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Northwest Atlantic Fisheries Organization

Serial No. N6452 **NAFO SCR Doc. 15/028**

SCIENTIFIC COUNCIL MEETING – JUNE 2015

An Assessment of Beaked Redfish (*S. mentella and S. fasciatus*) in NAFO Division 3M (*at times when natural mortality is driven stock dynamics and fishing mortality reference points are useless to scientific advice)*

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.

The Extended Survivor Analysis assessment used as tuning file the 1989-2014 EU survey abundance at age matrix included in a revised input framework. Continuing pressure over Flemish Cap redfish stocks by cod predation, at levels higher, or much higher, than the levels prior to 2006 lead to higher natural mortalities since then. Natural mortality have been tuned to survey at age data 2006 onwards by the sensitivity analysis preceding each assessment, and on 2013-2104 has a best estimate at slightly higher level from previous years. A 2015-2011 retrospective XSA was carried out, confirming that the present assessment is very much in line with their immediate predecessors.

Above average year classes coupled with low fishing mortalities allowed a rapid growth of biomass and abundance since 2003, pulling the stock to a 2008-2010 high. From 2009 onwards abundance went down for causes other than fishing, being still in 2014 at a level well above the 1990's low. Biomass and female spawning biomass (SSB) also declined but these trends were reversed by 2011-2012. Due to individual growth of survivors stock biomass has improved on recent years and is still on 2013-2014 at high levels. Recruitment at age 4 increased from 2002 till 2006 and was maintained at maximum levels till 2009. Recruitment declined since then and is on 2013-2014 at the low level of the weak year classes from the 1990's, despite an SSB still well above average and well above the level that originated the high 2002-2006 recruitments.

Short and medium term projections were carried under several options of fishing mortality, including updated $F_{0.1}$ and F_{max} from a new yield per recruit analysis accommodating the actual natural mortality.

Under the present circumstances $F_{0.1}$ and F_{max} are no management options, being unable to sustain the actual SSB size even on the short term. If natural mortality stays within its 2011-2014 boundaries, the actual low fishing mortality is the only option able to hold female SSB on the next coming years and on medium term keep female SSB on a safe zone, even if the actual low recruitment regime is here to stay.

Introduction

There are three stocks of redfish on the Flemish Cap Bank (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*. Beaked redfish represents the majority of redfish biomass (77% on average, according to the EU Flemish Cap survey series, 1988-2014) and redfish commercial catch on the bank.

Flemish Cap beaked redfish are long living species with slow growth, slow maturation and a long recruitment processes 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 are exploited primarily by bottom trawl, but also by pelagic trawl. Due to the similarity of their external morphology their commercial catches 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 as by-catch of the Greenland halibut fishery (Table 1a, Fig. 1a). This drop of the 3M redfish catches was related with the simultaneous decline of stock biomass and fishing effort deployed in this fishery on the first half o the 1990's. Catch increased again on the 2000's, but at a much smaller scale than in the past and with a decreasing proportion coming from directed redfish fisheries. Portugal, the Russian Federation and the Baltic states are responsible for the bulk of the redfish landings nowadays (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 fisheries) respond positively to those events and raised to levels between 6,000-10,000 tons between 2006 and 2014. So, on recent years, redfish catch on Division 3M is a blend of by-catch from cod fisheries at depths above 300m (a mixture of golden and beaked redfish), catches between 300-700m (primarily beaked redfish), mainly taken by Portuguese bottom trawl directed fishery, and by-catch again bellow 700m, from Greenland halibut fisheries of Russia, Spain, Portugal and Baltic states (100% beaked redfish).

The no neglect proportion of golden redfish forced the development of a method to split into golden and beaked redfish the annual redfish catches of Portugal, Russia and Spain, from 2005 onwards. Beaked redfish catches from fleets other than these ones were estimated with the average beaked redfish proportion found each year on the redfish catches of Portugal and Spain. This method is fully described on previous assessments (Ávila de Melo *et al.* 2011 and 2013). At the same time the available redfish length sampling from the main fleets has been separated as well on these two categories.

No STACFIS catch estimates were available since 2011. 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 independent catch data a 15% surplus has been added to the STATLANT catch of each fleet since 2011. For 2014 and for the countries with no provisional STATLANT catch available yet, their nominal catch was taken from the "Provisional Catches for December 2014" (NAFO Circ. Letter Ref. No.: GFS/15-061, 11 February 2015). The inflated STALANT catches (2011-2014) are included in the present assessment along with the STACFIS catch estimates (1989-2010).

The 1989-2014 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 2005-2014 EU surveys (Gonzalez, *pers. comm.,*2009-2013; Casas, *pers. comm.*, 2014) 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 between 2001 and 2003 increased again, reaching 1006 tons in 2003. That event does not reflect any expansion of the 3M shrimp fishery and was justified by the income of above average beaked redfish 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 corresponds to the commercial catch.

Length composition of the commercial catch and by-catch

The 1998-2010 and 2012-2014 3M beaked redfish commercial length weight relationships from the Portuguese commercial catch (Table 2a) (Alpoim and Vargas, 2004; Vargas *et al*, 2005 and 2007-2011 and 2013-2015) were used to compute the mean weights of all commercial catches and correspondent catch numbers at length. Due to the small individual length/weight sample 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 and Spanish 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 2003-2004. However on recent years this pattern is reversed: no pelagic redfish catch recorded on 2010 and 2012-2014. 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 other bottom trawl fleets with the exception of the Russian, Spanish and Japanese fleets for the years where respective length sampling data are available (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 annual mean lengths falling within 27-31cm (Table 3b, Fig. 2). Small sizes increase their presence in the commercial catch afterwards, being responsible of annual mean lengths bellow 28cm since then and a general shift of length distributions towards smaller sizes. On the first years of this second interval the presence of small redfish in the commercial catch was the outcome of several recruitment processes from a sequence of abundant year classes. However the maintenance of mean lengths just bellows average since 2007 should reflect a declining exploitable stock, as suggested by the 2007-2014 EU survey results (Fig. 5c).

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 1989-2014 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 2009-2014 EU surveys. 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. 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. The 1999-2002 and 2005 cohorts dominated the overall catch through most years of the 2001-2012 interval, 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 at age 7 are the most abundant on the 2013 and 2014 catch.

The length weight relationships from the Portuguese commercial catch (Table 2a) were used to calculate mean weights at age in the redfish 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 (1988-2014). An earlier bottom trawl survey series has been carried out by Canada from 1979 till 1985. This series was discontinued since then despite an isolated Canadian bottom trawl survey conducted in 1996.

For reasons explained 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 in 2003. Swept area is divided according to the Flemish Cap bank stratification proposed by Doubleday (1981) and revised 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 can be found in the 2005 assessment (Ávila de Melo *et al*, 2005). The conversion from former *RV Cornide de Saavedra* (CS) to the actual *RV Vizconde de Eza* (VE) units has been previously reported (González-Troncoso and Casas, 2005).

Length weight relationships

Annual length weight relationships for *S. mentella* and *S. fasciatus* (1992-2014) and for the two species combined (1988-2014) were available from survey data (Troncoso and Casas *pers. comm.*, 2005-2015) (Table 2b). *S. mentella* and *S. fasciatus* length weight relationships were used to get 1992-2014 *SOP* survey biomass for each redfish species. The *Sebastes sp*. length weight relationships were used to get the 1988-1991 *SOP* survey biomasses for beaked redfish.

Survey abundance at length

Each of the redfish categories included in the beaked redfish assemblage (beaked redfish including juveniles, 1988-1989; beaked redfish, 1990-1991; *S. mentella*, 1992- ; *S. fasciatus*, 1992- and juveniles, 1990-) had their own survey abundance at length original series up to 2002 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 former series were then linked to the 2003-2014 *RV Vizconde de Eza* length distributions (Troncoso *pers. comm.*, 2005-2013; Casas *pers. comm.*, 2014). 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*, Saborido Rey *pers. comm.*, 1999). New 2011 and 2012 maturity ogives were available for the previous assessment (Dominguez-Petit and Saborido Rey *pers. comm.*, 2013) but the analysis of samples from the rest of the years has not finish yet. 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). 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. This shift is confirmed on the new 2013 and 2014 maturity ogives available for both species (Dominguez-Petit and Saborido Rey *pers. comm.*, 2014 and 2015).

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 mature female component

The survey abundance at age for the 1989-2014 3M beaked redfish stock (Table 5b) were obtained using the *S.mentella* age length keys from the 1990-2007 and 2009-2014 surveys. 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 was first detected on *S. mentella* and *S. fasciatus* maturity ogives at length since 2011. The use of the new ogives on the most recent 2011-2014 interval, instead of the former ones, from 1999 (for *S. mentella*) and 1994 (for *S. fasciatus*), would lead to a sudden increase of the mature female proportion at age and also of the survey female spawning stock size, perhaps to unrealistic high magnitudes. And the use of a knife edge female age 7 plus criteria to get a proxy of the beaked redfish mature female proportion at age, in place on last assessment (Ávila de Melo et al., 2013), would generally inflate the number of female spawners at age throughout the whole assessment interval (Table 6a, Fig. 4). So, in order to keep a conservative approach to spawning stock size, this assessment return to the old *S. mentella* and *S. fasciatus* maturity ogives at length to get the survey beaked redfish mature females at age each year; and finally the correspondent mature female proportions at age and the survey female spawning stock abundance and biomass (Tables 6b to 6d; Fig. 4b).

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 spawning female stock (Table 7a and 7b).

Survey biomass and abundance, 1988-2014

The 1989-2014 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, exploitable and spawning female stock can be found on Table 8b. Trends of the respective standardized series are on 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 levels between 1991 and 2003. A sequence of above average year classes (2001-2005), including the strongest of the survey series (2002), coupled with high survival rates lead the stock and its exploitable part to a maximum in 2006. Year class strength declined afterwards, and the last cohort entering the exploitable stock (2010 year class in 2014) is the lowest recruitment at age 4. 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 from average. However biomass and abundance declined again on the last couple of years and on July 2014 were at or just below average. The spawning female survey indices extended their increase till 2009 but fall on 2010 and 2011. Those indices went up again on 2012-2013 to the level of the 2009 high but declined last year, staying well above average though.

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, namely its exploitable part, has not been able to hold its growth to levels well above average, suffering instead a decline on the second half of the 2000's which has not stopped yet. This unexpected decline on all survey indices (but the ones related to the female spawning stock), can only be attributed to high mortality levels other than fishing mortality that over the past nine years were able to depress the stock size continuously, from historical highs to the actual average level of the assessment interval.

Since 2004 a rapid increase was observed on survey biomass of both golden (*Sebastes marinus*) and Acadian (*Sebastes fasciatus*) redfish. Due to their shallower depth distributions these two redfish overlap with cod to an extent greater than deep sea redfish (*Sebastes mentella*). There is a strong possibility that an important increase on redfish natural mortality is associated to cod growth on Flemish Cap (Pérez-Rodríguez and Saborido-Rey, 2012), not only in terms of cod abundance but also in terms of individual growth, leading to a consistent increase of cod biomass from 2006 onwards (Gonzalez *et al*, 2014). An attempt to quantify the redfish consumption by cod on top of natural mortality can be found in the sensitivity analysis of the previous assessment (Ávila de Melo *et al.*, 2013).

The 2015 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 at age with stock size at age, and 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 26 years, and so is considered by the authors a valid tool to calibrate 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 9. Natural mortality over 2006-2012 remained unchanged (Ávila de Melo et al., 2011 and 2013) and on the first run of sensitivity analysis was kept at 0.125 on 2013 and 2014.

A female maturity ogive at age matrix was build using three year moving averages of annual mature female proportions at age. February, the spawning peak of 3M *Sebastes mentella*, (Saborido-Rey, 1994), was the month used to estimate the proportion of F and M before spawning. The assessment starts at age 4 (the first 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 1989-2014 EU survey abundance at age matrix, with the 1989-2002 indices converted into the new *RV Vizconde de Eza* units (Casas *et al.*, 2015).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 six 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 (fishing mortalities at age are usually not stable on last ages of each cohort or last years of the assessment interval).
- Fishing mortality at oldest true age of each cohort were not shrunk either.
- survivors at younger ages were not shrunk to mean of abundance on those ages on previous years.

A run with catchability independent of year-class strength on all ages till the penultimate true age (17) showed no significant *t* values for the slopes of *log* survey index/*log* abundance linear regressions at recruiting ages 4 and 5 (*Student's t* test with 24 degrees of freedom = No. points – 2, significance level of 0.05). This lack of a trend on the regression slopes for the youngest ages led us to accept catchability independent with respect to year class strength on all ages.

On the first two steps of sensitivity analysis catchability was set constant with respect to age only at the penultimate true age (a model constraint) in all runs to maximize the sum of squared (*SS*) $\log q_{age}$ residuals and so increase the accuracy of the goodness of fit criteria. In order to avoid overweight of each cohort's terminal population estimate by its 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 return to maturity at length ogives from the 1990's to get female maturity at age and spawning stock biomass, the 2014 XSA framework of all runs performed on the sensitivity analysis, remained unchanged from the 2013 assessment (Ávila de Melo *et al.*, 2013): no recruiting ages with catchability dependent of year-class strength, constant catchability just at the penultimate age, and a minimum standard error of the *log* catchability for each last true age of 0.5.

Sensitivity Analysis: adjusting natural mortality towards a better XSA fit to 2006-2014 survey data.

The rational to select the best options for natural mortality between 2006 and 2012 are thoroughly explained in the sensitivity analysis sections of last assessments (Ávila de Melo *et al*., 2011 and 2013). Years before 2006 M remained at 0.1. A natural mortality of 0.4 was adopted for ages 4-6 through the 2006-2010 interval, extended to all ages in 2009-2010. Since then natural mortality was assumed to be a time dependent/age independent parameter and on 2011-2012 declined to 0.125, a level much closer to what is usually considered the magnitude of natural mortality on redfish stocks (0.1).

Based on survey data, since 2006 Flemish Cap cod biomass has grown reaching historical highs on most recent years; while combined *S. mentella* and *S. fasciatus* declined as a single (beaked redfish) stock (Casas, 2015). At the same time beaked redfish catch remained at low levels, even droping by half between 2011 and 2014 (Table 1c). Under such scenario one should expect that during the last nine years in general, and on 2013-2014 in particular

- M may vary but should continue to be above 0.1,
- F should be below to well bellow M ,
- And therefore the closer is the relation between abundance at age by the survey and abundance at age by the model, the closer is M in the model to the true magnitude of natural

mortality (since 2006 the major part of the total mortality that drives abundance at each age on each year).

On the sensitivity analysis of the present assessment eleven options regarding 2013-2014 natural mortality has been considered, from 0.1 to 0.4, with a closer look to the 0.1-0.2 interval. A set of eleven XSA runs were performed and labeled according to the natural mortality adopted on each run on the last couple of years:

Each XSA 2015 run	M0.1	M0.125	M0.13	M0.14	M0.15	M0.16	M0.17	M0.18	M0.20	M0.30	M0.40
with a 2013-2014 M option	0.1	0.125	0.13	0.14	0.15	0.16	0.17	0.18	0.2	0.3	0.4

All XSA 2015 runs — M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010;

M = 0.125 on all age groups on 2011-2012.(XSA2013 assessment framework)

M is kept constant on all age groups and between years on 2013 and 2014

The sensitivity analysis of the diagnostics of these runs has follow three steps in order to select a M candidate that will allow a better fit of the model and then optimize the model performance with the adopted 2006-2014 natural mortality frame.

1st Step: goodness of fit of the model to survey data is measured by relative

1. Lower $SS \log q_{age}$ residuals on 2013-2014 (for which a "best" M option is needed);
2. Lower $SS \log q_{age}$ residuals extended backwards to 2006 (beginning of M increase by increasing cod predation);
3. Higher correlation between exploitable (4+) survey abundance and XSA abundance on 2006-2014.

In the event of a tie between M candidates each of the three criteria has an importance according to the order of their presentation above.

Diagnostics results for this set of runs are shown below under a traffic light format.

1st step diagnostics	Run M0.1	M0.125	M0.13	M0.14	M0.15	M0.16	M0.17	M0.18	M0.20	M0.30	M0.40
SS log q residuals$_{2013\text{-}2014}$	4.870	4.838	4.844	4.800	4.796	4.800	4.811	4.821	4.817	5.070	5.656
SS log q residuals$_{2006\text{-}2014}$	50.953	50.807	50.789	50.801	50.798	50.801	50.828	50.808	50.910	51.353	52.286
XSA$_{4+abundance}$ versus SURVEY$_{4+abundance}$ r^2	0.612	0.606	0.605	0.603	0.600	0.597	0.595	0.592	0.586	0.556	0.522

A minimum $SS \log q_{age}$ residuals plateau is found for M between 0.14 and 0.16, regardless the time interval considered. This best range of natural mortalities also outputs "intermediate" correlations between 2006-2014 survey and XSA abundances that are closer to the green region of this diagnostic on the left (Fig.'s 7a to 7c). M0.13 run has been discarded taking into account its 2nd and 3rd rate green diagnostics compared with 1st and 2nd rate diagnostics of M0.14 to M0.16.

2nd Step: within the M green zone do other key diagnostics differ? And if not, what M to pick?

At this stage of the analysis an option for a particular value within the "best 2013-2014 natural mortality" interval can be justified by a clear improvement on the model performance leading to much more robust results and if so to much more consistent further projections. The available diagnostics to take into account when addressing this question are the ones that measure the variability around survivors at age (in other words, the stock at the beginning of projections). When looking at these diagnostics from the corresponding three XSA_{2015} runs (Table 10, Fig. 8a and 8b) they are virtually the same and so no improvement can be anticipated by picking up either of those M's.

Taking into account the above traffic light frame, low values at the left of the M green zone had a better diagnostics outlook than the higher ones at the right. So it is fair to conclude the lower boundary of the "best 2013-2014 natural mortality" interval is the M option more in line with the qualitative evaluation of the 1st Step diagnostics.

Therefore **the 2015 XSA assessment will run with an age independent natural mortality of 0.14 on 2013 and 2014**.

3rd Step: **Beyond the "best M option"**, is it possible to go further in the model performance?

In the 3M beaked redfish assessments catchability at age is roughly stable between age 4 to 6, decline from age 7 till age 11 and fluctuate with no apparent trend beyond, at older ages. Being the last true age of the assessment age 18, and taking into account that XSA assumes that any fish stock should have a set of at least two (older) true ages with age independent catchability, the first age in this set has been age 17 in previous 3M beaked redfish assessments (Ávila de Melo *et al.*, 2011 and 2013). The major reason to work with a maximum range of catchabilities at age was that on one hand no clear improvement for the assessment was foreseen to shorten this range and on the other there was no evidence that redfish from a certain size/age onwards would behave the same way regarding the survey bottom gear.

On the present sensitivity analysis a final run, already with the newly selected 2006-2014 M frame and with the first age of independent catchability set one year younger (at age 16), was performed. Main diagnostics and trajectories were compared to the former run (with age 17 as the start of age independent catchability) on Tables 11a and b and on Fig.'s 9a and b. Increasing the independent catchability range by starting at the previous younger age will speed the way to convergence by an important decline from 52 to 34 iterations, with opposite (but discrete) signals as regards the diagnostics used in the sensitive analysis. Mean catchabilities at age shown slight increases that turn into minimal increases in fishing mortality and minimal declines in abundance and biomass.

In overall terms this is a bit more conservative picture of the stock given by a more robust assessment, and so **the 2015 XSA assessment will run with age 16 as the first age at which catchability is considered to be independent of age**.

Diagnostics

The 2015 diagnostics (Table 12) kept the main features from past assessments: high variability associated with mean catchabilities and survivors, namely at younger ages, together with a familiar patchwork of $\log q_{age}$ residuals that remained with only small changes from its predecessors (Fig. 10). Positive *log q* residuals dominate during the intermediate years of 1994-2001, after a first 1989-1993 interval with a clear negative pattern. Between 1989 and 1991, large to very large residuals were maintained from one age to the next within some of the major cohorts (1982-1985), suggesting that at the time these year classes may be overestimated by the model. From 2002 onwards residuals start getting smaller while the marked alternate negative/positive pattern of the former intervals fades away. This outlook is extended through most ages on the last couple of years.

Retrospective Analysis

A retrospective $XSA_{2014\text{-}2010\ (last\ year)}$ was carried out for checking patterns and magnitude of bias on the main results of recent assessments back in time (Table 13, Fig. 11). It covers a period of unrest on the dynamics of the stock, driven by important fluctuations on natural mortality and the fall of recruitment at age 4. As regards exploitable biomass the retro XSA show no clear retrospective pattern, being the present assessment very much in line with their immediate predecessors. Reverse retrospective patterns are observed on the female spawning biomass (under estimate) and average fishing mortality (over estimate) but with small biases, even for recent years. Recruitment at age 4 of the most abundant year class (2002 year class in 2006) has been clearly over estimated on previous assessments.

Retrospective Analysis is a useful check to consistency of stock assessment over time. From the possible causes of retrospective patterns – patterns of catch misreporting, patterns on catchability at age 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. However, the previous adjustment of the latest M by the sensitivity analysis seems to improve both magnitude and patterns of retrospective bias on 2015 XSA.

2015 XSA Results

Very high fishing mortalities until 1996 forced a rapid decline of abundance, biomass and female spawning biomass (Table 14, Fig. 12a: *4+ Biomass vs 4+ Abundance and Fem Spawning Biomass vs FBar*). With low fishing mortalities since then the stock decline was halted. But the weak 1991-1999 year classes kept the stock size depressed till 2002-2003, 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, pulling the stock to a 2008-2010 high. From 2009 onwards abundance went down for causes other than fishing, being still on 2014 at a level well above the 1990's low. Biomass and female spawning biomass also declined but these trends were reversed by 2011-2012. Due to individual growth of survivors stock size in weight has improved on recent years and is still on 2013-2014 at high levels.

Recruitment at age 4 increased from 2002 till 2006 and was maintained at maximum levels till 2009, with 2005 year class as the most abundant recruitment of the assessment interval (Table 15, Fig. 12b). Recruitment to exploitable stock declined continuously since then and was on 2014 at the lowest levels of the series.

The reproductive potential of the stock increased steadily from the late 1990's to 2006, 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 most of the 1990's. However SSB has been kept well above average and well above the level that originated the high 2002-2006 recruitments (Fig. 12a, *SR plot*). This apparent decline on reproductive potential reflects the chronically depressed pre-recruited ages regardless the strength of the year classes they belong, exposed since 2006 to unusually high mortalities by cod predation.

Final quality considerations on the 2015 assessment

An "erratic" pelagic-demersal distribution, associated with schooling and longevity will always doom bottom survey dependent redfish analytical assessments to relatively poor diagnostics. Nevertheless, when stock unit shows a clear dynamics and an apparently stable bottom-water column distribution, as it seems to be the case for 3M beaked redfish over the 2000's, survey results can generate consistent assessment results over time. Despite recent changes on natural mortality, the assessment presents a sound retrospective pattern and sensitivity analysis suggests that after all natural mortality has not experienced dramatic changes on most recent years (as anticipated at the entry of this decade). Being so, these assessment results are considered to be robust enough to initialize short term projections under the present estimated level of natural mortality, which in turn will allow scientific advice for the 2016-2017 management of this stock.

Stock projections

Background

In terms of an exploitation strategy for this resource, keeping female spawning stock biomass above the average SSB level that generated the good year classes of the 2000's continues to be the management target, even taking into account the apparent lack of relationship between the size of the year classes at age 4 and the parental female stock biomass. However the unavoidable negative impact of high M 's prior the entry of young redfish in the exploitable stock may always undermine the efficiency of such strategy.

Short term projections (2016-2017) were carried out for female spawning stock biomass (SSB) and catch under most recent level o natural mortality and several options of fishing mortality:

1. No fishing, F_0
2. Average 2012-2014 fishing mortality at age, F @age $_{2012\text{-}2014}$
3. Average 2013-2014 fishing mortality at age, F @age $_{2013\text{-}2014}$
4. $F_{0.1}$ and F_{max} under current M of 0.14

Average fishing mortality (ages 6 to 16) drop between 2012 and 2013 and stabilized on 2013-2014 (summary without SOP correction at the bottom of Table 14,); so instead of just the usual three-year average used on short term projections with $F_{statusquo}$, an extra F option was also considered just for the last couple of years. The sustainability of each one of those exploitation levels was evaluated by medium term SSB projections (2016-2025).

Projections were initialized at the beginning of 2016 assuming $Catch_{statusquo}$@age on the present year (2015). Recruitment entering in 2015 was set at the 1989-2012 age 4 geo mean. XSA survivors of each cohort were step frontwards by the modified cohort's Pope Equation (1972)

$$N_{a+1,2016} = N_{a,2015}e^{-M} - C_{a,2015}e^{-M/2} \text{ With } M = 0.14$$

Yield per recruit analysis (ypr)

In order to get the updated ypr F reference points a new yield per recruit analysis with M = 0.14 has to be performed, with all other inputs averaged from the whole interval where beaked redfish natural mortality took off (2006-2014). Partial recruitment was assumed flat top at the last three (true) ages considered on the XSA, and a relative F @age 4-18 vector was given each year by the ratio of the F 's @age to $Fbar_{16-18}$. The average relative F vector was the adopted the PR of this yield per recruit analysis. In order to reduce the weight of the plus group on the final results, ages were virtually extended to age 29 with a plus group set at age 30. Mean weights and female maturity were kept constant and were the ones of the XSA 19 plus group. Input vectors are presented on Table 15.

As expected increasing natural mortality led to inflated fishing mortality reference points, with $F_{0.1}$ =0.2095 and F_{max} = 0.9250. Last yield per recruit analysis was performed with the natural mortality at 0.1, the M level usually accepted for slow growth/long living fish stocks such as redfish stocks, and lead to a $F_{0.1}$ also at 0.1 (Ávila de Melo et al., 2002).

The *Mterm* projections: framework and main results

Short and medium term stochastic projections of yield and female spawning stock biomass (SSB) under the five F options 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 2016 (given by the forward projection of the XSA survivors by the end of 2014 as explained above) 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, 2016 and 2017, recruitment varies around the 1989-2012 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). Input data were aggregated in two categories of files:

a. *.srr* stock-recruitment file (Table 16a), assuming no stock recruitment relationship and with a random recruitment around the geo-mean of the 1989-2012 recruitments (numbers at age 4, from the XSA). From the third year of projection onwards, age 4 is given by the re-sampling of the *log* residuals of the 1989-2012 recruitments. The two last recruitments were excluded from average due to greater uncertainty of their estimates.

b. *.sen* sensitivity file (Table 16b), with the all vectors needed to forward projections. Natural mortality was fixed at 0.14 for all ages and years. Other inputs at age (relative fishing mortality, stock and catch weights and maturity ogive) are the last three year averages with associated errors at age. Being the internal and external standard errors from XSA diagnostics (Table 12/Terminal year survivors and F estimates) two measures of the uncertainty around the survivor estimate for each age, their average was adopted as the coefficients of variation of the starting population. Each F option was kept constant through projection interval.

Main results of short term projections for female SSB and yield under several F options and M at 0.14 are summarized on Table 17 , coupled with medium term SSB trajectories on Table 18a and Fig. 13a ($50\%_{ile}$). At a first glance all F 's but F_{max} are suitable to pursue a management strategy that not only will keep SSB by the entry of 2018 at or above its present high level of 48 000t, but also would sustain a medium term SSB within a comfort zone above 40000 tons. Furthermore, if there is a high probability that from 2006 onwards natural mortality has been the major force driving the beaked redfish stock dynamics, sometimes at levels well above " M as usual", it is also most likely that since 2011 natural mortality has returned to lower levels much closer to 0.1, over the recruited ages that build the exploited stock. In conclusion a first approach to projection results suggest that there is room to allow some increase on fishing mortality on 2016 and 2017.

However cod predation on redfish pre recruited ages has not yet shown signs to ease the pressure, on the contrary, year classes continue to enter every year the exploitable stock at increasingly smaller sizes. Taking into account recruitment negative trend since 2009, either from EU survey or XSA (Fig's 6a and 12b), medium term SSB projections are more likely to follow the 20th ile steeper trajectories presented on Table 18b and Fig. 13b rather than the smoother ones predicted by the 50th ile scenario. If a conservative forecast as regards future recruitment fits better with recent observed past, then keeping the actual low F on the next coming years is the only option able to sustain female SSB within high magnitude levels, even if a low recruitment regime is here to stay.

Conclusions

The stock started to decline in the late 2000's, despite recovery observed since 2011 on biomass and namely on female spawning biomass. The recent high levels of biomass are supported by low fishing mortalities and individual growth of survivors. Abundance decline is more pronounced on the size of year classes entering the exploitable stock than on the overall 4 plus abundance. Natural mortality declined substantially on 2011-2012 and stayed in the vicinity of its regular value on 2013-2014, though with a marginal increase. Taking into account the extension in time of the actual low recruitment/high SSB relationship, cod pressure on redfish pre recruited ages is likely to be kept at the high levels of the late 2000's.

If natural mortality and fishing mortality stay at their most recent levels, the actual high of female spawning biomass can hold on 2016-2017. But on the long term it will be natural mortality, namely over pre recruited ages, to determine the future of beaked redfish as a fishery resource.

Acknowledgements

This assessment is part of a EU research project supported by the European Commission (DG XIV, Program for the collection of data in fisheries sector), IPMA, CSIC, IEO and AZTI.

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Table 1a: 3M Redfish nominal catches (ton) by country, 1989-2014.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014[1]
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	1711	1808	1342
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			0.122
E-EST						47	863	13				631	158	5	23	60	1093	1249	728	950	1643	1161	820		1036	601
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	416	1019
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	4236	3493	3462
EU																								5		7
FR-STP										2							10			8			68	69		
UK																						1	2		8	
KOR-S	17885	8332	2936	8350	2962																					
FAROE IS.				16			15	1						6		6				215	1	122	420	149	10	4
NORWAY						8																		0		
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	7282	6771	6436

Table 1b: Redfish commercial catches on Div. 3M from various sources (STACFIS, 1989-2010; based on STALANT, 2011-2014).

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	58100	81000	48500	43300	29000	11300	13500	5789	1300	971	1068	3658	3224	2934	1881	2923	6550	7156	6662	8465	11317	8496	11121	8775	7778	7401

Table 1c: Beaked redfish on Div. 3M commercial catch estimates from various sources (STACFIS, 1989-2010; based on STALANT, 2011-2014).

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 and K. Fromin *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	2013	2014
Total	58100	81000	48500	43300	29000	11300	13500	5789	1300	971	1068	3658	3224	2934	1881	2923	4148	5997	5149	4277	3656	5410	8994	6779	5168	4553

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 and Mikel Casas *pers. comm.*).

<200m	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	**200-300m**	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
golden	36.1	51.1	97.9	100.0	100.0	100.0	90.0	96.5	99.04	98.87	golden	54.5	50.7	32.4	68.3	84.9	68.3	52.9	63.5	65.39	91.84
beaked	63.9	48.9	2.1	0.0	0.0	0.0	10.0	3.5	0.96	1.13	beaked	45.5	49.3	67.6	31.7	15.1	31.7	47.1	36.5	34.61	8.16

300-400m	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	**400-700m**	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
golden	18.8	5.9	12.0	28.5	22.0	28.5	3.7	5.5	10.04	34.07	golden	2.1	5.0	1.3	8.8	0.9	8.8	0.6	0.0	1.35	0.29
beaked	81.2	94.1	88.0	71.5	78.0	71.5	96.3	94.5	89.96	65.93	beaked	97.9	95.0	98.7	91.2	99.1	91.2	99.4	100.0	98.65	99.71

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), 1989-2014.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
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	17.1	20.0	14.3
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	17.1	20.0	14.3

[1] From NAFO Circ. Letters.

Table 2a: Length weight relationships
for 3M beaked redfish from commercial catch
(Alpoim,2004; Vargas, 2005, 2007-2011 and 2013-2015)

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
2013	0.0114	3.0575
2014	0.0106	3.0799

Table 2b: Length weight relationships for 3M beaked redfish from EU survey (Troncoso and Casas, *pers. comm. 2005-2015*)

	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
2013	0.021	2.874	0.032	2.779	0.0294	2.7873
2014	0.016	2.968	0.024	2.873	0.0236	2.8658

Table 3a: Availability of length data for commercial catches and by-catch of 3M beaked redfish, 1989-2014

	Portugal	Spain	Japan	Russia	Canada (by-catch)
1989	░			░	
1990	░			░	
1991	░			░	
1992	░			▨	
1993	▨			▨	░
1994	▨			▨	░
1995	░			░	░
1996	░		░	▦	░
1997	░				░
1998	░	░	░	░	░
1999	░			░	░
2000	░			░	░
2001	░	░		░	░
2002	░			░	░
2003	░	░	░	░	░
2004	░	░		▦	░
2005		░		░	
2006	░	░		░	
2007	░	░		░	
2008	░			░	
2009	░				
2010	░			░	
2011	░	░			
2012	░	░			
2013	░	░			
2014	░	░		░	

░ 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, 1989-2014.

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	2013	2014
10	3													10			3	16	12					7		
11				1	3									48		1	18	40	41			3	1	9	1	1
12	3			1	7							5		220		3	108	86	133		1	9	3	23	4	1
13	11				5							11		723		5	381	70	172		5	28	27	36	7	6
14	25	4			40	4						1		590		12	509	91	88		5	99	87	69	5	5
15	8	73		1	120	15				2		6	4	175		43	474	112	23	6	37	248	209	95	35	26
16	30	190		4	167	66		20				1	4	70		203	516	313	18	14	68	341	309	122	68	62
17	59	724		3	55	244		20	1	2		6	20	53	6	352	423	436	31	12	102	481	352	162	135	108
18	30	2489	156	6	39	607	118	20		1		17	57	84	6	464	285	635	138	47	121	669	586	222	210	180
19	11	5774	647	97	54	922	265	66	6	8	1	27	41	144		666	183	1296	433	166	147	912	806	388	392	313
20	111	6179	1331	418	71	491	1142	360	8	13	1	50	43	187		**1165**	157	2168	371	381	226	1559	1452	709	368	320
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**	1004	770
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**	1622	**1182**
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**	1785	**1135**
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	**1984**	**839**
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	**2400**	**978**
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	**2634**	**1339**
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	**2376**	**1261**
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	1518	**1115**
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	1056	747
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	680	665
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**	512	544
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**	345	431
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**	251	424
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	190	425
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	149	370
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	85	292
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	64	222
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	52	173
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	29	136
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	3	77
41	504	581	640	522	517	105	346	38	12	11	4	26	5	1		41	34	17	16	65	4		50	80	6	74
42	341	345	201	214	476	37	164	46	5	8		19	6	2		14		11	6	61	2		**19**	25	6	31
43	289	264	283	237	118	10	69	18	1	3	1	25	3	5	2	18		11	3	52	1		**9**	19		18
44	135	130	19	172	170	9	50	3	6	2		14	2			12		4	8	26	2		20	21		13
45	143	73	14	39	26	9	34	2	1		2	3	1		1	6		3	3	5	2			0.3		1
46	75	32	8	9	17		7	4	1	1		10	1			5		4	5	20			2			0.4
47	46	16			17		19	1	1			6						1		7	1					0.1
48	28	12	8	17			4						1			1		1		10						0.2
49	4	12																1	3							0.1
50	11	4						27											8					13		0.1
51	4	12																						0.4		0.0
52	4																									0.1
53	7	16																1	2							0.1
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	258	319
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	26.0	27.5

Table 3c: Length composition (absolute frequencies in'000s) of the 3M redfish total annual catch, 1989-2014 (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	2013	2014
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	1	1
12	3			1	9	19	36	841	512	1830	313	1011	4996	3205	1368	1498	108	86	133		1	9	3	23	4	1
13	11			0	29	338	34	459	164	1721	286	761	2126	5809	2741	1229	381	70	172		5	28	27	36	7	6
14	25	4		0	257	979	64	488	120	340	97	182	746	4660	2546	1093	509	91	88		5	99	87	69	5	5
15	8	73		1	1998	2232	247	731	119	63	90	90	531	1946	1886	1022	474	112	23	6	37	248	209	95	35	26
16	30	190		4	7682	7312	430	1713	647	116	86	50	522	865	1994	999	516	313	18	14	68	341	309	122	68	62
17	59	724		3	29380	17576	758	1182	184	85	62	22	453	430	2513	987	423	436	31	12	102	481	352	162	135	108
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	210	180
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	392	313
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	368	320
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	1004	770
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	1622	1182
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	1785	1135
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	1984	839
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	2400	978
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	2634	1339
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	2376	1261
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	1518	1115
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	1056	747
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	680	665
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	512	544
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	345	431
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	251	424
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	190	425
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	149	370
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	85	292
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	64	222
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	52	173
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	29	136
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	3	77
41	504	581	640	522	517	105	346	38	12	11	4	26	5	1		41	34	17	16	65	4		50	80	6	74
42	341	345	201	214	476	37	164	46	5	8		19	6	2		14		11	6	61	2		19	25	6	31
43	289	264	283	237	118	10	69	18	1	3	1	25	3	5	2	18		11	3	52	1		9	19		18
44	135	130	19	172	170	9	50	3	6	2		14	2			12		4	8	26	2		20	21		13
45	143	73	14	39	26	9	34	2	1		2	3	1		1	6		3	3	5	2			0.3		1
46	75	32	8	9	17		7	4	1	1		10	1			5		4	5	20			2			0.4
47	46	16			17		19	1	1			6						1		7	1					0.1
48	28	12	8	17			4						1			1		1		10						0.2
49	4	12																1	3							0.1
50	11	4						27											8					13		0.1
51	4	12																						0.4		
52	4	0																								0.1
53	7	16																1	2							0.1
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	19978	14284
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	5163	4553

Table 3d: Catch in numbers at age (' 000) of 3M redfish, 1989-2014, 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	75	253	245	1093	1812	1877	1483	879	373	257	624	1192	2036	1029	775	469	140	43	2430	17085	1999
2013	11	90	297	694	1719	3672	5599	3229	1522	948	425	398	204	257	243	75	180	74	343	19978	2006
2014	7	70	301	498	1961	1858	2371	1763	1337	636	496	438	163	411	559	303	206	48	858	14283	2007

Table 3e: Weights at age in the catch and by-catch (Kg) of 3M redfish, 1989-2014.

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	0.203	0.247	0.290	0.336	0.395	0.407	0.509	0.508	0.502	0.576	0.634	0.625	0.463	0.734
2013	0.029	0.060	0.082	0.103	0.149	0.179	0.237	0.276	0.331	0.363	0.395	0.420	0.512	0.489	0.493	0.477	0.588	0.575	0.613
2014	0.030	0.054	0.079	0.109	0.146	0.183	0.246	0.288	0.338	0.413	0.416	0.468	0.486	0.533	0.581	0.524	0.694	0.554	0.786

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. fasciatus	-19.91	0.7505	26.5	-19.91	0.7505	26.5	-8.44	0.441	19.1	-20.11	1.1153	18	12.1
S. mentella	-14.43	0.4787	30.1				-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), 2003-2014 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	2013	2014
4																							60				
5											2868					63							8				
6		73	239	1042				144			956			455	1091	2905					136	54	23		79	148	146
7	1203	160	1952	39644	4931	1102		31	2453		695	291		1240	9720	11241	286	499	304	1547	573	477	369	93	176	299	296
8	8538	1890	15439	194701	117561	3160		594	12310	1359	3390	2417	1883	18643	14581	19009	12530	5985	94129	26849	5315	2640	2873	22	679	618	611
9	8327	2007	11861	90135	75875	1764		1816	6548	2887	6048	12420	6848	152327	44733	10989	69454	8679	410980	214426	4271	5731	8073	746	1411	1186	1173
10	7082	2894	846	9088	57005	7812	274	1889	867	1615	1573	8840	5242	246451	53017	5810	181225	11172	569937	471628	5446	3386	11485	4620	423	1299	1285
11	20338	8434	412	17232	332037	36153	1573	3397	1762	4312	2626	3052	4412	29300	52317	13578	178289	47283	83653	269398	21536	5348	23157	4759	776	1442	1426
12	39345	20228	390	18876	381332	46734	2665	9269	5827	12810	13751	2976	15579	9424	115720	38207	306313	109207	93826	255837	62810	7229	29988	6950	4118	1788	1759
13	27472	21581	1062	5790	90012	29392	5209	4666	5993	14318	22307	4851	30605	16454	247642	31594	217455	305354	168066	460809	135178	7342	25966	15311	9633	3131	3031
14	4000	46259	1865	1174	16174	79964	25338	4768	8609	7064	11124	4639	18860	19286	292527	34465	109487	563721	368890	359968	146220	14300	20163	30837	14883	3505	3673
15	802	87282	2527	1706	27540	165019	58046	9835	16820	13161	14504	19442	6447	31061	99677	61037	59669	496389	570816	235990	109149	37040	25053	48357	25999	6484	1711
16	1034	71271	6765	8180	41045	138724	130198	24357	14379	23773	29969	39114	4277	71951	73453	96960	93021	321931	705419	132602	150419	74563	26704	50389	45269	17687	1444
17	1499	22119	15552	25997	9939	29763	219435	64809	23877	29710	20988	26097	8270	56570	59348	87339	130177	216267	1022160	204730	200256	106859	34783	34593	52347	31911	2786
18	1140	3665	17573	47123	7593	9245	230202	110934	54208	30013	13414	32861	19781	22594	72239	40866	155247	199060	785217	363584	236520	147862	62837	35136	53475	38805	4709
19	4032	2167	10349	74331	14615	4970	121884	144384	108902	36047	14029	29489	27898	12501	74283	28312	179357	182684	502051	489233	195040	182429	88896	54993	45700	37724	10856
20	7430	3097	2514	83897	24467	3328	33879	100682	153048	68928	13962	20335	29190	18149	55461	22778	156658	169721	357550	396759	241170	274446	108084	108351	56535	39184	16088
21	16559	4479	1078	40486	46504	3306	16450	38742	135158	101923	18530	14731	24042	24890	28013	18751	86575	163284	189221	256720	256356	244424	138236	158583	85639	40895	15534
22	33994	9816	3011	10581	70167	5125	8472	9863	83283	98256	33310	17528	21181	25754	23745	12635	48011	179265	120687	144663	241869	209744	150168	160054	170639	53157	20601
23	68369	18570	10028	3744	51568	7222	7632	3978	37902	62655	56319	29378	18209	17298	19916	8313	29273	132897	99934	101176	141913	137275	112686	134422	229288	86481	29962
24	102943	33229	13236	3855	23847	8078	9824	3261	17322	24171	57007	61585	29389	15498	21186	7521	18368	81899	76563	71205	106627	138138	74872	101986	207034	113144	47408
25	108959	50665	28825	7720	10049	5812	11309	3704	7875	9733	33609	75417	54137	14734	16263	7312	11706	41610	57756	42237	61464	93215	61323	58822	138854	120194	71544
26	79514	60423	42888	9638	12417	5431	9941	4600	4102	5921	14895	57490	76085	18293	14695	7561	11260	32227	25060	38613	45511	49136	37645	31084	89036	103975	87171
27	33899	49923	41939	9642	16819	4256	6971	4265	5830	4280	5807	20106	78418	17465	13793	7875	8280	18476	13669	25283	31512	37652	24648	20314	44921	66107	77264
28	13963	31600	28902	8402	18154	4326	8135	4642	4150	3998	2710	6614	54137	13151	12150	6742	7280	12570	8322	13766	20128	19937	16266	12887	24186	39337	55550
29	6818	17451	16287	5836	12743	3066	6925	4694	4325	2790	1258	2472	21494	7232	9235	4988	5204	8890	5071	8331	10536	19353	10922	6369	14517	22292	29457
30	9150	10747	9819	4833	11009	2882	4765	4493	2995	3195	828	804	4582	5003	5643	3945	3753	7874	5648	9541	3737	6364	6414	3902	10679	13479	15175
31	7567	8245	7209	3513	7557	2362	3995	3479	2489	1977	959	701	1715	1439	2210	2264	2651	3273	2393	3284	5765	4025	2468	2551	6786	6348	9152
32	8886	9234	6686	3034	4866	1882	3611	2792	2280	1514	762	652	890	782	818	1556	1835	2954	1722	2100	1171	2631	1586	1917	4326	5045	5462
33	8570	6908	5710	3287	4450	2012	2463	2304	2050	1291	619	470	1120	337	572	756	1132	1085	1340	3374	1034	2360	1450	1031	4062	2836	3982
34	7451	6529	6333	3279	4276	1660	1613	1897	1410	981	517	401	578	405	286	639	762	736	479	909	371	175	572	383	2266	2037	2924
35	5646	6544	4312	2567	3486	1536	1468	1591	948	590	293	347	382	199	122	171	323	310	383	238	312	1587	151	21	721	581	1394
36	4929	5410	3975	2295	2635	1518	1039	1441	757	544	310	221	388	161	113	207	166	174	192	71	29	563	60	21	693	536	1951
37	3631	3912	3065	1811	2014	1425	590	1205	568	305	194	134	357	67	68	135	108	29		20	29	249	50	21	322	607	272
38	3166	2501	2223	1488	1620	904	549	717	402	212	142	81	67	80	54	117	98	29	96	10	39	46	30	11		105	415
39	3092	4145	2425	1739	2156	1392	520	932	471	212	168	78	131	67	27	117		19			29	46	101		171	219	88
40	2090	2908	1634	1079	1410	831	379	493	266	143	65	39	87	27	14	45			95	10	20	1657					
41	1499	1192	842	471	586	378	225	433	243	124	77	26	44	54	14	9	10				10	37		10		10	
42	665	742	421	367	426	362	84	313	162	37	26	26		13	14	9					10		10				125
43	253	291	253	179	165	103	28	156	69		65	13	29	40	14												
44	84	87	51	53	165	168	28	36	23	25	26		15			9											
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	596833	2085973	3325555	6341632	4604910	2442512	1838324	1108180	1089546	1345643	862595	526425

Table 5b: 3M beaked redfish abundance at age ('000s) from EU bottom trawl survey series, 1989-2014.

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	664025	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	50017	119643	202461	63004	84160	24769	14624	10827	6967	3974	2233	1323	11068	465	53	248	274	52	669	596833	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	22890	174292	86905	187410	250116	157413	138615	34940	18552	15351	12900	4018	1728	910	286	310	209	145	1189	1108180	2005
2011	49172	91360	75528	218920	223439	244352	115969	25006	13555	13365	6080	4043	4378	852	2009	790	101	319	310	1089546	2005
2012	19153	81326	79996	131612	202027	313659	292199	139414	29159	6307	13926	9276	10094	6559	2852	1808	265	271	5742	1345643	2005
2013	9912	22790	54171	80792	80595	166954	248641	109374	38934	20075	7757	6820	2721	3361	3395	893	1498	739	3172	862595	2006
2014	9726	6287	8035	18283	44969	67747	151366	101293	59229	16226	14018	9358	2155	4406	5510	3283	1107	382	2921	526300	2007

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 mature female abundance at age ('000s) from EU survey series, 1989-2014.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+	Total
1988	0	10	19	166	457	3852	11667	11447	6085	3947	3723	2798	3047	2824	2606	1536	1405	1278	6465	63303
1989	0	8	140	91	157	1545	7734	11709	7329	4218	3366	2593	2910	2829	2722	1561	1440	1231	7823	59258
1990	1	0	60	76	59	840	5392	9830	6743	3922	2988	2245	2655	2529	2300	1346	1110	1020	4432	47488
1991	8	5	4	536	895	834	2102	2501	2086	1445	1634	1659	1620	1449	597	1054	768	445	2433	22059
1992	0	69	34	104	1691	1817	2280	4334	4320	3147	2222	1829	1981	1668	1644	1413	818	811	1614	31692
1993	0	10	17	128	136	995	925	1009	463	779	778	761	707	834	676	942	598	983	1068	11780
1994	0	4	70	966	425	1006	1912	1682	1508	1510	1247	900	674	478	515	344	302	405	665	14540
1995	0	2	64	357	1357	360	910	1343	1005	1105	1269	720	525	523	568	498	296	425	1344	12604
1996	0	2	14	23	1533	3427	1505	1754	1528	980	852	893	521	593	492	394	291	283	793	15859
1997	0	2	10	110	475	2724	6144	2287	1841	1263	705	605	333	403	113	157	201	67	428	17857
1998	0	4	31	50	213	933	1560	5282	785	120	119	647	86	96	26	61	155	9	231	10373
1999	0	12	152	447	514	1184	3118	4740	15008	1341	102	153	340	41	101	99	103	199	307	27796
2000	0	35	53	200	752	1135	3056	10012	9198	29716	1352	162	97	638	83	55	60	34	615	57164
2001	0	29	291	412	803	1329	2140	2777	1922	1815	6695	335	108	65	71	57	20	24	175	18750
2002	0	270	438	1533	847	1643	1933	2574	3161	1826	1136	5364	308	82	113	28	26	9	62	20646
2003	0	124	556	254	747	716	1012	1258	1342	1114	913	647	3199	281	36	173	156	39	502	12389
2004	0	325	439	618	3982	2987	3028	2990	2112	1528	1100	749	785	3754	57	161	165	31	333	24379
2005	0	597	616	1628	2581	13745	11962	11076	7139	4410	2717	2266	921	469	1840	33	26	12	9	60834
2006	0	533	1685	4246	5755	11696	12617	8104	4431	1675	1265	750	554	394	430	2012	131	23	187	54269
2007	0	138	426	2236	4799	4890	29711	14750	11948	2989	3319	2194	1166	1072	519	5111	1297	9	353	86362
2008	0	97	263	1138	3490	20273	23927	21308	13256	5989	2827	1638	986	590	144	69	53	1667	50	97404
2009	1	247	971	5054	4452	16405	18890	18985	16470	16945	6487	5358	838	2691	321	591	280	1205	6647	121620
2010	0	235	624	2012	4546	8402	21248	11573	8155	8378	8127	2652	1301	678	249	263	154	127	912	78778
2011	36	147	255	3756	4684	12221	10719	9781	6194	6046	3691	2864	2349	680	1483	528	99	308	293	65695
2012	8	81	232	1233	4408	13601	27045	22811	9457	3402	7002	5391	6129	3865	1872	1252	234	165	3901	111769
2013	2	36	148	426	1438	6052	26929	24823	18792	11667	5303	5335	2311	2804	2752	751	1272	672	2786	114112
2014	2	3	20	118	705	2756	16504	20693	18523	8239	5780	4542	1293	2683	3501	2137	704	224	2344	90747

Table 6c: 3M beaked reddish proportion of mature females at age, from the EU survey series, 1989-2014.

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	0.002	0.008	0.016	0.036	0.068	0.108	0.160	0.218	0.322	0.398	0.446	0.469	0.511	0.526	0.594	0.591	0.758
1989	0.000	0.000	0.001	0.005	0.019	0.044	0.086	0.131	0.168	0.194	0.272	0.360	0.445	0.476	0.513	0.518	0.584	0.562	0.797
1990	0.000	0.000	0.002	0.003	0.023	0.048	0.096	0.146	0.187	0.213	0.293	0.399	0.498	0.525	0.574	0.581	0.599	0.590	0.707
1991	0.000	0.000	0.001	0.003	0.007	0.047	0.103	0.188	0.258	0.345	0.421	0.489	0.537	0.585	0.627	0.696	0.674	0.682	0.771
1992	0.000	0.000	0.001	0.002	0.012	0.025	0.075	0.164	0.256	0.327	0.370	0.411	0.488	0.541	0.576	0.682	0.650	0.789	0.795
1993	0.000	0.000	0.000	0.000	0.013	0.046	0.088	0.157	0.212	0.260	0.300	0.310	0.370	0.417	0.425	1.096	0.684	0.696	0.659
1994	0.000	0.000	0.001	0.001	0.005	0.046	0.085	0.148	0.201	0.305	0.317	0.320	0.320	0.426	0.409	0.523	0.628	0.656	0.687
1995	0.000	0.000	0.001	0.003	0.004	0.043	0.102	0.153	0.213	0.279	0.312	0.310	0.320	0.363	0.370	0.477	0.490	0.580	0.781
1996	0.000	0.000	0.000	0.001	0.008	0.009	0.128	0.203	0.268	0.352	0.418	0.458	0.525	0.531	0.555	0.598	0.642	0.649	0.700
1997	0.000	0.000	0.000	0.001	0.005	0.035	0.028	0.460	0.493	0.456	0.472	0.477	0.483	0.482	0.478	0.525	0.546	0.545	0.643
1998	0.000	0.000	0.000	0.001	0.007	0.018	0.052	0.042	0.201	0.247	0.301	0.325	0.334	0.386	0.332	0.392	0.451	0.318	0.665
1999	0.000	0.001	0.003	0.006	0.011	0.031	0.067	0.121	0.099	0.228	0.399	0.454	0.396	0.372	0.411	0.391	0.510	0.457	0.639
2000	0.000	0.001	0.002	0.006	0.012	0.025	0.065	0.141	0.257	0.175	0.458	0.350	0.614	0.412	0.546	0.682	0.720	0.647	0.619
2001	0.000	0.001	0.002	0.005	0.015	0.031	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	0.001	0.001	0.006	0.014	0.036	0.064	0.117	0.178	0.373	0.374	0.384	0.531	0.503	0.468	0.345	0.433	0.417	0.436
2003	0.000	0.001	0.003	0.004	0.009	0.029	0.069	0.116	0.193	0.280	0.409	0.489	0.289	0.603	0.685	0.697	0.569	0.759	0.751
2004	0.000	0.000	0.001	0.004	0.009	0.029	0.088	0.174	0.254	0.328	0.465	0.576	0.664	0.428	0.784	0.695	0.660	0.758	0.676
2005	0.000	0.000	0.001	0.004	0.009	0.029	0.097	0.235	0.348	0.406	0.550	0.589	0.554	0.716	0.603	0.514	0.568	0.592	0.571
2006	0.000	0.000	0.001	0.003	0.008	0.031	0.094	0.212	0.369	0.452	0.511	0.471	0.565	0.601	0.725	0.483	0.615	0.959	0.871
2007	0.000	0.000	0.000	0.004	0.007	0.013	0.105	0.222	0.477	0.787	0.866	0.922	0.939	0.934	0.902	0.761	0.856	0.656	0.877
2008	0.000	0.000	0.001	0.003	0.008	0.036	0.134	0.323	0.488	0.616	0.677	0.707	0.709	0.737	0.557	0.438	0.406	0.732	0.454
2009	0.000	0.003	0.005	0.014	0.011	0.056	0.076	0.148	0.278	0.456	0.655	0.497	0.824	0.706	0.668	0.785	0.933	0.892	0.769
2010	0.000	0.001	0.007	0.011	0.018	0.053	0.153	0.331	0.440	0.546	0.630	0.660	0.753	0.745	0.871	0.847	0.739	0.874	0.767
2011	0.001	0.002	0.003	0.017	0.021	0.050	0.092	0.391	0.457	0.452	0.607	0.708	0.536	0.798	0.738	0.669	0.980	0.964	0.946
2012	0.000	0.001	0.003	0.009	0.022	0.043	0.093	0.164	0.324	0.539	0.503	0.581	0.607	0.589	0.656	0.692	0.882	0.608	0.679
2013	0.000	0.002	0.003	0.005	0.018	0.036	0.108	0.227	0.483	0.581	0.684	0.782	0.849	0.834	0.811	0.840	0.849	0.910	0.878
2014	0.000	0.000	0.002	0.006	0.016	0.041	0.109	0.204	0.313	0.508	0.412	0.485	0.600	0.609	0.635	0.651	0.636	0.586	0.802

Table 6d: maturity ogive at age for 3M beaked reddish as the average proportion of mature females at age, from the EU survey series, 1989-2014.

Fem proportion	0.000	0.001	0.002	0.005	0.012	0.036	0.090	0.194	0.293	0.387	0.459	0.496	0.543	0.565	0.588	0.613	0.641	0.663	0.719
cv 1989-2014	0.000	0.001	0.002	0.004	0.006	0.012	0.026	0.092	0.116	0.148	0.154	0.157	0.172	0.158	0.158	0.175	0.161	0.171	0.120

Table 7a: Weights at age of the 3M beaked redfish stock (Kg) from EU surveys, 1989-2014.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1989	0.012	0.032	0.060	0.100	0.164	0.205	0.248	0.284	0.317	0.349	0.431	0.511	0.563	0.586	0.631	0.643	0.706	0.703	0.880
1990	0.011	0.028	0.082	0.097	0.171	0.212	0.261	0.299	0.331	0.361	0.443	0.524	0.582	0.602	0.652	0.668	0.731	0.727	0.920
1991	0.012	0.029	0.067	0.109	0.135	0.214	0.276	0.337	0.385	0.465	0.515	0.569	0.616	0.649	0.700	0.779	0.764	0.794	0.892
1992	0.013	0.032	0.070	0.096	0.171	0.208	0.292	0.354	0.396	0.452	0.525	0.571	0.635	0.680	0.704	0.807	0.769	0.879	0.933
1993	0.010	0.034	0.051	0.066	0.156	0.212	0.287	0.365	0.395	0.434	0.513	0.554	0.624	0.687	0.714	0.871	0.853	0.867	1.101
1994	0.000	0.045	0.076	0.090	0.130	0.226	0.276	0.348	0.395	0.464	0.493	0.530	0.549	0.673	0.659	0.719	0.816	0.852	0.912
1995	0.011	0.027	0.071	0.102	0.113	0.217	0.288	0.357	0.405	0.456	0.514	0.546	0.632	0.702	0.726	0.812	0.822	0.869	1.067
1996	0.011	0.036	0.062	0.079	0.138	0.141	0.270	0.328	0.384	0.443	0.480	0.533	0.580	0.600	0.649	0.697	0.756	0.794	0.956
1997	0.013	0.031	0.059	0.090	0.127	0.190	0.174	0.355	0.406	0.466	0.505	0.573	0.609	0.621	0.682	0.746	0.787	0.759	0.933
1998	0.010	0.034	0.062	0.089	0.138	0.181	0.229	0.222	0.371	0.422	0.490	0.550	0.624	0.687	0.714	0.809	0.832	0.729	1.103
1999	0.014	0.033	0.064	0.087	0.121	0.176	0.223	0.260	0.246	0.323	0.473	0.564	0.513	0.552	0.541	0.552	0.642	0.615	0.766
2000	0.016	0.037	0.060	0.097	0.132	0.174	0.234	0.285	0.329	0.297	0.418	0.528	0.668	0.564	0.497	0.673	0.718	0.718	0.750
2001	0.015	0.028	0.062	0.085	0.140	0.179	0.238	0.297	0.328	0.384	0.340	0.516	0.598	0.663	0.668	0.616	0.771	0.853	1.010
2002	0.013	0.034	0.052	0.101	0.132	0.184	0.227	0.282	0.323	0.390	0.408	0.398	0.561	0.595	0.629	0.719	0.644	0.894	0.952
2003	0.009	0.035	0.061	0.076	0.109	0.161	0.217	0.264	0.321	0.355	0.413	0.462	0.351	0.558	0.584	0.638	0.509	0.694	0.754
2004	0.015	0.030	0.066	0.094	0.120	0.163	0.221	0.278	0.343	0.378	0.444	0.498	0.553	0.426	0.635	0.685	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	0.015	0.048	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	0.037	0.059	0.081	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	0.034	0.062	0.084	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
2013	0.029	0.071	0.092	0.114	0.163	0.200	0.247	0.284	0.335	0.363	0.386	0.419	0.476	0.469	0.460	0.479	0.528	0.558	0.548
2014	0.028	0.056	0.096	0.128	0.164	0.219	0.273	0.310	0.345	0.413	0.389	0.421	0.492	0.522	0.527	0.504	0.589	0.577	0.583

Table 7b: Weights at age of the 3M mature female beaked redfish stock (Kg) from EU surveys, 1988-2014.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
1989	0.013	0.035	0.069	0.131	0.174	0.220	0.267	0.306	0.337	0.376	0.461	0.541	0.575	0.596	0.636	0.647	0.728	0.725	0.886
1990	0.012	0.032	0.095	0.113	0.181	0.228	0.283	0.323	0.352	0.390	0.474	0.553	0.594	0.615	0.658	0.671	0.749	0.746	0.926
1991	0.013	0.032	0.070	0.120	0.146	0.249	0.304	0.354	0.406	0.473	0.528	0.585	0.629	0.661	0.713	0.791	0.778	0.809	0.907
1992	0.000	0.035	0.074	0.123	0.182	0.225	0.310	0.372	0.412	0.459	0.534	0.593	0.656	0.706	0.732	0.828	0.800	0.889	0.947
1993	0.000	0.043	0.057	0.075	0.177	0.226	0.288	0.375	0.411	0.438	0.518	0.558	0.645	0.705	0.728	0.929	0.865	0.875	1.156
1994	0.000	0.051	0.090	0.101	0.149	0.244	0.286	0.357	0.402	0.470	0.502	0.539	0.569	0.702	0.684	0.750	0.824	0.874	0.952
1995	0.000	0.030	0.085	0.119	0.126	0.226	0.296	0.366	0.412	0.459	0.516	0.546	0.638	0.723	0.740	0.837	0.854	0.889	1.079
1996	0.000	0.039	0.067	0.080	0.166	0.171	0.281	0.337	0.389	0.449	0.483	0.536	0.583	0.606	0.658	0.702	0.757	0.799	0.959
1997	0.000	0.033	0.071	0.105	0.145	0.225	0.240	0.358	0.410	0.465	0.503	0.576	0.612	0.625	0.684	0.747	0.790	0.768	0.957
1998	0.000	0.036	0.068	0.097	0.146	0.195	0.266	0.243	0.384	0.436	0.493	0.554	0.626	0.707	0.712	0.815	0.844	0.729	1.128
1999	0.000	0.037	0.067	0.093	0.127	0.190	0.238	0.277	0.264	0.341	0.464	0.572	0.514	0.542	0.534	0.544	0.673	0.643	0.778
2000	0.000	0.038	0.073	0.103	0.141	0.187	0.270	0.304	0.344	0.327	0.424	0.519	0.681	0.574	0.494	0.695	0.724	0.728	0.770
2001	0.000	0.030	0.065	0.091	0.152	0.191	0.246	0.306	0.344	0.390	0.374	0.514	0.602	0.665	0.667	0.622	0.776	0.853	1.035
2002	0.000	0.036	0.056	0.116	0.149	0.204	0.238	0.305	0.340	0.399	0.453	0.408	0.557	0.587	0.616	0.715	0.643	0.888	0.968
2003	0.000	0.041	0.065	0.082	0.123	0.184	0.234	0.274	0.334	0.378	0.432	0.476	0.398	0.560	0.584	0.651	0.524	0.694	0.778
2004	0.000	0.034	0.073	0.107	0.133	0.188	0.243	0.288	0.352	0.399	0.466	0.518	0.566	0.460	0.635	0.675	0.550	0.756	0.718
2005	0.000	0.044	0.067	0.108	0.131	0.189	0.244	0.286	0.345	0.385	0.472	0.493	0.481	0.585	0.514	0.705	0.719	0.900	0.861
2006	0.000	0.049	0.077	0.098	0.138	0.198	0.239	0.288	0.352	0.406	0.447	0.440	0.511	0.540	0.595	0.441	0.545	0.839	0.804
2007	0.000	0.032	0.063	0.118	0.143	0.163	0.265	0.290	0.367	0.400	0.461	0.522	0.543	0.539	0.524	0.408	0.490	0.730	0.554
2008	0.000	0.048	0.082	0.115	0.156	0.204	0.247	0.292	0.333	0.376	0.425	0.442	0.438	0.475	0.539	0.565	0.539	0.442	0.624
2009	0.022	0.067	0.086	0.168	0.139	0.219	0.236	0.270	0.317	0.331	0.401	0.336	0.552	0.448	0.494	0.506	0.676	0.852	0.565
2010	0.000	0.074	0.102	0.123	0.159	0.205	0.244	0.274	0.297	0.331	0.368	0.397	0.461	0.456	0.638	0.523	0.479	0.518	0.519
2011	0.043	0.062	0.086	0.156	0.163	0.211	0.236	0.299	0.320	0.334	0.379	0.426	0.346	0.451	0.420	0.435	0.582	0.488	0.574
2012	0.039	0.066	0.088	0.127	0.167	0.205	0.248	0.276	0.307	0.351	0.355	0.413	0.454	0.433	0.492	0.512	0.594	0.441	0.507
2013	0.038	0.076	0.096	0.122	0.176	0.214	0.270	0.303	0.352	0.378	0.392	0.423	0.482	0.473	0.471	0.481	0.537	0.559	0.556
2014	0.038	0.058	0.100	0.131	0.170	0.228	0.278	0.318	0.351	0.400	0.391	0.422	0.467	0.502	0.513	0.482	0.574	0.547	0.604

Table 8a: 3M beaked redfish survey mean catch per tow from EU bottom trawl survey series, 1988-2002 by RV Cornide Saavedra (CS), 2003-2014 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
mean weight per tow (Kg/tow)	199	159	109	85	147	68	125	90	125	104	74	103	146
SE	32	21	13	10	17	24	38	10	17	18	12	30	57
CV	16%	13%	12%	12%	12%	36%	30%	11%	14%	18%	16%	29%	39%

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
mean weight per tow (Kg/tow)	78	129	59	185	297	532	279	224	342	178	132	183	233	178
SE	12	17	7	26	53	79	43	45	92	34	16	23	26	26
CV	16%	13%	12%	14%	18%	15%	15%	20%	27%	19%	12%	12%	11%	15%

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), 2003-2014 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
abundance (millions)	664	639	331	749	1509	623	936	582	731	571	401	496	567	869
4+abundance (millions)	541	362	265	367	385	376	840	497	657	502	284	410	471	273
biomass ('000 ton)	160	128	89	72	119	78	105	73	100	84	60	82	118	64
4+ biomass ('000 ton)	155	113	86	67	92	45	100	71	101	82	56	81	116	51
female spawning biomass ('000 ton)	55	48	38	15	23	9	9	8	7	19	20	31	54	14
SSB proportion	34%	37%	43%	20%	19%	11%	9%	12%	7%	22%	33%	37%	45%	22%

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
abundance (millions)	1435	597	2086	3326	6342	4605	2443	1838	1108	1090	1346	863	526
4+abundance (millions)	437	227	759	1402	2854	1971	1708	1553	824	873	1165	776	502
biomass ('000 ton)	107	50	157	302	485	386	308	286	164	168	251	188	143
4+ biomass ('000 ton)	69	34	106	209	333	279	264	266	147	159	242	182	144
female spawning biomass ('000 ton)	14	8	12	28	22	48	39	72	33	25	63	63	63
SSB proportion	13%	16%	8%	9%	5%	13%	13%	25%	20%	15%	25%	33%	44%

Table 9: REDFISH NAFO DIVISION 3M INPUT FILES FOR 2015 XSA ASSESSMENT

REDFISH NAFO DIVISION 3M INDEX OF INPUT XSA FILES 2015

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	2014
4	19
5	
58086	
80223	
48500	
43300	
43100	
17664	
13879	
6101	
1408	
1011	
1095	
3658	
3327	
2964	
2273	
3260	
4039	
5936	
5131	
4274	
3639	
5235	
8904	
6736	
5133	
4525	

REDFISH NAFO 3M CATCH NUMBERS thousands

1	2														
1989	2014														
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
1093	1812	1877	1483	879	373	257	624	1192	2036	1029	775	469	140	43	2430
694	1719	3672	5599	3229	1522	948	425	398	204	257	243	75	180	74	343
498	1961	1858	2371	1763	1337	636	496	438	163	411	559	303	206	48	858

REDFISH NAFO 3M CATCH WEIGHT AT AGE kg

1	3														
1989	2014														
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
0.085	0.144	0.190	0.260	0.307	0.371	0.354	0.456	0.532	0.661	0.567	0.506	0.664	0.718	0.754	0.803
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	0.203	0.247	0.290	0.336	0.395	0.407	0.509	0.508	0.502	0.576	0.634	0.625	0.463	0.734
0.103	0.149	0.179	0.237	0.276	0.331	0.363	0.395	0.420	0.512	0.489	0.493	0.477	0.588	0.575	0.613
0.109	0.146	0.183	0.246	0.288	0.338	0.413	0.416	0.468	0.486	0.533	0.581	0.524	0.694	0.554	0.786

REDFISH NAFO 3M STOCK WEIGHT AT AGE kg

1	4														
1989	2014														
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
0.114	0.163	0.200	0.247	0.284	0.335	0.363	0.386	0.419	0.476	0.469	0.460	0.479	0.528	0.558	0.548
0.128	0.164	0.219	0.273	0.310	0.345	0.413	0.389	0.421	0.492	0.522	0.527	0.504	0.589	0.577	0.583

REDFISH NAFO 3M NATURAL MORTALITY (from 2013 assessment)

1	5														
1989	2014														
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
0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125

REDFISH NAFO 3M PROPORTION MATURE FEMALES

1	6														
1989	2014														
4	19														
1															
0.008	0.016	0.036	0.068	0.108	0.160	0.218	0.322	0.398	0.446	0.469	0.511	0.526	0.594	0.591	0.758
0.005	0.019	0.044	0.086	0.131	0.168	0.194	0.272	0.360	0.445	0.476	0.513	0.518	0.584	0.562	0.797
0.003	0.023	0.048	0.096	0.146	0.187	0.213	0.293	0.399	0.498	0.525	0.574	0.581	0.599	0.590	0.707
0.003	0.007	0.047	0.103	0.188	0.258	0.345	0.421	0.489	0.537	0.585	0.627	0.696	0.674	0.682	0.771
0.002	0.012	0.025	0.075	0.164	0.256	0.327	0.370	0.411	0.488	0.541	0.576	0.682	0.650	0.789	0.795
0.000	0.013	0.046	0.088	0.157	0.212	0.260	0.300	0.310	0.370	0.417	0.425	1.096	0.684	0.696	0.659
0.001	0.005	0.046	0.085	0.148	0.201	0.305	0.317	0.320	0.320	0.426	0.409	0.523	0.628	0.656	0.687
0.003	0.004	0.043	0.102	0.153	0.213	0.279	0.312	0.310	0.320	0.363	0.370	0.477	0.490	0.580	0.781
0.001	0.008	0.009	0.128	0.203	0.268	0.352	0.418	0.458	0.525	0.531	0.555	0.598	0.642	0.649	0.700
0.001	0.005	0.035	0.028	0.460	0.493	0.456	0.472	0.477	0.483	0.482	0.478	0.525	0.546	0.545	0.643
0.001	0.007	0.018	0.052	0.042	0.201	0.247	0.301	0.325	0.334	0.386	0.332	0.392	0.451	0.318	0.665
0.006	0.011	0.031	0.067	0.121	0.099	0.228	0.399	0.454	0.396	0.372	0.411	0.391	0.510	0.457	0.639
0.006	0.012	0.025	0.065	0.141	0.257	0.175	0.458	0.350	0.614	0.412	0.546	0.682	0.720	0.647	0.619
0.005	0.015	0.031	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
0.006	0.014	0.036	0.064	0.117	0.178	0.373	0.374	0.384	0.531	0.503	0.468	0.345	0.433	0.417	0.436
0.004	0.009	0.029	0.069	0.116	0.193	0.280	0.409	0.489	0.289	0.603	0.685	0.697	0.569	0.759	0.751
0.004	0.009	0.029	0.088	0.174	0.254	0.328	0.465	0.576	0.664	0.428	0.784	0.695	0.660	0.758	0.676
0.004	0.009	0.029	0.097	0.235	0.348	0.406	0.550	0.589	0.554	0.716	0.603	0.514	0.568	0.592	0.571
0.003	0.008	0.031	0.094	0.212	0.369	0.452	0.511	0.471	0.565	0.601	0.725	0.483	0.615	0.959	0.871
0.004	0.007	0.013	0.105	0.222	0.477	0.787	0.866	0.922	0.939	0.934	0.902	0.761	0.856	0.656	0.877
0.003	0.008	0.036	0.134	0.323	0.488	0.616	0.677	0.707	0.709	0.737	0.557	0.438	0.406	0.732	0.454
0.014	0.011	0.056	0.076	0.148	0.278	0.456	0.655	0.497	0.824	0.706	0.668	0.785	0.933	0.892	0.769
0.011	0.018	0.053	0.153	0.331	0.440	0.546	0.630	0.660	0.753	0.745	0.871	0.847	0.739	0.874	0.767
0.017	0.021	0.050	0.092	0.391	0.457	0.452	0.607	0.708	0.536	0.798	0.738	0.669	0.980	0.964	0.946
0.009	0.022	0.043	0.093	0.164	0.324	0.539	0.503	0.581	0.607	0.589	0.656	0.692	0.882	0.608	0.679
0.005	0.018	0.036	0.108	0.227	0.483	0.581	0.684	0.782	0.849	0.834	0.811	0.840	0.849	0.910	0.878
0.006	0.016	0.041	0.109	0.204	0.313	0.508	0.412	0.485	0.600	0.609	0.635	0.651	0.636	0.586	0.802

REDFISH NAFO 3M PROPORTION OF F BEFORE SPAWNING
1 7
1989 2014
4 19
3
0.08

REDFISH NAFO 3M PROPORTION OF M BEFORE SPAWNING
1 8
1989 2014
4 19
3
0.08

REDFISH NAFO 3M F ON OLDEST AGE GROUP BY YEAR
1 9
1989 2014
4 19
5
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
0.2138
0.1735
0.3813
0.2052
0.9477
0.049
0.1316
0.107
0.8465
0.1353
0.1353
0.1353

REDFISH NAFO 3M F AT AGE IN LAST YEAR
1 10
1989 2014
4 19
2

0.0283	0.036	0.0388	0.0423	0.0239	0.0212	0.0416	0.0674	0.1061	0.1324	0.162	0.3761	0.6431	0.3603	0.3629	0.3629

REDFISH NAFO 3M SURVEY TUNNING DATA
101
EU BOTTOM TRAWL SURVEY
1989 2014
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	63004	84160	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	131612	202027	313659	292199	139414	29159	6307	13926	9276	10094	6559	2852	1808	265	271	5742
10555	80792	80595	166954	248641	109374	38934	20075	7757	6820	2721	3361	3395	893	1498	739	3172
10555	18283	44969	67747	151366	101293	59229	16226	14018	9358	2155	4406	5510	3283	1107	382	2921

Table 10: Complementary diagnostics of XSA_{2015} runs for three "best fit" M options between 0.14 and 0.16 (ages 6 to 17).

	Ages												
Run	6	7	8	9	10	11	12	13	14	15	16	17	Av. se_{int} surv
M0.14	0.518	0.403	0.347	0.309	0.284	0.255	0.239	0.224	0.216	0.211	0.201	0.208	0.285
M0.15	0.518	0.403	0.347	0.309	0.284	0.255	0.239	0.224	0.216	0.211	0.201	0.208	0.285
M0.16	0.518	0.402	0.347	0.309	0.284	0.255	0.239	0.224	0.216	0.211	0.201	0.207	0.284
	6	7	8	9	10	11	12	13	14	15	16	17	Av. se_{ext} surv
M0.14	0.109	0.061	0.183	0.120	0.132	0.143	0.255	0.182	0.144	0.177	0.107	0.164	0.148
M0.15	0.105	0.065	0.184	0.119	0.130	0.143	0.255	0.181	0.144	0.177	0.108	0.164	0.148
M0.16	0.102	0.069	0.184	0.118	0.129	0.144	0.255	0.180	0.144	0.178	0.108	0.164	0.148
	6	7	8	9	10	11	12	13	14	15	16	17	Var ratio (se_{int}/se_{ext})
M0.14	0.210	0.150	0.530	0.390	0.460	0.560	1.070	0.810	0.670	0.840	0.530	0.790	0.584
M0.15	0.200	0.160	0.530	0.390	0.460	0.560	1.070	0.810	0.670	0.840	0.540	0.790	0.585
M0.16	0.200	0.170	0.530	0.380	0.450	0.560	1.070	0.800	0.670	0.840	0.540	0.790	0.583

Table 11a: M0.14 XSA with independent q at age 17 or at age 16 diagnostics

M0.14 XSA2015 independent q at age	**17**	**16**
N iterations for convergence	52	34
SS log q residuals$_{2013\text{-}2014}$	4.8000	4.6343
SS log q residuals$_{2006\text{-}2014}$	50.8014	50.7869
Av. se log q	0.705442	0.709833
XSA$_{4+abundance}$ versus SURVEY$_{4+abundance}$ r^2	0.602652	0.600964
Av. se$_{int}$ survivors	0.284583	0.286333
Av. se$_{ext}$ survivors	0.148083	0.148083
Var ratio (se$_{int}$/se$_{ext}$) survivors	0.58417	0.579167

Table 11b: M0.14 XSA with independent q at age 17 or at age 16 results

M0.14 XSA2015 independent q at age			**17**				**16**
Age	Mean Q	Reg s.e	q	Age	Mean Q	Reg s.e	q
4	-8.33	0.77	0.0002412	4	-8.32	0.78	0.0002436
5	-8.32	1.38	0.0002436	5	-8.31	1.4	0.0002460
6	-8.34	0.91	0.0002388	6	-8.33	0.92	0.0002412
7	-8.44	0.68	0.0002161	7	-8.43	0.69	0.0002182
8	-8.75	0.84	0.0001585	8	-8.74	0.85	0.0001601
9	-9.14	0.83	0.0001073	9	-9.13	0.84	0.0001084
10	-9.55	0.86	0.0000712	10	-9.54	0.87	0.0000719
11	-9.79	0.65	0.0000560	11	-9.77	0.66	0.0000571
12	-9.8	0.85	0.0000555	12	-9.78	0.85	0.0000566
13	-10.01	0.72	0.0000449	13	-9.98	0.73	0.0000463
14	-9.87	0.78	0.0000517	14	-9.84	0.79	0.0000533
15	-10.06	0.84	0.0000428	15	-10.02	0.84	0.0000445
16	-9.75	0.82	0.0000583	16	-9.69	0.83	0.0000619
17	-9.81	1.24	0.0000549	17	-9.72	1.26	0.0000601
18	-9.85	0.35	0.0000527	18	-9.73	0.34	0.0000595

FBAR 6-16	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
17	0.3188	0.4839	0.368	0.5683	0.6546	0.4596	0.6922	0.521	0.1425	0.0843	0.1243	0.2338	0.1605
16	0.3227	0.4886	0.3703	0.5725	0.664	0.4661	0.708	0.5387	0.1472	0.0871	0.1301	0.2421	0.1657
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
17	0.1881	0.1451	0.0987	0.1599	0.0751	0.1252	0.0622	0.0434	0.0595	0.1944	0.1053	0.0401	0.0392
16	0.1936	0.15	0.1018	0.1649	0.0776	0.1309	0.0647	0.0446	0.061	0.2012	0.1095	0.0410	0.0400

Table 12: 2015 Extended Survivor Analysis summary of diagnostics (Lowestoft VPA Version 3.1).

single EU survey, 1989-2014
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
M=0.14 all ages 2013-2014

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

Catch data for 26 years. 1989 to 2014. Ages 4 to 19.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU BOTTOM TRAWL SURV	1989	2014	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 >= 16

Terminal population estimati 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 34 iterations

Log catchability residuals.
Fleet : EU BOTTOM TRAWL SURV

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
4	**-1.92**	**-1.27**	**1.02**	0.09	0.89	0.87	0.61	-0.13	0.82	-0.02	0.35	-0.66	0.14
5	**-3.07**	**-3.8**	0.68	**1.24**	**-1.08**	0.65	0.56	**1.35**	**1.38**	-0.05	0.34	0.19	-0.1
6	-1.9	**-2.11**	**-1.63**	0.51	-0.25	0.29	-0.98	0.99	0.68	0.89	0.23	0.48	-0.06
7	-1	-0.95	**-1.46**	-0.33	-0.86	0.3	-0.07	-0.03	0.64	-0.04	0.98	0.67	0.27
8	-0.39	-0.36	**-1.42**	-0.03	-0.8	-0.04	0.21	0.84	-0.32	0.5	0.65	**1.91**	0.33
9	-0.29	-0.27	**-1.31**	0.01	-1.42	0.37	-0.09	0.88	0.88	0.02	**1.19**	**1.14**	0.5
10	-0.32	-0.19	**-1.37**	-0.06	-0.57	0.34	0.82	0.23	**1.1**	-0.52	**1.07**	**1.88**	-0.17
11	-0.32	-0.39	-0.93	-0.28	-0.37	0.67	1.22	**1.12**	0.15	-0.35	-0.75	0.97	0.5
12	-0.61	-0.67	-1.01	-0.27	-0.44	0.54	0.97	**1.49**	**1.22**	0.71	-0.28	0.12	0.16
13	-0.22	-0.27	-0.66	-0.16	-0.07	0.32	1.02	1.04	**1.31**	0.11	0.38	-0.6	0.24
14	-0.4	-0.1	-0.73	-0.3	-0.16	0.03	0.38	**1.33**	**1.21**	0.46	-0.68	**1.55**	-0.43
15	0.24	-0.1	-1.1	0.12	0.07	0.4	**1.57**	0.55	0.42	-0.76	1.02	0.09	0.31
16	-0.09	-0.27	-0.94	-0.19	-0.63	-0.41	0.81	**1.61**	-0.64	-0.11	0.38	0.04	0.14
17	-0.25	0.19	-0.39	-0.75	-0.25	-0.63	0.02	0.77	**1.7**	-0.33	0.49	-0.41	0.05
18	0	0.05	-0.01	0.1	0.48	0.16	0.34	0.15	-0.23	-0.62	0.14	-0.44	-0.39

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
4	0.44	**-1.31**	-0.69	0.1	**1.22**	0.25	0.03	-0.34	-0.64	-0.12	0.17	0.12	0
5	-0.09	-0.47	0.73	0.11	0.95	0.76	0.38	0.32	-0.27	-0.2	-0.06	-0.17	-0.28
6	-0.09	-0.87	-0.09	0.96	0.7	0.73	1.05	0.46	-0.15	0.01	0.31	-0.06	-0.12
7	-0.16	-1.01	-0.3	0.32	-0.03	0.85	0.32	0.78	0.26	-0.06	0.45	0.36	0.12
8	0.5	-0.74	-0.39	0.51	-0.39	-0.26	-0.12	0.61	-0.45	-0.84	0.58	-0.06	-0.04
9	0.84	-0.07	-0.47	0.37	-0.29	-0.25	-0.61	0.48	-0.5	-0.72	-0.15	-0.14	-0.11
10	0.57	-0.04	0.11	0.39	-0.76	-0.86	-0.63	0.42	-0.01	-0.11	-0.94	0.04	-0.44
11	-0.26	0.25	-0.16	0.64	-0.67	-0.32	-0.38	-0.07	0.05	-0.37	0.35	-0.35	0.09
12	0.05	-0.91	-0.07	0.59	-0.26	-0.52	-0.64	0.91	-0.52	-0.71	0.29	-0.19	0.02
13	0.45	0.19	-0.66	0.64	-0.33	-0.11	-0.68	-0.96	-0.24	0.08	0.71	-0.55	-0.98
14	-0.14	0.64	-0.02	-1.21	-0.16	-0.11	-0.48	0.51	-0.77	-0.66	0.58	-0.31	-0.03
15	0.51	-0.79	-0.7	-0.72	-0.95	0.18	-1.22	-0.49	**-1.46**	0.79	**1.14**	0.32	0.56
16	-0.57	0.87	0.76	-0.67	-0.56	1.54	-1.16	-0.13	-0.78	-0.07	0.93	-0.03	0.16
17	-0.39	**1.13**	**1.54**	-0.04	1.42	-1.41	-2.02	-0.14	-0.93	-1.19	-0.58	1.18	0.46
18	-0.57	-0.14	-0.31	-0.35	0	-0.15	-0.85	0.68	-0.37	0.28	0.31	0.73	0.11

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	-8.32	-8.3083	-8.3279	-8.4262	-8.7384	-9.1279	-9.5361	-9.7674	-9.7805	-9.981	-9.8384	-10.0179	-9.6941	-9.6941	-9.6941
S.E(Log q)	0.7494	1.173	0.867	0.6321	0.6732	0.6687	0.7175	0.5686	0.6735	0.6171	0.6728	0.7785	0.7227	0.9263	0.392

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	1.02	-0.11	8.28	0.65	26	0.78	-8.32
5	1.17	-0.545	7.89	0.29	26	1.4	-8.31
6	1.04	-0.187	8.24	0.5	26	0.92	-8.33
7	1.07	-0.46	8.3	0.66	26	0.69	-8.43
8	1.32	-1.878	8.31	0.59	26	0.85	-8.74
9	1.33	-2.042	8.94	0.62	26	0.84	-9.13
10	1.24	-1.447	9.58	0.61	26	0.87	-9.54
11	1.19	-1.546	9.9	0.74	26	0.66	-9.77
12	1.51	-3.45	10.35	0.65	26	0.85	-9.78
13	1.33	-2.773	10.53	0.75	26	0.73	-9.98
14	1.24	-1.923	10.29	0.73	26	0.79	-9.84
15	1.07	-0.555	10.19	0.72	26	0.84	-10.02
16	1.16	-1.289	10.11	0.73	26	0.83	-9.69
17	1.62	-3.429	11.66	0.56	26	1.26	-9.72
18	0.92	1.81	9.44	0.95	26	0.34	-9.73
1							

Terminal year survivor and F summaries :

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2010

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	6472	0.764	0	0	1	1	0.069

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2009

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	20715	0.644	0.182	0.28	2	1	0.085

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 2008

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	27485	0.52	0.109	0.21	3	1	0.061

Age 7 Catchability constant w.r.t. time and dependent on age
Year class = 2007

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	53315	0.405	0.061	0.15	4	1	0.041

Age 8 Catchability constant w.r.t. time and dependent on age
Year class = 2006

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	57818	0.349	0.184	0.53	5	1	0.028

Age 9 Catchability constant w.r.t. time and dependent on age
Year class = 2005

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	53598	0.311	0.12	0.39	6	1	0.023

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 2004

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	30742	0.286	0.132	0.46	7	1	0.019

Age 11 Catchability constant w.r.t. time and dependent on age
Year class = 2003

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	19755	0.257	0.143	0.55	8	1	0.023

Age 12 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	14240	0.24	0.255	1.06	9	1	0.028

Age 13 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	10956	0.226	0.183	0.81	10	1	0.014

Age 14 Catchability constant w.r.t. time and dependent on age
Year class = 2000

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	7401	0.217	0.144	0.66	11	1	0.05

Age 15 Catchability constant w.r.t. time and dependent on age
Year class = 1999

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	6023	0.213	0.177	0.83	12	1	0.083

Age 16 Catchability constant w.r.t. time and dependent on age
Year class = 1998

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	3902	0.202	0.106	0.53	13	1	0.07

Age 17 Catchability constant w.r.t. time and dependent on age
Year class = 1997

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	930	0.21	0.163	0.77	14	1	0.188

Age 18 Catchability constant w.r.t. time and age (fixed at the value for age) 17
Year class = 1996

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	472	0.224	0.173	0.77	15	1	0.091

Table 13: Main results of retrospective $XSA_{2014-2010}$

Biomass

	2014	2013	2012	2011	2010
1989	218	218	216	217	218
1990	186	186	185	185	186
1991	134	134	133	133	134
1992	99	99	98	98	99
1993	68	68	67	67	68
1994	45	45	44	44	44
1995	36	36	35	35	35
1996	25	25	24	24	24
1997	24	23	22	22	23
1998	25	25	24	24	24
1999	26	26	25	24	24
2000	32	32	30	29	29
2001	33	33	31	29	29
2002	39	38	36	34	33
2003	43	42	40	36	36
2004	61	60	58	53	54
2005	78	79	78	71	73
2006	100	101	102	99	109
2007	111	111	111	108	125
2008	133	135	136	127	143
2009	136	139	141	124	135
2010	130	134	131	112	122
2011	112	114	112	95	
2012	121	123	120		
2013	122	124			
2014	129				

7+FemBiomass

	2014	2013	2012	2011	2010
1989	53.0	53.0	51.9	52.2	53.0
1990	45.8	45.7	44.8	45.1	45.7
1991	39.1	39.0	38.3	38.5	39.0
1992	33.2	33.2	32.6	32.7	33.2
1993	21.4	21.4	21.0	21.1	21.3
1994	9.6	9.5	9.3	9.3	9.5
1995	7.7	7.7	7.4	7.4	7.6
1996	4.3	4.3	4.1	4.1	4.3
1997	4.6	4.6	4.3	4.4	4.6
1998	5.7	5.7	5.3	5.4	5.5
1999	5.5	5.5	5.2	5.2	5.3
2000	5.8	5.8	5.4	5.4	5.6
2001	6.8	6.7	6.4	6.3	6.3
2002	7.4	7.3	6.9	6.7	6.7
2003	7.5	7.5	6.9	6.7	6.6
2004	10.8	10.7	9.9	9.5	9.4
2005	14.3	14.2	13.0	12.2	11.9
2006	16.2	15.9	14.7	13.3	13.0
2007	23.6	23.1	21.5	18.9	18.5
2008	36.6	36.0	34.1	30.3	30.6
2009	35.2	34.8	33.7	29.5	30.7
2010	30.9	31.0	30.9	27.9	30.7
2011	27.0	27.2	27.5	25.0	
2012	37.3	37.9	37.6		
2013	39.3	40.4			
2014	48.8				

FBAR

	2014	2013	2012	2011	2010
1989	0.323	0.323	0.326	0.325	0.323
1990	0.489	0.489	0.493	0.492	0.489
1991	0.370	0.370	0.372	0.372	0.371
1992	0.573	0.573	0.577	0.576	0.573
1993	0.664	0.665	0.673	0.671	0.665
1994	0.466	0.467	0.473	0.471	0.467
1995	0.708	0.710	0.726	0.720	0.709
1996	0.539	0.542	0.560	0.553	0.540
1997	0.147	0.148	0.153	0.152	0.149
1998	0.087	0.087	0.090	0.090	0.087
1999	0.130	0.131	0.137	0.135	0.131
2000	0.242	0.243	0.252	0.250	0.245
2001	0.166	0.166	0.173	0.174	0.173
2002	0.194	0.195	0.201	0.203	0.203
2003	0.150	0.151	0.157	0.159	0.158
2004	0.102	0.103	0.108	0.113	0.115
2005	0.165	0.166	0.175	0.186	0.193
2006	0.078	0.079	0.083	0.092	0.094
2007	0.131	0.132	0.144	0.157	0.164
2008	0.065	0.065	0.069	0.078	0.080
2009	0.045	0.045	0.048	0.055	0.059
2010	0.061	0.062	0.064	0.079	0.079
2011	0.201	0.206	0.280	0.439	
2012	0.110	0.117	0.145		
2013	0.041	0.041			
2014	0.040				

REC

	2014	2013	2012	2011	2010
1989	54.4	54.4	54.4	54.4	54.4
1990	42.3	42.3	42.2	42.2	42.3
1991	23.7	23.7	23.6	23.7	23.7
1992	22.0	22.0	21.9	21.9	21.9
1993	139.5	139.5	139.4	139.5	139.5
1994	151.0	150.5	146.5	145.6	145.5
1995	27.4	27.3	26.6	26.5	26.5
1996	12.8	12.8	12.6	12.5	12.7
1997	16.1	16.0	15.7	15.6	14.4
1998	14.8	14.8	14.6	13.1	13.4
1999	23.2	23.2	19.6	18.4	16.6
2000	26.3	25.5	22.9	18.8	16.5
2001	31.4	30.5	29.7	26.0	26.6
2002	63.0	62.0	58.9	53.8	50.9
2003	97.2	93.6	94.8	80.5	85.5
2004	119.0	117.5	127.1	119.2	134.1
2005	157.7	183.3	190.9	177.8	191.7
2006	220.5	219.9	240.0	288.5	378.3
2007	204.1	199.2	194.8	196.2	268.8
2008	206.8	225.6	236.6	194.4	200.7
2009	241.1	249.3	256.9	182.9	163.7
2010	174.2	177.7	138.8	96.2	86.9
2011	104.7	96.6	93.4	86.1	
2012	46.8	50.4	55.0		
2013	30.6	34.7			
2014	8.0				

Table 14: XSA results for 2015 assessment

Run title : REDFISH NAFO DIVISION 3M INDEX OF INPUT FILES 2015

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	0.2987	0.0561	0.0114	1.802	0.4695	0.1124	0.1439	0.0463	0.0078	0.0069	0.0036	0.0281	0.0242
5	0.0157	0.0615	0.1428	0.317	0.8152	0.3912	0.1791	0.1843	0.0152	0.0045	0.0034	0.0066	0.0151	0.0134
6	0.0846	0.102	0.1927	0.4027	0.2761	0.2457	0.5899	0.0784	0.0383	0.0129	0.0013	0.018	0.0219	0.0241
7	0.2129	0.4394	0.458	0.858	0.3095	0.3219	0.4413	0.2623	0.0157	0.0209	0.0093	0.0366	0.0865	0.0357
8	0.301	0.7686	0.6581	1.028	0.5154	0.3518	0.5513	0.6052	0.0665	0.0155	0.0213	0.1619	0.1495	0.1068
9	0.2787	0.7363	0.6138	0.7528	0.261	0.5395	0.3384	0.6542	0.2073	0.1254	0.0146	0.1422	0.1813	0.1485
10	0.2424	0.5996	0.3801	0.5312	0.5416	0.5838	0.6088	0.3307	0.2609	0.0636	0.1374	0.123	0.1061	0.1439
11	0.3027	0.4515	0.3865	0.4118	0.7774	0.7109	0.8697	0.6597	0.1015	0.081	0.0891	0.3444	0.1176	0.0973
12	0.2727	0.348	0.3017	0.4419	0.8063	0.6751	0.7263	0.9185	0.3026	0.2124	0.1506	0.2434	0.3058	0.0809
13	0.3705	0.4024	0.3228	0.426	0.9857	0.4504	0.7472	0.5238	0.2516	0.095	0.2153	0.1186	0.2352	0.4304
14	0.3636	0.5495	0.3095	0.4316	1.0185	0.43	0.51	0.7206	0.2619	0.1759	0.1003	0.9516	0.1296	0.3189
15	0.56	0.4565	0.1795	0.5274	1.0272	0.5211	1.3556	0.2542	0.0812	0.0339	0.4028	0.2123	0.2081	0.4897
16	0.5607	0.5206	0.2703	0.4862	0.7851	0.2964	1.0489	0.9181	0.0322	0.1213	0.2891	0.3107	0.2812	0.2538
17	0.4202	0.7533	0.4731	0.2842	0.8921	0.2252	0.51	0.4037	0.2836	0.089	0.3539	0.1737	0.2249	0.3553
18	0.5592	0.6661	0.7199	0.4988	1.6034	0.4662	0.6499	0.2268	0.0416	0.0495	0.1787	0.2989	0.197	0.1416
+gp	0.5592	0.6661	0.7199	0.4988	1.6034	0.4662	0.6499	0.2268	0.0416	0.0495	0.1787	0.2989	0.197	0.1416
0 FBAR 6-16	0.3227	0.4886	0.3703	0.5725	0.664	0.4661	0.708	0.5387	0.1472	0.0871	0.1301	0.2421	0.1657	0.1936

(Table 8) Fishing mortality (F) at age

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	FBAR **-**
AGE													
4	0.0187	0.009	0.0041	0.0113	0.0026	0.0015	0.0022	0.0194	0.0347	0.0206	0.0246	0.0693	0.0382
5	0.0375	0.0513	0.0031	0.0426	0.0066	0.0065	0.0041	0.0419	0.0348	0.0179	0.0466	0.0846	0.0497
6	0.0121	0.0576	0.0097	0.1124	0.0111	0.0334	0.0193	0.0571	0.0446	0.0171	0.0522	0.0611	0.0435
7	0.0223	0.0775	0.0225	0.0924	0.0804	0.0454	0.0317	0.0758	0.0396	0.0154	0.0735	0.0406	0.0432
8	0.0404	0.0658	0.0747	0.071	0.0424	0.0662	0.0392	0.0297	0.0299	0.0164	0.0466	0.028	0.0303
9	0.086	0.0523	0.1165	0.0886	0.0728	0.0551	0.0446	0.0262	0.0355	0.0108	0.0386	0.023	0.0241
10	0.0771	0.0689	0.1154	0.0499	0.053	0.0453	0.0445	0.0487	0.0936	0.0103	0.0373	0.0191	0.0222
11	0.1253	0.0577	0.1871	0.0488	0.0889	0.0582	0.0411	0.0668	0.1242	0.0325	0.0232	0.0231	0.0263
12	0.0563	0.0856	0.2367	0.0695	0.1129	0.0511	0.0607	0.0482	0.1894	0.0879	0.0286	0.0283	0.0482
13	0.0646	0.0537	0.2305	0.0678	0.121	0.0399	0.0244	0.1101	0.0821	0.167	0.021	0.0138	0.0673
14	0.4739	0.0592	0.1057	0.1292	0.14	0.0949	0.0729	0.0692	0.2281	0.1337	0.0313	0.0505	0.0719
15	0.0875	0.0613	0.0918	0.0601	0.2351	0.0683	0.0311	0.0263	0.5504	0.3441	0.046	0.083	0.1577
16	0.6046	0.4802	0.6229	0.0641	0.4822	0.1542	0.0812	0.113	0.7958	0.3698	0.0528	0.0699	0.1642
17	0.4886	0.5344	0.9559	0.9327	0.0523	0.0839	0.0645	0.0788	0.7333	0.169	0.2475	0.1878	0.2014
18	0.2445	0.2129	0.4406	0.2387	1.1436	0.0526	0.1359	0.127	0.9179	0.1166	0.1329	0.0906	0.1134
+gp	0.2445	0.2129	0.4406	0.2387	1.1436	0.0526	0.1359	0.127	0.9179	0.1166	0.1329	0.0906	
0 FBAR 6-16	0.15	0.1018	0.1649	0.0776	0.1309	0.0647	0.0446	0.061	0.2012	0.1095	0.041	0.04	

(Table 9) Relative F at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE														
4	0.0267	0.6113	0.1515	0.0199	2.714	1.0075	0.1588	0.2671	0.3144	0.089	0.0527	0.0147	0.1697	0.1252
5	0.0487	0.126	0.3857	0.5537	1.2277	0.8394	0.253	0.3422	0.1033	0.0514	0.0261	0.0271	0.091	0.0693
6	0.2623	0.2088	0.5206	0.7034	0.4159	0.5273	0.8333	0.1456	0.2598	0.1482	0.0103	0.0744	0.132	0.1245
7	0.6596	0.8994	1.2369	1.4987	0.4661	0.6906	0.6233	0.4869	0.1065	0.2396	0.0712	0.1513	0.5222	0.1844
8	0.9327	1.5731	1.7774	1.7957	0.7762	0.7549	0.7788	1.1234	0.4514	0.1784	0.1638	0.6689	0.9021	0.5517
9	0.8637	1.507	1.6576	1.315	0.3931	1.1577	0.4781	1.2144	1.4079	1.4398	0.1125	0.5872	1.0943	0.7668
10	0.7511	1.2272	1.0266	0.9278	0.8157	1.2526	0.8599	0.6139	1.7723	0.7306	1.0559	0.5082	0.6401	0.743
11	0.9379	0.924	1.0438	0.7193	1.1709	1.5253	1.2285	1.2246	0.6893	0.9299	0.6845	1.4227	0.7096	0.5027
12	0.8451	0.7123	0.8147	0.7719	1.2143	1.4486	1.0259	1.705	2.0555	2.4393	1.1574	1.0055	1.8457	0.4176
13	1.1481	0.8237	0.8719	0.7441	1.4846	0.9664	1.0554	0.9724	1.7089	1.0908	1.655	0.49	1.4196	2.2225
14	1.1266	1.1248	0.836	0.7539	1.5339	0.9226	0.7204	1.3378	1.7786	2.0204	0.7708	3.931	0.782	1.647
15	1.7353	0.9343	0.4847	0.9212	1.547	1.1181	1.9148	0.4719	0.5514	0.3897	3.0963	0.8772	1.2556	2.5291
16	1.7375	1.0655	0.7299	0.8492	1.1824	0.6359	1.4817	1.7043	0.2184	1.3933	2.2223	1.2836	1.6969	1.3107
17	1.3019	1.5418	1.2778	0.4965	1.3436	0.4831	0.7204	0.7495	1.9263	1.022	2.7197	0.7176	1.357	1.8349
18	1.7327	1.3634	1.9442	0.8713	2.4147	1.0004	0.918	0.4209	0.2824	0.5688	1.3732	1.2349	1.1891	0.7311
+gp	1.7327	1.3634	1.9442	0.8713	2.4147	1.0004	0.918	0.4209	0.2824	0.5688	1.3732	1.2349	1.1891	0.7311
0 REFMEAN	0.3227	0.4886	0.3703	0.5725	0.664	0.4661	0.708	0.5387	0.1472	0.0871	0.1301	0.2421	0.1657	0.1936

(Table 9) Relative F at age

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	MEAN **-**
AGE													
4	0.1246	0.0883	0.0248	0.1457	0.0202	0.0225	0.0494	0.3174	0.1724	0.1884	0.601	1.7304	0.8399
5	0.2497	0.5035	0.0186	0.5489	0.0501	0.1003	0.0928	0.6874	0.1729	0.1634	1.1354	2.1124	1.1371
6	0.0804	0.5655	0.059	1.4484	0.0847	0.5163	0.4317	0.936	0.2217	0.1564	1.2727	1.5265	0.9852
7	0.1486	0.7617	0.1362	1.1904	0.6141	0.7009	0.7112	1.2419	0.1967	0.141	1.7921	1.0146	0.9826
8	0.2693	0.6462	0.4534	0.9141	0.3237	1.0227	0.8778	0.4864	0.1487	0.1494	1.1358	0.7001	0.6618
9	0.5735	0.514	0.7067	1.1419	0.5561	0.851	0.999	0.43	0.1763	0.0989	0.941	0.5742	0.5381
10	0.5137	0.677	0.7002	0.6427	0.405	0.6999	0.9976	0.7979	0.465	0.0942	0.9096	0.4771	0.4937
11	0.8354	0.567	1.1348	0.6284	0.6793	0.8991	0.9215	1.0955	0.6171	0.2963	0.5668	0.5779	0.4803
12	0.3752	0.841	1.4356	0.8948	0.8622	0.7894	1.3605	0.7899	0.9413	0.802	0.6964	0.7061	0.7348
13	0.4305	0.5272	1.3981	0.8733	0.9246	0.6163	0.5467	1.8044	0.4081	1.5241	0.5126	0.3441	0.7936
14	3.1595	0.5816	0.641	1.665	1.07	1.4664	1.6342	1.1346	1.1336	1.2209	0.7641	1.2608	1.082
15	0.5834	0.6025	0.5569	0.7746	1.7965	1.0556	0.6982	0.4314	2.7359	3.1411	1.1217	2.0727	2.1118
16	4.0305	4.7164	3.7782	0.8264	3.684	2.3825	1.8215	1.8519	3.9555	3.3757	1.2871	1.7458	2.1362
17	3.2575	5.2485	5.7979	12.0154	0.3999	1.2965	1.4457	1.2913	3.645	1.5426	6.0359	4.6905	4.0897
18	1.6298	2.0911	2.6727	3.0747	8.7374	0.8132	3.0478	2.0811	4.5626	1.0645	3.2401	2.263	2.1892
+gp	1.6298	2.0911	2.6727	3.0747	8.7374	0.8132	3.0478	2.0811	4.5626	1.0645	3.2401	2.263	
0 REFMEAN	0.15	0.1018	0.1649	0.0776	0.1309	0.0647	0.0446	0.061	0.2012	0.1095	0.041	0.04	

(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	54439	42273	23678	21955	139458	150951	27387	12801	16083	14840	23220	26262	31382	63005
5	71311	48836	28374	20255	19640	20816	85406	22146	10030	13894	13324	20867	23678	27608
6	102203	63520	41551	22257	13349	7865	12737	64604	16666	8939	12516	12015	18757	21104
7	125987	84972	51901	31006	13464	9164	5566	6389	54047	14514	7985	11310	10678	16605
8	97283	92141	49547	29706	11896	8940	6010	3239	4447	48143	12861	7158	9865	8861
9	62695	65144	38658	23215	9615	6429	5690	3133	1600	3765	42890	11392	5509	7687
10	47449	42929	28229	18935	9895	6701	3391	3670	1474	1177	3006	38245	8942	4158
11	35389	33691	21327	17466	10073	5209	3382	1669	2386	1027	999	2371	30599	7277
12	27362	23658	19410	13111	10469	4189	2315	1282	781	1950	857	827	1520	24616
13	21614	18848	15115	12989	7626	4230	1930	1013	463	522	1427	667	587	1013
14	20289	13502	11404	9903	7676	2575	2439	827	543	326	430	1041	536	420
15	12746	12762	7052	7572	5820	2508	1516	1325	364	378	247	352	364	426
16	7262	6588	7316	5333	4043	1885	1348	354	930	304	331	150	257	267
17	6503	3751	3542	5052	2967	1669	1268	427	128	815	243	224	99	176
18	4833	3865	1598	1997	3440	1100	1205	689	258	87	675	155	170	72
+gp	12217	9804	6727	4610	1966	1548	2710	1494	1961	1130	943	2264	358	429
0 TOTAL	709584	566284	355428	245361	271397	235778	164301	125065	112162	111812	121954	135298	143302	183723

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

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	GMST 89-**	AMST 89-**
AGE															
4	97225	119019	157697	220523	204124	206838	241101	174175	104749	46849	30571	7978	0	61596	92501
5	55644	86345	106729	142109	146158	136467	138446	161259	114514	89290	40500	25930	6472	46927	66798
6	24648	48498	74224	96277	91285	97333	90884	92420	103656	97604	77400	33607	20715	36420	51455
7	18641	22035	41428	66511	57674	60516	63100	59760	58512	87487	84671	63867	27485	28346	40802
8	14498	16495	18450	36653	54870	48155	52328	40976	37135	49633	76023	68394	53315	21339	31637
9	7205	12599	13975	15492	30893	47589	40782	33730	26664	31806	43090	63083	57818	15005	22840
10	5996	5982	10819	11255	12829	25991	40753	26145	22024	22711	27766	36042	53598	10709	16779
11	3258	5023	5052	8722	9688	11009	22476	26128	16693	17700	19837	23255	30742	7760	12442
12	5974	2601	4290	3791	7516	8020	9398	14460	16382	13012	15122	16849	19755	5403	9075
13	20543	5109	2160	3063	3200	6075	6896	5929	9236	11963	10517	12776	14240	3696	6759
14	596	17426	4382	1552	2590	2566	5282	4511	3560	7509	8934	8953	10956	2565	5079
15	276	336	14861	3567	1234	2037	2111	3292	2822	2501	5797	7527	7401	1688	3603
16	236	229	286	12267	3039	883	1722	1372	2149	1436	1565	4813	6023	1142	2499
17	188	117	128	139	10410	1698	685	1064	821	856	876	1290	3902	722	1790
18	111	104	62	45	49	8939	1413	430	659	348	638	594	930	465	1346
+gp	1286	1871	247	553	452	9567	8192	5867	2651	21121	2941	10602	8890		
0 TOTAL	256326	343788	454790	622520	636014	673682	725567	651518	522229	501825	446247	385561	322242		

(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							54	25	32	15	69	104	155	374
4	270	205	94	65	240	144	585	130	60	96	106	207	305	383
5	1342	916	445	274	201	200	542	2038	478	177	348	286	539	648
6	4330	2688	1867	855	505	298	490	652	4605	992	388	682	715	1101
7	10198	6755	4715	2613	1160	735	873	514	1194	11210	2649	708	1286	1142
8	12059	11002	7228	4506	1925	1345	1148	670	507	1187	11220	2078	1023	1635
9	10462	10480	7449	5074	2261	1362	900	1106	520	409	917	8152	2225	1227
10	9603	8443	6818	5311	2923	1884	967	548	941	402	384	883	11096	2579
11	10109	9510	6749	6052	3409	1606	678	429	314	799	352	303	587	9123
12	10252	8810	7819	5436	3924	1366	608	374	199	230	562	294	260	485
13	9638	8383	7204	6327	3251	1591	934	341	242	149	175	373	204	174
14	9580	6281	5838	5220	3608	1138	541	573	168	170	97	147	156	186
15	6444	6506	3938	4263	2888	1122	858	174	491	151	140	71	120	121
16	3733	3398	4247	3323	3104	1401	726	241	69	438	118	123	51	86
17	3693	2074	2094	3140	1834	1063	731	422	151	43	290	71	82	34
18	2664	2112	914	1308	2167	751	1809	1052	1372	747	598	1405	234	254
+gp	8739	6953	4782	3331	1273	1056								

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

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
AGE												
4	482	590	626	854	791	601	1634	1516	1448	556	332	55
5	715	938	953	1234	1132	1057	1206	2024	1922	1766	798	458
6	782	1485	2134	2772	2120	2538	3076	4366	5420	4729	3277	1323
7	1274	1608	3487	6091	5628	6640	6401	6961	6179	9776	8157	6484
8	1763	2214	3184	7484	12097	11975	11671	10611	10637	14477	19548	13361
9	1384	2589	3640	4944	12127	20916	16294	13105	10319	12805	17884	23225
10	1986	1930	3594	4393	6945	15877	24345	13596	10497	11525	14345	19323
11	1101	2063	2345	4387	6126	7435	15882	16462	10326	10138	11708	12234
12	2490	1238	2301	2038	4884	5547	6422	8677	9937	8315	10309	10240
13	7948	2498	1056	1795	2157	4434	5492	4337	6405	7386	6894	8657
14	281	8792	2508	887	1906	1912	4028	3167	2596	5229	6530	5969
15	137	214	10113	2479	893	1463	1446	2221	2029	1819	4198	5183
16	105	126	171	6828	1700	485	1095	909	1531	1016	1131	3445
17	81	62	71	78	6993	1047	483	710	678	725	767	992
18	56	66	42	33	33	6906	1029	343	552	278	516	409
+gp	808	1133	157	380	317	6937	5494	3729	2017	16511	2403	8191

(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							2794	1011	1447	1321	2020	2547	2667	6364
	4	5444	4100	2581	2108	9204	13586	9651	3056	1274	1917	1612	2754	3315	3644
	5	11695	8351	3831	3464	3064	2706	2764	9109	3166	1618	2203	2091	3358	3883
	6	20952	13466	8892	4630	2830	1777	1603	1725	9404	3324	1781	2646	2541	3769
	7	31245	22178	14325	9054	3864	2529	2146	1063	1579	10688	3344	2040	2930	2499
	8	27628	27550	16697	10516	4342	3111	2304	1203	650	1397	10551	3748	1807	2483
	9	19874	21563	14883	9193	3798	2539	1547	1626	687	497	971	11359	3434	1622
	10	16560	15497	13126	8558	4294	3109	1738	801	1205	503	473	991	10404	2969
	11	15253	14925	10983	9170	5167	2568	1264	684	448	1073	484	437	784	9797
	12	13982	12397	11044	7486	5800	2220	1219	588	282	326	732	446	351	568
	13	12169	10970	9311	8248	4758	2322	1712	496	337	224	237	587	356	250
	14	11890	8128	7401	6734	5274	1733	1100	860	248	270	134	175	243	268
	15	8043	8321	4936	5331	4155	1653	1094	246	694	246	183	101	159	192
	16	4670	4401	5699	4303	3522	1356	1043	323	101	678	156	161	76	113
	17	4591	2742	2706	3885	2531	1362	1048	547	196	63	415	111	145	64
	18	3397	2810	1269	1755	2983	937	2891	1428	1829	1247	722	1698	361	409
	+gp	10751	9020	6001	4301	2165	1412	35918	24767	23547	25391	26017	31891	32931	38894
0	TOTALBIO	218143	186418	133686	98735	67752	44920								

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

	YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	AGE												
	4	7389	11188	14508	19406	22250	20891	28209	20553	14455	5622	3485	1021
	5	6065	10361	12701	16200	17539	17741	18413	24350	17864	14197	6601	4253
	6	3968	7905	12321	15115	12506	16352	16087	16820	19591	18935	15480	7360
	7	4045	4870	8866	14300	11823	13192	11989	13087	12580	19684	20914	17436
	8	3827	4586	5037	9713	13717	13243	11879	10777	10881	12508	21591	21202
	9	2313	4321	4738	5221	9701	15466	10603	9782	8266	9415	14435	21764
	10	2128	2261	4100	4513	5093	9591	13000	8497	6916	7949	10079	14886
	11	1346	2230	2319	3759	4427	4569	8901	9511	6060	6177	7657	9046
	12	2760	1295	2063	1627	3908	3513	3064	5596	6749	5270	6336	7093
	13	7211	2825	998	1507	1735	2685	3744	2709	3113	5347	5006	6286
	14	333	7423	2589	827	1396	1262	2303	2034	1591	3176	4190	4673
	15	161	213	7460	2097	645	1155	1005	2047	1162	1188	2667	3967
	16	151	157	203	5177	1213	534	863	723	939	696	749	2426
	17	96	63	93	76	5091	1003	463	503	478	508	462	760
	18	77	79	56	37	36	4005	1154	223	322	154	356	343
	+gp	970	1412	214	428	250	7357	4358	3033	1524	10244	1612	6181
0	TOTALBIO	42840	61191	78267	100005	111330	132559	136034	130247	112492	121069	121620	128696

(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	27	20	10	6	16	13	5	2	3	1	6	10	13	38
	5	220	157	60	47	31	26	66	18	8	13	13	27	43	51
	6	888	570	400	178	107	67	118	287	91	32	61	50	96	119
	7	2529	1763	1301	763	333	203	141	176	801	227	86	160	170	250
	8	3425	3290	2436	1595	703	468	312	169	424	2489	689	202	382	322
	9	3316	3469	2868	2009	893	538	465	257	206	440	2760	684	336	528
	10	3351	3048	3171	2400	1269	874	411	490	242	173	296	2421	855	479
	11	4357	4213	3476	3177	1749	792	497	263	475	197	182	369	3773	1052
	12	5239	4617	4449	3104	2174	724	370	229	180	439	199	160	303	3631
	13	5426	4879	4438	4017	2029	873	384	217	121	143	288	196	155	272
	14	5614	3781	3789	3550	2479	766	656	204	150	102	96	211	135	104
	15	4066	4242	2756	3001	2062	739	393	372	115	122	52	73	104	117
	16	2401	2270	3309	2681	2704	1007	697	121	366	122	77	48	74	87
	17	2607	1516	1600	2415	1564	868	597	182	54	365	76	88	39	55
	18	1872	1536	726	1149	1879	640	635	335	115	32	179	51	70	30
	+gp	7690	6396	4265	3107	1402	963	1931	1006	1280	824	458	1054	236	241
0	TOTSPBIO	53028	45765	39053	33202	21392	9562	7677	4329	4631	5721	5519	5803	6784	7376

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

	YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	AGE												
	4	37	55	58	75	86	61	191	179	200	67	38	7
	5	78	113	113	141	136	137	160	306	300	281	130	75
	6	126	242	354	435	290	426	544	795	1024	917	655	290
	7	276	355	746	1310	1154	1447	1216	1524	1328	2199	2015	1770
	8	466	615	869	1983	3024	3293	2649	2791	3117	3648	5552	4142
	9	444	888	1234	1666	3808	6798	4236	3800	3199	3790	5991	8013
	10	705	729	1362	1761	2757	5859	7766	4419	3296	4034	5207	7981
	11	455	916	1076	1891	2800	3086	6289	5992	3748	3538	4519	4759
	12	1150	616	1107	875	2540	2429	2094	3358	4094	3367	4320	4311
	13	2790	1382	488	883	1169	1960	2982	1982	2158	3302	3281	4259
	14	157	3745	1482	473	1027	941	1756	1428	1160	2212	3063	3116
	15	80	136	5077	1458	467	830	688	1381	836	864	1931	2732
	16	67	87	122	2882	678	294	549	479	669	493	542	1737
	17	41	33	51	43	3420	619	326	336	395	430	405	584
	18	39	50	38	28	24	3094	840	178	269	123	288	236
	+gp	609	855	137	294	175	5334	2923	1928	1160	8008	1317	4776
0	TOTSPBIO	7520	10819	14314	16197	23555	36607	35212	30875	26953	37273	39253	48786

(Table 16) Summary (without SOP correction)

Terminal Fs derived using XSA (Without F shrinkage)

	RECRUITS Age 4	TOTALBIO	TOTALABUND	TOTSPBIO	LANDINGS	YIELD/SSI	FBAR 6-16
1989	54439	218143	709584	53028	58086	1.0954	0.3227
1990	42273	186418	566284	45765	80223	1.7529	0.4886
1991	23678	133686	355428	39053	48500	1.2419	0.3703
1992	21955	98735	245361	33202	43300	1.3041	0.5725
1993	139458	67752	271397	21392	43100	2.0148	0.664
1994	150951	44920	235778	9562	17664	1.8474	0.4661
1995	27387	35918	164301	7677	13879	1.8079	0.708
1996	12801	24767	125065	4329	6101	1.4095	0.5387
1997	16083	23547	112162	4631	1408	0.304	0.1472
1998	14840	25391	111812	5721	1011	0.1767	0.0871
1999	23220	26017	121954	5519	1095	0.1984	0.1301
2000	26262	31891	135298	5803	3658	0.6304	0.2421
2001	31382	32931	143302	6784	3327	0.4904	0.1657
2002	63005	38894	183723	7376	2964	0.4019	0.1936
2003	97225	42840	256326	7520	2273	0.3023	0.15
2004	119019	61191	343788	10819	3260	0.3013	0.1018
2005	157697	78267	454790	14314	4039	0.2822	0.1649
2006	220523	100005	622520	16197	5936	0.3665	0.0776
2007	204124	111330	636014	23555	5131	0.2178	0.1309
2008	206838	132559	673682	36607	4274	0.1168	0.0647
2009	241101	136034	725567	35212	3639	0.1033	0.0446
2010	174175	130247	651518	30875	5235	0.1696	0.061
2011	104749	112492	522229	26953	8904	0.3304	0.2012
2012	46849	121069	501825	37273	5874	0.1576	0.1095
2013	30571	121620	446247	39253	5130	0.1307	0.041
2014	7978	128696	385561	48786	4525	0.0928	0.04
2015			322242				
Arith. Mean	86869	87129		22200	14713	0.6633	0.2417
0 Units	(Thousands)	(Tonnes)		(Tonnes)	(Tonnes)		

Table 15: Input framework for yield per recruit analysis under M at 0.14.

Age	mean weights 2006-2014			% mat females	PR	Ref. M
	stock	catch	stock mat f	2006-2014	2006-2014	2013-2014
4	0.115	0.117	0.127	0.007	0.129	0.14
5	0.143	0.155	0.171	0.018	0.200	0.14
6	0.180	0.189	0.215	0.040	0.267	0.14
7	0.223	0.243	0.265	0.103	0.318	0.14
8	0.269	0.285	0.299	0.198	0.256	0.14
9	0.312	0.335	0.337	0.373	0.244	0.14
10	0.361	0.390	0.376	0.543	0.244	0.14
11	0.394	0.406	0.380	0.533	0.289	0.14
12	0.417	0.467	0.419	0.616	0.342	0.14
13	0.470	0.502	0.468	0.686	0.358	0.14
14	0.479	0.509	0.469	0.677	0.502	0.14
15	0.517	0.552	0.492	0.701	0.570	0.14
16	0.484	0.547	0.492	0.728	0.908	0.14
17	0.563	0.636	0.568	0.789	1.073	0.14
18	0.602	0.531	0.516	0.701	1.019	0.14
19	0.593	0.714	0.556	0.787	1.000	0.14
20	0.593	0.714	0.556	0.787	1.000	0.14
21	0.593	0.714	0.556	0.787	1.000	0.14
22	0.593	0.714	0.556	0.787	1.000	0.14
23	0.593	0.714	0.556	0.787	1.000	0.14
24	0.593	0.714	0.556	0.787	1.000	0.14
25	0.593	0.714	0.556	0.787	1.000	0.14
26	0.593	0.714	0.556	0.787	1.000	0.14
27	0.593	0.714	0.556	0.787	1.000	0.14
28	0.593	0.714	0.556	0.787	1.000	0.14
29	0.593	0.714	0.556	0.787	1.000	0.14
30	0.593	0.714	0.556	0.787	1.000	0.14

Table 16a: stock recruitment Mterm input file

5	Nparams
5	Geometric mean model
61.596	1989-2012 age 4 XSA geomean in millions
0.00000E+000	
0.00000E+000	
0	
0.00000E+000	
24	Ndata log residuals
-0.124	
-0.376	
-0.956	
-1.032	
0.817	
0.896	
-0.811	
-1.571	
-1.343	
-1.423	
-0.976	
-0.852	
-0.674	
0.023	
0.456	
0.659	
0.940	
1.275	
1.198	
1.211	
1.365	
1.039	
0.531	
-0.274	
0	No extra data

Table 16b: An explanation of the red.sen file input data for several F@age options

N4=1989-2012 age 4 XSA geometric mean *Catch@age2015=Catch@age2014*

Population@age at the beginning of 2016 (from 2015 survivors@age) / Exploitation pattern

	Value	C.V.		F@age$_{2013-2014}$ Average	C.V.	F@age$_{2012-2014}$ Average	C.V.	F0.1@age Value	Fmax@age Value	C.V. Frel$_{2006-2014}$
'N4'	61596	0.76	'sH4'	0.0470	0.0316	0.0382	0.0270	0.0269	0.1190	0.1877
'N5'	53084	0.41	'sH5'	0.0656	0.0269	0.0497	0.0335	0.0418	0.1846	0.2392
'N6'	3798	0.31	'sH6'	0.0567	0.0063	0.0435	0.0233	0.0559	0.2468	0.1939
'N7'	16276	0.23	'sH7'	0.0571	0.0233	0.0432	0.0291	0.0667	0.2945	0.2207
'N8'	21684	0.27	'sH8'	0.0373	0.0132	0.0303	0.0152	0.0536	0.2368	0.2044
'N9'	44706	0.22	'sH9'	0.0308	0.0110	0.0241	0.0139	0.0511	0.2255	0.1779
'N10'	49018	0.21	'sH10'	0.0282	0.0129	0.0222	0.0138	0.0512	0.2262	0.1761
'N11'	46003	0.20	'sH11'	0.0232	0.0001	0.0263	0.0054	0.0606	0.2678	0.2072
'N12'	26263	0.25	'sH12'	0.0285	0.0002	0.0482	0.0343	0.0716	0.3160	0.1715
'N13'	16766	0.20	'sH13'	0.0174	0.0051	0.0673	0.0864	0.0749	0.3307	0.3285
'N14'	12228	0.18	'sH14'	0.0409	0.0136	0.0719	0.0544	0.1051	0.4640	0.2673
'N15'	9142	0.20	'sH15'	0.0645	0.0262	0.1577	0.1625	0.1195	0.5276	0.4311
'N16'	5913	0.15	'sH16'	0.0614	0.0121	0.1642	0.1783	0.1902	0.9250	0.5086
'N17'	4954	0.19	'sH17'	0.2177	0.0422	0.2014	0.0410	0.2247	0.9250	0.6623
'N18'	3200	0.20	'sH18'	0.1118	0.0299	0.1134	0.0213	0.2134	0.9250	0.5000
'N19'	7693	0.20	'sH19'	0.1118	0.0299	0.1134	0.0213	0.2134	0.9250	0.5000

Stock weight@age $_{2012-2014}$	Average	C.V.	Catch weight@age $_{2012-2014}$	Average	C.V.	Natural mortality@age $_{best\ fit\ 2013-2014}$	Value	C.V.	Maturity@age $_{2012-2014}$	Average	C.V.
'WS4'	0.120	0.007	'WH4'	0.117	0.019	'M4'	0.14	0.00	'MT4'	0.008	0.002
'WS5'	0.162	0.003	'WH5'	0.155	0.013	'M5'	0.14	0.00	'MT5'	0.020	0.003
'WS6'	0.204	0.013	'WH6'	0.189	0.013	'M6'	0.14	0.00	'MT6'	0.041	0.004
'WS7'	0.249	0.024	'WH7'	0.243	0.006	'M7'	0.14	0.00	'MT7'	0.102	0.009
'WS8'	0.282	0.029	'WH8'	0.285	0.007	'M8'	0.14	0.00	'MT8'	0.195	0.032
'WS9'	0.326	0.026	'WH9'	0.335	0.003	'M9'	0.14	0.00	'MT9'	0.367	0.095
'WS10'	0.375	0.033	'WH10'	0.390	0.025	'M10'	0.14	0.00	'MT10'	0.547	0.037
'WS11'	0.375	0.022	'WH11'	0.406	0.011	'M11'	0.14	0.00	'MT11'	0.507	0.138
'WS12'	0.415	0.009	'WH12'	0.467	0.046	'M12'	0.14	0.00	'MT12'	0.600	0.152
'WS13'	0.472	0.023	'WH13'	0.502	0.014	'M13'	0.14	0.00	'MT13'	0.650	0.142
'WS14'	0.471	0.050	'WH14'	0.509	0.023	'M14'	0.14	0.00	'MT14'	0.653	0.136
'WS15'	0.487	0.035	'WH15'	0.552	0.051	'M15'	0.14	0.00	'MT15'	0.691	0.096
'WS16'	0.489	0.013	'WH16'	0.547	0.083	'M16'	0.14	0.00	'MT16'	0.692	0.100
'WS17'	0.570	0.036	'WH17'	0.636	0.054	'M17'	0.14	0.00	'MT17'	0.770	0.134
'WS18'	0.525	0.074	'WH18'	0.531	0.059	'M18'	0.14	0.00	'MT18'	0.762	0.181
'WS19'	0.539	0.049	'WH19'	0.714	0.090	'M19'	0.14	0.00	'MT19'	0.763	0.100

Natural mortality multiplier in year			Effort multiplier in year (H - Human consumption)		
'K2015'	1	0.0	'HF2015'	1.0	0.0
'K2016'	1	0.0	'HF2016'	1.0	0.0
'K2017'	1	0.0	'HF2017'	1.0	0.0

Table 17: Short term projections (50th %ile) for female SSB (beginning 2018) and average 2016-2017 yield under several F options and M at 0.14

	SSB	F_0	$F_{2012-2014}$	$F_{2013-2014}$	$F_{0.1}$	F_{max}	Yield	F0	$F_{2012-2014}$	$F_{2013-2014}$	$F_{0.1}$	F_{max}
2018 $_{50th\ \%ile}$		57675	51235	52879	48563	28756	2016-2017$_{50th\ \%ile}$		6477	5345	8991	22800
2018 $_{20th\ \%ile}$		54201	48182	49732	45681	26900	2015(3)		4429	4429	4429	4429
2014	48786						2014(4) 4525					
							(1) 2016-2017 TAC$_{50th\ \%ile}$		10124	8353	14052	35634

(2) average beaked redfish proportion in the 2013-2014 3M redfish catch 0.64

(3) Catch@age2015=Catch@age2014; Catch weight@age 2015= Average Catch weight@age 2012-2014

(4) Sumprod with Catch weight@age 2014

Table 18a: SSB 50% probability profiles under under several F options and M at 0.14, 2016-2024.

	SSB 50th %ile				
Year	F_0	$F_{2012-2014}$	$F_{2013-2014}$	$F_{0.1}$	F_{max}
2016	54185	54185	54185	54185	54185
2017	56561	53413	54196	51973	39472
2018	**57675**	**51235**	**52879**	**48563**	**28756**
2019	58403	48613	51141	45147	21078
2020	59781	46484	49749	42453	16003
2021	63012	45810	49641	41335	13116
2022	66100	45042	49127	40299	11472
2023	69428	45320	48952	40159	11121
2024	73286	46708	49420	40991	11098
2025	76284	47876	49809	41537	11242

Table 18b: SSB 20% probability profiles under under several F options and M at 0.14, 2016-2024.

	SSB 20th %ile				
Year	F_0	$F_{2012-2014}$	$F_{2013-2014}$	$F_{0.1}$	F_{max}
2016	51043	51043	51043	51043	51043
2017	53291	50241	51037	48890	37117
2018	**54201**	**48182**	**49732**	**45681**	**26900**
2019	55112	45848	48251	42520	19696
2020	55965	43492	46517	39603	14637
2021	58120	42153	45795	37929	11625
2022	59658	40269	44323	35762	9507
2023	61171	38783	42859	34156	8561
2024	63844	39331	42435	33915	8218
2025	65372	39246	41646	33410	8501

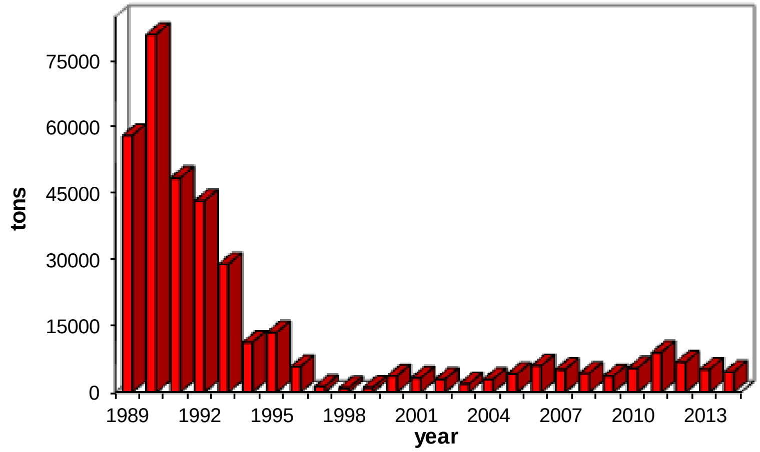


Fig. 1a: Beaked redfish commercial catch.

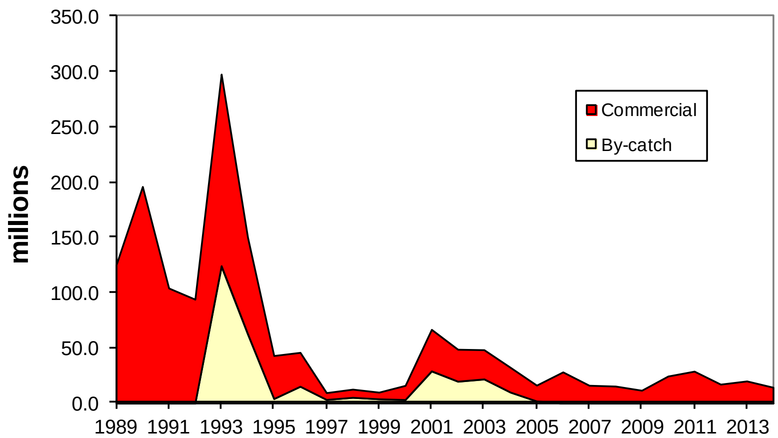


Fig. 1b: Beaked redfish commercial catch and by-catch in numbers

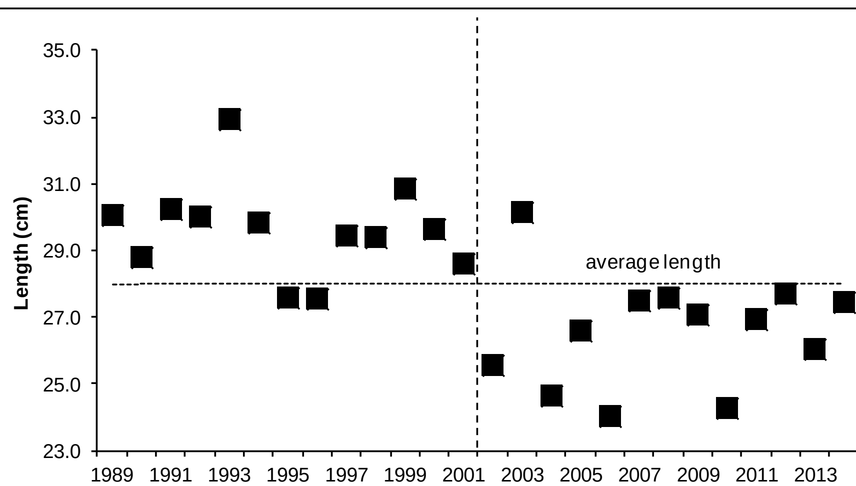


Fig. 2: Mean length of the commercial catch, 1989-2014

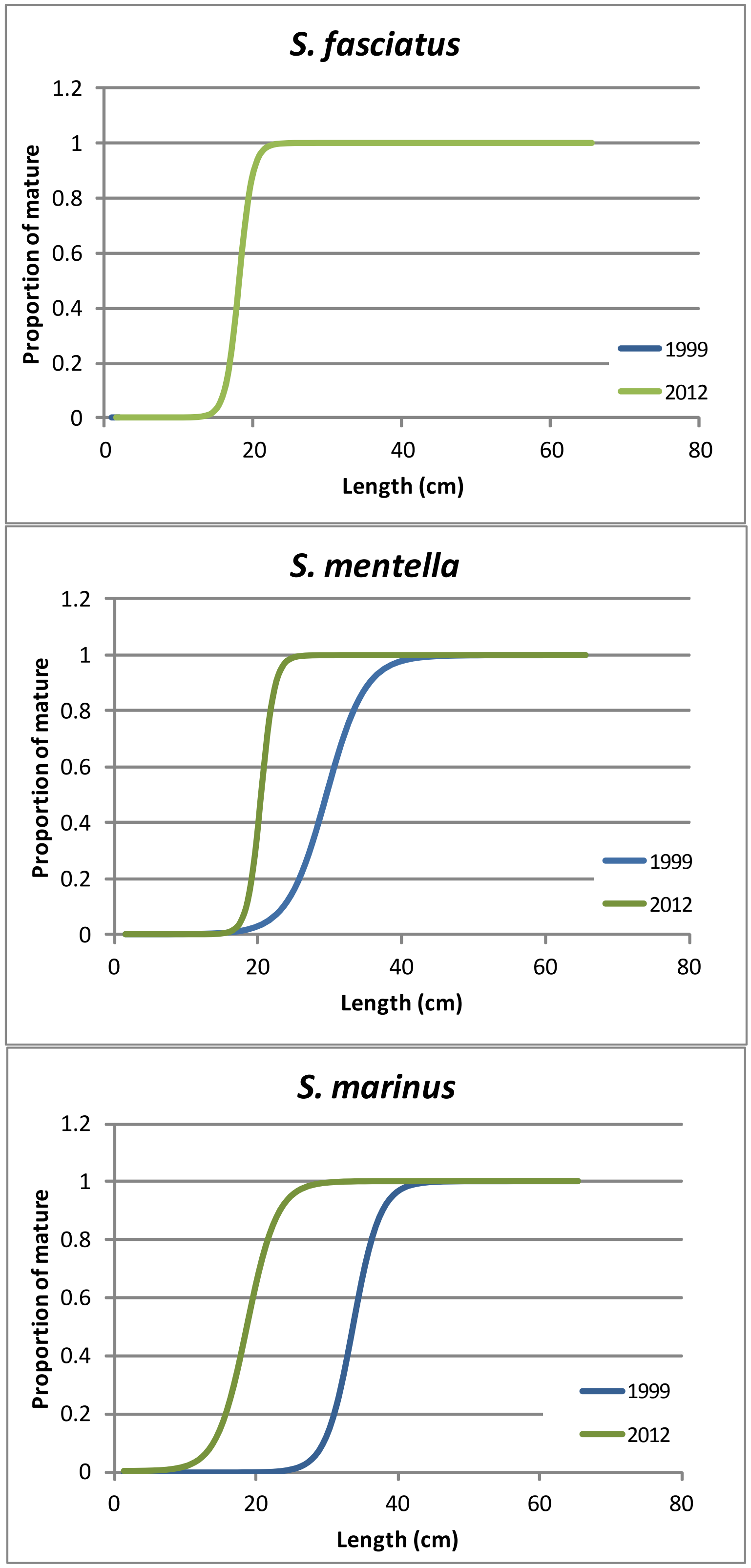


Figure 3: Temporal variation of maturity ogives for the three species of the genus Sebastes in Flemish Cap *(S. fasciatus* , *S. mentella* and *S. marinus*) between 1999 and 2012.

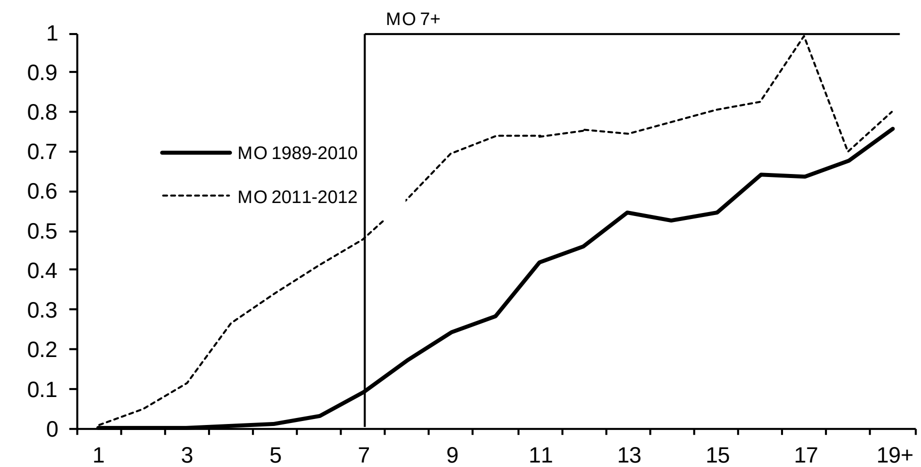


Fig. 4: Female mature proportions at age for 3M beaked redfish, 2011-2012: age 7+ versus proportions from old and new maturity ogives at length for *S. mentella* and *S. fasciatus*

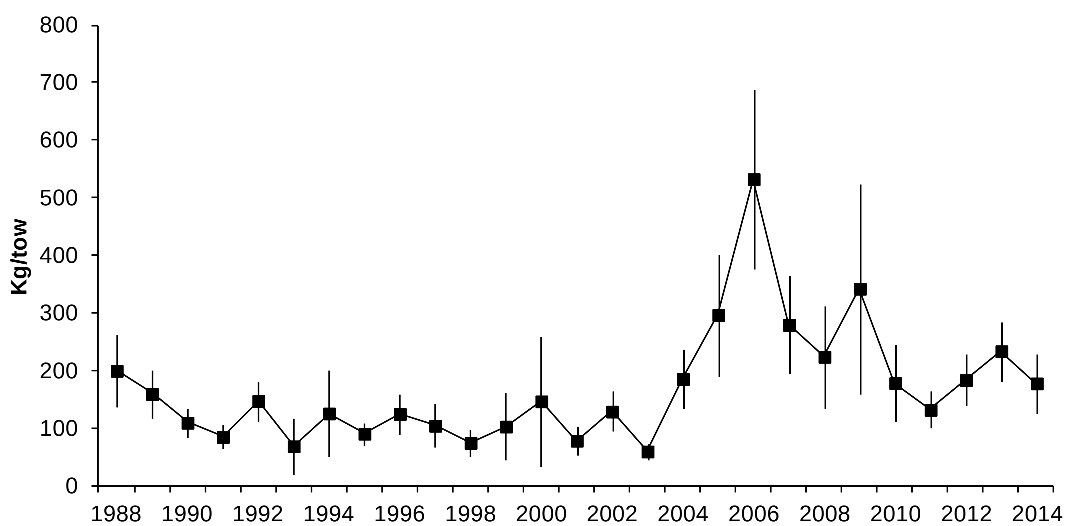


Fig. 5: mean catch per tow for 3M beaked refish (EU survey, 1988-2014) with associated +/- 1.96 se

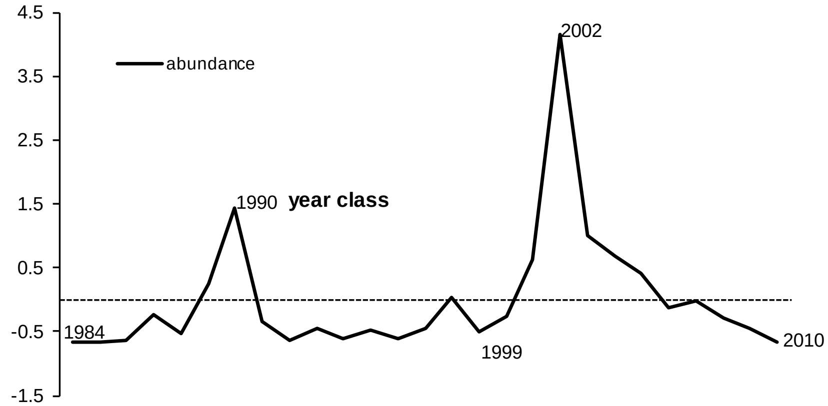


Fig 6a : Standardized *year class strength at age 4* given by EU surveys, 1988-2014

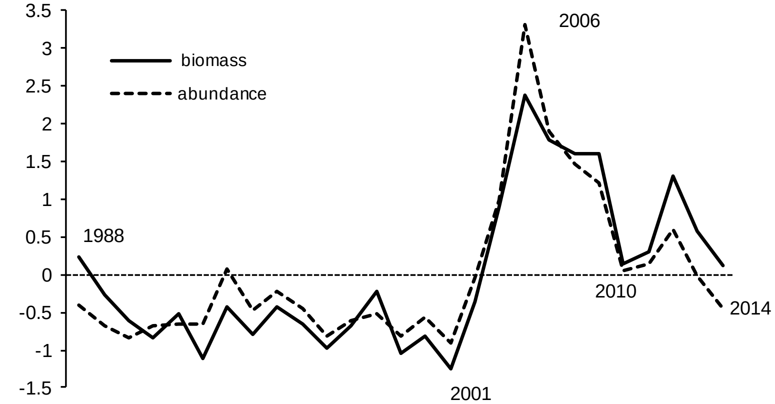


Fig 6c : Standardized *4+ abundance and biomass* given by EU surveys, 1988-2014

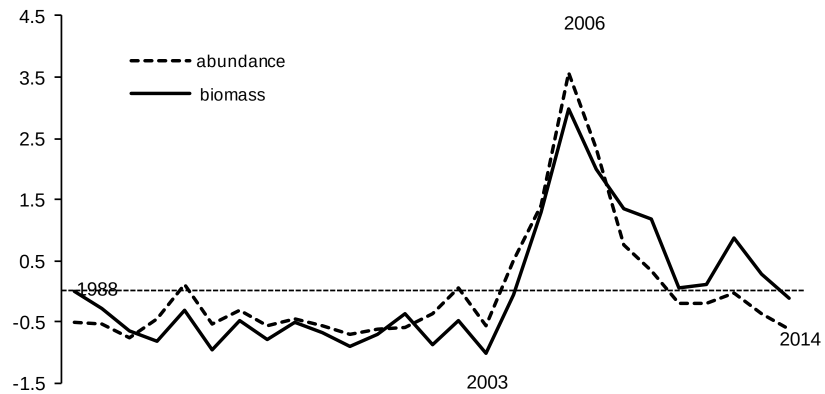


Fig 6b: Standardized *total abundance and biomass* given by EU surveys, 1988-2014

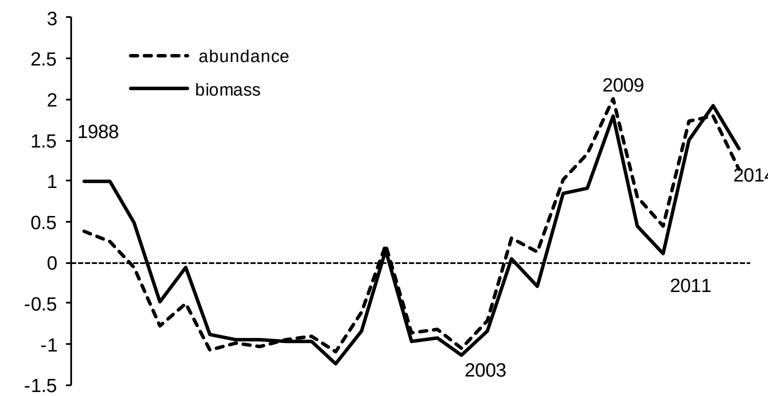


Fig 6d: Standarized *female spawning abundance and biomass* given by EU surveys, 1988-2014

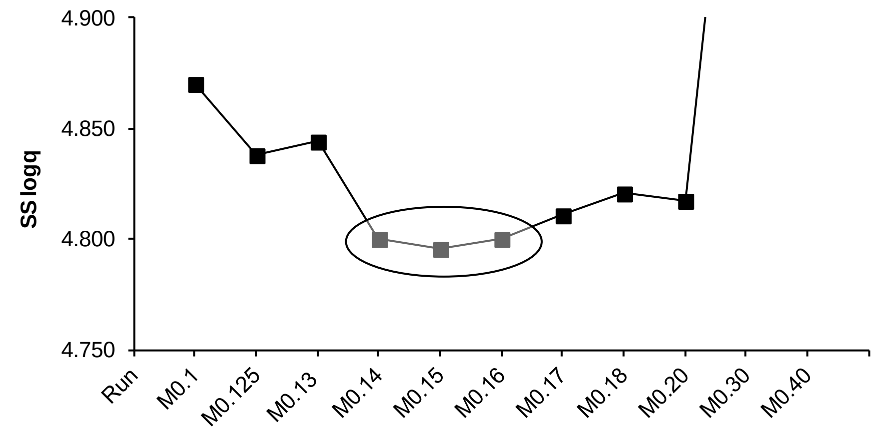


Fig 7a: XSA_{2015} $SS_{2013\text{-}2014}$ log q residuals for a set of 2013-2014 M options (see text)

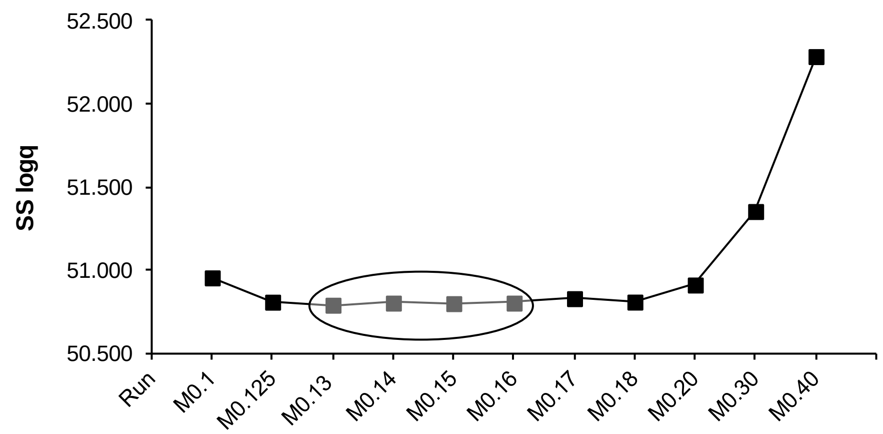


Fig 7b: XSA_{2015} $SS_{2006\text{-}2014}$ log q residuals for a set of 2013-2014 M options (see text)

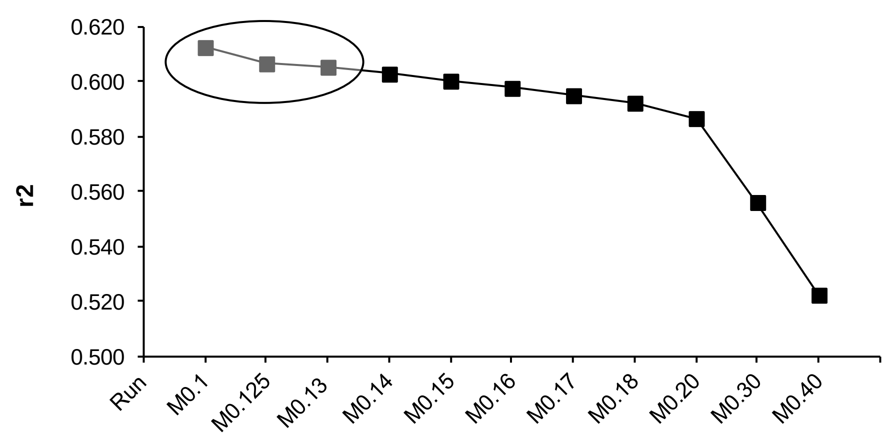


Fig. 7c: Correlation between XSA_{2015} versus Survey 4+abundance for a set of 2013-2014 M options (see text)

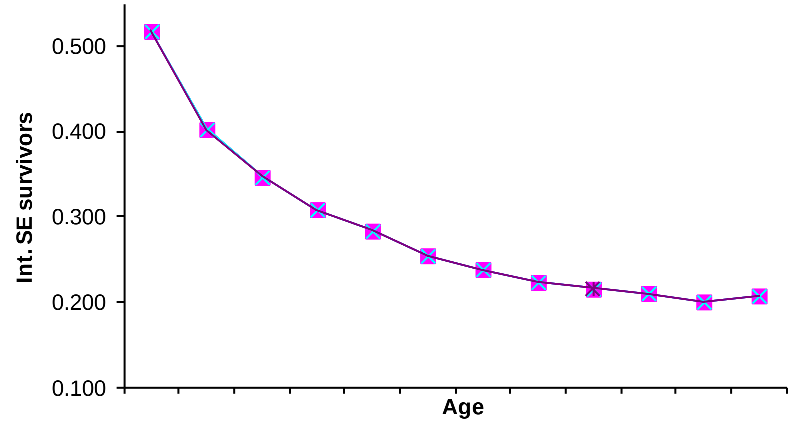


Fig. 8a: XSA$_{2015}$ Int. SE of survivors for M between 0.14 and 0.16

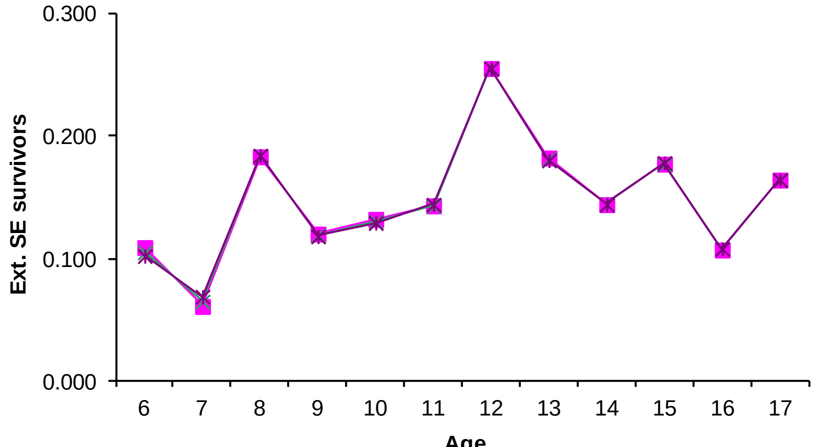


Fig. 8b: XSA$_{2015}$ Ext. SE of survivors for a gradient for M between 0.14 and 0.16

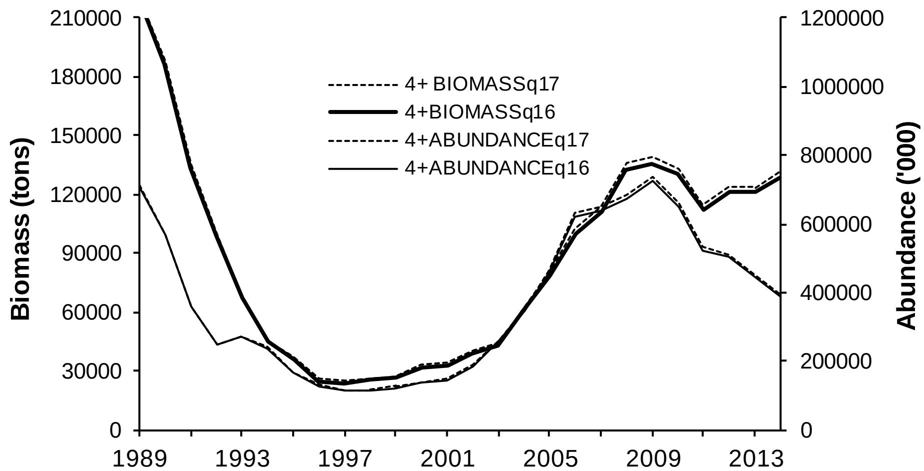


Fig. 9a: 4+Biomass and Abundance from M0.14XSA with ind *q* starting at age 16 or 17

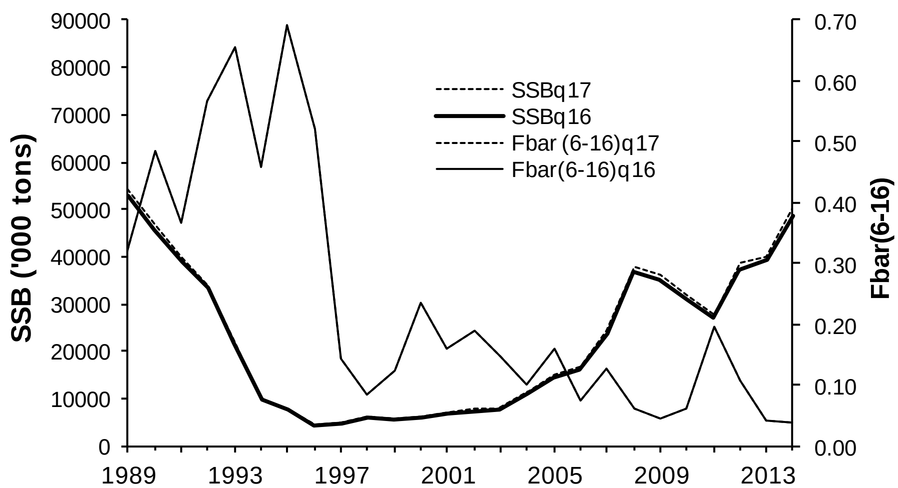


Fig. 9b: SpawningFembiomass vs FBar from M0.14 XSA2015 with ind *q* starting at age 16 or 17

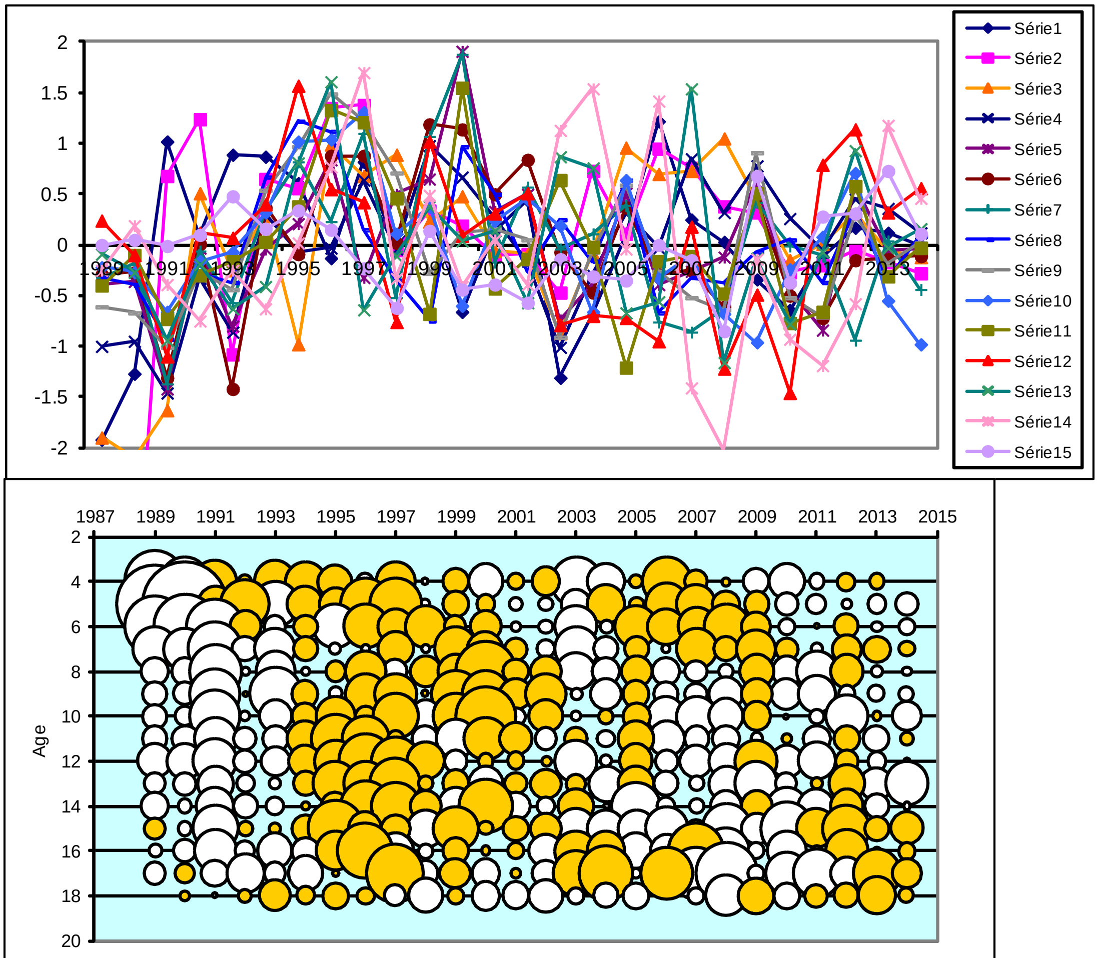
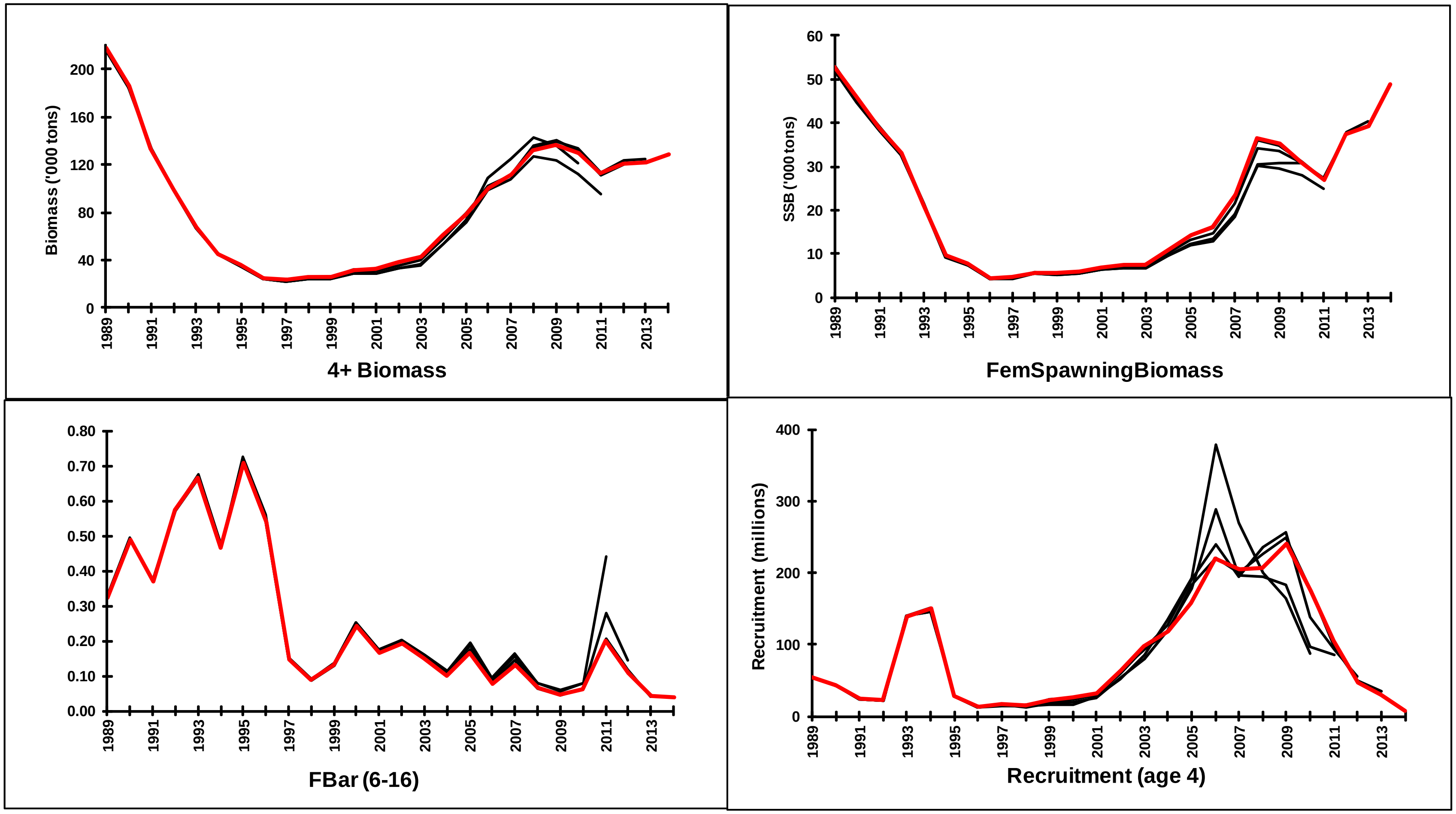
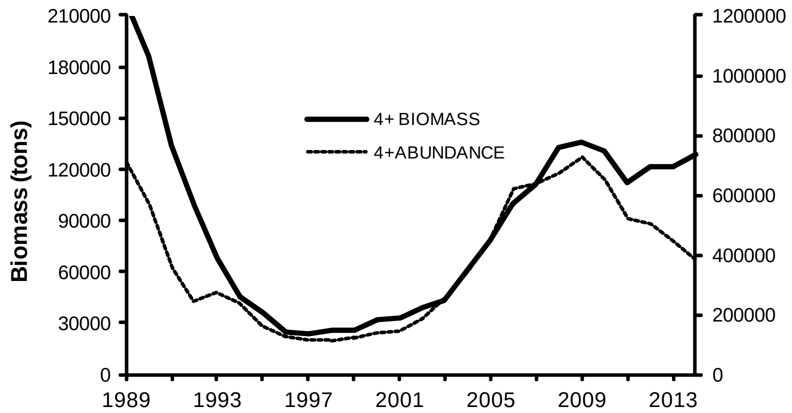


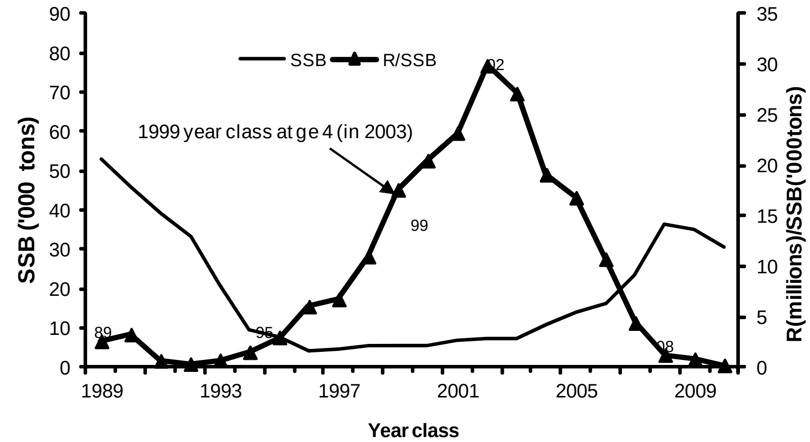
Fig. 10: XSA 2015 $M_{2013\text{-}2014}$ 0.14 EU survey log q residuals, 1989-2014

Fig. 11: Main results of retrospective XSA$_{2014-2010}$

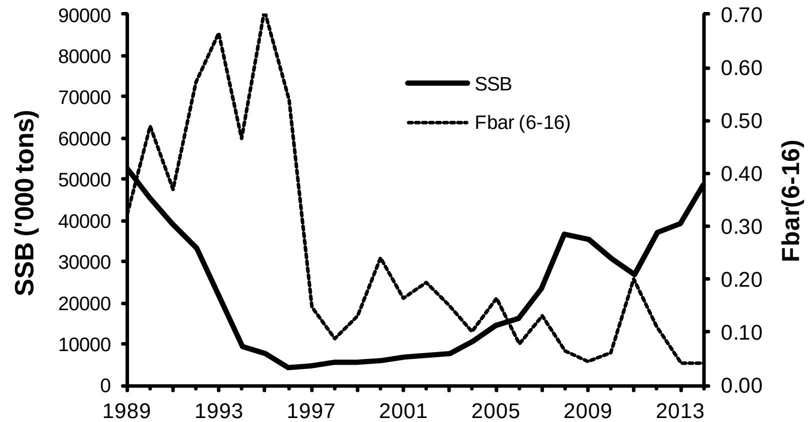




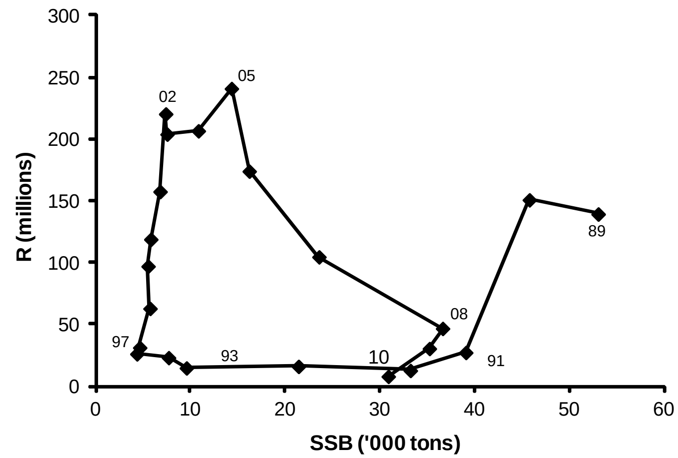
4+Biomass vs 4+Abundance from XSA 2015



Recruitment (age 4)/Spawning Fembiomass from XSA2015



SpawningFembiomass vs FBar from XSA2015



SR plot from XSA2015

Fig. 12a: XSA results for 2015 assessment.

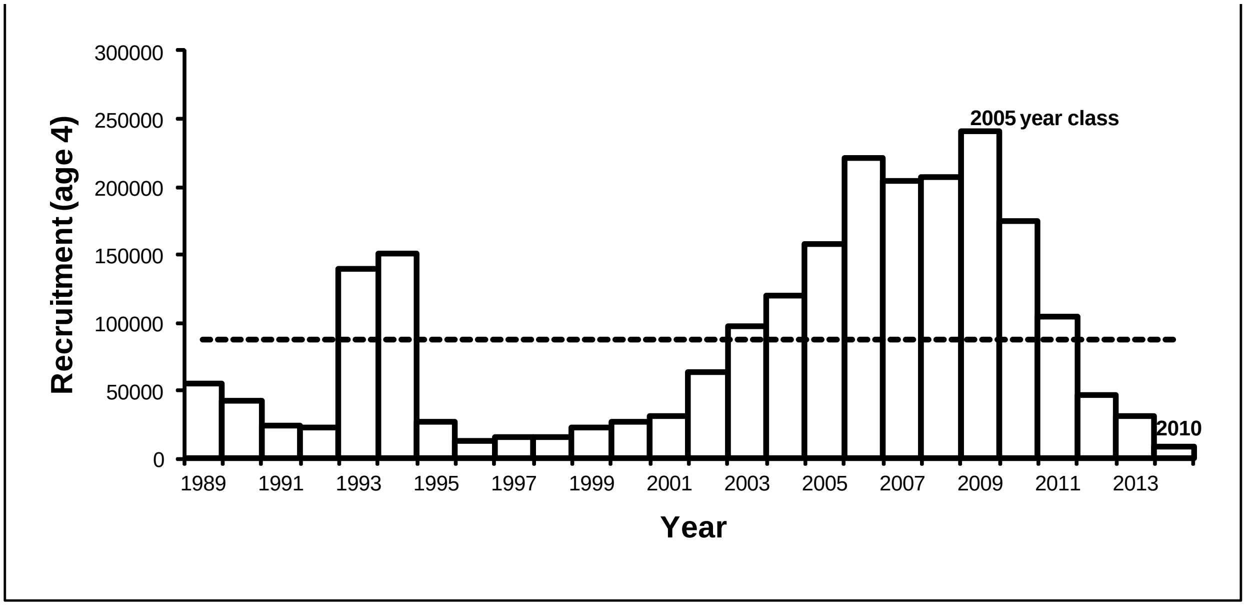


Fig. 12b: Year Class strength at recruitment from 2015 XSA.

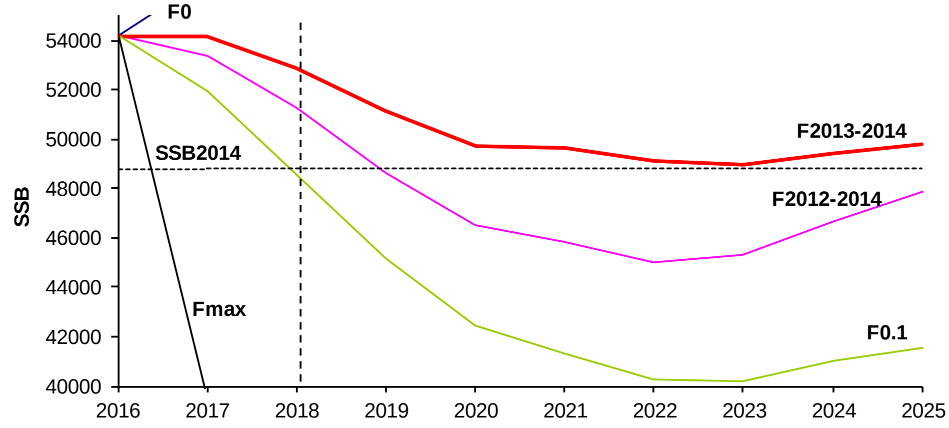


Fig.13a: SSB 50% probability profiles under several F's and M=0.14

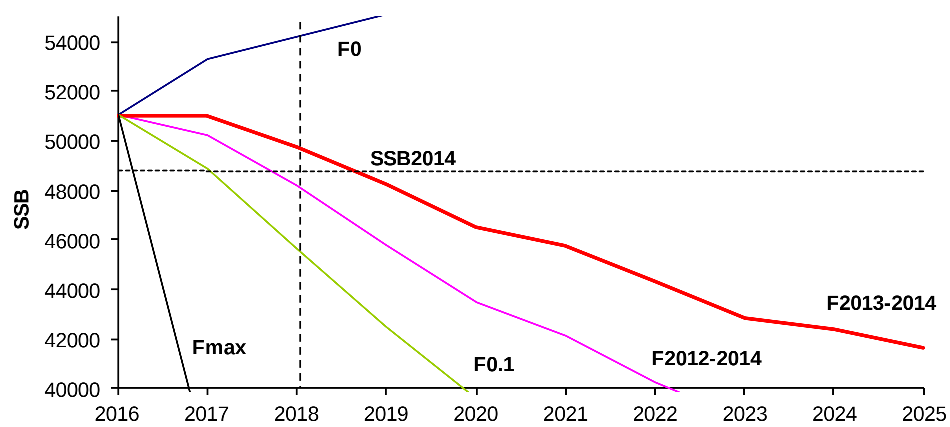


Fig.13b: SSB 20% probability profiles under several F's and M=0.14