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An assessment of beaked redfish (*S. mentella* and *S. fasciatus*) in NAFO Division 3M (an update using the same approach as last assessment in 2019)

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. norvegicus*) 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. norvegicus*) and beaked (*S. mentella* and *S. fasciatus*) redfish catches.

The Extended Survivor Analysis assessment used as tuning file the 1989-2020 EU survey abundance at age matrix. Continuing pressure over Flemish Cap redfish stocks by increasing cod predation led 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 onwards were found to be the most suitable option to the *M* input vector. The 2021 *M* sensitivity analysis was not to track a best value for *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 2015 -2020 kept at 0.10.

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. Abundance decline is more pronounced. These declines were halted in 2020. Recruitment to exploitable stock is declining continuously since 2009 and was in 2017-2019 at an historic minimum level. The recruitment estimate for 2020 is high but associated with high uncertainty. Natural mortality has stayed on recent years (2015-2020) at 0.1. Between 1989-1993 very high commercial catches led to high fishing mortalities through the first half of the 1990's. Fishing mortality fell until 1997 and fluctuated between low and average levels since then. Fishing mortality remains relatively low compared to the 1980s and 1990s.

The yield per recruit was revised and the $F_{0.1}$ reference point used for short- and medium-term 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 six options for fishing mortality: F_0 - No fishing, $F_{0.1}$, $F_{statusquo}$, $F=M=0.1$, 1.25 TAC and 0.75 TAC ($F_{0.1}$ given by the revised yield per recruit analysis). With the exception of the F_0 scenario, for all other five projection scenarios, the SSB is projected to decline, and to be at around the average for the assessment time-series (since the late 1980s) by 2024. The results of the medium-term projections indicate a pattern similar to that of the short-term projections.

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 norvegicus*) 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, 1988-2020) 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 1989-2020 redfish (beaked and *S. norvegicus* redfish) nominal catch is presented on Table 1a. STACFIS catch estimates were available till 2010. Over 2006-2010 an average annual bias of 15% plus was recorded between STACFIS 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 2011 and 2014. For 2015 the annual catch was given by the Daily Catch Reports (DCR's) by country provided by the NAFO Secretariat (Blasdale 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 2020 catch estimates were obtained with the application of the CESAG method (COM-SC CESAG-WP 18-01REV2, COM-SC CESAG-WP 19-03 (Revised), COM-SC CESAG-WP 20-05 REV and COM-SC CESAG-WP 21-05). The 1989-2020 catch estimates from those different sources are accepted as the 3M redfish landings and assembled on Table 1b.

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 1b, Figure 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 of 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). In 2018-2019 catches were around respective TAC of 10,500 tons. In 2020 catches decreased (to 8,773 tons) following the decrease in the TAC to 8,500 tons (Tables 1b). EU-Portugal,

EU-Spain, the Russian Federation and EU-Estonia 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 times increase in bottom biomass of both golden and Acadian redfish (Casas and González-Troncoso, 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 (below 700m, 100% deep sea redfish).

From 2005 onwards, the no neglect proportion of golden redfish forced the development of a method, using the information on distribution of redfish species by depth of the EU survey (González-Troncoso *pers. comm.*), to split into golden and beaked redfish the annual redfish catches by depth of Portugal, Russia (Pochtar and Fromin *pers. comm.*) and Spain (González-Costas *pers. comm.*). 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.

The beaked redfish catch estimates used in the assessment are on Table 1b and Figure 1a. On Table 1c are tabulated the golden and beaked redfish proportions in weight, and by depth, found in the 2005-2020 EU surveys (González-Troncoso, *pers. comm.*, 2009-2020; 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 1,006 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 tons in 2005 (Table 1d) 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 1e and Figure 1b). From 2006 onwards the beaked redfish catch corresponds to the commercial catch only.

Length composition of the commercial catch and by-catch

1998-2004, 2006-2010 and 2012-2020 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 2013-2021) 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 2005 and 2011, the 2004 and 2010 length weight relationship was applied to the 2005 and 2011 catch respectively. The 1993-2004 beaked redfish length weight relationships from the EU surveys (Table 2b: González-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 at 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 at length substitute the Portuguese relative catch at length as regards the length distributions for other countries estimated catches on those years. Depth distribution of Portuguese redfish catches went back to normal on 2017-2020 and so Portuguese length sampling return to be applied to other countries but Spain and Russia on 2017 and including Russia on 2018. In 2020 due to the lack of sampling from Spain the Portuguese length was applied to all countries unless Russia.

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 25-33cm (Table 3b, Figure 2a). Smaller sizes (<22cm corresponding to less than age 5 – Figure 2b) increase their presence in the commercial catch afterwards, being responsible of bellow average mean lengths (<28.3cm) till 2016. The recruitment from a sequence of abundant year classes, followed by the decline of stock size (as suggested by the 2007-2016 EU survey results, Figures 5b and 5c) should justify the bellow average mean lengths generally observed up to 2016. From 2017 to 2020 the situation reversed and returned to the same pattern as before 2004 (from an average of 26.2cm over 2004-2016 to 30.8 cm over 2017-2020). In addition to the variation in recruitment, one of the consequences may be the change in depth at which the fishery takes place.

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 2005 redfish by-catch in numbers at length was derived using the mean of the 3 previous years. The sum of the absolute length compositions of the 1989-2020 commercial catch with the absolute length compositions of the 1993-2005 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 2009-2017 EU surveys, and using the beaked redfish age length keys combined from the 2018-2020 EU surveys due to the reduced number of otolith age readings. 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 grids 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 2005 (despite the implementation of sorting grids escape devices). The 1999-2002 and 2005 cohorts dominated the overall catch through most years of the 2001-2012 interval, the 1999 year-class being at age 13, on 2012. The 2009-2011 cohorts are the most abundant in the catch between 2014 and 2016. Larger sizes corresponding to older ages, and 11 and 12 years old fish (from 2005-2006 cohorts) were the most abundant in the catch on 2017. However most abundant ages return to much younger redfish on 2018, with ages 6 and 7 (2012-2011 cohorts) being the most abundant in the catch. In 2019 and 2020 larger sizes in the catch correspond to fish aged 8+ years older (from cohorts as old as that of 2004) dominated catches (Figures 2c and 2d).

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 (1988-2020). 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) and in the EU survey protocols (Vazquez *et al*, 2014). 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* (1992-2020) and for the two species combined (1988-2020) were available from survey data (González-Troncoso and Casas *pers. comm.*, 2005-2020) (Table 2b). *S. mentella* and *S. fasciatus* length weight relationships were used to get 1992-2020 *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 unsplit 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 2003-2020 *RV Vizconde de Eza* length distributions (González-Troncoso *pers. comm.*, 2005-2020; 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 since the 2017 assessment. The 2019 and 2020 length at maturity data were used

to update the correspondent *S. mentella* and *S. fasciatus* ogives (Tables 4a and 4b and Figures 3a and 3b) (Saborido-Rey and Rábade *pers. comm.*, 2021).

Age composition of the survey stock and mature female component

The survey abundance at age for the 3M beaked redfish stock (1989-2020, Table 5b) was obtained using the *S. mentella* age length keys from the 1990-2007 and 2009-2017 EU surveys, and using the beaked redfish age length keys combined from the 2018-2020 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 (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 age length keys of the year. Survey female spawning stock (SSB) 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, 1988-2020

The 1989-2020 survey mean catch per tow for beaked redfish is presented on Table 7a and Figure 4. 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 Figures 5a to 5d.

The survey stock abundance and biomass (age 4+) 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 at age 4 (2001-2005), including the strongest of the survey series at age 4 (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 during 6 years (year classes 2010-2015). The 2016 year class with 4 years in 2020 shows an improvement in recruitment after 6 years (Figure 5a). The annual classes of 2017 and 2018 (ages 3 and 2 in 2020, respectively) show potential for good recruitment to the exploitable stock - ages 4+ (Table 5b and Figure 5e). Exploitable stock fell between 2006 and 2010 showing some recovery on 2011-2012. However, the indices resume the declining trend afterwards, this downward trend was halted in 2019 and even reversed in 2020, showing an increase, due to the growth of the existing exploitable stock and the entry of the 2016 year class in it (Figures 5b and 5c). Based on EU survey results, recruitment at age 4 experienced a rapid decline between 2006 and 2013 being kept below average until 2019. Before the arrival of the 2016 year class, the 2005 year class was the last above average (Figure 5a) and so, at this moment, and based on the EU survey, the prospects for stock recovery are in the recent years classes, namely that of 2016 (already in exploitable stock) and those of 2017 and 2018 that promise to be a good recruitment for the exploitable stock (Table 5b and Figure 5a).

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 (Figures 3b and 5d). Spite the SSB being above the mean (Figure 5d), the female spawners are slightly below the mean on 2020, 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, at age 4, 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 until 2019, in 2020 survey shows an increase of these indices. The stock biomass declined and by 2018 landed on below average levels recovering since then to slightly below the average in 2020, while

female spawning biomass remained relatively high.

Natural mortality (M)

Since 2004 a rapid increase was observed on survey biomass of golden (*Sebastes norvegicus*) and Acadian (*Sebastes fasciatus*) redfish (González-Troncoso, 2021). 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 2020 though, cod spawning stock biomass was still at a high level, sustained by the survival and growth of the dominant 2009-2011 cohorts, and a few, and not so strong, more recent cohorts (González-Troncoso *et al*, 2021). 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, 2017 and 2019). It is a fact that, since the 2010, recruitments (age 4) fall abruptly and stay depressed from 2014 to 2019. 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. 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 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. 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 2019 XSA assessment was a natural mortality of 0.1 on 2017-2018 after a sensitive analysis (Ávila de Melo *et al.*, 2019) and previous natural mortality levels kept from the past 3M beaked redfish assessments.

The 2021 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 8. Natural mortality over 2006-2018 remained unchanged from last assessment (Ávila de Melo *et al.*, 2019).

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 1989-2020 EU survey abundance at age matrix, with the 1989-2002 indices converted into the new *RV Vizconde de Eza* units (González-Troncoso *et al.*, 2021).

The framework

Apart the use of the new data input such; maturity at length ogives to get female maturity at age and spawning stock biomass each year, the XSA frameworks remained unchanged since the 2015 assessment (Ávila de Melo *et al.*, 2015, 2017 and 2019): 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. 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 all 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.

Quick sensitivity analysis around possible levels of natural mortality on recent years

The objective of the present exercise is to check (as it was checked in the 2019 assessment), using the survey based diagnostics combined with retrospective analysis, if average natural mortality on most recent years, 2019-2020, could have returned to a level higher than 0.1 (the best “biological based” 2015-2016 M option found on 2017 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 2017-2018 and 2019-2020? Or in turn the evidence is that most likely M stayed flat, or could even had declined, over most recent years?

Before 2006 M remained at 0.1. M from 2006 to 2014 varies by ages and years between 0.1 and 0.4. In 2015 M returned to 0.1 and remained at this level till 2018 (Table 8). The rationale for selecting the best options for natural mortality until 2018 are thoroughly explained in the sensitivity analysis sections of previous assessments (Ávila de Melo *et al.*, 2011, 2013, 2015, 2017 and 2019).

The sensitivity analysis in this assessment considered four M candidates (equal for all ages) for the 2019-2020 period ($M = 0.08; 0.1; 1.2$ and 1.4) since no major changes seem, besides decline, in the cod stock status during these years.

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 2019-2020 (Table 9 and Figure 6a) together with
2. Lower $SS \log q_{age}$ residuals back to 2011 (M started to decline from the anomalous high 2006-2010 levels) (Table 9 and Figure 6a) and
3. Higher correlation between exploitable (4+) survey abundance and XSA abundance over recent years (2011-2020) (Table 9 and Figure 6b).

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 2019-2020). On the present analysis, as a complement of the 2019-2020 and 2011-2020 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 9).

Both $SS \log q_{age}$ and (survey/XSA) correlation results showed not significant improvement on the diagnostics when changing M , all of them are very similar. Furthermore, slightly better 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 in the previous assessment, as the best option for average M on 2017-2018, or not. And, from the results presented on Table 9, Figures 6a and 6b, that hypothesis has not been confirmed.

So, the 2021 XSA assessment run with average M on 2019 and 2020 kept at 0.10.

Diagnostics

The 2021 diagnostics (Table 10, Figures 7a and 7b) kept the main features from past assessments: high residuals to mean log catchabilities at age (most obvious at younger ages on former years), mean log q 's with high *s.e.* and $\log q_{age}$ residual patterns: mostly positive during 1993-2001, after a clear negative pattern over the first years (1989-1993). Between 1989 and 1991 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 more scattered than previously, while the marked alternate negative/positive pattern of the two previous intervals fades away. However, on most recent years a clear annual pattern of positive residuals appears again in older ages, not showing though the magnitudes of the older times.

Retrospective Analysis

A retrospective XSA₂₀₂₀₋₂₀₁₆ was carried out for checking patterns and magnitude of bias on the main results of recent assessments back in time (Table 11 and Figure 8). Strong retrospective pattern is observed in both biomass and *SSB*, being constantly under estimated biomasses. The reverse is observed in fishing mortality, however the magnitude in this case is quite small not showing a strong retrospective pattern and overestimating *F*. Recruitment, with the exception of the last year (that shows the arrival of what could be an above average recruitment) also show a little retrospective pattern in the recent years.

2021 XSA Results

Very high fishing mortalities until 1996 forced a rapid decline of abundance, biomass and female spawning biomass (Table 12, Figure 9: *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 2008-2019 high. But from 2010 onwards abundance went down for causes other than fishing, being still on 2020 at a level above the 1995-2001 low. Biomass went down and up again between 2010 and 2014 staying however at a very high level. Its decline starts afterwards and continues till 2019, in 2020 this decline was halted, mostly due the arrival of the new recruitment at age 4. In addition, 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 2020. 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 since 2017.

Recruitment at age 4 increased with a sequence of above average year classes from 1999 till 2007, some of them the highest observed in the series (2002-2006) (Table 12 and Figure 9 and 10). However, recruitment to exploitable stock declined continuously since 2009 and was on 2017-2018 at an historic minimum level, the 2016 year class with 4 years old in 2020 are above the mean.

The reproductive potential of the stock increased steadily from the late 1990's to 2002, but fell abruptly after and was at very low level since 2011 but still declining until 2016, (Figure 9, *R/SSB plot*). With the exception of 2016 year class, 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 2002-2005 recruitments (Figure 9, *SSB/R plot*). Mortality caused by cod predation, acting in the premature suppression of pre-recruited annual classes of beaked red, may be one of the consequences of the persistence of this apparently very low reproductive potential.

Final quality considerations on the 2021 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 dynamic, 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 2019 and 2021 retrospective patterns, showing a consistent underestimation of biomass and recruits and overestimation of fishing mortality, allow the 2021 assessment to be regarded as precautionary enough to output survivor's results able to deliver conservative projections.

Yield per recruit analysis (*ypr*)

The proxies of $F_{0.1}$ and F_{max} from last assessment (Ávila de Melo *et al*, 2019) were revised by a new yield per recruit analysis (*ypr*), 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 2018-2020 relative *F* at age 4-18 vectors (for each year, relative *F* at age 4-18 vector is given by the ratios of the *F*'s at age to $F_{bar6-16}$ (see 2018-2020 average relative *F* at age – last column on table 9 XSA output files - in Table 12 XSA results for 2021 assessment).

M's were kept at 0.10 through ages and years but with an associated *CV* corresponding to an allowable variability of natural mortality between 0.08 and 0.12 (the *M* range associated with best sensitivity analysis diagnostics). All input weight at age and maturity at age vectors were averages from the most recent three years (2018-2020).

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 13.

As regards $F_{0.1}$ the 2021 *ypr* result (Figure 11) was below from the previous ones of 2017 and 2019. $F_{0.1}$ is at 0.0669 (0.0911 in 2019 assessment; 0.086 in 2017 assessment) and F_{max} is at 0.2997 (0.1883 in 2019 assessment; 0.163 in 2017 assessment). F_{max} is considered to be estimated with high uncertainty associated and therefore not accepted. The $F_{0.1}$ value have been used for short term projections. The results regarding $F_{0.1}$ and F_{max} are at the moment candidates to 3M beaked redfish fishing mortality reference points that still need to be confirmed in near future.

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. Abundance decline is more pronounced. These declines were halted in 2020. Recruitment to exploitable stock is declining continuously since 2009 and was in 2017-2019 at an historic minimum level. After an extended period of declining recruitment, the recruitment estimate for 2020 is high but associated with high uncertainty, and its magnitude needs to be confirmed in future assessments. Natural mortality has stayed on recent years (2015-2020) at 0.1, its 1980's-1990's-early 2000's assumed magnitude. Between 1989-1993 very high commercial catches led to high fishing mortalities through the first half of the 1990's. Fishing mortality fell until 1997 and fluctuated between low and average levels since then. Fishing mortality remains relatively low compared to the 1980s and 1990s.

Short and medium term projections

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

1. No fishing, F_0
2. $F_{0.1}$
3. $F_{statusquo}$ (last year $F_{bar6-16,2020}$ times average partial recruitment for the last three years, 2018-2020)
4. $F=M=0.1$
5. 1.25 TAC
6. 0.75 TAC

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

Background, input data and projections tool

Short- (three years, 2022-2024) and medium-term (ten years, 2022-2031) stochastic projections of yield and female spawning stock biomass (*SSB*) under the six *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 at age (5 and older) at the beginning of projections (2022) to account for a measure of uncertainty. The initial 2022 population at age (5 and older) is the forward projection of the XSA survivors by the end of 2020 assuming $F_{statusquo}$ at age during 2021. The coefficients of variation for population at age at the beginning of 2022 were set as the internal standard errors from 2021 XSA diagnostics. All other inputs at age are given by the last three year average (2018-2020) with associated errors at age.

Recruitment (age 4) entering in 2021, 2022 and 2023 is assumed constant at the geometric mean of recent recruitments (age 4 XSA, 2017-2019). From 2024 till 2031, recruitment is randomly resampled with residuals from 2017-2019 geometric mean recruitment.

Input data were aggregated in two categories of files:

- a. *.srr* stock-recruitment file (Table 14a), assuming no stock recruitment relationship and with a random recruitment around the geo-mean of the 2017-2019 recruitments (numbers at age 4, from the 2021 XSA). From the third year of projection onwards (2024), age 4 is given by the resampling of the *log* residuals of the 2017-2019 recruitments. The recruitment from last year (2020) is excluded from average due to greater uncertainty associated with its estimate.
- b. *.sen* sensitivity file (Table 14b, 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 (2019-2020) with associated errors at age. Each *F* option was kept constant through projection interval (2022-2031).

Results and discussion

Main results of short-term projections for female *SSB* and yield under several *F* options are summarized on Table 15a and Figure 12. Medium-term *SSB* (50% percentile) trajectories are presented on Table 15b and Figure 13.

Projection results indicate a 10% decline from 2021 to 2022 (i.e., interim year under *Fstatusquo*). Thereafter, the stock remains stable if there is no fishing ($F=0$). Results for the six projection scenarios show biomass declines of 11% (for $F=0$), 30% (for $F_{0.1}$), 37% (for $F=M$), 27% (for $F_{statusquo}$), 29% (for 1.25 TAC) and 22% (for 0.75 TAC) between 2021 and 2024. With the exception of the $F=0$ scenario, for all other five projection scenarios, the *SSB* is projected to decline, and to be at around the average for the assessment time-series (since the late 1980s) by 2024.

The results of the medium-term projections indicate a pattern similar to that of the short-term projections, predicting a steady decline in *SSB* until the end of the projected period (2031), except for the $F=0$ scenario.

The probability of *SSB* arrive at the beginning of 2024 greater than it was at the beginning of 2021 is less than 10% regardless the *F* option in place, not taking in consideration the scenario $F=0$.

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Table 1a. 3M Total redfish (beaked and *S. norvegicus* redfish) nominal catches (ton) by country, 1989- 2020.

Country	CAN	CUB	ICEL. IS.	DDR	GRL	JPN	SUN/RUS	UKR	E-LVA	E-LTU	E-EST	E-SP	E PRT	EU	FR-STP	UK	KOR-S	FAROE IS.	NORWAY	Total
1989		1765				885	13937					211	13012	2			17885			47697
1990		4195		4025		2082	34581					1916	11665	91			8332			66887
1991	2	1772				1431	24763					472	3788	6237		5	2936			41406
1992		2304			1	1424	2937		7441	2149		204	3198	3443			8350	19		31470
1993	10	945			55	967	2035		5099	2112	2188	100	4782	295			2962	61		21611
1994			10		25	488	2980		94	8	47	610	5632					12	8	9914
1995					4	553	3560		304		863	165	1284					15		6748
1996					2	678	52				13	113	281					1		1140
1997						212						129	83							424
1998					2	439	7					262	259		2	1				972
1999		2				320	108					268	97							795
2000	5				11	31	1864		13		631	348	925							3828
2001						80	1281		11		158	272	1590	4						3396
2002					9	67	1155			10	5	220	1513					6		2985
2003						98	115	5		1	23	633	1113							1988
2004						209	6	3	2		61	264	2574					6		3125
2005						483	1023		48	522	1093	542	2696		10					6417
2006						383	849	1	250	397	1249	596	2594							6319
2007						613	780			542	728	533	2357		39					5592
2008						603	1215				950	1126	3707		8			215		7824
2009							1184		58		1643	745	5028					1		8659
2010							927			348	1161	892	4703		69	1		122	3	8226
2011	2	875					1573		71	478	820	339	5024		68	2		420	4	9676
2012		600					1711			417		512	3569		69	5		149	9	7041
2013							1812				1036	416	3493			8		5		6770
2014							1342			0.1	601	1031	3462	7				5		6449
2015 ¹							1332				498	1318	3720					75		6944
2016 ²						136	790				526	1385	3596			10		68		6510
2017 ³						197	576				764	2021	3596			7		2	3	7165
2018 ⁴						636	686				2017	2236	4838					65		10478
2019 ⁵						450	0.21				1911	1978	6210		1				44	10595
2020 ⁶						286	39				848	1885	5714					0.1		8773

¹ NAFO Daily Catch Reports² SCWP17-21 CDAG catch Estimation: Catch estimates for the 2016 calendar year calculated using the CDAG Estimation Strategy (NAFO Regulatory Area Only)³ COM-SC CESAG-WP 18-01REV2 Catch Estimation-Secretariat Supplementary Information⁴ COM-SC CESAG-WP 19-03 (Revised) Catch Estimation-Secretariat Supplementary Information⁵ COM-SC CESAG-WP 20-05 REV 2019 Catch Estimation-Secretariat⁶ COM-SC CESAG-WP 21-05 2020 Catch Estimation-Secretariat

Table 1b. Div. 3M Redfish and Beaked redfish 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 2017-2020). From 2005 onwards also using information on distribution by depth of the EU survey redfish catch by species and of the commercial redfish catch of Portugal, Russia and Spain.

Year	Redfish	Beaked redfish	Year
1989	58100	58100	1989
1990	81000	81000	1990
1991	48500	48500	1991
1992	43300	43300	1992
1993	29000	29000	1993
1994	11300	11300	1994
1995	13500	13500	1995
1996	5789	5789	1996
1997	1300	1300	1997
1998	971	971	1998
1999	1068	1068	1999
2000	3658	3658	2000
2001	3224	3224	2001
2002	2934	2934	2002
2003	1881	1881	2003
2004	2923	3140	2004
2005	6550	4148	2005
2006	7156	5997	2006
2007	6662	5149	2007
2008	8465	4277	2008
2009	11317	3656	2009
2010	8496	5410	2010
2011	11123	8996	2011
2012	8008	6472	2012
2013	7777	5169	2013
2014	7416	4565	2014
2015 ¹	6944	5243	2015 ¹
2016 ²	6510	6152	2016 ²
2017 ³	7165	6914	2017 ³
2018 ⁴	10478	10330	2018 ⁴
2019 ⁵	10595	10246	2019 ⁵
2020 ⁶	8773	8695	2020 ⁶

¹ NAFO Daily Catch Reports

² SCWP17-21 CDAG catch Estimation: Catch estimates for the 2016 calendar year calculated using the CDAG Estimation Strategy (NAFO Regulatory Area Only)

³ COM-SC CESAG-WP 18-01REV2 Catch Estimation-Secretariat Supplementary Information

⁴ COM-SC CESAG-WP 19-03 (Revised) Catch Estimation-Secretariat Supplementary Information

⁵ COM-SC CESAG-WP 20-05 REV 2019 Catch Estimation-Secretariat

⁶ COM-SC CESAG-WP 21-05 2020 Catch Estimation-Secretariat

Table 1c. Percentage of golden and beaked redfish found in the EU survey redfish catch (*excluding juveniles; redfish beyond 700m depth is 100% S. mentella*).

Year	<200m		200-300m		300-400m		400-700m	
	Golden	Beaked	Golden	Beaked	Golden	Beaked	Golden	Beaked
2005	36.12	63.88	54.46	45.54	18.82	81.18	2.07	97.93
2006	51.10	48.90	50.68	49.32	5.88	94.12	5.04	94.96
2007	97.88	2.12	32.45	67.55	11.99	88.01	1.34	98.66
2008	100.00	0.00	68.26	31.74	28.45	71.55	8.79	91.21
2009	100.00	0.00	84.89	15.11	22.00	78.00	0.88	99.12
2010	100.00	0.00	68.26	31.74	28.45	71.55	8.79	91.21
2011	90.02	9.98	52.92	47.08	3.66	96.34	0.59	99.41
2012	96.51	3.49	63.45	36.55	5.53	94.47	0.03	99.97
2013	99.04	0.96	65.39	34.61	10.04	89.96	1.35	98.65
2014	98.87	1.13	91.84	8.16	34.07	65.93	0.29	99.71
2015	97.98	2.02	94.50	5.50	25.92	74.08	0.38	99.62
2016	99.23	0.77	80.77	19.23	10.15	89.85	0.16	99.84
2017	91.00	9.00	53.87	46.13	2.67	97.33	0.50	99.50
2018	96.70	3.30	59.11	40.89	5.93	94.07	0.04	99.96
2019	96.81	3.19	47.55	52.45	25.44	74.56	0.09	99.91
2020	96.14	3.86	58.26	41.74	13.35	86.65	0.00	100.00

Table 1d. Redfish by-catch in weight (ton) from the 3M shrimp fishery, 1993-2005.

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

Table 1e. 3M Beaked redfish catch in the shrimp fishery, in numbers (millions), 1989-2020.

Year	Commercial catches	Beaked redfish by-catch in shrimp fishery.	Total
1989	125.3		125.3
1990	196.3		196.3
1991	104.2		104.2
1992	94.1		94.1
1993	49.2	124.5	173.7
1994	24.6	62.9	87.5
1995	34.9	4.0	39.0
1996	15.5	15.2	30.7
1997	3.0	3.2	6.2
1998	2.2	5.2	7.4
1999	2.3	3.8	6.1
2000	9.6	3.2	12.8
2001	8.5	29.1	37.6
2002	9.1	19.8	28.9
2003	4.6	21.9	26.4
2004	12.5	9.9	22.4
2005	12.5	1.8	14.4
2006	28.2		28.2
2007	16.1		16.1
2008	15.3		15.3
2009	11.6		11.6
2010	24.4		24.4
2011	28.8		28.8
2012	15.9		15.9
2013	20.0		20.0
2014	16.5		16.5
2015	20.5		20.5
2016	24.2		24.2
2017	21.1		21.1
2018	35.1		35.1
2019	26.8		26.8
2020	15.1		15.1

Table 2a. Length weight relationships for 3M beaked redfish from commercial catch.

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
2005		
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
2019	0.0703	2.4832
2020	0.0081	3.1857

Table 2b. Length weight relationships for 3M beaked redfish from EU survey.

Year	<i>S. mentella</i>		<i>S. fasciatus</i>		<i>Sebastes sp.</i>	
	a	b	a	b	a	b
1988					0.0580	2.5927
1989					0.0218	2.8670
1990					0.0182	2.9280
1991					0.0269	2.8140
1992	0.0191	2.9106	0.0269	2.8412	0.0302	2.7879
1993	0.0134	3.0212	0.0280	2.8244	0.0167	2.9652
1994	0.0167	2.9597	0.0204	2.9267	0.0212	2.8958
1995	0.0111	3.0734	0.0156	3.0014	0.0132	3.0340
1996	0.0167	2.9480	0.0234	2.8756	0.0209	2.8903
1997	0.0143	2.9988	0.0186	2.9601	0.0149	3.0009
1998	0.0132	3.0248	0.0188	2.9442	0.0140	3.0192
1999	0.0144	2.9943	0.0203	2.9097	0.0182	2.9280
2000	0.0175	2.9382	0.0250	2.8533	0.0223	2.8738
2001	0.0122	3.0432	0.0169	2.9784	0.0145	3.0083
2002	0.0119	3.0540	0.0176	2.9673	0.0138	3.0260
2003	0.0108	3.0688	0.0091	3.1506	0.0117	3.0553
2004	0.0145	2.9990	0.0168	2.9769	0.0119	3.0742
2005	0.0154	2.9742	0.0125	3.0608	0.0112	3.0879
2006	0.0114	3.0691	0.0121	3.0658	0.0112	3.0879
2007	0.0096	3.1191	0.0156	2.9958	0.0137	3.0256
2008	0.0187	2.9206	0.0159	2.9831	0.0202	2.9021
2009	0.0116	3.0666	0.0160	2.9833	0.0146	3.0039
2010	0.0125	3.0206	0.0237	2.8500	0.0179	2.9254
2011	0.0150	2.9726	0.0231	2.8750	0.0206	2.8932
2012	0.0158	2.9604	0.0236	2.8606	0.0209	2.8862
2013	0.0208	2.8742	0.0322	2.7793	0.0294	2.7873
2014	0.0160	2.9680	0.0240	2.8730	0.0236	2.8658
2015	0.0168	2.9515	0.0237	2.8805	0.0230	2.8753
2016	0.0223	2.8750	0.0291	2.8194	0.0257	2.8435
2017	0.0144	2.9936	0.0119	3.0687	0.0130	3.0224
2018	0.0176	2.9260	0.0152	2.9999	0.0130	3.0224
2019	0.0171	2.9397	0.0141	3.0297	0.0162	2.9710
2020	0.0118	3.0546	0.0126	3.0740	0.0138	3.0299

Table 3a. Length data for commercial catches and by-catch of 3M beaked redfish used in assessments, 1989-2020.

Year\Country	Portugal	Spain	Japan	Russia	Canada (by-catch)
1989					
1990					
1991					
1992					
1993					
1994					
1995					
1996					
1997					
1998					
1999					
2000					
2001					
2002					
2003					
2004					
2005					
2006					
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2009					
2010					
2011					
2012					
2013					
2014					
2015					
2016					
2017					
2018					
2019					
2020					


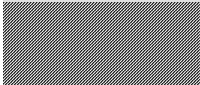
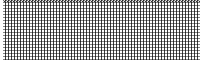
 available length data
 derived from the length composition of the 1993-1994 beaked redfish EU survey abundance (Portugal) or derived from the length composition of the 1992-1994 beaked redfish EU survey abundance (Russia)
 assumed as by-catch of Russian Greenland halibut fishery with the same length composition of EU commercial bottom trawl

Table 3b. Length composition (absolute frequencies in'000s) of the 3M redfish commercial catch, 1989-2020.

Length (cm)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
8																
9																
10	3			0.1	0.1	0.0								10		
11				1	3	0.0								48		1
12	3			1	7	0.1						5		220		3
13	11			0.2	5	0.3						11		723		5
14	25	4		0.1	40	4						1		590		12
15	8	73		1	120	15				2		6	4	175		43
16	30	190		4	167	66	0.2	20				1	4	70		203
17	59	724		3	55	244		20	1	2		6	20	53	6	352
18	30	2489	156	6	39	607	118	20	1	1		17	57	84	6	464
19	11	5774	647	97	54	922	265	66	6	8	1	27	41	144		666
20	111	6179	1331	418	71	491	1142	360	8	13	1	50	43	187		1165
21	383	2904	1234	1987	125	427	2874	964	14	28	1	48	63	173	2	1513
22	1149	1205	1179	3834	337	408	5895	2215	41	52	2	103	117	166	4	1512
23	3766	1927	945	3016	668	457	5715	1641	104	94	1	112	197	175	30	961
24	8408	5526	1697	1690	1116	701	1691	1324	263	116	9	206	277	284	89	845
25	14733	11932	3737	2468	1159	870	1157	785	325	222	118	317	451	414	262	720
26	14793	19979	6292	7519	1577	1020	793	513	310	223	112	717	891	511	363	571
27	11148	25688	10368	11599	1701	986	953	740	198	207	220	1322	1241	672	516	596
28	7059	26047	12852	11899	2456	1688	1185	758	169	173	303	1654	1450	854	535	553
29	5773	20113	15100	8677	2448	2039	1476	855	210	168	301	1467	1193	841	588	426
30	7424	15200	13056	7505	3277	1987	1506	899	248	162	191	1036	996	814	475	384
31	6972	10134	7456	5452	3846	2327	1257	954	223	172	204	677	537	625	390	269
32	7393	8308	7054	4705	3974	2611	1304	891	248	157	242	451	339	463	359	304
33	7030	6551	3519	4150	4831	1963	1219	689	268	112	169	321	210	366	331	319
34	6927	6397	3891	4309	4283	1347	1008	672	107	74	75	300	146	221	258	204
35	6520	5486	3101	4286	3737	1154	1035	281	76	54	136	187	77	111	200	111
36	4920	4398	2620	3104	3474	776	1041	198	43	47	72	151	38	70	94	76
37	4080	3047	2394	2336	2914	404	915	220	24	46	65	150	31	26	47	53
38	2441	2206	1672	1582	1753	366	749	103	27	33	7	113	37	18	16	50
39	1566	1557	1748	1343	2453	328	488	125	11	29	30	56	17	14	8	31
40	946	769	1024	917	1151	191	469	45	3	16	2	34	10	7	2	33
41	504	581	640	522	517	105	346	38	12	11	4	26	5	1	0.4	41
42	341	345	201	214	476	37	164	46	5	8	0.4	19	6	2	0.3	14
43	289	264	283	237	118	10	69	18	1	3	1	25	3	5	2	18
44	135	130	19	172	170	9	50	3	6	2	0.2	14	2	0.2		12
45	143	73	14	39	26	9	34	2	1	0.3	2	3	1		1	6
46	75	32	8	9	17		7	4	1	1		10	1			5
47	46	16			17		19	1	1		0.2	6	0.4			
48	28	12	8	17			4			0.2			1			1
49	4	12								0.1						
50	11	4						27					0.1			
51	4	12														
52	4															
53	7	16														
54		8														
55		4														
56																
57																
58		4														
59																
60																
61									11							
mean weight (g)	464	413	465	460	590	460	386	374	438	435	471	379	379	321	410	250
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

Table 3b. Cont.

Length (cm)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
8												2				
9												2				
10	3	16	12					5				19				
11	18	40	41			3	1	7	1	0.1	6	55			1	
12	108	86	133		1	9	3	18	4	10	10	69			1	0.02
13	381	70	172		5	30	28	31	7	51	48	137				
14	509	91	88	0.3	5	107	87	54	5	97	119	140			2	
15	474	112	23	6	37	268	209	84	35	106	160	156			4	0.1
16	516	313	18	14	68	369	309	97	68	180	164	218	0.2		0.4	0.3
17	423	436	31	12	102	519	352	135	135	170	287	295		41	1	0.2
18	285	635	138	47	121	723	586	173	211	366	370	356	1	49	2	0.2
19	183	1296	433	166	147	986	806	313	393	691	647	524	13	130	1	0.4
20	157	2168	371	381	226	1684	1453	555	368	1363	1113	1173	82	258	5	1
21	132	3104	658	622	308	2436	2131	819	1005	1463	1780	1669	195	519	9	1
22	159	3939	490	1032	535	3992	3198	1269	1623	1963	2726	2652	273	1187	27	1
23	216	3658	720	794	869	3520	2779	1230	1786	1101	2607	2408	677	1607	61	2
24	287	3179	760	1198	981	1797	1543	740	1987	845	1485	1383	1039	2013	129	3
25	555	2261	947	787	1257	1232	990	508	2404	770	999	1227	1563	2578	175	50
26	724	1427	1471	1760	1266	911	821	525	2638	1198	842	1808	1874	2725	424	207
27	927	1181	1876	2050	1145	831	774	435	2380	1075	758	1481	2204	2360	762	312
28	1057	1058	1405	2306	1086	942	964	525	1520	919	885	1639	2362	2387	1314	660
29	1111	779	1348	1244	877	919	1116	563	1057	498	821	1607	2603	3079	2564	850
30	779	619	1350	692	590	885	1803	1060	681	574	1067	1563	2415	3473	4283	1513
31	770	444	998	437	596	662	1886	972	513	509	1004	1239	1943	3485	4771	1914
32	525	353	850	272	434	528	2230	1249	345	406	700	881	1460	3402	4596	2023
33	543	262	639	311	300	422	1970	1265	251	432	536	561	869	2060	3518	2085
34	527	193	463	208	216	247	1018	808	190	366	485	340	551	1519	2124	1876
35	536	169	312	59	156	193	587	565	149	330	271	208	345	1026	972	1465
36	412	124	162	230	88	108	372	505	85	272	207	162	232	511	513	849
37	105	47	33	105	64	61	265	426	64	197	88	98	141	266	280	572
38	25	36	28	158	44	36	222	275	52	174	82	33	69	140	160	317
39	25	15	34	59	14	2	137	168	29	138	79	18	60	102	28	213
40	7	14	5	137	5	5	108	124	3	98	43	14	35	65	27	50
41	34	17	16	65	4	0	50	149	6	88	26	14	23	47	15	55
42	0.3	11	6	61	2		19	26	6	34	57	8	11	22	16	6
43	0.4	11	3	52	1		9	80		22	15	7	9	6	9	12
44	0.2	4	8	26	2		20	74		14	12	6	2	6	5	11
45		3	3	5	2			1.3		1	5	3	4	2	5	20
46		4	5	20						0.4	22	6	2	11	12	7
47	1	1	0.2	7	1					0.1	2	0.2	1	3	8	8
48		1		10						0.2	0.4		0.2	1	3	4
49		1	3							0.1		8.5	1	9	2	5
50		0.3	8					65		0.1			0.1		3	7
51								1.8				4.2		1	1	3
52										0.1				2	0.003	1
53		1	2							0.1			0.1		0.002	
54														0.3	0.2	0.04
55												0.9		3		1
56																
57																
58															0.001	
59																
60																
61																
mean weight (g)	331	213	321	279	316	221	312	407	258	276	255	254	328	294	382	576
mean length (cm)	26.6	24.0	27.5	27.6	27.1	24.2	26.9	28.9	26.0	25.9	25.7	25.9	29.1	29.2	31.8	33.1

Table 3c. Length composition (absolute frequencies in'000s) of the 3M redfish total annual catch, 1989-2020 (including redfish by-catch in the 3M shrimp fishery, 1993-2005).

Length (cm)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5												3	9	10	55	14
6								147	1	3	15	5	200	60	246	95
7							5	4306	105	109	115	59	534	381	601	182
8							7	2412	127	248	550	123	1486	668	1131	242
9							5	211	71	40	812	55	4218	538	1432	355
10	3			0.1	0.1	0.002	3	416	258	45	845	193	6537	888	1454	593
11				1	3	0.04	15	1056	569	391	390	593	6275	1655	913	1055
12	3			1	9	19	36	841	512	1830	313	1011	4996	3205	1368	1498
13	11			0.2	29	338	34	459	164	1721	286	761	2126	5809	2741	1229
14	25	4		0.1	257	979	64	488	120	340	97	182	746	4660	2546	1093
15	8	73		1	1998	2232	247	731	119	63	90	90	531	1946	1886	1022
16	30	190		4	7682	7312	430	1713	647	116	86	50	522	865	1994	999
17	59	724		3	29380	17576	758	1182	184	85	62	22	453	430	2513	987
18	30	2489	156	6	47422	21654	1105	758	61	32	41	27	339	339	1751	815
19	11	5774	647	97	30110	11939	1086	444	68	34	39	35	146	297	657	927
20	111	6179	1331	418	6815	2807	1569	428	85	19	14	60	89	265	224	1398
21	383	2904	1234	1987	1117	745	3001	1058	75	39	7	52	91	209	183	1690
22	1149	1205	1179	3834	697	521	5922	2220	82	65	9	105	142	186	93	1588
23	3766	1927	945	3016	669	457	5722	1641	126	102	6	114	210	187	80	988
24	8408	5526	1697	1690	1116	701	1694	1324	273	135	11	208	288	290	108	857
25	14733	11932	3737	2468	1159	870	1162	785	328	237	122	317	455	417	272	727
26	14793	19979	6292	7519	1577	1020	798	513	311	243	112	719	893	513	364	574
27	11148	25688	10368	11599	1701	986	957	740	198	217	223	1322	1242	672	517	597
28	7059	26047	12852	11899	2456	1688	1192	758	169	174	303	1654	1451	855	536	553
29	5773	20113	15100	8677	2448	2039	1483	855	210	169	301	1467	1194	841	589	426
30	7424	15200	13056	7505	3277	1987	1509	899	248	162	191	1036	996	815	475	384
31	6972	10134	7456	5452	3846	2327	1258	954	223	172	204	677	537	626	390	270
32	7393	8308	7054	4705	3974	2611	1304	891	248	158	242	451	339	464	359	304
33	7030	6551	3519	4150	4831	1963	1219	689	268	112	169	321	210	366	331	319
34	6927	6397	3891	4309	4283	1347	1008	672	107	75	75	300	146	221	258	204
35	6520	5486	3101	4286	3737	1154	1035	281	76	54	136	187	77	111	200	111
36	4920	4398	2620	3104	3474	776	1041	198	43	47	72	151	38	70	94	76
37	4080	3047	2394	2336	2914	404	915	220	24	46	65	150	31	26	47	53
38	2441	2206	1672	1582	1753	366	749	103	27	33	7	113	37	18	16	50
39	1566	1557	1748	1343	2453	328	488	125	11	29	30	56	17	14	8	31
40	946	769	1024	917	1151	191	469	45	3	16	2	34	10	7	2	33
41	504	581	640	522	517	105	346	38	12	11	4	26	5	1	0.4	41
42	341	345	201	214	476	37	164	46	5	8	0	19	6	2	0.3	14
43	289	264	283	237	118	10	69	18	1	3	1	25	3	5	2	18
44	135	130	19	172	170	9	50	3	6	2	0.2	14	2	0.2		12
45	143	73	14	39	26	9	34	2	1	0.3	2	3	1		1	6
46	75	32	8	9	17		7	4	1	1		10	1			5
47	46	16			17		19	1	1			0.2	6	0.4		
48	28	12	8	17			4			0.2			1			1
49	4	12								0.1						
50	11	4						27								
51	4	12											0.1			
52	4															
53	7	16														
54		8														
55		4														
56																
57																
58		4														
59																
60																
61									11							
number ('000)	125310	196321	104246	94117	173677	87505	38979	30697	6180	7385	6051	12804	37630	28932	26441	22436
weight (ton)	58100	81000	48500	43300	40970	17203	13874	6339	1457	1162	1164	3764	3962	3701	2887	3612

Table 3c. Count.

Length (cm)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
5	3															
6	15															
7	40															
8	67											2				
9	79											2				
10	107	16	12					5				19				
11	159	40	41			3	1	7	1	0	6	55			1	
12	331	86	133		1	9	3	18	4	10	10	69			1	0.02
13	691	70	172		5	30	28	31	7	51	48	137				
14	773	91	88	0.3	5	107	87	54	5	97	119	140			2	
15	642	112	23	6	37	268	209	84	35	106	160	156			4	0.1
16	646	313	18	14	68	369	309	97	68	180	164	218	0		0.4	0.3
17	544	436	31	12	102	519	352	135	135	170	287	295		41	1	0.2
18	364	635	138	47	121	723	586	173	211	366	370	356	1	49	2	0.2
19	222	1296	433	166	147	986	806	313	393	691	647	524	13	130	1	0.4
20	181	2168	371	381	226	1684	1453	555	368	1363	1113	1173	82	258	5	1
21	149	3104	658	622	308	2436	2131	819	1005	1463	1780	1669	195	519	9	1
22	167	3939	490	1032	535	3992	3198	1269	1623	1963	2726	2652	273	1187	27	1
23	220	3658	720	794	869	3520	2779	1230	1786	1101	2607	2408	677	1607	61	2
24	289	3179	760	1198	981	1797	1543	740	1987	845	1485	1383	1039	2013	129	3
25	556	2261	947	787	1257	1232	990	508	2404	770	999	1227	1563	2578	175	50
26	724	1427	1471	1760	1266	911	821	525	2638	1198	842	1808	1874	2725	424	207
27	927	1181	1876	2050	1145	831	774	435	2380	1075	758	1481	2204	2360	762	312
28	1057	1058	1405	2306	1086	942	964	525	1520	919	885	1639	2362	2387	1314	660
29	1111	779	1348	1244	877	919	1116	563	1057	498	821	1607	2603	3079	2564	850
30	779	619	1350	692	590	885	1803	1060	681	574	1067	1563	2415	3473	4283	1513
31	770	444	998	437	596	662	1886	972	513	509	1004	1239	1943	3485	4771	1914
32	525	353	850	272	434	528	2230	1249	345	406	700	881	1460	3402	4596	2023
33	543	262	639	311	300	422	1970	1265	251	432	536	561	869	2060	3518	2085
34	527	193	463	208	216	247	1018	808	190	366	485	340	551	1519	2124	1876
35	536	169	312	59	156	193	587	565	149	330	271	208	345	1026	972	1465
36	412	124	162	230	88	108	372	505	85	272	207	162	232	511	513	849
37	105	47	33	105	64	61	265	426	64	197	88	98	141	266	280	572
38	25	36	28	158	44	36	222	275	52	174	82	33	69	140	160	317
39	25	15	34	59	14	2	137	168	29	138	79	18	60	102	28	213
40	7	14	5	137	5	5	108	124	3	98	43	14	35	65	27	50
41	34	17	16	65	4	0	50	149	6	88	26	14	23	47	15	55
42	0.3	11	6	61	2		19	26	6	34	57	8	11	22	16	6
43	0.4	11	3	52	1		9	80		22	15	7	9	6	9	12
44	0.2	4	8	26	2		20	74		14	12	6	2	6	5	11
45		3	3	5	2			1.3		1	5	3	4	2	5	20
46		4	5	20			2			0.4	22	6	2	11	12	7
47		1	0.2	7	1					0.1	2	0.2	1	3	8	8
48		1		10						0.2	0.4		0.2	1	3	4
49		1	3							0.1		9	1	9	2	5
50		0.3	8					65		0.1			0.1		3	7
51								1.8				4		1	1	3
52										0.1				2	0.003	1
53		1	2							0.1			0.1		0.002	
54														0.3	0.2	0.04
55												1		3		1
56																
57																
58															0.001	
59																
60																
61																
number ('000)	14352	28179	16062	15333	11556	24426	28849	15897	20000	16520	20529	24191	21058	35093	26835	15106
weight (ton)	4228	5997	5149	4277	3656	5410	8996	6472	5169	4565	5243	6152	6914	10330	10246	8695

Table 3d. Catch in numbers at age (' 000) of 3M redfish, 1989-2020, including redfish by-catch in the shrimp fishery (1993-2005).

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				316	6830	7733	16337	17715	11639	7493	5607	4430	4233	3256	2920	1942	1183	758	1717	94117	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	42	16	72	265	610	370	82	112	261	39	77	77	68	102	144	6051	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	311	2231	1159	768	373	717	878	1264	1462	1122	820	860	423	418	1240	126	75	21	84	14352	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	67	226	218	968	1602	1683	1370	827	351	239	577	1123	1878	962	752	460	138	39	2418	15897	1999
2013	11	90	297	694	1720	3675	5607	3234	1523	949	425	398	204	258	243	75	180	74	343	20000	2006
2014	61	315	587	1396	3659	2111	2054	1472	1101	531	429	382	153	386	511	275	198	44	853	16520	2009
2015	15	342	751	1260	3928	5040	1624	1223	1018	1032	1217	667	479	343	661	152	126	101	548	20529	2009
2016	147	509	668	1060	3834	3832	3374	1604	1895	2013	1596	1738	452	607	206	154	209	125	168	24191	2010/2011
2017				61	840	1940	2344	1870	2002	939	2887	2726	2122	378	912	390	674	375	597	21058	2005/2006
2018				196	1304	4510	3789	1995	2737	2864	1123	1381	1852	3386	2890	2007	1144	1111	2796	35093	2011/2012
2019	2	6	2	3	43	203	685	1035	1633	793	1121	1076	1749	2041	2164	2591	3104	1869	6716	26835	2010
2020	0.02	0.2	0	1	2	20	288	398	561	651	647	852	802	1152	1570	1638	1491	1598	3437	15106	2004/2005

Table 3e. Weights at age in the catch and by-catch (kg) of 3M redfish, 1989-2020.

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	0.154	0.198	0.263	0.337	0.389	0.438	0.503	0.583	0.626	0.693	0.732	0.751	0.851	0.804	0.933	1.014
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	1.029
1999	0.020	0.040	0.072	0.101	0.139	0.201	0.326	0.364	0.350	0.432	0.509	0.596	0.552	0.579	0.567	0.581	0.673	0.609	0.735
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	0.990
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	0.876
2003	0.013	0.038	0.066	0.085	0.107	0.190	0.253	0.288	0.341	0.384	0.454	0.500	0.409	0.584	0.587	0.633	0.550	0.692	0.664
2004	0.012	0.032	0.062	0.091	0.131	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	0.012	0.039	0.064	0.087	0.112	0.182	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	0.204	0.248	0.290	0.335	0.394	0.407	0.514	0.508	0.505	0.582	0.640	0.625	0.463	0.746
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	0.614
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	0.487	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	0.807
2017			0.075	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			0.065	0.084	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
2019	0.034	0.060	0.089	0.107	0.158	0.200	0.249	0.278	0.332	0.343	0.338	0.371	0.394	0.426	0.422	0.405	0.404	0.388	0.394
2020	0.025	0.054	0.070	0.108	0.150	0.234	0.305	0.331	0.392	0.447	0.549	0.529	0.542	0.530	0.604	0.625	0.607	0.608	0.658

Table 4a. 3M beaked redfish new maturity ogives at length (*Sebastes sp.*: *S. mentella* and *S. fasciatus* combined), 1994-2020.

Parameter \ Year	1994	1996	1999	2000	2004	2007	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
<i>a</i>	-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	-20.17	-17.01
<i>b</i>	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	0.76	0.60
<i>n</i>	402	93	340	94	379	411	476	603	467	412	432	509	374	528	406	344
<i>L50</i>	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	26.38	28.51

Table 4b. 3M beaked redfish mean length at maturity (*S. mentella*, *S. fasciatus* and *Sebastes sp.*), 1994-2020.

Species \ Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
<i>S. mentella</i>	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	25.79
<i>S. fasciatus</i>	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	25.69
<i>Sebastes sp.</i>	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	25.72
Species \ Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
<i>S. mentella</i>	25.88	25.91	25.92	25.93	25.93	26.02	26.12	26.23	28.59	26.50	27.72	26.85	30.05	
<i>S. fasciatus</i>	25.68	25.67	25.66	25.65	24.15	23.10	24.44	26.43	28.14	25.35	27.11	25.94	27.94	
<i>Sebastes sp.</i>	25.79	25.83	25.85	25.86	25.30	25.17	25.50	26.29	28.42	25.90	27.39	26.38	28.51	

Table 5a. 3M beaked redfish abundance at length ('000s) from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2020 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
4											2868					63	
5											956			455	1091	2905	
6		73	239	1042				144									
7	1203	160	1952	39644	4931	1102		31	2453		695	291		1240	9720	11241	286
8	8538	1890	15439	194701	117561	3160		594	12310	1359	3390	2417	1883	18643	14581	19009	12530
9	8327	2007	11861	90135	75875	1764		1816	6548	2887	6048	12420	6848	152327	44733	10989	69454
10	7082	2894	846	9088	57005	7812	274	1889	867	1615	1573	8840	5242	246451	53017	5810	181225
11	20338	8434	412	17232	332037	36153	1573	3397	1762	4312	2626	3052	4412	29300	52317	13578	178289
12	39345	20228	390	18876	381332	46734	2665	9269	5827	12810	13751	2976	15579	9424	115720	38207	306313
13	27472	21581	1062	5790	90012	29392	5209	4666	5993	14318	22307	4851	30605	16454	247642	31594	217455
14	4000	46259	1865	1174	16174	79964	25338	4768	8609	7064	11124	4639	18860	19286	292527	34465	109487
15	802	87282	2527	1706	27540	165019	58046	9835	16820	13161	14504	19442	6447	31061	99677	61037	59669
16	1034	71271	6765	8180	41045	138724	130198	24357	14379	23773	29969	39114	4277	71951	73453	96960	93021
17	1499	22119	15552	25997	9939	29763	219435	64809	23877	29710	20988	26097	8270	56570	59348	87339	130177
18	1140	3665	17573	47123	7593	9245	230202	110934	54208	30013	13414	32861	19781	22594	72239	40866	155247
19	4032	2167	10349	74331	14615	4970	121884	144384	108902	36047	14029	29489	27898	12501	74283	28312	179357
20	7430	3097	2514	83897	24467	3328	33879	100682	153048	68928	13962	20335	29190	18149	55461	22778	156658
21	16559	4479	1078	40486	46504	3306	16450	38742	135158	101923	18530	14731	24042	24890	28013	18751	86575
22	33994	9816	3011	10581	70167	5125	8472	9863	83283	98256	33310	17528	21181	25754	23745	12635	48011
23	68369	18570	10028	3744	51568	7222	7632	3978	37902	62655	56319	29378	18209	17298	19916	8313	29273
24	102943	33229	13236	3855	23847	8078	9824	3261	17322	24171	57007	61585	29389	17322	21186	7521	18368
25	108959	50665	28825	7720	10049	5812	11309	3704	7875	9733	33609	75417	54137	14734	16263	7312	11706
26	79514	60423	42888	9638	12417	5431	9941	4600	4102	5921	14895	57490	76085	18293	14695	7561	11260
27	33899	49923	41939	9642	16819	4256	6971	4265	5830	4280	5807	20106	78418	17465	13793	7875	8280
28	13963	31600	28902	8402	18154	4326	8135	4642	4150	3998	2710	6614	54137	13151	12150	6742	7280
29	6818	17451	16287	5836	12743	3066	6925	4694	4325	2790	1258	2472	21494	7232	9235	4988	5204
30	9150	10747	9819	4833	11009	2882	4765	4493	2995	3195	828	804	4582	5003	5643	3945	3753
31	7567	8245	7209	3513	7557	2362	3995	3479	2489	1977	959	701	1715	1439	2210	2264	2651
32	8886	9234	6686	3034	4866	1882	3611	2792	2280	1514	762	652	890	782	818	1556	1835
33	8570	6908	5710	3287	4450	2012	2463	2304	2050	1291	619	470	1120	337	572	756	1132
34	7451	6529	6333	3279	4276	1660	1613	1897	1410	981	517	401	578	405	286	639	762
35	5646	6544	4312	2567	3486	1536	1468	1591	948	590	293	347	382	199	122	171	323
36	4929	5410	3975	2295	2635	1518	1039	1441	757	544	310	221	388	161	113	207	166
37	3631	3912	3065	1811	2014	1425	590	1205	568	305	194	134	357	67	68	135	108
38	3166	2501	2223	1488	1620	904	549	717	402	212	142	81	67	80	54	117	98
39	3092	4145	2425	1739	2156	1392	520	932	471	212	168	78	131	67	27	117	
40	2090	2908	1634	1079	1410	831	379	493	266	143	65	39	87	27	14	45	
41	1499	1192	842	471	586	378	225	433	243	124	77	26	44	54	14	9	10
42	665	742	421	367	426	362	84	313	162	37	26	26		13	14	9	
43	253	291	253	179	165	103	28	156	69		65	13	29	40	14		
44	84	87	51	53	165	168	28	36	23	25	26		15			9	
45	84	87	67	53	45	26	28	36	23		13	26					
46		58	17	53	30	26		36			13						10
47			34	11		26		12									
48						39			12								
49																	
total	664025	638823	330614	748931	1509292	623284	935746	581692	730719	570876	400725	496163	566768	869393	1434771	596833	2085973

Table 5a. Cont.

Length (cm)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
4						60				6						
5						8							49	98		36
6				136	54	23		79	148		8	6	24	448		100
7	499	304	1547	573	477	369	93	176	299	29	104	73	73	14208	204	181
8	5985	94129	26849	5315	2640	2873	22	679	618	1107	1257	275	276	82525	714	562
9	8679	410980	214426	4271	5731	8073	746	1411	1186	6523	3578	464	319	51165	1020	2330
10	11172	569937	471628	5446	3386	11485	4620	423	1299	1922	1354	751	323	6862	3571	5015
11	47283	83653	269398	21536	5348	23157	4759	776	1442	983	885	1227	699	2955	11223	7345
12	109207	93826	255837	62810	7229	29988	6950	4118	1788	1438	4655	3534	1396	4966	81522	7088
13	305354	168066	460809	135178	7342	25966	15311	9633	3131	2223	8877	9595	1820	6436	290784	10138
14	563721	368890	359968	146220	14300	20163	30837	14883	3505	3070	10715	7083	2165	5139	326310	14105
15	496389	570816	235990	109149	37040	25053	48357	25999	6484	1617	4525	3772	2135	396	79894	33589
16	321931	705419	132602	150419	74563	26704	50389	45269	17687	1417	4320	9607	7030	2084	8084	109352
17	216267	1022160	204730	200256	106859	34783	34593	52347	31911	2773	4467	16026	8443	4337	6663	293069
18	199060	785217	363584	236520	147862	62837	35136	53475	38805	4709	4324	12224	6968	3825	6694	267280
19	182684	502051	489233	195040	182429	88896	54993	45700	37724	10856	5135	8913	10154	5497	7521	69949
20	169721	357550	396759	241170	274446	108084	108351	56535	39184	16088	8006	5861	13067	8430	7540	12827
21	163284	189221	256720	256356	244424	138236	158583	85639	40895	15534	12036	7385	10986	8874	8205	9979
22	179265	120687	144663	241869	209744	150168	160054	170639	53157	20601	19944	9485	8982	9114	8141	10116
23	132897	99934	101176	141913	137275	112686	134422	229288	86481	29962	22363	11989	10229	10066	9161	10797
24	81899	76563	71205	106627	138138	74872	101986	207034	113144	47408	25442	17167	17548	10602	13469	14457
25	41610	57756	42237	61464	93215	61323	58822	138854	120194	71544	34361	26812	25997	9734	15351	16582
26	32227	25060	38613	45511	49136	37645	31084	89036	103975	87171	47505	36954	35518	13409	18835	18749
27	18476	13669	25283	31512	37652	24648	20314	44921	66107	77264	57230	56320	43539	15608	20863	20504
28	12570	8322	13766	20128	19937	16266	12887	24186	39337	55550	56570	63205	56312	22358	18245	20205
29	8890	5071	8331	10536	19353	10922	6369	14517	22292	29457	38241	52836	56838	29229	20131	22738
30	7874	5648	9541	3737	6364	6414	3902	10679	13479	15175	27938	39903	46772	28332	21480	18233
31	3273	2393	3284	5765	4025	2468	2551	6786	6348	9152	13637	21091	33945	26976	20404	18036
32	2954	1722	2100	1171	2631	1586	1917	4326	5045	5462	7251	14203	23785	22176	20134	20204
33	1085	1340	3374	1034	2360	1450	1031	4062	2836	3982	3708	6908	10878	13854	14870	12276
34	736	479	909	371	175	572	383	2266	2037	2924	2433	2999	5472	7490	11217	8365
35	310	383	238	312	1587	151	21	721	581	1394	3185	1910	1714	3455	7585	5944
36	174	192	71	29	563	60	21	693	536	1951	1877	1036	1257	1259	3180	5509
37	29		20	29	249	50	21	322	607	272	800	662	823	992	1799	2087
38	29	96	10	39	46	30	11		105	415	1245	65	336	333	699	1390
39	19			29	46	101		171	219	88	263	64	94	78	405	540
40		95	10	20	1657						283		28	45	152	382
41				10	37		10				10		85	49	10	
42				10		10				125				12	130	51
43														59		
44														16	10	
45																
46														7		
47																
48														10		
49															10	
total	3325555	6341632	4604910	2442512	1838324	1108180	1089546	1345643	862595	530193	438533	450404	446079	433509	1066230	1070110

Table 5b. 3M beaked redfish abundance at age ('000s) from EU bottom trawl survey series, 1989-2020.

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	51141	5419	154985	127962	17656	20484	13299	8087	4191	3885	3395	3015	2480	954	1514	1139	652	3151	748931	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	2002
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	2006
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	2007
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
2019	98254	627081	76920	12370	23242	19818	26852	22285	14126	7763	7209	8585	11574	12642	14469	15284	17375	11843	38538	1066230	2017
2020	22657	71527	397682	317249	39026	29533	30136	22358	15713	12108	7159	8544	8683	12357	12685	12157	12151	12507	25878	1070110	2017

Table 5c. 3M beaked redfish mature female abundance at age ('000s) from EU survey series, 1988-2020.

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
2019	1	15	6	7	113	760	2790	3428	2920	1759	1622	3446	5690	8542	9654	9201	9800	5717	20233	85683
2020	0	8	66	134	249	1090	2999	3152	3333	3132	2923	3417	3539	4775	6677	6652	6089	6962	13991	69114

Table 5d. 3M beaked redfish proportion of mature females at age from the EU survey series, 1988-2020.

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	0.584	0.626	0.696	0.675	0.683	0.772
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
2019	0.000	0.000	0.000	0.001	0.005	0.038	0.104	0.154	0.207	0.227	0.225	0.401	0.492	0.676	0.667	0.602	0.564	0.483	0.525
2020	0.000	0.000	0.000	0.000	0.006	0.037	0.099	0.141	0.212	0.259	0.408	0.400	0.408	0.386	0.526	0.547	0.501	0.557	0.541

Table 5e. maturity ogive at age for 3M beaked redfish as the average proportion of mature females at age, from the EU survey series, 1989-2020.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+
Fem. proportion	0.001	0.002	0.005	0.011	0.022	0.050	0.107	0.200	0.290	0.375	0.445	0.490	0.539	0.574	0.591	0.633	0.640	0.667	0.712
cv 1989-2020	0.001	0.003	0.006	0.012	0.015	0.024	0.052	0.106	0.123	0.149	0.142	0.142	0.157	0.155	0.153	0.184	0.157	0.167	0.135

Table 6a. Weights at age of the 3M beaked redfish stock (kg) from EU surveys, 1989-2020.

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
2019	0.028	0.042	0.057	0.084	0.125	0.182	0.238	0.276	0.332	0.331	0.360	0.404	0.449	0.512	0.516	0.494	0.485	0.445	0.486
2020	0.022	0.054	0.080	0.094	0.132	0.202	0.265	0.300	0.348	0.380	0.446	0.456	0.442	0.450	0.511	0.522	0.497	0.518	0.523

Table 6b. Weights at age of the 3M mature female beaked redfish stock (kg) from EU surveys, 1989-2020.

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
2019	0.029	0.044	0.060	0.094	0.144	0.200	0.253	0.284	0.346	0.363	0.366	0.488	0.517	0.545	0.564	0.538	0.530	0.507	0.545
2020	0.025	0.056	0.083	0.108	0.161	0.217	0.281	0.312	0.368	0.410	0.512	0.501	0.498	0.498	0.565	0.577	0.559	0.567	0.589

Table 7a. 3M beaked redfish survey mean catch per tow from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2020 by RV Vizconde de Eza (VE); former period converted to new RV units).

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
mean weight per tow (kg/tow)	199	159	109	85	147	68	125	90	125	104	74	103	146	78	129	57	185
SE	32	21	13	10	17	24	38	10	17	18	12	30	57	12	17	7	26
CV	16%	13%	12%	12%	12%	36%	30%	11%	14%	18%	16%	29%	39%	16%	13%	13%	14%
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
mean weight per tow (kg/tow)	297	532	279	224	342	178	132	183	233	178	158	169	174	111	149	195	
SE	53	79	43	45	92	34	16	23	26	26	19	23	32	11	19	35	
CV	18%	15%	15%	20%	27%	19%	12%	12%	11%	15%	12%	14%	18%	9%	13%	18%	

Table 7b. 3M beaked redfish abundance, stock and female spawning biomass ('000 tons) from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2020 by RV Vizconde de Eza (VE); former period converted to new RV units).

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
abundance (millions)	664	639	331	749	1509	623	936	582	731	571	401	496	567	869	1435	597	2086
4 abundance (millions)	20	19	25	155	58	306	678	115	25	86	35	80	33	86	236	63	145
4+abundance (millions)	541	362	265	367	385	376	840	497	657	502	284	410	471	273	437	225	758
biomass ('000 ton)	160	128	89	72	127	55	107	76	104	85	61	85	120	66	107	51	153
4+ biomass ('000 ton)	155	113	86	67	92	45	100	71	101	82	56	81	116	51	69	34	106
female spawning biomass ('000 ton)	28	28	23	12	16	7	7	7	7	6	3	8	19	7	8	4	10
SSB proportion	18%	25%	26%	18%	18%	16%	7%	10%	7%	8%	6%	10%	16%	13%	11%	13%	9%
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
abundance (millions)	3326	6342	4605	2443	1838	1108	1060	1346	863	530	439	450	446	434	1066	1070	
4 abundance (millions)	425	1528	538	442	354	187	219	132	81	18	10	14	20	12	12	224	
4+abundance (millions)	1402	2854	1971	1708	1553	824	873	1165	776	502	391	391	421	256	256	466	
biomass ('000 ton)	300	482	377	307	286	164	172	254	189	146	126	136	137	89	126	157	
4+ biomass ('000 ton)	209	329	282	267	266	147	159	242	182	144	124	132	135	87	92	111	
female spawning biomass ('000 ton)	20	24	39	40	47	27	20	36	39	57	34	48	64	40	43	35	
SSB proportion	10%	7%	14%	15%	18%	18%	13%	15%	22%	40%	27%	37%	47%	47%	47%	32%	

Table 8. 3M beaked redfish input files of the 2021 XSA analysis.

REDFISH NAFO DIVISION 3M INDEX OF INPUT XSA FILES 2021

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	2020
	4	19
	5	
58086		
80223		
48500		
43300		
43100		
17664		
13879		
6101		
1408		
1011		
1095		
3841		
3327		
2964		
2273		
3260		
4065		
5936		
5131		
4274		
3639		
5235		
8904		
6433		
5139		
4500		
5169		
6067		
6914		
10329		
10245		
8695		

Table 8. Cont.

REDFISH NAFO 3M CATCH NUMBERS thousands

1	2															
1989	2020															
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	
316	6830	7733	16337	17715	11639	7493	5607	4430	4233	3256	2920	1942	1183	758	1717	
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	42	16	72	265	610	370	82	112	261	39	77	77	68	102	144	
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	
768	373	717	878	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	
968	1602	1683	1370	827	351	239	577	1123	1878	962	752	460	138	39	2418	
694	1720	3675	5607	3234	1523	949	425	398	204	258	243	75	180	74	343	
1396	3659	2111	2054	1472	1101	531	429	382	153	386	511	275	198	44	853	
1260	3928	5040	1624	1223	1018	1032	1217	667	479	343	661	152	126	101	548	
1060	3834	3832	3374	1604	1895	2013	1596	1738	452	607	206	154	209	125	168	
61	840	1940	2344	1870	2002	939	2887	2726	2122	378	912	390	674	375	597	
196	1304	4510	3789	1995	2737	2864	1123	1381	1852	3386	2890	2007	1144	1111	2796	
3	43	203	685	1035	1633	793	1121	1076	1749	2041	2164	2591	3104	1869	6716	
1	2	20	288	398	561	651	647	852	802	1152	1570	1638	1491	1598	3437	

REDFISH NAFO 3M CATCH WEIGHT AT AGE kg

1	3														
1989	2020														
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
0.154	0.198	0.263	0.337	0.389	0.438	0.503	0.583	0.626	0.693	0.732	0.751	0.851	0.804	0.933	1.014
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	1.029
0.101	0.139	0.201	0.326	0.364	0.350	0.432	0.509	0.596	0.552	0.579	0.567	0.581	0.673	0.609	0.735
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	0.990
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	0.876
0.085	0.107	0.190	0.253	0.288	0.341	0.384	0.454	0.500	0.409	0.584	0.587	0.633	0.550	0.692	0.664
0.091	0.131	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
0.087	0.112	0.182	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	0.204	0.248	0.290	0.335	0.394	0.407	0.514	0.508	0.505	0.582	0.640	0.625	0.463	0.746
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	0.614
0.110	0.140	0.179	0.245	0.286	0.339	0.421	0.422	0.474	0.487	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	0.807
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
0.084	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
0.107	0.158	0.200	0.249	0.278	0.332	0.343	0.338	0.371	0.394	0.426	0.422	0.405	0.404	0.388	0.394
0.108	0.150	0.234	0.305	0.331	0.392	0.447	0.549	0.529	0.542	0.530	0.604	0.625	0.607	0.608	0.658

Table 8. Cont.

REDFISH NAFO 3M STOCK WEIGHT AT AGE kg

1 1989 4 1	4 2020 19														
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
0.084	0.125	0.182	0.238	0.276	0.332	0.331	0.360	0.404	0.449	0.512	0.516	0.494	0.485	0.445	0.486
0.094	0.132	0.202	0.265	0.300	0.348	0.380	0.446	0.456	0.442	0.450	0.511	0.522	0.497	0.518	0.523

Table 8. Cont.

REDFISH NAFO 3M PROPORTION MATURE FEMALES (Build using three year moving averages of annual mature female proportions at age).

1	6														
1989	2020														
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	0.612	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	0.310	0.363	0.403	0.465	0.514	0.543	0.825	0.670	0.723	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	0.092	0.146	0.250	0.298	0.348	0.459	0.592	0.740	0.624	0.797	0.652	0.674	0.713
0.000	0.004	0.028	0.079	0.129	0.209	0.241	0.318	0.410	0.500	0.577	0.606	0.660	0.579	0.570	0.590
0.000	0.004	0.028	0.079	0.129	0.209	0.241	0.318	0.410	0.500	0.577	0.606	0.660	0.579	0.570	0.590

REDFISH NAFO 3M PROPORTION OF F BEFORE
SPAWNING

1	7
1989	2020
4	19
3	
0.08	

REDFISH NAFO 3M PROPORTION OF M BEFORE
SPAWNING

1	8
1989	2020
4	19
3	
0.08	

Table 8. Cont.

REDFISH NAFO 3M F ON OLDEST AGE GROUP
BY YEAR

1	9
1989	2020
4	19
5	
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	
0.2066	
0.1700	
0.3548	
0.1995	
0.9460	
0.0443	
0.1203	
0.0996	
0.7619	
0.1187	
0.1180	
0.0735	
0.0838	
0.0453	
0.0777	
0.1903	
0.1903	
0.1903	

Table 8. Cont.

REDFISH NAFO 3M SURVEY TUNNING DATA

101

EU BOTTOM TRAWL SURVEY

1989

2020

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	154985	127962	17656	20484	13299	8087	4191	3885	3395	3015	2480	954	1514	1139	652	3151
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
10555	12370	23242	19818	26852	22285	14126	7763	7209	8585	11574	12642	14469	15284	17375	11843	38538
10555	317249	39026	29533	30136	22358	15713	12108	7159	8544	8683	12357	12685	12157	12151	12507	25878



Table 9. 3M beaked redfish key diagnostics of XSA2021 runs for a set of 2019-2020 M candidates

<i>M</i> ₂₀₁₉₋₂₀₂₀	0.08	0.1	0.12	0.14
SS log q residuals ₂₀₁₉₋₂₀₂₀	10.86	10.86	10.86	10.86
SS log q residuals ₂₀₁₁₋₂₀₂₀	41.63	41.63	41.63	41.63
XSA versus SURVEY r^2 ₂₀₁₁₋₂₀₂₀	0.8877	0.8868	0.8859	0.8850
Survivors Average Int. <i>s.e</i>	0.3176	0.3179	0.3183	0.3186
Survivors Average Ext. <i>s.e</i>	0.1839	0.1865	0.1889	0.1913

Table 10. 3M beaked redfish 2021 Extended Survivor Analysis summary of diagnostics.

Lowestoft VPA Version 3.1

02/06/2021 20:52:00

Extended Survivors Analysis

REDFISH NAFO DIVISION 3M INDEX OF INPUT XSA FILES 2021

CPUE data from file red3mtun.txt

Catch data for 32 years. 1989 to 2020. Ages 4 to 19.

Fleet	First year	Last year	First age	Last age	Alpha	Beta						
EU BOTTOM TRAWL SURV	1989	2020	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 107 iterations												
Log catchability residuals.												
Fleet : EU BOTTOM TRAWL SURV												
Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
4	-1.52	-0.94	1.31	0.47	1.26	1.04	1.01	0.04	1.11	0.3	0.73	-0.35
5	-2.84	-3.55	0.85	1.41	-0.86	0.86	0.51	1.61	1.38	0.09	0.51	0.41
6	-1.71	-1.91	-1.42	0.65	-0.08	0.47	-0.82	0.88	0.92	0.87	0.34	0.62
7	-0.87	-0.83	-1.32	-0.19	-0.8	0.39	0.04	0.05	0.46	0.13	0.89	0.71
8	-0.25	-0.23	-1.29	0.1	-0.68	0.01	0.29	0.94	-0.24	0.32	0.84	1.81
9	-0.2	-0.18	-1.24	0.07	-1.37	0.43	-0.12	0.85	0.91	0.05	0.97	1.28
10	-0.19	-0.07	-1.25	0.04	-0.5	0.4	0.88	0.19	1.06	-0.46	1.14	1.68
11	-0.17	-0.26	-0.82	-0.17	-0.32	0.67	1.19	1.12	0.08	-0.4	-0.68	1.02
12	-0.41	-0.49	-0.85	-0.14	-0.34	0.53	0.87	1.26	1.18	0.64	-0.32	0.22
13	-0.02	-0.05	-0.47	-0.01	-0.02	0.37	0.84	0.76	0.89	0.05	0.28	-0.66
14	-0.09	0.17	-0.42	-0.04	-0.01	0.04	0.42	0.92	0.86	0.03	-0.68	1.29
15	0.37	0.14	-0.91	0.35	0.2	0.34	1.12	0.42	-0.23	-1.25	0.35	-0.03
16	0.12	-0.02	-0.51	0.15	-0.23	-0.16	0.64	0.72	-0.61	-0.64	-0.01	-0.66
17	-0.06	0.22	-0.24	-0.32	0	-0.25	0.18	0.26	0.38	-0.33	-0.2	-0.93
18	0	0.08	-0.3	0.11	0.88	0.27	0.69	0.21	-0.86	-2.07	0.1	-1.36
Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
4	0.37	0.69	-1.05	-0.56	0.33	1.04	0.26	-0.2	-0.19	-0.43		
5	0.05	-0.02	-0.38	0.83	0.08	1.02	0.42	0.24	-0.07	-0.28		
6	0.14	0.04	-0.83	-0.04	1.03	0.63	0.76	0.67	0.28	-0.59		
7	0.35	-0.03	-0.95	-0.32	0.3	-0.03	0.69	0.28	0.32	0.01		
8	0.38	0.58	-0.6	-0.32	0.48	-0.41	-0.25	-0.29	0.58	-0.91		
9	0.32	0.82	-0.04	-0.37	0.38	-0.37	-0.32	-0.66	0.25	-0.58		
10	0.02	0.39	-0.03	0.18	0.54	-0.7	-0.91	-0.67	0.41	-0.21		
11	0.27	-0.05	0.04	-0.15	0.71	-0.52	-0.26	-0.43	-0.1	0.05		
12	0.21	-0.17	-0.65	-0.28	0.62	-0.16	-0.32	-0.55	0.88	-0.52		
13	0.33	0.45	-0.04	-0.39	0.39	-0.31	0	-0.47	-0.86	-0.26		
14	-0.42	0	0.62	-0.19	-0.85	-0.39	-0.02	-0.3	0.81	-0.58		
15	-0.25	0.34	-0.76	-0.85	-0.98	-0.65	-0.2	-1.22	-0.38	-1.22		
16	0.13	-1.08	0.67	0.92	-0.78	-0.65	2.06	-1.43	0.05	-0.48		
17	-0.83	-0.53	0.37	1.04	-0.13	0.89	-1.53	-1.48	-0.47	-0.77		
18	-1.02	-1.59	-0.42	-1.31	-1.17	-0.34	-1.44	-0.99	1.24	-0.75		
Age	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020		
4	0.35	0.18	-0.14	-1.2	-1.53	-1.07	-0.37	-0.53	-0.39	0		
5	-0.15	0.26	-0.32	-0.7	-0.71	-0.9	-0.22	-0.29	0.08	0.69		
6	-0.03	0.33	0.24	-0.32	-0.24	-0.75	-0.07	-0.22	-0.25	0.42		
7	-0.59	0.33	0.3	0.36	-0.06	0.09	0.23	-0.39	0.12	0.32		
8	-1.09	0.06	-0.17	-0.09	0.02	-0.07	0.09	-0.49	0.47	0.41		
9	-1.24	-0.46	-0.72	-0.27	-0.25	0.49	0.39	0.25	0.29	0.65		
10	-0.16	-1.42	-0.23	-0.99	-0.5	0.43	-0.1	0.45	-0.23	0.81		
11	-0.58	0.31	-0.82	-0.18	0	0.31	0.83	-0.48	-0.3	0.08		
12	-0.7	0.09	-0.2	-0.43	-0.16	0.43	0.76	-0.65	-0.4	0.07		
13	0.09	0.71	-0.75	-0.97	0.03	-0.09	0.73	-0.27	-0.26	-0.03		
14	-0.64	0.66	-0.23	-0.16	-0.48	0.2	-0.59	0.41	-0.21	-0.11		
15	0.86	1.03	0.32	0.56	1.11	-0.51	0.64	1.04	0.22	0.05		
16	0.35	1.14	0.01	0.34	-0.45	-1.1	0.02	0.45	0.94	0.08		
17	-0.98	-0.17	1.33	0.45	-0.15	-0.52	1.06	0.71	1.21	0.96		
18	0.26	0.44	1.15	0.22	0.59	-0.69	0.73	1.01	1.58	1.18		

Table 10. Cont.

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	-8.7078	-8.5417	-8.5328	-8.5686	-8.8928	-9.2374	-9.6911	-9.937	-9.9861	-10.2067	-10.1516	-10.2645	-10.1371	-10.1371	-10.1371
S.E(Log q)	0.8032	1.0613	0.7523	0.5219	0.6195	0.6556	0.6996	0.5405	0.5789	0.488	0.5212	0.7116	0.7312	0.7429	0.9562

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	0.93	0.604	8.88	0.69	32	0.75	-8.71
5	1.15	-0.668	8.22	0.41	32	1.23	-8.54
6	1.05	-0.357	8.43	0.6	32	0.8	-8.53
7	1.1	-0.927	8.39	0.74	32	0.58	-8.57
8	1.37	-2.669	8.41	0.63	32	0.78	-8.89
9	1.38	-2.721	8.98	0.63	32	0.83	-9.24
10	1.27	-1.952	9.69	0.64	32	0.85	-9.69
11	1.12	-1.242	9.99	0.79	32	0.6	-9.94
12	1.25	-2.617	10.19	0.78	32	0.67	-9.99
13	1.12	-1.663	10.37	0.86	32	0.53	-10.21
14	1.08	-1.043	10.27	0.86	32	0.56	-10.15
15	0.88	1.558	10.01	0.84	32	0.61	-10.26
16	0.99	0.145	10.1	0.77	32	0.73	-10.14
17	0.95	0.457	10.04	0.77	32	0.72	-10.16
18	0.74	3.176	9.42	0.83	32	0.61	-10.25

Terminal year survivor and F summaries :

Age 4 Catchability constant w.r.t. time and dependent on age**Year class = 2016**

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	173834	0.816	0	0	1	1	0
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
173834	0.82	0	1	0	0		

Age 5 Catchability constant w.r.t. time and dependent on age**Year class = 2015**

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	9096	0.65	0.521	0.8	2	1	0
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
9096	0.65	0.52	2	0.801	0		

Age 6 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	8945	0.495	0.299	0.6	3	1	0.002
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
8945	0.5	0.3	3	0.604	0.002		

Age 7 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	10288	0.362	0.181	0.5	4	1	0.026
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
10288	0.36	0.18	4	0.5	0.026		

Age 8 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	9620	0.318	0.22	0.69	5	1	0.039
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
9620	0.32	0.22	5	0.691	0.039		

Table 10. Cont.**Age 9** 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	7426	0.292	0.291	0.99	6	1	0.069
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
7426	0.29	0.29	6	0.995	0.069		

Age 10 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	7635	0.271	0.248	0.92	7	1	0.078
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
7635	0.27	0.25	7	0.915	0.078		

Age 11 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	12067	0.243	0.077	0.32	8	1	0.05
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
12067	0.24	0.08	8	0.319	0.05		

Age 12 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	15323	0.223	0.093	0.42	9	1	0.052
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
15323	0.22	0.09	9	0.417	0.052		

Age 13 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	21527	0.203	0.108	0.53	10	1	0.035
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
21527	0.2	0.11	10	0.532	0.035		

Age 14 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	31620	0.189	0.135	0.71	11	1	0.034
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
31620	0.19	0.14	11	0.715	0.034		

Age 15 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	30605	0.183	0.106	0.58	12	1	0.048
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
30605	0.18	0.11	12	0.578	0.048		

Age 16 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	25046	0.178	0.146	0.82	13	1	0.06
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
25046	0.18	0.15	13	0.823	0.06		

Table 10. Cont.**Age 17** Catchability constant w.r.t. time and age (fixed at the value for age) 16**Year class = 2003**

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	10039	0.174	0.163	0.94	14	1	0.132
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
10039	0.17	0.16	14	0.935	0.132		

Age 18 Catchability constant w.r.t. time and age (fixed at the value for age) 16**Year class = 2002**

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	8131	0.171	0.209	1.22	15	1	0.171
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
8131	0.17	0.21	15	1.22	0.171		

Table 11. 3M beaked redfish Main results of retrospective 2021 XSA2020-2016.

Biomass	2020	2019	2018	2017	2016	FemBiomass	2020	2019	2018	2017	2016
1989	228.5	225.4	220.9	221.0	220.2	1989	59.0	57.3	54.8	54.9	54.4
1990	194.5	191.8	188.6	188.7	188.0	1990	54.8	53.3	51.6	51.7	51.3
1991	142.6	139.8	135.5	135.6	135.1	1991	46.7	45.0	42.6	42.6	42.3
1992	104.5	102.5	100.2	100.3	99.8	1992	36.1	35.0	34.1	34.1	33.8
1993	71.3	70.0	68.7	68.8	68.5	1993	20.9	20.3	20.2	20.2	20.0
1994	51.2	49.5	46.3	46.2	45.8	1994	10.4	9.9	9.3	9.3	9.2
1995	42.1	40.4	37.5	37.4	36.9	1995	9.4	8.9	8.4	8.4	8.3
1996	31.6	29.9	26.3	26.1	25.7	1996	6.5	6.0	5.0	5.0	4.9
1997	33.7	31.3	25.3	25.1	24.6	1997	8.0	7.1	4.7	4.7	4.6
1998	39.2	36.0	27.3	27.1	26.6	1998	11.4	9.9	5.7	5.7	5.5
1999	32.8	31.1	27.7	27.5	27.0	1999	6.0	5.6	4.7	4.6	4.5
2000	42.9	40.2	34.0	33.8	33.2	2000	10.9	9.8	7.0	6.9	6.7
2001	41.0	39.1	35.2	35.0	34.3	2001	9.6	9.0	7.5	7.4	7.3
2002	48.8	46.4	41.1	40.8	40.0	2002	11.3	10.5	8.5	8.4	8.2
2003	52.1	49.7	45.4	45.1	43.6	2003	11.8	11.1	9.5	9.4	9.1
2004	78.5	74.4	67.1	65.0	62.2	2004	18.3	16.8	13.3	13.1	12.7
2005	95.7	91.9	84.7	81.6	78.1	2005	20.7	19.6	17.2	16.9	16.4
2006	132.7	125.5	112.9	108.0	102.2	2006	25.2	23.9	21.7	21.4	20.6
2007	152.3	142.1	125.8	119.2	114.3	2007	34.8	32.9	29.7	29.0	27.8
2008	194.5	181.9	159.4	150.9	140.9	2008	52.9	49.8	43.8	42.4	40.2
2009	188.9	177.5	162.0	156.1	143.9	2009	45.2	42.7	40.3	38.7	36.4
2010	184.2	173.6	156.9	154.2	139.3	2010	46.7	43.7	38.4	36.6	34.1
2011	152.0	143.7	132.2	132.1	120.3	2011	39.4	36.9	33.1	31.4	29.1
2012	166.6	156.7	145.4	145.0	131.1	2012	55.1	50.8	46.0	43.9	40.5
2013	169.9	160.5	149.1	148.5	133.1	2013	63.7	59.4	53.1	50.8	45.9
2014	186.2	175.5	162.0	161.8	143.5	2014	81.5	76.3	68.1	66.5	59.6
2015	176.1	165.5	153.1	152.8	134.1	2015	78.4	73.5	66.7	66.1	58.9
2016	170.4	159.5	145.7	144.5	125.3	2016	76.9	71.9	64.5	63.7	56.3
2017	147.0	136.6	125.0	123.7		2017	72.7	67.9	61.6	60.9	
2018	138.6	128.0	116.5			2018	69.7	64.9	58.9		
2019	128.6	117.6				2019	60.4	56.2			
2020	133.1					2020	56.5				
FBAR	2020	2019	2018	2017	2016	REC	2020	2019	2018	2017	2016
1989	0.304	0.310	0.317	0.317	0.319	1989	53.9	53.8	53.6	53.6	53.6
1990	0.471	0.478	0.483	0.482	0.484	1990	44.4	44.1	43.3	43.3	43.3
1991	0.361	0.364	0.368	0.368	0.369	1991	26.0	25.9	25.6	25.6	25.6
1992	0.544	0.552	0.565	0.565	0.566	1992	22.2	22.2	22.1	22.1	22.1
1993	0.602	0.619	0.651	0.651	0.654	1993	139.9	139.8	139.5	139.5	139.5
1994	0.400	0.415	0.457	0.457	0.459	1994	178.8	173.4	157.7	156.6	154.7
1995	0.532	0.564	0.685	0.685	0.690	1995	26.8	26.5	28.1	28.0	27.7
1996	0.366	0.391	0.512	0.512	0.518	1996	15.6	15.0	13.4	13.3	13.2
1997	0.106	0.113	0.140	0.140	0.142	1997	17.7	17.1	16.7	16.6	16.4
1998	0.060	0.065	0.083	0.083	0.084	1998	15.8	15.4	15.3	15.3	15.1
1999	0.080	0.087	0.120	0.120	0.123	1999	23.4	23.0	23.9	23.8	23.6
2000	0.167	0.179	0.229	0.229	0.233	2000	28.4	27.9	27.1	27.1	26.9
2001	0.127	0.135	0.157	0.158	0.160	2001	36.6	35.7	35.1	35.0	34.5
2002	0.144	0.153	0.184	0.185	0.187	2002	72.6	69.3	59.9	59.6	58.6
2003	0.104	0.112	0.142	0.142	0.144	2003	110.3	106.4	103.6	102.9	93.2
2004	0.082	0.087	0.096	0.097	0.098	2004	154.7	149.8	148.5	130.4	121.5
2005	0.124	0.133	0.155	0.156	0.159	2005	186.3	181.5	159.7	152.3	148.2
2006	0.062	0.066	0.070	0.072	0.075	2006	388.8	352.0	288.8	271.8	251.3
2007	0.115	0.122	0.119	0.121	0.126	2007	296.3	266.3	228.0	208.0	212.3
2008	0.049	0.051	0.058	0.059	0.062	2008	386.8	364.1	318.1	300.6	259.2
2009	0.036	0.038	0.040	0.042	0.043	2009	305.4	291.4	278.8	289.2	255.7
2010	0.047	0.050	0.054	0.056	0.058	2010	208.2	204.7	202.8	224.1	187.5
2011	0.172	0.180	0.181	0.185	0.193	2011	96.4	93.8	95.1	107.0	108.9
2012	0.090	0.095	0.105	0.107	0.114	2012	68.1	65.5	67.5	62.8	54.3
2013	0.031	0.033	0.036	0.036	0.039	2013	58.0	55.5	55.2	51.3	45.7
2014	0.027	0.029	0.032	0.033	0.037	2014	38.3	33.5	28.8	28.2	16.6
2015	0.038	0.040	0.042	0.045	0.051	2015	29.8	25.9	19.8	15.3	7.9
2016	0.051	0.056	0.063	0.066	0.110	2016	25.3	21.6	14.6	10.5	7.0
2017	0.062	0.070	0.083	0.096		2017	17.6	12.6	11.0	10.0	
2018	0.133	0.156	0.221			2018	12.4	8.5	6.2		
2019	0.076	0.091				2019	11.1	6.9			
2020	0.045					2020	192.1				

Table 12. 3M beaked redfish XSA results for 2021 assessment.

Run title : REDFISH NAFO DIVISION 3M INDEX OF INPUT XSA FILES 2021
 Terminal Fs derived using XSA (Without F shrinkage)

Table 8 Fishing mortality (F) at age		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
YEAR	AGE																
	4	0.0087	0.2821	0.0509	0.0151	1.7845	0.3803	0.1149	0.1164	0.042	0.0073	0.0068	0.0033	0.0241	0.021	0.0165	0.0069
	5	0.0157	0.0622	0.1331	0.3869	0.8043	0.3813	0.1354	0.189	0.0121	0.004	0.0031	0.0065	0.0139	0.0114	0.0323	0.045
	6	0.0839	0.1017	0.1949	0.4135	0.2669	0.2404	0.5657	0.0574	0.0394	0.0102	0.0012	0.0169	0.0217	0.0223	0.0103	0.0493
	7	0.2106	0.4341	0.4563	0.8228	0.287	0.3075	0.4277	0.2463	0.0113	0.0215	0.0075	0.0331	0.0811	0.0354	0.0206	0.0655
	8	0.2973	0.7548	0.6442	0.9782	0.5002	0.3171	0.5139	0.5743	0.0617	0.0112	0.0226	0.126	0.1337	0.0995	0.04	0.0604
	9	0.273	0.7208	0.5924	0.7175	0.2453	0.5132	0.2932	0.5771	0.192	0.1156	0.0108	0.1469	0.1354	0.1306	0.0796	0.0518
	10	0.2367	0.5806	0.3666	0.5056	0.4978	0.5315	0.5578	0.2721	0.2159	0.0583	0.1265	0.0864	0.1101	0.1028	0.0668	0.0634
	11	0.2977	0.4365	0.367	0.3903	0.6983	0.61	0.7215	0.5628	0.0801	0.0649	0.0821	0.3073	0.0795	0.1015	0.086	0.0496
	12	0.2716	0.34	0.2874	0.4061	0.7313	0.5478	0.5428	0.6132	0.2372	0.1619	0.1157	0.2183	0.2621	0.0529	0.0589	0.0568
	13	0.3599	0.4001	0.3126	0.3914	0.8401	0.3787	0.5077	0.3221	0.1336	0.0711	0.154	0.0898	0.2053	0.3466	0.0412	0.0563
	14	0.3624	0.5248	0.307	0.4048	0.8759	0.3201	0.3905	0.3649	0.136	0.084	0.0732	0.5599	0.0951	0.2674	0.3434	0.0369
	15	0.5022	0.4543	0.1682	0.5134	0.9211	0.3881	0.7363	0.1758	0.0331	0.0164	0.1616	0.1482	0.0928	0.3274	0.0708	0.041
	16	0.449	0.4348	0.2684	0.4411	0.7576	0.2437	0.5987	0.2575	0.0212	0.0465	0.1245	0.1005	0.1809	0.099	0.3259	0.3653
	17	0.3286	0.5088	0.3576	0.2801	0.7459	0.2127	0.3851	0.1588	0.0494	0.0575	0.1147	0.0669	0.0602	0.2017	0.15	0.2132
	18	0.3653	0.4498	0.3608	0.3335	1.5572	0.3379	0.595	0.1546	0.0142	0.0075	0.1066	0.078	0.0674	0.033	0.1206	0.0505
	+gp	0.3653	0.4498	0.3608	0.3335	1.5572	0.3379	0.595	0.1546	0.0142	0.0075	0.1066	0.078	0.0674	0.033	0.1206	0.0505
	0 FBAR 6-16	0.304	0.4711	0.3605	0.5441	0.6019	0.3998	0.5324	0.3658	0.1056	0.0601	0.08	0.1667	0.1271	0.1441	0.104	0.0815

Table 8 Fishing mortality (F) at age		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	FBAR **..**
YEAR	AGE																	
	4	0.0043	0.0064	0.0018	0.0008	0.0017	0.0162	0.0378	0.0153	0.0129	0.0398	0.0455	0.045	0.0037	0.0168	0.0003	0	0.0057
	5	0.0028	0.036	0.0037	0.0045	0.0022	0.0329	0.0289	0.021	0.0317	0.0821	0.1381	0.1703	0.0411	0.0904	0.0041	0.0002	0.0316
	6	0.0089	0.0852	0.0093	0.0187	0.0132	0.0301	0.0347	0.0153	0.0573	0.0465	0.1427	0.1739	0.1096	0.2865	0.0164	0.0021	0.1017
	7	0.0192	0.0802	0.0594	0.038	0.0175	0.0511	0.0203	0.013	0.0606	0.0387	0.0422	0.1204	0.1374	0.2878	0.0573	0.0263	0.1238
	8	0.0624	0.06	0.0365	0.048	0.0325	0.0161	0.0198	0.0091	0.0359	0.019	0.0268	0.0481	0.0816	0.1492	0.1061	0.0386	0.098
	9	0.1062	0.073	0.0609	0.0471	0.0318	0.0217	0.019	0.0078	0.0193	0.0144	0.0151	0.0477	0.0705	0.148	0.1573	0.0694	0.1249
	10	0.1141	0.0451	0.0431	0.0375	0.0377	0.0343	0.0765	0.006	0.0244	0.0079	0.0155	0.0338	0.0271	0.1226	0.0524	0.078	0.0843
	11	0.1702	0.0482	0.0799	0.0468	0.0338	0.0562	0.0852	0.0285	0.0122	0.0129	0.0206	0.027	0.056	0.037	0.0581	0.0497	0.0483
	12	0.1988	0.0624	0.1114	0.0456	0.0482	0.0393	0.1558	0.0638	0.023	0.0128	0.0231	0.0334	0.053	0.0309	0.0407	0.0515	0.0411
	13	0.1446	0.0555	0.1077	0.0393	0.0217	0.0859	0.0661	0.1452	0.0138	0.0104	0.0184	0.0176	0.047	0.0417	0.045	0.0348	0.0405
	14	0.1113	0.0755	0.1124	0.0834	0.0718	0.0611	0.1711	0.1154	0.0248	0.0306	0.0267	0.0263	0.0166	0.0886	0.0533	0.0341	0.0587
	15	0.0556	0.0636	0.1269	0.0537	0.0272	0.0259	0.4657	0.2654	0.0359	0.059	0.0619	0.0181	0.0452	0.1523	0.0677	0.0476	0.0892
	16	0.3668	0.0376	0.5198	0.0757	0.0628	0.0976	0.7766	0.3224	0.0352	0.0488	0.0206	0.0166	0.039	0.1194	0.1779	0.0604	0.1192
	17	0.5804	0.3724	0.03	0.0927	0.0299	0.0598	0.5894	0.1812	0.1863	0.1153	0.0262	0.0321	0.0843	0.138	0.2444	0.1322	0.1715
	18	0.1277	0.1102	0.2225	0.0294	0.1521	0.0559	0.6002	0.0926	0.1296	0.0593	0.0728	0.0295	0.0669	0.1745	0.3109	0.1714	0.219
	+gp	0.1277	0.1102	0.2225	0.0294	0.1521	0.0559	0.6002	0.0926	0.1296	0.0593	0.0728	0.0295	0.0669	0.1745	0.3109	0.1714	
	0 FBAR 6-16	0.1235	0.0624	0.1152	0.0485	0.0362	0.0472	0.1719	0.0902	0.0311	0.0273	0.0376	0.0512	0.0621	0.1331	0.0756	0.0448	



Table 12. Cont.

Table 9 Relative F at age																		
YEAR	AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	
	4	0.0286	0.5987	0.1413	0.0277	2.9645	0.9513	0.2158	0.3182	0.3975	0.1214	0.085	0.0198	0.1893	0.1457	0.1583	0.0848	
	5	0.0515	0.1319	0.3692	0.7112	1.3362	0.9537	0.2544	0.5168	0.1147	0.0673	0.0391	0.0391	0.1097	0.0794	0.3109	0.5517	
	6	0.2758	0.2159	0.5408	0.76	0.4434	0.6012	1.0626	0.1568	0.3727	0.1703	0.0152	0.1017	0.1705	0.1544	0.0987	0.6055	
	7	0.6926	0.9213	1.2659	1.5123	0.4768	0.769	0.8035	0.6733	0.1073	0.3571	0.0944	0.1985	0.6386	0.2454	0.1977	0.8043	
	8	0.9779	1.6021	1.7873	1.798	0.831	0.7932	0.9653	1.5702	0.5847	0.1858	0.2821	0.7558	1.0521	0.6907	0.3848	0.7414	
	9	0.8981	1.5299	1.6436	1.3187	0.4075	1.2835	0.5508	1.5778	1.8182	1.9227	0.1349	0.8816	1.0656	0.9061	0.7659	0.6355	
	10	0.7786	1.2323	1.017	0.9294	0.827	1.3293	1.0478	0.7439	2.0446	0.9694	1.5814	0.5182	0.8666	0.7136	0.6427	0.7781	
	11	0.9791	0.9264	1.0181	0.7174	1.1601	1.5256	1.3554	1.5385	0.7587	1.0794	1.027	1.8437	0.6258	0.704	0.8277	0.6085	
	12	0.8934	0.7217	0.7972	0.7465	1.2148	1.3701	1.0196	1.6765	2.2465	2.691	1.4466	1.3099	2.0624	0.3671	0.5663	0.6972	
	13	1.1838	0.8492	0.8672	0.7195	1.3956	0.9472	0.9538	0.8805	1.2652	1.1822	1.9261	0.5391	1.6154	2.4046	0.3961	0.6907	
	14	1.1922	1.1139	0.8517	0.744	1.4551	0.8005	0.7336	0.9977	1.2879	1.3971	0.9153	3.3593	0.7484	1.8551	3.3038	0.4528	
	15	1.6518	0.9642	0.4666	0.9436	1.5302	0.9706	1.3832	0.4805	0.3132	0.2722	2.0204	0.8891	0.7307	2.2718	0.6812	0.5036	
	16	1.4768	0.923	0.7447	0.8108	1.2586	0.6096	1.1246	0.7041	0.2011	0.7728	1.5565	0.6032	1.4238	0.6872	3.1352	4.4823	
	17	1.0808	1.08	0.9921	0.5148	1.2391	0.5319	0.7233	0.4341	0.468	0.9566	1.4341	0.4012	0.4739	1.3994	1.4428	2.6168	
	18	1.2014	0.9547	1.0009	0.6129	2.587	0.8451	1.1178	0.4227	0.1344	0.1246	1.3335	0.4681	0.5305	0.2292	1.16	0.6197	
+gp		1.2014	0.9547	1.0009	0.6129	2.587	0.8451	1.1178	0.4227	0.1344	0.1246	1.3335	0.4681	0.5305	0.2292	1.16	0.6197	
0 REFMEAN		0.304	0.4711	0.3605	0.5441	0.6019	0.3998	0.5324	0.3658	0.1056	0.0601	0.08	0.1667	0.1271	0.1441	0.104	0.0815	
Table 9 Relative F at age																		
YEAR	AGE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	MEAN **_**
	4	0.0352	0.1026	0.0158	0.016	0.048	0.3426	0.2196	0.1692	0.415	1.4568	1.2111	0.8789	0.0588	0.1264	0.0038	0.0001	0.0434
	5	0.0229	0.5763	0.0321	0.092	0.061	0.6977	0.1682	0.2334	1.0174	3.0031	3.6739	3.3277	0.6623	0.6791	0.0545	0.0047	0.2461
	6	0.0722	1.3648	0.0809	0.3848	0.3643	0.6366	0.2019	0.17	1.841	1.7	3.7962	3.3979	1.7654	2.1527	0.2169	0.0474	0.8057
	7	0.1555	1.2859	0.5159	0.7823	0.4826	1.0825	0.1184	0.1441	1.9453	1.4136	1.1219	2.3528	2.2131	2.1622	0.7575	0.5869	1.1689
	8	0.5055	0.962	0.3164	0.9891	0.8988	0.3414	0.1153	0.1006	1.1522	0.6959	0.7137	0.9407	1.3144	1.1207	1.4026	0.862	1.1284
	9	0.8599	1.1696	0.5285	0.9701	0.8788	0.4591	0.1104	0.0863	0.6215	0.5267	0.4017	0.9314	1.1346	1.112	2.0788	1.5498	1.5802
	10	0.9245	0.723	0.374	0.7733	1.0428	0.7262	0.4449	0.0661	0.7836	0.2876	0.4112	0.6606	0.4364	0.9214	0.693	1.7415	1.1186
	11	1.3787	0.7722	0.6932	0.9646	0.9335	1.1906	0.4954	0.3164	0.3923	0.4725	0.5487	0.5272	0.9026	0.2779	0.7679	1.1109	0.7189
	12	1.6103	1.0005	0.9667	0.9388	1.3324	0.8325	0.9066	0.7073	0.7404	0.4675	0.6138	0.6533	0.8535	0.2325	0.5382	1.151	0.6406
	13	1.1711	0.8894	0.9347	0.8105	0.5982	1.8201	0.3847	1.6107	0.4417	0.3789	0.4886	0.3445	0.7563	0.3135	0.5948	0.7777	0.562
	14	0.9013	1.2104	0.9758	1.7191	1.9836	1.295	0.9951	1.2796	0.7973	1.1188	0.7102	0.5138	0.267	0.6657	0.7045	0.7608	0.7103
	15	0.4501	1.0192	1.1014	1.1065	0.7502	0.5487	2.7093	2.9435	1.1533	2.1557	1.6463	0.354	0.7287	1.144	0.8946	1.064	1.0342
	16	2.9709	0.6029	4.5123	1.5608	1.7349	2.0671	4.5178	3.5754	1.1314	1.7827	0.5476	0.3238	0.628	0.8974	2.3513	1.3478	1.5322
	17	4.7007	5.9679	0.26	1.9111	0.8263	1.2659	3.4288	2.0093	5.9827	4.2141	0.6959	0.6274	1.357	1.0371	3.231	2.9513	2.4064
	18	1.0347	1.7657	1.9312	0.6069	4.2017	1.1838	3.4915	1.0276	4.1642	2.1678	1.9386	0.576	1.0771	1.3115	4.1101	3.8278	3.0831
+gp		1.0347	1.7657	1.9312	0.6069	4.2017	1.1838	3.4915	1.0276	4.1642	2.1678	1.9386	0.576	1.0771	1.3115	4.1101	3.8278	
0 REFMEAN		0.1235	0.0624	0.1152	0.0485	0.0362	0.0472	0.1719	0.0902	0.0311	0.0273	0.0376	0.0512	0.0621	0.1331	0.0756	0.0448	

Table 12. Cont.

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	2003	2004	
AGE																	
	4	53926	44408	26023	22227	139947	178787	26831	15615	17695	15756	23431	28377	36620	72604	110256	154663
	5	71498	48372	30306	22377	19811	21259	110593	21642	12577	15353	14153	21057	25592	32348	64330	98136
	6	103125	63689	41131	24006	13751	8020	13138	87395	16210	11243	13836	12766	18930	22836	28936	56357
	7	127220	85806	52054	30626	14365	9528	5706	6752	74669	14101	10070	12504	11357	16761	20208	25916
	8	98329	93256	50301	29844	12171	9756	6339	3366	4776	66802	12488	9043	10946	9475	14639	17913
	9	63831	66091	39667	23898	10153	6678	6428	3431	1715	4062	59774	11048	7214	8665	7761	12727
	10	48460	43957	29086	19848	10552	7188	3617	4338	1743	1281	3274	53505	8630	5701	6881	6485
	11	35901	34606	22257	18241	10831	5804	3823	1874	2990	1271	1093	2611	44408	6995	4654	5823
	12	27461	24122	20238	13953	11172	4875	2854	1681	966	2497	1078	911	1737	37110	5719	3864
	13	22142	18938	15535	13738	8411	4865	2551	1500	824	689	1922	869	663	1210	31849	4879
	14	20342	13980	11485	10283	8404	3285	3014	1389	984	652	581	1491	718	488	774	27655
	15	13844	12811	7484	7645	6207	3167	2158	1846	873	777	543	489	771	591	338	497
	16	8617	7581	7359	5724	4140	2236	1944	935	1401	764	692	418	381	636	386	285
	17	7965	4977	4441	5091	3332	1756	1586	967	654	1241	660	553	342	288	521	252
	18	6765	5189	2707	2810	3482	1430	1285	976	746	563	1060	532	468	291	213	406
	+gp	17130	13184	11433	6345	1991	2014	2889	2117	5669	7320	1495	7808	983	1746	2458	7295
0	TOTAL	726558	580966	371507	256656	278720	270648	194754	155825	144491	144373	146148	163980	169759	217745	299922	423152

Table 10		Stock number at age (start of year)		Numbers*10**3													GMST 89-**	AMST 89-**		
YEAR	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021			
AGE																				
	4	186252	388750	296307	386804	305445	208232	96359	68079	57991	38332	29772	25337	17595	12355	11115	192105	0	59282	102826
	5	138982	167798	258924	198258	259081	204391	137343	81886	59170	49768	32023	25740	21917	15862	10993	10054	173834	48720	76018
	6	84893	125401	108505	172922	132305	173284	132568	117751	70759	49837	39854	25239	19643	19033	13112	9906	9096	40573	60245
	7	48539	76132	77196	72058	113769	87525	112717	113001	102333	58089	41358	31267	19192	15929	12931	11671	8945	33809	49558
	8	21962	43085	63576	65820	62773	74941	55747	97469	98436	83736	48585	35877	25083	15136	10809	11049	10288	27703	41389
	9	15258	18669	36713	55466	56765	40731	49431	48231	85239	82561	71425	42798	30937	20917	11798	8796	9620	21345	32943
	10	10934	12415	15704	31257	47880	36860	26717	42803	42234	72683	70749	63659	36922	26089	16323	9122	7426	16283	26382
	11	5508	8827	10738	13610	27241	30906	23875	21842	37549	35831	62693	63034	55686	32516	20882	14015	7635	12392	21101
	12	5014	4203	7611	8971	11752	17653	19585	19350	18733	32247	30750	55569	55518	47641	28353	17828	12067	9055	16494
	13	3303	3719	3573	6161	7755	7507	11377	14789	16021	15915	27678	27189	48628	47641	41794	24631	15323	6452	12395
	14	4173	2587	3183	2903	5360	5087	4617	9398	11287	13738	13693	24589	24172	41982	41346	36153	21527	4644	9077
	15	24117	3378	2170	2574	2417	3344	3208	3434	7390	9572	11583	12064	21671	21512	34766	35470	31620	3238	6282
	16	431	20643	2868	1730	2207	1576	2184	1777	2324	6198	7845	9852	10720	18741	16716	29399	30605	2274	4420
	17	179	270	17989	1543	1451	1390	959	887	1136	1951	5132	6954	8768	9329	15049	12661	25046	1544	3085
	18	184	91	169	15796	1273	944	877	469	653	820	1511	4524	6093	7293	7353	10664	10039	1098	2321
	+gp	735	1127	1556	16908	7376	12902	3540	29042	3019	15869	8191	6076	9691	18318	26342	22894	25583		
0	TOTAL	550464	877094	906781	1052781	1044849	907272	681105	670207	614275	567146	502841	459768	412237	370293	319681	456418	398653		



Table 12. Cont.

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
YEAR	AGE																
	4	267	172	77	44	120	344	79	46	35	47	93	366	834	1654	2622	3374
	5	1346	764	416	237	184	164	977	169	112	122	140	480	862	1058	2101	3104
	6	4370	2883	1607	899	521	359	448	2762	369	312	329	455	825	1040	1463	2729
	7	10300	7811	4531	2532	1156	867	596	591	5254	684	609	878	806	1210	1641	2430
	8	12192	13499	7867	4654	1810	1453	1038	880	1117	13772	1249	1155	1354	1100	1795	2830
	9	10656	12626	8782	5417	2202	1335	1433	1063	540	1054	11020	2026	1473	1582	1423	2842
	10	9812	10448	8266	5862	2988	1927	1071	1529	598	393	698	13073	2478	1834	2064	1882
	11	10259	10907	7740	6367	3343	1694	1242	707	1164	489	416	925	15496	2320	1811	2520
	12	10289	9688	8496	5400	3627	1449	973	653	392	1025	398	348	616	15067	2631	1992
	13	9882	8970	7635	6142	3066	1573	933	635	358	275	844	388	321	452	15210	2279
	14	9606	7035	6115	5076	3583	1274	1261	608	446	265	223	544	301	232	368	15318
	15	7032	6998	4337	3953	2689	1218	888	836	390	313	228	210	345	286	214	330
	16	4470	4344	4666	4522	2965	1518	971	481	696	329	332	196	171	291	215	174
	17	4557	2934	2744	3309	2036	1028	889	526	352	615	363	289	170	127	277	145
	18	3787	3039	1793	1962	2177	888	759	562	371	246	494	258	221	148	135	282
	+gp	12444	9576	8353	4548	1245	1377	1970	1465	3752	4710	942	5150	583	1114	1497	4793
												674	1759	249	335		

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
YEAR	AGE																
	4	5541	12418	8321	9365	4733	3223	1522	1279	859	378	177	125	70	0	0	0
	5	6065	7454	11281	7294	8530	5726	4341	2509	1693	1173	628	453	260	78	44	40
	6	5470	7599	8296	15218	13440	15738	9816	6753	3970	2504	1837	1210	773	720	364	275
	7	5481	10056	13186	12543	21566	13676	16935	12964	16012	8819	5479	2980	1469	1421	1009	913
	8	4206	10081	18300	19058	19950	24718	17964	26518	27759	23067	11783	5673	3436	2166	1372	1410
	9	4127	6794	15838	23462	23032	16264	20474	20091	39134	36778	26397	12096	7904	5126	2416	1814
	10	3644	6062	8989	18456	24503	17444	13329	21771	25593	42235	37012	26200	12719	7637	3886	2167
	11	2490	5207	6848	9362	16445	18088	13147	12449	22553	21096	34088	30450	24418	11192	6557	4404
	12	2472	2581	4984	6100	6848	10346	11988	12636	12574	20993	18422	29909	28573	21639	11495	7221
	13	1808	2380	2488	4844	5519	4968	6902	9350	11268	10583	16834	16161	30950	27886	20656	12184
	14	2273	1857	2288	2180	3623	3540	3093	6582	7753	9581	9001	17501	17745	30601	23566	20638
	15	16268	2374	1511	1747	1600	2388	2252	2363	5356	6369	8084	7660	14887	13155	20787	21242
	16	229	11433	1452	1086	1432	1126	1453	1219	1746	4335	5851	7896	9668	14677	10790	19156
	17	102	172	10735	1080	953	1165	774	771	895	1305	3663	4961	6730	5968	8476	7196
	18	139	66	127	11647	988	810	656	372	454	589	1121	3694	5009	4808	4056	5948
	+gp	507	843	1091	11379	4573	10076	2609	23346	2372	11791	6382	4798	8224	12777	15039	13217



Table 12. Cont.

Table 12 Stock biomass at age (start of year)		Tonnes														
YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE																
4	5393	4308	2836	2134	9237	16091	2737	1234	1593	1402	2038	2753	3113	7333	8379	14538
5	11726	8272	4091	3826	3091	2764	12497	2987	1597	2119	1712	2780	3583	4270	7012	11776
6	21141	13502	8802	4993	2915	1812	2851	12323	3080	2035	2435	2221	3388	4202	4659	9186
7	31550	22395	14367	8943	4123	2630	1643	1823	12992	3229	2246	2926	2703	3805	4385	5727
8	27926	27883	16951	10565	4442	3395	2263	1104	1695	14830	3247	2577	3251	2672	3865	4980
9	20235	21876	15272	9463	4010	2638	2603	1317	696	1507	14704	3635	2366	2799	2491	4365
10	16913	15868	13525	8971	4580	3335	1649	1922	812	540	1058	15891	3314	2223	2443	2451
11	15474	15331	11462	9576	5556	2861	1965	899	1510	623	517	1091	15099	2854	1922	2586
12	14033	12640	11515	7967	6189	2584	1558	896	553	1374	608	481	896	14770	2642	1924
13	12466	11022	9569	8724	5248	2671	1612	870	502	430	986	580	396	679	11179	2698
14	11921	8416	7454	6992	5774	2211	2116	833	611	448	321	841	476	291	432	11781
15	8736	8352	5239	5382	4432	2087	1567	1198	595	555	294	243	515	372	198	315
16	5541	5064	5733	4619	3606	1608	1579	652	1045	618	382	281	235	457	246	195
17	5624	3638	3393	3915	2842	1433	1303	731	515	1032	424	397	264	185	265	137
18	4756	3772	2150	2470	3019	1218	1116	775	566	411	652	382	399	260	148	307
+gp	15074	12129	10198	5920	2192	1837	3083	2024	5289	8074	1145	5856	993	1662	1853	5508
0 TOTALBIO	228505	194469	142558	104462	71256	51175	42142	31588	33652	39227	32768	42934	40991	48833	52119	78475

Table 12 Stock biomass at age (start of year)		Tonnes														
YEAR	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AGE																
4	17135	34210	32297	39067	35737	24571	13298	8170	6611	4907	3602	2914	1830	1124	934	18058
5	16539	19129	31071	25774	34458	30863	21426	13020	9645	8162	5380	4170	3134	2094	1374	1327
6	14092	19688	14865	29051	23418	31538	25055	22844	14152	10914	8409	5174	4047	3635	2386	2001
7	10387	16368	15825	15709	21616	19168	24234	25425	25276	15858	11621	8255	4856	3759	3078	3093
8	5996	11417	15894	18100	14249	19709	16334	24562	27956	25958	15110	11337	7023	4283	2983	3315
9	5172	6292	11528	18026	14759	11812	15324	14276	28555	28484	25570	14979	10302	7091	3917	3061
10	4144	4979	6234	11534	15274	11979	8389	14981	15331	30018	28795	24509	13181	8896	5403	3466
11	2528	3804	4907	5648	10787	11250	8667	7623	14494	13938	25829	25970	20882	11836	7517	6251
12	2412	1803	3958	3929	3831	6832	8069	7837	7849	13576	13745	24117	21652	18961	11455	8130
13	1526	1830	1937	2723	4211	3430	3834	6611	7626	7830	11874	12426	20715	21248	18765	10887
14	2466	1379	1716	1428	2337	2294	2064	3975	5294	7171	7298	11409	12110	19354	21169	16269
15	12107	1986	1135	1460	1150	2080	1322	1631	3399	5045	5259	6659	8885	9616	17939	18125
16	306	8711	1144	1046	1106	831	954	862	1113	3124	4205	6414	5982	10064	8258	15346
17	130	149	8796	912	981	657	558	526	600	1149	2756	4485	3937	4319	7299	6292
18	166	76	123	7077	1040	489	428	207	364	473	822	3189	3059	3457	3272	5524
+gp	639	871	861	13002	3924	6670	2035	14085	1654	9585	5816	4405	5379	8903	12802	11974
0 TOTALBIO	95746	132692	152292	194487	188878	184175	151991	166634	169919	186191	176092	170411	146974	138640	128551	133119

Table 12. Cont.

Table 13 Spawning stock biomass at age (spawning time)		Tonnes														
YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE																
4	27	17	8	4	8	31	8	4	3	4	8	35	71	167	199	317
5	221	131	56	40	29	21	110	23	14	17	17	63	121	140	229	372
6	896	611	344	187	110	81	97	389	70	56	58	79	148	191	236	445
7	2554	2039	1250	739	332	239	172	160	914	157	136	206	192	275	356	537
8	3463	4036	2651	1648	661	506	371	289	397	3057	325	329	402	310	474	787
9	3378	4179	3381	2145	870	527	580	408	219	391	2711	666	483	511	457	975
10	3424	3772	3844	2650	1297	894	488	677	279	166	225	3883	952	715	733	711
11	4422	4832	3986	3343	1715	835	638	339	588	240	197	387	5269	946	748	1119
12	5258	5076	4834	3083	2009	768	531	348	225	564	225	184	318	5997	1216	992
13	5563	5221	4703	3900	1913	864	590	369	218	171	433	259	192	253	5339	1260
14	5629	4235	3968	3452	2462	857	885	365	277	182	123	307	200	138	205	6526
15	4437	4562	3036	2783	1920	803	645	543	266	224	123	104	230	180	125	210
16	2874	2902	3635	3649	2582	1092	788	335	520	266	183	132	106	209	137	119
17	3217	2145	2097	2545	1737	839	731	398	277	512	233	207	131	82	141	79
18	2662	2209	1423	1725	1888	756	660	447	282	179	304	185	188	133	94	213
+gp	10951	8810	7450	4243	1371	1255	2102	1400	3501	5195	722	3862	589	1061	1129	3619
0 TOTSPBIO	58976	54776	46668	36136	20903	10369	9397	6493	8049	11381	6023	10890	9589	11309	11816	18280

Table 13 Spawning stock biomass at age (spawning time)		Tonnes														
YEAR	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AGE																
4	510	1093	907	946	554	380	210	153	98	48	21	14	7	0	0	0
5	722	850	1354	948	1134	865	677	399	276	192	106	73	37	10	5	5
6	908	1193	1137	2557	2379	2864	1855	1310	794	548	388	248	159	137	66	56
7	1173	2162	2703	2734	4098	2995	3641	2917	3955	2407	1540	787	372	335	240	242
8	1148	2672	4575	5241	4529	6501	5263	6683	7884	7151	3665	1793	962	613	379	423
9	1399	2290	4973	7625	5988	4717	6347	5947	13110	12688	9450	4234	2632	1738	802	631
10	1381	2431	3569	6810	7817	5669	4185	7620	9290	17443	15064	10087	4541	2604	1286	824
11	1143	2244	3130	3885	6512	6584	4772	4345	8706	8206	14044	12545	9157	4074	2360	1964
12	1189	1107	2592	2672	2232	4004	4939	5118	5268	8838	8234	12980	11143	8612	4644	3293
13	835	1171	1349	2141	2997	2270	2326	4179	5363	5207	7222	7386	13185	12437	9274	5385
14	1343	990	1233	1073	1580	1597	1383	2784	3636	5001	4797	8121	8890	14107	12066	9287
15	8167	1396	790	990	761	1485	928	1123	2464	3356	3670	4228	6104	5880	10726	10855
16	162	4825	579	657	717	593	635	591	837	2185	3136	5141	5395	7882	5330	9999
17	74	95	5249	639	644	551	450	457	473	769	1967	3200	3022	2763	4111	3576
18	126	55	92	5218	807	420	320	164	253	340	610	2604	2514	2279	1805	3081
+gp	440	652	603	8751	2433	5209	1500	11323	1300	7122	4531	3479	4564	6210	7309	6913
0 TOTSPBIO	20720	25225	34835	52887	45182	46704	39433	55113	63706	81503	78445	76920	72685	69683	60404	56534

Table 12. Cont.

	RECRUITS	TOTALBIO	TOTABUND	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 6-16
	Age 4						
1989	53926	228505	726558	58976	58086	0.9849	0.304
1990	44408	194469	580966	54776	80223	1.4646	0.4711
1991	26023	142558	371507	46668	48500	1.0393	0.3605
1992	22227	104462	256656	36136	43300	1.1983	0.5441
1993	139947	71256	278720	20903	43100	2.0619	0.6019
1994	178787	51175	270648	10369	17664	1.7035	0.3998
1995	26831	42142	194754	9397	13879	1.4769	0.5324
1996	15615	31588	155825	6493	6101	0.9397	0.3658
1997	17695	33652	144491	8049	1408	0.1749	0.1056
1998	15756	39227	144373	11381	1011	0.0888	0.0601
1999	23431	32768	146148	6023	1095	0.1818	0.08
2000	28377	42934	163980	10890	3841	0.3527	0.1667
2001	36620	40991	169759	9589	3327	0.347	0.1271
2002	72604	48833	217745	11309	2964	0.2621	0.1441
2003	110256	52119	299922	11816	2273	0.1924	0.104
2004	154663	78475	423152	18280	3260	0.1783	0.0815
2005	186252	95746	550464	20720	4065	0.1962	0.1235
2006	388750	132692	877094	25225	5936	0.2353	0.0624
2007	296307	152292	906781	34835	5131	0.1473	0.1152
2008	386804	194487	1052781	52887	4274	0.0808	0.0485
2009	305445	188878	1044849	45182	3639	0.0805	0.0362
2010	208232	184175	907272	46704	5235	0.1121	0.0472
2011	96359	151991	681105	39433	8904	0.2258	0.1719
2012	68079	166634	670207	55113	6433	0.1167	0.0902
2013	57991	169919	614275	63706	5139	0.0807	0.0311
2014	38332	186191	567146	81503	4500	0.0552	0.0273
2015	29772	176092	502841	78445	5169	0.0659	0.0376
2016	25337	170411	459768	76920	6067	0.0789	0.0512
2017	17595	146974	412237	72685	6914	0.0951	0.0621
2018	12355	138640	370293	69683	10329	0.1482	0.1331
2019	11115	128551	319681	60404	10245	0.1696	0.0756
2020	192105	133119	456418	56534	8695	0.1538	0.0448
Arith.							
Mean	102750	117248	466825.5	37845	13460	0.459	0.1752
0 Units	(Thousands)	(Tonnes)	(Thousands)	(Tonnes)	(Tonnes)		

Table 13. 3M beaked redfish Yield per recruit parameters.

Age	mean weights 2018-2020			% mat females 2018-2020	PR 2018-2020	Ref. M 2018-2020
	stock	catch	stock mat f			
4	0.090	0.100	0.102	0.000	0.043	0.10
5	0.130	0.143	0.151	0.004	0.246	0.10
6	0.192	0.199	0.210	0.031	0.806	0.10
7	0.247	0.250	0.262	0.083	1.169	0.10
8	0.286	0.277	0.299	0.134	1.128	0.10
9	0.339	0.331	0.354	0.223	1.580	0.10
10	0.351	0.354	0.381	0.260	1.119	0.10
11	0.390	0.392	0.423	0.328	0.719	0.10
12	0.419	0.408	0.471	0.426	0.641	0.10
13	0.446	0.434	0.494	0.531	0.562	0.10
14	0.475	0.443	0.507	0.631	0.710	0.10
15	0.492	0.464	0.533	0.612	1.034	0.10
16	0.518	0.490	0.555	0.705	1.532	0.10
17	0.482	0.465	0.529	0.603	2.406	0.10
18	0.479	0.463	0.526	0.605	3.083	0.10
19	0.498	0.494	0.547	0.631	3.083	0.10
20	0.498	0.494	0.547	0.631	3.083	0.10
21	0.498	0.494	0.547	0.631	3.083	0.10
22	0.498	0.494	0.547	0.631	3.083	0.10
23	0.498	0.494	0.547	0.631	3.083	0.10
24	0.498	0.494	0.547	0.631	3.083	0.10
25	0.498	0.494	0.547	0.631	3.083	0.10
26	0.498	0.494	0.547	0.631	3.083	0.10
27	0.498	0.494	0.547	0.631	3.083	0.10
28	0.498	0.494	0.547	0.631	3.083	0.10
29	0.498	0.494	0.547	0.631	3.083	0.10
30	0.498	0.494	0.547	0.631	3.083	0.10

Table 14a. red.srr file

```

5          Nparams
5          Geometric mean model
13.419    2017-2019 age 4 XSA geomean in millions
0.00000E+000
0.00000E+000
0
0.00000E+000
3          Ndata log residuals
0.271
-0.083
-0.188
0          No extra data

```

Table 14b. An explanation of the red.sen file input data with an exploitation pattern corresponding to *Fstatusquo*

N4 = 2017-2019 age 4 XSA geometric mean - low recruitments
F at age 2021-2023 = Fbar2018 x average PR at age 2018-2020
M at age 2021 = 0.10
M at age 2022-2023 = 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 2022			Exploitation pattern (H - Human consumption)			Exploitation pattern (D - Discards)			Exploitation pattern (I - Industrials)		
'N4'	13419	0.816	'sH4'	0.0024	0.010	'sD4'	0.00	0.00	'sI4'	0.00	0.00
'N5'	12112	0.650	'sH5'	0.0137	0.051	'sD5'	0.00	0.00	'sI5'	0.00	0.00
'N6'	155147	0.495	'sH6'	0.0449	0.160	'sD6'	0.00	0.00	'sI6'	0.00	0.00
'N7'	7869	0.362	'sH7'	0.0652	0.143	'sD7'	0.00	0.00	'sI7'	0.00	0.00
'N8'	7583	0.318	'sH8'	0.0629	0.056	'sD8'	0.00	0.00	'sI8'	0.00	0.00
'N9'	8741	0.292	'sH9'	0.0881	0.048	'sD9'	0.00	0.00	'sI9'	0.00	0.00
'N10'	7970	0.271	'sH10'	0.0624	0.036	'sD10'	0.00	0.00	'sI10'	0.00	0.00
'N11'	6313	0.243	'sH11'	0.0401	0.011	'sD11'	0.00	0.00	'sI11'	0.00	0.00
'N12'	6637	0.223	'sH12'	0.0357	0.010	'sD12'	0.00	0.00	'sI12'	0.00	0.00
'N13'	10535	0.203	'sH13'	0.0313	0.005	'sD13'	0.00	0.00	'sI13'	0.00	0.00
'N14'	13437	0.189	'sH14'	0.0396	0.028	'sD14'	0.00	0.00	'sI14'	0.00	0.00
'N15'	18722	0.183	'sH15'	0.0577	0.056	'sD15'	0.00	0.00	'sI15'	0.00	0.00
'N16'	27007	0.178	'sH16'	0.0855	0.059	'sD16'	0.00	0.00	'sI16'	0.00	0.00
'N17'	25424	0.174	'sH17'	0.1342	0.063	'sD17'	0.00	0.00	'sI17'	0.00	0.00
'N18'	19816	0.171	'sH18'	0.1720	0.080	'sD18'	0.00	0.00	'sI18'	0.00	0.00
'N19'	27140	0.171	'sH19'	0.1720	0.080	'sD19'	0.00	0.00	'sI19'	0.00	0.00
Stock weight at age			Catch weight at age (H - Human consumption)			Catch weight at age (D - Discards)			Catch weight at age (I - Industrials)		
'WS4'	0.090	0.005	'WH4'	0.100	0.013	'WD4'	0.00	0.00	'WI4'	0.00	0.00
'WS5'	0.130	0.004	'WH5'	0.143	0.020	'WD5'	0.00	0.00	'WI5'	0.00	0.00
'WS6'	0.192	0.010	'WH6'	0.199	0.036	'WD6'	0.00	0.00	'WI6'	0.00	0.00
'WS7'	0.247	0.016	'WH7'	0.250	0.055	'WD7'	0.00	0.00	'WI7'	0.00	0.00
'WS8'	0.286	0.012	'WH8'	0.277	0.054	'WD8'	0.00	0.00	'WI8'	0.00	0.00
'WS9'	0.339	0.008	'WH9'	0.331	0.062	'WD9'	0.00	0.00	'WI9'	0.00	0.00
'WS10'	0.351	0.026	'WH10'	0.354	0.088	'WD10'	0.00	0.00	'WI10'	0.00	0.00
'WS11'	0.390	0.049	'WH11'	0.392	0.137	'WD11'	0.00	0.00	'WI11'	0.00	0.00
'WS12'	0.419	0.032	'WH12'	0.408	0.108	'WD12'	0.00	0.00	'WI12'	0.00	0.00
'WS13'	0.446	0.003	'WH13'	0.434	0.094	'WD13'	0.00	0.00	'WI13'	0.00	0.00
'WS14'	0.475	0.033	'WH14'	0.443	0.080	'WD14'	0.00	0.00	'WI14'	0.00	0.00
'WS15'	0.492	0.038	'WH15'	0.464	0.125	'WD15'	0.00	0.00	'WI15'	0.00	0.00
'WS16'	0.518	0.022	'WH16'	0.490	0.118	'WD16'	0.00	0.00	'WI16'	0.00	0.00
'WS17'	0.482	0.017	'WH17'	0.465	0.123	'WD17'	0.00	0.00	'WI17'	0.00	0.00
'WS18'	0.479	0.037	'WH18'	0.463	0.125	'WD18'	0.00	0.00	'WI18'	0.00	0.00
'WS19'	0.498	0.021	'WH19'	0.494	0.144	'WD19'	0.00	0.00	'WI19'	0.00	0.00
Natural mortality at age			Maturity								
'M4'	0.1	0.014	'MT4'	0.000	0.000						
'M5'	0.1	0.014	'MT5'	0.004	0.001						
'M6'	0.1	0.014	'MT6'	0.031	0.006						
'M7'	0.1	0.014	'MT7'	0.083	0.008						
'M8'	0.1	0.014	'MT8'	0.134	0.010						
'M9'	0.1	0.014	'MT9'	0.223	0.024						
'M10'	0.1	0.014	'MT10'	0.260	0.033						
'M11'	0.1	0.014	'MT11'	0.328	0.018						
'M12'	0.1	0.014	'MT12'	0.426	0.028						
'M13'	0.1	0.014	'MT13'	0.531	0.053						
'M14'	0.1	0.014	'MT14'	0.631	0.094						
'M15'	0.1	0.014	'MT15'	0.612	0.010						
'M16'	0.1	0.014	'MT16'	0.705	0.079						
'M17'	0.1	0.014	'MT17'	0.603	0.042						
'M18'	0.1	0.014	'MT18'	0.605	0.060						
'M19'	0.1	0.014	'MT19'	0.631	0.071						
Natural mortality multiplier in year			Effort multiplier in year (H - Human consumption)								
'K2020'	1	0.0	'HF2018'	1.0	0.0						
'K2021'	1	0.0	'HF2019'	1.0	0.0						
'K2022'	1	0.0	'HF2020'	1.0	0.0						

Table 15a. Beaked redfish in Div. 3M: Short-term projections – female SSB (tons) (50%ile at the beginning of 2021, 90%ile, 50%ile and 10%ile at the beginning of 2022-2024), yield of beaked redfish predicted for 2022 and 2023 (50%ile) under several F options and TAC for all three redfish species, based on beaked redfish proportions on observed catch.

F=0

Year	SSB Median and 80% CI	Yield	TAC
2021 _{deterministic}	54264	8271	8448
2022	49021 (45226 - 54929)	0	0
2023	48718 (44682 - 54634)	0	0
2024	48557 (44044 - 55328)		

F0.1=0.0669

Year	SSB Median and 80% CI	Yield	TAC
2021 _{deterministic}	54264	8271	8448
2022	49021 (45226 - 54929)	10704	10933
2023	43311 (39721 - 48611)	10937	11171
2024	38147 (34488 - 43820)		

F=M=0.1

Year	SSB Median and 80% CI	Yield	TAC
2021 _{deterministic}	54264	8271	8448
2022	49021 (45226 - 54929)	15506	15837
2023	40898 (37522 - 45931)	14898	15217
2024	34029 (30695 - 39319)		

FsqTAC= 0.0558

Year	SSB Median and 80% CI	Yield	TAC
2021 _{deterministic}	54264	8271	8448
2022	49021 (45226 - 54929)	9027	9220
2023	44164 (40476 - 49546)	9415	9616
2024	39674 (35891 - 45447)		

1.25 TAC (F= 0.0644)

Year	SSB Median and 80% CI	Yield	TAC
2021 _{deterministic}	54264	8271	8448
2022	49021 (45226 - 54929)	10339	10560
2023	43497 (39888 - 48815)	10610	10837
2024	38481 (34787 - 44163)		

0.75 TAC (F=0.0376)

Year	SSB Median and 80% CI	Yield	TAC
2021 _{deterministic}	54264	8271	8448
2022	49021 (45226 - 54929)	6204	6337
2023	45578 (41810 - 51106)	6697	6840
2024	42303 (38374 - 48389)		

average beaked redfish proportion in the 2019-2020 3M redfish catch

0.979

Table 15b. Beaked redfish in Div. 3M: Medium-term projections - SSB 50% probability profiles under several F scenarios.

Year	F0	F0.1	F=M	Fsq (TAC 2021)	F 1.25 TAC	F 0.75 TAC
2022	49021	49021	49021	49021	49021	49021
2023	48718	43311	40898	44164	43497	45578
2024	48557	38147	34029	39674	38481	42303
2025	50406	35076	29697	37158	35508	40931
2026	49295	30246	24210	32699	30765	37211
2027	50019	27691	21329	30335	28245	35455
2028	51395	26406	19786	29215	26992	34831
2029	52953	25567	18808	28542	26192	34372
2030	54071	25019	18193	28027	25641	34128
2031	51280	22347	15975	25228	22941	31151

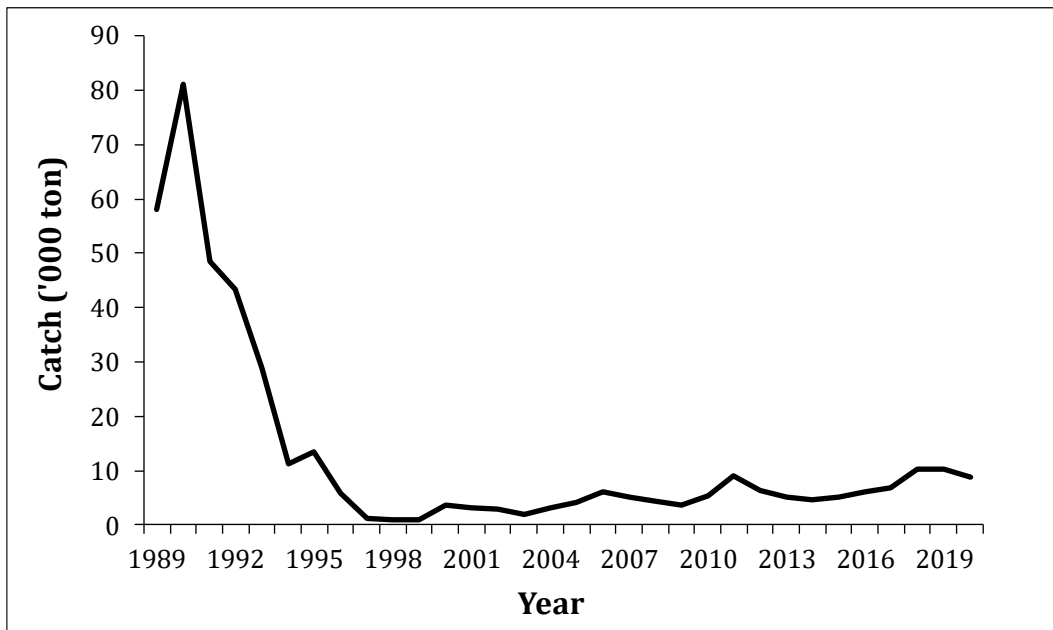


Figure 1a. Beaked redfish in Div. 3M: commercial catch.

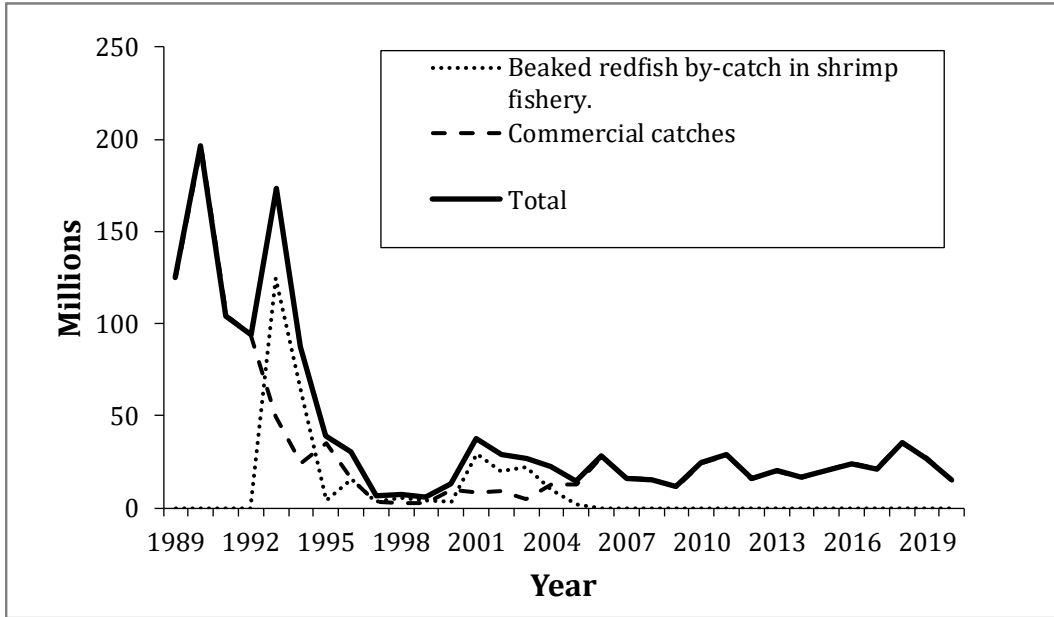


Figure 1b. Beaked redfish in Div. 3M: commercial catch and by-catch in the shrimp fishery in numbers

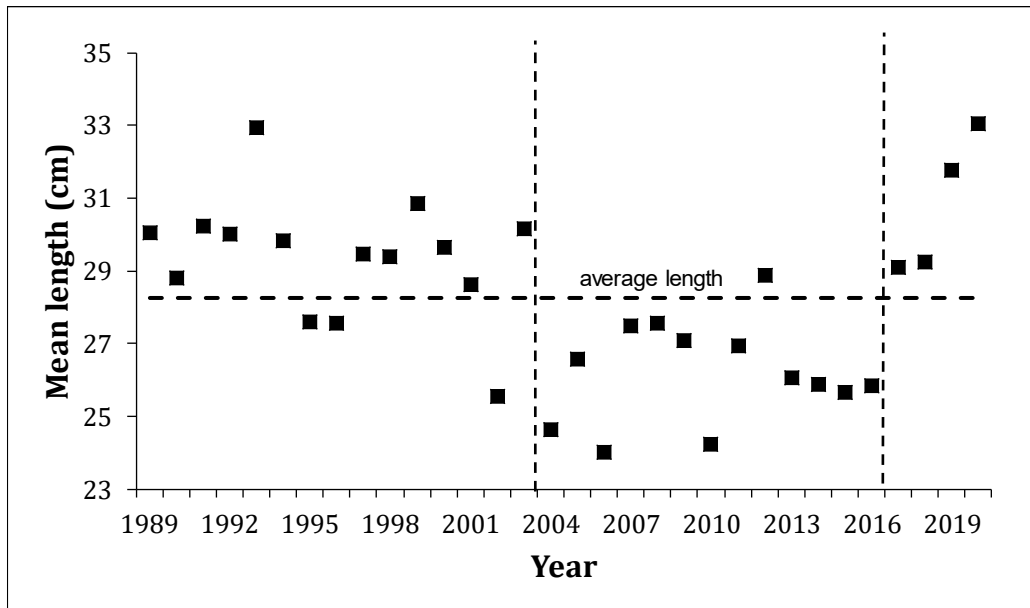


Figure 2a. Beaked redfish in Div. 3M: mean length of the commercial catch, 1989-2020.

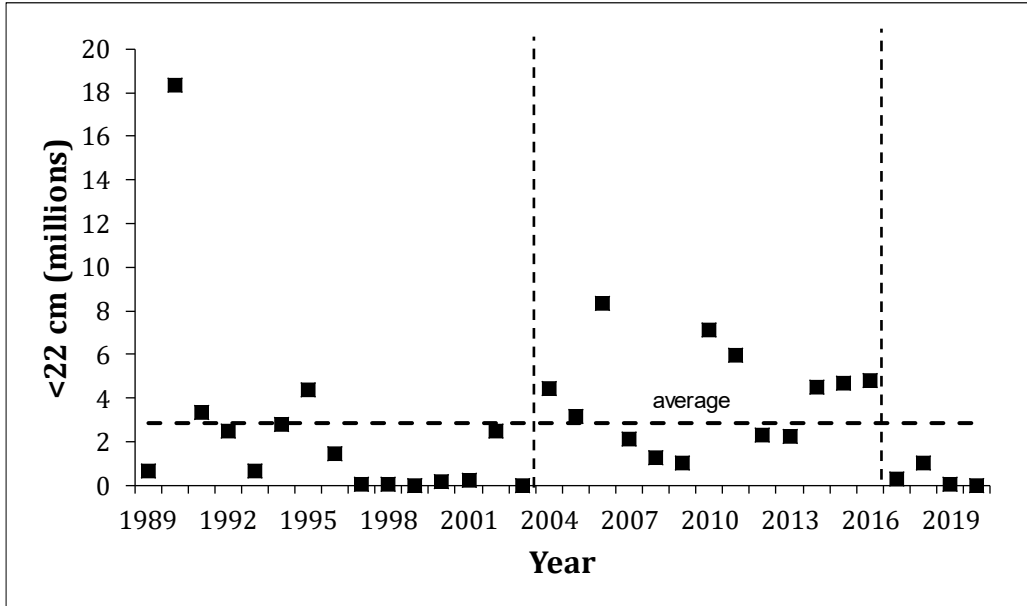


Figure 2b. Beaked redfish in Div. 3M: <22cm abundance of the commercial catch, 1989-2020

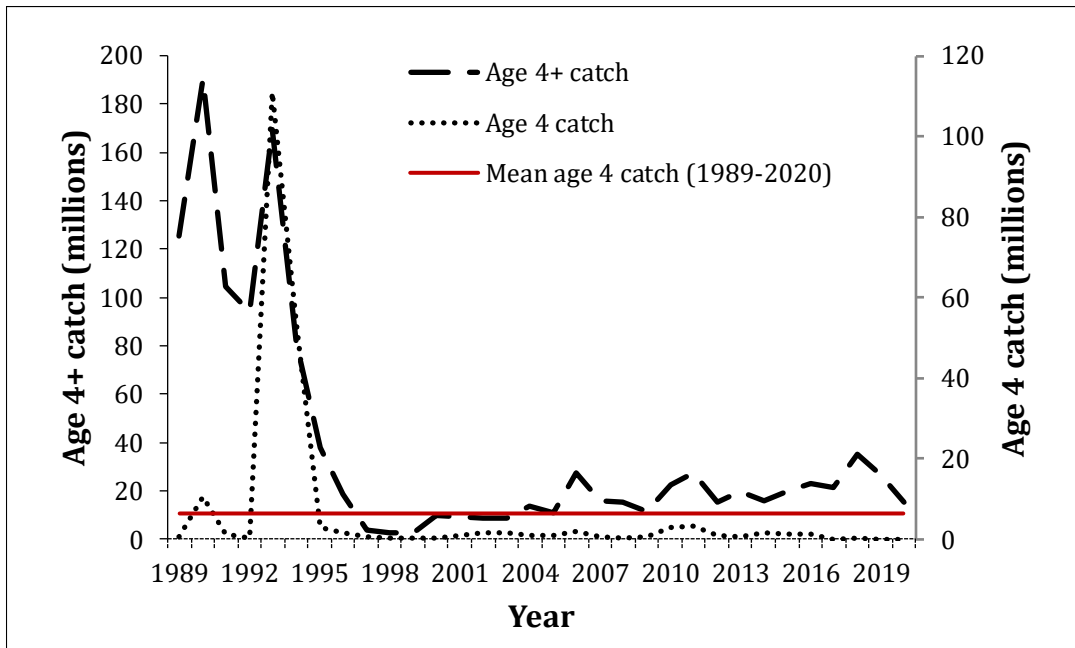


Figure 2c. Beaked redfish in Div. 3M: catch in number of age 4+, age 4 and its mean 1989-2020.

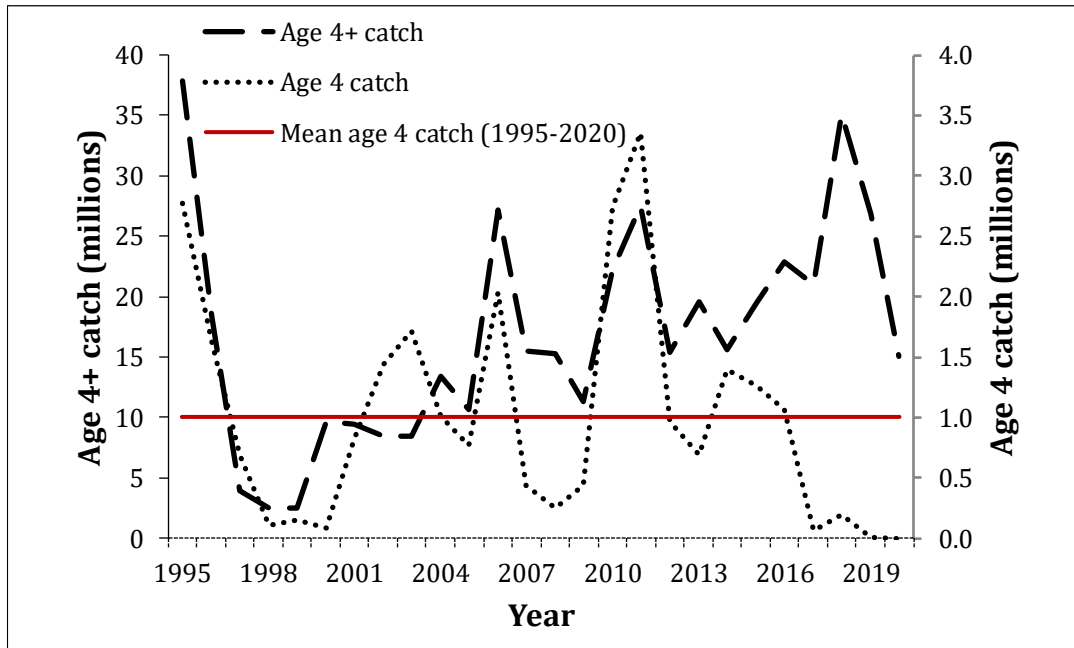


Figure 2d. Beaked redfish in Div. 3M: catch in number of age 4+, age 4 and its mean 1995-2020.

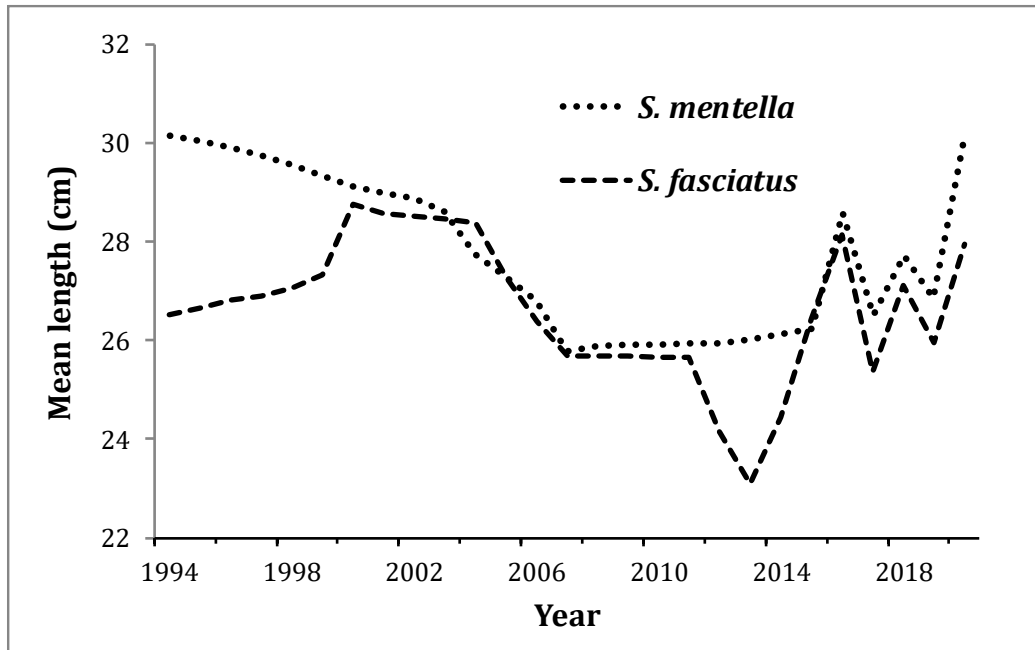


Figure 3a. Beaked redfish in Div. 3M: *S. mentella* and *S. fasciatus* mean length at maturity 1994-2020.

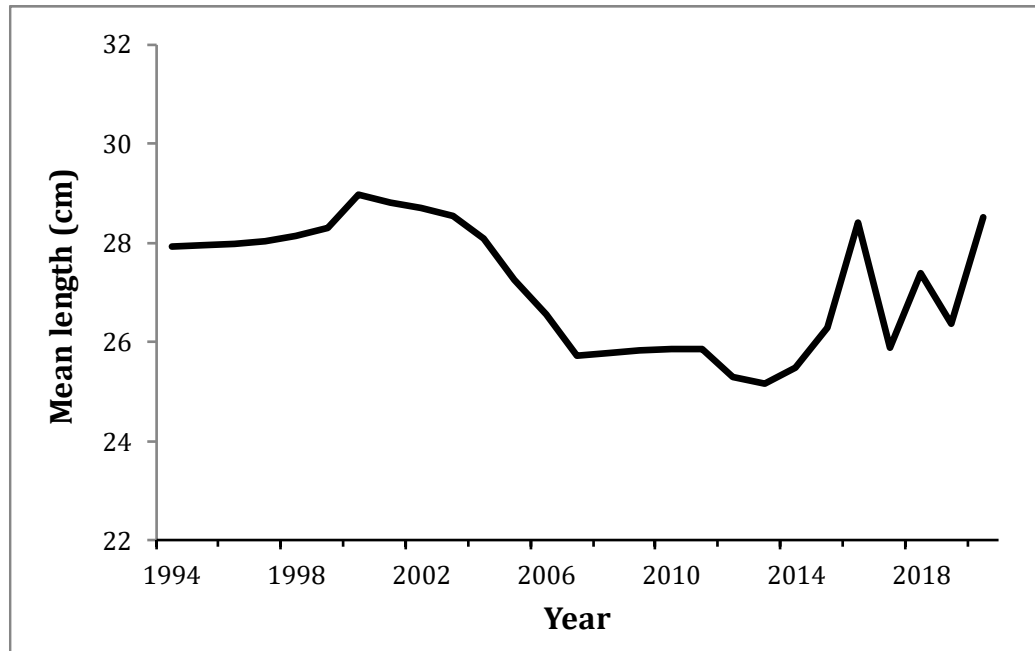


Figure 3b. Beaked redfish in Div. 3M: mean length at maturity 1994-2020.

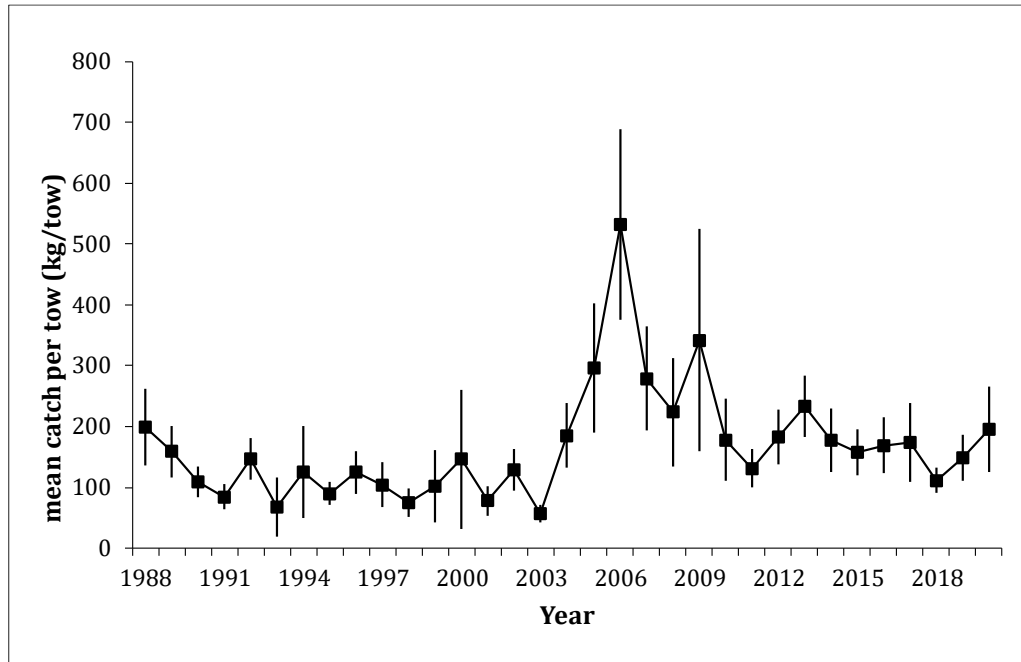


Figure 4. Beaked redfish in Div. 3M: Mean catch per tow for 3M beaked redfish (EU survey, 1988-2020) with associated +/- 1.96 se.

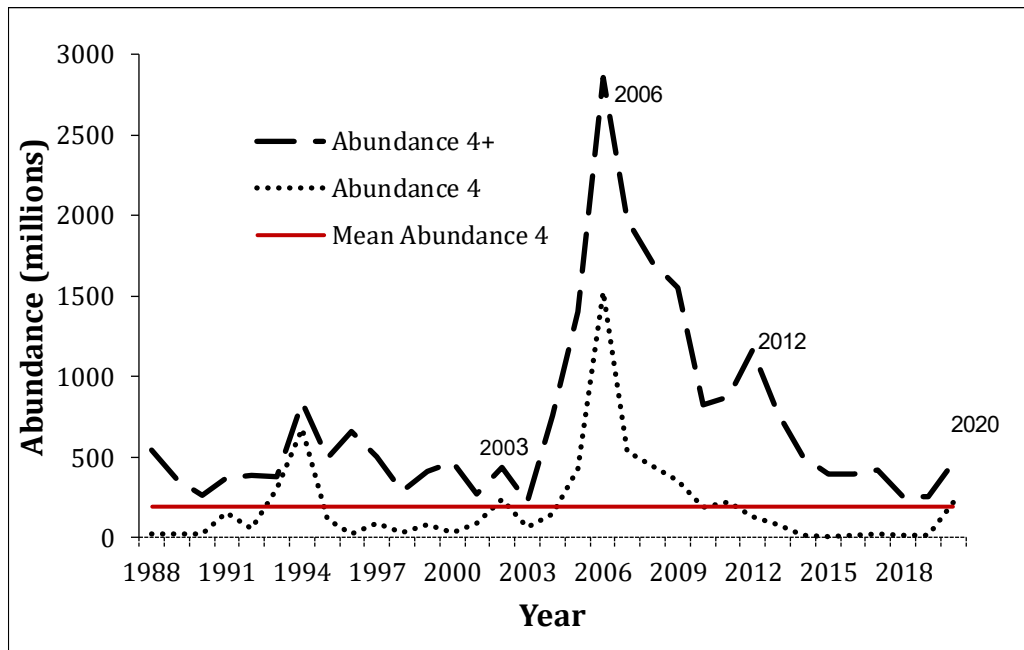


Figure 5a. Beaked redfish in Div. 3M: 4 and 4+ abundance from EU survey, 1988-2020.

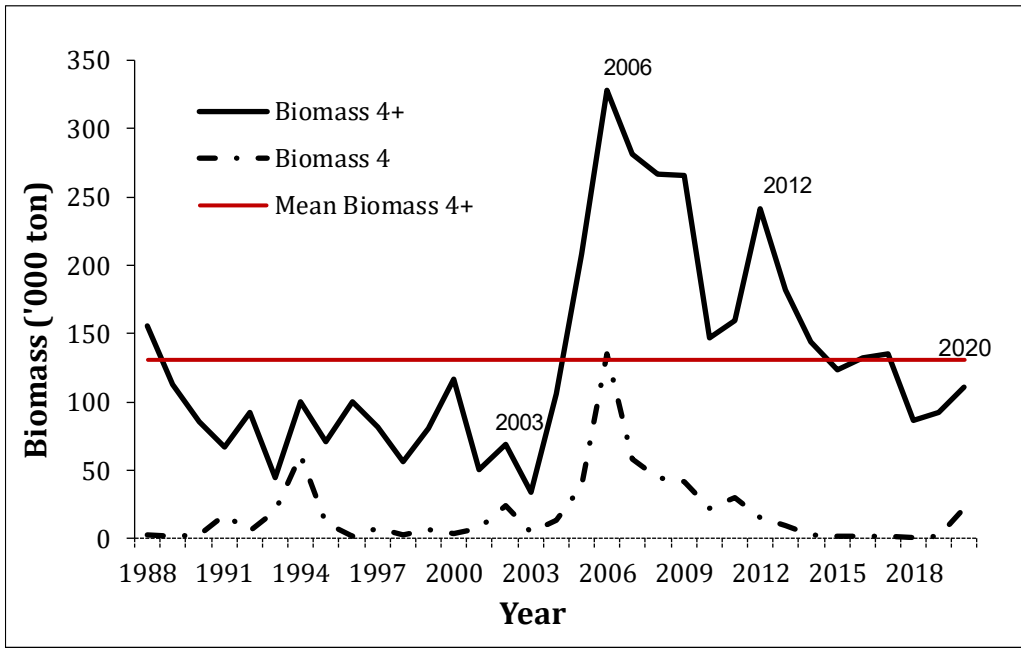


Figure 5b. Beaked redfish in Div. 3M: 4 and 4+ biomass from EU survey, 1988-2020.

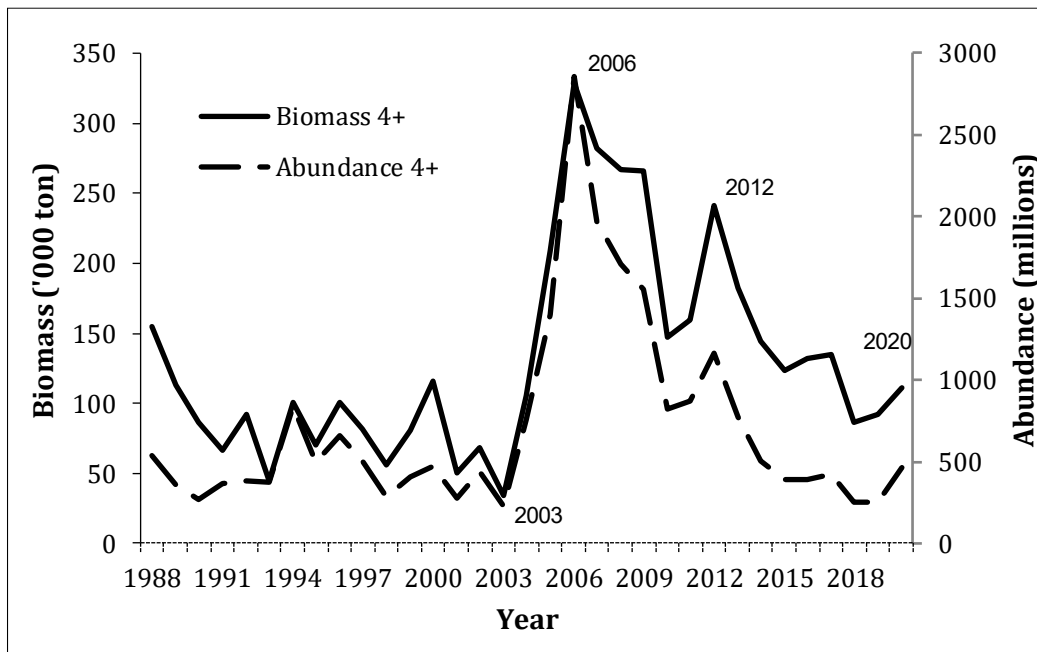


Figure 5c. Beaked redfish in Div. 3M: 4 and 4+ biomass and abundance from EU survey, 1988-2020.

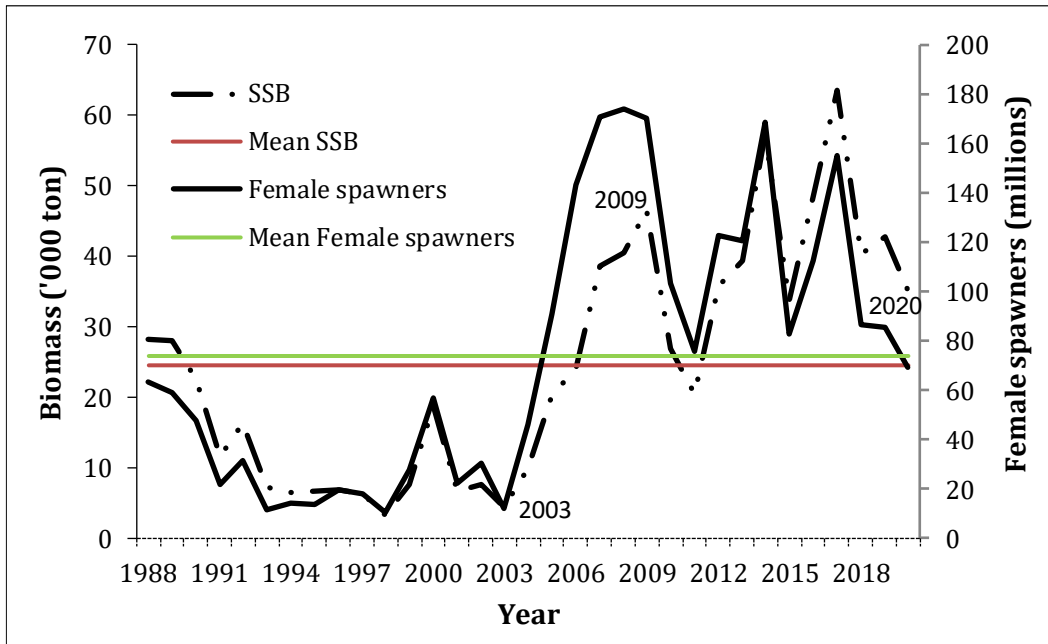


Figure 5d. Beaked redfish in Div. 3M: SSB and Female spawners from EU survey, 1988-2020

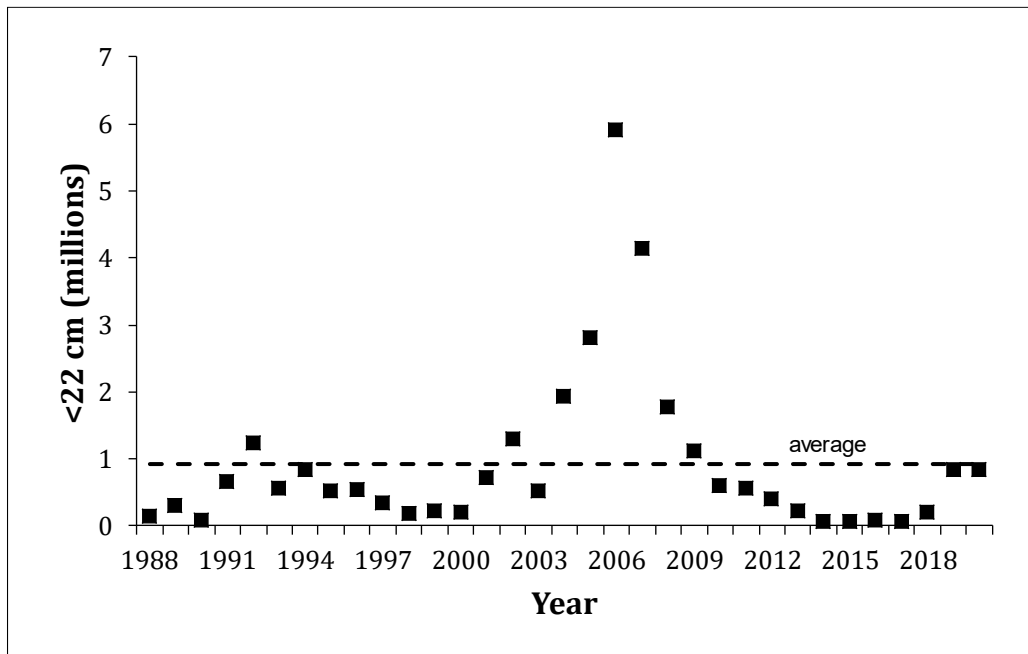


Figure 5e. Beaked redfish in Div. 3M: <22cm abundance of EU survey, 1989-2020

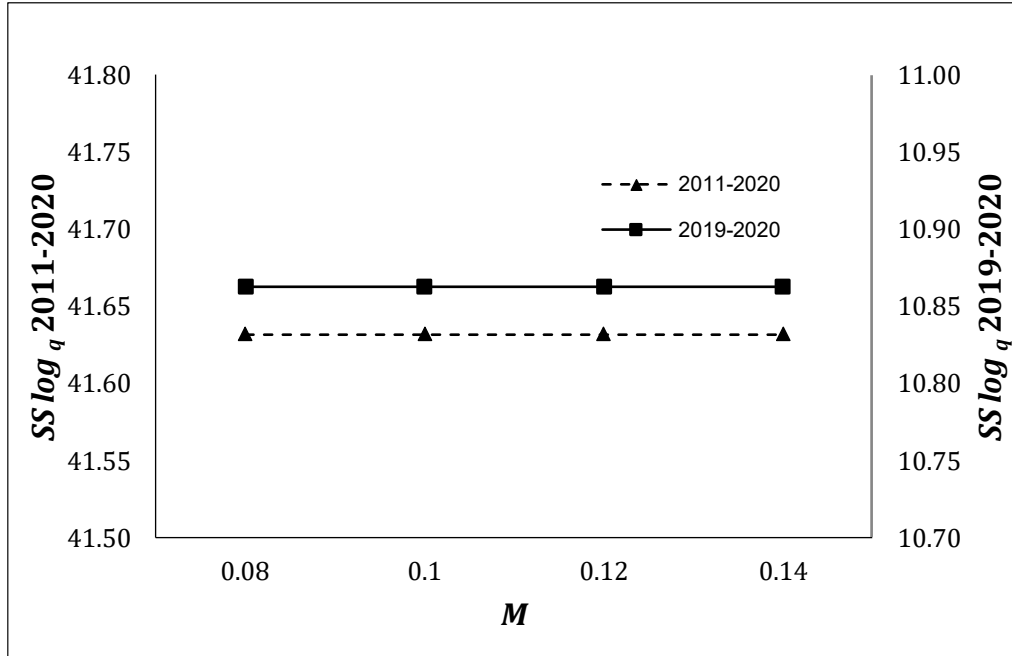


Figure 6a. Beaked redfish in Div. 3M: XSA2021 SS 2011-2020 and SS 2019-2020 \log_q residuals for a set of 2019-2020 M candidates.

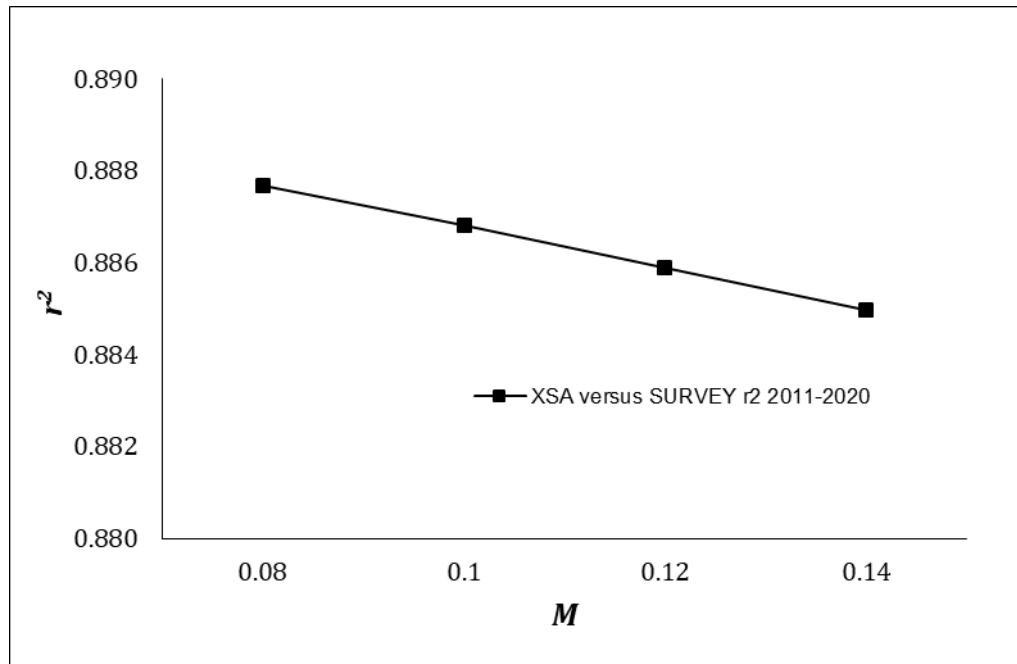


Figure 6b. Beaked redfish in Div. 3M: 2011-2020 correlation between XSA2021 versus Survey 4+ abundance for a set of 2019-2020 M candidates.

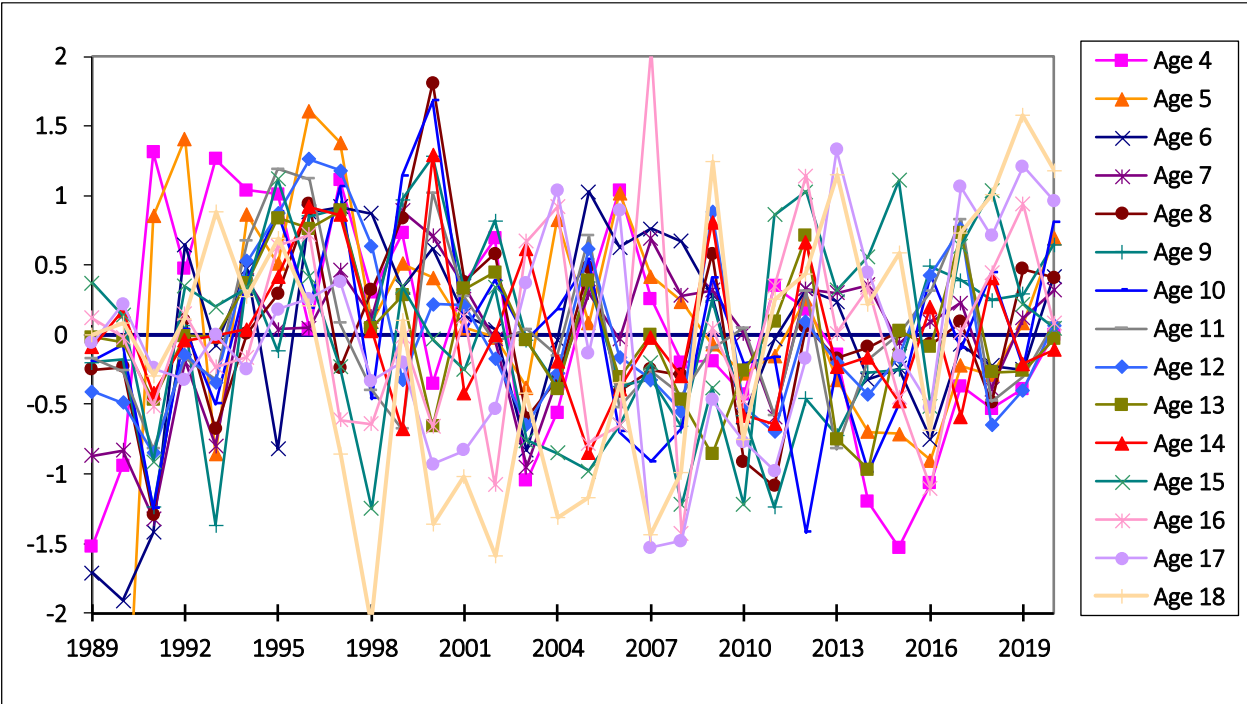


Figure 7a. Beaked redfish in Div. 3M: EU survey log q residuals by age and by year, 1989-2020.

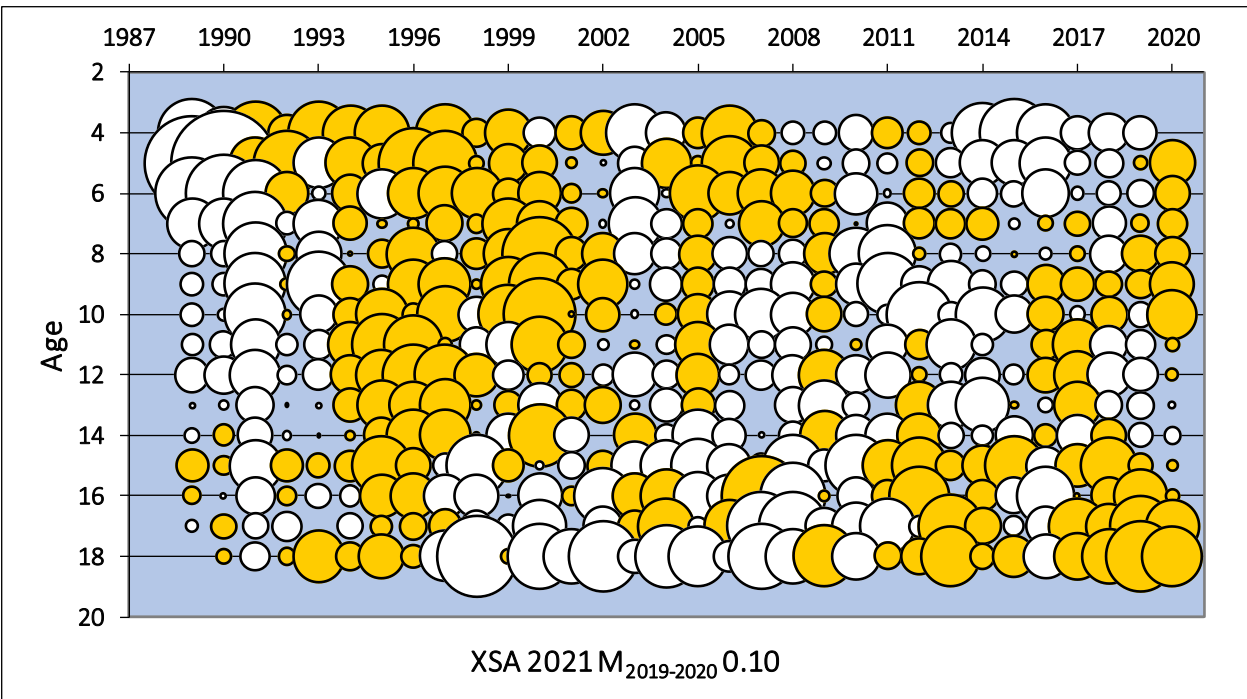


Figure 7b. Beaked redfish in Div. 3M: EU survey log q residuals by age and by year, 1989-2020.

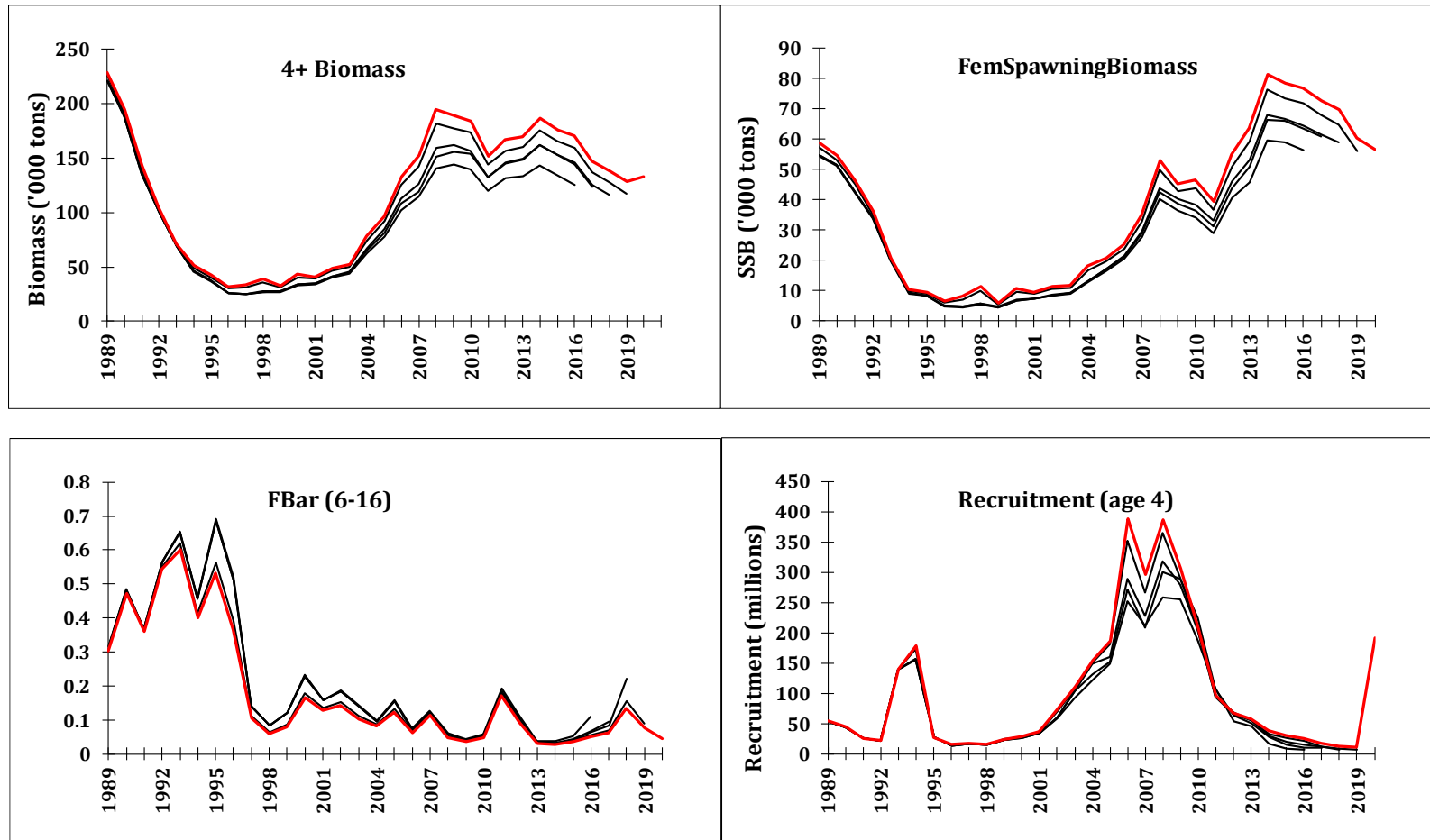


Figure 8. Beaked redfish in Div. 3M: Main results of retrospective 2021 XSA₂₀₂₀₋₂₀₁₆.

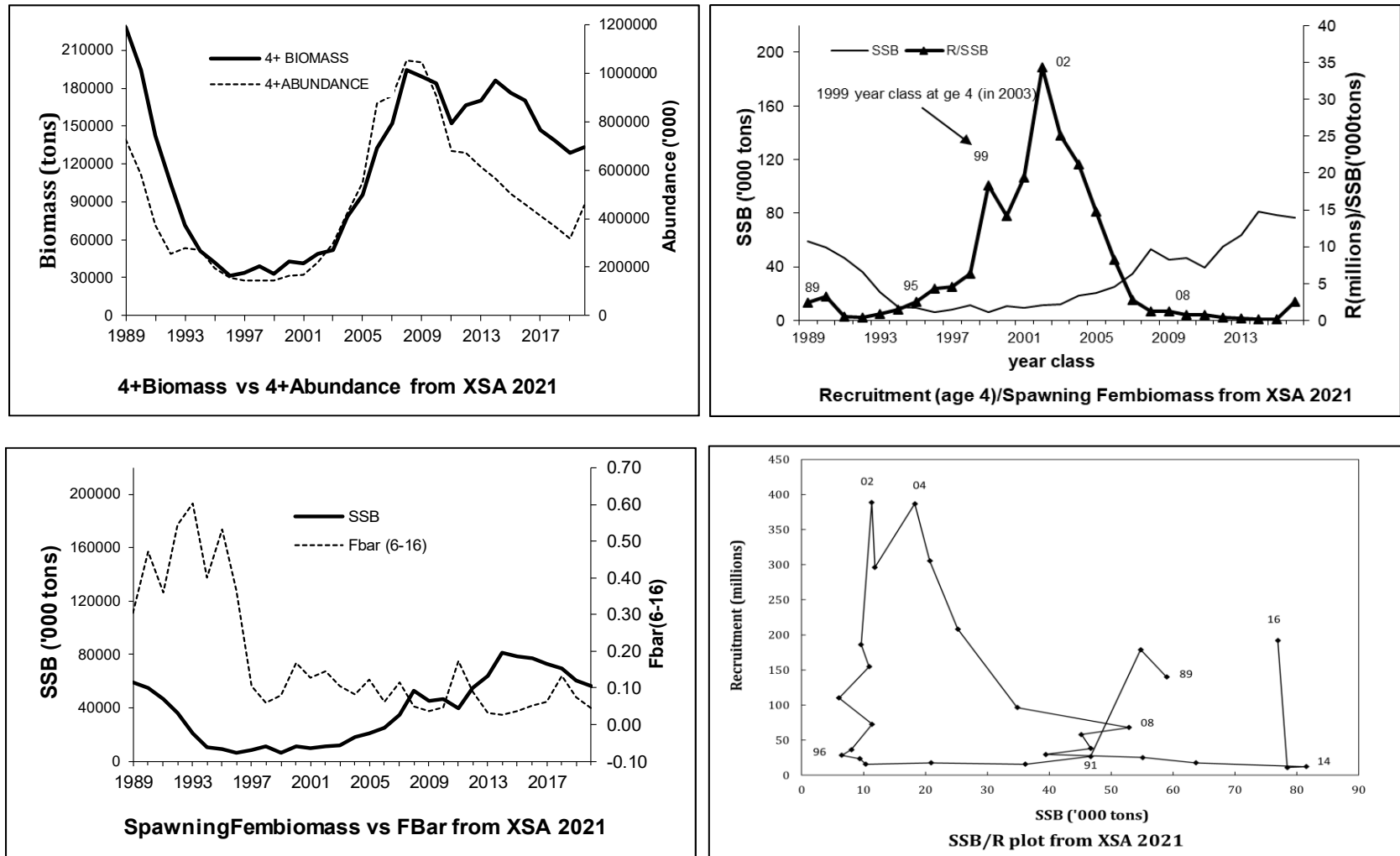


Figure 9. Beaked redfish in Div. 3M: XSA results for 2021 assessment



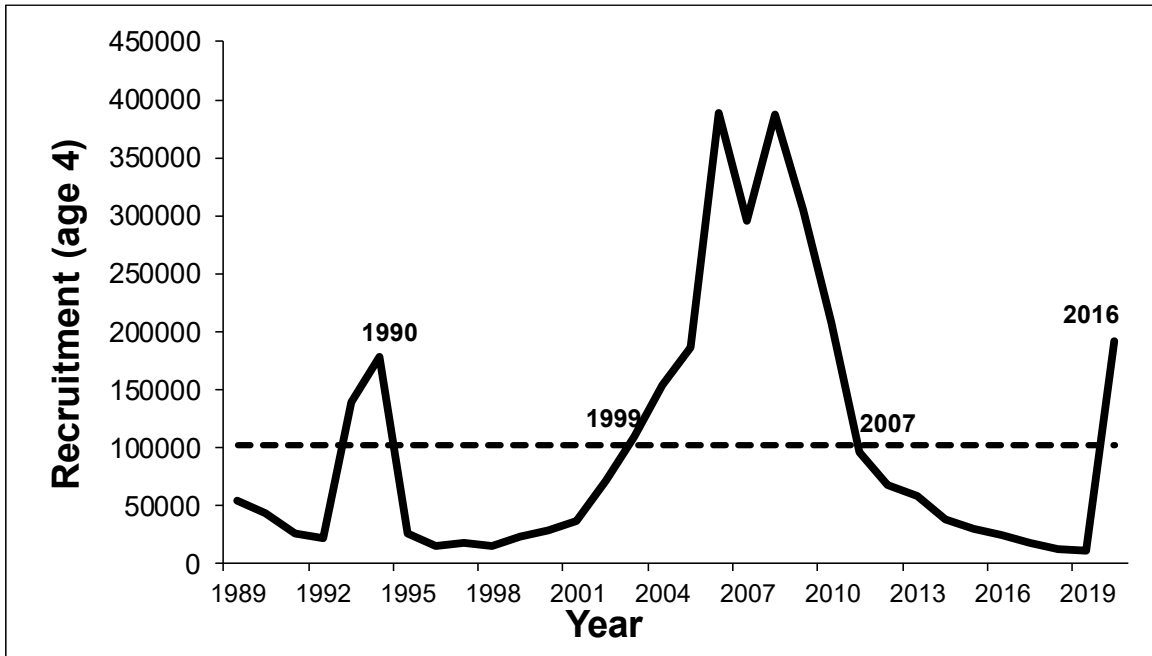


Figure 10. Beaked redfish in Div. 3M: Year Class strength at recruitment from 2021 XSA.

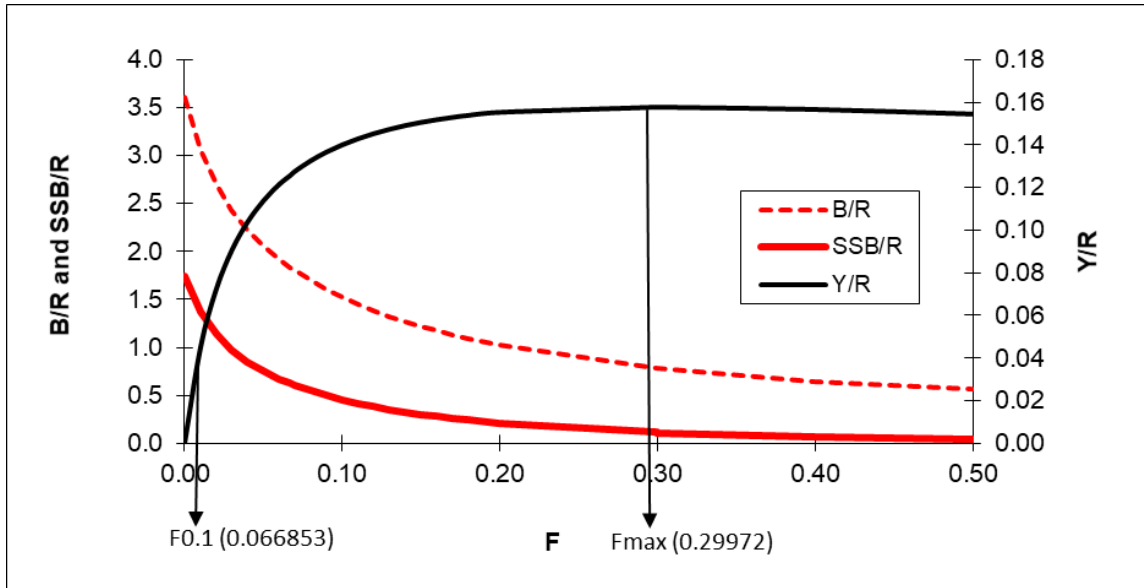


Figure 11. Beaked redfish in Div. 3M: yield per recruit analysis at M=0.10 (2018-2020 average inputs).

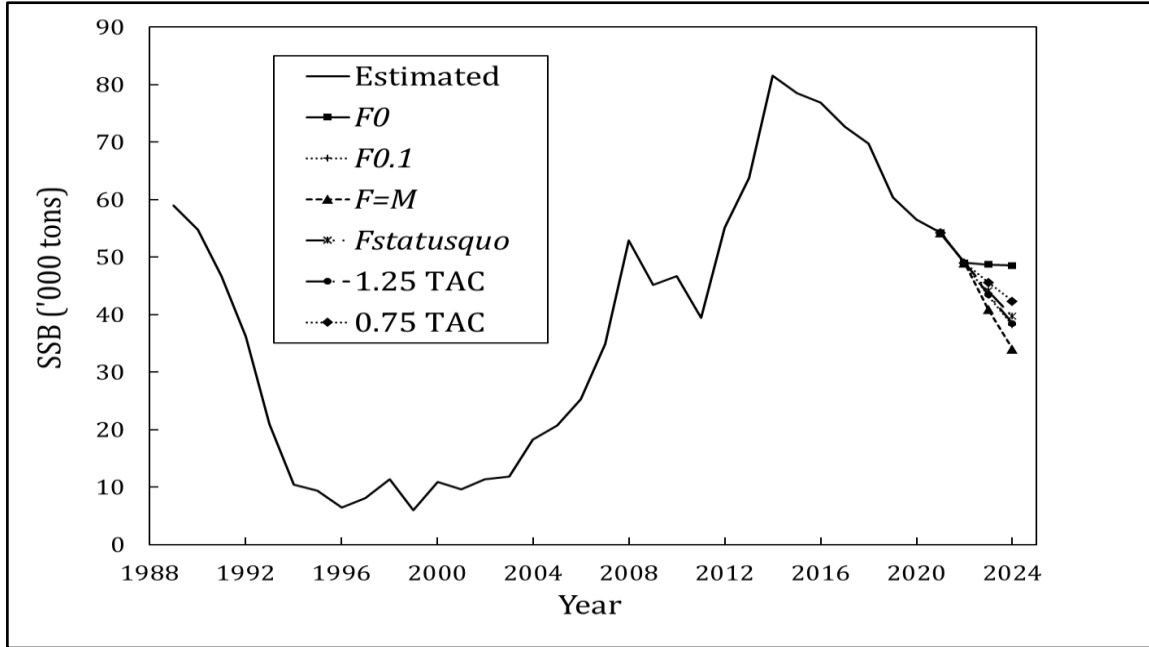


Figure 12. Beaked redfish in Div. 3M: Short-term projections - SSB trajectory (1989-2020) and 2022-2024 SSB 50% probability profiles under several F scenarios.

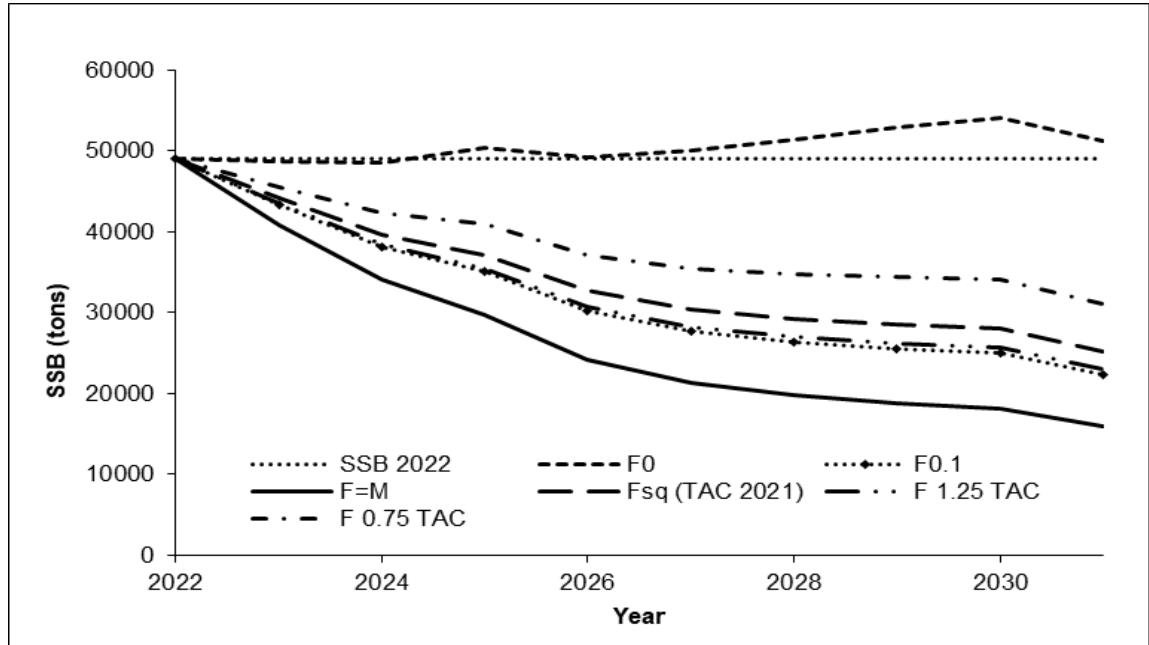


Figure 13. Beaked redfish in Div. 3M: Medium-term projections - SSB 50% probability profiles under several F scenarios.