catchability constant w.r.t. time and age (fixed at the value for age) 17
Year class = 1994

Fleet	Estim Surviv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	305	0.215	0.128	0.6	15	1	0.135

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
305	0.22	0.13	15	0.596	0.135

Table 14: Main results of retrospective $XSA_{2013\text{-}2009}$

Biomass

	2012	2011	2010	2009	2008
1989	222	220	217	217	212
1990	189	188	186	185	181
1991	136	135	133	133	130
1992	100	100	98	98	96
1993	69	68	67	67	66
1994	46	45	44	44	42
1995	37	36	35	35	32
1996	26	25	24	24	21
1997	25	24	22	22	20
1998	26	25	24	24	21
1999	27	25	24	24	21
2000	32	30	28	29	25
2001	33	30	28	29	26
2002	38	35	32	34	29
2003	42	38	35	37	32
2004	62	55	54	56	49
2005	82	73	73	81	71
2006	107	101	109	135	128
2007	116	110	124	150	140
2008	142	130	142	170	155
2009	146	127	135	158	
2010	136	115	121		
2011	115	97			
2012	122				

7+FemBiomass

	2012	2011	2010	2009	2008
1989	87.0	86.0	84.3	84.0	80.8
1990	78.3	77.5	76.2	76.0	73.4
1991	61.8	61.1	60.1	59.9	57.9
1992	45.6	44.9	44.1	44.0	42.1
1993	24.7	24.3	23.7	23.7	22.6
1994	12.4	12.1	11.8	11.7	11.0
1995	9.7	9.4	9.0	9.0	8.1
1996	6.4	6.2	6.0	5.9	5.4
1997	10.1	9.7	9.1	9.0	7.9
1998	10.6	10.1	9.5	9.5	8.1
1999	10.7	10.2	9.7	9.8	8.5
2000	13.9	13.3	12.5	12.6	10.8
2001	13.5	12.8	12.0	12.2	10.4
2002	15.3	14.3	13.2	13.6	11.5
2003	10.5	9.6	8.8	9.1	7.6
2004	19.1	17.3	15.8	16.4	13.6
2005	24.0	21.4	19.5	20.5	17.3
2006	28.9	24.9	23.3	24.3	20.4
2007	43.0	36.9	35.4	37.6	32.0
2008	53.4	46.1	45.9	50.9	43.7
2009	52.8	47.3	49.4	59.6	
2010	54.3	50.3	56.5		
2011	46.9	43.0			
2012	54.6				

FBAR

	2012	2011	2010	2009	2008
1989	0.317	0.320	0.324	0.325	0.335
1990	0.481	0.485	0.490	0.491	0.503
1991	0.367	0.369	0.371	0.371	0.377
1992	0.566	0.570	0.575	0.575	0.586
1993	0.651	0.658	0.668	0.669	0.694
1994	0.457	0.462	0.469	0.470	0.486
1995	0.688	0.697	0.714	0.718	0.758
1996	0.517	0.527	0.546	0.551	0.599
1997	0.141	0.145	0.150	0.151	0.166
1998	0.083	0.085	0.088	0.089	0.097
1999	0.123	0.126	0.133	0.135	0.154
2000	0.231	0.238	0.248	0.248	0.274
2001	0.160	0.166	0.174	0.172	0.190
2002	0.188	0.195	0.204	0.201	0.219
2003	0.146	0.152	0.160	0.157	0.172
2004	0.101	0.109	0.116	0.113	0.126
2005	0.164	0.179	0.195	0.185	0.207
2006	0.077	0.089	0.095	0.088	0.105
2007	0.130	0.148	0.166	0.152	0.259
2008	0.063	0.074	0.081	0.071	0.080
2009	0.046	0.053	0.059	0.053	
2010	0.061	0.077	0.080		
2011	0.261	0.407			
2012	0.129				

REC

	2012	2011	2010	2009	2008
1989	54.5	54.5	54.4	54.4	54.3
1990	42.4	42.3	42.3	42.2	42.1
1991	23.7	23.7	23.7	23.7	23.6
1992	22.0	22.0	21.9	21.9	21.9
1993	139.5	139.5	139.5	139.4	139.4
1994	153.5	149.6	144.7	145.4	136.3
1995	27.6	27.0	26.4	26.5	22.2
1996	13.2	12.9	12.6	13.4	13.3
1997	16.3	16.0	14.3	14.9	14.1
1998	15.2	13.3	13.3	14.0	13.7
1999	20.1	18.7	16.5	17.9	15.6
2000	23.2	19.1	16.5	16.7	17.0
2001	30.4	26.4	26.5	27.6	22.9
2002	60.8	54.7	50.7	54.2	50.7
2003	98.0	81.8	85.4	84.3	72.9
2004	130.7	121.0	133.6	145.8	133.7
2005	196.5	180.4	191.0	244.2	225.1
2006	246.5	292.5	377.4	573.0	608.4
2007	199.8	199.0	267.7	287.8	252.3
2008	242.6	197.0	199.9	229.5	199.6
2009	264.7	185.4	163.0	170.7	
2010	142.8	97.4	86.5		
2011	95.8	87.1			
2012	56.6				

Table 15: XSA results for 2013 assessment

Run title : REDFISH NAFO DIVISION 3M INDEX OF INPUT FILES 2011

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
AGE														
4	0.0086	0.2978	0.056	0.0114	1.8011	0.4571	0.1119	0.1384	0.0455	0.0076	0.0079	0.004	0.029	0.0251
5	0.0157	0.0615	0.1423	0.3163	0.8135	0.3907	0.1727	0.1833	0.0146	0.0044	0.0033	0.0076	0.0171	0.0138
6	0.0846	0.1019	0.1925	0.4008	0.2754	0.2449	0.5886	0.0752	0.038	0.0124	0.0013	0.0176	0.0254	0.0274
7	0.2127	0.4388	0.4574	0.8559	0.3075	0.3207	0.4391	0.2614	0.015	0.0207	0.0089	0.036	0.0843	0.0416
8	0.3	0.7675	0.6565	1.0249	0.5129	0.3486	0.5482	0.6002	0.0662	0.0149	0.0212	0.1545	0.1466	0.1038
9	0.2785	0.732	0.612	0.7492	0.2596	0.5352	0.3341	0.6473	0.2048	0.1248	0.014	0.1411	0.1716	0.1452
10	0.2417	0.5987	0.3764	0.5285	0.5367	0.5788	0.6	0.3248	0.2567	0.0627	0.1367	0.1172	0.1052	0.1348
11	0.3005	0.4496	0.3855	0.4058	0.7699	0.6988	0.8543	0.642	0.0992	0.0794	0.0877	0.3422	0.1114	0.0965
12	0.2697	0.3445	0.2998	0.4403	0.7847	0.6619	0.7013	0.8796	0.2899	0.2069	0.1473	0.2392	0.3031	0.0762
13	0.3653	0.3961	0.3183	0.4223	0.978	0.4286	0.7178	0.4915	0.2336	0.0901	0.2085	0.1157	0.23	0.4248
14	0.3549	0.5373	0.3027	0.4228	0.9998	0.4234	0.4713	0.6642	0.2388	0.1606	0.0947	0.8975	0.126	0.3097
15	0.5368	0.4402	0.1738	0.5098	0.9831	0.5014	1.3027	0.227	0.0722	0.0305	0.3572	0.1986	0.1884	0.4713
16	0.5335	0.4846	0.2567	0.4649	0.7355	0.2735	0.9639	0.8187	0.0283	0.1066	0.2555	0.2629	0.2583	0.2243
17	0.3772	0.6853	0.4218	0.2657	0.8163	0.203	0.453	0.3432	0.2333	0.0776	0.301	0.149	0.1817	0.3167
18	0.4695	0.5564	0.5969	0.4165	1.3447	0.3953	0.5549	0.1921	0.0341	0.0395	0.153	0.2405	0.1643	0.1102
+gp	0.4695	0.5564	0.5969	0.4165	1.3447	0.3953	0.5549	0.1921	0.0341	0.0395	0.153	0.2405	0.1643	0.1102
0 FBAR 6-16	0.3162	0.481	0.3665	0.5659	0.6494	0.456	0.6838	0.512	0.1402	0.0827	0.1212	0.2293	0.1591	0.1869

(Table 8) Fishing mortality (F) at age

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	FBAR **-**
AGE											
4	0.0185	0.0082	0.0033	0.0101	0.0027	0.0012	0.002	0.0237	0.038	0.0233	0.0283
5	0.0389	0.0508	0.0028	0.034	0.0059	0.0066	0.0035	0.0381	0.0428	0.027	0.036
6	0.0125	0.0599	0.0096	0.1017	0.0088	0.0298	0.0197	0.0484	0.0404	0.0277	0.0388
7	0.0254	0.0802	0.0234	0.0916	0.072	0.0358	0.0282	0.0775	0.0333	0.0162	0.0423
8	0.0475	0.0755	0.0775	0.0741	0.042	0.0588	0.0306	0.0263	0.0306	0.0146	0.0239
9	0.0834	0.062	0.1356	0.0922	0.0762	0.0545	0.0394	0.0204	0.0313	0.0119	0.0212
10	0.0753	0.0667	0.1391	0.0589	0.0553	0.0476	0.044	0.0428	0.0717	0.0104	0.0416
11	0.1174	0.0563	0.1801	0.0598	0.1064	0.0609	0.0433	0.0661	0.1079	0.0283	0.0674
12	0.0555	0.0797	0.2298	0.0665	0.1411	0.062	0.0636	0.0509	0.187	0.0804	0.1061
13	0.0614	0.0529	0.212	0.0655	0.1154	0.0509	0.0298	0.116	0.087	0.1943	0.1324
14	0.4657	0.0561	0.1041	0.117	0.1349	0.0901	0.0945	0.0856	0.2427	0.1575	0.162
15	0.0847	0.06	0.0867	0.0591	0.2089	0.0655	0.0294	0.0346	0.7508	0.3429	0.3761
16	0.5734	0.4599	0.603	0.0603	0.4716	0.1338	0.0777	0.1064	1.2912	0.5317	0.6431
17	0.4209	0.4876	0.875	0.8693	0.049	0.0815	0.0551	0.075	0.6691	0.3367	0.3603
18	0.2138	0.1735	0.3813	0.2052	0.9477	0.0491	0.1316	0.107	0.8465	0.1353	0.3629
+gp	0.2138	0.1735	0.3813	0.2052	0.9477	0.0491	0.1316	0.107	0.8465	0.1353	
0 FBAR 6-16	0.1456	0.1008	0.1637	0.077	0.1302	0.0627	0.0455	0.0614	0.2613	0.1287	

(Table 9) Relative F at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE														
4	0.0272	0.6189	0.1528	0.0201	2.7689	1.0055	0.1624	0.2692	0.3224	0.0907	0.0648	0.0175	0.1814	0.1338
5	0.0496	0.1277	0.3883	0.5587	1.2508	0.8546	0.2531	0.354	0.1037	0.0528	0.0271	0.0329	0.1068	0.0737
6	0.2671	0.2117	0.525	0.7082	0.4236	0.5358	0.8563	0.1469	0.2684	0.149	0.0108	0.076	0.1589	0.1458
7	0.6718	0.9117	1.2475	1.5115	0.4731	0.7018	0.639	0.5061	0.1073	0.2479	0.0727	0.1558	0.5272	0.2219
8	0.9477	1.5946	1.7911	1.8105	0.7889	0.7635	0.7982	1.1627	0.4687	0.1799	0.1722	0.6722	0.9174	0.5527
9	0.8797	1.5212	1.6698	1.3237	0.3994	1.1716	0.4869	1.2554	1.4511	1.4973	0.1153	0.6087	1.0796	0.7736
10	0.7637	1.244	1.0271	0.9339	0.8263	1.268	0.8743	0.6304	1.8225	0.7533	1.1154	0.5123	0.6555	0.7233
11	0.9494	0.9344	1.0519	0.7172	1.1856	1.5327	1.2469	1.2468	0.7049	0.9557	0.7166	1.4811	0.7044	0.5115
12	0.8519	0.716	0.8184	0.778	1.2084	1.4527	1.026	1.7165	2.0625	2.4914	1.2067	1.0361	1.8969	0.4106
13	1.1546	0.8231	0.8687	0.7465	1.5063	0.9406	1.0515	0.9612	1.6765	1.0879	1.7092	0.5029	1.441	2.2647
14	1.121	1.1173	0.8258	0.7473	1.5412	0.9295	0.689	1.3039	1.7153	1.9588	0.7778	3.9171	0.7919	1.6527
15	1.7001	0.9144	0.4748	0.9005	1.5153	1.1029	1.9129	0.4427	0.5213	0.3722	2.9783	0.8661	1.1958	2.5269
16	1.693	1.0114	0.7	0.8227	1.1318	0.601	1.419	1.6274	0.2017	1.3067	2.125	1.1718	1.6314	1.2163
17	1.2008	1.4362	1.1589	0.4692	1.2606	0.4446	0.6633	0.6794	1.7255	0.939	2.5226	0.6603	1.1795	1.7089
18	1.5035	1.1705	1.6551	0.7437	2.0685	0.8717	0.809	0.3752	0.2479	0.498	1.2605	1.0781	1.0563	0.6125
+gp	1.5035	1.1705	1.6551	0.7437	2.0685	0.8717	0.809	0.3752	0.2479	0.498	1.2605	1.0781	1.0563	0.6125
0 REFMEAN	0.3166	0.4814	0.3667	0.5664	0.6505	0.4572	0.6875	0.5167	0.1413	0.0834	0.1226	0.2312	0.16	0.1879

Table 9 Relative F at age

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	MEAN **-**
AGE											
4	0.1273	0.0811	0.02	0.1314	0.0208	0.0198	0.0441	0.3857	0.1454	0.181	0.2374
5	0.267	0.5043	0.017	0.442	0.045	0.1058	0.0775	0.6212	0.1637	0.2098	0.3316
6	0.0855	0.594	0.0589	1.3212	0.0676	0.475	0.4326	0.7893	0.1545	0.215	0.3863
7	0.1746	0.7954	0.1429	1.1899	0.553	0.5713	0.6195	1.263	0.1275	0.1255	0.5054
8	0.326	0.7488	0.4734	0.9623	0.3222	0.9384	0.6738	0.4281	0.1173	0.1138	0.2197
9	0.5727	0.6151	0.8284	1.1978	0.5854	0.8698	0.8655	0.3322	0.1197	0.0922	0.1814
10	0.5167	0.6611	0.8495	0.7653	0.4246	0.7589	0.9684	0.6969	0.2744	0.0808	0.3507
11	0.8064	0.5582	1.1001	0.777	0.8168	0.9706	0.9516	1.0774	0.4129	0.2198	0.57
12	0.3813	0.7903	1.4038	0.8643	1.0832	0.9889	1.3995	0.8289	0.7159	0.6248	0.7232
13	0.4216	0.5248	1.2948	0.8511	0.8863	0.8113	0.6562	1.89	0.3329	1.5098	1.2443
14	3.1971	0.5567	0.6356	1.5201	1.0355	1.4362	2.0773	1.3955	0.9289	1.2238	1.1827
15	0.5817	0.5946	0.5294	0.7681	1.6042	1.045	0.6476	0.5643	2.8738	2.6636	2.0339
16	3.9365	4.5612	3.6832	0.7831	3.6212	2.1344	1.708	1.7343	4.942	4.1309	3.6024
17	2.8899	4.8353	5.3445	11.2921	0.3764	1.2999	1.2122	1.223	2.5612	2.6157	2.1333
18	1.4681	1.7205	2.3288	2.6658	7.2762	0.7834	2.894	1.7435	3.2401	1.0508	2.0115
+gp	1.4681	1.7205	2.3288	2.6658	7.2762	0.7834	2.894	1.7435	3.2401	1.0508	
0 REFMEAN	0.1456	0.1008	0.1637	0.077	0.1302	0.0627	0.0455	0.0614	0.2613	0.1287	

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

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE														
4	54496	42359	23709	21981	139480	153473	27563	13213	16335	15198	20059	23199	30436	60779
5	71368	48888	28452	20284	19664	20836	87689	22305	10404	14122	13648	18007	20906	26752
6	102288	63571	41598	22328	13375	7886	12755	66670	16810	9277	12722	12309	16169	18596
7	126067	85049	51947	31048	13527	9187	5585	6406	55916	14644	8290	11496	10943	14263
8	97544	92213	49616	29747	11934	8997	6031	3257	4463	49834	12979	7435	10034	9101
9	62735	65381	38723	23278	9653	6464	5742	3152	1616	3779	44420	11499	5759	7840
10	47554	42965	28443	18994	9952	6736	3423	3717	1491	1191	3018	39629	9039	4384
11	35599	33786	21359	17659	10126	5260	3413	1698	2429	1043	1012	2382	31852	7364
12	27626	23848	19496	13141	10644	4237	2362	1310	807	1989	871	839	1530	25750
13	21857	19087	15287	13067	7653	4388	1973	1056	488	545	1462	680	597	1022
14	20700	13721	11621	10059	7747	2599	2583	866	581	349	451	1073	548	429
15	13130	13134	7250	7768	5961	2572	1538	1455	400	413	268	371	392	437
16	7512	6935	7652	5512	4220	2013	1406	373	1047	336	362	168	275	293
17	7053	3977	3856	5356	3130	1829	1384	479	146	921	273	252	116	191
18	5465	4363	1802	2281	3716	1247	1350	793	305	103	771	181	196	87
+gp	13825	11077	7595	5270	2128	1756	3038	1721	2319	1343	1077	2652	412	521
0 TOTAL	714820	570354	358407	247772	272908	239481	167834	128473	115557	115088	121685	132171	139205	177810

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

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	GMST 89-**	AMST 89-**
AGE													
4	97977	130733	196450	246473	199842	242621	264687	142814	95785	56593	0	61515	98358
5	53630	87025	117328	177174	163553	133596	162432	177070	93492	81379	48794	44660	67961
6	23874	46675	74839	105867	114790	108993	88960	108498	114254	79052	69904	33769	49493
7	16372	21334	39778	67068	64102	76271	70916	58470	69290	96839	67860	26324	39031
8	12379	14442	17816	35161	55374	53972	66585	46216	36271	59144	84092	20273	31597
9	7422	10682	12117	14919	29543	48045	46045	43286	30176	31043	51436	14240	22823
10	6134	6179	9084	9574	12310	24769	41165	29673	28430	25810	27073	9988	16337
11	3463	5148	5230	7152	8167	10539	21371	26405	19058	23354	22542	7163	11930
12	6053	2786	4403	3952	6096	6644	8973	13718	16568	15099	20035	4909	8503
13	21569	5181	2328	3166	3346	4790	5650	5644	8740	12127	12295	3367	6402
14	604	18354	4446	1704	2683	2698	4119	3676	3369	7070	8812	2435	5073
15	285	343	15701	3625	1372	2121	2231	2512	2262	2332	5330	1675	3785
16	246	237	293	13027	3092	1007	1798	1452	1627	942	1461	1168	2693
17	211	125	135	145	11098	1746	797	1115	875	395	489	778	2015
18	126	125	70	51	55	9561	1456	506	693	395	249	528	1573
+gp	1449	2253	278	633	504	10233	8444	6899	2790	14837	11742		
0 TOTAL	251793	351622	500297	689692	675927	737606	795629	667955	523680	506412	432113		

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

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE														
4														
5														
6														
7	55943	36494	20518	10642	5224	3775	2252	2881	28588	7324	3756	4037	4507	5895
8	42701	39401	20969	11690	4022	3255	2107	1358	2818	25281	6877	3642	4329	3492
9	27328	28566	17411	11157	3667	2506	2213	1315	962	1759	22184	7670	3172	3406
10	19989	18486	12704	9229	3906	2941	1408	1843	774	531	1753	21029	6464	3218
11	14170	14323	10437	7937	3617	2176	1299	881	1293	432	504	1731	18664	4632
12	11667	11162	10442	6028	3679	1658	857	656	409	786	449	344	784	19117
13	10466	10200	8634	6667	2878	1703	656	594	250	203	702	441	250	678
14	10479	7549	7033	5537	3149	1136	950	477	294	142	195	459	229	260
15	6850	7723	4646	4476	2443	1083	534	839	199	143	126	250	156	236
16	3927	4083	5302	3672	4382	1100	631	217	564	133	164	119	117	108
17	4120	2333	2563	3490	2024	1146	663	306	80	420	149	189	44	92
18	3074	2574	1185	1746	2337	802	755	513	170	34	413	121	74	37
+gp	10628	7500	5598	4054	1255	1179	2266	1187	1494	888	714	1687	309	231

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

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AGE										
4										
5										
6										
7	6337	10914	21191	34675	34332	45495	34812	32810	34414	46057
8	4233	7120	11400	20007	34054	35758	39434	32830	26687	32285
9	2319	5198	6754	9094	21585	32886	28362	32689	22798	20726
10	2238	3372	5008	5889	11052	18016	29995	23228	21354	18817
11	1545	3416	3575	4837	7431	7824	17532	21496	15040	16725
12	3551	2128	3191	2438	5716	4984	6779	11314	13364	10887
13	7772	4325	1546	2212	3177	3616	4788	4739	6677	8617
14	402	11655	3784	1226	2528	2027	3433	3122	2784	5004
15	214	313	11400	3036	1263	1193	1884	2329	1797	1723
16	184	182	158	8334	2656	444	1478	1223	1070	734
17	161	104	79	99	9957	724	728	922	821	377
18	101	101	41	50	36	7369	1294	438	634	284
+gp	1145	1680	160	578	429	4661	7170	5684	2517	11596

(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
AGE														
4	5450	4109	2584	2110	9206	13813	2811	1044	1470	1353	1745	2250	2587	6139
5	11704	8360	3841	3468	3068	2709	9909	3078	1321	1949	1651	2377	2927	3531
6	20969	13477	8902	4644	2835	1782	2768	9400	3194	1679	2239	2142	2894	3422
7	31265	22198	14337	9066	3882	2536	1609	1730	9729	3353	1849	2690	2604	3238
8	27703	27572	16721	10531	4356	3131	2153	1068	1584	11063	3375	2119	2980	2566
9	19887	21641	14908	9218	3813	2553	2326	1210	656	1402	10927	3783	1889	2532
10	16596	15510	13226	8585	4319	3125	1561	1647	695	503	975	11770	3471	1710
11	15343	14967	11000	9271	5195	2593	1754	815	1226	511	479	996	10830	3005
12	14117	12496	11093	7503	5897	2246	1290	698	462	1094	491	443	790	10248
13	12305	11109	9417	8298	4775	2409	1247	612	297	340	750	454	357	573
14	12130	8260	7542	6840	5322	1749	1813	520	361	240	249	605	363	255
15	8285	8563	5075	5468	4256	1695	1116	944	273	295	145	184	262	275
16	4830	4633	5961	4448	3676	1447	1141	260	781	272	200	113	169	211
17	4979	2907	2946	4119	2670	1492	1137	362	115	766	175	181	90	123
18	3842	3172	1431	2005	3221	1063	1173	630	232	75	474	130	167	78
+gp	12166	10191	6775	4917	2343	1601	3241	1645	2164	1481	825	1989	416	496
0 TOTALBIO	221572	189165	135760	100492	68833	45944	37050	25665	24561	26376	26549	32226	32796	38403

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

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AGE										
4	7446	12289	18073	21690	21783	24505	30968	16852	13218	6791
5	5846	10443	13962	20198	19626	17368	21603	26738	14585	12939
6	3844	7608	12423	16621	15726	18311	15746	19747	21594	15336
7	3553	4715	8513	14420	13141	16627	13474	12805	14897	21789
8	3268	4015	4864	9318	13843	14842	15115	12155	10627	14904
9	2383	3664	4108	5028	9277	15615	11972	12553	9355	9189
10	2178	2336	3443	3839	4887	9140	13132	9644	8927	9034
11	1430	2286	2401	3083	3732	4374	8463	9611	6918	8150
12	2796	1387	2118	1696	3170	2910	2925	5309	6826	6115
13	7571	2865	1075	1558	1814	2117	3068	2579	2945	5421
14	337	7819	2628	908	1446	1327	1796	1658	1506	2991
15	166	218	7882	2132	717	1203	1062	1563	932	1108
16	157	162	208	5497	1234	609	901	765	711	457
17	107	68	98	80	5427	1032	539	527	509	234
18	87	95	63	43	40	4283	1190	262	338	174
+gp	1093	1701	241	490	279	7869	4492	3567	1604	7196
0 TOTALBIO	42261	61670	82099	106598	116142	142131	146445	136335	115493	121828

(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
AGE														
4														
5														
6														
7	13874	9525	5663	3107	1499	1042	649	778	4974	1677	838	945	1073	1338
8	12127	11781	7067	4138	1468	1133	752	445	1001	5612	1788	1038	1286	985
9	8663	9455	6703	4418	1449	990	896	505	391	653	5457	2523	1040	1100
10	6976	6673	5907	4172	1695	1365	642	817	361	224	566	6246	2482	1255
11	6107	6345	5375	4167	1856	1073	668	423	653	212	238	724	6346	1890
12	5962	5849	5941	3442	2038	879	468	350	234	432	253	181	404	7608
13	5892	5936	5318	4234	1796	935	414	344	152	127	360	295	149	380
14	6141	4545	4564	3765	2163	765	667	286	182	98	108	259	152	155
15	4322	5035	3252	3151	1744	714	388	545	136	102	68	124	104	149
16	2525	2727	4131	2963	3816	791	512	151	421	108	91	80	72	78
17	2909	1705	1958	2684	1726	935	545	231	63	349	96	136	34	59
18	2161	1871	941	1535	2026	683	656	407	129	25	254	87	63	33
+gp	9353	6900	4994	3782	1382	1075	2417	1134	1393	980	547	1265	312	220
0 TOTSPBIO	87011	78349	61814	45558	24658	12379	9674	6418	10089	10598	10664	13903	13517	15250

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

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AGE										
4										
5										
6										
7	1375	2412	4535	7455	7038	9918	6614	7185	7399	10363
8	1117	1979	3112	5302	8513	9833	8952	8634	7819	8136
9	744	1783	2290	3065	6778	10688	7374	9480	7067	6135
10	794	1274	1898	2361	4387	6648	9568	7549	6705	6586
11	638	1517	1641	2085	3396	3247	6943	7824	5459	5837
12	1640	1060	1535	1046	2973	2183	2210	4378	5506	4409
13	2728	2391	714	1088	1722	1598	2600	2166	2250	3852
14	224	4965	2236	653	1362	997	1497	1408	1244	2117
15	125	199	5723	1785	661	677	897	1449	740	819
16	118	124	112	3517	1060	268	740	644	468	356
17	82	56	57	55	4869	428	492	436	478	224
18	70	77	37	42	26	3301	1057	227	310	125
+gp	863	1268	139	447	237	3585	3815	2939	1447	5624
0 TOTSPBIO	10520	19106	24030	28901	43022	53372	52758	54320	46893	54582

(Table 16) Summary (without SOP correction)

Terminal Fs derived using XSA (Without F shrinkage)

	RECRUITS Age 4	4+BIO	ABUNDANCE	7+ FEMBIO	LANDINGS	YIELD/7+FEI	FBAR 6-16
1989	54496	221572	714820	87011	58086	0.6676	0.3166
1990	42359	189165	570354	78349	80223	1.0239	0.4814
1991	23709	135760	358407	61814	48500	0.7846	0.3667
1992	21981	100492	247772	45558	43300	0.9504	0.5664
1993	139480	68833	272908	24658	43100	1.7479	0.6505
1994	153473	45944	239481	12379	17664	1.427	0.4572
1995	27563	37050	167834	9674	13879	1.4347	0.6875
1996	13213	25665	128473	6418	6101	0.9506	0.5167
1997	16335	24561	115557	10089	1408	0.1396	0.1413
1998	15198	26376	115088	10598	1011	0.0954	0.0834
1999	20059	26549	121685	10664	1095	0.1027	0.1226
2000	23199	32226	132171	13903	3665	0.2636	0.2312
2001	30436	32796	139205	13517	3327	0.2461	0.16
2002	60779	38403	177810	15250	2964	0.1944	0.1879
2003	97977	42261	251793	10520	2273	0.2161	0.1456
2004	130733	61670	351622	19106	3260	0.1706	0.1008
2005	196450	82099	500297	24030	4039	0.1681	0.1637
2006	246473	106598	689692	28901	5936	0.2054	0.077
2007	199842	116142	675927	43022	5131	0.1193	0.1302
2008	242621	142131	737606	53372	4274	0.0801	0.0627
2009	264687	146445	795629	52758	3639	0.069	0.0455
2010	142814	136335	667955	54320	5235	0.0964	0.0614
2011	95785	115493	523680	46893	8904	0.1899	0.2613
2012	56593	121828	506412	54582	5864	0.1074	0.1287
Arith. Mean	96671	86737	383424	32600	15537	0.4885	0.2551
0 Units	(Thousands)	(Tonnes)	(Thousands)	(Tonnes)	(Tonnes)		

Table 16a: stock recruitment Mterm input file

5	Nparams
5	Geometric mean model
61.515	1989-2010 age 4 XSA geomean in millions
0.00000E+000	
0.00000E+000	
0	
0.00000E+000	
22	Ndata log residuals
-0.121	
-0.373	
-0.953	
-1.029	
0.819	
0.914	
-0.803	
-1.538	
-1.326	
-1.398	
-1.121	
-0.975	
-0.704	
-0.012	
0.465	
0.754	
1.161	
1.388	
1.178	
1.372	
1.459	
0.842	
0	No extra data

Table 16b: An explanation of the red.sen file input data with an exploitation pattern corresponding to F*statusquo*

N4=1989-2010 age 4 XSA geometric mean

Name	Value	C.V.	Name	Value	C.V.	Name	Value	C.V.	Name	Value	C.V.
Population at age in 2011			Exploitation pattern (H - Human consumption)			Exploitation pattern (D - Discards)			Exploitation pattern (I - Industrials)		
'N4'	61515	0.79	'sH4'	0.0283	0.0084	'sD4'	0.00	0.00	'sI4'	0.00	0.00
'N5'	48794	0.34	'sH5'	0.0360	0.0081	'sD5'	0.00	0.00	'sI5'	0.00	0.00
'N6'	69904	0.42	'sH6'	0.0388	0.0104	'sD6'	0.00	0.00	'sI6'	0.00	0.00
'N7'	67860	0.31	'sH7'	0.0423	0.0316	'sD7'	0.00	0.00	'sI7'	0.00	0.00
'N8'	84092	0.25	'sH8'	0.0239	0.0083	'sD8'	0.00	0.00	'sI8'	0.00	0.00
'N9'	51436	0.26	'sH9'	0.0212	0.0097	'sD9'	0.00	0.00	'sI9'	0.00	0.00
'N10'	27073	0.32	'sH10'	0.0416	0.0307	'sD10'	0.00	0.00	'sI10'	0.00	0.00
'N11'	22542	0.21	'sH11'	0.0674	0.0398	'sD11'	0.00	0.00	'sI11'	0.00	0.00
'N12'	20035	0.21	'sH12'	0.1061	0.0716	'sD12'	0.00	0.00	'sI12'	0.00	0.00
'N13'	12295	0.22	'sH13'	0.1324	0.0555	'sD13'	0.00	0.00	'sI13'	0.00	0.00
'N14'	8812	0.17	'sH14'	0.1620	0.0786	'sD14'	0.00	0.00	'sI14'	0.00	0.00
'N15'	5330	0.21	'sH15'	0.3761	0.3593	'sD15'	0.00	0.00	'sI15'	0.00	0.00
'N16'	1461	0.23	'sH16'	0.6431	0.6002	'sD16'	0.00	0.00	'sI16'	0.00	0.00
'N17'	489	0.20	'sH17'	0.3603	0.2978	'sD17'	0.00	0.00	'sI17'	0.00	0.00
'N18'	249	0.17	'sH18'	0.3629	0.4190	'sD18'	0.00	0.00	'sI18'	0.00	0.00
'N19'	11742	0.17	'sH19'	0.3629	0.4190	'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'	0.125	0.011	'WH4'	0.131	0.008	'WD4'	0.00	0.00	'WI4'	0.00	0.00
'WS5'	0.155	0.004	'WH5'	0.159	0.010	'WD5'	0.00	0.00	'WI5'	0.00	0.00
'WS6'	0.188	0.006	'WH6'	0.188	0.012	'WD6'	0.00	0.00	'WI6'	0.00	0.00
'WS7'	0.220	0.005	'WH7'	0.224	0.018	'WD7'	0.00	0.00	'WI7'	0.00	0.00
'WS8'	0.269	0.021	'WH8'	0.288	0.012	'WD8'	0.00	0.00	'WI8'	0.00	0.00
'WS9'	0.299	0.010	'WH9'	0.325	0.014	'WD9'	0.00	0.00	'WI9'	0.00	0.00
'WS10'	0.330	0.019	'WH10'	0.396	0.038	'WD10'	0.00	0.00	'WI10'	0.00	0.00
'WS11'	0.359	0.008	'WH11'	0.411	0.019	'WD11'	0.00	0.00	'WI11'	0.00	0.00
'WS12'	0.401	0.013	'WH12'	0.472	0.027	'WD12'	0.00	0.00	'WI12'	0.00	0.00
'WS13'	0.414	0.067	'WH13'	0.461	0.066	'WD13'	0.00	0.00	'WI13'	0.00	0.00
'WS14'	0.441	0.015	'WH14'	0.483	0.025	'WD14'	0.00	0.00	'WI14'	0.00	0.00
'WS15'	0.503	0.108	'WH15'	0.516	0.043	'WD15'	0.00	0.00	'WI15'	0.00	0.00
'WS16'	0.483	0.045	'WH16'	0.578	0.028	'WD16'	0.00	0.00	'WI16'	0.00	0.00
'WS17'	0.549	0.066	'WH17'	0.572	0.066	'WD17'	0.00	0.00	'WI17'	0.00	0.00
'WS18'	0.482	0.039	'WH18'	0.492	0.034	'WD18'	0.00	0.00	'WI18'	0.00	0.00
'WS19'	0.526	0.046	'WH19'	0.661	0.067	'WD19'	0.00	0.00	'WI19'	0.00	0.00

Name	Value	C.V.	Name	Value	C.V.
Natural mortality at age			Maturity		
'M4'	0.125	0.00	'MT4'	0.000	0.000
'M5'	0.125	0.00	'MT5'	0.000	0.000
'M6'	0.125	0.00	'MT6'	0.000	0.000
'M7'	0.125	0.00	'MT7'	0.523	0.053
'M8'	0.125	0.00	'MT8'	0.677	0.109
'M9'	0.125	0.00	'MT9'	0.740	0.057
'M10'	0.125	0.00	'MT10'	0.770	0.038
'M11'	0.125	0.00	'MT11'	0.791	0.061
'M12'	0.125	0.00	'MT12'	0.805	0.064
'M13'	0.125	0.00	'MT13'	0.794	0.074
'M14'	0.125	0.00	'MT14'	0.819	0.084
'M15'	0.125	0.00	'MT15'	0.859	0.097
'M16'	0.125	0.00	'MT16'	0.812	0.070
'M17'	0.125	0.00	'MT17'	0.951	0.079
'M18'	0.125	0.00	'MT18'	0.875	0.130
'M19'	0.125	0.00	'MT19'	0.877	0.090
Natural mortality multiplier in year			Effort multiplier in year (H - Human consumption)		
'K2012'	1	0.0	'HF2012'	1.0	0.0
'K2013'	1	0.0	'HF2013'	1.0	0.0
'K2014'	1	0.0	'HF2014'	1.0	0.0

Table 17a: Short term (2015) 7plus Fembiomass projections under a range of Fstatus quo multilpiers.

	Relative Fbar					$F_{satusquo}$					
2015	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
5^{th} %ile	69656	68521	67432	66389	65384	64417	63487	62588	61720	60881	60068
10^{th} %ile	72307	71222	70180	69111	68051	67021	66107	65236	64333	63464	62643
25^{th} %ile	75101	73982	72894	71787	70717	69693	68743	67838	66965	66090	65232
50^{th} %ile	81823	80609	79425	78291	77226	**76180**	75174	74184	73229	72332	71460
95^{th} %ile	97863	96505	95180	93903	92671	91480	90329	89215	88136	87089	86074

Final assessment data year	2012	
First year for populations in Sen	2013	
First SSB profile 3 years ahead	2015	SSB 2015

Tab. 17b: SSB and yield 5th, 25th, 50th and 95% %ile probability profiles under $F_{statusquo}$, 2013-2022

	5th %ile	10th %ile	25th %ile	50th %ile	95th %ile
Year	SSB				
2013	62032	63972	66520	71326	83475
2014	**64837**	66953	69568	75683	90023
2015	**64417**	67021	69693	76180	91480
2016	63817	66622	69736	76592	94384
2017	61571	64490	68585	76921	99432
2018	57657	61324	65972	77100	103149
2019	54659	58116	64995	78013	106708
2020	51238	55834	62667	77519	110378
2021	47288	53054	61046	76465	110449
2022	45647	51001	59425	76537	112242
Year	Yield				
2013	8318	8507	8766	9346	10525
2014	**8412**	8653	8924	9518	10885
2015	**8710**	8987	9323	10047	11597
2016	9313	9616	10031	10940	12723
2017	9905	10257	10711	11779	13893
2018	9985	10390	10905	11910	14255
2019	10348	10761	11313	12483	15132
2020	10767	11220	12064	13318	16474
2021	10519	11023	11731	13359	16959
2022	9481	10025	10773	12522	16359

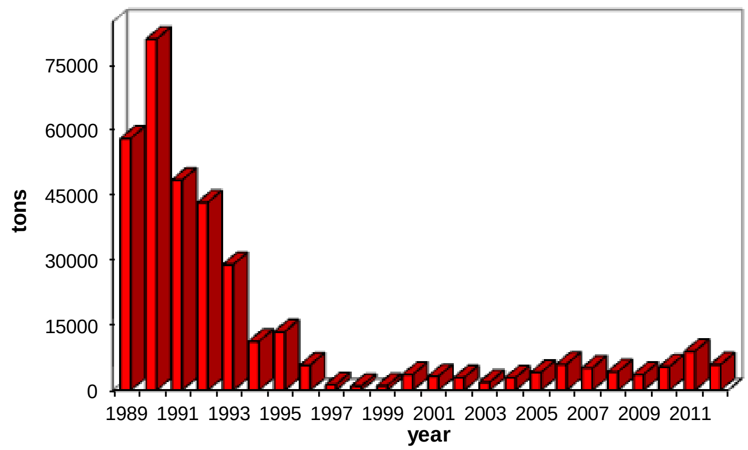


Fig. 1a: Beaked redfish commercial catch estimates.

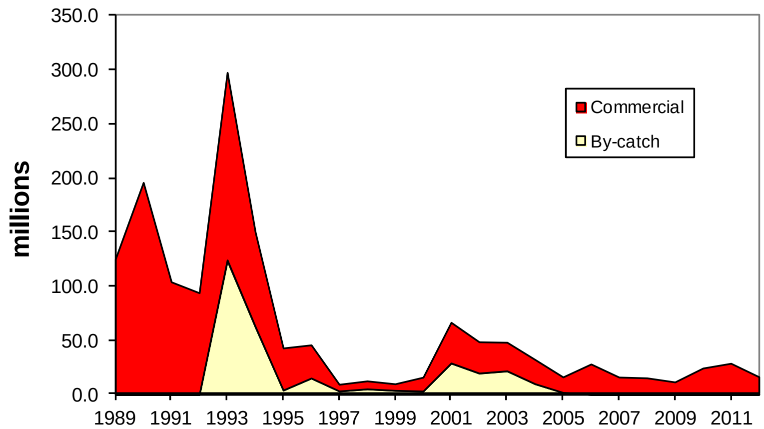


Fig. 1b: Beaked redfish commercial catch and by-catch in numbers

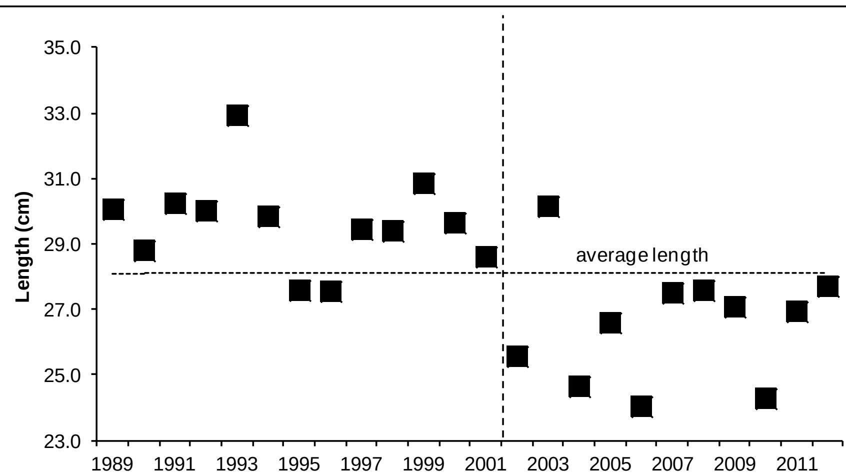


Fig. 2: Mean length of the commercial catch, 1989-2012

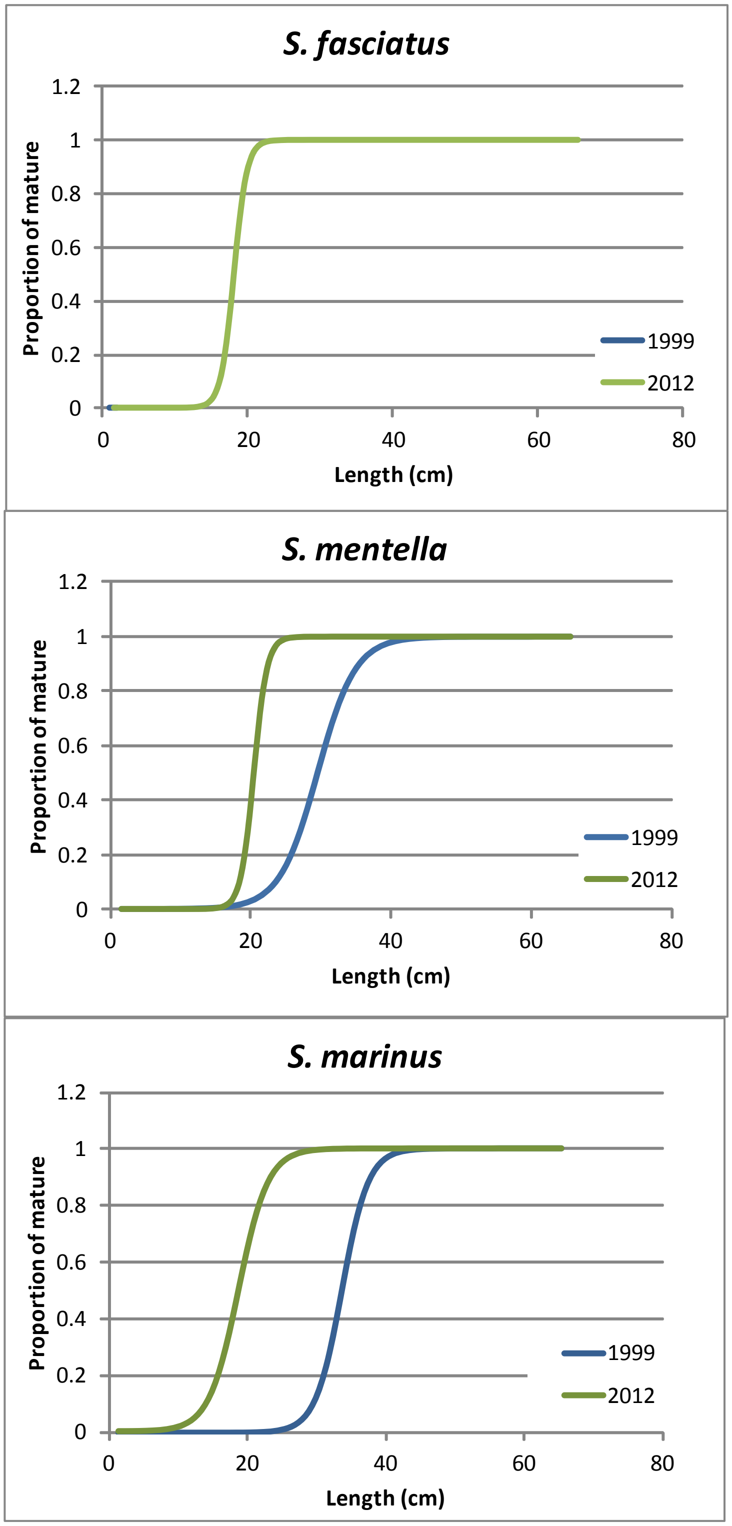


Figure 3: Temporal variation of maturity ogives for the three species of the genus *Sebastes* in Flemish Cap (*S. fasciatus*, *S. mentella* and *S. marinus*) between 1999 and 2012.

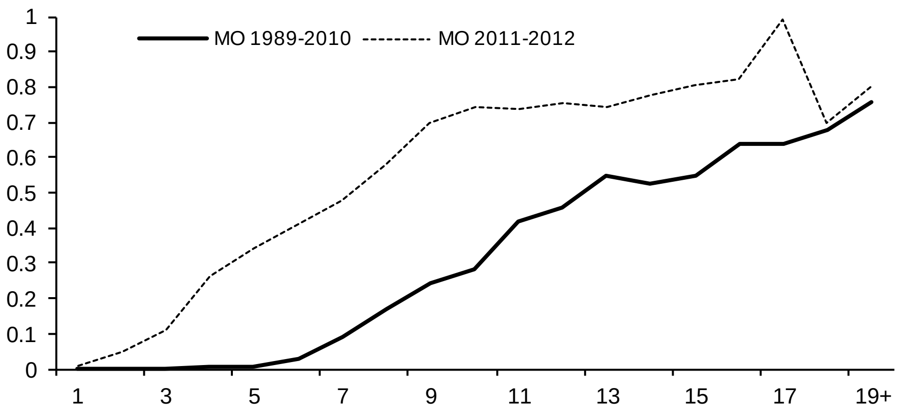


Fig. 4a: Female mature proportion at age, 1989-2010 and 2011-2012

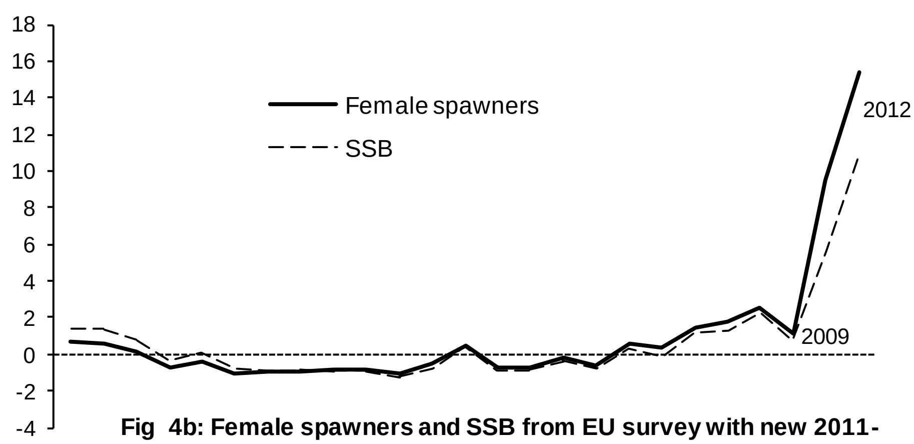


Fig 4b: Female spawners and SSB from EU survey with new 2011-2012 maturity ogives at length (standardized to the 1988-2010 average)

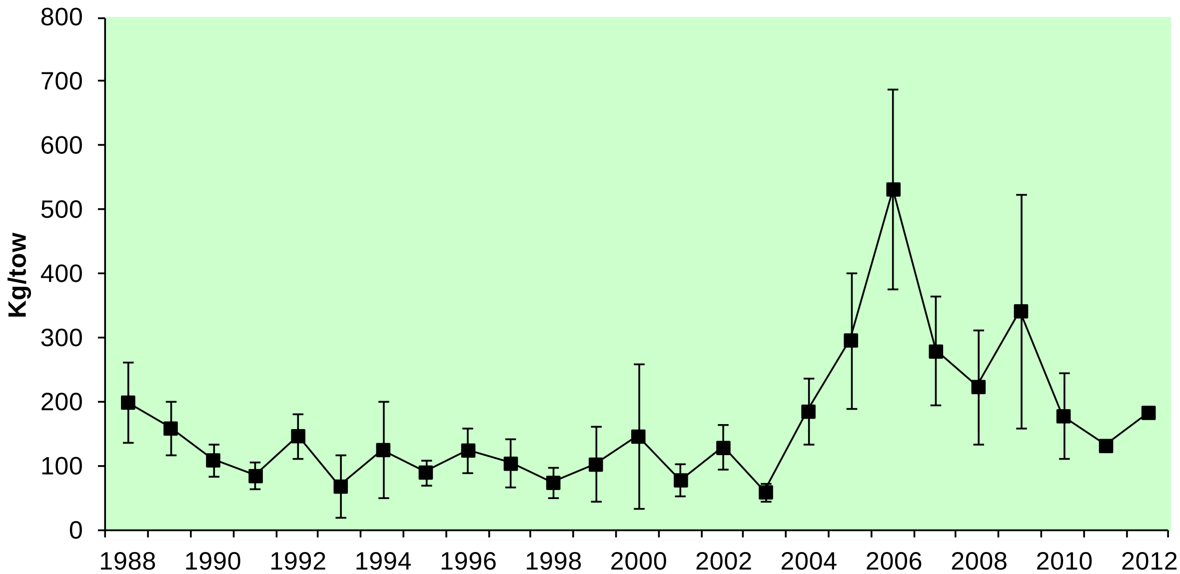


Fig. 5: mean catch per tow for 3M beaked refish (EU survey, 1988-2012) with associated +/- 1.96 se

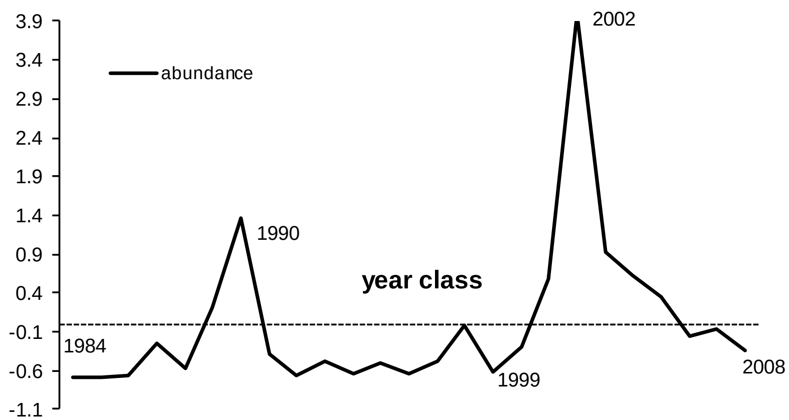


Fig 6a : Standardized *year class strength at age 4* given by EU surveys, 1989-2012

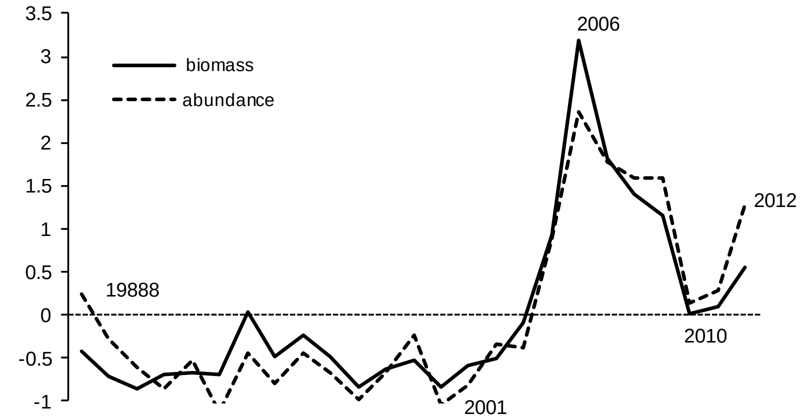


Fig 6c : Standardized *4+ abundance and biomass* given by EU surveys, 1988-2012

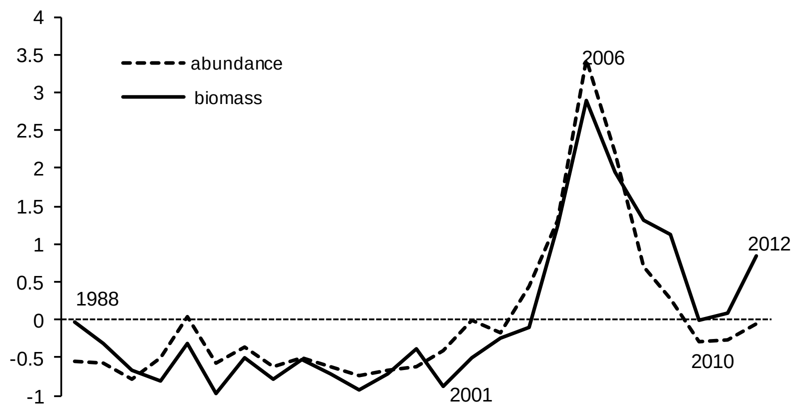


Fig 6b: Standardized *total abundance and biomass* given by EU surveys, 1988-2012

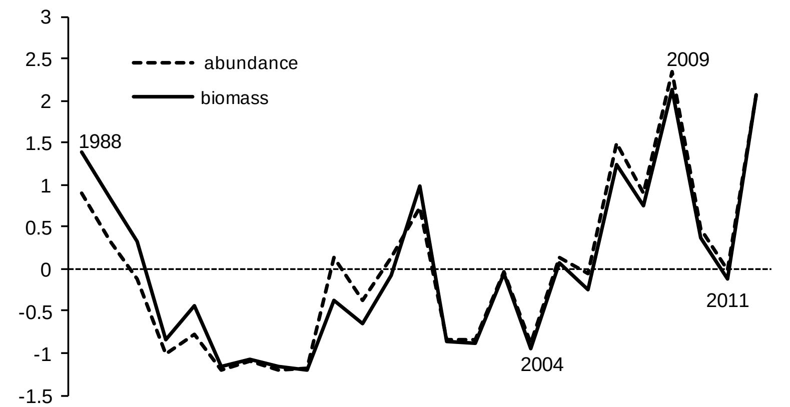


Fig 6d: Standarized *7+ female abundance and biomass* given by EU surveys, 1988-2012

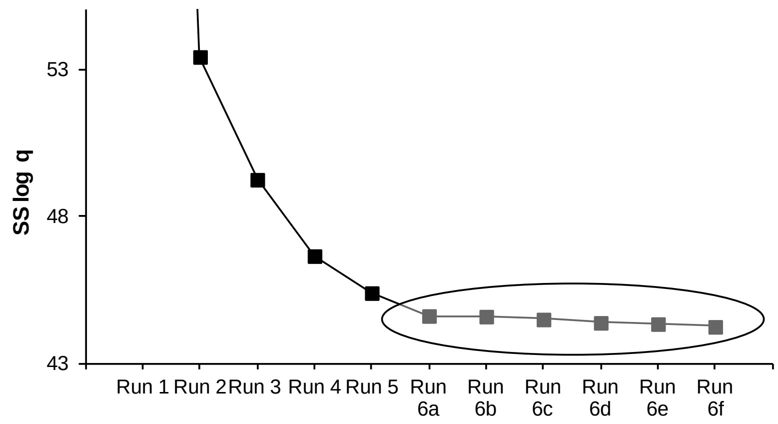


Fig 7a: XSA$_{2013}$ SS$_{2006\text{-}2012}$ log q residuals with different M sets (see text)

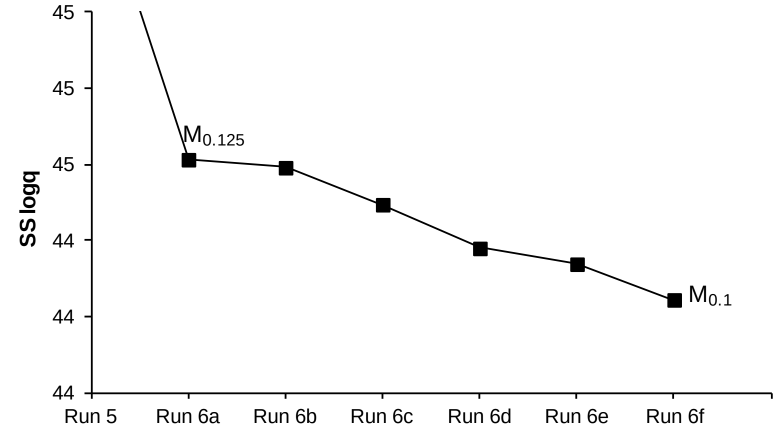


Fig 7b: XSA$_{2013}$ SS$_{2006\text{-}2012}$ log q residuals with the six "best" 2011-2012 M sets (see text)

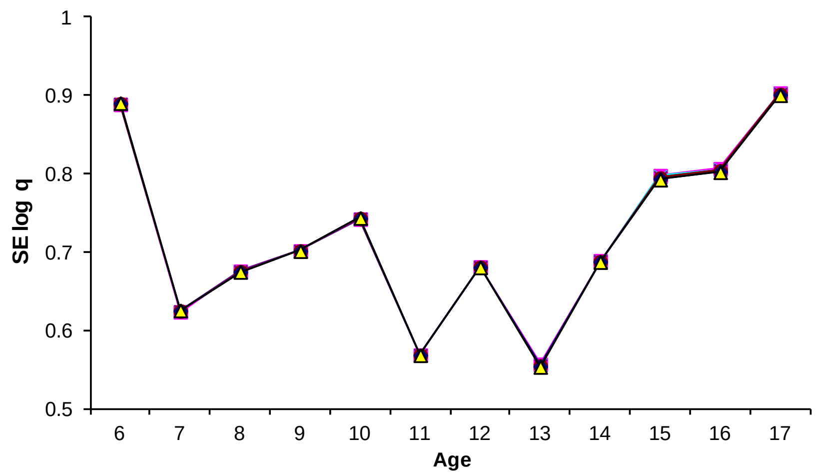


Fig. 8a: XSA$_{2013}$SE Log q for a gradient of M between 0.1 and 0.125

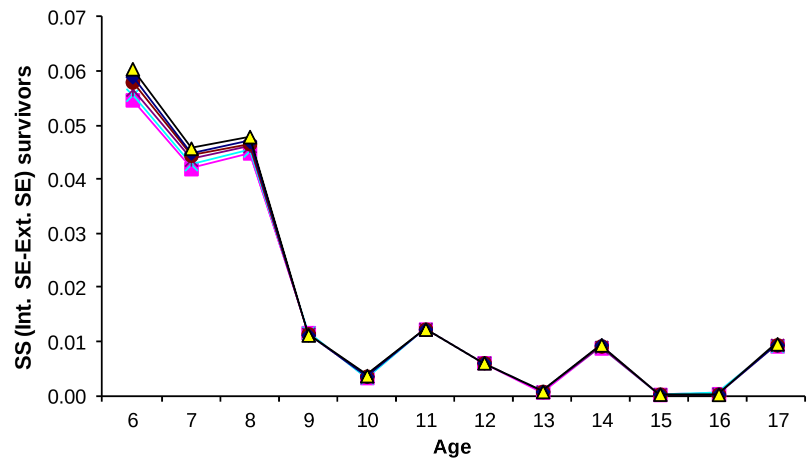


Fig. 8b : XSA2013 SS (Int. SE-Ext. SE) of survivors for a gradient of M between 0.1 and 0.125

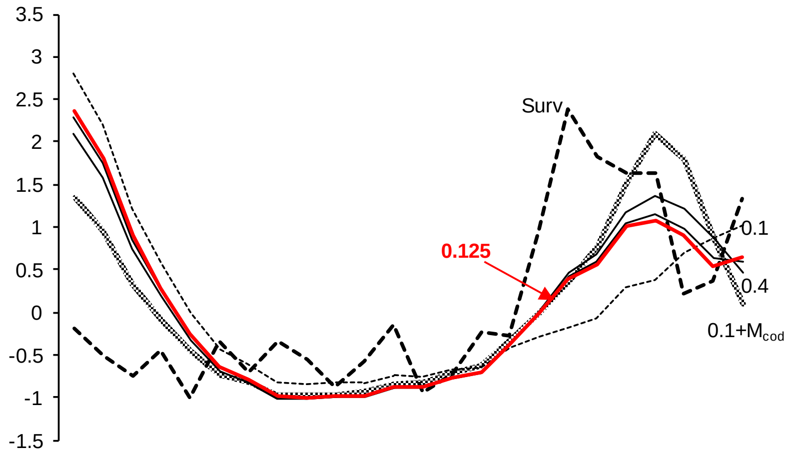


Fig 9a: Standardized 4+ biomass given by XSA_{2013} with six different M sets versus 4+EU survey biomass, 1989-2012

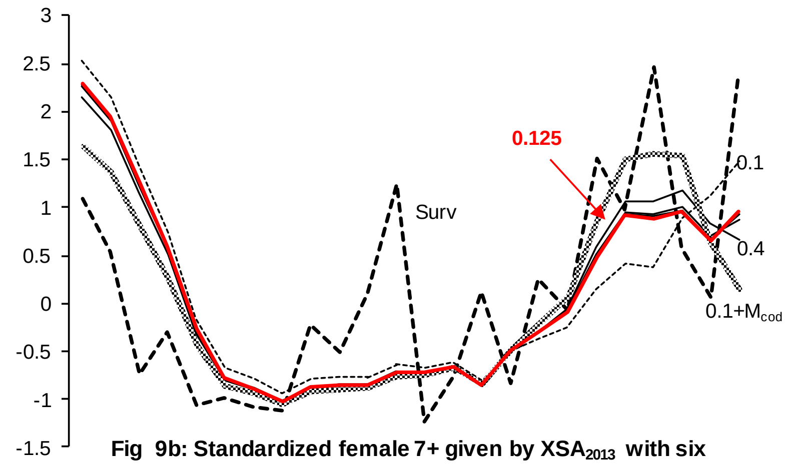


Fig 9b: Standardized female 7+ given by XSA_{2013} with six different M sets versus and female 7+ given by EU survey, 1989-2012

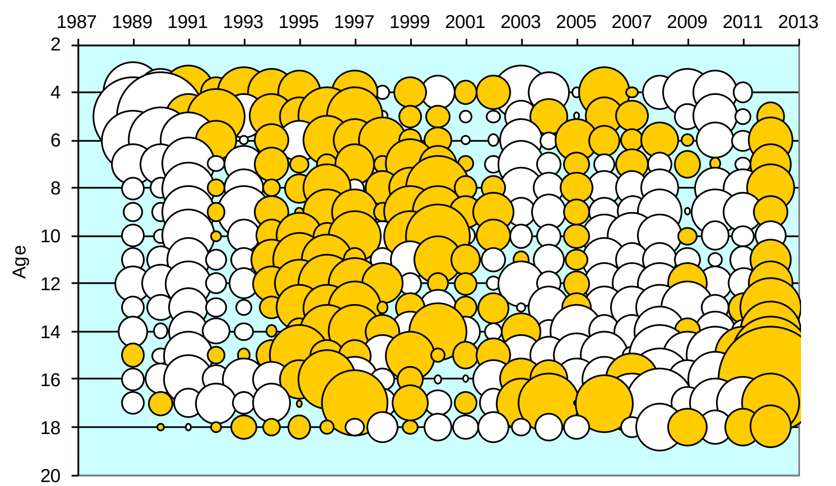


Fig. 10a: XSA 2013 $M+M_{cod}$

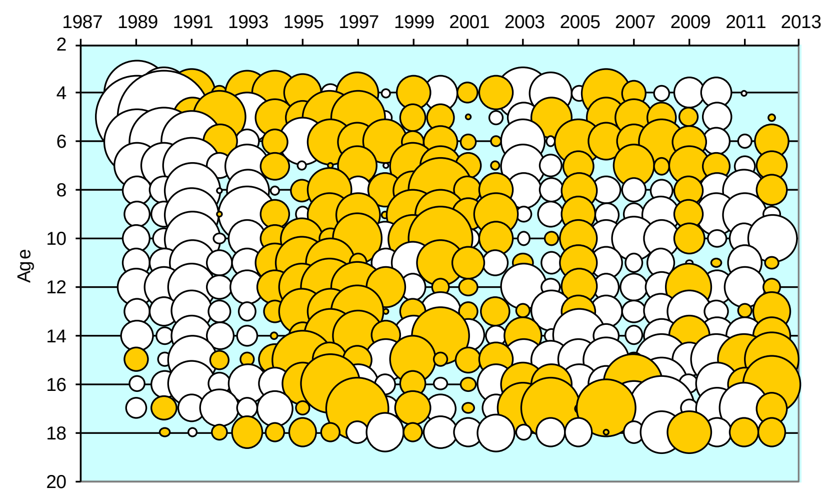


Fig. 10b: XSA 2013 M 0.125

Fig. 10a and 10b: Log q residuals for the worst and one of the best options considered on the XSA2013 sensitivity analysis (see text).

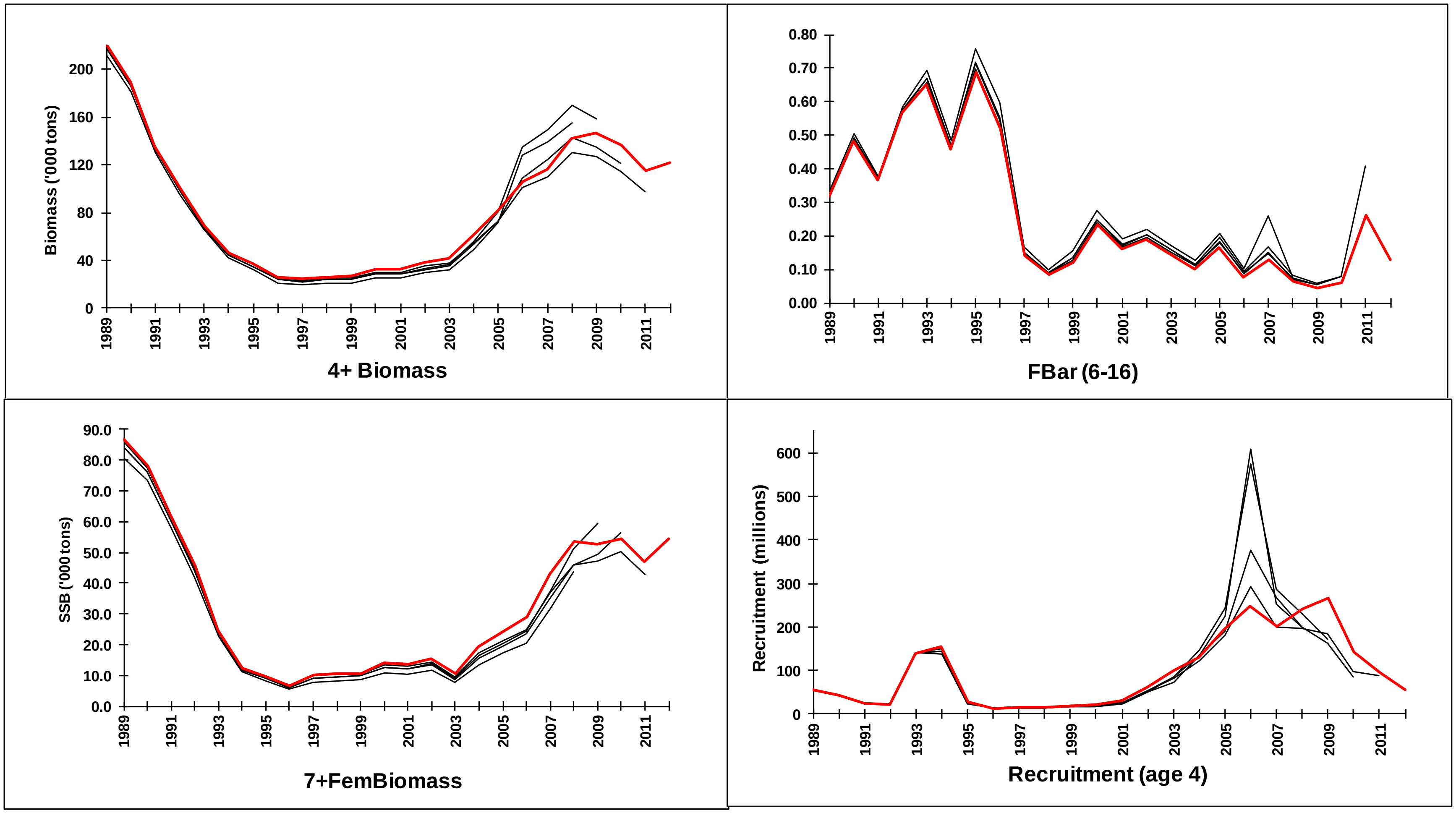
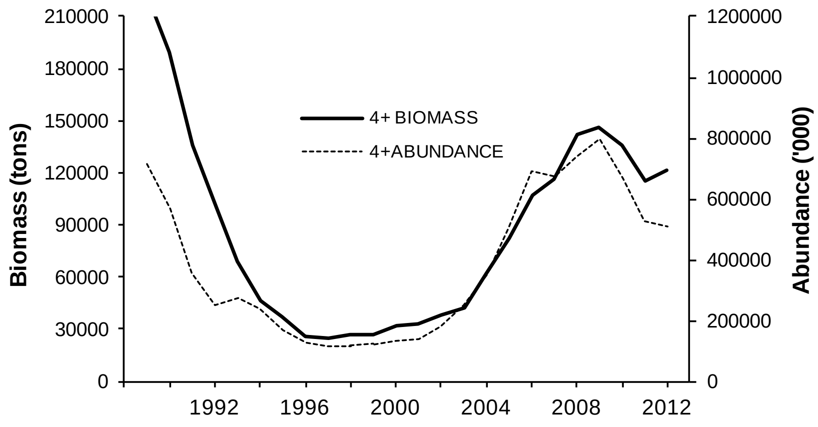
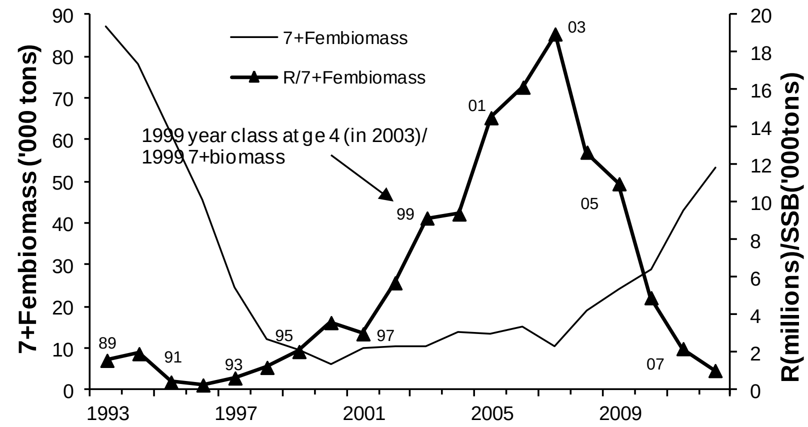


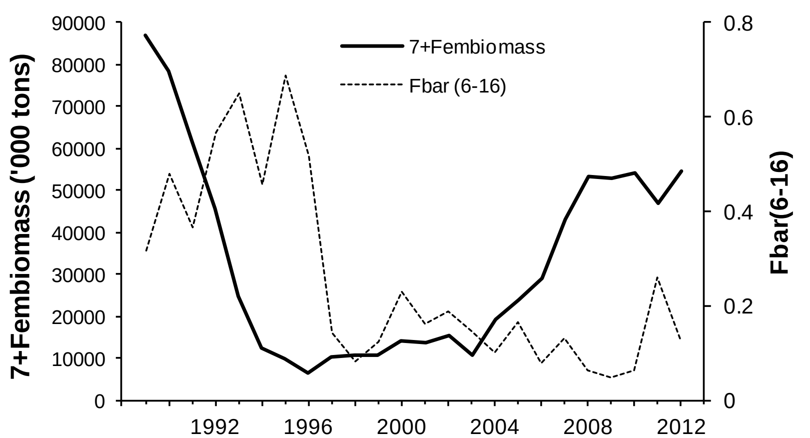
Fig. 11: Main results of retrospective XSA2013-2009



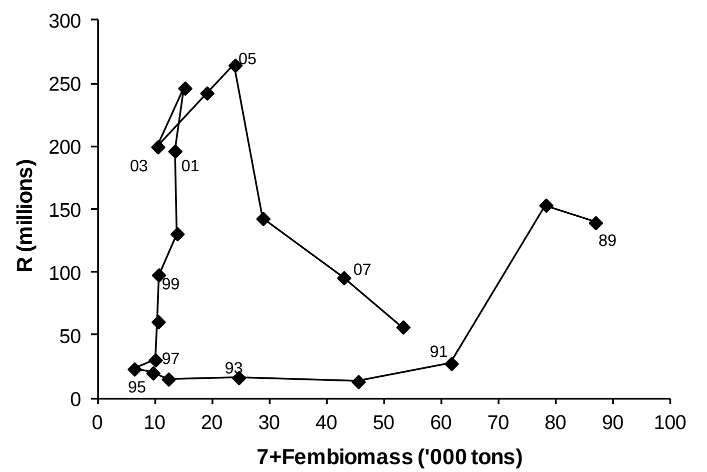
4+Biomass vs 4+Abundance from XSA



Recruitment (age 4)/7+Fembiomass from XSA



7+Fembiomass vs FBar from XSA



SR plot from XSA

Fig. 12a: XSA results for 2013 assessment.

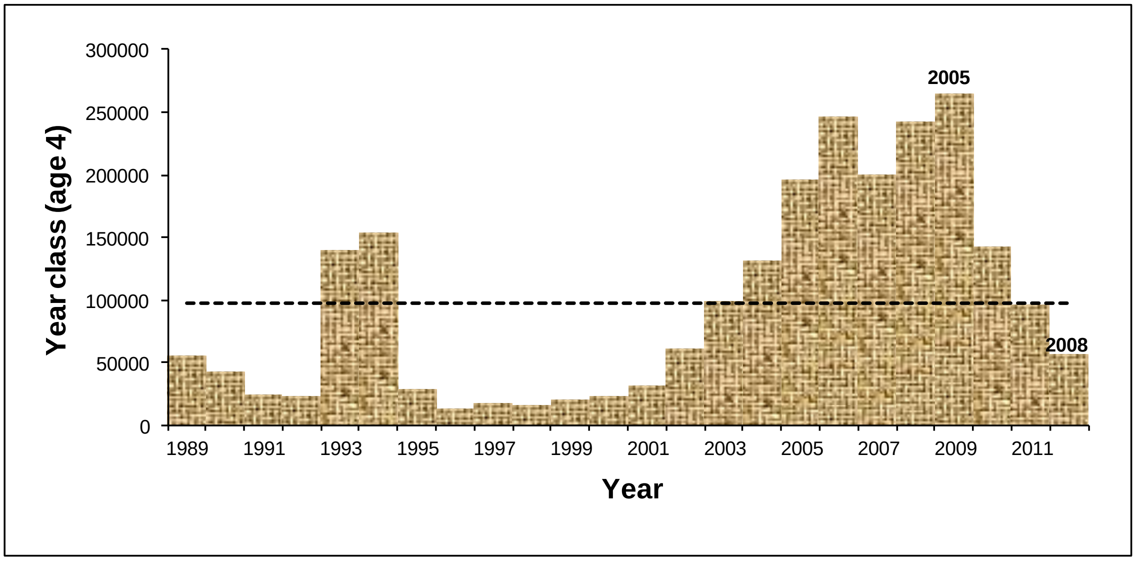


Fig. 12b: Year Class strength at recruitment from 2013 XSA.

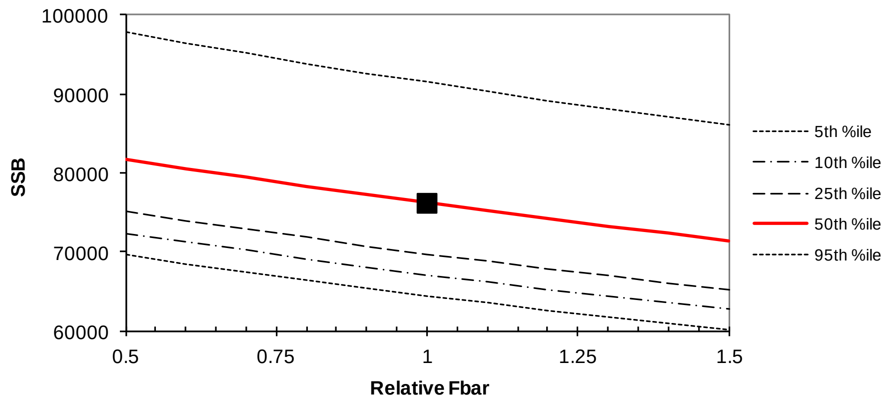


Fig. 13a: 7plus Fembiomass$_{2015}$ projections under a range of F$_{statusquo}$ multipliers

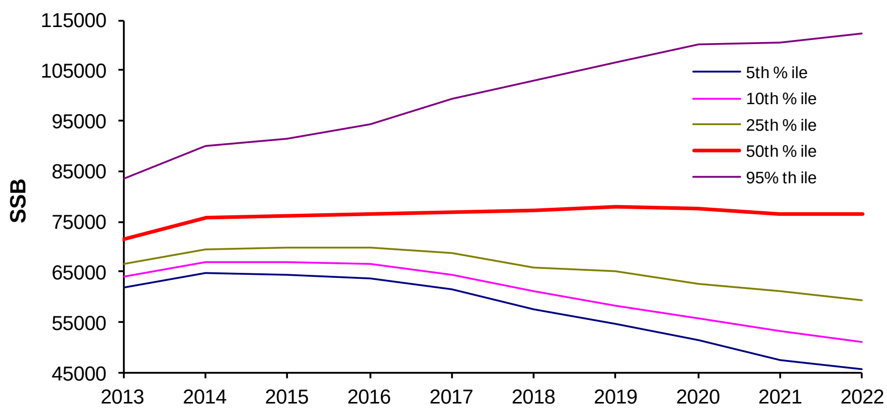


Fig. 13b: SSB probability profiles under Fstatus quo

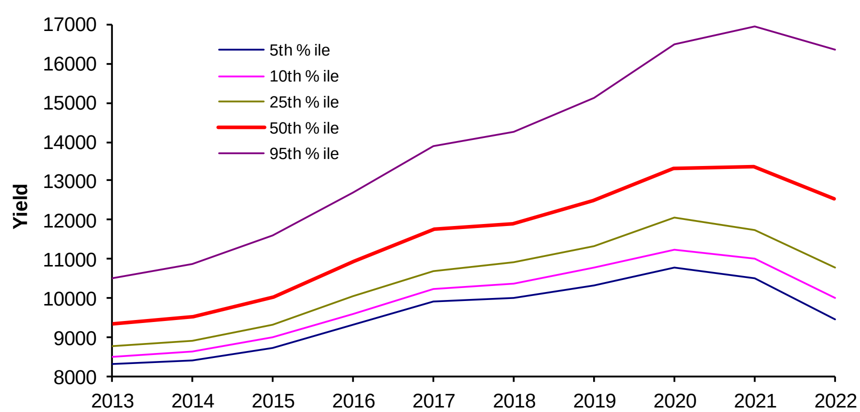


Fig. 13c: Yield probability profiles under Fstatusquo