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An assessment of beaked redfish (*S. mentella and S. fasciatus*) in NAFO Division 3M (*including an update for the most recent level of natural mortality*)

By

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Abstract

The 3M redfish assessment is focused on beaked redfish, regarded as a management unit composed of two populations from 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, despite the emergence of an occasional golden redfish fishery (*S. marinus*) by the mid 2000's and the reopening of the Flemish Cap cod fishery by 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 1989-2018 EU survey abundance at age matrix. Continuing pressure over Flemish Cap redfish stocks by increasing cod predation lead to unusual high levels of beaked redfish natural mortality between 2006 and 2014. In 2017 the sensitivity *M* framework included an independent approach to natural mortality estimates based on a number of different biological models. A natural mortality of 0.1 on 2015-2016 and the natural mortalities already adjusted on previous assessments were found to be the most suitable options to the *M* input vector in the 2017 assessment. The primary aim of the 2019 *M* sensitivity analysis was not to track a best value for the most recent (2017-2018) *M* level, but to find out if there was evidence that natural mortality has increased from the former level of 0.1. And from the results presented that hypothesis has not been confirmed. So, the present XSA assessment run with average *M* on 2017 and 2018 kept at 0.10.

The stock is declining since 2014 after a marked recovery that started by 2002-2003 on biomass and female spawning biomass. Recent high levels of biomass were maintained until 2014 supported by low fishing mortalities and individual growth of survivors, but could not be sustained. Abundance decline is more pronounced, with no perspective to stop on the short term since year classes at recruitment (age 4) continue to be extremely weak. Natural mortality has stayed on recent years (2015-2018) at 0.1, its 1980's-1990's-early 2000's assumed magnitude. The apparent low productivity regime is still in place, as the easing of cod pressure on juvenile redfish can only impact positively redfish recruitment after several years of cod SSB decline.

The proxy's of $F_{0.1}$ and F_{max} from last assessment were revised by a new yield per recruit analysis, taking

into account not only recent declines observed in all mean weights@age but also using the same approach to partial recruitment (*PR*) as the one in place on projections. Taking into account what were considered consistent retrospective results the assessment proceed to short and medium term projections under most recent level of natural mortality and four options for fishing mortality: No fishing, F_0; $F_{statusquo}$; $F_{0.1}$ and F_{max} (reference points given by the revised yield per recruit analysis).

At present, and for the next coming years, the future of 3M beaked redfish continues to depend on how the survival of young pre recruited redfish is able to recover, or not, and at what speed, from its actual long time depression.

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 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, 1994).

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 (average of 78%, according to the EU Flemish Cap survey series, 1988-2018) and the majority of the 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 and 1b, 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. On the 2000's catches recorded a stepwise increase, from an average level of 3,000 tons (2000-2004) to 7,000 tons (2005-2017) and to 10, 478 tons on 2018, sticking to the 2018-2019 TAC of 10,500 tons. EU-Portugal, EU-Spain, the Russian Federation and EU-Estonia states are responsible for the bulk of the redfish landings over the last two decades (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 responded positively to those events and since the mid 2000's is a blend of by-catch from cod fishery (depths above 300m, a mixture of golden and beaked redfish), catch from bottom trawl directed fishery (depths between 300-700m, primarily beaked redfish), and by-catch from Greenland halibut fishery (bellow 700m, 100% deep sea redfish). The 1989-2018 redfish nominal catch is presented on Table 1a.

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, Spain and Russia. 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.

STACFIS catch estimates were available till 2010. Over 2006-2010 an average annual bias of 15% plus was recorded between SACFIS catch estimate and 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 between 2011and 2014. For 2015 the annual catch was given by the Daily Catch Reports (DCR's) by country provided by the NAFO Secretariat (Blasdale, T. pers. comm., March 2017). For 2016 catch was calculated using the CDAG Estimation Strategy (NAFO Regulatory Area Only) (scwp17-21 CDAG Catch Estimation). The 2017 and 2018 catch estimates were obtained with the application of the CESAG method (com-sc cesag-wp 18-01REV2 and com-sc cesag-wp 19-03REV). The 1989-2018 catch estimates from those different sources are accepted as the 3M redfish landings and assembled on Table 1b.

The beaked redfish catch estimates used in the assessment are on Table 1c and Fig. 1a. On Table 1d are tabulated the golden and beaked redfish proportions in weight and by depth found in the 2005-2018 EU surveys (Gonzalez, *pers. comm.,*2009-2018; Casas, *pers. comm.*, 2014), that have been 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 tons in 2004 and 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 only.

Length composition of the commercial catch and by-catch

1998-2010 and 2012-2018 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 2013-2019) 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 2010 length weight relationship was applied to the 2011 catch. The 1993-2004 beaked redfish length weight relationships from the EU surveys (Table 2b: Troncoso and Casas, *pers. comm.* 2005) were used to compute the mean weights of the redfish by-catch in the 3M shrimp fishery and correspondent by-catch numbers at length for that interval.

Length samplings from the Portuguese and Spanish bottom trawl are at present the major sources to get beaked redfish catch@length for the different bottom trawl fleets involved in the 3M fisheries. When available, pelagic and bottom trawl beaked redfish length sampling from Russia are applied to their segments of the Russian catch (until 2009 the pelagic catch was 100% of the Russian catch most years, however from 2010 onwards this pattern was reversed and nowadays, when available, Russian sampling came from bottom trawl catches).

Usually Portuguese beaked redfish length sampling was 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). However, on 2015 and 2016, most of the Portuguese sampling effort was made on beaked redfish catch from shallower depths than the ones traditionally associated with the redfish fishery, while Spanish sampling still came from 300-700m bottoms where most of the beaked redfish catch is expected to occur. So Spanish relative catch@length substitute the Portuguese relative catch@lengthas regards the length distributions for other countries estimated catches on those years. Depth distribution of Portuguese redfish catches went back to normal on 2017-2018 and so Portuguese length sampling return to be applied to other countries but Spain and Russia on 2017 and including Russia on 2018.

For details regarding how the length distributions of the Portuguese catches on 1993-1994 and of the Russian catches on 1992-1994 were derived see Ávila de Melo et al., 2009.

Length structure of the commercial catch show relative stability between 1989 and 2003, with annual mean lengths falling within 27-33cm (Table 3b, Fig. 2). Smaller sizes increase their presence in the commercial catch afterwards, being responsible of bellow average mean lengths (<28cm) till 2016. The recruitment from a sequence of abundant year classes, followed by the decline of stock size (as suggested by the 2007-2018 EU survey results, Fig. 6b and c) should justify the bellow average mean lengths generally observed up to 2016. The larger lengths and the consequent increase in the mean length of commercial beaked redfish catch on the last couple of years (from an average of 26.3cm over 2004-2016 to 29.2 cm on 2018) may be a consequence of a shift towards deeper bottoms (300-700m) of most of the 2017-2018 fishing effort.

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 1989-2018 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 (Table 3d) was obtained using the *S.mentella* age length keys from the 1990-2007 and 2009-2018 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 and the decline of the redfish fishery lead to even younger modal age groups between 1996 and 2004 (despite the implementation of sorting grade escape devices). The 1999-2002 and 2005 cohorts were the most abundant within the overall catch through most years of the 2001-2012 interval, the 1999 year class being at age 13, on 2012, the oldest most abundant age on record. The 2009-2011 year classes, at ages 5-6, were the most abundant between 2014 and 2016. As mentioned above recent larger sizes in the catch correspond to older ages, and 11 and 12 years old fish (from 2005-2006 cohorts) were the most abundant on 2017. However modal ages return to much younger redfish on 2018, with ages 6 and 7 (2012-2011 cohorts) being the most abundant in the 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 (1988-2016). 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 also been reported that year (González-Troncoso and Casas, 2005).

Length weight relationships

Annual length weight relationships for *S. mentella* and *S. fasciatus* (1992-2018) and for the two species combined (1988-2018) were available from survey data (Troncoso and Casas *pers. comm.*, 2005-2018) (Table 2b). *S. mentella* and *S. fasciatus* length weight relationships were used to get 1992-2018 *SOP* survey biomass for each of these redfish species. The *Sebastes sp*. length weight relationships were used to get the 1988-1991 *SOP* survey biomasses for unslipt beaked redfish.

Survey abundance at length

Each of the redfish categories considered within the beaked redfish assemblage (beaked redfish with juveniles, 1988-1989; beaked redfish, 1990-1991; *S. mentella* since 1992; *S. fasciatus* since 1992; beaked redfish juveniles since 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 2003-2018 *RV Vizconde de Eza* length distributions (Troncoso *pers. comm.*, 2005-2018; 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 three beaked redfish categories were assembled into one single survey abundance at length matrix 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 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 maturity ogives at length were estimated based on microscopic inspection of 5,661 histological sections of gonads collected throughout 12 years between 1994 and 2016 (Saborido Rey *pers. comm.* 2017), 2,445 ovaries for *S. mentella* and 3,216 for *S. fasciatus*. Maturity at length data for each species and year were fitted to a logistic function (same as used on Flemish Cap cod, Saborido Rey and Junquera 1998). For years in between where maturity data were missing, average curve parameters were estimated from adjacent years where length ogives were available. The maturity staging criteria was evaluated and agreed in 2016, following a workshop to deal with observed discrepancies in staging from former analysis (Saborido Rey *pers. comm.* 2017). The new maturity at length results were incorporated in both 2017 and present assessments, with the 2017 and 2018 length at maturity data used to update the correspondent *S. mentella* and *S. fasciatus* ogives (Tables 4a and 4b and Fig.'s 4a and 4b) (Saborido Rey *pers. comm.* 2019).

Age composition of the survey stock and mature female component

The survey abundance at age for the 3M beaked redfish stock (1989-2018, Table 5b) was obtained using the *S.mentella* age length keys from the 1990-2007 and 2009-2018 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 is set at age 19.

As mentioned above, this assessment adopts the available *S. mentella* and *S. fasciatus* maturity ogives at length to get the survey female mature abundance at length of *S. mentella* and *S. fasciatus* each year. For each year these two length vectors are summed and converted into the survey beaked redfish mature female at age and mature female proportion at age vectors using the *S. mentella* age length key of the year. Survey female spawning stock abundance and mature female proportion at age (annual and average for the assessment interval) are presented Tables 5c to 5e.

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 (Tables 6a and 6b).

Survey biomass and abundance, 1988-2018

The 1989-2018 survey mean catch per tow for beaked redfish is presented on Table 7a and Fig. 5. Details on the computation of this combined index can be found in the 2003 assessment (Ávila de Melo et al, 2003). Survey year class strength (at age 4), abundance and biomass for the total stock, exploitable stock and spawning female stock can be found on Table 7b. Trends of recruitment, exploitable stock and female spawning stock are on Fig.'s 6a to 6d.

The survey stock abundance and biomass declined on the first years of the survey series (1988-1990/1991) and were kept at very low levels till 2003. A sequence of relatively abundant year classes (2001-2005), including the strongest of the survey series (2002), coupled with high survival rates, lead the exploitable stock to a maximum in 2006. Year class size at age 4 declined afterwards, down to a stable but very low level of the lasts five cohorts entering the exploitable stock (2010-2014, Fig. 6a). Exploitable stock fell between 2006 and 2010, showing some recovery on 2011-2012. . However the indices resume the declining trend afterwards . Based on EU survey results recruitment experienced a rapid decline between 2006 and 2010 being kept below average until present. The 2007 year class was the last above average to show up on the 2011 survey (Fig. 6a) and so for the moment, and based on the EU survey, the prospects of recovery for this stock are bleak. After being at chronically low levels through the 1990's early 2000's spawning female survey indices showed a sharp increase between 2003 and 2009, in part due to high survival rates in part due to a decline on maturity at length overlapping most of these years (Fig. 4b and Fig. 6d). Female spawning stock is still above average on 2018, regardless wide inter annual fluctuations that are difficult to explain but should be certainly related with different trends and wider fluctuations observed within the maturity processes of both S. mentella and S. fasciatus since 2011.

Survey results show the income of abundant year classes on a row (2001-2005) triggering a rapid and sharp increase of stock size through the mid 2000's. Both stock and recruitment fell next as fast as they went up. The stock size declined and by 2015 landed on bellow average levels while female spawning biomass remained relatively high.

Natural mortality

Since 2004 a rapid increase was observed on survey biomass of golden (*Sebastes marinus*) and Acadian (*Sebastes fasciatus*) redfish. Due to their shallower depth distributions these two redfish species overlap with cod to a greater extent than deep sea redfish (*Sebastes mentella*). On the mid 2000's the Flemish Cap cod stock start recovering, not only in terms of abundance but also in terms of individual growth, leading to a continuous and steep increase of cod biomass between 2006 and 2012. Since then the cod stock is declining, abundance at much faster pace than biomass. In 2017 though, spawning stock biomass was still at a very high level, sustained by the survival and growth of the dominant 2009-2011 cohorts (Gonzalez-Troncoso *et al*, 2018). There is a strong possibility that important increases on redfish consumption by cod are associated to the cod recovery over the second half of the 2000's (Pérez-Rodríguez and Saborido-Rey, 2012), leading to anomalous high levels of beaked redfish natural mortality (*M*> 0.1), from 2006 onwards and as long as cod spawning biomass remains high.

Attempts to track these changes on natural mortality have been made on previous assessments since 2011 (Ávila de Melo *et al.*, 2011, 2013, 2015 and 2017). It is a fact that, since the 2010, recruitments (age 4) fall abruptly and stay depressed on recent years (2014-2018). With negligent incomes to the exploitable component, the feedback of a variable natural mortality on stock dynamics over time became an issue more and more important to address. Namely taking into account the very low/low exploitation levels on this stock since 1997 until very recently (only in 2018 fishing mortality should overcome $F_{0.1}$). This would mean a natural mortality with a lion share in total mortality over many years and until very recently. Finally, within natural mortality, high levels of predation by cod should be the main cause of *M*'s higher than 0.1 for Flemish Cap beaked redfish.

As mentioned above, a sensitivity analysis for a range of *M* candidates between 0.1 - 0.4 has been carried out prior to each 3M beaked redfish assessment since 2011. Having 2006 as starting year, time windows of variable width were considered where the best *M* option should minimize the $SS \log q_{age}$ residuals and maximize correlation between (4+) exploitable survey abundance and XSA abundance. Until the 2017 assessment the approach to the actual magnitudes of *M* over time have been strictly dependent of beaked redfish survey indices, which in turn should capture the dynamics of the ensemble of the two redfish populations at times of very low recruitment, low exploitation and high predation.

On 2015 STACFIS **recommended** that, *in order to quantify the most likely redfish depletion by cod on Flemish Cap, and be able to have an assessment independent approach to the magnitude of such impact by species and to the size structure of the redfish most affected by cod predation, the existing feeding data from the past EU surveys be analyzed on a refined scale*. STACFIS also **recommended** that *work continue to investigate recent changes in natural mortality* (NAFO, 2015).

It was recognized however, that the quantitative analysis of feeding data from the Flemish Cap EU survey is difficult to carry out as consumption of redfish by cod is concerned (Ávila de Melo *et al*,2017).

Despite these constraints, and in order to include an independent approach to natural mortality in the sensitivity *M* framework, the 2011-2016 beaked redfish natural mortality was revisited/estimated by a number of different published models derived from cross-species comparative analyses, with size/age-independent methods and size/age-dependent methods, both based on von Bertalanfy growth parameters derived from combined ALK's for the two beaked redfish species and using age/length data assembled for two periods, 2011-2016 and 2015-2016.

An independent evaluation of natural mortality has been therefore deployed at the beginning of the 2017 assessment, using several biological (growth/longevity/maturity/environment) based models to estimate several "XSA free" M candidates, constant over age and time over two alternate time periods: (1) 2015-2016, keeping the whole range of previously adopted M's back in time or (2) 2011-2016, assuming that after2010 M fell from the high former level to a low level more or less constant since then. These two sets of natural mortality candidates were then in contest for a better XSA fit to the 2011-2016 survey data. Details on the application and results of the *M* sensitivity analysis for those two approaches can be found on (Ávila de Melo et al., 2017).

The best *M* option found for the 2017 XSA assessment was a natural mortality of 0.1 on 2015-2016 (given by the Hoenig method (1983) applied to a von Bertalanfy growth model fitted to those most recent age length data) and previous natural mortality levels kept from the past 3M beaked redfish assessments.

The 2019 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 trawl 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 year effect patterns on diagnostic results such as log catchability residuals. Nevertheless, the long EU survey series seems to reflect well the overall dynamic of the beaked redfish stock and has been considered a valid tool to calibrate an XSA based assessment (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 2006-2016 remained unchanged from last assessment (Ávila de Melo et al., 2017).

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 age in the catch at age matrix with catches assigned every year) and age 18 was the last true age (from age 19 onwards both survey and commercial sampling data are scarce and so the plus group was set at age 19). Landings were given by the *SOP* of the 4+ catch at age and commercial weight at age matrices.

The present Extended Survivor Analysis used as tuning file the 1989-2018 EU survey abundance at age matrix, with the 1989-2002 indices converted into the new *RV Vizconde de Eza* units (Casas *et al.*, 2017).

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 thirty 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 age 16 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 28 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.

Since 2015 assessment age 16 is the first age at which catchability is considered to be independent of age. Retrieving the independent catchability range to the next younger age was shown to speed the way to convergence despite triggering slight increases on catchabilities at age that would reflect on minimal increases in fishing mortality and minimal declines in abundance and biomass (Ávila de Melo et al., 2015). In order to avoid overweight of each cohort's terminal population estimate by their preceding older ages, the minimum allowable standard error of the *log* catchability on the last true ages of each cohort was set at 0.5.

In summary, apart the use of the new maturity at length ogives to get female maturity at age and spawning stock biomass each year, the 2017 and 2019 XSA frameworks remained unchanged from previous assessments (Ávila de Melo *et al*., 2013 and 2015): no recruiting ages with catchability dependent of year-class strength, constant catchability at the last couple of true ages, and a minimum 0.5 standard error for survivor estimates from the oldest ages of each cohort.

Sensitivity analysis around possible levels of natural mortality on recent years

Due to time constraints this sensitivity analysis for best fit of average *M* 2017-2018 was carried out using the *S. mentella* 2017 ALK on 2018, and the 2016 *S. mentella* and *S. fasciatus* maturity ogives on 2017 and 2018.

The objective of the present exercise is to check, using the survey based diagnostics combined with retrospective analysis, if average natural mortality on most recent years, 2017-2018, could have returned to a level higher than 0.1(the best "biological based" 2015-2016 *M* option found on last assessment) and, if so, what level would optimize the model fit. In other words is there any evidence that natural mortality has increased again between 2015-2016 and 2017-2018? Or in turn the evidence is that most likely *M* stayed flat, or could even declined, over most recent years?

Before 2006 M remained at 0.1.The rational to select the best options for natural mortality between 2006 and 2014 are thoroughly explained in the sensitivity analysis sections of previous assessments (Ávila de Melo *et al*., 2011, 2013 and 2015). Based on survey, data Flemish Cap cod biomass has grown since 2006 reaching an historical high on 2014, while combined *S. mentella* and *S. fasciatus* declined as a single (beaked redfish) stock (Casas, 2017). At the same time beaked redfish catch remained at low levels, even dropping by half between 2011 and 2014 (Table 1c). Under such scenario one should expect that, between 2006 and 2014,

- M may varied but should have stayed above 0.1,
- F should be below 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 real magnitude of natural mortality (since within this time window the major part of total mortality that has driven abundance is from causes other than fishing).

A natural mortality of 0.4 was tuned to ages 4-6 between 2006 and 2010, and extended to all ages in 2009-2010. Since then natural mortality was assumed to be again an age independent parameter and on 2011-2012 declined to 0.125, a level much closer to what is considered the magnitude of natural mortality on redfish stocks (0.1). However, on 2013-2014 the best fit to survey data implied a new marginal increase of M to 0.14.

The rational to select the best option for natural mortality on 2015 and 2016 is thoroughly explained in the sensitivity analysis section of the last assessment (Ávila de Melo *et al*., 2017). Cod survey biomass has substantially declined on 2015 and 2016 and so the predation pressure over the beaked redfish unit may have slowdown on the last couple of years. If so the above rational may not be enough to justify by itself the search for an optimal M . An independent evaluation of natural mortality has been therefore introduced, using several biological (growth/longevity/maturity/environment) based models to estimate several "XSA free" M candidates (for details see section on natural mortality above), constant over age and time on two alternate time periods: (1) 2015-2016, keeping the whole range of previously adopted M 's back in time or (2) 2011-2016, assuming that after 2010 M fell from the high former level to a low level more or less constant since then. These two sets of natural mortality candidates were then in contest for a better XSA fit to the 2011-2016 survey data. Based on the results of that previous sensitivity analysis the 2017 XSA assessment has run with a natural mortality of 0.1 on 2015-2016, and with the previous 2006-2014 natural mortality levels.

The sensitivity analysis preceding the 2019 XSA assessment considers the following set of 2017-2018 candidate *M*'s

XSA2019 sensitivity analysis									
M candidates for 2017-2018	0.08	0.09	0.1	0.11	0.12	0.14	0.16	0.18	0.2

For all XSA 2019 preliminary runs	M = 0.40 on ages 4 - 6 on 2006 - 2008, and on all ages groups on 2009 - 2010;
M2015-2016 XSA 2017 runs	M = 0.125 on all age groups on 2011-2012.(XSA2013 & 2015 assessment framework)
	M = 0.14 on all age groups on 2013-2014.(XSA2015 assessment framework)
M2011-2016 XSA 2017 runs	M is kept constant on all age groups on 2011-2018

The goodness of fit of the model runs to survey data is measured by the following diagnostics

1. Lower $SS \log q_{age}$ residuals on 2017-2018 (Table 9a Fig. 7a) together with
2. Lower $SS \log q_{age}$ residuals back to 2011 (M started to decline from the anomalous high 2006-2010 levels) (Table 9a Fig. 7a) and
3. Higher correlation between exploitable (4+) survey abundance and XSA abundance over recent years (2011-2018) (Table 9a Fig. 7b).

Dealing with an assessment where more or less pronounced positive or negative (catchability) year effects show up frequently over time, a best bet for average natural mortality on most recent years can be hit by those effects if they happen to occur on consecutive years with the same signal and large magnitude. That is why larger time intervals and other criteria are required to confirm our hypothesis (*M* has not increased from 0.1 on 2017-2018). On the present analysis, as a complement of the 2017-2018 and 2011-2018 diagnostics, internal and external standard errors of the survivors estimates for the nine preliminary 2019 XSA runs each with a 2017-2018 *M* are tabulated as well (Table 9a).

A comparative one (2018-2017) and two years window (2018-2016) retrospective analysis for the range of the best 2017-2018 *M* candidates, according with the above criteria, was finally performed in order to confirm the goodness of the diagnostics results (Table 9b).

Both $SS \log q_{age}$ and (survey/XSA) correlation results showed that an average 2017-2018 natural mortality level within 0.08 and 0.11 deliver better diagnostics of the model fit than levels of *M* equal or greater to 0.12. And that same judgement can be inferred from the comparative retrospective analysis as regards either 4+ biomass, (female) SSB or average *F* (ages 6-16). Furthermore the best results are achieved with the lowest value of *M* in the ranking (0.08).

However the primary aim of this exercise was not to track a best value for the most recent *M* level, but to find out if there was evidence that natural mortality has increased from the former level of 0.1, adopted on 2017 assessment as the best option for average *M* on 2015-2016, or not. And, from the results presented on Tables 9a and 9b and Fig.'s 7a and 7b, that hypothesis has not been confirmed.

So, the 2019 XSA assessment run with average *M* on 2017 and 2018 kept at 0.10. The final 2019 XSA input files, updated with the 2018 *S. mentella* age length key and the *S. mentella* and *S. fasciatus* maturity at length ogives, are presented on table 10.

Diagnostics

The 2019 diagnostics (Table 11, Fig.'s 8a and 8b) kept the main features from past assessments: high residuals to mean log catchabilities @age (most obvious at younger ages on former years), mean log *q*'s with high *s.e.*'s and abide to a familiar patchwork of $\log q_{age}$ residual patterns: mostly positive during the intermediate years (1994-2001) , after a clear negative pattern over the first years (1989-1993).. Between 1989 and 1991 large to very large residuals were maintained from one age to the next within some of the major cohorts at the time (1982-1985), suggesting that these year classes may be overestimated by the model. Through 2002-2016 residuals are generally smaller and scattered than previously, while the marked alternate negative/positive pattern of the two previous intervals fades away. However on most recent yeas a clear annual pattern of positive residuals appear again, not showing though the magnitudes of older times.

Retrospective Analysis

A retrospective $XSA_{2018-2014\ (last\ year)}$ was carried out for checking patterns and magnitude of bias on the main results of recent assessments back in time (Table 12ab, Fig. 9). It covers the end a period of unrest on the dynamics of the stock, driven by an important increase of natural mortality and its subsequent landing at their "historical" level, along with a continuous fall of recruitment at age 4. Reverse retrospective patterns, most between 10 and 20% are observed most years of the recent 2011-2016 interval between the two last assessments (2017 and 2019) on exploitable and female spawning biomass and recruitment (positive bias) and average fishing mortality (negative bias). Higher biases are however associated with the revised magnitude of the 2010-2012 year classes at age 4, corresponding to the 2014-2016 recruitments, as estimated in 2019 back to 2017 (Table 12b). The very small size of these cohorts makes them difficult to quantify, namely on their first age and year within the assessment. Furthermore, these cohorts, as they grow older their survivors are submitted to lower 2015-2018 natural mortalities. On next assessments their survivors, when extended backwards, will arrive larger at the recruitment age. Taking into account the age of those three cohorts on 2016 (too old to be fully exploited but too young to fully spawn) their positive biomass bias as a whole could explain the gap observed on retrospective exploitable biomass estimates between 2016-2014 and 2018-2017, which magnitude is not reflected in the correspondent retrospective SSB bias magnitude. Taking into account that on 2016 the same year classes have been among the most abundant in the commercial catch, their important upward revision (at ages 6, 5 and 4 on 2016, by the two last assessments) should have also impact on the unusual high downward revision of the average fishing mortality for that year (2016, see Table 12b).

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 most likely impact this redfish assessment.

2019 XSA Results

Very high fishing mortalities until 1996 forced a rapid decline of abundance, biomass and female spawning biomass (Table 13, Fig. 10: *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 1991-1998 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. But from 2010 onwards abundance went down for causes other than fishing, being still on 2018 at a level above the 1995-2001 low. Biomass went down and up again between 2009 and 2014 staying however at a very high level. Its decline starts afterwards and continues on 2018. However, due to individual growth and relatively low fishing mortalities over surviving cohorts, stock size in weight was still at a high level on the beginning of 2018. Same caveats, plus a thorough revision of maturity at length over time, are valid to explain female spawning biomass overall growth since 2003 and its maintenance at maximum level on 2017-2018.

Recruitment at age 4 increased with a sequence of above average years classes from 1999 till 2007, some of them the highest observed in the series (2002-2006) (Table 13, Fig. 11). However recruitment to exploitable stock is declining continuously since 2009 and was on 2017-2018 at an historic minimum level.

The reproductive potential of the stock increased steadily from the late 1990's to 2003, was kept at maximum level till 2008, fell abruptly after and is at very low level since 2012 but still declining (Fig. 12a, *R/SSB plot*). It seems that the stock returned to the low productivity regime of most of the 1990's. Meanwhile SSB rose to a maximum level well above the average size that originated the high 2002-2006 recruitments (Fig. 12a, *SR plot*). The persistence of this apparent very low reproductive potential at a time where 3M cod has still a high SSB level (Gonzalez, 2018) may be the aftermath of pre-recruited beaked redfish year classes prematurely depressed regardless their strength, most likely still exposed to high mortalities by cod predation.

Final quality considerations on the 2019 assessment

An "erratic" pelagic-demersal distribution associated with schooling will always doom redfish analytical assessments, stick in terms of tuning to just one bottom survey and hit by year effects. All these constraints give poor diagnostics. Nevertheless, when a stock unit shows a clear dynamics, as it seems to be the case for 3M beaked redfish, survey results may allow consistent assessment results over time. Despite the abrupt increase on natural mortality and its further gradual decline to the actual level usually associated with redfish stocks, the 2017 and 2019 retrospective patterns, showing a consistent underestimation of biomass and recruits and overestimation of fishing mortality, allow the 2019 assessment to be regarded as precautionary enough to output survivor's results able to deliver conservative projections.

Yield per recruit analysis (*ypr*)

The proxy's of $F_{0.1}$ and F_{max} from last assessment (Ávila de Melo *et al*, 2017) were revised by a new yield per recruit analysis (*ypr*), taking into account not only recent declines observed in all mean weights@age but also using the same approach to partial recruitment (*PR*) as the one in place on short and medium term projections.

The *PR* vector for the *ypr* analysis is the one of the projections to be presented next, and corresponds to the average of the 2016-2018 relative *F*@age 4-18 vectors (for each year, relative *F*@age 4-18 vector is given by the ratios of the F 's @age to $F_{bar6-16}$ (*see* 2016-2018 average relative *F*@age on Table 9 *last column in* Table 13 XSA results for 2019 assessment) .

M's were kept at 0.10 through ages and years but with an associated *CV* correspondent to an allowed variability of natural mortality between 0.08 and 0.12(the *M* range associated with best sensitivity analysis diagnostics). All input weight@age and maturity@age vectors were averages from the most recent three years (2016-2018).

In conclusion, both "long term" *ypr* analysis and short/medium term projections share the same set of input vectors. 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. Through the extended age range *PR*, mean weights and female maturity at age were kept constant and were the ones of the 19 plus group. Input vectors are presented on Table 14.

As regards $F_{0.1}$ the 2019 *ypr* results (Fig. 12) were close to the ones of 2017, despite the former analysis different input framework, from a larger time interval back in time (2006-2016) and a flat top *PR* not assumed at present. $F_{0.1}$ is at 0.0911 against a former estimate of 0.086 (+6%). Anyway, with an average F_{6-16} of 0.119 on 2018 there is a high probability that this stock has been exploited above $F_{0.1}$ on the terminal year. F_{max} is at 0.1883, against a former estimate of 0.163 (+16%). Lower mean weights both in the stock and in the catch and lower *PR*'s on older ages should be the main causes of the differences found between 2017 and 2019, namely on F_{max}.

Conclusions

The stock is declining since 2014, after a marked recovery on biomass and female spawning biomass that started by 2002-2003. Recent high levels of biomass were maintained until 2014 supported by low fishing mortalities and individual growth of survivors, but could not be sustained. Abundance decline is more pronounced, with no perspective to stop on the short term since year classes at recruitment continue to be extremely weak. Natural mortality has stayed on recent years (2015-2018) at 0.1, its 1980's-1990's-early 2000's assumed magnitude. The apparent low productivity regime is still in place, as the easing of cod pressure on juvenile redfish can only impact positively redfish recruitment after several years of cod SSB decline.

Short and medium term projections

3M beaked redfish has been assessed, with 2015-2018 natural mortality at 0.1. Results show a stock still high on spawning biomass (as result of survival and growth of above average/high 1999-2007 year classes) but declining in biomass, abundance and recruitment. In 2017 and 2018 recruiting year classes were the lowest on record while fishing mortality raise to above $F_{0.1}$ on the terminal year.

Taking into what were considered consistent results the assessment proceed to short and medium term projections under most recent level of natural mortality and four options for fishing mortality as follows:

1. No fishing, F_0
2. $F_{statusquo}$ (last year $F_{bar6\text{-}16,2018}$ times average partial recruitment for the last three years, 2016-2018)
3. $F_{0.1}$
4. F_{max}

Fishing mortality reference points were given by the revised yield per recruit analysis previously presented.

Background, input data and projections tool

Short (three years, 2020-2022) and medium term (ten years, 2020-2029) stochastic projections of yield and female spawning stock biomass (SSB) under the four *F* options were obtained with *Mterm*, a program of the CEFAS laboratory (Lowestoft/UK), first applied to a NAFO stock in 2000 (Mahe and Darby, 2000). The program has been upgraded to allow projections for long living stocks with a large number of ages included in the analytical assessment (Smith and Darby, *pers. comm*. 2001).

The *Mterm* algorithm use input abundance@age (5 and older) at the beginning of projections (2020) abide to a measure of uncertainty. The initial 2020 population at age (5 and older) is the forward projection of the XSA survivors by the end of 2018 assuming $F_{statusquo}$@age during 2019. The coefficients of variation for population@age at the beginning of 2020 were set as the internal standard errors from 2019 XSA diagnostics. All other inputs@age are given by the last three year average (2016-2018) with associated errors at age.

Recruitment (age 4) entering in 2019, 2020 and 2021 is assumed constant at the geometric mean of recent recruitments (age 4 XSA, 2015-2017). From 2022 till 2029, recruitment is randomly re sampled with residuals from 2015-2017 geomean recruitment.

Input data were aggregated in two categories of files:

a. *.srr* stock-recruitment file (Table 15a), assuming no stock recruitment relationship and with a random recruitment around the geo-mean of the 2015-2017 recruitments (numbers at age 4, from the 2019 XSA). From the third year of projection onwards (2022), age 4 is given by the re-sampling of the *log* residuals of the 2015-2017 recruitments. The recruitment from last year (2018) is excluded from average due to greater uncertainty associated with its estimate.

b. *.sen* sensitivity file (Table 15b, an explanation of the *.sen* file on an Excel spreadsheet format), with the all vectors needed to forward projections. Natural mortality was set around 0.1 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 (2016-2018) with associated errors at age. Each *F* option was kept constant through projection interval (2020-2029).

Results and discussion

Medium term SSB trajectories are presented on Table 16a and Fig. 13 (50%ile). Main results of short term projections for female SSB and yield under several *F* options are summarized on Table 16b. If most recent very low level of recruitment prevails, both $F_{statusquo}$ and F_{max} will drive SSB by the entry of 2022 close to the 2012 level of 45 000t, historically still a high level of SSB. However, from present (2019) onwards SSB will decline regardless the *F* option considered, and at a faster pace if either of the higher options ($F_{statusquo}$ and F_{max}) is implemented.

At present, and for the next coming years, the future of 3M beaked redfish continues to depend on how the survival of young pre recruited redfish is able to recover, or not, and at what speed, from its actual long time depression.

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Table 1a. 3M Redfish nominal catches (ton) by country, 1989-2018.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CAN			2		10							5			
CUB	1765	4195	1772	2303	945						2				
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
SUN/RUS	13937	34581	24661	2937	2035	2980	3560	52		7	108	1864	1281	1155	115
UKR															5
E-LVA				7441	5099	94	304					13	11		
E-LTU					2128									10	1
E-EST						47	863	13				631	158	5	23
E-SP	213	2007	6324	3647	100	610	165	113	129	262	268	348	272	220	633
E PRT	13012	11665	3787	3198	4781	5630	1284	281	83	259	97	925	1590	1513	1113
EU															
FR-STP										2					
UK															
KOR-S	17885	8332	2936	8350	2962										
FAROE IS.				16			15	1						6	
NORWAY						8									
Total	47697	66887	40914	29317	19027	9883	6748	1140	423.8	970.7	795	3828	3392	2976	1988

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015[1]	2016[2]	2017[3]	2018[4]
CAN								2							
CUB								875	600						
DDR															
GRL															
JPN	209	483	383	613	603								136	197	636
SUN/RUS	6	1023	849	780	1212	1184	927	1571	0	1808	1342	1332	790	576	686
UKR	3		1												
E-LVA	2	48	250			58		71							
E-LTU		522	397	542			348	478			0.122				
E-EST	60	1093	1249	728	950	1643	1161	820		1036	601	498	526	764	2017
E-SP	266	542	596	533	1225	745	892	339	512	416	1031	1318	1385	2021	2236
E PRT	2574	2696	2594	2357	3707	5027	4703	5024	4236	3493	3462	3720	3596	3596	4838
EU									0		7				
FR-STP		10			8			68	69						
UK							1	2		8			10	7	
KOR-S															
FAROE IS.	6				215	1	122	420	0	10	5	75.3	68	2	65
NORWAY									0					3	
Total	3126	6417	6319	5553	7920	8658	8154	9670	5417	6771	6449	6944	6510	7165	10478

Table 1b. Redfish commercial catches on Div. 3M from various sources (STACFIS, 1989-2010; based on STALANT plus 15%, 2011-2014; based on Daily Catch Records, 2015; cdag catch estimates 2016; cesag catch estimates 2017 and 2018).

	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	2015	2016	2017	2018
Total	58100	81000	48500	43300	29000	11300	13500	5789	1300	971	1068	3658	3224	2934	1881	2923	6550	7156	6662	8465	11317	8496	11121	7870	7778	7416	6944	6510	7165	10478

Table 1c. Beaked redfish on Div. 3M commercial catch estimates from various sources (STACFIS, 1989-2010; based on STALANT, 2011-2014; based on Daily Catch Records, 2015; cdag catch estimates 2016; cesag catch estimates 2017 and 2018).

From 2005 onwards also using information on distribution by depth of the EU survey redfish catch by species (D. Gonzalez pers. comm.) and of the commercial redfish 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	2015	2016	2017	2018
Total	58100	81000	48500	43300	29000	11300	13500	5789	1300	971	1068	3658	3224	2934	1881	2923	4148	5997	5149	4277	3656	5410	8994	6320	5168	4565	5243	6152	6914	10330

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	2015	2016	2017	2018
golden	36.1	51.1	97.9	100.0	100.0	100.0	90.0	96.5	99.0	98.9	98.0	99.2	91.0	96.7
beaked	63.9	48.9	2.1	0.0	0.0	0.0	10.0	3.5	1.0	1.1	2.0	0.8	9.0	3.3

200-300m	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
golden	54.5	50.7	32.4	68.3	84.9	68.3	52.9	63.5	65.4	91.8	94.5	80.8	53.9	59.1
beaked	45.5	49.3	67.6	31.7	15.1	31.7	47.1	36.5	34.6	8.2	5.5	19.2	46.1	40.9

300-400m	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
golden	18.8	5.9	12.0	28.5	22.0	28.5	3.7	5.5	10.0	34.1	25.9	10.2	2.7	5.9
beaked	81.2	94.1	88.0	71.5	78.0	71.5	96.3	94.5	90.0	65.9	74.1	89.8	97.3	94.1

400-700m	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
golden	2.1	5.0	1.3	8.8	0.9	8.8	0.6	0.0	1.3	0.3	0.4	0.2	0.50	0.04
beaked	97.9	95.0	98.7	91.2	99.1	91.2	99.4	100.0	98.7	99.7	99.6	99.8	99.50	99.96

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	2015	2016
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	16.6	20.5	24.6
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	16.6	20.5	24.6

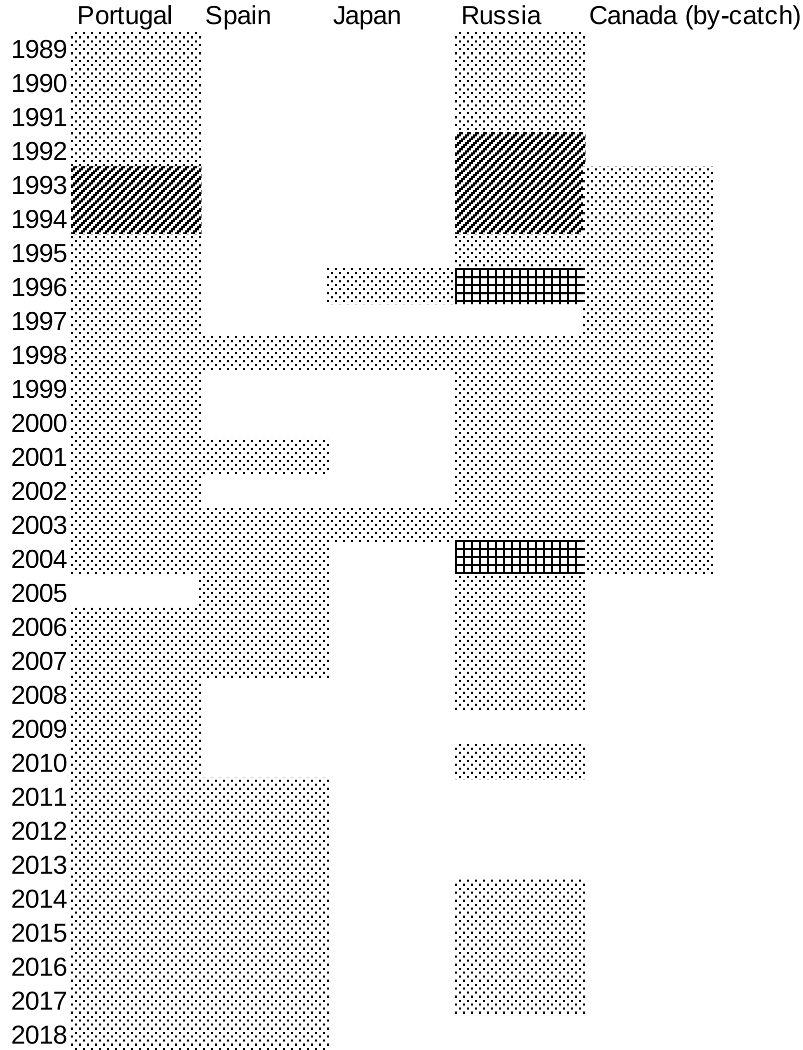
Table 2a. Length weight relationships for 3M beaked redfish from commercial catch (Alpoim,2004; Vargas, 2005, 2007-2011 and 2013-2019)

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
2015		0.0127	3.0175
2016	#	0.0285	2.7710
2017		0.0168	2.9204
2018		0.0186	2.8509

Table 2b. Length weight relationships for 3M beaked redfish from EU survey (Troncoso and Casas, pers. comm. 2005-2019)

	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	2.787
2014	0.016	2.968	0.024	2.873	0.0236	2.866
2015	0.017	2.952	0.0237	2.881	0.023	2.875
2016	0.022	2.875	0.0291	2.819	0.0257	2.844
2017	0.014	2.994	0.012	3.069	0.013	3.022
2018	0.018	2.926	0.015	3.000	0.013	3.022

Table 3a. Availability of length data for commercial catches and by-catch of 3M beaked redfish, 1989-2018



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, 1989-2018.

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	2015	2016	2017	2018
6																														
7																														
8																												2		
9																												2		
10	3													10			3	16	12					7				20		
11				1	3									48		1	18	40	41			3	1	9	1	1	6	57		
12	3			1	7							5		220		3	108	86	133		1	9	3	23	4	1	10	71		
13	11				5							11		723		5	381	70	172		5	28	27	36	7	6	48	140		
14	25	4			40	4						1		590		12	509	91	88		5	99	87	69	5	5	119	143		
15	8	73		1	120	15				2		6	4	175		43	474	112	23	6	37	248	209	95	35	26	160	160		
16	30	190		4	167	66		20				1	4	70		203	516	313	18	14	68	341	309	122	68	62	164	223		
17	59	724		3	55	244		20	1	2		6	20	53	6	352	423	436	31	12	102	481	352	162	135	108	287	303		
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	370	365	1	49
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	647	537	13	130
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	1113	1202	82	258
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	**1780**	**1710**	195	519
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**	**2726**	**2717**	273	1187
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**	**2607**	**2466**	677	**1607**
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**	**1485**	**1414**	1039	**2013**
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**	999	**1251**	**1563**	**2578**
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**	842	**1833**	**1874**	**2725**
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**	758	**1497**	**2204**	**2360**
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**	885	**1650**	**2362**	**2387**
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	821	**1617**	**2603**	**3079**
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	1067	**1575**	**2415**	**3473**
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	1004	**1247**	**1943**	**3485**
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	700	888	**1460**	**3402**
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	536	568	869	**2060**
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	485	343	551	**1519**
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	271	209	345	1026
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	207	163	232	511
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	88	98	141	266
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	82	33	69	140
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	79	18	60	102
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	43	14	35	65
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	26	14	23	47
42	341	345	201	214	476	37	164	46	5	8		19	6	2		14		11	6	61	2		**19**	25	6	31	57	8	11	22
43	289	264	283	237	118	10	69	18	1	3	1	25	3	5	2	18		11	3	52	1		**9**	19		18	15	7	9	6
44	135	130	19	172	170	9	50	3	6	2		14	2			12		4	8	26	2		20	21		13	12	6	2	6
45	143	73	14	39	26	9	34	2	1		2	3	1		1	6		3	3	5	2			0.3		1	5	3	4	2
46	75	32	8	9	17		7	4	1	1		10	1			5		4	5	20			2			0.4	22	6	2	11
47	46	16			17		19	1	1			6						1		7	1					0.1	2	0.2	1	3
48	28	12	8	17			4						1			1		1		10						0.2	0.4		0.2	1
49	4	12																1	3							0.1		8.5	1	9
50	11	4						27											8					13		0.1			0.1	
51	4	12																						0.4		0.0		4.2		1
52	4																									0.1				2
53	7	16																1	2							0.1			0.1	
54		8																												
55		4																										0.9		3
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	255	253	328	294
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	25.7	25.8	29.1	29.2

Table 3c. Length composition (absolute frequencies in'000s) of the 3M redfish total annual catch, 1989-2018 (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	2015	2016	2017	2018
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												2		
9							5	211	71	40	812	55	4218	538	1432	355												2		
10	3						3	416	258	45	845	193	6537	888	1454	593	3	16	12					7				20		
11				1	3		15	1056	569	391	390	593	6275	1655	913	1055	18	40	41			3	1	9	1	1	6	57		
12	3			1	9	19	36	841	512	1830	313	1011	4996	3205	1368	1498	108	86	133		1	9	3	23	4	1	10	71		
13	11			0	29	338	34	459	164	1721	286	761	2126	5809	2741	1229	381	70	172		5	28	27	36	7	6	48	140		
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	119	143		
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	160	160		
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	164	223		
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	287	303		
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	370	365	1	49
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	647	537	13	130
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	1113	1202	82	258
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	1780	1710	195	519
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	2726	2717	273	1187
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	2607	2466	677	1607
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	1485	1414	1039	2013
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	999	1251	1563	2578
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	842	1833	1874	2725
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	758	1497	2204	2360
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	885	1650	2362	2387
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	821	1617	2603	3079
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	1067	1575	2415	3473
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	1004	1247	1943	3485
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	700	888	1460	3402
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	536	568	869	2060
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	485	343	551	1519
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	271	209	345	1026
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	207	163	232	511
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	88	98	141	266
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	82	33	69	140
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	79	18	60	102
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	43	14	35	65
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	26	14	23	47
42	341	345	201	214	476	37	164	46	5	8		19	6	2		14		11	6	61	2		19	25	6	31	57	8	11	22
43	289	264	283	237	118	10	69	18	1	3	1	25	3	5	2	18		11	3	52	1		9	19		18	15	7	9	6
44	135	130	19	172	170	9	50	3	6	2		14	2			12		4	8	26	2		20	21		13	12	6	2	6
45	143	73	14	39	26	9	34	2	1		2	3	1		1	6		3	3	5	2			0.3		1	5	3	4	2
46	75	32	8	9	17		7	4	1	1		10	1			5		4	5	20			2			0.4	22	6	2	11
47	46	16			17		19	1	1			6						1		7	1					0.1	2	0.2	1	3
48	28	12	8	17			4						1			1		1		10						0.2	0.4		0.2	1
49	4	12																1	3							0.1		8	1	9
50	11	4						27											8					13		0.1			0.1	
51	4	12																						0.369				4		1
52	4	0																								0.1				2
53	7	16																1	2							0.1			0.1	
54		8																												0.3
55		4																										1		3
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	20529	24591	21058	35055
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	5243	6232	6914	10330

Table 3d. Catch in numbers at age (' 000) of 3M redfish, 1989-2018, 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		16	136	444	1057	7890	22978	24054	14508	9716	8792	6213	6366	5883	5199	2965	2122	1969	5003	125310	1981
1990			5996	10382	2773	5860	28741	47007	32291	18415	11643	6614	5940	5430	4449	2543	1888	1788	4562	196321	1982
1991				1229	3592	6929	18141	22725	16867	8491	6503	4808	3967	2888	1102	1648	1270	780	3305	104246	1983
1992				237	5234	7018	16988	18149	11681	7422	5608	4455	4286	3302	2952	1953	1189	746	1730	92949	1984
1993		274	3805	110773	10414	3064	3409	4557	2101	3936	5178	5512	4547	4665	3554	2092	1666	2614	1514	173677	1989
1994		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	2003
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		5	31	246	723	2619	2553	2934	2426	1095	592	380	226	221	128	120	130	436	467	15333	2002
2009		66	163	434	468	1419	1613	1645	1455	1452	741	453	136	304	53	110	35	147	862	11556	2001
2010		1118	1097	2735	5422	4200	3570	981	715	1017	1383	557	506	247	70	120	66	42	579	24426	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	61	317	590	1401	3672	2118	2057	1473	1102	532	429	383	153	386	512	275	198	44	854	16558	2009
2015	15	342	751	1260	3928	5040	1624	1223	1018	1032	1217	667	479	343	661	152	126	101	548	20529	2009
2016	151	522	684	1086	3928	3923	3439	1623	1910	2029	1608	1751	456	612	208	155	211	126	169	24591	2010/2011
2017				61	840	1940	2344	1870	2002	939	2887	2726	2122	378	912	390	674	375	597	21058	2005/2006
2018				163	1304	4510	3789	1995	2737	2864	1123	1381	1852	3386	2891	2007	1144	1111	2797	35055	2011/2012

Table 3e. Weights at age in the catch and by-catch (Kg) of 3M redfish, 1989-2018.

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			0.000	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			0.000	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	0.015	0.034	0.057	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
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		0.058	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		0.059	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		0.064	0.094	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
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	0.031	0.050	0.080	0.110	0.140	0.179	0.245	0.286	0.339	0.421	0.422	0.474	0.486	0.532	0.586	0.523	0.699	0.552	0.805
2015	0.024	0.046	0.077	0.104	0.143	0.173	0.234	0.263	0.336	0.409	0.417	0.452	0.430	0.503	0.495	0.566	0.533	0.509	0.768
2016	0.027	0.051	0.082	0.114	0.149	0.170	0.223	0.268	0.309	0.352	0.371	0.393	0.430	0.424	0.493	0.567	0.565	0.610	0.806
2017			0.084	0.115	0.155	0.195	0.233	0.257	0.307	0.329	0.347	0.367	0.403	0.468	0.415	0.506	0.462	0.492	0.577
2018			0.000	0.088	0.120	0.162	0.194	0.223	0.269	0.272	0.291	0.324	0.366	0.374	0.365	0.441	0.383	0.394	0.428

Table 4a. 3M beaked redfish new maturity ogives at length (*S. mentella*, *S.fasciatus* and *Sebastes spp.*), 1994-2018

Year	1994	1996	1999	2000	2004	2007	2011	2012	2013	2014	2015	2016	2017	2018
a	-17.17	-15.16	-8.83	-6.64	-7.68	-8.41	-25.76	-36.36	-31.5	-33.94	-29.79	-15.03	-32.32	-36.83
b	0.61	0.54	0.31	0.23	0.27	0.33	1	1.44	1.25	1.33	1.13	0.53	1.25	1.34
n	402	93	340	94	379	411	476	603	467	412	432	509	374	528.00
L50	27.94	27.97	28.31	28.98	28.09	25.72	25.86	25.3	25.17	25.5	26.29	28.42	25.90	27.39

Table 4b. 3M beaked redfish mean length at maturity (*S. mentella*, *S.fasciatus* and *Sebastes spp.*), 1994-2018

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
S. mentella	30.14	30.03	29.90	29.74	29.56	29.32	29.11	29.00	28.88	28.61	27.74	27.28	26.80
S. fasciatus	26.53	26.66	26.80	26.91	27.06	27.34	28.75	28.57	28.51	28.46	28.38	27.26	26.39
Sebastes spp.	**27.94**	**27.95**	**27.97**	**28.05**	**28.15**	**28.31**	**28.98**	**28.81**	**28.71**	**28.53**	**28.09**	**27.27**	**26.55**
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
S. mentella	25.79	25.88	25.91	25.92	25.93	25.93	26.02	26.12	26.23	28.59	26.50	27.72	
S. fasciatus	25.69	25.68	25.67	25.66	25.65	24.15	23.10	24.44	26.43	28.14	25.35	27.11	
Sebastes spp.	**25.72**	**25.79**	**25.83**	**25.85**	**25.86**	**25.30**	**25.17**	**25.50**	**26.29**	**28.42**	**25.90**	**27.39**	

Table 5a. 3M beaked redfish abundance at length ('000s) from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2018 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	2015	2016	2017	2018
4																							60				6				
5											2868					63							8							49	98
6		73	239	1042				144			956			455	1091	2905					136	54	23		79	148		8	6	24	448
7	1203	160	1952	39644	4931	1102		31	2453		695	291		1240	9720	11241	286	499	304	1547	573	477	369	93	176	299	29	104	73	73	14208
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	1107	1257	275	276	82525
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	6523	3578	464	319	51165
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	1922	1354	751	323	6862
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	983	885	1227	699	2955
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	1438	4655	3534	1396	4966
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	2223	8877	9595	1820	6436
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	3070	10715	7083	2165	5139
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	1617	4525	3772	2135	396
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	1417	4320	9607	7030	2084
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	2773	4467	16026	8443	4337
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	4324	12224	6968	3825
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	5135	8913	10154	5497
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	8006	5861	13067	8430
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	12036	7385	10986	8874
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	19944	9485	8982	9114
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	22363	11989	10229	10066
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	25442	17167	17548	10602
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	34361	26812	25997	9734
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	47505	36954	35518	13409
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	57230	56320	43539	15608
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	56570	63205	56312	22358
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	38241	52836	56838	29229
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	27938	39903	46772	28332
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	13637	21091	33945	26976
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	7251	14203	23785	22176
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	3708	6908	10878	13854
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	2433	2999	5472	7490
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	3185	1910	1714	3455
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	1877	1036	1257	1259
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	800	662	823	992
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	1245	65	336	333
39	3092	4145	2425	1739	2156	1392	520	932	471	212	168	78	131	67	27	117		19			29	46	101		171	219	88	263	64	94	78
40	2090	2908	1634	1079	1410	831	379	493	266	143	65	39	87	27	14	45			95	10	20	1657						283		28	45
41	1499	1192	842	471	586	378	225	433	243	124	77	26	44	54	14	9	10				10	37		10		10		10		85	49
42	665	742	421	367	426	362	84	313	162	37	26	26		13	14	9					10		10				125				12
43	253	291	253	179	165	103	28	156	69		65	13	29	40	14																59
44	84	87	51	53	165	168	28	36	23	25	26		15			9															16
45	84	87	67	53	45	26	28	36	23		13	26																			
46		58	17	53	30	26		36			13						10														7
47			34	11		26		12																							
48						39			12																						10
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	530193	438533	450404	446079	433509

Table 5b. 3M beaked redfish abundance at age ('000s) from EU bottom trawl survey series, 1989-2018.

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	14231	5572	8012	18283	44969	67747	151366	101293	59229	16226	14018	9358	2155	4406	5510	3283	1107	382	3047	530193	2007
2015	11841	24444	11450	10420	28486	56936	71896	67015	53847	26296	29895	11870	10423	3259	11819	1959	1721	1035	3922	438533	2008
2016	6330	23840	29284	14054	18621	21224	60564	44506	65870	59059	41005	38476	9047	11583	2508	1285	1611	887	648	450404	2009
2017	3158	7526	14040	20071	33502	33811	42628	36122	42769	20370	59602	53038	36336	5158	13898	4235	9535	4819	5460	446079	2006
2018	163227	12132	2552	11855	22076	25602	17534	11776	23967	23712	9487	11268	13142	23419	19480	10854	6974	7224	17229	433509	2017

Table 5c. 3M beaked redfish mature female abundance at age ('000s) from EU survey series, 1988-2018.

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	3	71	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	3	103	524	1952	393	968	1390	1023	1110	1261	714	520	518	563	495	295	423	1341	13490
1996	1	6	40	59	2722	6023	1573	1802	1544	978	842	875	509	580	483	388	287	280	788	19732
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	2258	483	2151	2262	2328	2212	2355	2618	1830	1744	6453	318	107	65	71	56	20	24	175	22639
2002	562	5162	6753	8933	2851	2594	2143	2393	2875	1761	1101	5183	303	81	111	28	26	9	62	30454
2003	0	124	556	254	747	716	1012	1258	1342	1114	913	647	3199	281	36	173	156	39	502	12389
2004	986	5791	5404	4531	19242	6961	3628	2527	1684	1267	975	698	755	3321	56	160	157	31	331	46324
2005	70	11628	9758	13128	12576	24678	13518	10161	5776	3593	2438	2076	818	457	1686	33	26	12	9	90985
2006	2578	10966	23110	44701	34122	28193	16832	8369	4095	1536	1187	698	533	384	424	1866	128	23	186	143277
2007	1564	4593	9967	20852	31767	23137	47394	18443	12148	2803	3137	2111	1127	1035	500	4838	1233	9	341	170875
2008	6	1306	2982	8767	17032	56713	40101	24867	13195	5696	2690	1556	936	564	140	67	52	1583	49	174010
2009	2	116	371	5845	9428	32350	34169	28608	18502	17365	6198	5430	817	2585	312	573	277	1195	6472	170128
2010	6	426	488	2332	9640	15937	31251	13455	8568	8272	7795	2554	1266	659	247	257	151	124	894	103402
2011	54	287	499	4006	5751	16811	14267	10351	6295	6217	3592	2756	2307	651	1416	505	97	298	288	75608
2012	25	393	657	2407	6189	16783	31076	24801	9625	3264	6769	5191	5948	3740	1825	1223	233	160	3811	123044
2013	8	107	584	1620	2925	8395	29800	25487	18228	11235	5074	5105	2236	2717	2665	731	1241	663	2731	120853
2014	0	0	8	98	855	4540	38003	45406	35312	12416	9594	6854	1563	3127	4300	2594	797	247	2693	168401
2015	0	4	14	39	489	1973	6635	10373	15490	11550	13469	5875	4909	1968	5455	1021	861	669	2039	82816
2016	3	32	104	144	464	865	3626	5903	15465	22357	21056	22619	5851	7857	2206	1218	1519	853	625	112627
2017	0	0	0	9	356	2384	5916	6932	14368	8736	29777	29059	24828	4516	8070	4060	6873	4178	4959	155021
2018	0	0	0	0	5	188	595	1073	4973	5636	3030	4821	7909	15638	12178	9004	4685	4845	12157	86737

Table5d. 3M beaked reddish proportion of mature females at age, from the EU survey series, 1988-2018.

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	0.002	0.005	0.006	0.047	0.108	0.159	0.217	0.280	0.310	0.307	0.317	0.360	0.367	0.474	0.487	0.577	0.779
1996	0.000	0.000	0.001	0.002	0.014	0.015	0.134	0.208	0.271	0.352	0.414	0.449	0.514	0.519	0.545	0.588	0.634	0.642	0.696
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	0.005	0.009	0.018	0.026	0.045	0.052	0.080	0.129	0.204	0.341	0.240	0.373	0.351	0.372	0.357	0.357	0.361	0.369	0.749
2002	0.005	0.011	0.017	0.038	0.046	0.056	0.071	0.108	0.162	0.359	0.363	0.371	0.522	0.494	0.460	0.341	0.427	0.417	0.435
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	0.004	0.008	0.018	0.031	0.045	0.067	0.105	0.147	0.202	0.272	0.412	0.537	0.639	0.379	0.779	0.689	0.628	0.758	0.673
2005	0.003	0.009	0.015	0.031	0.043	0.053	0.109	0.215	0.282	0.331	0.494	0.539	0.492	0.697	0.553	0.514	0.568	0.592	0.571
2006	0.002	0.009	0.019	0.029	0.045	0.075	0.126	0.219	0.341	0.414	0.479	0.439	0.543	0.586	0.716	0.448	0.601	0.959	0.863
2007	0.002	0.005	0.011	0.039	0.049	0.060	0.167	0.277	0.485	0.738	0.818	0.888	0.909	0.902	0.868	0.720	0.814	0.656	0.848
2008	0.000	0.003	0.010	0.020	0.041	0.101	0.225	0.377	0.486	0.586	0.644	0.672	0.673	0.706	0.542	0.429	0.395	0.695	0.445
2009	0.000	0.001	0.002	0.017	0.024	0.111	0.137	0.224	0.312	0.467	0.626	0.504	0.804	0.678	0.650	0.761	0.924	0.884	0.749
2010	0.000	0.002	0.006	0.012	0.039	0.101	0.225	0.385	0.462	0.539	0.604	0.636	0.733	0.724	0.863	0.830	0.722	0.855	0.752
2011	0.001	0.003	0.007	0.018	0.026	0.069	0.123	0.414	0.464	0.465	0.591	0.682	0.527	0.765	0.705	0.639	0.966	0.932	0.928
2012	0.001	0.005	0.008	0.018	0.031	0.054	0.106	0.178	0.330	0.518	0.486	0.560	0.589	0.570	0.640	0.676	0.879	0.590	0.664
2013	0.001	0.005	0.011	0.020	0.036	0.050	0.120	0.233	0.468	0.560	0.654	0.749	0.821	0.808	0.785	0.818	0.829	0.898	0.861
2014	0.000	0.000	0.001	0.005	0.019	0.067	0.251	0.448	0.596	0.765	0.684	0.732	0.726	0.710	0.781	0.790	0.720	0.647	0.884
2015	0.000	0.000	0.001	0.004	0.017	0.035	0.092	0.155	0.288	0.439	0.451	0.495	0.471	0.604	0.462	0.521	0.501	0.646	0.520
2016	0.000	0.001	0.004	0.010	0.025	0.041	0.060	0.133	0.235	0.379	0.513	0.588	0.647	0.678	0.879	0.948	0.943	0.962	0.965
2017	0.000	0.000	0.000	0.000	0.011	0.071	0.139	0.192	0.336	0.429	0.500	0.548	0.683	0.876	0.581	0.959	0.721	0.867	0.908
2018	0.000	0.000	0.000	0.000	0.000	0.007	0.034	0.091	0.207	0.238	0.319	0.428	0.602	0.668	0.625	0.830	0.672	0.671	0.706

Table 5e. maturity ogive at age for 3M beaked reddish as the average proportion of mature females at age, from the EU survey series, 1989-2018.

Fem proportion	0.001	0.003	0.005	0.012	0.023	0.051	0.108	0.204	0.296	0.383	0.454	0.496	0.545	0.577	0.591	0.637	0.647	0.677	0.724
cv 1989-2018	0.001	0.003	0.006	0.012	0.015	0.025	0.053	0.108	0.125	0.150	0.141	0.145	0.160	0.155	0.157	0.190	0.159	0.168	0.131

Table 6a. Weights at age of the 3M beaked redfish stock (Kg) from EU surveys, 1989-2018.

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	0.022	0.057	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	0.604
2015	0.023	0.050	0.087	0.121	0.168	0.211	0.281	0.311	0.358	0.407	0.412	0.447	0.429	0.533	0.454	0.536	0.537	0.544	0.710
2016	0.028	0.053	0.090	0.115	0.162	0.205	0.264	0.316	0.350	0.385	0.412	0.434	0.457	0.464	0.552	0.651	0.645	0.705	0.725
2017	0.020	0.047	0.072	0.104	0.143	0.206	0.253	0.280	0.333	0.357	0.375	0.390	0.426	0.501	0.410	0.558	0.449	0.502	0.555
2018	0.010	0.038	0.066	0.091	0.132	0.191	0.236	0.283	0.339	0.341	0.364	0.398	0.446	0.461	0.447	0.537	0.463	0.474	0.486

Table 6b. Weights at age of the 3M mature female beaked redfish stock (Kg) from EU surveys, 1989-2018.

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	0.014	0.034	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	0.011	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	0.012	0.029	0.084	0.117	0.124	0.226	0.296	0.365	0.412	0.459	0.516	0.546	0.638	0.723	0.740	0.837	0.854	0.889	1.079
1996	0.012	0.038	0.067	0.080	0.162	0.163	0.280	0.337	0.389	0.449	0.483	0.536	0.583	0.606	0.658	0.703	0.758	0.800	0.960
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	0.015	0.029	0.063	0.090	0.142	0.185	0.242	0.307	0.344	0.390	0.374	0.514	0.603	0.665	0.667	0.623	0.776	0.853	1.035
2002	0.014	0.036	0.054	0.106	0.134	0.190	0.233	0.301	0.342	0.400	0.455	0.409	0.557	0.587	0.616	0.715	0.644	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	0.015	0.033	0.071	0.100	0.124	0.172	0.229	0.284	0.353	0.402	0.472	0.523	0.569	0.466	0.635	0.676	0.553	0.756	0.719
2005	0.013	0.043	0.064	0.100	0.121	0.175	0.237	0.282	0.344	0.386	0.476	0.496	0.488	0.586	0.520	0.705	0.719	0.900	0.861
2006	0.014	0.048	0.075	0.093	0.122	0.172	0.229	0.282	0.352	0.408	0.451	0.442	0.513	0.542	0.596	0.445	0.546	0.839	0.805
2007	0.016	0.032	0.062	0.113	0.130	0.147	0.240	0.276	0.356	0.400	0.462	0.522	0.544	0.539	0.525	0.409	0.492	0.730	0.556
2008	0.015	0.048	0.080	0.109	0.146	0.188	0.234	0.285	0.331	0.376	0.425	0.443	0.439	0.476	0.540	0.565	0.540	0.443	0.625
2009	0.017	0.064	0.090	0.186	0.150	0.210	0.222	0.251	0.304	0.328	0.402	0.334	0.553	0.449	0.496	0.506	0.676	0.855	0.569
2010	0.016	0.061	0.100	0.134	0.161	0.200	0.235	0.269	0.294	0.330	0.368	0.397	0.462	0.457	0.639	0.523	0.479	0.518	0.520
2011	0.044	0.063	0.084	0.165	0.168	0.212	0.235	0.298	0.317	0.331	0.378	0.427	0.345	0.451	0.420	0.435	0.582	0.488	0.575
2012	0.042	0.065	0.086	0.125	0.164	0.204	0.246	0.273	0.306	0.351	0.354	0.414	0.455	0.434	0.494	0.515	0.594	0.441	0.509
2013	0.035	0.074	0.100	0.120	0.167	0.209	0.267	0.301	0.351	0.378	0.392	0.424	0.484	0.474	0.473	0.481	0.539	0.559	0.557
2014	0.038	0.063	0.104	0.133	0.172	0.237	0.281	0.315	0.342	0.392	0.376	0.404	0.463	0.497	0.499	0.477	0.565	0.547	0.586
2015	0.030	0.057	0.098	0.127	0.176	0.220	0.291	0.328	0.371	0.428	0.428	0.465	0.450	0.526	0.478	0.527	0.520	0.543	0.696
2016	0.031	0.057	0.095	0.122	0.173	0.214	0.269	0.338	0.375	0.421	0.433	0.456	0.476	0.480	0.555	0.652	0.645	0.706	0.725
2017	0.026	0.054	0.081	0.121	0.179	0.217	0.260	0.283	0.359	0.370	0.393	0.412	0.442	0.503	0.473	0.559	0.466	0.504	0.559
2018	0.021	0.045	0.069	0.105	0.149	0.213	0.251	0.300	0.348	0.370	0.391	0.422	0.468	0.477	0.471	0.550	0.498	0.504	0.508

Table 7a. 3M beaked redfish survey mean catch per tow from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2018 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	2015	2016	2017	2018
mean weight per tow (Kg/tow)	78	129	57	185	297	532	279	224	342	178	132	183	233	178	158	169	174	111
SE	12	17	7	26	53	79	43	45	92	34	16	23	26	26	19	23	32	11
CV	16%	13%	13%	14%	18%	15%	15%	20%	27%	19%	12%	12%	11%	15%	12%	14%	18%	9%

Table 7b. 3M beaked redfish abundance, stock and female spwanning biomass ('000 tons) from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2016 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)	20	19	25	155	58	306	678	115	25	86	35	80	33	86
4+abundance (millions)	541	362	265	367	385	376	840	497	657	502	284	410	471	273
biomass ('000 ton)	160	128	89	72	127	55	107	76	104	85	61	85	120	66
4+ biomass ('000 ton)	155	113	86	67	92	45	100	71	101	82	56	81	116	51
female spawning biomass ('000 ton)	0	28	28	23	12	16	7	7	7	7	6	3	8	19
SSB proportion	0%	25%	33%	34%	13%	36%	7%	9%	7%	8%	11%	4%	7%	37%

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
abundance (millions)	1435	597	2086	3326	6342	4605	2443	1838	1108	1090	1346	863	530	439	450	446	434
4 abundance (millions)	236	63	145	425	1528	538	442	354	187	219	132	81	18	10	14	20	12
4+abundance (millions)	437	225	758	1402	2854	1971	1708	1553	824	873	1165	776	502	391	391	421	256
biomass ('000 ton)	107	51	153	300	482	377	307	286	164	173	254	189	146	126	136	137	89
4+ biomass ('000 ton)	69	34	106	209	329	282	267	266	147	159	242	182	144	124	132	135	87
female spawning biomass ('000 ton)	7	8	4	10	20	24	39	40	47	27	20	36	39	57	34	48	64
SSB proportion	10%	23%	4%	5%	6%	9%	14%	15%	32%	17%	8%	20%	27%	46%	25%	36%	73%

Table 8. Redfish NAFO Division 3M Input Files For 2019 Sensitivity Analysis

REDFISH NAFO DIVISION 3M INDEX OF INPUT XSA FILES 2019	
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	2018
4	19
5	
58086	
80223	
48500	
43300	
43100	
17664	
13879	
6101	
1408	
1011	
1095	
3841	
3327	
2964	
2273	
3260	
4039	
5936	
5131	
4274	
3639	
5235	
8904	
6736	
5133	
4507	
5169	
6147	
6914	
10280	

REDFISH NAFO 3M CATCH NUMBERS thousands

1	2														
1989	2018														
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
1401	3672	2118	2057	1473	1102	532	429	383	153	386	512	275	198	44	854
1260	3928	5040	1624	1223	1018	1032	1217	667	479	343	661	152	126	101	548
1086	3928	3923	3439	1623	1910	2029	1608	1751	456	612	208	155	211	126	169
61	840	1940	2344	1870	2002	939	2887	2726	2122	378	912	390	674	375	597
190	1700	2594	2447	1620	1910	926	3236	3373	3108	753	1577	811	1246	897	2887

REDFISH NAFO 3M CATCH WEIGHT AT AGE kg

1	3														
1989	2018														
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
0.110	0.140	0.179	0.245	0.286	0.339	0.421	0.422	0.474	0.486	0.532	0.586	0.523	0.699	0.552	0.805
0.104	0.143	0.173	0.234	0.263	0.336	0.409	0.417	0.452	0.430	0.503	0.495	0.566	0.533	0.509	0.768
0.114	0.149	0.170	0.223	0.268	0.309	0.352	0.371	0.393	0.430	0.424	0.493	0.567	0.565	0.610	0.806
0.115	0.155	0.195	0.233	0.257	0.307	0.329	0.347	0.367	0.403	0.468	0.415	0.506	0.462	0.492	0.577
0.097	0.135	0.170	0.203	0.224	0.278	0.293	0.315	0.337	0.367	0.409	0.419	0.441	0.453	0.474	0.804

REDFISH NAFO 3M STOCK WEIGHT AT AGE kg

1 4
1989 2018
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	0.604
0.121	0.168	0.211	0.281	0.311	0.358	0.407	0.412	0.447	0.429	0.533	0.454	0.536	0.537	0.544	0.710
0.115	0.162	0.205	0.264	0.316	0.350	0.385	0.412	0.434	0.457	0.464	0.552	0.651	0.645	0.705	0.725
0.104	0.143	0.206	0.253	0.280	0.333	0.357	0.375	0.390	0.426	0.501	0.410	0.558	0.449	0.502	0.555
0.106	0.147	0.199	0.250	0.279	0.347	0.363	0.387	0.411	0.446	0.512	0.465	0.558	0.477	0.512	0.571

REDFISH NAFO 3M NATURAL MORTALITY (from 2015 assessment)

1	5														
1989	2018														
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
0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

REDFISH NAFO 3M PROPORTION MATURE FEMALES

1	6														
1989	2018														
4	19														
1															
0.005	0.019	0.043	0.083	0.128	0.172	0.208	0.295	0.386	0.463	0.490	0.533	0.542	0.592	0.581	0.754
0.004	0.016	0.046	0.095	0.155	0.204	0.251	0.329	0.416	0.493	0.529	0.571	0.598	0.619	0.611	0.759
0.003	0.014	0.040	0.091	0.166	0.234	0.295	0.361	0.433	0.508	0.550	0.592	0.653	0.641	0.687	0.758
0.002	0.011	0.039	0.089	0.170	0.242	0.311	0.363	0.403	0.465	0.514	0.543	0.824	0.669	0.722	0.742
0.001	0.010	0.039	0.083	0.156	0.223	0.297	0.329	0.347	0.393	0.461	0.470	0.767	0.654	0.714	0.714
0.002	0.008	0.046	0.094	0.154	0.210	0.282	0.309	0.313	0.336	0.401	0.400	0.698	0.600	0.643	0.708
0.003	0.009	0.036	0.109	0.172	0.230	0.312	0.347	0.359	0.384	0.435	0.440	0.528	0.583	0.625	0.721
0.003	0.008	0.032	0.090	0.276	0.327	0.363	0.398	0.411	0.438	0.454	0.463	0.529	0.556	0.588	0.706
0.002	0.009	0.023	0.071	0.237	0.322	0.352	0.395	0.417	0.443	0.462	0.452	0.502	0.544	0.502	0.668
0.003	0.008	0.028	0.049	0.208	0.264	0.311	0.390	0.419	0.404	0.413	0.407	0.436	0.502	0.440	0.649
0.004	0.010	0.024	0.061	0.101	0.186	0.217	0.386	0.376	0.448	0.390	0.429	0.488	0.560	0.474	0.641
0.013	0.023	0.036	0.071	0.130	0.187	0.248	0.366	0.392	0.454	0.385	0.438	0.477	0.530	0.491	0.669
0.023	0.034	0.044	0.072	0.126	0.208	0.292	0.354	0.365	0.496	0.426	0.454	0.460	0.503	0.478	0.601
0.023	0.033	0.046	0.073	0.118	0.186	0.327	0.337	0.411	0.387	0.490	0.501	0.465	0.453	0.515	0.645
0.024	0.033	0.051	0.082	0.124	0.186	0.304	0.395	0.466	0.483	0.492	0.641	0.576	0.542	0.645	0.620
0.022	0.032	0.049	0.095	0.160	0.226	0.294	0.438	0.522	0.473	0.560	0.672	0.633	0.589	0.703	0.665
0.030	0.044	0.065	0.114	0.194	0.275	0.339	0.462	0.505	0.558	0.554	0.683	0.550	0.599	0.770	0.702
0.033	0.046	0.063	0.134	0.237	0.369	0.494	0.597	0.622	0.648	0.728	0.712	0.560	0.661	0.736	0.761
0.029	0.045	0.079	0.173	0.291	0.437	0.579	0.647	0.666	0.708	0.731	0.709	0.532	0.603	0.770	0.719
0.025	0.038	0.091	0.176	0.293	0.428	0.597	0.696	0.688	0.795	0.762	0.687	0.637	0.711	0.745	0.680
0.016	0.034	0.105	0.196	0.329	0.420	0.530	0.625	0.604	0.736	0.702	0.685	0.673	0.680	0.811	0.648
0.016	0.029	0.094	0.162	0.341	0.413	0.490	0.607	0.607	0.688	0.722	0.739	0.743	0.870	0.890	0.810
0.016	0.032	0.075	0.152	0.326	0.419	0.507	0.560	0.626	0.616	0.686	0.736	0.715	0.855	0.792	0.781
0.019	0.031	0.058	0.116	0.275	0.421	0.514	0.577	0.663	0.646	0.714	0.710	0.711	0.891	0.807	0.818
0.015	0.029	0.057	0.159	0.286	0.465	0.614	0.608	0.680	0.712	0.696	0.735	0.762	0.809	0.711	0.803
0.010	0.024	0.051	0.154	0.279	0.451	0.588	0.596	0.659	0.673	0.707	0.676	0.710	0.683	0.730	0.755
0.006	0.020	0.047	0.134	0.245	0.373	0.528	0.549	0.605	0.614	0.664	0.707	0.753	0.721	0.752	0.790
0.007	0.021	0.041	0.072	0.123	0.244	0.368	0.442	0.499	0.560	0.694	0.608	0.794	0.680	0.800	0.779
0.009	0.022	0.044	0.060	0.092	0.215	0.295	0.399	0.465	0.581	0.751	0.658	0.907	0.695	0.838	0.878
0.008	0.020	0.046	0.061	0.072	0.206	0.253	0.341	0.404	0.548	0.788	0.548	0.887	0.570	0.776	0.835

REDFISH NAFO 3M PROPORTION OF F BEFORE SPAWNING

1	7
1989	2018
4	19
3	
0.08	

REDFISH NAFO 3M PROPORTION OF M BEFORE SPAWNING

1	8
1989	2018
4	19
3	
0.08	

REDFISH NAFO 3M F ON OLDEST AGE GROUP BY YEAR

1	9
1989	2018
4	19
5	
0.5011	
0.5960	
0.6338	
0.4439	
1.4444	
0.4160	
0.5887	
0.2022	
0.0359	
0.0408	
0.1618	
0.2562	
0.1711	
0.1195	
0.2160	
0.1798	
0.3761	
0.2097	
0.9883	
0.0477	
0.1281	
0.1098	
0.8210	
0.1270	
0.1245	
0.0772	
0.0880	
0.0477	
0.0477	
0.0477	

REDFISH NAFO 3M F AT AGE IN LAST YEAR

1	10														
1989	2018														
4	19														
2															
0.1784	1.1592	0.7041	0.1716	0.0638	0.0414	0.0386	0.0336	0.0538	0.0268	0.0449	0.0255	0.0264	0.0487	0.0477	0.0477

REDFISH NAFO 3M SURVEY TUNNING DATA

101

EU BOTTOM TRAWL SURVEY

1989	2018															
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	187410	250116	157413	138615	34940	18552	15351	12900	4018	1728	910	286	310	209	145	1189
10555	218920	223439	244352	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	3047
10555	10420	28486	56936	71896	67015	53847	26296	29895	11870	10423	3259	11819	1959	1721	1035	3922
10555	14054	18621	21224	60564	44506	65870	59059	41005	38476	9047	11583	2508	1285	1611	887	648
10555	20071	33502	33811	42628	36122	42769	20370	59602	53038	36336	5158	13898	4235	9535	4819	5460
10555	11668	27088	20195	16833	13156	19451	10034	33257	32806	27786	5357	9981	5598	7206	4839	6552

Table 9a. Key diagnostics of XSA_{2019} runs for a set of 2017-2018 M candidates

$M_{2017\text{-}2018}$		**0.08**	**0.09**	**0.1**	**0.11**	**0.12**	**0.14**	**0.16**	**0.18**	**0.2**
SS log q $residuals_{2017\text{-}2018}$		7.04	7.10	7.12	7.18	7.24	7.36	7.53	7.666	7.86
SS log q $residuals_{2011\text{-}2018}$		23.02	23.19	23.30	23.46	23.57	23.90	24.25	24.59	25.00
XSA *versus* SURVEY $r^2_{2011\text{-}2018}$		0.8957	0.8953	0.8949	0.8944	0.8939	0.8928	0.891514	0.8901	0.8885
Survivors Aver Int s.e		0.3261	0.3261	0.3263	0.3265	0.3265	0.3269	0.3273	0.3278	0.3281
Survivors Aver Ext s.e		0.1607	0.1617	0.1625	0.1635	0.1646	0.1665	0.1687	0.1709	0.1731

Table 9b. Comparitive 1 and 2 yr retro results for a set of 2017-2018 M candidates

Biomass 4+	1yr revision (XSA2019/XSA2018)				Biomass 4+	2yr revision (XSA2019/XSA2017)			
ratios	M0.11	M0.10	M0.09	M0.08	ratios	M0.11	M0.10	M0.09	M0.08
1989	0.0039	0.0040	0.0040	0.0041	1989	0.0077	0.0078	0.0079	0.0080
1990	0.0037	0.0038	0.0038	0.0039	1990	0.0074	0.0075	0.0075	0.0076
1991	0.0042	0.0043	0.0043	0.0044	1991	0.0082	0.0083	0.0084	0.0085
1992	0.0047	0.0048	0.0049	0.0049	1992	0.0094	0.0095	0.0096	0.0097
1993	0.0044	0.0044	0.0045	0.0046	1993	0.0087	0.0087	0.0088	0.0089
1994	0.0097	0.0098	0.0098	0.0099	1994	0.0185	0.0186	0.0187	0.0188
1995	0.0141	0.0142	0.0143	0.0144	1995	0.0271	0.0273	0.0274	0.0276
1996	0.0191	0.0193	0.0194	0.0195	1996	0.0364	0.0366	0.0367	0.0369
1997	0.0238	0.0240	0.0241	0.0242	1997	0.0446	0.0449	0.0451	0.0453
1998	0.0243	0.0245	0.0246	0.0248	1998	0.0451	0.0453	0.0455	0.0457
1999	0.0211	0.0212	0.0212	0.0213	1999	0.0407	0.0407	0.0408	0.0409
2000	0.0210	0.0211	0.0212	0.0212	2000	0.0405	0.0406	0.0408	0.0409
2001	0.0202	0.0202	0.0203	0.0203	2001	0.0390	0.0391	0.0392	0.0392
2002	0.0209	0.0209	0.0210	0.0210	2002	0.0407	0.0407	0.0408	0.0409
2003	0.0201	0.0202	0.0203	0.0203	2003	0.0548	0.0548	0.0548	0.0548
2004	0.0359	0.0355	0.0352	0.0348	2004	0.0821	0.0816	0.0811	0.0806
2005	0.0417	0.0412	0.0407	0.0402	2005	0.0889	0.0882	0.0875	0.0868
2006	0.0382	0.0375	0.0368	0.0360	2006	0.0970	0.0959	0.0948	0.0938
2007	0.0424	0.0416	0.0407	0.0399	2007	0.0882	0.0870	0.0858	0.0846
2008	0.0213	0.0204	0.0196	0.0187	2008	0.0946	0.0933	0.0919	0.0906
2009	0.0286	0.0274	0.0262	0.0250	2009	0.1171	0.1152	0.1134	0.1115
2010	0.0297	0.0283	0.0269	0.0254	2010	0.1411	0.1387	0.1364	0.1341
2011	0.0398	0.0381	0.0363	0.0345	2011	0.1430	0.1402	0.1374	0.1346
2012	0.0378	0.0360	0.0343	0.0325	2012	0.1498	0.1469	0.1441	0.1412
2013	0.0368	0.0347	0.0327	0.0306	2013	0.1589	0.1556	0.1523	0.1490
2014	0.0385	0.0364	0.0343	0.0322	2014	0.1723	0.1689	0.1654	0.1619
2015	0.0426	0.0403	0.0379	0.0356	2015	0.1907	0.1868	0.1830	0.1792
2016	0.0478	0.0453	0.0427	0.0402	2016	0.2108	0.2065	0.2022	0.1980
2017	0.0517	0.0489	0.0462	0.0434					

SSB	1yr revision (XSA2019/XSA2018)			
ratios	M0.11	M0.10	M0.09	M0.08
1989	0.0093	0.0094	0.0095	0.0097
1990	0.0083	0.0084	0.0085	0.0086
1991	0.0083	0.0085	0.0086	0.0087
1992	0.0087	0.0088	0.0089	0.0091
1993	0.0090	0.0091	0.0092	0.0093
1994	0.0134	0.0135	0.0137	0.0139
1995	0.0175	0.0177	0.0180	0.0182
1996	0.0209	0.0211	0.0215	0.0217
1997	0.0297	0.0299	0.0303	0.0307
1998	0.0319	0.0323	0.0326	0.0330
1999	0.0249	0.0251	0.0251	0.0253
2000	0.0280	0.0281	0.0283	0.0284
2001	0.0270	0.0270	0.0271	0.0271
2002	0.0303	0.0304	0.0305	0.0305
2003	0.0307	0.0306	0.0309	0.0310
2004	0.0318	0.0319	0.0319	0.0320
2005	0.0317	0.0316	0.0316	0.0315
2006	0.0283	0.0282	0.0281	0.0279
2007	0.0316	0.0313	0.0311	0.0309
2008	0.0389	0.0386	0.0382	0.0378
2009	0.0404	0.0399	0.0393	0.0387
2010	0.0406	0.0398	0.0390	0.0382
2011	0.0410	0.0399	0.0388	0.0377
2012	0.0407	0.0397	0.0386	0.0375
2013	0.0339	0.0323	0.0307	0.0291
2014	0.0338	0.0322	0.0305	0.0288
2015	0.0394	0.0375	0.0356	0.0337
2016	0.0443	0.0422	0.0402	0.0381
2017	0.0422	0.0401	0.0380	0.0359

SSB	2yr revision (XSA2019/XSA2017)			
ratios	M0.11	M0.10	M0.09	M0.08
1989	0.0184	0.0186	0.0188	0.0190
1990	0.0167	0.0168	0.0170	0.0172
1991	0.0163	0.0164	0.0166	0.0168
1992	0.0175	0.0177	0.0178	0.0180
1993	0.0180	0.0182	0.0183	0.0185
1994	0.0263	0.0266	0.0269	0.0271
1995	0.0350	0.0354	0.0356	0.0360
1996	0.0404	0.0408	0.0412	0.0416
1997	0.0545	0.0549	0.0555	0.0562
1998	0.0569	0.0575	0.0580	0.0586
1999	0.0485	0.0487	0.0489	0.0491
2000	0.0541	0.0544	0.0547	0.0550
2001	0.0519	0.0520	0.0522	0.0522
2002	0.0579	0.0581	0.0582	0.0583
2003	0.0601	0.0602	0.0604	0.0605
2004	0.0633	0.0634	0.0635	0.0636
2005	0.0647	0.0646	0.0645	0.0645
2006	0.0654	0.0652	0.0650	0.0648
2007	0.0757	0.0753	0.0749	0.0745
2008	0.0970	0.0964	0.0958	0.0952
2009	0.1049	0.1039	0.1029	0.1020
2010	0.1164	0.1152	0.1139	0.1127
2011	0.1226	0.1208	0.1191	0.1173
2012	0.1312	0.1295	0.1278	0.1261
2013	0.1470	0.1444	0.1419	0.1393
2014	0.1556	0.1529	0.1503	0.1476
2015	0.1686	0.1655	0.1624	0.1593
2016	0.1818	0.1784	0.1750	0.1717

FBAR	1yr revision (XSA2019/XSA2018)			
ratios	M0.11	M0.10	M0.09	M0.08
1989	-0.0050	-0.0050	-0.0050	-0.0054
1990	-0.0037	-0.0037	-0.0039	-0.0039
1991	-0.0025	-0.0027	-0.0027	-0.0027
1992	-0.0030	-0.0030	-0.0032	-0.0032
1993	-0.0060	-0.0061	-0.0062	-0.0063
1994	-0.0059	-0.0059	-0.0061	-0.0064
1995	-0.0098	-0.0099	-0.0102	-0.0102
1996	-0.0146	-0.0150	-0.0152	-0.0154
1997	-0.0143	-0.0143	-0.0143	-0.0143
1998	-0.0145	-0.0145	-0.0157	-0.0157
1999	-0.0181	-0.0181	-0.0190	-0.0190
2000	-0.0170	-0.0170	-0.0170	-0.0175
2001	-0.0178	-0.0178	-0.0171	-0.0178
2002	-0.0157	-0.0157	-0.0162	-0.0157
2003	-0.0190	-0.0190	-0.0197	-0.0197
2004	-0.0176	-0.0176	-0.0176	-0.0176
2005	-0.0179	-0.0179	-0.0179	-0.0179
2006	-0.0347	-0.0333	-0.0333	-0.0333
2007	-0.0330	-0.0330	-0.0330	-0.0330
2008	-0.0372	-0.0372	-0.0372	-0.0372
2009	-0.0337	-0.0337	-0.0337	-0.0337
2010	-0.0271	-0.0271	-0.0253	-0.0253
2011	-0.0272	-0.0266	-0.0261	-0.0261
2012	-0.0359	-0.0367	-0.0367	-0.0358
2013	-0.0475	-0.0475	-0.0447	-0.0446
2014	-0.0426	-0.0395	-0.0424	-0.0394
2015	-0.0553	-0.0552	-0.0508	-0.0485
2016	-0.0482	-0.0451	-0.0405	-0.0389
2017	-0.1180	-0.1131	-0.1102	-0.1053

FBAR	2yr revision (XSA2019/XSA2017)			
ratios	M0.11	M0.10	M0.09	M0.08
1989	-0.0097	-0.0097	-0.0097	-0.0100
1990	-0.0074	-0.0074	-0.0076	-0.0076
1991	-0.0052	-0.0054	-0.0054	-0.0054
1992	-0.0060	-0.0060	-0.0062	-0.0062
1993	-0.0115	-0.0116	-0.0118	-0.0119
1994	-0.0113	-0.0113	-0.0115	-0.0118
1995	-0.0178	-0.0181	-0.0184	-0.0185
1996	-0.0264	-0.0268	-0.0272	-0.0276
1997	-0.0275	-0.0275	-0.0282	-0.0282
1998	-0.0274	-0.0274	-0.0286	-0.0286
1999	-0.0364	-0.0364	-0.0372	-0.0372
2000	-0.0314	-0.0318	-0.0318	-0.0322
2001	-0.0319	-0.0319	-0.0319	-0.0325
2002	-0.0283	-0.0283	-0.0288	-0.0288
2003	-0.0326	-0.0326	-0.0333	-0.0333
2004	-0.0326	-0.0326	-0.0326	-0.0326
2005	-0.0347	-0.0347	-0.0347	-0.0347
2006	-0.0733	-0.0720	-0.0720	-0.0720
2007	-0.0661	-0.0661	-0.0661	-0.0661
2008	-0.0808	-0.0808	-0.0808	-0.0808
2009	-0.0739	-0.0716	-0.0716	-0.0716
2010	-0.0708	-0.0708	-0.0691	-0.0691
2011	-0.0687	-0.0682	-0.0676	-0.0671
2012	-0.0974	-0.0974	-0.0974	-0.0966
2013	-0.1279	-0.1279	-0.1253	-0.1228
2014	-0.1486	-0.1459	-0.1459	-0.1432
2015	-0.1676	-0.1657	-0.1618	-0.1579
2016	-0.4352	-0.4325	-0.4290	-0.4263

Biomass 4+	1yr revision (XSA2019/XSA2018)			
ratios	M0.11	M0.10	M0.09	M0.08
2011	0.0398	0.0381	0.0363	0.0345
2012	0.0378	0.0360	0.0343	0.0325
2013	0.0368	0.0347	0.0327	0.0306
2014	0.0385	0.0364	0.0343	0.0322
2015	0.0426	0.0403	0.0379	0.0356
2016	0.0478	0.0453	0.0427	0.0402
2017	0.0517	0.0489	0.0462	0.0434

SSB	1yr revision (XSA2019/XSA2018)			
ratios	M0.11	M0.10	M0.09	M0.08
2011	0.0410	0.0399	0.0388	0.0377
2012	0.0407	0.0397	0.0386	0.0375
2013	0.0339	0.0323	0.0307	0.0291
2014	0.0338	0.0322	0.0305	0.0288
2015	0.0394	0.0375	0.0356	0.0337
2016	0.0443	0.0422	0.0402	0.0381
2017	0.0422	0.0401	0.0380	0.0359

FBAR	1yr revision (XSA2019/XSA2018)			
ratios	M0.11	M0.10	M0.09	M0.08
2011	-0.0272	-0.0266	-0.0261	-0.0261
2012	-0.0359	-0.0367	-0.0367	-0.0358
2013	-0.0475	-0.0475	-0.0447	-0.0446
2014	-0.0426	-0.0395	-0.0424	-0.0394
2015	-0.0553	-0.0552	-0.0508	-0.0485
2016	-0.0482	-0.0451	-0.0405	-0.0389
2017	-0.1180	-0.1131	-0.1102	-0.1053

Biomass 4+	2yr revision (XSA2019/XSA2017)			
ratios	M0.11	M0.10	M0.09	M0.08
2011	0.1430	0.1402	0.1374	0.1346
2012	0.1498	0.1469	0.1441	0.1412
2013	0.1589	0.1556	0.1523	0.1490
2014	0.1723	0.1689	0.1654	0.1619
2015	0.1907	0.1868	0.1830	0.1792
2016	0.2108	0.2065	0.2022	0.1980

SSB	2yr revision (XSA2019/XSA2017)			
ratios	M0.11	M0.10	M0.09	M0.08
2011	0.1226	0.1208	0.1191	0.1173
2012	0.1312	0.1295	0.1278	0.1261
2013	0.1470	0.1444	0.1419	0.1393
2014	0.1556	0.1529	0.1503	0.1476
2015	0.1686	0.1655	0.1624	0.1593
2016	0.1818	0.1784	0.1750	0.1717

FBAR	2yr revision (XSA2019/XSA2017)			
ratios	M0.11	M0.10	M0.09	M0.08
2011	-0.0687	-0.0682	-0.0676	-0.0671
2012	-0.0974	-0.0974	-0.0974	-0.0966
2013	-0.1279	-0.1279	-0.1253	-0.1228
2014	-0.1486	-0.1459	-0.1459	-0.1432
2015	-0.1676	-0.1657	-0.1618	-0.1579
2016	-0.4352	-0.4325	-0.4290	-0.4263

Table 10. Redfish NAFO Division 3M Input Files For 2019 XSA Assessment

```
REDFISH NAFO DIVISION 3M INDEX OF INPUT XSA FILES 2019
         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       2018
         4         19
         5
     58086
     80223
     48500
     43300
     43100
     17664
     13879
      6101
      1408
      1011
      1095
      3841
      3327
      2964
      2273
      3260
      4039
      5936
      5131
      4274
      3639
      5235
      8904
      6736
      5133
      4507
      5169
      6147
      6914
     10328
```

REDFISH NAFO 3M CATCH NUMBERS thousands

1	2														
1989	2018														
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
1401	3672	2118	2057	1473	1102	532	429	383	153	386	512	275	198	44	854
1260	3928	5040	1624	1223	1018	1032	1217	667	479	343	661	152	126	101	548
1086	3928	3923	3439	1623	1910	2029	1608	1751	456	612	208	155	211	126	169
61	840	1940	2344	1870	2002	939	2887	2726	2122	378	912	390	674	375	597
163	1304	4510	3789	1995	2737	2864	1123	1381	1852	3386	2891	2007	1144	1111	2797

REDFISH NAFO 3M CATCH WEIGHT AT AGE kg

1	3														
1989	2018														
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
0.110	0.140	0.179	0.245	0.286	0.339	0.421	0.422	0.474	0.486	0.532	0.586	0.523	0.699	0.552	0.805
0.104	0.143	0.173	0.234	0.263	0.336	0.409	0.417	0.452	0.430	0.503	0.495	0.566	0.533	0.509	0.768
0.114	0.149	0.170	0.223	0.268	0.309	0.352	0.371	0.393	0.430	0.424	0.493	0.567	0.565	0.610	0.806
0.115	0.155	0.195	0.233	0.257	0.307	0.329	0.347	0.367	0.403	0.468	0.415	0.506	0.462	0.492	0.577
0.088	0.120	0.162	0.194	0.223	0.269	0.272	0.291	0.324	0.366	0.374	0.365	0.441	0.383	0.394	0.428

REDFISH NAFO 3M STOCK WEIGHT AT AGE kg

1	4														
1989	2018														
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	0.604
0.121	0.168	0.211	0.281	0.311	0.358	0.407	0.412	0.447	0.429	0.533	0.454	0.536	0.537	0.544	0.710
0.115	0.162	0.205	0.264	0.316	0.350	0.385	0.412	0.434	0.457	0.464	0.552	0.651	0.645	0.705	0.725
0.104	0.143	0.206	0.253	0.280	0.333	0.357	0.375	0.390	0.426	0.501	0.410	0.558	0.449	0.502	0.555
0.091	0.132	0.191	0.236	0.283	0.339	0.341	0.364	0.398	0.446	0.461	0.447	0.537	0.463	0.474	0.486

REDFISH NAFO 3M NATURAL MORTALITY (from 2015 assessment)

1	5														
1989	2018														
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
0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

REDFISH NAFO 3M PROPORTION MATURE FEMALES

1	6														
1989	2018														
4	19														
1															
0.005	0.019	0.043	0.083	0.128	0.172	0.208	0.295	0.386	0.463	0.490	0.533	0.542	0.592	0.581	0.754
0.004	0.016	0.046	0.095	0.155	0.204	0.251	0.329	0.416	0.493	0.529	0.571	0.598	0.619	0.611	0.759
0.003	0.014	0.040	0.091	0.166	0.234	0.295	0.361	0.433	0.508	0.550	0.592	0.653	0.641	0.687	0.758
0.002	0.011	0.039	0.089	0.170	0.242	0.311	0.363	0.403	0.465	0.514	0.543	0.824	0.669	0.722	0.742
0.001	0.010	0.039	0.083	0.156	0.223	0.297	0.329	0.347	0.393	0.461	0.470	0.767	0.654	0.714	0.714
0.002	0.008	0.046	0.094	0.154	0.210	0.282	0.309	0.313	0.336	0.401	0.400	0.698	0.600	0.643	0.708
0.003	0.009	0.036	0.109	0.172	0.230	0.312	0.347	0.359	0.384	0.435	0.440	0.528	0.583	0.625	0.721
0.003	0.008	0.032	0.090	0.276	0.327	0.363	0.398	0.411	0.438	0.454	0.463	0.529	0.556	0.588	0.706
0.002	0.009	0.023	0.071	0.237	0.322	0.352	0.395	0.417	0.443	0.462	0.452	0.502	0.544	0.502	0.668
0.003	0.008	0.028	0.049	0.208	0.264	0.311	0.390	0.419	0.404	0.413	0.407	0.436	0.502	0.440	0.649
0.004	0.010	0.024	0.061	0.101	0.186	0.217	0.386	0.376	0.448	0.390	0.429	0.488	0.560	0.474	0.641
0.013	0.023	0.036	0.071	0.130	0.187	0.248	0.366	0.392	0.454	0.385	0.438	0.477	0.530	0.491	0.669
0.023	0.034	0.044	0.072	0.126	0.208	0.292	0.354	0.365	0.496	0.426	0.454	0.460	0.503	0.478	0.601
0.023	0.033	0.046	0.073	0.118	0.186	0.327	0.337	0.411	0.387	0.490	0.501	0.465	0.453	0.515	0.645
0.024	0.033	0.051	0.082	0.124	0.186	0.304	0.395	0.466	0.483	0.492	0.641	0.576	0.542	0.645	0.620
0.022	0.032	0.049	0.095	0.160	0.226	0.294	0.438	0.522	0.473	0.560	0.672	0.633	0.589	0.703	0.665
0.030	0.044	0.065	0.114	0.194	0.275	0.339	0.462	0.505	0.558	0.554	0.683	0.550	0.599	0.770	0.702
0.033	0.046	0.063	0.134	0.237	0.369	0.494	0.597	0.622	0.648	0.728	0.712	0.560	0.661	0.736	0.761
0.029	0.045	0.079	0.173	0.291	0.437	0.579	0.647	0.666	0.708	0.731	0.709	0.532	0.603	0.770	0.719
0.025	0.038	0.091	0.176	0.293	0.428	0.597	0.696	0.688	0.795	0.762	0.687	0.637	0.711	0.745	0.680
0.016	0.034	0.105	0.196	0.329	0.420	0.530	0.625	0.604	0.736	0.702	0.685	0.673	0.680	0.811	0.648
0.016	0.029	0.094	0.162	0.341	0.413	0.490	0.607	0.607	0.688	0.722	0.739	0.743	0.870	0.890	0.810
0.016	0.032	0.075	0.152	0.326	0.419	0.507	0.560	0.626	0.616	0.686	0.736	0.715	0.855	0.792	0.781
0.019	0.031	0.058	0.116	0.275	0.421	0.514	0.577	0.663	0.646	0.714	0.710	0.711	0.891	0.807	0.818
0.015	0.029	0.057	0.159	0.286	0.465	0.614	0.608	0.680	0.712	0.696	0.735	0.762	0.809	0.711	0.803
0.010	0.024	0.051	0.154	0.279	0.451	0.588	0.596	0.659	0.673	0.707	0.676	0.710	0.683	0.730	0.755
0.006	0.020	0.047	0.134	0.245	0.373	0.528	0.549	0.605	0.614	0.664	0.707	0.753	0.721	0.752	0.790
0.005	0.018	0.049	0.097	0.160	0.286	0.416	0.488	0.544	0.600	0.719	0.641	0.809	0.721	0.825	0.798
0.004	0.012	0.040	0.078	0.139	0.259	0.348	0.444	0.521	0.644	0.741	0.695	0.912	0.779	0.833	0.860
0.000	0.005	0.039	0.086	0.142	0.272	0.333	0.409	0.488	0.643	0.772	0.603	0.894	0.696	0.769	0.807

REDFISH NAFO 3M PROPORTION OF F BEFORE SPAWNING

1	7
1989	2018
4	19
3	
0.08	

REDFISH NAFO 3M PROPORTION OF M BEFORE SPAWNING

1	8
1989	2018
4	19
3	
0.08	

REDFISH NAFO 3M F ON OLDEST AGE GROUP BY YEAR

1	9
1989	2018
4	19
5	
0.5011	
0.5960	
0.6338	
0.4439	
1.4444	
0.4160	
0.5887	
0.2022	
0.0359	
0.0408	
0.1618	
0.2562	
0.1711	
0.1195	
0.2160	
0.1798	
0.3761	
0.2097	
0.9883	
0.0477	
0.1281	
0.1098	
0.8210	
0.1270	
0.1245	
0.0772	
0.0880	
0.0477	
0.0477	
0.0477	

REDFISH NAFO 3M F AT AGE IN LAST YEAR

1	10														
1989	2018														
4	19														
2															
0.1784	1.1592	0.7041	0.1716	0.0638	0.0414	0.0386	0.0336	0.0538	0.0268	0.0449	0.0255	0.0264	0.0487	0.0477	0.0477

REDFISH NAFO 3M SURVEY TUNNING DATA

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EU BOTTOM TRAWL SURVEY

1989	2018															
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	187410	250116	157413	138615	34940	18552	15351	12900	4018	1728	910	286	310	209	145	1189
10555	218920	223439	244352	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	3047
10555	10420	28486	56936	71896	67015	53847	26296	29895	11870	10423	3259	11819	1959	1721	1035	3922
10555	14054	18621	21224	60564	44506	65870	59059	41005	38476	9047	11583	2508	1285	1611	887	648
10555	20071	33502	33811	42628	36122	42769	20370	59602	53038	36336	5158	13898	4235	9535	4819	5460
10555	11855	22076	25602	17534	11776	23967	23712	9487	11268	13142	23419	19480	10854	6974	7224	17229

Table 11. 2019 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
M=0.10 all ages 20115-2016
M=0.10 all ages 20117-2018

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REDFISH NAFO DIVISION 3M INDEX OF INPUT FILES 2019
CPUE data from file red3mtun.txt

Catch data for 30 years. 1989 to 2018. Ages 4 to 19.

Fleet	Fi year	Last year	First age	Last age	Alpha	Beta
EU BOTTOM TRAWL SURV	1989	2018	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 estimation : Final estimates not shrunk towards mean F
Minimum standard error for population
estimates derived from each fleet = .500
Prior weighting not applied

Tuning converged after 47 iterations

Log catchability residuals.
Fleet : EU BOTTOM TRAWL SURV

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
4	**-1.69**	**-1.04**	**1.25**	0.32	1.11	1.04	0.81	0.05	1.01	0.17	0.55	-0.47	0.25	0.72
5	**-2.94**	**-3.67**	0.81	**1.37**	**-0.96**	0.78	0.61	**1.45**	**1.45**	0.04	0.44	0.29	-0.01	-0.08
6	-1.82	**-2.03**	**-1.55**	0.59	-0.17	0.36	-0.9	0.99	0.73	0.92	0.28	0.53	-0.01	-0.04
7	-0.96	-0.92	**-1.42**	-0.29	-0.83	0.33	-0.03	0.01	0.59	-0.04	0.97	0.67	0.28	-0.15
8	-0.31	-0.28	**-1.35**	0.05	-0.73	0.04	0.28	0.92	-0.25	0.49	0.7	**1.94**	0.37	0.55
9	-0.24	-0.23	**-1.26**	0.05	-1.38	0.41	-0.05	0.91	0.91	0.07	**1.15**	**1.15**	0.48	0.83
10	-0.25	-0.12	**-1.31**	0.01	-0.51	0.41	0.87	0.29	**1.15**	-0.47	**1.14**	**1.86**	-0.15	0.56
11	-0.29	-0.35	-0.89	-0.25	-0.34	0.69	1.25	**1.13**	0.17	-0.33	-0.73	1	0.43	-0.27
12	-0.58	-0.63	-0.96	-0.22	-0.42	0.57	0.98	**1.5**	**1.22**	0.73	-0.26	0.15	0.2	-0.02
13	-0.2	-0.25	-0.64	-0.13	-0.04	0.31	1.02	1	**1.28**	0.09	0.39	-0.6	0.25	0.47
14	-0.34	-0.04	-0.67	-0.24	-0.09	0.1	0.39	**1.33**	**1.19**	0.46	-0.66	**1.57**	-0.38	-0.09
15	0.19	-0.14	-1.14	0.08	0.02	0.35	**1.5**	0.43	0.3	-0.89	0.9	0	0.21	0.44
16	0.02	-0.19	-0.84	-0.09	-0.55	-0.33	0.87	**1.63**	-0.61	-0.09	0.39	0.04	0.19	-0.54
17	-0.19	0.25	-0.34	-0.66	-0.19	-0.58	0.06	0.76	**1.64**	-0.31	0.48	-0.42	0.01	-0.38
18	0	0.04	-0.04	0.09	0.45	0.15	0.35	0.14	-0.26	-0.71	0.15	-0.5	-0.43	-0.65

Age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4	**-1.15**	-0.68	0.32	**1.17**	0.36	-0.17	-0.26	-0.57	0.2	0.03	-0.25	-1.07	-1.27	-0.66	-0.06	0
5	-0.29	0.79	0.01	**1.07**	0.62	0.39	0.01	-0.3	-0.23	0.17	-0.42	-0.76	-0.49	-0.52	0.28	0.11
6	-0.91	0.05	**0.97**	0.55	0.8	0.85	0.42	-0.52	-0.06	0.23	0.13	-0.44	-0.31	-0.49	0.39	0.45
7	-1.01	-0.38	0.42	-0.07	0.63	0.35	0.53	0.19	-0.49	0.32	0.23	0.27	-0.16	0.05	0.61	0.32
8	-0.69	-0.35	0.46	-0.25	-0.26	-0.31	0.68	-0.66	-0.88	0.19	-0.14	-0.14	-0.04	-0.14	0.09	0.02
9	-0.06	-0.45	0.37	-0.39	-0.14	-0.65	0.24	-0.47	-0.98	-0.23	-0.57	-0.23	-0.28	0.44	0.34	0.27
10	-0.03	0.14	0.43	-0.73	-0.94	-0.5	0.4	-0.24	-0.05	-1.17	-0.01	-0.86	-0.48	0.37	-0.17	0.38
11	0.2	-0.18	0.63	-0.67	-0.33	-0.5	0.04	0	-0.65	0.38	-0.62	-0.01	0.09	0.29	0.73	-0.6
12	-0.91	-0.13	0.57	-0.27	-0.51	-0.65	0.78	-0.4	-0.77	-0.01	-0.15	-0.25	-0.01	0.49	0.71	-0.77
13	0.1	-0.68	0.55	-0.38	-0.13	-0.69	-0.98	-0.39	0.2	0.63	-0.87	-0.96	0.18	0.03	0.78	-0.34
14	0.7	-0.08	-1.19	-0.22	-0.12	-0.47	0.54	-0.74	-0.8	0.76	-0.34	-0.32	-0.5	0.33	-0.5	0.43
15	-0.85	-0.73	-0.88	-1.03	-0.01	-1.33	-0.58	**-1.52**	0.69	**0.87**	0.43	0.43	0.92	-0.55	0.75	1.14
16	0.93	0.86	-0.56	-0.57	1.6	-1.21	-0.09	-0.7	0	0.99	-0.17	0.44	-0.61	-1.32	-0.05	0.56
17	**1.11**	**1.54**	-0.01	**1.49**	-1.43	-1.99	-0.22	-0.9	-1.17	-0.54	1.22	0.28	-0.04	-0.67	0.84	0.67
18	-0.17	-0.39	-0.43	-0.04	-0.22	-0.88	0.71	-0.46	0.22	0.3	0.75	0.14	0.43	-0.56	0.59	0.81

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	-8.5481	-8.4361	-8.4094	-8.4661	-8.8203	-9.1753	-9.6069	-9.8091	-9.8285	-10.0164	-9.9195	-10.0047	-9.8418	-9.8418	-9.8418
S.E(Log q)	0.7847	1.0978	0.8029	0.5772	0.6219	0.6451	0.7055	0.5761	0.6517	0.6017	0.6566	0.7874	0.7384	0.8802	0.4525

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	0.95	0.39	8.66	0.69	30	0.76	-8.55
5	1.15	-0.619	8.1	0.37	30	1.28	-8.44
6	1.09	-0.545	8.21	0.54	30	0.89	-8.41
7	1.13	-1.024	8.23	0.69	30	0.65	-8.47
8	1.34	-2.324	8.38	0.63	30	0.78	-8.82
9	1.33	-2.33	8.94	0.64	30	0.8	-9.18
10	1.24	-1.753	9.61	0.65	30	0.85	-9.61
11	1.12	-1.19	9.87	0.78	30	0.64	-9.81
12	1.3	-2.654	10.08	0.73	30	0.77	-9.83
13	1.2	-2.08	10.29	0.8	30	0.68	-10.02
14	1.18	-1.784	10.22	0.77	30	0.75	-9.92
15	0.97	0.329	9.93	0.77	30	0.77	-10
16	1.17	-1.5	10.25	0.74	30	0.85	-9.84
17	1.35	-2.494	10.82	0.65	30	1.09	-9.83
18	0.89	2.442	9.49	0.95	30	0.37	-9.86
1							

Terminal year survivor and F summaries :

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2014

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	5468	0.798	0	0	1	1	0.028

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2013

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	7716	0.649	0.079	0.12	2	1	0.149

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 2012

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	5004	0.509	0.364	0.71	3	1	0.619

Age 7 Catchability constant w.r.t. time and dependent on age
Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	4122	0.393	0.354	0.9	4	1	0.628

Age 8 Catchability constant w.r.t. time and dependent on age
Year class = 2010

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	6284	0.339	0.272	0.8	5	1	0.264

Age 9 Catchability constant w.r.t. time and dependent on age
Year class = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	14923	0.297	0.117	0.39	6	1	0.161

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 2008

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	20665	0.273	0.117	0.43	7	1	0.124

Age 11 Catchability constant w.r.t. time and dependent on age
Year class = 2007

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	27879	0.247	0.131	0.53	8	1	0.038

Age 12 Catchability constant w.r.t. time and dependent on age
Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	40429	0.232	0.171	0.74	9	1	0.032

Age 13 Catchability constant w.r.t. time and dependent on age
Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	36664	0.217	0.123	0.57	10	1	0.047

Age 14 Catchability constant w.r.t. time and dependent on age
Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	26638	0.206	0.161	0.78	11	1	0.114

Age 15 Catchability constant w.r.t. time and dependent on age
Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	11277	0.2	0.141	0.71	12	1	0.218

Age 16 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	9701	0.193	0.201	1.04	13	1	0.18

Age 17 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	5608	0.19	0.152	0.8	14	1	0.177

Age 18 Catchability constant w.r.t. time and age (fixed at the value for age) 17
Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	5042	0.18	0.187	1.04	15	1	0.19

Table 12a. Main results of retrospective 2019 $XSA_{2018-2014}$

Biomass	2018	2017	2016	2015	2014
1989	221.2	221.3	220.4	219.3	218.1
1990	188.8	188.9	188.2	187.3	186.4
1991	135.6	135.7	135.1	134.4	133.7
1992	100.3	100.4	99.9	99.3	98.7
1993	68.7	68.8	68.5	68.1	67.8
1994	46.3	46.2	45.8	45.4	44.9
1995	37.5	37.4	36.9	36.5	35.9
1996	26.2	26.1	25.7	25.3	24.8
1997	25.3	25.1	24.6	24.2	23.6
1998	27.3	27.1	26.5	26.1	25.4
1999	27.7	27.5	27.0	26.6	26.0
2000	34.0	33.8	33.2	32.7	32.0
2001	35.2	35.0	34.4	33.9	33.0
2002	41.1	40.8	40.1	40.1	39.1
2003	45.5	45.2	43.7	43.8	43.1
2004	67.2	65.1	62.3	63.4	61.5
2005	84.8	81.8	78.3	80.2	78.7
2006	113.1	108.2	102.4	103.7	100.6
2007	126.1	119.5	114.5	115.4	111.9
2008	159.7	151.2	141.1	139.7	133.3
2009	162.4	156.4	144.1	140.8	136.8
2010	157.2	154.5	139.6	134.3	130.9
2011	132.6	132.4	120.5	115.0	113.1
2012	144.8	144.4	130.4	123.9	121.1
2013	149.2	148.6	133.0	124.9	121.7
2014	162.1	161.9	143.5	133.5	129.5
2015	153.2	153.0	134.1	123.6	
2016	145.8	144.6	125.3		
2017	125.1	123.8			
2018	116.6				

FemBiomass	2018	2017	2016	2015	2014
1989	54.82	54.88	54.39	53.72	53.03
1990	51.68	51.74	51.31	50.76	50.19
1991	42.65	42.69	42.35	41.89	41.44
1992	34.20	34.24	33.94	33.56	33.19
1993	20.17	20.18	20.00	19.78	19.57
1994	9.26	9.27	9.15	9.00	8.84
1995	8.40	8.40	8.26	8.09	7.92
1996	5.02	5.02	4.92	4.80	4.67
1997	4.73	4.72	4.61	4.46	4.29
1998	5.70	5.67	5.53	5.37	5.17
1999	4.66	4.62	4.52	4.43	4.31
2000	6.95	6.90	6.73	6.56	6.36
2001	7.51	7.44	7.26	7.13	6.93
2002	8.54	8.45	8.23	8.08	7.83
2003	9.49	9.40	9.14	8.98	8.71
2004	13.28	13.11	12.72	12.51	12.09
2005	17.21	16.94	16.41	16.32	15.83
2006	21.79	21.41	20.66	20.72	20.13
2007	29.81	29.10	27.91	28.26	27.47
2008	43.96	42.54	40.29	40.80	39.48
2009	40.41	38.79	36.54	37.38	36.44
2010	38.48	36.66	34.18	34.44	33.25
2011	33.20	31.49	29.21	29.23	28.23
2012	45.28	43.19	39.76	39.20	37.54
2013	53.07	50.82	45.84	44.47	42.73
2014	68.14	66.53	59.56	56.81	54.79
2015	66.75	66.10	58.84	55.67	
2016	64.53	63.65	56.26		
2017	61.64	60.85			
2018	63.70				

FBAR	2018	2017	2016	2015	2014
1989	0.317	0.317	0.319	0.321	0.323
1990	0.482	0.482	0.484	0.486	0.489
1991	0.367	0.367	0.368	0.369	0.370
1992	0.567	0.566	0.568	0.570	0.573
1993	0.651	0.651	0.654	0.659	0.664
1994	0.457	0.456	0.459	0.462	0.466
1995	0.685	0.684	0.690	0.699	0.708
1996	0.512	0.512	0.518	0.528	0.539
1997	0.140	0.140	0.142	0.144	0.147
1998	0.083	0.083	0.084	0.085	0.087
1999	0.121	0.121	0.124	0.127	0.130
2000	0.229	0.229	0.233	0.237	0.242
2001	0.157	0.158	0.160	0.162	0.166
2002	0.184	0.185	0.187	0.190	0.194
2003	0.142	0.142	0.144	0.147	0.150
2004	0.096	0.097	0.098	0.099	0.102
2005	0.155	0.156	0.159	0.161	0.165
2006	0.070	0.072	0.075	0.075	0.077
2007	0.119	0.121	0.126	0.126	0.130
2008	0.058	0.059	0.062	0.062	0.064
2009	0.040	0.042	0.043	0.043	0.044
2010	0.053	0.055	0.058	0.058	0.061
2011	0.181	0.184	0.192	0.192	0.198
2012	0.109	0.112	0.119	0.117	0.125
2013	0.036	0.036	0.039	0.040	0.041
2014	0.032	0.033	0.037	0.036	0.037
2015	0.042	0.045	0.051	0.058	
2016	0.064	0.067	0.112		
2017	0.083	0.096			
2018	0.220				

REC	2018	2017	2016	2015	2014
1989	54.512	54.514	54.492	54.470	54.439
1990	42.369	42.365	42.343	42.306	42.272
1991	23.726	23.723	23.712	23.698	23.678
1992	21.986	21.985	21.977	21.968	21.955
1993	139.481	139.480	139.475	139.466	139.458
1994	157.630	156.610	154.612	153.178	151.031
1995	28.082	28.006	27.714	27.678	27.414
1996	13.407	13.318	13.146	12.974	12.804
1997	16.699	16.617	16.436	16.334	16.094
1998	15.301	15.263	15.110	15.001	14.865
1999	23.914	23.855	23.642	23.537	23.325
2000	27.190	27.144	26.942	26.806	26.543
2001	35.158	35.072	34.648	34.400	31.673
2002	60.079	59.788	58.806	63.375	63.367
2003	104.091	103.478	93.556	94.646	97.979
2004	148.731	130.593	121.638	131.195	119.574
2005	159.701	152.249	148.092	152.988	158.311
2006	288.843	271.849	251.164	239.766	221.341
2007	228.201	208.116	212.374	209.851	204.769
2008	318.704	301.143	259.513	233.463	207.559
2009	279.378	289.770	256.147	234.122	241.994
2010	203.450	224.769	187.976	172.946	175.000
2011	95.439	107.291	109.149	100.979	105.200
2012	67.768	63.073	54.488	52.143	47.209
2013	55.344	51.442	45.820	35.573	31.046
2014	28.998	28.405	16.625	11.533	8.571
2015	19.905	15.475	7.975	5.225	
2016	14.663	10.490	6.987		
2017	11.003	10.027			
2018	6.215				

Table 12b. Relative retrospective bias between the two last 3M beaked redfish assessments

2019/2017 XSA				
ratios (%)	Biomass	SSB	FBAR	REC
1989	0.3%	0.8%	-0.4%	0.0%
1990	0.3%	0.7%	-0.3%	0.1%
1991	0.4%	0.7%	-0.2%	0.1%
1992	0.4%	0.8%	-0.3%	0.0%
1993	0.4%	0.8%	-0.5%	0.0%
1994	1.0%	1.2%	-0.5%	2.0%
1995	1.6%	1.6%	-0.8%	1.3%
1996	2.2%	2.0%	-1.2%	2.0%
1997	2.7%	2.6%	-1.3%	1.6%
1998	2.8%	3.0%	-1.3%	1.3%
1999	2.7%	3.0%	-1.8%	1.2%
2000	2.6%	3.2%	-1.6%	0.9%
2001	2.6%	3.4%	-1.8%	1.5%
2002	2.7%	3.8%	-1.7%	2.2%
2003	4.1%	3.9%	-1.8%	11.3%
2004	7.8%	4.4%	-1.9%	22.3%
2005	8.4%	4.9%	-2.3%	7.8%
2006	10.5%	5.4%	-6.4%	15.0%
2007	10.1%	6.8%	-5.1%	7.5%
2008	13.2%	9.1%	-7.1%	22.8%
2009	12.7%	10.6%	-6.9%	9.1%
2010	12.7%	12.6%	-7.8%	8.2%
2011	10.0%	13.6%	-6.1%	-12.6%
2012	11.0%	13.9%	-8.3%	24.4%
2013	12.1%	15.8%	-7.9%	20.8%
2014	12.9%	14.4%	-13.5%	74.4%
2015	14.3%	13.4%	-18.7%	149.6%
2016	16.4%	14.7%	-43.0%	109.9%

Table 13. XSA results for 2019 assessment

Run title : REDFISH NAFO DIVISION 3M INDEX OF INPUT XSA FILES 2019

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	0.2979	0.056	0.0114	1.8012	0.4445	0.1095	0.1369	0.0445	0.0075	0.0067	0.0034	0.0251	0.0254
5	0.0157	0.0615	0.1423	0.3162	0.8133	0.3908	0.1663	0.1787	0.0144	0.0043	0.0033	0.0064	0.0146	0.0119
6	0.0846	0.1019	0.1924	0.4009	0.2752	0.2448	0.5887	0.0721	0.037	0.0122	0.0013	0.0175	0.0212	0.0233
7	0.2127	0.4388	0.4574	0.8556	0.3076	0.3204	0.439	0.2615	0.0144	0.0201	0.0088	0.0352	0.0837	0.0346
8	0.3001	0.7675	0.6565	1.0253	0.5126	0.3488	0.5474	0.5998	0.0662	0.0142	0.0206	0.1526	0.143	0.103
9	0.2785	0.7324	0.6121	0.7491	0.2598	0.5346	0.3344	0.6456	0.2046	0.1249	0.0134	0.1367	0.169	0.1411
10	0.2418	0.5986	0.3767	0.5287	0.5366	0.5795	0.599	0.3252	0.2556	0.0627	0.1368	0.1116	0.1015	0.1325
11	0.3006	0.4497	0.3855	0.4064	0.7705	0.6985	0.8564	0.6399	0.0994	0.079	0.0876	0.3424	0.1055	0.0927
12	0.2701	0.3447	0.3	0.4402	0.7866	0.6628	0.7008	0.8847	0.2884	0.2073	0.1466	0.2388	0.3035	0.0718
13	0.3658	0.397	0.3186	0.4226	0.9777	0.4305	0.7199	0.4908	0.2359	0.0896	0.209	0.115	0.2296	0.4255
14	0.3567	0.5385	0.3037	0.4234	1.0012	0.4231	0.4746	0.6681	0.2383	0.1625	0.0941	0.9009	0.1251	0.3089
15	0.5407	0.4435	0.1744	0.5122	0.9864	0.5029	1.3008	0.2293	0.0728	0.0305	0.3628	0.1971	0.1896	0.4669
16	0.5372	0.4905	0.2594	0.467	0.7422	0.2751	0.9697	0.8154	0.0286	0.1076	0.2548	0.2685	0.2559	0.2261
17	0.3856	0.6941	0.43	0.2694	0.8237	0.2058	0.4569	0.347	0.2317	0.0785	0.3044	0.1486	0.1866	0.3127
18	0.4856	0.5766	0.6115	0.4289	1.3915	0.4018	0.5667	0.1943	0.0346	0.0392	0.1551	0.2441	0.1637	0.1136
+gp	0.4856	0.5766	0.6115	0.4289	1.3915	0.4018	0.5667	0.1943	0.0346	0.0392	0.1551	0.2441	0.1637	0.1136
0 FBAR 6-16	0.3172	0.4821	0.367	0.5665	0.6506	0.4565	0.6846	0.512	0.1401	0.0828	0.1214	0.2288	0.1571	0.1842

Table 8	Fishing mortality (F) at age															
YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	FBAR **-**
AGE																	
4	0.0174	0.0072	0.004	0.0086	0.0024	0.0009	0.0019	0.0166	0.0381	0.0173	0.0135	0.0532	0.0689	0.0811	0.0058	0.028	0.0383
5	0.0394	0.0477	0.0024	0.0421	0.005	0.0058	0.0027	0.0361	0.0296	0.0241	0.0319	0.0866	0.1897	0.2819	0.0749	0.1491	0.1686
6	0.0107	0.0607	0.009	0.0887	0.0109	0.0253	0.0172	0.0366	0.0381	0.0175	0.058	0.047	0.1508	0.262	0.1957	0.6192	0.359
7	0.0215	0.0685	0.0237	0.0855	0.0621	0.0447	0.0238	0.0673	0.0249	0.0155	0.0621	0.0393	0.0425	0.131	0.2204	0.6283	0.3266
8	0.0391	0.0633	0.0654	0.0751	0.039	0.0503	0.0386	0.0221	0.0264	0.0119	0.0396	0.0196	0.0272	0.0491	0.0879	0.2639	0.1336
9	0.0827	0.0506	0.1117	0.0768	0.0774	0.0505	0.0334	0.0258	0.0262	0.0111	0.0239	0.016	0.0155	0.0488	0.0711	0.1608	0.0936
10	0.0728	0.066	0.1113	0.0477	0.0455	0.0484	0.0407	0.036	0.0921	0.0089	0.0328	0.0098	0.0172	0.0351	0.0275	0.1238	0.0622
11	0.1141	0.0543	0.1782	0.0469	0.0847	0.0495	0.044	0.0608	0.0898	0.0376	0.017	0.0175	0.0256	0.0303	0.0578	0.0376	0.0419
12	0.0534	0.0772	0.2206	0.0657	0.1081	0.0485	0.0512	0.0518	0.17	0.0718	0.0283	0.018	0.0315	0.0421	0.0593	0.032	0.0445
13	0.0568	0.0508	0.2043	0.0625	0.1139	0.0381	0.0231	0.0915	0.0886	0.1756	0.0147	0.0128	0.0259	0.0244	0.0594	0.0469	0.0436
14	0.4656	0.0517	0.0996	0.1121	0.128	0.0888	0.0694	0.0654	0.1839	0.172	0.0281	0.0327	0.033	0.0377	0.0229	0.1141	0.0583
15	0.0842	0.0599	0.0794	0.0564	0.1986	0.0619	0.029	0.025	0.5097	0.301	0.0519	0.0674	0.0663	0.0228	0.0654	0.2182	0.1021
16	0.5574	0.456	0.6028	0.0549	0.4431	0.1261	0.073	0.1047	0.736	0.3782	0.0396	0.0719	0.0236	0.0179	0.0489	0.1796	0.0822
17	0.4145	0.465	0.8603	0.8687	0.0444	0.0752	0.0516	0.0702	0.6529	0.1693	0.2249	0.1308	0.0393	0.0374	0.0909	0.1773	0.1019
18	0.2066	0.17	0.3548	0.1995	0.946	0.0443	0.1203	0.0996	0.7619	0.1187	0.118	0.0735	0.0838	0.0453	0.0777	0.1903	0.1044
+gp	0.2066	0.17	0.3548	0.1995	0.946	0.0443	0.1203	0.0996	0.7619	0.1187	0.118	0.0735	0.0838	0.0453	0.0777	0.1903	
0 FBAR 6-16	0.1417	0.0963	0.1551	0.0702	0.1192	0.0575	0.0403	0.0534	0.1805	0.1092	0.036	0.032	0.0417	0.0638	0.0833	0.2204	

Table 9	Relative F at age													
YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE														
4	0.0271	0.6178	0.1526	0.0201	2.7687	0.9737	0.1599	0.2674	0.3179	0.0908	0.0549	0.0151	0.1596	0.138
5	0.0495	0.1275	0.3879	0.5581	1.2502	0.856	0.2428	0.3491	0.1029	0.052	0.0271	0.0279	0.0927	0.0648
6	0.2666	0.2114	0.5244	0.7078	0.423	0.5364	0.86	0.1408	0.2639	0.1476	0.0106	0.0763	0.1351	0.1262
7	0.6706	0.9101	1.2465	1.5104	0.4728	0.7019	0.6412	0.5107	0.1025	0.2433	0.0722	0.1538	0.5332	0.1879
8	0.9462	1.592	1.7889	1.8099	0.7879	0.7641	0.7996	1.1714	0.4726	0.1716	0.1693	0.6669	0.9107	0.5594
9	0.878	1.5192	1.668	1.3223	0.3993	1.1712	0.4884	1.2609	1.4601	1.5084	0.1101	0.5977	1.0759	0.7659
10	0.7622	1.2416	1.0265	0.9333	0.8248	1.2695	0.8749	0.6351	1.8246	0.757	1.1264	0.488	0.6463	0.7192
11	0.9479	0.9328	1.0504	0.7173	1.1843	1.5303	1.2509	1.2498	0.7094	0.9547	0.7217	1.497	0.6715	0.5033
12	0.8517	0.715	0.8174	0.7771	1.2091	1.4521	1.0237	1.7278	2.0587	2.504	1.207	1.0439	1.9321	0.3895
13	1.1535	0.8235	0.8682	0.7459	1.5028	0.9432	1.0516	0.9586	1.6838	1.0825	1.721	0.5028	1.462	2.3099
14	1.1247	1.117	0.8275	0.7474	1.539	0.927	0.6932	1.3048	1.7009	1.9636	0.7748	3.9381	0.7968	1.6769
15	1.7048	0.9199	0.4752	0.9041	1.5162	1.1016	1.9001	0.4478	0.5195	0.3679	2.9882	0.8617	1.2072	2.5347
16	1.6937	1.0175	0.7069	0.8244	1.1408	0.6027	1.4164	1.5924	0.204	1.2995	2.0987	1.1739	1.6292	1.2271
17	1.2159	1.4396	1.1717	0.4756	1.2662	0.4509	0.6674	0.6778	1.6536	0.9488	2.5069	0.6494	1.1881	1.6976
18	1.5312	1.196	1.6662	0.7571	2.1388	0.8802	0.8277	0.3795	0.2466	0.4733	1.2772	1.0669	1.0421	0.6167
+gp	1.5312	1.196	1.6662	0.7571	2.1388	0.8802	0.8277	0.3795	0.2466	0.4733	1.2772	1.0669	1.0421	0.6167
0 REFMEAN	0.3172	0.4821	0.367	0.5665	0.6506	0.4565	0.6846	0.512	0.1401	0.0828	0.1214	0.2288	0.1571	0.1842

Table 9	Relative F at age															
YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN **-*
AGE																	
4	0.1231	0.0746	0.026	0.1229	0.0199	0.0164	0.0471	0.3102	0.2112	0.1586	0.3761	1.6636	1.6499	1.2715	0.0702	0.1269	0.4895
5	0.2779	0.4958	0.0158	0.5991	0.0418	0.101	0.0665	0.6759	0.164	0.2205	0.8852	2.7081	4.5439	4.4212	0.8994	0.6763	1.999
6	0.0756	0.63	0.0582	1.2636	0.0918	0.4404	0.4265	0.6861	0.2112	0.1606	1.6121	1.4689	3.614	4.11	2.349	2.8092	3.0894
7	0.1517	0.7115	0.1529	1.2186	0.5209	0.7788	0.5911	1.2607	0.1381	0.1419	1.7264	1.2277	1.0176	2.0548	2.6459	2.8506	2.5171
8	0.2761	0.6577	0.4218	1.07	0.3273	0.875	0.9576	0.4145	0.1463	0.1086	1.0998	0.6127	0.652	0.7703	1.0547	1.1972	1.0074
9	0.5837	0.5255	0.7204	1.0935	0.6493	0.8795	0.8282	0.4843	0.1452	0.1013	0.6629	0.4997	0.3723	0.7652	0.8534	0.7296	0.7827
10	0.5139	0.6859	0.7175	0.6791	0.3814	0.8416	1.0086	0.6752	0.5102	0.0815	0.9113	0.3051	0.4111	0.5507	0.3306	0.5619	0.481
11	0.8054	0.5642	1.149	0.6678	0.7105	0.8617	1.0918	1.1385	0.4975	0.3445	0.4729	0.5475	0.6138	0.4745	0.6942	0.1706	0.4464
12	0.3771	0.8017	1.4225	0.9364	0.9068	0.8442	1.2692	0.9699	0.9418	0.6579	0.7864	0.5615	0.7537	0.661	0.7115	0.1451	0.5059
13	0.4011	0.5276	1.3174	0.8903	0.9557	0.6629	0.5732	1.715	0.491	1.6083	0.4072	0.3995	0.6202	0.3834	0.7127	0.2129	0.4364
14	3.2866	0.537	0.6419	1.5964	1.0739	1.5449	1.722	1.2259	1.0185	1.5751	0.7793	1.0214	0.7918	0.5919	0.2753	0.5179	0.4617
15	0.5942	0.6226	0.5117	0.8028	1.6659	1.077	0.7195	0.4684	2.8233	2.7569	1.4422	2.1081	1.5876	0.3573	0.7854	0.99	0.7109
16	3.9345	4.7362	3.8866	0.7814	3.7166	2.194	1.8122	1.9615	4.0768	3.4633	1.0994	2.2478	0.566	0.281	0.5872	0.815	0.5611
17	2.9262	4.8293	5.5466	12.3735	0.3723	1.3083	1.2808	1.3161	3.6166	1.5502	6.2463	4.0895	0.9408	0.5861	1.0909	0.8046	0.8272
18	1.4584	1.7655	2.2873	2.8419	7.935	0.7704	2.9849	1.8672	4.2204	1.0871	3.2775	2.2993	2.0073	0.7101	0.933	0.8634	0.8355
+gp	1.4584	1.7655	2.2873	2.8419	7.935	0.7704	2.9849	1.8672	4.2204	1.0871	3.2775	2.2993	2.0073	0.7101	0.933	0.8634	
0 REFMEAN	0.1417	0.0963	0.1551	0.0702	0.1192	0.0575	0.0403	0.0534	0.1805	0.1092	0.036	0.032	0.0417	0.0638	0.0833	0.2204	
1																	

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	54512	42369	23726	21986	139481	157630	28082	13407	16699	15301	23914	27190	35158	60079
5	71372	48902	28461	20299	19668	20837	91449	22775	10578	14452	13741	21495	24517	31025
6	102308	63574	41611	22336	13389	7891	12756	70073	17234	9435	13020	12392	19326	21864
7	126077	85067	51950	31060	13534	9200	5589	6406	58995	15028	8433	11766	11019	17119
8	97538	92222	49632	29750	11945	9004	6043	3260	4463	52620	13327	7564	10278	9169
9	62750	65375	38731	23292	9655	6473	5748	3163	1619	3779	46941	11813	5876	8061
10	47563	42978	28438	19001	9965	6738	3432	3723	1501	1194	3018	41910	9323	4490
11	35595	33795	21372	17655	10133	5272	3415	1706	2433	1051	1015	2382	33916	7622
12	27592	23845	19504	13152	10640	4243	2372	1312	814	1994	879	841	1530	27617
13	21843	19057	15284	13074	7663	4384	1979	1065	490	552	1466	687	600	1022
14	20614	13709	11593	10056	7753	2608	2579	872	590	350	457	1076	554	431
15	13086	13056	7239	7743	5958	2578	1546	1452	404	421	269	376	396	442
16	7500	6895	7582	5502	4198	2011	1411	381	1045	340	369	170	279	296
17	6971	3966	3820	5292	3121	1808	1382	484	152	919	276	259	117	196
18	5381	4290	1793	2249	3658	1239	1332	792	310	109	768	184	202	88
+gp	13611	10888	7554	5194	2094	1744	2996	1717	2351	1422	1074	2702	424	528
0 TOTAL	714314	569987	358289	247641	272854	243660	172110	132586	119679	118967	128969	142808	153516	190050

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	2016	2017	2018	2019	GMST 89-**	AMST 89-**
AGE																			
4	104091	148731	159701	288844	228201	318704	279378	203450	95439	67768	55344	28998	19905	14663	11003	6215	0	58573	95455
5	52997	92557	133614	143923	191955	152606	213432	186917	134137	81074	58778	47466	23903	16812	12234	9898	5468	47316	70348
6	27740	46102	79845	120603	92501	128031	101703	142685	120855	114922	69845	49497	37841	17892	11476	10271	7716	39287	56331
7	19328	24833	39260	71597	73980	61331	83678	67012	92206	102665	99655	57297	41055	29446	12458	8538	5004	32837	46950
8	14963	17117	20982	34692	59472	62910	53066	54770	41996	79368	89208	81415	47894	35604	23373	9043	4122	26217	38938
9	7485	13020	14538	17783	29119	51753	54132	34224	35910	36096	69216	74543	69406	42173	30672	19370	6284	19258	30096
10	6334	6235	11200	11764	14901	24385	44521	35095	22356	30871	31504	58754	63777	61832	36342	25849	14923	14040	23100
11	3559	5329	5281	9067	10149	12884	21023	28654	22692	17993	27002	26504	50583	56726	54018	31991	20665	10109	16957
12	6286	2873	4567	3998	7828	8437	11095	13486	18075	18305	15292	23078	22642	44611	49798	46131	27879	7001	12032
13	23259	5392	2406	3314	3388	6357	7273	7066	8584	13457	15035	12924	19706	19853	38700	42466	40429	4763	8471
14	604	19883	4637	1775	2817	2735	5537	4764	4322	6932	9963	12880	11093	17375	17530	32999	36664	3359	6377
15	286	343	17084	3798	1436	2243	2265	3463	2991	3174	5151	8422	10838	9711	15139	15502	26638	2247	4506
16	251	238	293	14279	3248	1065	1907	1475	2264	1586	2073	4252	6844	9178	8589	12831	11277	1501	3105
17	214	130	137	145	12231	1887	850	1188	890	957	959	1732	3440	6048	8157	7400	9701	941	2128
18	130	128	74	52	55	10586	1584	541	743	409	713	666	1321	2993	5272	6739	5608	603	1514
+gp	1495	2296	295	650	505	11330	9190	7382	2991	23068	3298	12897	7160	4011	8384	16933	17708		
0 TOTAL	269021	385207	493914	726283	731785	857245	890633	792172	606452	598644	553036	501325	437408	388927	343146	302177	240087		
1																			

Table 11	Spawning stock number at age (spawning time)		Numbers*10**-3											
YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE														
4	270	164	70	44	120	302	83	39	33	46	95	351	801	1368
5	1344	772	391	216	183	160	806	178	94	115	136	490	826	1015
6	4335	2878	1626	837	507	353	435	2212	392	262	310	442	842	996
7	10206	7740	4521	2561	1087	836	584	560	4151	729	510	826	782	1236
8	12092	13336	7755	4622	1774	1338	987	851	1044	10845	1333	964	1270	1065
9	10471	12477	8561	5267	2092	1292	1277	974	509	980	8652	2168	1196	1471
10	9626	10201	8075	5619	2813	1800	1012	1306	513	367	643	10219	2679	1441
11	10169	10640	7421	6154	3109	1528	1098	640	946	404				
12	10340	9573	8179	5076	3439	1249	799	499	329	815	386	841	11811	2529
13	9744	9029	7509	5831	2763	1412	712	445	211	220	324	321	541	11196
14	9738	6891	6173	4957	3273	1003	1072	372	265	142	641	307	290	379
15	6626	7138	4193	4003	2567	983	608	655	180	169	175	383	232	204
16	3863	3933	4810	4333	3010	1362	684	187	519	146	111	161	176	212
17	3970	2304	2347	3438	1896	1059	770	260	81	455	175	79	125	134
18	2983	2483	1163	1556	2318	765	789	455	154	48	150	135	58	86
+gp	9793	7828	5409	3694	1327	1186	2048	1184	1554	913	357	88	95	45
											674	1759	249	335

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	2015	2016	2017	2018
AGE																
4	2475	3244	4751	9225	6408	7716	4329	3149	1507	1273	820	286	118	72	44	0
5	1730	2927	5831	6390	8363	5614	7027	5235	4240	2483	1681	1119	467	294	145	49
6	1402	2230	5145	7307	7071	11261	10328	12952	8947	6590	3919	2487	1743	852	448	378
7	1570	2328	4432	9453	12634	10670	15854	10458	13848	11776	15591	8698	5439	2804	947	693
8	1835	2703	4017	8108	17115	18212	16857	18056	13526	21588	25150	22427	11615	5629	3200	1247
9	1372	2907	3931	6470	12546	21885	21961	13661	14865	15032	31766	33202	25650	11919	7836	5160
10	1899	1809	3733	5743	8528	14386	22779	16607	11139	15698	19078	34136	33360	25446	12519	8455
11	1382	2305	2386	5350	6470	8861	12681	16764	12491	10248	16212	15599	27492	27395	23683	12941
12	2893	1479	2248	2454	5127	5736	6464	7895	11051	11947	10260	15017	13555	23994	25617	22276
13	11094	2520	1310	2120	2358	4999	5175	4674	5198	8487	10573	8592	11978	11794	24607	26987
14	284	11000	2528	1270	2022	2053	3744	3314	2893	4834	6842	8982	7287	12356	12862	25043
15	181	228	11502	2671	994	1521	1499	2474	2092	2178	3728	5600	7561	6164	10384	9113
16	137	144	152	7898	1655	666	1236	1052	1511	1083	1557	2968	5103	7355	7740	11217
17	111	73	76	89	7290	1323	557	996	715	833	753	1158	2453	4313	6258	5038
18	82	88	55	38	39	7796	1232	463	548	324	497	478	979	2440	4330	5064
+gp	904	1494	199	483	334	7616	5712	5745	2176	18505	2594	9572	5574	3164	7109	13351
1																

Table 12	Stock biomass at age (start of year)			Tonnes										
YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE														
4	5451	4110	2586	2111	9206	14187	2864	1059	1503	1362	2081	2637	2988	6068
5	11705	8362	3842	3471	3068	2709	10334	3143	1343	1994	1663	2837	3432	4095
6	20973	13478	8905	4646	2838	1783	2768	9880	3275	1708	2292	2156	3459	4023
7	31267	22202	14338	9070	3884	2539	1610	1730	10265	3441	1881	2753	2623	3886
8	27701	27574	16726	10532	4360	3133	2157	1069	1584	11682	3465	2156	3053	2586
9	19892	21639	14912	9224	3814	2557	2328	1215	657	1402	11548	3887	1927	2604
10	16600	15515	13223	8589	4325	3126	1565	1649	699	504	975	12447	3580	1751
11	15342	14971	11006	9269	5198	2599	1755	819	1229	515	480	996	11532	3110
12	14100	12495	11098	7510	5895	2249	1295	700	466	1096	496	444	790	10992
13	12298	11091	9415	8302	4782	2407	1251	618	299	344	752	459	359	573
14	12080	8253	7524	6838	5326	1755	1811	523	366	241	252	607	367	257
15	8257	8512	5068	5451	4254	1699	1122	942	276	300	146	187	264	278
16	4822	4606	5906	4440	3656	1446	1145	265	779	275	204	114	172	213
17	4922	2899	2919	4070	2662	1476	1136	366	120	764	177	186	90	126
18	3783	3118	1423	1976	3171	1056	1157	629	235	80	473	132	172	79
+gp	11978	10017	6738	4846	2306	1591	3196	1641	2193	1568	823	2027	428	503
0 TOTALBIO	221169	188843	135629	100343	68745	46311	37495	26248	25291	27278	27705	34026	35237	41143

Table 12	Stock biomass at age (start of year)		Tonnes												
YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
AGE																
4	7911	13981	14693	25418	24874	32189	32687	24007	13171	8132	6309	3712	2408	1686	1144	566
5	5777	11107	15900	16407	23035	19839	28387	28224	20925	12891	9581	7784	4016	2724	1749	1307
6	4466	7515	13254	18935	12673	21509	18001	25969	22842	22295	13969	10840	7985	3668	2364	1962
7	4194	5488	8402	15393	15166	13370	15899	14676	19824	23100	24615	15642	11537	7774	3152	2015
8	3950	4759	5728	9193	14868	17300	12046	14405	12305	20001	25335	25239	14895	11251	6544	2559
9	2403	4466	4928	5993	9143	16820	14074	9925	11132	10684	23187	25717	24847	14760	10214	6566
10	2248	2357	4245	4717	5916	8998	14202	11406	7020	10805	11436	24266	25957	23805	12974	8814
11	1470	2366	2424	3908	4638	5347	8325	10430	8237	6280	10423	10310	20840	23371	20257	11645
12	2904	1431	2197	1715	4071	3695	3617	5219	7447	7414	6408	9716	10121	19361	19421	18360
13	8164	2982	1112	1630	1836	2810	3949	3229	2893	6015	7157	6358	8454	9073	16486	18940
14	337	8470	2741	946	1518	1346	2414	2148	1932	2932	4673	6724	5912	8062	8782	15213
15	167	218	8576	2233	751	1272	1078	2154	1232	1508	2370	4438	4920	5360	6207	6929
16	160	163	208	6026	1296	644	956	777	989	769	993	2143	3669	5975	4793	6890
17	109	71	99	80	5981	1115	574	562	518	568	506	1020	1847	3901	3662	3426
18	90	97	67	44	40	4743	1294	280	362	180	398	384	719	2110	2647	3195
+gp	1127	1733	256	502	279	8713	4889	3817	1720	11188	1807	7790	5084	2908	4653	8229
0 TOTALBIO	45477	67202	84828	113141	126084	159710	162393	157228	132550	144760	149166	162083	153211	145789	125051	116616
1																

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	16	8	4	8	27	8	3	3	4	8	34	68	138
5	220	132	53	37	29	21	91	25	12	16	16	65	116	134
6	889	610	348	174	107	80	94	312	74	47	55	77	151	183
7	2531	2020	1248	748	312	231	168	151	722	167	114	193	186	281
8	3434	3987	2613	1636	648	466	352	279	371	2408	347	275	377	300
9	3319	4130	3296	2086	826	510	517	374	207	364	2128	713	392	475
10	3360	3683	3755	2540	1221	835	462	579	239	155	208	3035	1029	562
11	4383	4714	3822	3231	1595	753	564	307	478	198	183	352	4016	1032
12	5284	5016	4654	2898	1905	662	436	266	189	448	183	169	279	4456
13	5486	5255	4625	3702	1724	775	450	258	129	137	329	205	173	213
14	5707	4148	4007	3371	2248	675	752	223	165	97	97	216	154	122
15	4181	4654	2935	2818	1833	647	441	425	123	121	60	80	117	133
16	2484	2627	3747	3497	2622	979	555	131	387	118	97	53	77	96
17	2803	1684	1793	2643	1617	864	633	196	64	378	96	97	44	55
18	2097	1805	924	1368	2010	652	686	361	117	35	219	63	81	40
+gp	8618	7202	4825	3447	1461	1082	2185	1132	1449	1007	517	1319	252	319
0 TOTSPBIO	54822	51683	42652	34200	20166	9260	8396	5021	4728	5699	4656	6945	7512	8539

Table 13	Spawning stock biomass at age (spawning time)			Tonnes												
YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
AGE																
4	188	305	437	812	698	779	506	372	208	153	93	37	14	8	5	0
5	189	351	694	729	1004	730	935	790	661	395	274	183	78	48	21	6
6	226	364	854	1147	969	1892	1828	2357	1691	1278	784	545	368	175	92	72
7	341	514	948	2032	2590	2326	3012	2290	2977	2650	3851	2375	1528	740	240	163
8	484	751	1097	2148	4279	5008	3826	4749	3963	5440	7142	6952	3612	1779	896	353
9	440	997	1333	2180	3939	7113	5710	3962	4608	4449	10642	11455	9183	4172	2609	1749
10	674	684	1415	2303	3386	5309	7266	5397	3498	5494	6925	14098	13578	9797	4469	2883
11	571	1024	1095	2306	2957	3677	5022	6102	4534	3576	6258	6068	11327	11287	8881	4711
12	1337	736	1081	1053	2666	2512	2107	3055	4553	4839	4299	6322	6059	10413	9990	8866
13	3894	1393	605	1043	1278	2209	2810	2136	1752	3794	5033	4227	5139	5390	10483	12036
14	159	4686	1494	677	1090	1010	1632	1494	1293	2045	3209	4688	3884	5733	6444	11545
15	106	145	5774	1570	520	862	714	1539	862	1034	1715	2951	3433	3402	4257	4073
16	88	99	108	3333	660	403	619	555	660	525	746	1496	2735	4788	4319	6024
17	57	40	55	49	3565	782	377	471	416	494	398	682	1317	2782	2810	2332
18	57	66	50	32	28	3493	1007	240	267	143	277	276	533	1720	2174	2400
+gp	682	1128	173	373	185	5857	3039	2970	1251	8975	1422	5782	3958	2294	3945	6489
0 TOTSPBIO	9490	13284	17213	21787	29813	43963	40410	38479	33196	45284	53067	68136	66746	64527	61635	63703
1																

Table 16 Summary (without SOP correction)							
Terminal Fs derived using XSA (Without F shrinkage)							
	RECRUITS	TOTALBIO	TOTABUND	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 6-16
	Age 4						
1989	54512	221169	714314	54822	58086	1.0595	0.3172
1990	42369	188843	569987	51683	80223	1.5522	0.4821
1991	23726	135629	358289	42652	48500	1.1371	0.367
1992	21986	100343	247641	34200	43300	1.2661	0.5665
1993	139481	68745	272854	20166	43100	2.1373	0.6506
1994	157630	46311	243660	9260	17664	1.9076	0.4565
1995	28082	37495	172110	8396	13879	1.653	0.6846
1996	13407	26248	132586	5021	6101	1.215	0.512
1997	16699	25291	119679	4728	1408	0.2978	0.1401
1998	15301	27278	118967	5699	1011	0.1774	0.0828
1999	23914	27705	128969	4656	1095	0.2352	0.1214
2000	27190	34026	142808	6945	3841	0.553	0.2288
2001	35158	35237	153516	7512	3327	0.4429	0.1571
2002	60079	41143	190050	8539	2964	0.3471	0.1842
2003	104091	45477	269021	9490	2273	0.2395	0.1417
2004	148731	67202	385207	13284	3260	0.2454	0.0963
2005	159701	84828	493914	17213	4039	0.2346	0.1551
2006	288844	113141	726283	21787	5936	0.2725	0.0702
2007	228201	126084	731785	29813	5131	0.1721	0.1192
2008	318704	159710	857245	43963	4274	0.0972	0.0575
2009	279378	162393	890633	40410	3639	0.0901	0.0403
2010	203450	157228	792172	38479	5235	0.136	0.0534
2011	95439	132550	606452	33196	8904	0.2682	0.1805
2012	67768	144760	598644	45284	6736	0.1487	0.1092
2013	55344	149166	553036	53067	5133	0.0967	0.036
2014	28998	162083	501325	68136	4507	0.0661	0.032
2015	19905	153211	437408	66746	5169	0.0774	0.0417
2016	14663	145789	388927	64527	6147	0.0953	0.0638
2017	11003	125051	343146	61635	6914	0.1122	0.0833
2018	6215	116616	302177	63703	10328	0.1621	0.2204
Arith.							
Mean	89666	102025	414760	31167	13737	0.5499	0.215
0 Units	(Thousands)	(Tonnes)	(Thousands)	(Tonnes)	(Tonnes)		
1							

Table 14. 2019 yield per recruit parameters

Age	mean weights 2016-2018			% mat females	PR	Ref. M
	stock	catch	stock mat f	2016-2018	2016-2018	2015-2018
4	0.103	0.106	0.116	0.003	0.490	0.10
5	0.146	0.141	0.167	0.012	1.999	0.10
6	0.201	0.176	0.215	0.042	3.089	0.10
7	0.251	0.217	0.260	0.087	2.517	0.10
8	0.293	0.249	0.307	0.147	1.007	0.10
9	0.341	0.295	0.361	0.272	0.783	0.10
10	0.361	0.318	0.387	0.366	0.481	0.10
11	0.384	0.337	0.406	0.447	0.446	0.10
12	0.408	0.361	0.430	0.518	0.506	0.10
13	0.443	0.400	0.462	0.629	0.436	0.10
14	0.475	0.422	0.487	0.744	0.462	0.10
15	0.470	0.424	0.500	0.646	0.711	0.10
16	0.582	0.505	0.587	0.872	0.561	0.10
17	0.519	0.470	0.536	0.732	0.827	0.10
18	0.560	0.499	0.571	0.809	0.836	0.10
19	0.588	0.604	0.597	0.821	0.836	0.10
20	0.588	0.604	0.597	0.821	0.836	0.10
21	0.588	0.604	0.597	0.821	0.836	0.10
22	0.588	0.604	0.597	0.821	0.836	0.10
23	0.588	0.604	0.597	0.821	0.836	0.10
24	0.588	0.604	0.597	0.821	0.836	0.10
25	0.588	0.604	0.597	0.821	0.836	0.10
26	0.588	0.604	0.597	0.821	0.836	0.10
27	0.588	0.604	0.597	0.821	0.836	0.10
28	0.588	0.604	0.597	0.821	0.836	0.10
29	0.588	0.604	0.597	0.821	0.836	0.10
30	0.588	0.604	0.597	0.821	0.836	0.10

Table 15. red.srr file

```
5                Nparams
5                Geometric mean model
14.754           2015-2017 age 4 XSA geomean in millions
0.00000E+000
0.00000E+000
0
0.00000E+000
3                Ndata log residuals
0.299
-0.006
-0.293
0                No extra data
```

Table 15b. An explanation of the red.sen file input data with an exploitation pattern corresponding to F*statusquo*

N4=2015-2017 age 4 XSA geometric mean low recruitments											
F@age2019-2021=Fbar2018x averagePR@age2016-2018											
M@age2019=0.10											
M@age2020-2021=0.10 with a CV=0.014 (0.12>=M=>0.08)											
Name	Value	C.V.	Name	Value	C.V.	Name	Value	C.V.	Name	Value	C.V.
Population at age at the beginning of 2020			Exploitation pattern (H - Human consumption)			Exploitation pattern (D - Discards)			Exploitation pattern (I - Industrials)		
'N4'	14754	0.798	'sH4'	0.1079	0.039	'sD4'	0.00	0.00	'sI4'	0.00	0.00
'N5'	11984	0.649	'sH5'	0.4406	0.105	'sD5'	0.00	0.00	'sI5'	0.00	0.00
'N6'	3185	0.509	'sH6'	0.6809	0.228	'sD6'	0.00	0.00	'sI6'	0.00	0.00
'N7'	3534	0.393	'sH7'	0.5548	0.265	'sD7'	0.00	0.00	'sI7'	0.00	0.00
'N8'	2600	0.339	'sH8'	0.2220	0.114	'sD8'	0.00	0.00	'sI8'	0.00	0.00
'N9'	2987	0.297	'sH9'	0.1725	0.059	'sD9'	0.00	0.00	'sI9'	0.00	0.00
'N10'	4785	0.273	'sH10'	0.1060	0.054	'sD10'	0.00	0.00	'sI10'	0.00	0.00
'N11'	12145	0.247	'sH11'	0.0984	0.014	'sD11'	0.00	0.00	'sI11'	0.00	0.00
'N12'	16946	0.232	'sH12'	0.1115	0.014	'sD12'	0.00	0.00	'sI12'	0.00	0.00
'N13'	22564	0.217	'sH13'	0.0962	0.018	'sD13'	0.00	0.00	'sI13'	0.00	0.00
'N14'	33227	0.206	'sH14'	0.1018	0.049	'sD14'	0.00	0.00	'sI14'	0.00	0.00
'N15'	29965	0.200	'sH15'	0.1567	0.103	'sD15'	0.00	0.00	'sI15'	0.00	0.00
'N16'	20608	0.193	'sH16'	0.1237	0.086	'sD16'	0.00	0.00	'sI16'	0.00	0.00
'N17'	9017	0.190	'sH17'	0.1823	0.071	'sD17'	0.00	0.00	'sI17'	0.00	0.00
'N18'	7315	0.180	'sH18'	0.1841	0.076	'sD18'	0.00	0.00	'sI18'	0.00	0.00
'N19'	4221	0.180	'sH19'	0.1841	0.076	'sD19'	0.00	0.00	'sI19'	0.00	0.00
Stock weight at age			Catch weight at age (H - Human consumption)			Catch weight at age (D - Discards)			Catch weight at age (I - Industrials)		
'WS4'	0.116	0.010	'WH4'	0.106	0.015	'WD4'	0.00	0.00	'WI4'	0.00	0.00
'WS5'	0.167	0.016	'WH5'	0.141	0.019	'WD5'	0.00	0.00	'WI5'	0.00	0.00
'WS6'	0.215	0.002	'WH6'	0.176	0.017	'WD6'	0.00	0.00	'WI6'	0.00	0.00
'WS7'	0.260	0.009	'WH7'	0.217	0.020	'WD7'	0.00	0.00	'WI7'	0.00	0.00
'WS8'	0.307	0.028	'WH8'	0.249	0.024	'WD8'	0.00	0.00	'WI8'	0.00	0.00
'WS9'	0.361	0.014	'WH9'	0.295	0.022	'WD9'	0.00	0.00	'WI9'	0.00	0.00
'WS10'	0.387	0.029	'WH10'	0.318	0.041	'WD10'	0.00	0.00	'WI10'	0.00	0.00
'WS11'	0.406	0.023	'WH11'	0.337	0.041	'WD11'	0.00	0.00	'WI11'	0.00	0.00
'WS12'	0.430	0.023	'WH12'	0.361	0.035	'WD12'	0.00	0.00	'WI12'	0.00	0.00
'WS13'	0.462	0.018	'WH13'	0.400	0.032	'WD13'	0.00	0.00	'WI13'	0.00	0.00
'WS14'	0.487	0.014	'WH14'	0.422	0.047	'WD14'	0.00	0.00	'WI14'	0.00	0.00
'WS15'	0.500	0.048	'WH15'	0.424	0.065	'WD15'	0.00	0.00	'WI15'	0.00	0.00
'WS16'	0.587	0.056	'WH16'	0.505	0.063	'WD16'	0.00	0.00	'WI16'	0.00	0.00
'WS17'	0.536	0.095	'WH17'	0.470	0.091	'WD17'	0.00	0.00	'WI17'	0.00	0.00
'WS18'	0.571	0.117	'WH18'	0.499	0.108	'WD18'	0.00	0.00	'WI18'	0.00	0.00
'WS19'	0.597	0.113	'WH19'	0.604	0.190	'WD19'	0.00	0.00	'WI19'	0.00	0.00

Natural mortality at age				Maturity		
'M4'	0.1	0.014		'MT4'	0.003	0.002
'M5'	0.1	0.014		'MT5'	0.012	0.006
'M6'	0.1	0.014		'MT6'	0.042	0.005
'M7'	0.1	0.014		'MT7'	0.087	0.010
'M8'	0.1	0.014		'MT8'	0.147	0.011
'M9'	0.1	0.014		'MT9'	0.272	0.013
'M10'	0.1	0.014		'MT10'	0.366	0.044
'M11'	0.1	0.014		'MT11'	0.447	0.039
'M12'	0.1	0.014		'MT12'	0.518	0.028
'M13'	0.1	0.014		'MT13'	0.629	0.025
'M14'	0.1	0.014		'MT14'	0.744	0.026
'M15'	0.1	0.014		'MT15'	0.646	0.046
'M16'	0.1	0.014		'MT16'	0.872	0.055
'M17'	0.1	0.014		'MT17'	0.732	0.042
'M18'	0.1	0.014		'MT18'	0.809	0.035
'M19'	0.1	0.014		'MT19'	0.821	0.033
Natural mortality multiplier in year				Effort multiplier in year		
				(H - Human consumption)		
'K2018'	1	0.0		'HF2016'	1.0	0.0
'K2019'	1	0.0		'HF2017'	1.0	0.0
'K2020'	1	0.0		'HF2018'	1.0	0.0

Table 16a: SSB 50% probability profiles under under several F options, 2020-2029.

	SSB 50th %ile			
Year	F_0	Fstatusquo	$F_{0.1}$	F_{max}
2020	55768	55768	55768	55768
2021	56783	49656	53703	50617
2022	**56753**	**43021**	**50573**	**44764**
2023	55051	35566	45822	37850
2024	53748	29207	41526	31828
2025	52290	23511	37200	26312
2026	50011	18552	32881	21331
2027	48212	14652	29116	17314
2028	46432	11572	25785	14074
2029	45144	9181	23020	11500

Table 16b: Short term projections (50th %ile and 10%ile) for female SSB (beginning 2022) and average 2020-2021 yield (50%ile) under several F options.

SSB			F_0	$F_{statusquo}$	$F_{0.1}$	F_{max}
$2022_{90th\ \%\ ile}$			62981	47816	56165	49757
$2022_{50th\ \%\ ile}$			**56753**	**43021**	**50573**	**44764**
$2022_{10h\ \%\ ile}$			51619	39130	46050	40713
2018	63703	$B_{2022}/B_{2018\ 90\%ile}$	-1.1%	-33.2%	-13.4%	-28.0%
		$B_{2022}/B_{2018\ 50\%il}$	**-12.2%**	**-48.1%**	**-26.0%**	**-42.3%**
		$B_{2022}/B_{2018\ 10\%ile}$	-23.4%	-62.8%	-38.3%	-56.5%
Yield $_{beaked\ redfish}$			F0	$F_{statusquo}$	$F_{0.1}$	F_{max}
$2020\text{-}2021_{50th\ \%\ ile}$				9472	4362	8310
2018	10330					
TAC						
2020-2021				**9710**	**4472**	**8519**
2018	10500					

average beaked redfish proportion in the 2017-2018 3M redfish catch 0.98

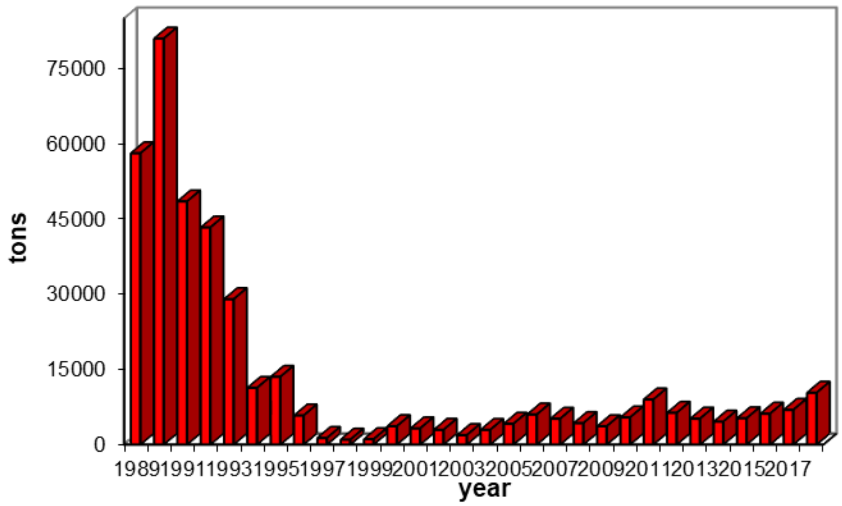


Fig. 1a: Beaked redfish commercial catch.

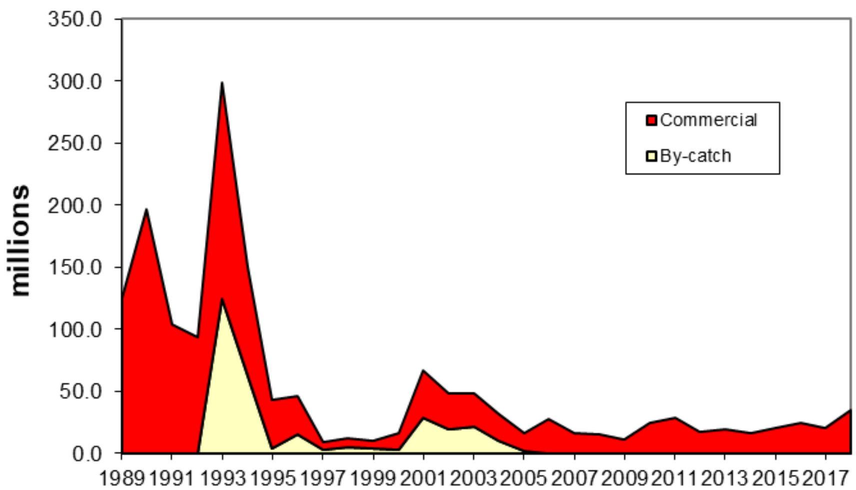


Fig. 1b: Beaked redfish commercial catch and by-catch in numbers

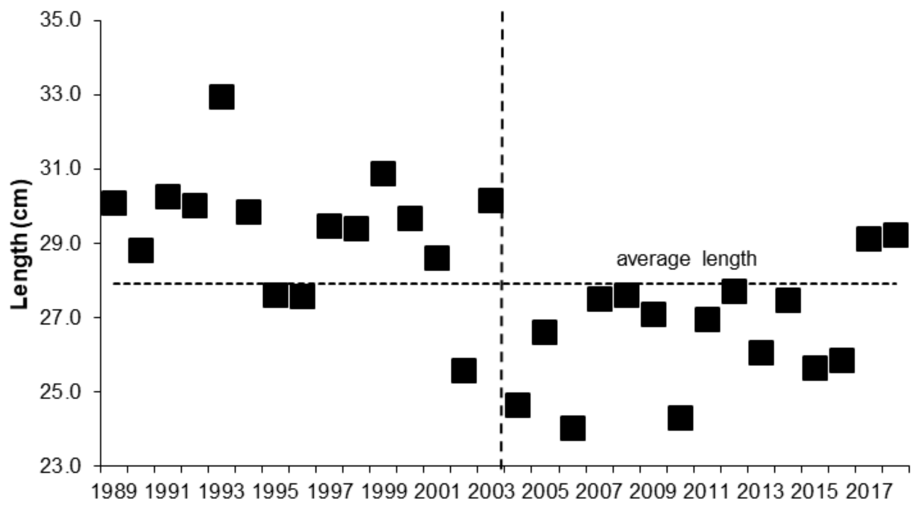


Fig. 2: Mean length of the commercial catch, 1989-2018

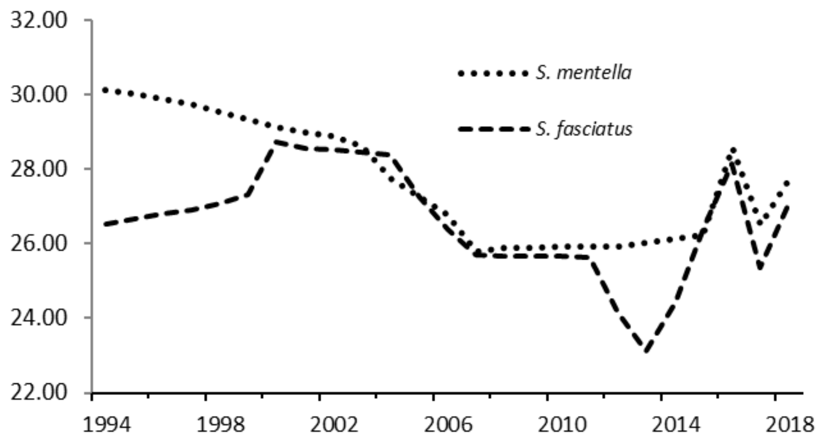


Fig. 3: 3M *S. mentella* and *S. fasciatus* mean length at maturity 1994-2018

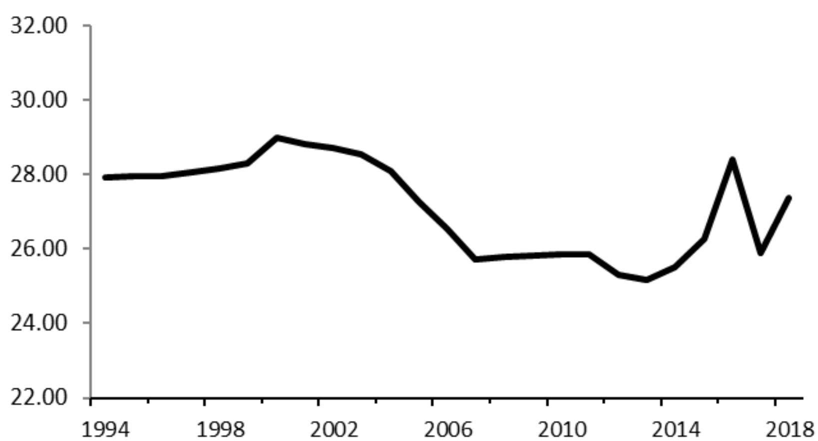


Fig. 4: 3M beaked redfish mean length at maturity 1994-2018

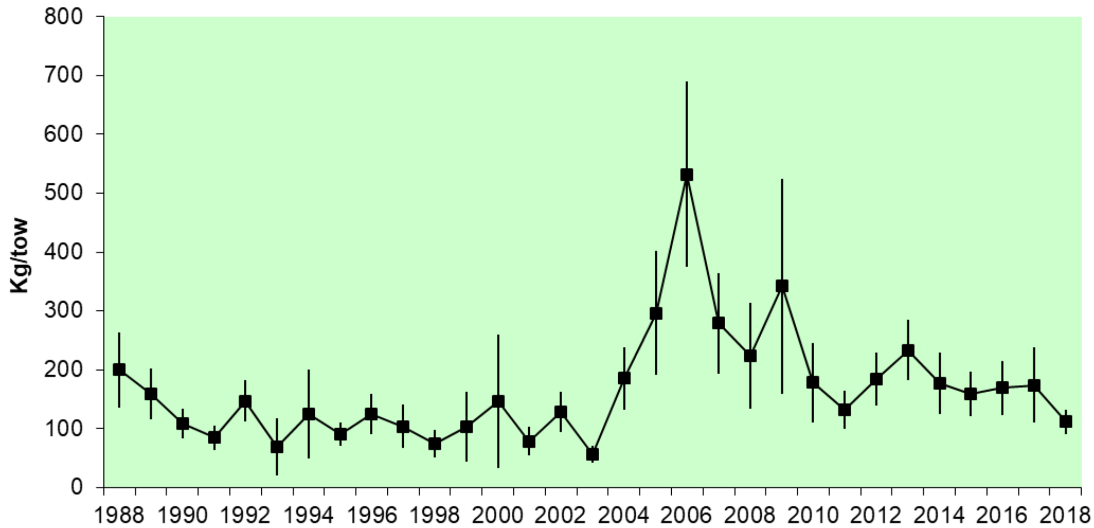


Fig. 5: mean catch per tow for 3M beaked refish (EU survey, 1988-2018) with associated +/- 1.96 se

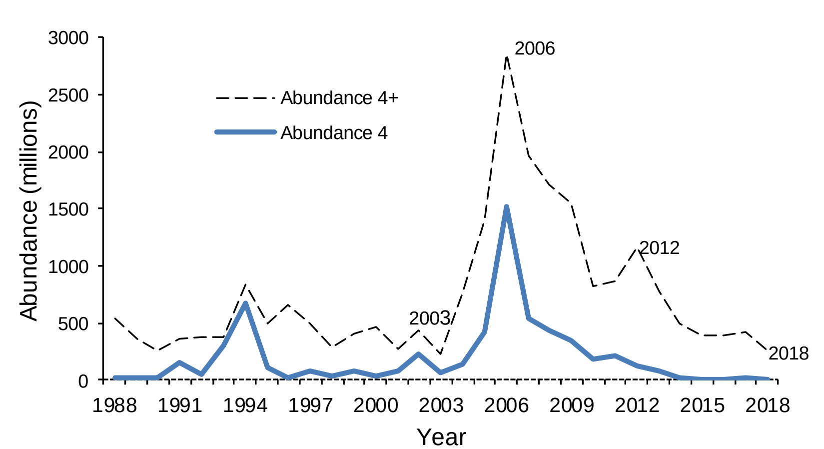


Fig 6a: 4 and 4+ abundance from EU survey, 1988-2018

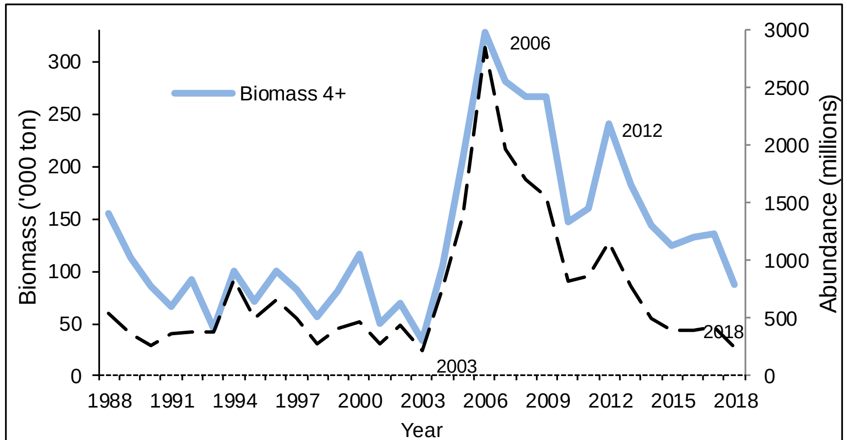


Fig 6c: 4 and 4+ biomass and abundance from EU survey, 1988-2018

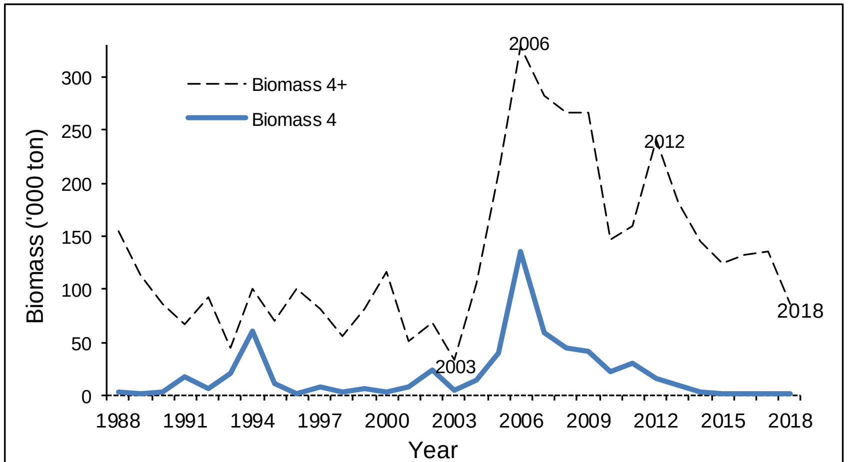


Fig 6b: 4 and 4+ biomass from EU survey, 1988-2018

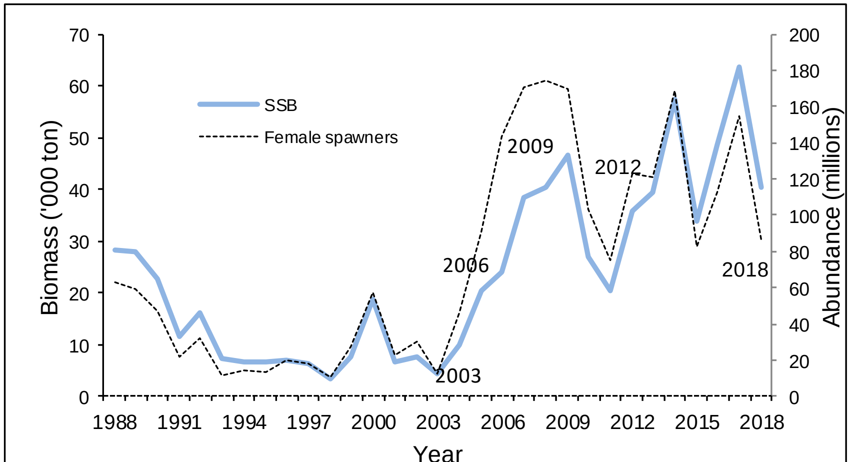


Fig 6d: SSB and Female spawners from EU survey, 1988-2018

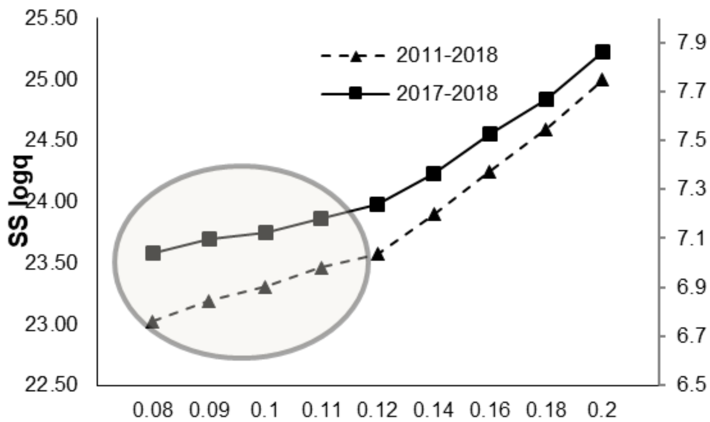


Fig 7a: XSA_{2019} $SS_{2011\text{-}2018}$ and $SS_{2017\text{-}2018}$ log q residuals for a set of 2017-2018 M candidates

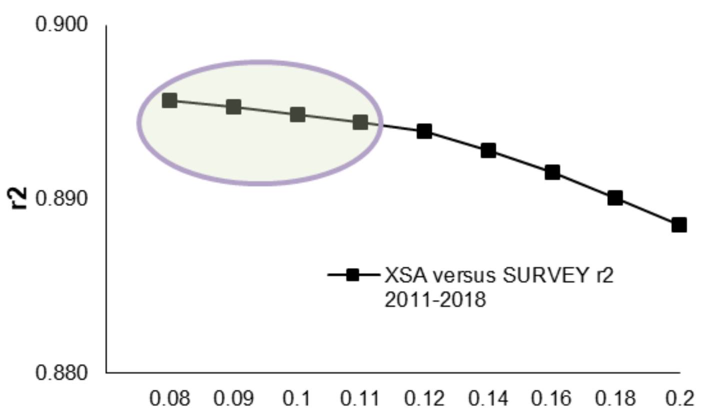


Fig7b: 2011-2016 correlation between XSA_{2019} versus Survey 4+abundance for a set of 2017-2018 M candidates

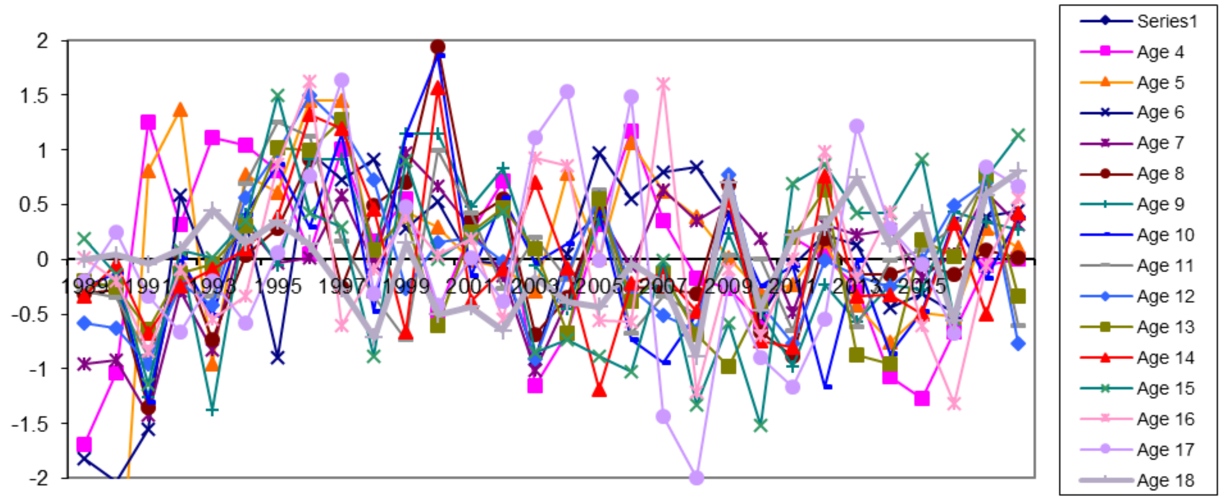


Fig 8a: EU survey log q residuals by age and by year, 1989-2018

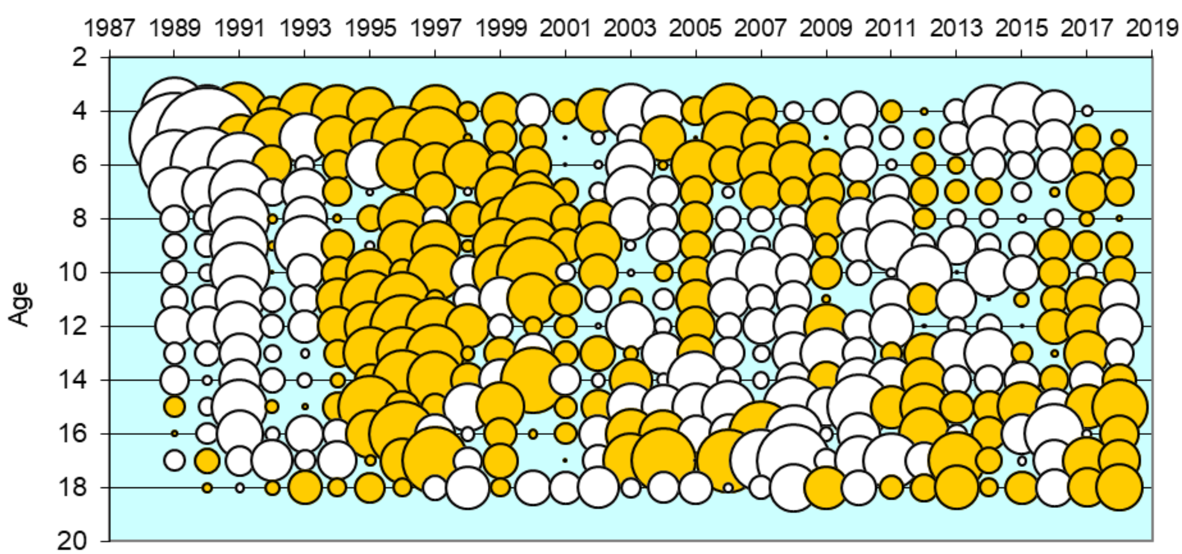


Fig. 8b: Log q residuals by age and year, 1989-2018

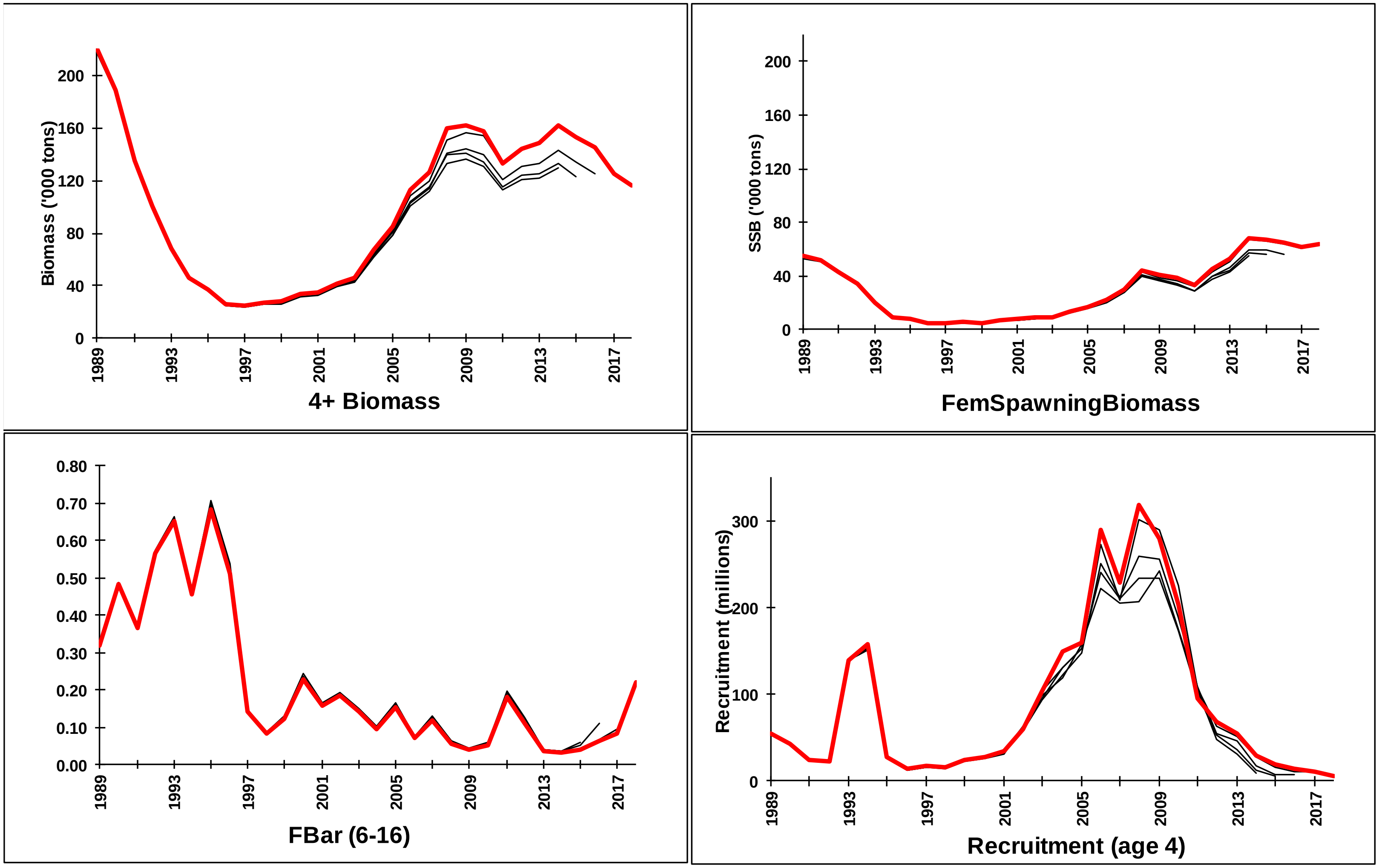
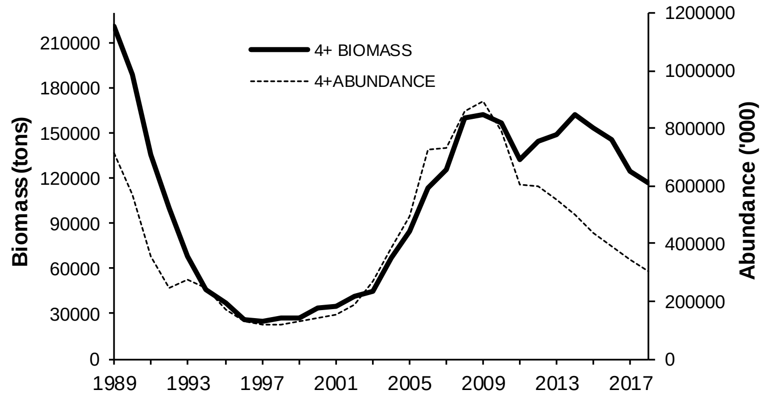
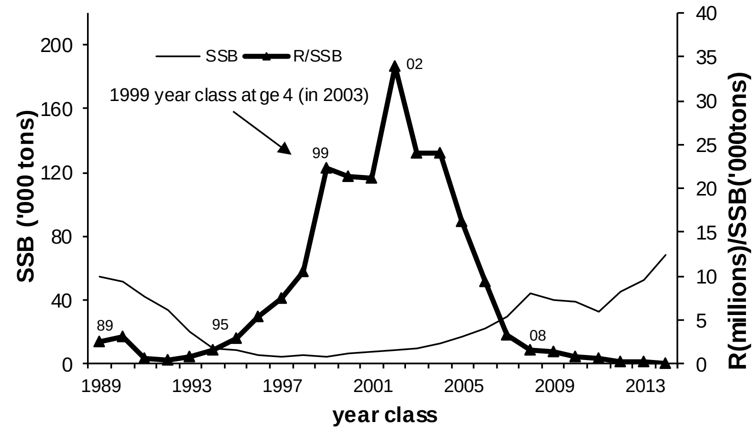


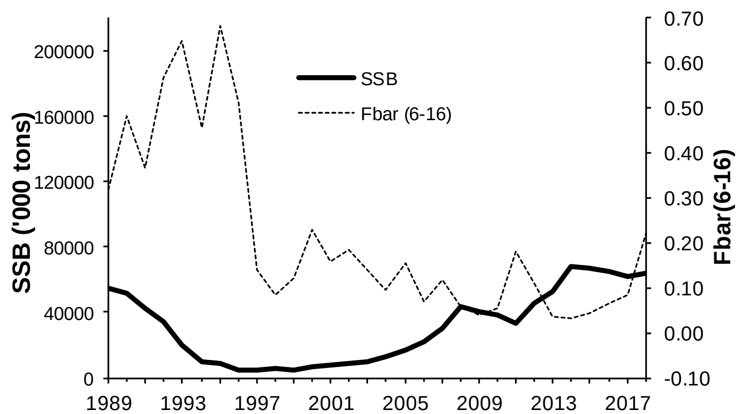
Fig. 9: Main results of retrospective 2019 XSA2018-2014



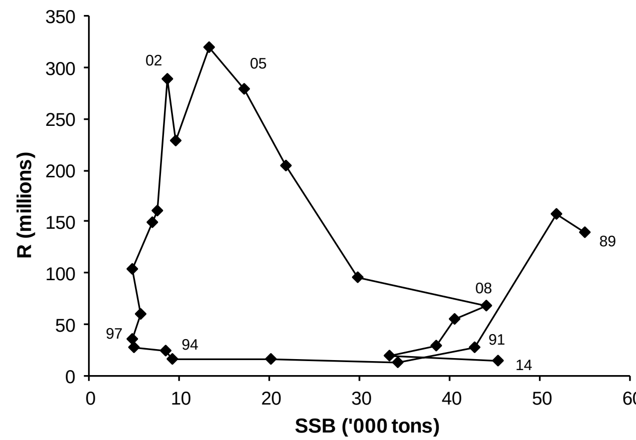
4+Biomass vs 4+Abundance from XSA 2019



Recruitment (age 4)/Spawning Fembiomass from XSA2019



SpawningFembiomass vs FBar from XSA2019



SR plot from XSA2019

Fig. 10: XSA results for 2019 assessment.

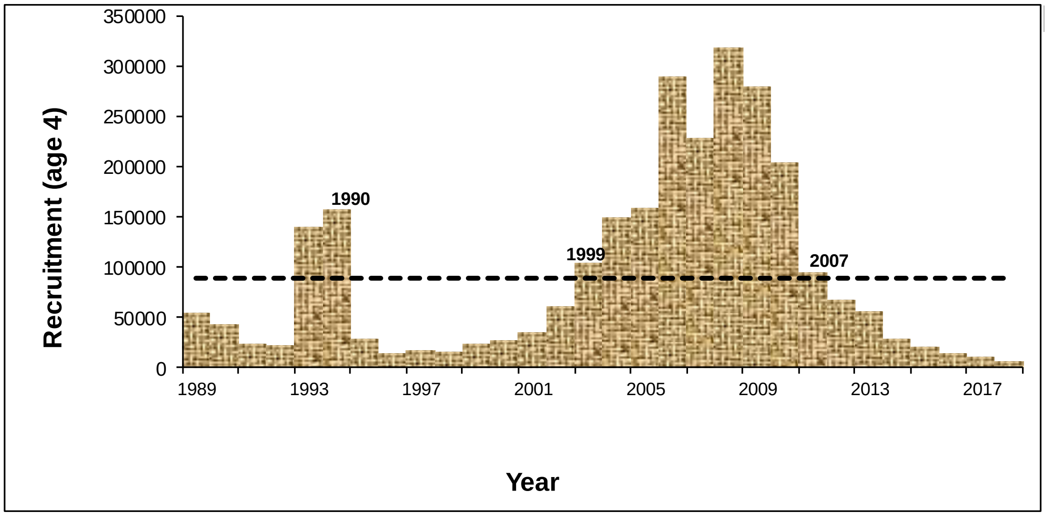


Fig. 11: Year Class strength at recruitment from 2019 XSA.

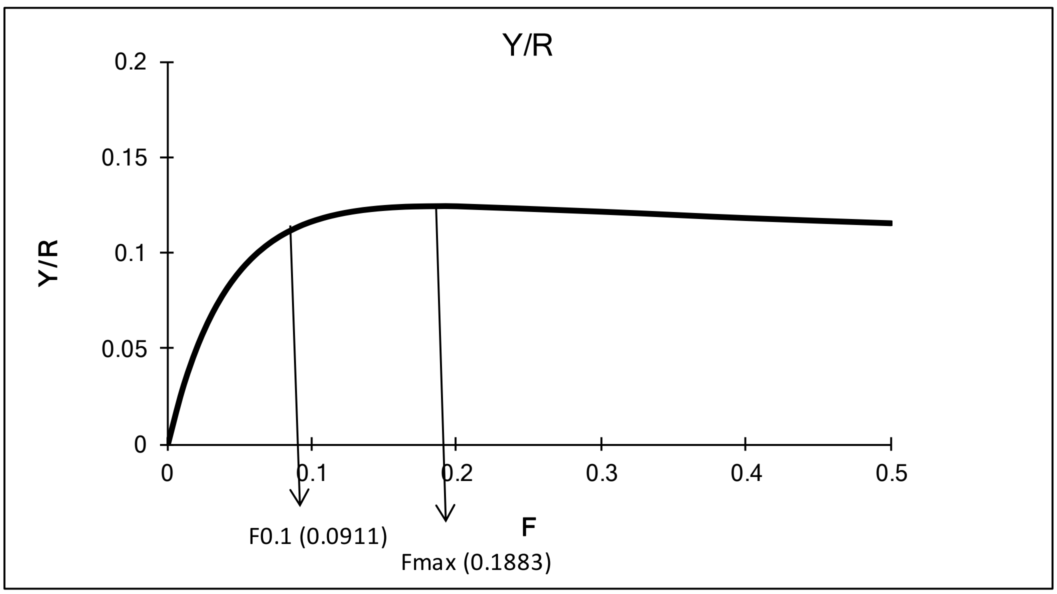


Fig. 12 Beaked redfish in Div. 3M: yield per recruit analysis at M=0.10 (20216-2018 average inputs)

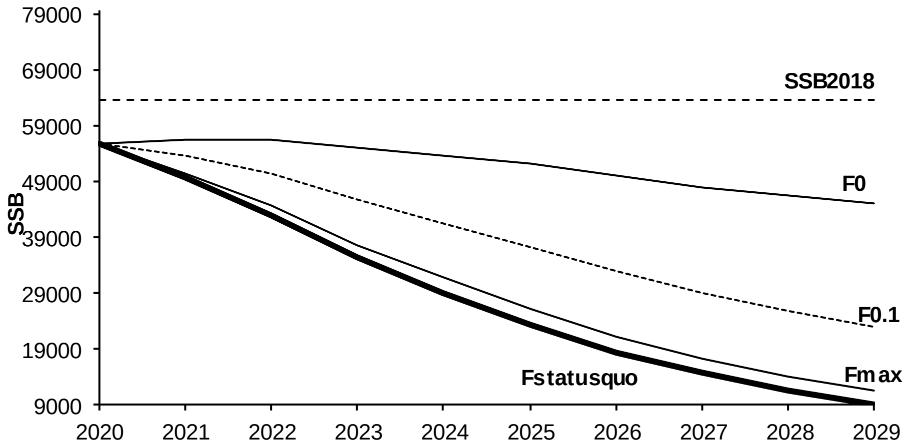


Fig 13 : SSB 50% probability profiles under several F options