Northwest Atlantic Fisheries Organization

Serial No. N6952 **NAFO SCR Doc. 19/035**

SCIENTIFIC COUNCIL MEETING – JUNE 2019

An assessment of golden redfish (*S. norvegicus* = *S. marinus*) in NAFO Division 3M

By

R. Alpoim [1], A. Ávila de Melo [1], D. González Troncoso[2],
[1] Instituto Português do Mar e da Atmosfera, IPMA, Rua Alfredo Magalhães Ramalho, nº6, 1495-006, Lisboa, Portugal
[2] Instituto Español de Oceanografia, Aptdo 1552, E-36280 Vigo (Pontevedra), Spain.

Abstract

There are three stocks of redfish on the Flemish Cap Bank (NAFO Division 3M): deep-sea redfish (*Sebastes mentella*); golden redfish (*Sebastes norvegicus*) and Acadian redfish (*Sebastes fasciatus*) which are difficult to distinguish externally and therefore reported together in commercial catches. Because beaked redfish (*S. mentella* and *S. fasciatus*) dominated historical catches, assessments have traditionally treated them as a single management unit. However, the emergence of a directed golden redfish fishery in 2005, on shallower depths of the Flemish Cap bank, required a revision of catch estimates. A method was developed to split catches into golden and beaked redfish for major fleets, with proportions for other fleets estimated Portuguese and Spanish data.

Attempts have already been made to assess the Div. 3M *S. norvegicus* stock. This study is a new attempt based on the Div. 3M EU survey. This assessment is focused on golden redfish and follows most of the methodology, in processing the data, use in the assessments of beaked redfish nevertheless no analytical assessment was tried.

Survey indices from 1988–2018 indicate persistently low biomass and abundance until a brief, unexplained increase between 2004 and 2008, followed by a steady decline to very low levels by 2018. Although survey results are noisy, the overall downward trend is clear. Only two strong recruitment pulses have been observed in the past three decades (1990/1991 and 2004/2006), with recruitment otherwise consistently poor. Recent catches are also minimal.

Due to limited and uncertain data, the stock is not suitable for a standalone analytical assessment. The stock will continue to be monitored, and the findings have contributed to a broader understanding of the red fish stocks in NAFO Division 3M.

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 of less than 400m. Due to their external resemblance *S. mentella* and *S. fasciatus* are commonly designated as beaked redfish. The identity of the Flemish Cap redfish populations is supported by morphometric studies (Saborido Rey, 1994). The Flemish Cap *S. mentella* and *S. fasciatus* (beaked redfish) represents the majority of redfish biomass (average of 78%,

according to the EU Flemish Cap survey series, 1988-2018) and the majority of the redfish commercial catch on the bank.

Redfish are long living species with slow growth, slow maturation and a long recruitment processes to the bottom. From the three species of redfish in the Flemish Cap golden redfish is the one that have higher longevity and reach bigger lengths since no major differences in the length growth are found between the three species. Redfish are viviparous with the larvae eclosion occurring right before or after birth. Mean age of female first maturation for golden redfish is at ages 10 - 11 (around 34cm). Spawning on Flemish Cap occurs through the end of March till May for golden redfish (Saborido Rey, 1994).

Attempts have already been made to assess the Div. 3M *S. norvegicus* stock (e.g. Vaskov, 2006). This is a new one based on the Div. 3M EU survey.

This assessment is focused on golden redfish and follows most of the methodology, in processing the data, use in the assessments of beaked redfish (Ávila de Melo *et al*, 2019), nevertheless no analytical assessment was attempted.

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 (1988-2018). 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 (such as year gaps, stratification, area surveyed and redfish species split in the Russian and Canadian surveys) explained previously in Ávila de Melo *et al* (2003), the only survey data used, in this assessment, are from the EU survey.

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 Vazquez *et al* (2014) and in the 2005 beaked assessment (Ávila de Melo *et al*, 2005). The conversion from former *RV Cornide de Saavedra* (CS) to the actual *RV Vizconde de Eza* (VE) units has also been reported that year (González-Troncoso and Casas, 2005).

Survey biomass and abundance, 1988-2018

Table 1 presents the 1988-2018 EU survey biomass indices for the redfish species. The juveniles were split in golden redfish and beaked redfish (Table 2, Fig. 1 to 3). Details on the computation of this combined index can be found in the 2003 beaked redfish assessment (Ávila de Melo et al, 2003).

Survey results are noisy, with the characteristic variance of redfish indices, but broad trends show through the noise. The survey golden redfish biomass index went down, from a relatively low state, in the first years of the series, and despite 3 small peaks (in 1994, 1997 and 2000), it remained at a low level until 2003. After 2003 the index increased considerably and reached the maximum of the series in 2006. 2007 was an unusual year with a decrease in biomass because in 2008 the biomass was still close to the series historical maximum. From 2008 to 2012 the index goes down again and since then it has remained at a relatively low level with the exception of 2018 when it went down to a very low level. The survey golden redfish abundance index, despite some differences follow the same general trend of the biomass index (Table 2, Fig. 1 to 3).

Survey length composition

From 1988 to 2002, each of the redfish categories considered within the golden redfish assemblage (golden redfish with juveniles) had their own survey abundance at length original series converted to the new RV units, using the conversion framework described in the 2005 beaked redfish assessment (Ávila de Melo *et al*, 2005). The transformed *S. norvegicus* and juvenile survey abundance at length former series were then linked to the 2003-2018 *RV Vizconde de Eza* length distributions (Troncoso *pers. comm.*, 2005-2018; Casas *pers. comm.*, 2014). For each year and redfish category, abundance at length is re-scaled in order to fit the correspondent swept area survey biomass estimated. Finally, the matrices of length distributions from the two golden redfish categories were assembled into one single survey abundance at length matrix for golden redfish (Table 3, Fig. 4). The annual mean length in the survey is also presented in the Table 3.

Survey age composition

The survey abundance at age for the 3M golden stock (1988-2018, Table 4, Fig. 5) was obtained using the *S. norvegicus* age length keys (ALK), by sex, from the 1988-1997, 2000, 2002, 2005, 2008-2018 surveys. For the years without ALKs, a combined ALKs of the year before and the following year were used. Gaps in the ALKs in some lengths/sex were fill with observations closer to the year in question or using a combination of all ALKs. A plus group was set at age 25.

Survey mean length/weight at age

The mean length at age was plotted in Fig. 6 to verify the consistence of the age readings. Mean lengths of some ages seems to be inconsistent and require a revision in future.

Annual length weight relationships for *S. norvegicus* (1988-2018) were available from survey data (Table 5) and were used to calculated the mean weight at age in the stock. The 1988-2018 mean weight in the stock is presented in the Table 6.

Maturity

Gonads of the Flemish Cap golden redfish species were collected and analyzed, but due to changes in the criteria the only available maturity ogives are the ones from 2015 to 2018 (Table 7 and Fig. 7). Previous ogives are being revised with the new criteria but are not yet available (Mandado *pers. comm.*, 2019). All ogives seem very similar and results show that L_{50} is around 35-36cm and A_{50} is between 10 and 12 years old.

Spawning stock biomass (SSB) and recruitment (R)

The 2017 age maturity ogive was adopted to transformed the female abundance at age in mature female abundance at age. The spawning stock biomass was calculated multiplying the mature female abundance at age by the correspondent mean weight at age (Table 8 and Fig. 8). The correspondent SSB was compare with the recruitment at several ages (1-4) to see if any SSB/R relationship could be detected (Table 8 and Fig. 9). Unfortunately, no relationship could be drawn, which is not surprising when it comes to redfish.

Description of the fishery

The 3M redfish stocks have been exploited primarily by bottom trawl, but also by pelagic trawl. Due to the similarity of their external morphology the commercial catches are reported together. Historically the majority of pelagic and bottom commercial catches from the 3M redfish fisheries were a mixture of *S. mentella* and *S. fasciatus*. The redfish by-catch from the 3M Greenland halibut fishery is 100% *S. mentella*. *S. norvegicus* is caught at shallower waters and is more related with the cod fishery.

STACFIS catch estimates were available till 2010. Over 2006-2010 an average annual bias of 15% plus was recorded between STACFIS catch estimates and STATLANT nominal catches. 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 were calculated using the Catch Data Advisory Group (CDAG) Estimation Strategy (NAFO Regulatory Area Only) (NAFO Secretariat, *pers. comm*.). The 2017 and 2018 catch estimates were obtained with the application of the Catch Estimation Strategy Advisory Group (CESAG) method (NAFO Secretariat, *pers. comm.*).

From July 2004 to July 2006 Flemish Cap EU survey showed a 3.5-fold increase in bottom biomass of both golden and Acadian redfish (Casas et al., 2007). Cod stock and cod by-catch also went up, and the Flemish Cap cod fishery reopened in 2010. Redfish catches responded positively to those events and since the mid 2000's is a blend of by-catch from cod fishery (depths shallower than 300m, a mixture of golden and beaked redfish), catch from bottom trawl redfish directed fishery (depths between 300-700m, primarily beaked redfish), and by-catch again from Greenland halibut fishery (bellow 700m, 100% deep sea redfish). The no neglect proportion of golden redfish forced the development of a method to split, the annual redfish catches of Portugal, Russia and Spain, into golden and beaked redfish from 2005 onwards. Golden redfish catches from fleets other than these ones were estimated with the average golden redfish proportion found each year on the redfish catches of Portugal and Spain. This method is fully described on beaked redfish 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.

Table 9a shows the 2005-2018 Div. 3M redfish nominal/STATLANT catches by country. On Table 9b are tabulated the golden and beaked redfish proportions, in weight and by depth, found in the 2005-2018 EU surveys (Gonzalez-Troncoso, *pers. comm.,* 2009-2018; Casas, *pers. comm.*, 2014), that has been used to get the golden redfish commercial catch estimates by fleet. The golden redfish 2005-2018 catch estimates from different sources were accepted and assembled on Table 9c and Fig. 10, these catches were used in this assessment. The golden redfish by-catch from the Flemish Cap shrimp fishery is assumed to be negligible.

Catches of golden redfish in Division 3M (Table 9c and Fig. 10) increased from 1,158 tons in 2006 to a peak of 7,662 tons in 2009. In 2010, catches decreased and remained relatively stable until 2014 between 2,000 and 3,000 tons. After 2014, catches decreased continuously, being from 2016 to 2018 at residual levels (148 tons in 2018). 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 9a).

Length composition of the commercial catches

The several national length compositions were used to estimate the length distribution of the correspondent total catch.

From each of these length distributions a mean weight in the catch was derived in order to transform the respective catch in weight into catch in number. Each mean weight was calculated as:

$$\overline{W} = \frac{\sum (N_{LC} * \overline{W}_{LC})}{\sum N_{LC}}$$

where N_{LC} is the number observed in length-class *LC* and $\overline{W}_{LC}$ is the mean weight of the length-class *LC*. Mean weights at length were determined for each year using the length/weight relationships provided by the biological sampling of the Portuguese commercial catches (Table 10). For missing years 2005 and 2012 were used the respective length weight relationships from the EU survey (Table 5) because length frequencies from Portugal were not available for those years. For missing years 2015-2017, the 2014 commercial length/weight relationship was used, because, in this case, the length frequencies from Portugal were available and were applied to most catches.

Length samplings from the Portuguese, Russia and Spanish bottom trawl are the only sources (for 2005-2018) to get golden catch at length for the different bottom trawl fleets involved in the 3M fisheries. As stated above length frequencies available when not split by species were split using the depth of the fishery.

The catches of the countries that do not presented length frequencies, or the sampling were very small, were summed to the catches of countries with length data. The breakdown by length of the total annual catch is given in Table 11. Length composition of the commercial catches are presented in Table 12 and Fig. 11. The annual mean length in the catches is also presented in the Table 12.

Age composition of the catch

Age composition of the golden redfish total catch (Table 13 and Fig. 12) was obtained using the *S. norvegicus* ALKs from the EU survey and the same criteria, to fill the gaps, described in the above section - *Survey age composition* was applied. A plus group was also set at age 25.

Catch mean weight at age

Catch mean weight at age of the golden redfish total catch (Table 14) was obtained using the length weight relationships from the Portuguese commercial catch (Table 10) and the same criteria, to fill the gaps, described in the above section - *Length composition of the commercial catches* was applied. The 2005-2018 mean weight in the catches is also presented in the Table 14.

Assessment

Partial recruitment vector (PR)

In order to generate an observed partial recruitment vector, an *F* index was first derived from the 2005-2018 ratios at each age between the sum of the annual permilles on the commercial catch and the correspondent sum of permilles for the EU survey abundance.

Those indicators of *F* at age were then standardized to its highest value, recorded at age 10 (Table 15). Assuming a flat top recruitment curve this observed partial recruitment vector was adjusted to a general logistic curve (Table 15, Fig. 13). The observed PR values were used in the yield per recruit analysis.

Vectors used in yield-per-recruit analysis (YPR)

A yield-per-recruit analysis was conducted incorporating the following sets of vectors (Table 16), all of them considered to be representative, in terms of growth and maturity, of Div. 3M golden redfish:

1) Mean weights at age in the stock.
2) Mean weights at age in the commercial catch.
3) Female maturity ogive at age.
4) Observed partial recruitment vector.
5) Natural mortality (*M*) set at 0.1. The same assumed for beaked redfish (Ávila de Melo, 2019), a commonly accepted M level for slow growing/long-living fish stocks such as redfish stocks.

Yield-per-recruit analysis

A yield-per-recruit analysis was conducted, incorporating the sets of vectors described above. The results of this analysis were (Table. 17, Fig. 14):

$F_{0.1}$ = 0.112
F_{max} = 0.278

These results are higher than expected for redfish specially F_{max}, unfortunately making the results of this analysis dubious and therefore unsuitable for use at this time.

Fishing mortality proxy (*F*)

A proxy to fishing mortality has been giving by the ratio between catch and EU survey biomass (without the juvenile portion). This *F* proxy was low from 2005 to 2008, in 2009 increased drastically to 0.1, then decreased

till 2012 to around 0.04. In 2013 the *F* index increased again to 0.08 and since then decreased. In 2016 is at the level of the 2005-2008 period, less than 0.02 (Table 18 and Fig. 15).

Precautionary approach (PA)

Although there are no acceptable reference points, survey biomass/*F* proxy were plotted (Table 18 and Fig. 16) in order to see the trajectory of the stock in relation to fishing mortality, within the precautionary approach.

Comments on trends on stock indicators

Besides some sporadic small peaks, the EU survey (1988-2018) stock abundance and biomass oscillated since the beginning (1988) of the series till 2003 at low levels. From 2004 to 2008 both measured a huge increase that could not be explained only by recruitment. Since then biomass and abundance, with the characteristic variance of redfish indices, declined and in 2018 are at very low levels. Survey results are noisy, but broad trends show through the noise.

Only two strong recruitment pulses have been observed in the past three decades (1990/1991 and 2004/2006), with recruitment otherwise consistently poor. No relationship has been detected between spawning biomass and recruitment. The proportion of golden redfish in the survey has become nearly residual in recent years, and catches have also been very low in recent years.

Plotting mean length in the survey on the same graph as survey abundance, would identify if rises in abundance are due the arrival of new recruits, or due to large fish entering the survey area. During the first major recruitment pulse (1990–1991), mean length declined concurrently with rising abundance, indicating a strong influx of small juveniles into the population. In contrast, during the second pulse (2004–2006), the decrease in mean length began before the peak in recruitment, suggesting that additional processes were influencing size structure. Following both recruitment events, periods of low recruitment were characterized by increasing mean length, reflecting the growth of existing cohorts in the absence of substantial new juvenile input (Figs. 17-19).

Yield, biomass and SSB per recruit analysis gives F reference points values that are high for redfish, however it is premature to draw conclusions from these due to the uncertainties found in several parameters.

Conclusions

The assessment of *Sebastes norvegicus* (golden redfish) in Div. 3M indicates a stock characterized by long periods of low abundance, limited recruitment, and high uncertainty in recent years. Survey indices from 1988–2018 show persistently low biomass and abundance until 2003, followed by a sharp but short lived increase between 2004 and 2008 that cannot be explained by recruitment alone. Only two strong recruitment pulses have been observed in the past three decades (1990/1991 and 2004/2006), with recruitment otherwise consistently poor . Since 2009, both biomass and abundance have declined steadily, reaching very low levels by 2018. Although survey results are noisy, the overall downward trend is clear. Catches have also been very low in recent years.

Given the limited and uncertain information, the stock is not currently considered suitable for a standalone analytical assessment. As in previous years, advice for golden redfish continues to be derived indirectly from the Div. 3M beaked redfish assessment, applying the current species composition. The stock will continue to be monitored, and the findings have contributed to a broader understanding of the red fish stocks in NAFO Division 3M.

Acknowledgements

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

This assessment was reviewed and approved by an external reviewer – Dr. Daniel Howell (Institute of Marine Research, Norway). Special thanks to Dr Howell.

References

Ávila de Melo, A.M., R. Alpoim and F. Saborido-Rey, 2003. An assessment of beaked redfish (*S. mentella and S. fasciatus*) in NAFO Div. 3M. *NAFO SCR Doc.* 03/45 Ser. No N4863, 72pp.

Ávila de Melo, A.M., R. Alpoim and F. Saborido-Rey, 2005. A revised assessment of beaked redfish (*S. mentella and S. fasciatus*) in NAFO Div. 3M using the original EU survey indices converted to the new RV Vizconde de Eza units. *NAFO SCR Doc.* 05/47 Ser. No N5133, 40pp.

Ávila de Melo, A.M., F. Saborido-Rey, D. González Troncoso, M. Pochtar and R. Alpoim, 2011. An Assessment of Beaked Redfish (*S. mentella and S. fasciatus*) in NAFO Division 3M (*With an Approach to the Likely Impact of Recent 3M Cod Growth on Redfish Natural Mortality*). *NAFO SCR Doc.* 11/026 Ser. No N5911, 65pp.

Ávila de Melo, A., R. Petit, A. Pérez-Rodríguez, D. González Troncoso, R. Alpoim, F. Saborido-Rey, M. Pochtar, F. González-Costas and N. Brites, 2013. An Assessment of Beaked Redfish (S. mentella and S. fasciatus) in NAFO Division 3M *(With a Revised Approach to Quantify the Increase on Redfish Natural Mortality Determined by the Increase on Cod Predation Observed Over Recent Years, 2006-2012)*. NAFO SCR Doc. 13/034, Serial N6188, 55 pp.

Ávila de Melo, A., F. Saborido-Rey, M. Fabeiro, S. Rábade, D. González Troncoso, F. González-Costas, M. Pochtar and R. Alpoim (2019) - An assessment of beaked redfish (*S. mentella* and *S. fasciatus*) in NAFO Division 3M (including an update for the most recent level of natural mortality). NAFO SCR Doc. 19/016. Serial No. N6932. 81pp.

Bishop, C. A., 1994. Revisions and additions to stratification schemes used during research vessel surveys in NAFO Subareas 2 and 3. *NAFO SCR. Doc.* 94/43 (rev.). Ser. No N2413. 23pp.

Casas, J. M. and Diana González Troncoso, 2007. Results from bottom trawl survey on Flemish Cap of June-July 2006. *NAFO SCR Doc.* 07/10, Ser. No N5353. 34 pp.

Doubleday, 1981. Manual of groundfish surveys in the Northwest Atlantic. . *NAFO Sci. Coun. Studies* 2, 55pp.

Fomin K. and V. Khlivnoy, 2014. Russian Research Report for 2013. NAFO SCS Doc. 14/13 Ser. No N6308, 27pp.

Fomin K., V. Khlivnoy, T. Mishin and P. Zavoloka, 2015. Russian Research Report for 2014. NAFO SCS Doc. 15/07 Ser. No N6433, 29pp.

Fomin K. and M. Pochtar, 2017. Russian Research Report for 2016. NAFO SCS Doc. 17/11 Ser. No N6686, 31pp.

Fomin K. and M. Pochtar, 2018. Russian Research Report for 2017. NAFO SCS Doc. 18/13 Ser. No N6824, 30pp.

González-Troncoso, D. and J. M. Casas, 2005. Calculation of the calibration factors from the comparative experience between the R/V *Cornide de Saavedra* and the R/V *Vizconde de Eza* in Flemish Cap in 2003 and 2004. *NAFO SCR Doc.* 05/29 Ser. No N5115, 8pp.

Pochtar, M. and K. Fomin, 2012. Russian Research Report for 2011. NAFO SCS Doc. 12/05 Ser. No N6018, 34pp.

Pochtar, M., K. Fomin, V. Zabavnikov, 2013. Russian Research Report for 2012. NAFO SCS Doc. 13/09 Ser. No N6159, 27pp.

Saborido-Rey, F., 1994. El género *Sebastes* Cuvier, 1829 (Pisce, Scorpaenidae) en el Atlántico Norte: identificación de espécies y poblaciones mediante métodos morfométricos; crescimiento y reproducción de las poblaciones en Flemish Cap. Universidad Autónoma de Madrid, Facultad de Biología, Departamento de Zoología, Madrid. Phd Thesis, xi, 276pp.

Skryabin, I.A., M.V. Pochtar, K.Yu. Fomin, V.I. Vinnichenko, 2009. Russian Research Report for 2008. NAFO SCS Doc. 09/12 Ser. No N5640, 33pp.

Skryabin, I.A. and M.V. Pochtar, 2011. Russian Research Report for 2010. NAFO SCS Doc. 11/11 Ser. No N5902, 25pp.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2007. Portuguese research report for 2006. NAFO SCS Doc. 07/9 Ser. No N5357, 54p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2008. Portuguese research report for 2007. NAFO SCS Doc. 08/05, Serial Nº 5495, 47 p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2009. Portuguese research report for 2008. NAFO SCS Doc. 09/5, Serial Nº N5624, 23 p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2010. Portuguese research report for 2009. NAFO SCS Doc. 10/07, Serial Nº N5761, 52 p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2011. Portuguese research report for 2010. NAFO SCS Doc. 11/05, Serial N 5881, 54 p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2012. Portuguese research report for 2011. NAFO SCS Doc. 12/08, Serial N 6022, 42 p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2014. Portuguese research report for 2013. NAFO SCS Doc. 14/010, Serial No. N6301, 52p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo., 2015. Portuguese research report for 2014. NAFO SCS Doc. 15/006, Serial No. N6426, 40 p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo., 2016. Portuguese research report for 2015. NAFO SCS Doc. 16/009, Serial No. N6555, 45 p.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2017. Portuguese research report for 2016*. NAFO SCS Doc.* 17/05REV Ser. No N6658, 38pp.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2018. Portuguese research report for 2017*. NAFO SCS Doc.* 18/08 Ser. No N6788, 30pp.

Vargas, J., Alpoim, R., E. Santos, and A.M. Ávila de Melo, 2019. Portuguese research report for 2018. NAFO SCS Doc. 19/09, Serial No. N 6921, 32 p.

Vaskov, A., 2006. On Including Golden Redfish (*Sebastes marinus*) into the Calculations to Estimate Redfish Stocks on the Flemish Cap. NAFO SCR Doc. 06/4, Serial No. N5214, 5 pp.

Vaskov, A. A., K. V. Gorchinsky, T. M. Igashov, and S. P. Melnikov, 2006. Russian Research Report for 2005*. NAFO SCS Doc.* 06/07 Ser. No N5223, 24pp.

Vaskov, A. A., K.V. Gorchinsky, S.F. Lisovsky, M.V. Pochtar, 2007. Russian Research Report for 2006. NAFO SCS Doc. 07/06 Ser. No N5350, 26pp.

Vaskov, A. A., M.V. Pochtar, I.A. Skryabin, 2008. Russian Research Report for 2007. NAFO SCS Doc. 08/06 Ser. No N5496, 28pp.

Vázquez, A., J. Miguel Casas, R. Alpoim. 2014. Protocols of the EU bottom trawl survey of Flemish Cap. *NAFO Scientific Council Studies*, **46**: 1–42. doi:10.2960/S.v46.m1

Table 1. EU survey biomass (tons) of the 3 species of redfish and juveniles (~ <15cm), 1988-2018.

Year	*S. norvegicus*	*Sebastes spp*.			Total
		S. mentella	*S. fasciatus*	juvenile	
1988	18,229	170,102			188,331
1989	27,312	135,223			162,535
1990	16,751	86,695		23,311	126,757
1991	4,864	59,552	6,755	5,784	76,955
1992	4,909	85,408	6,314	33,578	130,209
1993	4,789	21,235	5,175	41,409	72,608
1994	39,516	42,495	9,303	71,211	162,525
1995	10,754	70,567	5,986	337	87,644
1996	13,431	92,647	13,112	472	119,662
1997	77,125	66,710	20,780	1,201	165,816
1998	7,640	53,946	7,656	1,590	70,832
1999	11,215	77,610	9,460	366	98,651
2000	53,388	106,283	15,364	2,955	177,990
2001	10,244	45,931	13,715	7,455	77,345
2002	11,651	48,760	27,556	33,345	121,312
2003	40,110	28,785	15,031	9,890	93,816
2004	85,383	45,999	76,164	43,059	250,605
2005	147,688	105,110	123,326	75,762	451,215
2006	298,290	105,849	319,387	43,396	766,922
2007	88,071	51,191	261,790	63,576	464,628
2008	240,777	42,570	202,288	80,491	566,126
2009	72,211	111,787	171,676	2,804	358,479
2010	47,377	62,684	97,067	5,083	212,211
2011	29,056	103,678	59,753	4,543	197,030
2012	55,410	166,693	82,539	1,304	305,946
2013	32,016	102,500	84,801	420	219,737
2014	37,171	96,158	46,174	422	179,925
2015	30,672	45,668	80,494	1,167	158,001
2016	35,069	79,143	55,394	1,593	171,199
2017	23,371	92,136	47,521	234	163,262
2018	10,771	57,403	30,407	1,931	100,512

Table 2. Golden redfish EU survey biomass (000's tons) and abundance (000's) indices. Juveniles (~ <15cm) were split by species after the survey, 1988-2018.

Year	*S. norvegicus* biomass	Juveniles *S. norvegicus* biomass	Total biomass	Total abundance
1988	18.2	23.6	41.8	75,440
1989	27.3	18.5	45.8	80,825
1990	16.8	17.0	33.8	259,109
1991	4.9	0.3	5.2	76,798
1992	4.9	1.9	6.8	79,423
1993	4.8	11.5	16.2	327,635
1994	39.5	19.3	58.8	365,543
1995	10.8	0.0	10.8	68,799
1996	13.4	0.0	13.5	67,958
1997	77.1	0.1	77.2	208,744
1998	7.6	0.1	7.7	31,577
1999	11.2	0.0	11.2	29,327
2000	53.4	0.0	53.4	72,446
2001	10.2	1.0	11.2	22,542
2002	11.7	1.9	13.6	110,219
2003	40.1	4.0	44.1	381,494
2004	85.4	16.3	101.7	1,086,813
2005	147.7	12.4	160.1	1,023,208
2006	298.3	7.6	305.9	2,071,817
2007	88.1	3.9	91.9	504,536
2008	240.8	22.8	263.6	1,317,842
2009	72.2	0.2	72.4	265,741
2010	47.4	0.6	48.0	191,568
2011	29.1	0.2	29.3	90,096
2012	55.4	0.0	55.4	108,633
2013	32.0	0.0	32.0	60,126
2014	37.2	0.0	37.2	61,279
2015	30.7	0.1	30.8	50,691
2016	35.1	0.4	35.4	75,362
2017	23.4	0.0	23.4	28,624
2018	10.8	0.1	10.9	24,289

Table 3. 3M golden redfish abundance at length ('000s) from EU bottom trawl survey series (1988-2002 by RV Cornide Saavedra (CS), 2003-2018 by RV Vizconde de Eza (VE); former period converted to new RV units). EU survey mean length 1988-2018.

Length (cm)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Length (cm)
4																4
5											236					5
6		40	544	162							79			3	85	6
7	628	94	4,449	6,164	285	628			309		57	23		8	758	7
8	4,034	382	35,198	30,275	6,805	1,801		69	1,550	139	338	265	51	114	1,136	8
9	3,541	457	27,041	14,015	4,392	1,005		330	821	278	486	972	185	932	3,487	9
10	4,171	1,209	1,928	1,413	3,300	4,438	100	351	146	185	107	742	141	1,508	4,128	10
11	5,380	1,202	939	2,679	19,220	20,601	681	620	267	426	186	46	113	179	4,074	11
12	8,256	2,445	912	2,902	22,063	26,631	1,197	1,544	561	1,323	1,099	46	442	52	9,015	12
13	3,471	3,308	2,451	912	5,210	16,749	2,388	2,102	697	1,404	1,640	116	855	68	19,436	13
14	1,217	6,025	4,270	297	936	45,599	10,821	3,659	789	569	527	32	605	58	23,562	14
15	622	6,314	5,828	427	1,596	94,010	23,662	4,668	1,209	1,192	190	96	152	41	9,210	15
16	540	8,448	15,838	926	2,393	79,225	50,084	6,402	1,773	1,692	289	123	75	325	4,319	16
17	785	3,641	35,874	1,653	809	17,204	85,531	6,022	2,884	2,434	190	83	109	177	2,907	17
18	937	783	40,079	1,910	471	4,720	81,645	6,414	4,576	3,333	453	99	29	225	2,055	18
19	1,196	1,053	22,660	1,374	509	2,355	36,527	6,914	5,208	4,292	1,010	101	68	184	1,454	19
20	1,193	1,464	4,938	1,659	847	1,240	6,837	7,823	7,484	6,551	1,469	153	50	200	1,647	20
21	983	908	1,211	1,594	699	1,323	4,442	6,253	7,113	8,213	1,922	432	92	125	1,607	21
22	1,924	1,391	2,825	1,053	1,077	1,098	2,529	4,216	7,310	10,732	2,254	719	307	339	1,718	22
23	2,548	1,463	12,051	836	872	1,202	2,239	2,634	6,921	13,109	2,687	1,007	566	296	1,279	23
24	3,680	1,466	2,266	754	960	1,124	3,988	1,450	5,156	13,214	3,013	1,862	1,070	391	1,262	24
25	4,443	2,622	6,564	642	725	934	4,290	1,191	3,883	18,778	2,833	1,810	982	474	1,274	25
26	5,941	3,032	5,454	644	795	787	3,723	1,181	2,384	21,630	2,836	2,270	1,749	809	1,469	26
27	4,345	2,610	4,221	611	711	703	5,663	772	1,597	18,092	2,548	3,145	1,935	1,062	1,357	27
28	2,323	3,358	2,046	587	660	594	5,057	727	1,051	16,932	1,704	3,157	2,639	1,434	1,529	28
29	1,644	3,349	2,165	432	688	535	3,712	712	822	12,357	1,420	2,739	3,637	1,654	1,585	29
30	1,360	2,740	3,361	592	650	666	4,660	426	779	12,368	744	2,410	3,680	1,839	1,549	30
31	1,178	2,877	2,770	313	398	438	4,030	363	604	8,567	520	1,744	4,342	2,193	1,535	31
32	1,356	3,936	2,098	333	417	461	3,281	267	373	6,054	269	1,589	6,817	1,586	1,460	32
33	1,031	3,365	2,335	235	385	353	3,208	333	528	5,500	165	934	6,352	1,466	1,314	33
34	843	2,262	1,823	263	292	271	3,016	220	216	4,151	87	863	4,053	1,404	1,339	34
35	775	1,419	1,326	166	254	262	2,025	184	171	3,016	58	504	4,020	1,077	538	35
36	495	1,239	644	136	154	130	1,140	116	148	2,157	24	287	2,477	833	549	36
37	662	718	640	128	108	90	1,243	124	145	2,479	32	330	3,806	305	351	37
38	663	821	414	121	98	27	902	83	91	1,459	15	111	2,238	210	280	38
39	968	1,093	338	87	179	136	960	90	156	1,474	25	146	4,068	281	301	39
40	780	537	555	100	132	51	852	138	74	2,153	16	118	3,751	140	152	40
41	412	392	148	111	135	64	688	79	10	569	24	76	2,460	199	122	41
42	281	485	306	30	17	74	807	84	41	853		23	1,850	170	137	42
43	288	550	45	90	27	22	43	54	23	438	15	10	274	19		43
44	173	249	65	44	44	10	751	33	22	143		19	1,872	24	90	44
45	78	187	244	49	10	32	1,074	33	17	74		10	1,585	9	42	45
46	116	324	36	13	33		675	49	13	175		23	793	49	27	46
47	19	441	9	16	10	21	130	6		23		83	815	15	73	47
48	40	68	110	9	10		193	6		39		10	1,056	15		48
49	6	15	16	21			235			10			265			49
50	16		20	13		21	219			25				11		50
51	33	15	16		10		88	18		39	9			15		51
52	23	7			17		96	34		57				15		52
53	11	9	11	7	19		82	6		10					8	53
54	13	7					10			17						54
55			11				10		17	8						55
56			11						8	10			22			56
57	8						10		8							57
58	13															58
59																59
60																60
61																61
62																62
63																63
64																64
65																65
66																66
67																67
68														9		68
Total	75,440	80,825	259,109	76,798	79,423	327,635	365,543	68,799	67,958	208,744	31,577	29,327	72,446	22,542	110,219	Total

Mean length (cm)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Mean length (cm)
	20.5	23.4	17.1	12.0	13.7	15.0	19.4	19.3	21.2	26.5	22.5	26.8	33.8	27.6	16.7	

Table 3. cont.

Length (cm)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Length (cm)
4												0.2					4
5	32							2							0.3	6	5
6	1,481					47	27	5		1	3		1	2	0.2	26	6
7	5,730	126	78	65	86	165	188	78		3	6	1	14	28	1	837	7
8	9,690	5,527	938	20,185	1,488	1,745	1,003	551	1	12	12	34	173	106	2	4,860	8
9	5,601	30,637	1,361	88,129	11,881	1,179	2,177	1,696	31	26	23	200	492	179	3	3,013	9
10	2,962	79,940	1,751	122,215	26,132	1,486	1,286	2,413	191	8	25	59	185	290	3	404	10
11	6,921	78,645	7,412	17,938	14,927	6,840	2,032	4,866	196	14	27	30	141	474	6	174	11
12	19,476	135,117	17,108	20,120	14,175	21,251	2,754	6,308	287	75	34	44	649	1,388	13	292	12
13	16,096	95,921	47,665	36,040	25,522	46,536	2,501	5,336	613	173	58	68	1,228	3,704	17	379	13
14	17,187	48,258	86,840	79,203	19,586	50,493	5,288	4,156	1,383	359	78	86	1,454	2,712	18	302	14
15	40,572	23,261	68,010	103,261	12,850	38,886	8,934	4,927	2,208	299	136	84	772	1,468	52	17	15
16	80,710	21,053	31,329	80,142	6,416	58,424	16,410	4,187	1,951	563	309	46	521	3,729	75	169	16
17	63,187	40,336	24,178	94,593	11,875	74,623	13,611	6,305	1,863	573	290	101	357	5,682	55	399	17
18	41,649	78,305	28,102	137,295	19,170	88,284	12,120	10,967	2,059	613	258	278	427	6,165	30	474	18
19	14,393	102,805	35,213	119,359	23,085	91,502	7,314	12,751	2,519	987	628	196	214	2,072	44	236	19
20	14,922	138,035	56,710	137,423	27,726	90,008	7,591	11,167	4,759	1,004	924	281	344	866	100	261	20
21	2,929	99,420	82,968	118,975	32,690	98,442	8,313	9,782	6,362	1,882	1,157	188	382	746	126	276	21
22	1,731	57,159	112,819	125,043	34,264	107,955	10,920	7,747	6,115	2,411	1,602	737	498	862	223	191	22
23	685	20,041	155,879	123,934	30,369	78,155	14,450	6,859	5,671	3,453	1,357	792	446	968	189	128	23
24	1,493	8,348	120,174	170,694	31,923	69,029	15,432	6,590	6,223	5,056	2,310	1,051	508	891	76	244	24
25	1,740	4,551	78,975	139,524	31,015	55,428	15,839	9,455	5,939	5,470	2,776	1,481	621	1,049	109	186	25
26	1,094	2,612	28,540	140,015	32,135	60,419	15,220	9,260	3,746	5,686	3,020	2,114	940	756	183	123	26
27	1,664	1,155	12,469	97,637	23,165	49,506	15,003	9,134	3,544	5,106	3,369	2,400	1,055	1,126	278	179	27
28	1,398	1,547	5,574	61,039	29,108	58,927	14,908	7,270	4,180	4,599	3,409	3,246	1,120	1,208	318	285	28
29	656	904	2,972	18,374	19,917	43,097	14,189	10,269	3,573	5,779	3,503	3,781	1,625	1,298	291	104	29
30	1,160	1,105	1,831	10,322	10,059	41,946	13,101	6,602	3,559	6,231	3,772	4,435	2,148	1,850	827	178	30
31	2,245	1,296	1,341	4,713	7,022	26,503	12,785	7,439	3,716	7,393	3,048	4,119	2,758	2,365	680	225	31
32	1,398	2,039	1,971	1,973	2,623	23,418	8,325	7,552	3,666	8,901	4,177	4,587	3,265	3,644	797	299	32
33	4,508	2,662	2,152	629	585	14,476	7,988	5,262	4,178	6,640	4,332	4,131	3,724	3,427	1,129	484	33
34	4,898	1,798	1,361	491	1,281	7,975	6,005	3,619	2,993	8,795	4,616	4,379	4,082	3,688	2,067	454	34
35	1,322	834	1,561	352	1,140	4,337	3,355	2,510	2,135	6,437	3,624	4,946	4,490	3,592	2,584	655	35
36	3,928	854	1,381	395	393	2,173	2,775	2,179	1,739	4,857	2,655	4,388	4,307	5,032	2,516	1,200	36
37	761	693	1,321	395	555	1,787	2,066	2,248	1,513	4,488	1,573	3,202	2,968	3,375	2,639	1,141	37
38	770	713	320	682	787	829	815	924	1,164	3,953	1,711	2,608	2,164	2,325	2,487	999	38
39	894	111	991	192	71	166	412	538	1,030	2,113	1,131	2,127	2,046	1,850	2,205	893	39
40	1,636	321	190	213	61	681	134	122	523	1,798	811	1,363	1,208	1,404	2,487	1,018	40
41	1,408	291	260	85	71	562	93	119	195	1,423	962	1,242	1,029	1,093	1,546	673	41
42	894	291	951	96	272	18	85	85	46	733	461	949	919	1,184	1,156	472	42
43	599	90	30		61	83	21	32	92	268	206	619	392	508	833	377	43
44	314	10	160	75	20	175	40	35	69	306	695	364	467	604	915	520	44
45	447		160			138	8	25	10		31	308	233	424	642	482	45
46					10	101		25	20	52	50	109	99	310	380	191	46
47						9	132		35	40	44	44	77	404	215	138	47
48	304		160		10		8				266	21	35	222	155	143	48
49						28	42				258		7	182	25	90	49
50							39				19	27	76	57	18	59	50
51					10	10				51	109	7		53	86	21	51
52											252		7		11	6	52
53												7	7		6	6	53
54	10							150			6				6		54
55								14			6						55
56								8					14				56
57																	57
58																	58
59																	59
60																	60
61																	61
62																	62
63																	63
64																	64
65																	65
66																	66
67																	67
68																	68
Total	381,494	1,086,813	1,023,208	2,071,817	504,536	1,317,842	265,741	191,568	90,096	108,633	60,126	61,279	50,691	75,362	28,624	24,289	Total

Mean length (cm)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Mean length (cm)
	17.2	16.3	20.5	19.8	20.8	21.8	24.0	23.1	25.7	30.4	30.7	32.3	31.2	27.0	36.7	23.7	

Table 4. 3M golden redfish abundance at age ('000s) from EU bottom trawl survey series, 1989-2018.

Year\age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	Total
1988	5,450	12,078	9,261	5,665	7,567	9,574	7,824	3,118	1,957	1,353	1,601	1,588	1,173	1,152	1,708	1,230	703	426	950	262	169	157	80	81	313	75,440
1989	717	7,967	19,629	5,304	4,670	3,706	9,258	3,787	7,521	3,860	3,838	1,843	1,613	1,395	1,659	1,168	774	481	386	320	264	184	97	87	298	80,825
1990	38,486	25,051	53,899	60,622	19,159	19,724	11,468	4,295	6,126	3,829	1,601	3,238	3,287	1,968	2,252	1,394	592	329	574	664	133	127	45	76	172	259,109
1991	30,177	17,122	10,121	4,505	3,122	2,876	1,885	1,612	1,388	1,013	642	398	333	383	356	319	124	77	65	115	34	34	19	15	62	76,798
1992	6,640	27,041	17,022	11,169	5,980	2,151	1,772	1,439	1,491	1,009	469	824	512	482	480	294	187	98	107	74	40	39	18	18	67	79,423
1993	2,622	156,853	65,746	33,947	30,859	11,846	4,193	14,439	1,742	725	801	461	1,560	555	442	386	109	49	52	145	28	20	9	14	32	327,635
1994	11	38,710	38,808	82,470	57,624	43,116	28,644	15,403	18,534	5,703	4,342	4,532	6,659	5,483	3,113	3,837	1,505	1,004	730	3,806	388	326	141	199	454	365,543
1995	252	6,323	9,215	10,814	12,287	9,768	8,045	4,399	2,213	1,467	535	339	609	741	539	613	129	73	66	213	35	41	17	25	42	68,799
1996	1,598	1,865	4,671	8,960	9,956	11,432	10,290	7,870	4,408	1,714	978	561	624	858	724	868	162	73	90	131	30	30	9	10	47	67,958
1997	244	2,464	6,816	4,940	11,074	15,070	21,917	39,056	43,176	22,571	10,034	7,178	4,514	4,273	5,712	4,018	1,753	892	865	817	299	536	106	168	253	208,744
1998	765	2,555	1,433	1,714	3,092	5,696	5,031	2,991	1,891	1,948	1,139	779	224	576	670	548	74	27	183	119	14	60	2	6	40	31,577
1999	684	560	1,086	648	1,633	2,049	3,978	3,684	2,277	2,381	2,684	2,588	698	1,038	1,455	635	418	93	239	194	43	118	7	24	117	29,327
2000	142	1,322	729	573	1,053	1,716	3,673	4,304	6,393	3,738	9,040	9,005	8,164	3,895	5,266	3,976	3,037	1,107	1,670	1,200	887	557	278	288	434	72,446
2001	736	561	1,753	402	793	826	1,781	2,133	1,648	2,106	3,142	889	2,006	691	1,371	526	389	137	245	142	62	108	15	21	58	22,542
2002	3,770	38,833	20,758	11,093	8,771	3,703	5,374	5,948	2,315	2,253	2,290	646	1,248	757	1,121	482	249	123	129	181	52	38	18	27	40	110,219
2003	15,750	62,194	99,216	86,191	55,051	10,756	12,595	4,901	6,234	7,045	5,289	2,026	3,494	2,917	2,497	1,380	902	518	572	1,356	244	145	66	70	85	381,494
2004	28,309	225,857	197,712	167,287	275,600	46,637	71,643	25,051	17,613	9,351	3,622	1,470	1,737	1,785	5,288	5,487	220	132	217	1,565	50	30	14	30	106	1,086,813
2005	1,501	83,266	151,302	102,479	322,176	129,855	96,956	67,008	37,362	11,878	6,079	4,043	1,573	2,473	1,087	2,849	267	202	246	255	93	90	27	29	111	1,023,208
2006	71,460	123,999	388,534	299,004	260,522	287,905	201,356	184,822	138,819	48,880	18,676	13,910	3,031	6,342	4,407	14,543	370	171	1,426	1,957	42	306	15	9	1,310	2,071,817
2007	10,123	43,732	75,028	54,730	53,107	75,677	45,294	53,835	40,657	18,111	9,753	10,129	2,861	3,046	2,409	3,961	255	233	474	412	49	308	16	11	328	504,536
2008	1,941	71,336	164,245	173,327	129,839	194,384	181,861	146,220	76,792	38,912	20,076	30,565	14,574	21,389	14,348	23,528	1,301	797	5,387	4,431	125	1,347	22	32	1,062	1,317,842
2009	2,056	8,940	28,951	27,430	31,285	27,537	26,531	30,792	18,230	13,831	5,996	12,662	9,052	5,512	7,163	4,154	1,325	345	1,997	643	86	722	16	48	437	265,741
2010	1,552	12,920	15,242	21,396	16,895	20,226	23,172	22,114	17,515	8,852	5,602	6,370	3,652	3,463	4,934	3,689	1,359	372	862	654	128	294	15	99	190	191,568
2011	38	1,989	3,091	7,327	9,064	8,965	14,263	11,593	8,446	5,759	1,576	4,356	2,781	2,053	3,210	2,339	1,351	437	691	333	124	136	13	68	94	90,096
2012	26	182	541	1,702	5,904	6,905	7,325	8,006	20,130	9,761	9,439	4,135	6,394	4,451	8,300	6,394	3,812	1,370	1,758	654	388	626	106	135	188	108,633
2013	30	139	431	829	2,950	2,690	7,741	4,755	7,638	4,084	4,514	5,344	2,188	3,112	3,398	2,993	2,444	1,160	1,335	662	313	463	192	289	434	60,126
2014	133	168	282	418	1,326	3,289	4,694	5,627	6,740	4,810	6,569	4,791	3,214	3,183	4,154	2,646	3,626	1,607	1,748	855	520	365	155	185	175	61,279
2015	391	1,326	2,201	1,634	1,451	2,190	3,041	3,238	3,798	3,681	4,916	5,035	3,717	2,829	2,935	1,847	1,913	1,250	1,438	749	357	284	130	141	200	50,691
2016	215	5,010	6,272	4,068	7,962	5,223	4,406	2,676	5,035	4,193	2,740	3,436	4,824	4,075	3,488	3,060	2,249	1,435	2,044	1,183	554	409	198	220	388	75,362
2017	4	43	67	266	106	498	775	1,151	1,449	2,134	2,051	3,509	3,880	2,873	1,777	1,599	1,965	977	1,038	694	617	391	220	188	350	28,624
2018	5,124	2,846	1,838	807	907	679	700	534	883	506	925	1,040	1,082	1,072	1,498	778	782	556	453	336	265	177	142	108	253	24,289

Table 5. Length weight relationships for 3M golden redfish from EU survey.

Year	a	b
1988	0.0221	2.8881
1989	0.0298	2.8222
1990	0.0330	2.7887
1991	0.0298	2.8115
1992	0.0294	2.8239
1993	0.0231	2.8898
1994	0.0162	3.0027
1995	0.0155	3.0038
1996	0.0174	2.9662
1997	0.0190	2.9462
1998	0.0182	2.9618
1999	0.0163	2.9831
2000	0.0203	2.9246
2001	0.0173	2.9677
2002	0.0173	2.9693
2003	0.0119	3.0614
2004	0.0152	3.0070
2005	0.0171	2.9506
2006	0.0085	3.1684
2007	0.0136	3.0297
2008	0.0168	2.9703
2009	0.0141	3.0284
2010	0.0173	2.9592
2011	0.0184	2.9444
2012	0.0199	2.9328
2013	0.0198	2.9329
2014	0.0230	2.8993
2015	0.0209	2.9279
2016	0.0169	2.9879
2017	0.0191	2.9440
2018	0.0167	2.9869

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

Year\age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+
1988	0.013	0.030	0.033	0.064	0.147	0.244	0.318	0.338	0.398	0.421	0.511	0.549	0.617	0.611	0.689	0.766	0.875	0.970	0.511	0.901	1.050	0.925	1.111	1.370	0.949
1989	0.015	0.052	0.069	0.101	0.169	0.258	0.340	0.364	0.493	0.568	0.617	0.702	0.728	0.800	0.788	0.831	0.905	1.110	1.116	1.114	1.218	1.012	1.157	1.253	1.392
1990	0.014	0.030	0.075	0.116	0.159	0.196	0.273	0.333	0.343	0.460	0.529	0.532	0.417	0.546	0.537	0.531	0.761	0.959	0.616	0.366	0.889	0.858	1.136	1.070	0.978
1991	0.013	0.019	0.038	0.043	0.133	0.163	0.187	0.261	0.311	0.386	0.515	0.549	0.574	0.533	0.595	0.510	0.945	1.070	0.930	0.442	1.121	1.073	1.193	1.137	1.301
1992	0.014	0.035	0.037	0.043	0.074	0.165	0.230	0.252	0.337	0.408	0.450	0.520	0.495	0.590	0.603	0.637	0.793	0.974	0.739	0.763	1.045	0.923	1.266	1.399	1.445
1993	0.013	0.059	0.060	0.058	0.071	0.092	0.164	0.100	0.335	0.408	0.501	0.531	0.255	0.384	0.536	0.381	0.762	0.850	0.780	0.311	1.042	0.779	1.205	1.134	1.394
1994	0.019	0.066	0.075	0.096	0.099	0.118	0.157	0.233	0.286	0.434	0.532	0.590	0.329	0.501	0.709	0.592	1.029	1.232	1.172	0.317	1.315	1.173	1.483	1.597	1.798
1995	0.014	0.056	0.067	0.089	0.121	0.150	0.168	0.210	0.254	0.358	0.479	0.566	0.416	0.334	0.445	0.352	0.867	1.046	0.932	0.387	1.269	1.034	1.700	1.426	1.680
1996	0.010	0.033	0.074	0.112	0.150	0.169	0.193	0.245	0.262	0.323	0.408	0.488	0.482	0.338	0.394	0.273	0.699	0.852	0.761	0.331	0.892	0.685	1.382	0.739	1.747
1997	0.014	0.041	0.079	0.153	0.208	0.197	0.220	0.289	0.382	0.432	0.483	0.542	0.652	0.543	0.533	0.537	0.802	0.927	0.720	0.565	1.051	0.642	1.207	1.107	1.207
1998	0.009	0.039	0.062	0.123	0.196	0.219	0.262	0.307	0.297	0.309	0.387	0.416	0.484	0.325	0.366	0.282	0.703	0.656	0.347	0.350	0.695	0.467	1.058	0.989	0.465
1999	0.013	0.027	0.030	0.148	0.231	0.261	0.324	0.356	0.380	0.369	0.441	0.465	0.507	0.532	0.514	0.539	0.678	0.762	0.502	0.478	0.789	0.505	1.100	0.711	1.218
2000	0.014	0.042	0.051	0.163	0.239	0.349	0.459	0.460	0.505	0.530	0.631	0.666	0.804	0.869	0.800	1.022	0.973	1.072	1.103	1.356	1.247	1.012	1.336	1.436	1.355
2001	0.014	0.029	0.030	0.132	0.200	0.271	0.371	0.413	0.480	0.433	0.550	0.609	0.601	0.578	0.571	0.721	0.730	0.739	0.569	0.708	0.883	0.580	1.396	1.286	1.585
2002	0.012	0.042	0.047	0.054	0.111	0.135	0.228	0.233	0.422	0.460	0.540	0.668	0.604	0.629	0.542	0.578	0.814	0.960	0.891	0.521	1.122	0.982	1.152	1.135	1.320
2003	0.008	0.041	0.059	0.068	0.095	0.098	0.136	0.180	0.410	0.519	0.549	0.769	0.643	0.796	0.647	0.719	1.014	1.068	1.018	0.346	1.146	1.257	1.193	1.102	1.162
2004	0.014	0.034	0.044	0.087	0.129	0.126	0.139	0.160	0.195	0.292	0.514	0.702	0.611	0.533	0.219	0.175	0.874	0.841	0.589	0.143	0.892	0.900	1.094	0.654	0.352
2005	0.012	0.042	0.053	0.094	0.164	0.187	0.216	0.239	0.264	0.318	0.394	0.578	0.646	0.573	0.642	0.356	0.952	0.993	0.792	0.736	1.077	1.160	1.141	0.977	0.543
2006	0.011	0.033	0.047	0.094	0.144	0.190	0.224	0.243	0.265	0.272	0.315	0.362	0.417	0.299	0.354	0.181	0.556	0.721	0.311	0.192	0.850	0.443	0.997	0.828	0.279
2007	0.013	0.033	0.047	0.101	0.150	0.196	0.250	0.275	0.302	0.326	0.382	0.422	0.485	0.453	0.466	0.249	0.663	0.685	0.399	0.374	0.904	0.458	0.991	0.858	0.325
2008	0.011	0.042	0.069	0.100	0.148	0.182	0.235	0.270	0.323	0.349	0.477	0.472	0.493	0.382	0.403	0.237	0.634	0.594	0.328	0.212	0.830	0.434	1.249	1.001	0.328
2009	0.011	0.042	0.063	0.094	0.175	0.216	0.280	0.342	0.386	0.421	0.504	0.508	0.584	0.551	0.504	0.425	0.688	0.788	0.384	0.390	0.786	0.440	1.174	1.198	0.454
2010	0.013	0.038	0.057	0.095	0.153	0.188	0.229	0.318	0.355	0.421	0.508	0.544	0.554	0.406	0.502	0.419	0.648	0.736	0.556	0.286	0.641	0.606	1.230	1.512	1.326
2011	0.017	0.050	0.064	0.112	0.179	0.222	0.240	0.320	0.410	0.473	0.550	0.528	0.596	0.485	0.555	0.587	0.721	0.843	0.603	0.543	0.846	0.561	1.110	0.669	0.500
2012	0.012	0.047	0.086	0.140	0.219	0.286	0.352	0.395	0.462	0.587	0.580	0.601	0.577	0.599	0.609	0.717	0.798	0.900	0.772	0.767	0.863	0.556	1.088	0.786	0.711
2013	0.012	0.047	0.085	0.168	0.220	0.287	0.356	0.393	0.471	0.521	0.529	0.571	0.664	0.652	0.604	0.758	0.838	0.945	0.853	0.914	1.042	0.898	1.450	1.203	1.356
2014	0.015	0.038	0.117	0.189	0.250	0.349	0.435	0.480	0.582	0.553	0.622	0.644	0.637	0.720	0.707	0.753	0.838	0.988	0.943	0.940	1.010	0.830	1.092	0.813	1.053
2015	0.014	0.044	0.054	0.097	0.179	0.326	0.419	0.509	0.630	0.653	0.721	0.716	0.737	0.754	0.713	0.850	0.813	1.003	0.958	0.989	1.139	0.922	1.179	0.991	1.201
2016	0.013	0.044	0.066	0.089	0.114	0.198	0.297	0.464	0.553	0.581	0.684	0.710	0.700	0.758	0.777	0.813	0.867	1.009	1.034	0.961	1.244	1.081	1.321	1.398	1.237
2017	0.011	0.047	0.089	0.131	0.214	0.386	0.449	0.510	0.613	0.637	0.766	0.843	0.850	0.910	0.973	0.924	1.020	1.154	1.140	1.135	1.188	1.227	1.140	1.272	1.315
2018	0.011	0.017	0.024	0.056	0.128	0.201	0.339	0.453	0.528	0.695	0.789	0.821	0.858	0.991	0.975	1.122	1.120	1.175	1.143	1.183	1.255	1.290	1.295	1.522	1.473
1988-2018 mean weight	0.013	0.040	0.060	0.103	0.160	0.214	0.274	0.321	0.395	0.449	0.531	0.587	0.581	0.580	0.589	0.575	0.819	0.923	0.758	0.614	1.011	0.829	1.214	1.115	1.079

Table 7. 3M golden redfish female maturity ogive by length and age, 2015-2018.

Length Maturity Ogives

Year	a	b	L50	n
2015	-21.10	0.59	35.5	542
2016	-17.74	0.53	33.2	300
2017	-27.78	0.79	35.0	235
2018	-22.51	0.63	35.7	234

Age Maturity Ogives

Year	a	b	A50	n
2015	-9.55	0.79	12.2	536
2016	-4.19	0.40	10.5	86
2017	-8.47	0.73	11.7	128
2018	-6.16	0.50	12.3	220

Table 8. 3M golden redfish SSB(ton)/R(millions) relationship data (not lagged).

Year	SSB	Rec Age1	Rec Age2	Rec Age3	Rec Age4
1988	3901	5.450	12.078	9.261	5.665
1989	4855	0.717	7.967	19.629	5.304
1990	3794	38.486	25.051	53.899	60.622
1991	584	30.177	17.122	10.121	4.505
1992	945	6.640	27.041	17.022	11.169
1993	873	2.622	156.853	65.746	33.947
1994	12636	0.011	38.710	38.808	82.470
1995	1015	0.252	6.323	9.215	10.814
1996	1094	1.598	1.865	4.671	8.960
1997	13021	0.244	2.464	6.816	4.940
1998	898	0.765	2.555	1.433	1.714
1999	2099	0.684	0.560	1.086	0.648
2000	23994	0.142	1.322	0.729	0.573
2001	2808	0.736	0.561	1.753	0.402
2002	1473	3.770	38.833	20.758	11.093
2003	9372	15.750	62.194	99.216	86.191
2004	3180	28.309	225.857	197.712	167.287
2005	6743	1.501	83.266	151.302	102.479
2006	15279	71.460	123.999	388.534	299.004
2007	8055	10.123	43.732	75.028	54.730
2008	37118	1.941	71.336	164.245	173.327
2009	14849	2.056	8.940	28.951	27.430
2010	8334	1.552	12.920	15.242	21.396
2011	5075	0.038	1.989	3.091	7.327
2012	16552	0.026	0.182	0.541	1.702
2013	10800	0.030	0.139	0.431	0.829
2014	12578	0.133	0.168	0.282	0.418
2015	9849	0.391	1.326	2.201	1.634
2016	12164	0.215	5.010	6.272	4.068
2017	9044	0.004	0.043	0.067	0.266
2018	4285	5.124	2.846	1.838	0.807

Table 9a. 3M Redfish nominal catches (ton) by country, 2005-2018.

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CAN							2							
CUB							875	600						
DDR														
GRL														
JPN	483	383	613	603								136	197	636
SUN/RUS	1023	849	780	1212	1184	927	1571	1720	1808	1342	1332	790	576	686
UKR		1												
E-LVA	48	250			58		71							
E-LTU	522	397	542			348	478			0.122				
E-EST	1093	1249	728	950	1643	1161	820		1036	601	498	526	764	2017
E-SP	542	596	533	1225	745	892	339	512	416	1031	1318	1385	2021	2236
E PRT	2696	2594	2357	3707	5027	4703	5024	4236	3493	3462	3720	3596	3596	4838
EU										7				
FR-STP	10			8			68	69						
UK						1	2		8			10	7	
KOR-S														
FAROE IS.				215	1	122	420		10	5	75	68	2	65
NOR													3	
Total	6417	6319	5553	7920	8658	8154	9670	7137	6771	6449	6944	6510	7165	10478

Table 9b. Percentage of beaked and golden redfish found in the EU survey redfish catches (excluding juveniles; redfish beyond 700m depth is 100% *S. mentella*) (González Troncoso and Casas *pers comm.*).

Depth range	Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<200m	golden	36.1	51.1	97.9	100.0	100.0	100.0	90.0	96.5	99.0	98.9	98.0	99.2	91.0	96.7
	beaked	63.9	48.9	2.1	0.0	0.0	0.0	10.0	3.5	1.0	1.1	2.0	0.8	9.0	3.3
200-300m	golden	54.5	50.7	32.4	68.3	84.9	68.3	52.9	63.5	65.4	91.8	94.5	80.8	53.9	59.1
	beaked	45.5	49.3	67.6	31.7	15.1	31.7	47.1	36.5	34.6	8.2	5.5	19.2	46.1	40.9
300-400m	golden	18.8	5.9	12.0	28.5	22.0	28.5	3.7	5.5	10.0	34.1	25.9	10.2	2.7	5.9
	beaked	81.2	94.1	88.0	71.5	78.0	71.5	96.3	94.5	90.0	65.9	74.1	89.8	97.3	94.1
400-700m	golden	2.1	5.0	1.3	8.8	0.9	8.8	0.6	0.0	1.3	0.3	0.4	0.2	0.5	0.04
	beaked	97.9	95.0	98.7	91.2	99.1	91.2	99.4	100.0	98.7	99.7	99.6	99.8	99.5	99.96

Table 9c. Beaked and golden redfish on Div. 3M: commercial catch estimates (ton) from various sources (STACFIS, 2005-2010; based on STALANT plus 15%, 2011-2014; based on Daily Catch Records, 2015; CDAG catch estimates 2016; CESAG catch estimates 2017 and 2018). Also using information on distribution by depth of the EU survey redfish catch by species (D. Gonzalez *pers. comm*.) and of the commercial redfish catches of Portugal, Russia (M. Pochtar and K. Fromin *pers.comm*.) and Spain (F. Gonzalez *pers. comm*.)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Beaked redfish	4148	5997	5149	4277	3656	5410	8994	6281	5168	4565	5243	6152	6914	10330
Golden redfish	**2402**	**1158**	**1513**	**4188**	**7662**	**3086**	**2127**	**1927**	**2609**	**2851**	**1701**	**358**	**251**	**148**
Total	6550	7156	6662	8465	11317	8496	11121	8208	7778	7416	6944	6510	7165	10478

Table 10. Length weight relationships for 3M golden redfish from Portuguese commercial catch.

Year	Sex	a	b	Source
2006	Females	0.0067	3.2215	Vargas *et al* (2007) scs 07/09
2006	Males	0.0039	3.3547	
2006	Total	0.0051	3.2913	
2007	Females	0.0143	3.0062	Vargas *et al* (2008) scs 08/05
2007	Males	0.0170	2.9528	
2007	Total	0.0148	2.9987	
2008	Females	0.0088	3.1046	Vargas *et al* (2009) scs 09/05
2008	Males	0.0089	3.0994	
2008	Total	0.0085	3.1160	
2009	Females	0.0282	2.8072	Vargas *et al* (2010) scs 10/07
2009	Males	0.0284	2.8076	
2009	Total	0.0265	2.8278	
2010	Females	0.0765	2.5206	Vargas *et al* (2011) scs 11/05
2010	Males	0.0764	2.5257	
2010	Total	0.0704	2.5486	
2011	Females	0.0187	2.9053	Vargas *et al* (2012) scs 12/08
2011	Males	0.0156	2.9610	
2011	Total	0.0181	2.9168	
2013	Females	0.0024	3.5088	Vargas *et al* (2014) scs 14/10
2013	Males	0.0049	3.2938	
2013	Total	0.0026	3.4843	
2014	Females	0.0108	3.0572	Vargas *et al* (2015) scs 15/06
2014	Males	0.0060	3.2250	
2014	Total	0.0081	3.1379	
2018	Females	0.0041	3.3200	Vargas *et al* (2019) scs 19/09
2018	Males	0.0558	2.5843	
2018	Total	0.0202	2.8812	

Table 11. Criteria applied to convert total catches in weight to total catches in number, 2005-2018.

YEAR	TOTAL CATCH (ton)	BREAKDOWN TOTAL CATCH (ton)	LENGTHS COMPOSITION				Mean Weight (Kg)	TOTAL CATCH IN NUMBER (000's)	
			Country	Source	Gear	Source			
2005	**2402**	2402	Russia	Commercial	OTB	*Vaskov et al (2006); scs 06/07*	0.316	7602.2	**7602.2**
2006	**1158**	893	Portugal	Commercial	OTB	*Vargas et al (2007); scs 07/09*	0.305	2931.2	**3545.8**
		8	Espanha	Commercial	OTB	*González-Costas pers. comm. (2007)*	0.304	27.9	
		257	Russia	Commercial	OTB	*Vaskov et al (2007); scs 07/06*	0.438	586.7	
2007	**1513**	892	Portugal	Commercial	OTB	*Vargas et al (2008); scs 08/05*	0.386	2309.6	**4288.2**
		416	Espanha	Commercial	OTB	*González-Costas pers. comm. (2008)*	0.286	1453.2	
		205	Russia	Commercial	OTB	*Vaskov et al (2008); scs 08/06*	0.390	525.4	
2008	**4188**	3485	Portugal	Commercial	OTB	*Vargas et al (2009); scs 09/05*	0.326	10685.0	**13051.4**
		157	Espanha	Commercial	OTB	*González-Costas pers. comm. (2009)*	0.215	731.5	
		546	Russia	Commercial	OTB	*Skryabin et al (2009); scs 09/12*	0.334	1634.9	
2009	**7662**	7662	Portugal	Commercial	OTB	*Vargas et al (2010); scs 10/07*	0.385	19907.4	**19907.4**
2010	**21947**	2777	Portugal	Commercial	OTB	*Vargas et al (2011); scs 11/05*	0.384	7238.9	**45979.3**
		18906	Espanha	Commercial	OTB	*González-Costas pers. comm. (2011)*	0.495	38230.2	
		264	Russia	Commercial	OTB	*Skryabin and Pochtar (2011); scs 11/11*	0.517	510.2	
2011	**2127**	1742	Portugal	Commercial	OTB	*Vargas et al (2012); scs 12/08*	0.441	3951.5	**4665.5**
		118	Espanha	Commercial	OTB	*González-Costas pers. comm. (2012)*	0.434	271.5	
		267	Russia	Commercial	OTB	*Pochtar and Fomin (2012); scs 12/05*	0.604	442.6	
2012	**1927**	128	Espanha	Commercial	OTB	*González-Costas pers. comm. (2013)*	0.620	206.6	**2260.2**
		1799	Russia	Commercial	OTB	*Pochtar et al (2013); scs 13/09*	0.876	2053.5	
2013	**2609**	2205	Portugal	Commercial	OTB	*Vargas et al (2014); scs 14/10*	0.310	7123.1	**7767.9**
		160	Espanha	Commercial	OTB	*González-Costas pers. comm. (2014)*	0.471	339.0	
		245	Russia	Commercial	OTB	*Fomin and Khlivnoy (2014); scs 14/13*	0.801	305.8	
2014	**2851**	2226	Portugal	Commercial	OTB	*Vargas et al (2015); scs 15/06*	0.371	6003.6	**7062.5**
		230	Espanha	Commercial	OTB	*González-Costas pers. comm. (2015)*	0.459	501.5	
		395	Russia	Commercial	OTB	*Fomin et al (2015); scs 15/07*	0.708	557.4	
2015	**1701**	955	Portugal	Commercial	OTB	*Vargas et al (2016); scs 16/09*	0.294	3248.6	**4615.5**
		746	Espanha	Commercial	OTB	*González-Costas pers. comm. (2016)*	0.546	1367.0	
2016	**358**	261	Portugal	Commercial	OTB	*Vargas et al (2017); scs 17/05REV*	0.360	725.2	**808.0**
		98	Espanha	Commercial	OTB	*González-Costas pers. comm. (2017)*	1.178	82.8	
		0	Russia	Commercial	OTB	*Fomin and Pochtar (2017); scs 17/11*	0.793	0.0	
2017	**251**	86	Portugal	Commercial	OTB	*Vargas et al (2018); scs 18/08*	0.427	201.2	**413.4**
		150	Espanha	Commercial	OTB	*González-Costas pers. comm. (2018)*	0.771	195.2	
		14	Russia	Commercial	OTB	*Fomin and Pochtar (2018); scs 18/13*	0.837	17.0	
2018	**148**	148	Portugal	Commercial	OTB	*Vargas et al (2019); scs 19/09*	0.513	288.4	**288.4**

Table 12. Length composition (absolute frequencies in'000s) of the 3M golden redfish commercial catch, 2005-2018.

Length (cm)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Length (cm)
12				6.0					0.1						12
13	11.2			0.8											13
14	46.3	0.1													14
15	99.8	0.4	14.5	2.8			0.2		2.5	11.5	2.2				15
16	131.7	2.1	25.9	14.7			3.7		20.1	23.9	0.4				16
17	144.5	2.2	40.7	13.6		0.5	11.7		46.7	48.7	0.4				17
18	201.2	14.7	80.0	35.2	16.6	13.5	27.2		83.5	92.5	9.8	3.3	0.2		18
19	300.2	27.6	98.6	119.1		17.1	43.7		150.6	163.7	14.7	3.3			19
20	372.1	52.4	137.1	265.5		369.4	83.6		171.0	289.9	52.0	7.7			20
21	442.3	100.1	158.4	288.8	33.1	538.2	74.6	2.0	284.8	221.7	74.9	1.5	1.2		21
22	571.7	176.0	146.8	628.1	128.5	2090.5	104.0		555.9	628.0	182.4	8.9	1.8	0.0	22
23	816.0	162.6	142.3	694.8	393.7	2221.7	138.9	9.9	433.6	464.7	231.1	25.5	1.6	0.2	23
24	856.7	227.9	164.2	916.7	991.9	2191.6	194.3	11.9	406.6	401.4	288.4	36.7	4.6	0.4	24
25	714.6	307.8	180.1	773.1	1739.4	2032.0	216.4	9.1	561.8	210.7	323.1	47.1	11.0	0.8	25
26	570.1	338.5	297.7	1269.0	1680.3	1830.8	244.9	39.5	580.6	340.2	434.1	42.2	10.7	1.7	26
27	383.3	388.2	389.4	1032.8	2382.4	2785.0	230.6	35.2	540.0	132.6	511.5	63.9	16.8	2.9	27
28	231.6	388.7	411.8	1570.6	2519.0	3836.7	299.9	35.5	696.4	415.3	423.4	65.7	21.3	20.2	28
29	206.0	328.0	457.1	1246.2	2560.9	3932.3	287.2	33.2	468.8	281.8	385.4	61.9	18.1	37.7	29
30	162.1	319.3	482.1	1090.4	1981.9	2118.8	290.2	43.4	512.6	479.9	344.9	70.4	24.4	38.3	30
31	103.0	261.7	315.8	727.5	1850.2	1916.2	307.0	64.5	594.7	346.6	196.2	82.9	24.6	36.7	31
32	101.4	169.5	240.8	435.5	962.2	3426.6	312.9	151.5	514.1	246.0	135.4	82.2	26.4	30.0	32
33	117.4	50.7	175.2	409.9	1080.6	2850.3	277.5	96.6	309.9	232.8	147.2	45.5	27.1	33.2	33
34	126.2	27.2	125.0	257.0	524.1	2636.0	252.8	149.2	182.7	291.8	135.8	22.7	29.8	27.7	34
35	120.6	46.0	101.1	252.5	298.2	2272.7	229.6	179.0	143.1	237.9	133.8	29.3	25.9	9.9	35
36	79.8	24.0	15.0	264.7	259.8	985.1	222.3	181.0	81.9	259.8	106.1	12.4	26.3	8.9	36
37	93.4	15.8	18.8	164.3	192.7	669.7	196.3	189.0	91.3	217.6	109.9	10.1	24.8	9.9	37
38	83.8	19.5	10.9	176.2	103.4	2474.6	187.1	149.2	108.6	237.5	85.0	9.4	22.7	0.4	38
39	88.6	16.1	5.3	49.1		892.3	153.8	126.5	38.6	220.0	64.3	10.3	17.9	2.4	39
40	65.5	12.7	6.2	87.0	39.6	1589.5	88.5	147.5	65.9	213.7	57.9	7.4	19.3		40
41	61.5	9.2	4.9	20.9	84.5	1365.0	63.0	176.2	34.1	80.3	44.0	8.5	13.1	3.5	41
42	58.3	10.5	6.5	60.5		3.1	49.1	172.2	17.8	66.5	46.7	9.4	10.2		42
43	61.5	8.9	8.8	28.3	64.7	448.9	28.7	59.4	17.8	65.0	21.5	4.6	9.0	8.2	43
44	53.5	15.1	4.4	27.3		15.4	11.1	84.4	14.3	55.2	18.6	4.0	9.1	2.4	44
45	35.9	6.7	2.7	26.0			5.8	56.3	7.0	33.4	16.0	2.7	5.2		45
46	24.8	4.9	4.2	37.9		231.6	6.7	56.3	7.5	18.1	1.9	6.7	3.6		46
47	20.0	3.9	4.7	14.3			8.0		5.5	13.5	8.5	2.1	2.3	7.1	47
48	19.2	1.6	5.0	24.7	19.8	224.3	4.5	2.0	5.7	6.6	2.2	3.3	2.3	3.5	48
49	13.6	1.3	1.2	2.0					3.0	7.1	3.4	2.7	0.4	2.3	49
50	7.2	0.6	1.9	8.9			3.3		3.4	3.7		6.1	0.5		50
51	4.0	2.0	0.5	1.6			1.0		0.9	0.9	2.5	2.7	0.3		51
52	1.6	1.3	0.3	1.3			0.5		0.9			2.1	0.4		52
53				1.9			2.7		1.7	0.9					53
54			2.3	3.7			1.7			0.0		1.3	0.3		54
55		0.0	0.2							0.6			0.3		55
56			0.2	0.1						0.6		1.3			56
57									0.9						57
58									0.9						58
59				0.1											59
60							0.5								60
Total	7602.2	3545.8	4288.2	13051.4	19907.4	45979.3	4665.5	2260.2	7767.9	7062.5	4615.5	808.0	413.4	288.4	Total

Mean	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Mean
length (cm)	26.2	28.1	28.1	28.6	29.3	31.2	31.3	37.4	28.2	29.7	29.4	31.1	34.8	33.3	length (cm)

Table 13. Catch in numbers at age (' 000) of 3M golden redfish, 2005-2018.

Year\age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	Total
2005		48.8	260.7	582.4	1916.1	736.9	811.1	929.7	688.6	365.7	243.4	260.6	138.3	156.0	99.8	105.5	62.8	49.3	41.6	33.2	21.4	15.9	8.7	9.2	16.6	7602.2
2006		0.5	13.4	80.4	232.8	442.3	511.5	621.0	539.2	365.8	160.8	250.7	82.1	77.9	55.8	36.0	15.5	10.0	13.0	10.4	5.9	8.5	1.4	2.4	8.5	3545.8
2007		4.7	80.0	205.3	230.6	501.8	436.4	621.2	629.0	467.7	288.8	394.9	116.4	122.5	70.7	37.4	16.6	12.7	13.1	11.6	4.3	10.0	1.3	2.7	8.5	4288.2
2008		5.6	35.8	228.3	575.5	1464.8	2273.9	2242.4	1417.6	770.8	588.7	852.1	563.7	569.8	531.1	398.8	88.5	51.9	163.4	66.1	21.4	67.2	8.0	9.5	56.7	13051.4
2009			1.9	74.5	897.4	1691.1	2375.0	3847.0	2300.1	1829.8	806.7	1876.0	1142.5	675.6	1096.3	434.7	156.6	53.2	281.4	89.1	13.4	186.0	5.2	5.1	68.8	19907.4
2010			5.0	423.5	2479.4	2915.7	5166.0	6396.7	5460.6	3142.2	2597.3	3792.0	2953.2	1794.6	3124.6	1752.1	1331.1	723.7	711.2	339.1	326.8	265.6	133.1	79.8	66.3	45979.3
2011		0.5	8.5	79.7	200.2	306.0	539.5	624.9	583.6	445.5	140.1	329.5	230.0	175.9	342.9	237.5	147.6	68.9	85.0	37.4	22.6	21.4	7.7	9.7	21.0	4665.5
2012				0.4	17.6	45.4	68.5	79.6	243.0	160.6	164.5	112.1	145.9	117.3	258.3	262.3	209.6	117.0	108.3	54.4	37.2	21.6	17.1	6.9	12.7	2260.2
2013		1.8	27.4	160.0	645.2	582.3	1373.4	849.2	887.4	490.9	652.5	493.7	181.5	315.2	410.4	223.7	132.0	75.0	99.2	44.4	22.5	41.3	6.7	10.3	41.7	7767.9
2014		2.5	32.5	207.8	464.9	750.3	719.8	864.5	708.6	478.0	458.1	408.0	247.5	251.1	360.2	259.5	270.0	141.0	149.2	93.2	58.0	41.0	24.3	18.4	54.2	7062.5
2015		0.9	1.7	60.4	310.8	755.3	581.1	515.9	397.9	317.4	311.0	326.4	212.9	188.9	224.0	102.6	77.4	54.8	62.5	43.9	19.8	24.4	7.5	6.2	12.0	4615.5
2016			0.6	3.5	37.1	100.8	76.6	60.0	78.8	80.1	51.0	56.2	60.6	36.2	60.8	23.0	16.4	11.7	13.5	9.3	5.7	8.9	3.1	3.8	10.4	808.0
2017			0.01	0.7	2.9	26.3	20.4	31.3	43.8	39.8	32.5	41.3	45.3	30.2	20.1	16.8	19.5	9.7	9.9	6.4	5.1	4.1	1.9	1.9	3.5	413.4
2018				0.0	0.9	2.6	20.4	41.3	84.5	31.2	10.1	21.1	19.7	7.5	14.6	7.9	7.9	4.7	3.5	2.9	1.7	1.4	1.1	1.4	2.0	288.4

Table 14. Weights at age in the catch (kg) of 3M golden redfish, 2005-2018.

Year\age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+
2005		0.053	0.067	0.106	0.169	0.197	0.241	0.276	0.326	0.428	0.512	0.649	0.747	0.836	0.903	0.876	1.122	1.163	1.144	1.210	1.228	1.294	1.303	1.448	1.313
2006		0.047	0.079	0.129	0.169	0.203	0.263	0.291	0.317	0.360	0.404	0.449	0.568	0.619	0.627	0.652	0.820	0.910	0.728	0.940	1.200	0.790	1.408	1.625	0.993
2007		0.060	0.085	0.116	0.177	0.222	0.299	0.326	0.368	0.409	0.447	0.462	0.530	0.587	0.568	0.573	0.727	0.952	0.656	0.803	1.123	0.702	1.384	1.352	0.977
2008		0.032	0.069	0.117	0.161	0.205	0.247	0.254	0.314	0.333	0.441	0.410	0.510	0.481	0.473	0.416	0.817	0.795	0.382	0.568	1.105	0.551	1.064	1.341	0.869
2009			0.102	0.217	0.243	0.293	0.309	0.347	0.378	0.402	0.465	0.452	0.518	0.514	0.454	0.439	0.640	0.826	0.357	0.416	0.773	0.393	0.967	0.666	0.484
2010			0.126	0.181	0.241	0.297	0.316	0.362	0.407	0.481	0.547	0.580	0.621	0.614	0.627	0.662	0.727	0.851	0.714	0.761	0.859	0.680	0.945	0.840	0.764
2011		0.063	0.091	0.126	0.190	0.250	0.284	0.344	0.435	0.486	0.563	0.498	0.597	0.578	0.599	0.649	0.727	0.825	0.658	0.740	0.901	0.689	0.951	1.116	0.975
2012				0.231	0.282	0.455	0.633	0.581	0.611	0.749	0.713	0.766	0.793	0.859	0.892	0.976	1.036	1.134	1.084	1.118	1.148	1.175	1.126	1.121	1.105
2013		0.045	0.060	0.118	0.164	0.178	0.252	0.263	0.328	0.339	0.404	0.432	0.514	0.462	0.429	0.539	0.718	0.848	0.513	0.735	0.848	0.538	1.031	0.899	0.977
2014		0.044	0.079	0.112	0.148	0.192	0.225	0.279	0.375	0.369	0.484	0.511	0.528	0.540	0.559	0.570	0.758	0.867	0.812	0.865	0.947	0.789	0.956	0.901	1.220
2015		0.042	0.081	0.145	0.189	0.244	0.267	0.304	0.332	0.355	0.452	0.467	0.549	0.462	0.455	0.539	0.704	0.868	0.749	0.703	0.960	0.599	0.987	0.953	0.935
2016			0.083	0.142	0.195	0.243	0.308	0.370	0.363	0.364	0.396	0.437	0.505	0.550	0.515	0.650	0.729	0.812	0.906	0.984	1.075	0.799	1.336	1.531	1.457
2017			0.074	0.138	0.230	0.265	0.363	0.376	0.428	0.469	0.593	0.663	0.655	0.735	0.728	0.761	0.856	0.985	0.968	0.958	1.061	1.021	1.094	1.156	1.293
2018				0.183	0.358	0.303	0.360	0.361	0.414	0.453	0.473	0.471	0.571	0.717	0.634	0.826	0.959	1.065	0.895	1.109	1.098	1.059	1.394	1.527	1.260
2005-2018 mean weight		0.048	0.083	0.147	0.208	0.253	0.312	0.338	0.385	0.428	0.492	0.518	0.586	0.611	0.605	0.652	0.810	0.922	0.755	0.851	1.023	0.791	1.139	1.177	1.044

Table 15. 3M golden redfish exploitation pattern.

Age	F at age index	Observed PR	Logit PR	Squared difference
1	0.000	0.000	0.000	0.000
2	0.014	0.009	0.004	0.000
3	0.067	0.042	0.050	0.000
4	0.279	0.176	0.200	0.001
5	0.669	0.421	0.422	0.000
6	1.030	0.647	0.629	0.000
7	1.223	0.769	0.780	0.000
8	1.539	0.968	0.875	0.009
9	1.536	0.966	0.931	0.001
10	1.590	1.000	0.962	0.001
11	1.240	0.780	0.980	0.040
12	1.423	0.895	0.989	0.009
13	1.238	0.779	0.994	0.046
14	1.102	0.693	0.997	0.093
15	1.351	0.849	0.998	0.022
16	1.149	0.722	0.999	0.077
17	1.057	0.665	1.000	0.112
18	1.171	0.736	1.000	0.069
19	1.086	0.683	1.000	0.101
20	1.090	0.685	1.000	0.099
21	1.154	0.726	1.000	0.075
22	1.412	0.888	1.000	0.013
23	1.275	0.802	1.000	0.039
24	1.088	0.684	1.000	0.100
25	1.410	0.887	1.000	0.013
		Minimum sum of squares		0.920

Curve parameters	*a*	*b*	*m*
	4.012	0.623	1072.030

Table 16. 3M golden redfish *YPR* input data.

Age	mean weights		og mat (%)	PR 05-18	Ref. M
	stock	catch			
1	0.013	*0.013*	0.000	0.000	0.10
2	0.040	0.027	0.001	0.009	0.10
3	0.060	0.071	0.002	0.042	0.10
4	0.103	0.147	0.004	0.176	0.10
5	0.160	0.208	0.008	0.421	0.10
6	0.214	0.253	0.016	0.647	0.10
7	0.274	0.312	0.033	0.769	0.10
8	0.321	0.338	0.066	0.968	0.10
9	0.395	0.385	0.127	0.966	0.10
10	0.449	0.428	0.231	1.000	0.10
11	0.531	0.492	0.384	0.780	0.10
12	0.587	0.518	0.563	0.895	0.10
13	0.581	0.586	0.727	0.779	0.10
14	0.580	0.611	0.847	0.693	0.10
15	0.589	0.605	0.920	0.849	0.10
16	0.575	0.652	0.959	0.722	0.10
17	0.819	0.810	0.980	0.665	0.10
18	0.923	0.922	0.990	0.736	0.10
19	0.758	0.755	0.995	0.683	0.10
20	0.614	0.851	0.998	0.685	0.10
21	1.011	1.023	0.999	0.726	0.10
22	0.829	0.791	0.999	0.888	0.10
23	1.214	1.139	1.000	0.802	0.10
24	1.115	1.177	1.000	0.684	0.10
25	1.079	1.044	1.000	0.887	0.10

Table 17. 3M golden redfish yield per recruit results.

	Ref F	B	Y	SSB	Slope
	0.000	4143	0	2845	3,094
	0.000	4143	0	2845	1,143
	0.025	3188	58	1975	1,329
	0.050	2560	91	1423	795
	0.075	2123	111	1053	490
	0.100	1806	124	797	307
F0.1	**0.112**	**1687**	**128**	**704**	**309**
	0.125	1568	131	614	194
	0.150	1385	136	480	122
	0.175	1241	139	380	74
	0.200	1126	141	304	43
	0.225	1032	142	246	21
	0.250	954	143	201	7
	0.275	888	143	166	-3
Fmax	**0.278**	**881**	**143**	**162**	**0.0**
	0.300	833	143	137	-10
	0.325	785	142	115	-15
	0.350	744	142	97	-19
	0.375	708	142	82	-21
	0.400	676	141	70	-22

Table 18. Trend of the 3M golden redfish F index (Catch /EU survey biomass).

Year	Survey biomass (000' t)	Catch (000' t)	Catch / Survey biomass
2005	147.7	2.4	0.016
2006	298.3	1.2	0.004
2007	88.1	1.5	0.017
2008	240.8	4.2	0.017
2009	72.2	7.7	0.106
2010	47.4	3.1	0.065
2011	29.1	2.1	0.073
2012	55.4	1.9	0.035
2013	32.0	2.6	0.082
2014	37.2	2.9	0.077
2015	30.7	1.7	0.055
2016	35.1	0.4	0.010
2017	23.4	0.3	0.011
2018	10.8	0.1	0.014

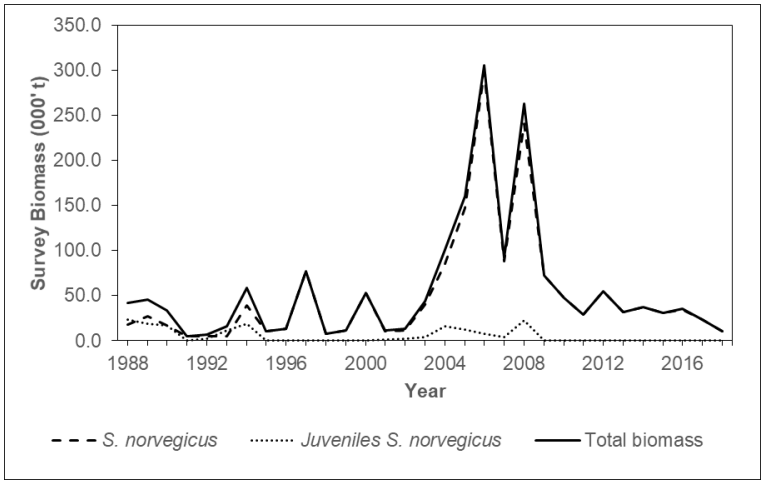

Figure 1. EU survey golden redfish biomass indices 1988-2018. Juveniles (~ <15cm) were split by species after the survey.

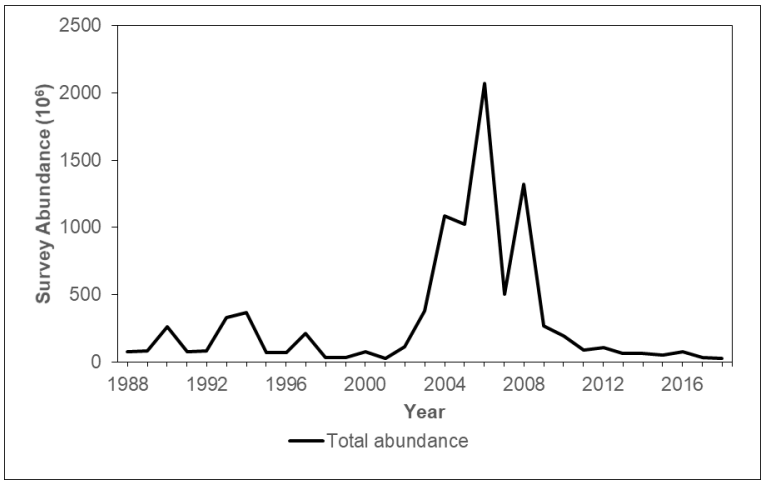

Figure 2. EU survey golden redfish abundance index, 1988-2018. Juveniles (~ <15cm) included.

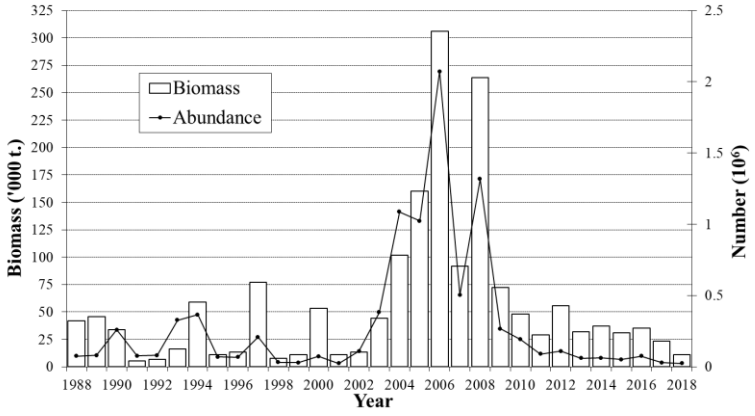

Figure 3. EU survey golden redfish 1988-2018 biomass and abundance indices. Juveniles (~ <15cm) included.

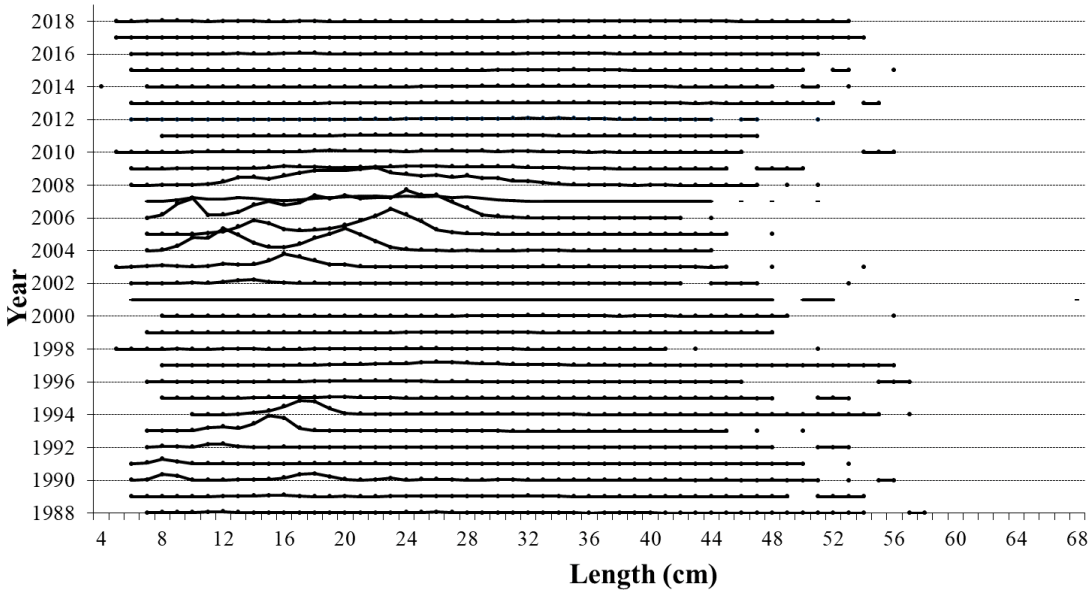

Figure 4. Golden redfish: EU survey length composition 1988-2018.

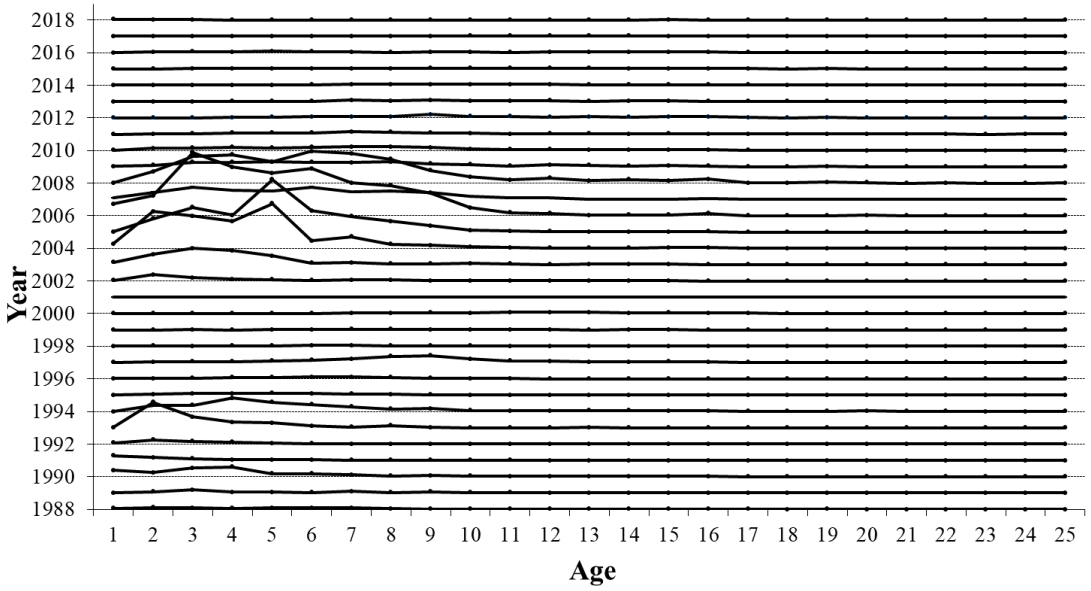

Figure 5. Golden redfish: EU survey age composition 1988-2018.

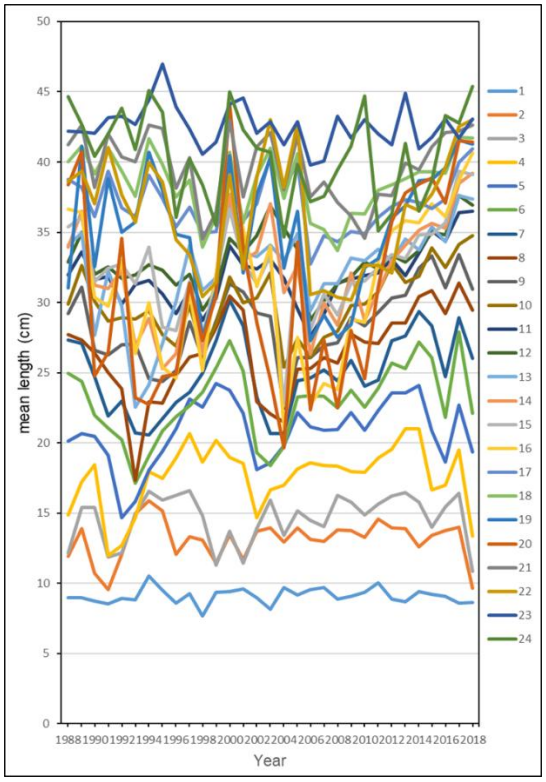

Figure 6. Golden redfish: EU survey mean length at age. Age 1 -24, 1988-2018.

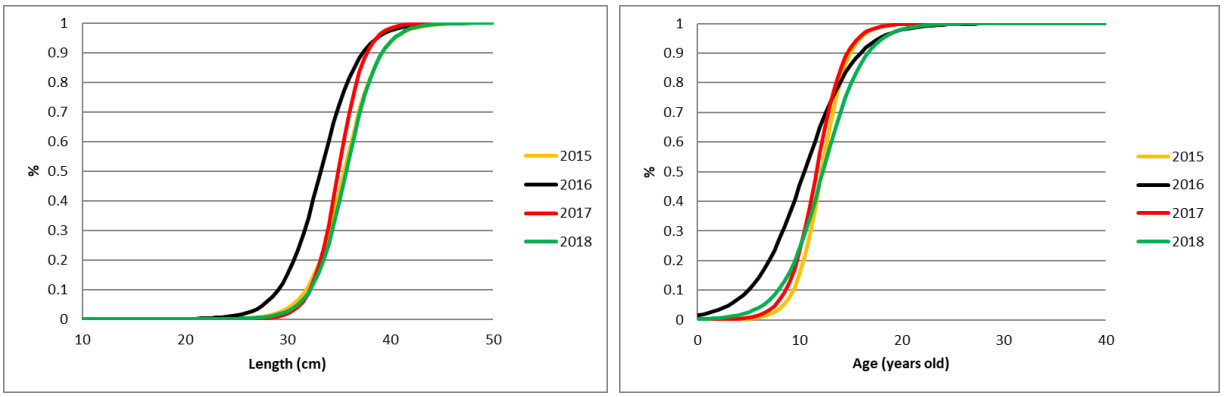

Figure 7. Golden Redfish: maturity ogives at length and at age from 2015 to 2018

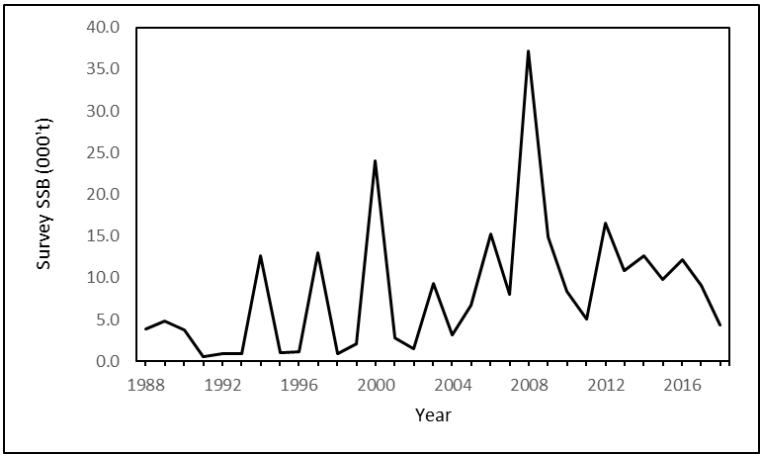

Figure 8. Golden Redfish: Female spawning stock biomass, 1988-2018.

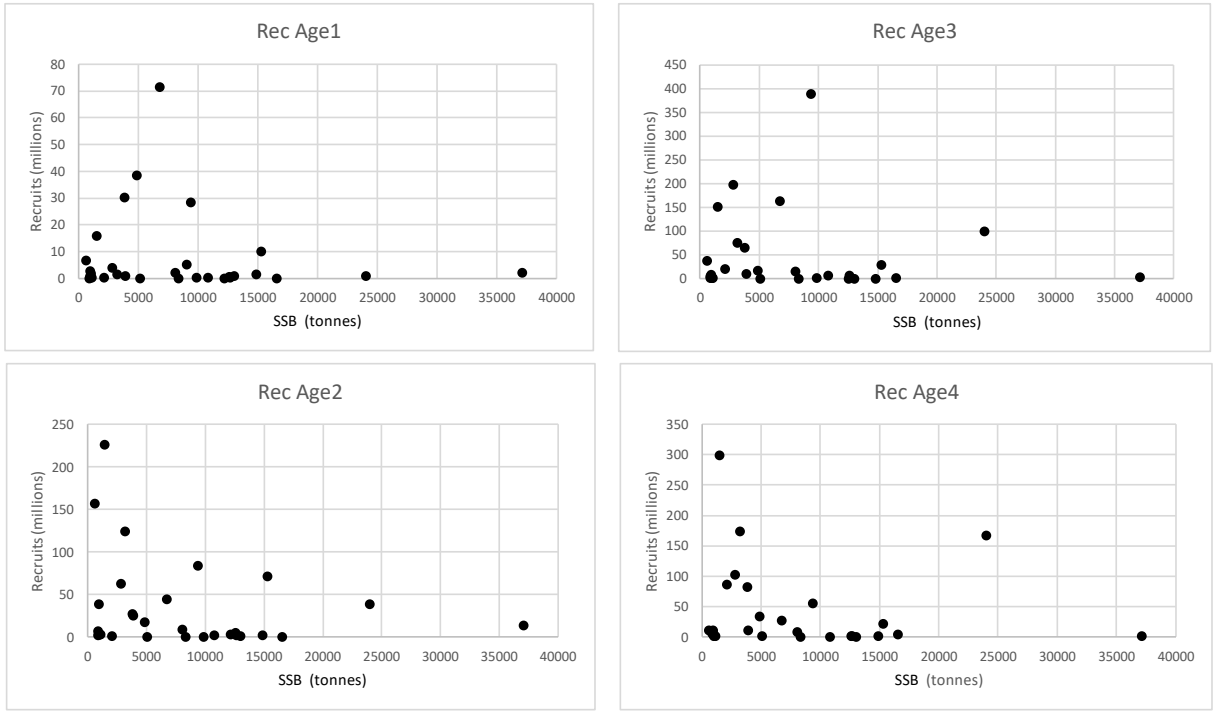

Figure 9. Golden Redfish: SSB/R relationship at ages 1-4.

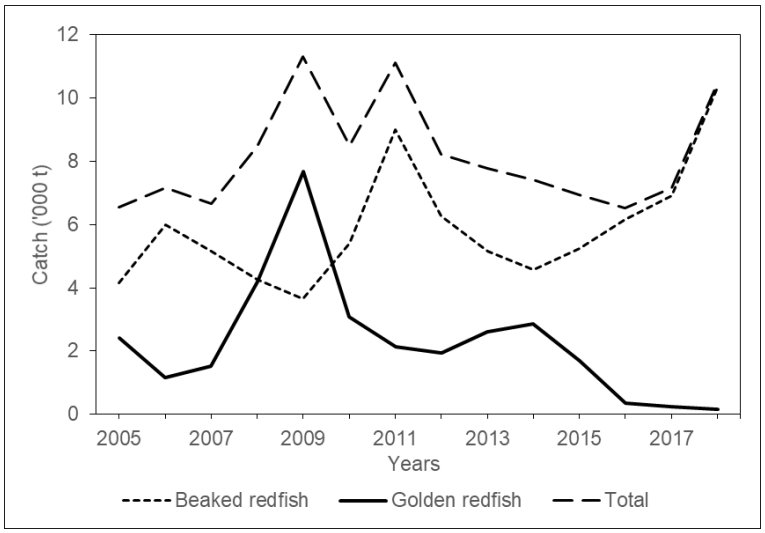

Figure 10. Beaked and golden redfish commercial catches.

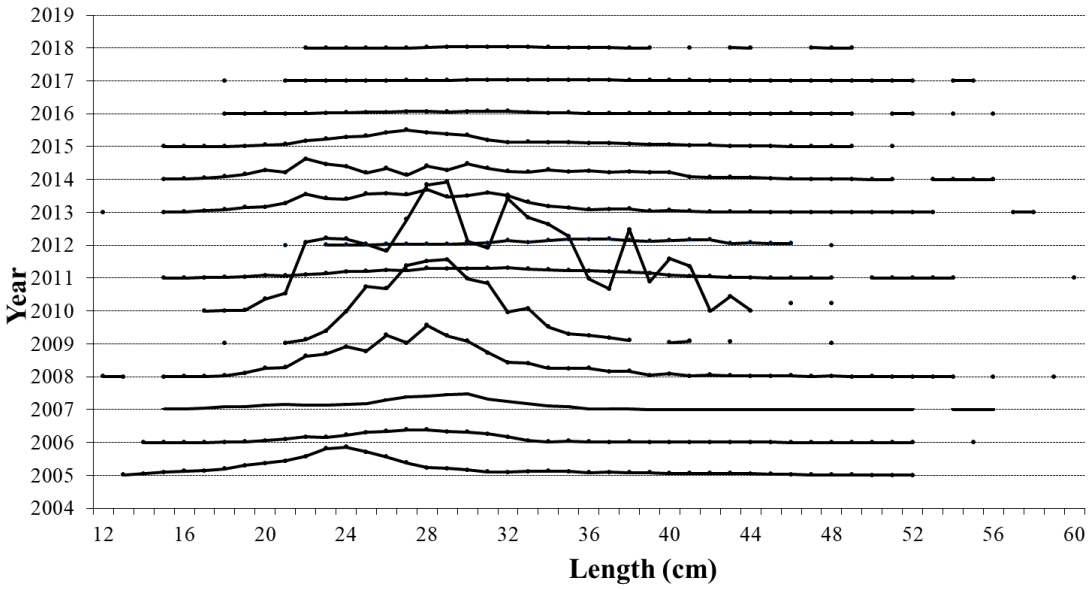

Figure 11. Golden redfish: Commercial catch length composition 2005-2018

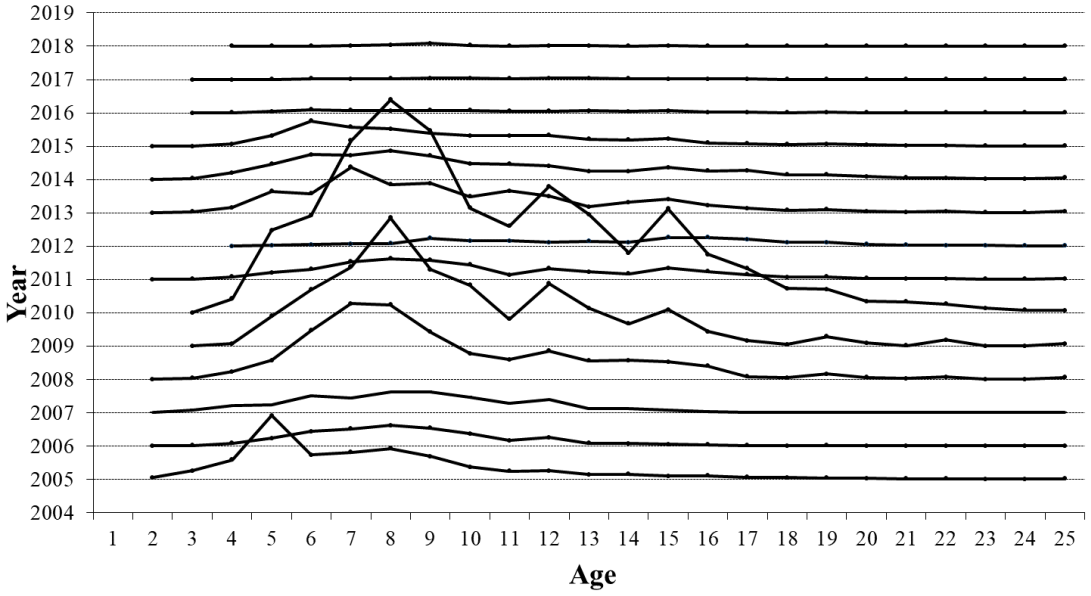

Figure 12. Golden redfish: Commercial catch age composition 2005-2018

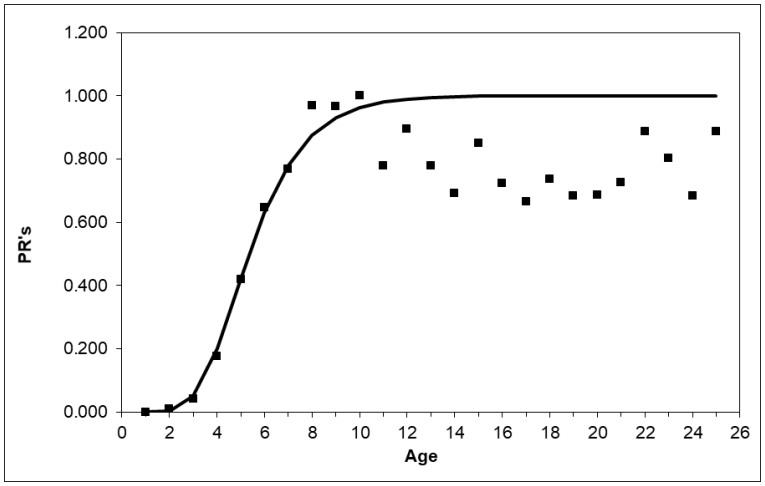

Figure 13. Golden redfish: Observed (squares) and logit (curve) PRs.

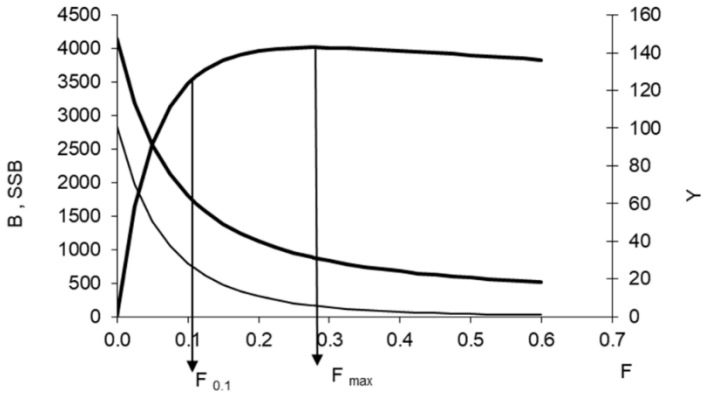

Figure 14. Golden redfish: Yield per recruit analysis.

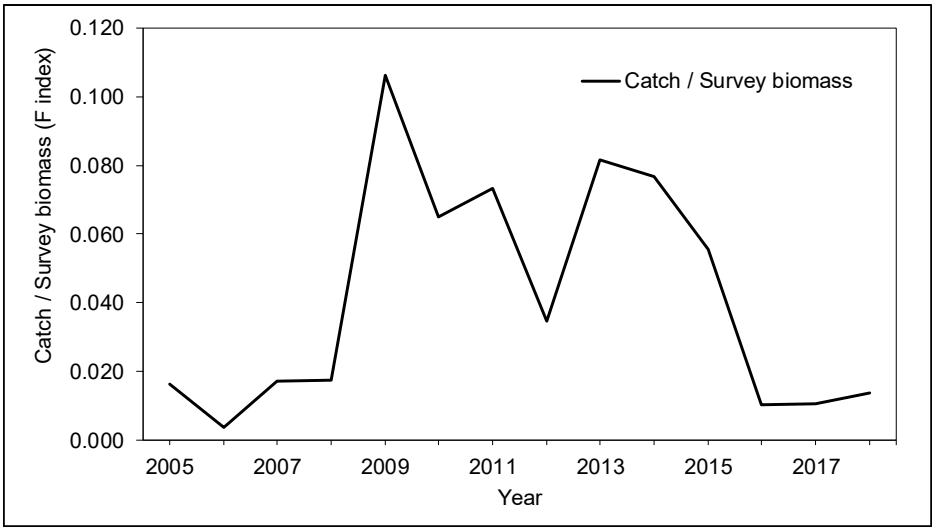

Figure 15. Golden redfish: Trend of the *F* index (Catch /EU survey biomass).

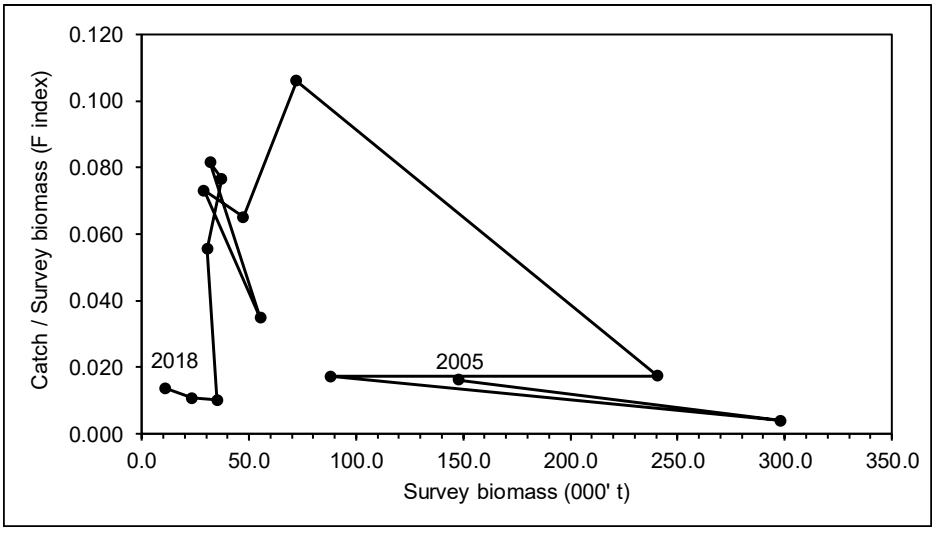

Figure 16. Golden redfish: Stock trajectory under PA (*F* index /EU survey biomass).

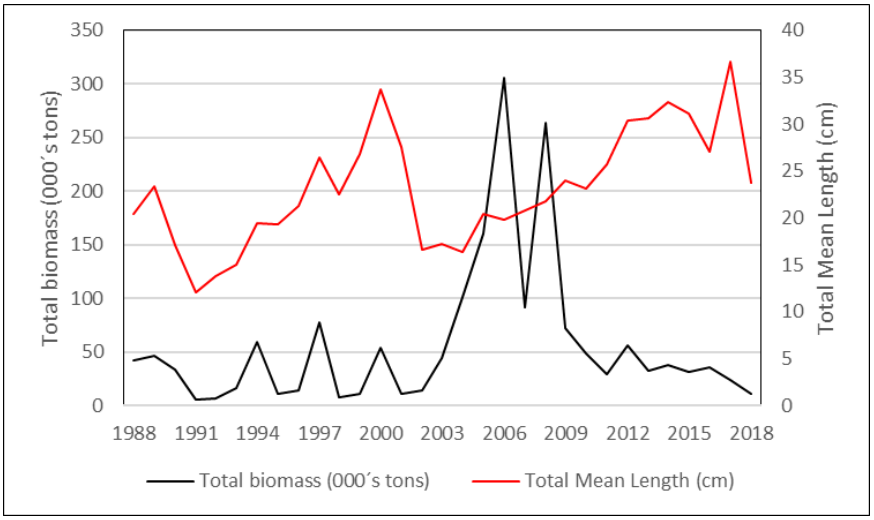

Figure 17. EU survey Golden redfish: Total biomass vs total mean length.

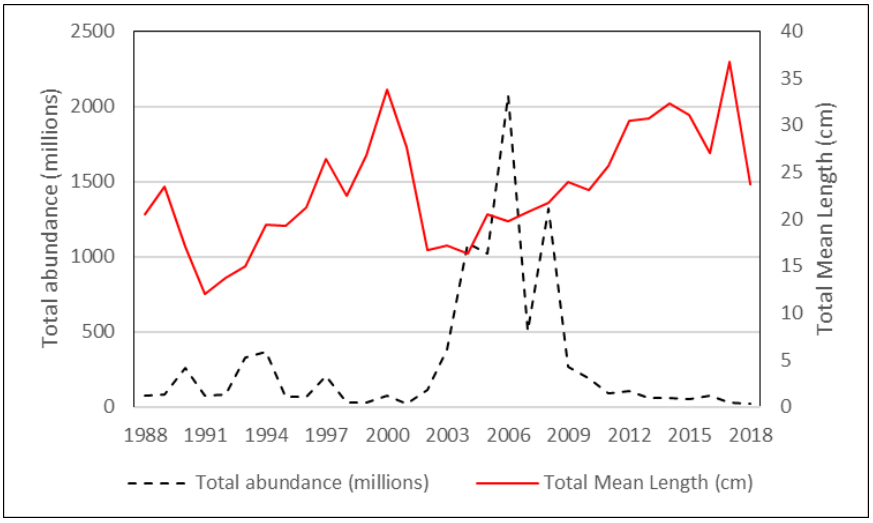

Figure 18. EU survey Golden redfish: Total abundance vs total mean length.

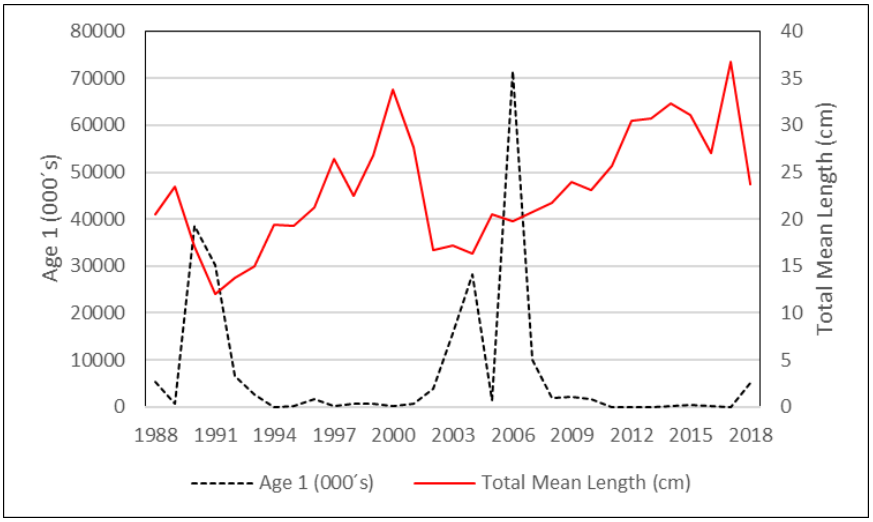

Figure 19. EU survey Golden redfish: Age 1 abundance vs total mean length.