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Assessment of the Cod Stock in NAFO Division 3M

by

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Abstract

An assessment of the cod stock in NAFO Division 3M was conducted using a Bayesian SCAA (statistical catch-at-age) model. The STACFIS catch estimates and the Flemish Cap survey indices were used to fit the model. In 2025, SC approved the Reference Points to be applied under the approved NAFO Precautionary Approach Framework. B_{msy} is defined for this stock as the equilibrium SSB that corresponds to the $F_{35\%SPR}$ estimated with the mean values of the biological parameters and recruitment of the 2007-2023 period. B_{lim} is 30% B_{msy} (B_{lim} = 15 724 t). $B_{trigger}$ was approved to be 75% B_{msy} ($B_{trigger}$ = 39 310 t). F_{lim} corresponds to $F_{35\%SPR}$ estimated with the mean values of the biological parameters of the 2007-2023 period (F_{lim} = 0.171) and F_{target} is the 85% of F_{lim} (F_{target} = 0.145). Results indicate that SSB declined rapidly since 2017 but has remained stable during the last five years and is estimated to be above B_{lim} and below $B_{trigger}$ (Cautious Zone) in 2025. Since 2013, recruitment has varied at intermediate levels but much lower than those observed in 2011-2012. In 2021 and 2022, good recruitments were observed, while since 2023 is at a very low level. F has remained below F_{lim} since the fishery reopened in 2010, and has been below F_{target} during that period except in 2011. In 2021, the minimum level of F since the re-opening was reached, increasing since then.

Introduction

The 3M cod stock was under fishing moratorium from 1999 to 2009 following a decline to well below B_{lim} (Vázquez and Cerviño, 2005). The stock collapse has been attributed to three simultaneous circumstances: 1) overfishing, 2) increased catchability at low abundance levels and 3) a series of very poor recruitments starting in 1993. The relatively good recruitments (age 1) observed after 2005 allowed the reopening of the fishery in 2009.

Since 1974, when a TAC was established for the first time, estimated catches ranged from 48 000 tons in 1989 to 5 tons in 2004. Annual catches were about 30 000 tons in the late 1980's (notwithstanding the fact that the fishery was under moratorium in 1988-1990) and diminished since then as a consequence of the stock decline. Between 1998 and 2009, almost coinciding with the last fishing moratorium, yearly catches were below 1 161 tons. The results of the 2009 assessment led to a reopening of the fishery with a TAC of 5 500 tons in 2010. With the results of the following years assessments established TACs for 2010-2025 ranged between 17 500 tons in 2019 and 1 500 tons in 2021, being 12 613 tons for 2025 and 15 360 for 2026. The STACFIS estimated catches for 2010-2025 were between 17 520 tons in 2019 and 2 055 tons in 2021, being 12 485 tons in 2025 (Table 1A and Figure 1).

A VPA based assessment of the cod stock in Flemish Cap was approved by NAFO Scientific Council (SC) in 1999 for the first time and was annually updated until 2002. However, catches between 2002 and 2005 were very small undermining the VPA based assessment, as its results are quite sensitive to assumed natural mortality when catches are at low levels. Cerviño and Vázquez (2003) developed a method which combines survey abundance indices at age with catchability at age, the latter estimated from the last reliable accepted XSA. The method estimates abundances at age with their associated uncertainty and allows calculating the SSB distribution and, hence, the probability that SSB is above or below any reference value. The method was used to assess the stock in the period 2003-2007. In 2007 results from an alternative Bayesian XSA model were also presented (Fernández *et al.*, 2007) and in 2008 this XSA model was further developed and approved by the NAFO SC (Fernández *et al.*, 2008), being used between 2008 and 2017 in the assessment of this stock.

In April 2018 a benchmark on the 3M cod was carried out by the NAFO Scientific Council (NAFO, 2018a). During that meeting it was decided to replace the Bayesian XSA with a Bayesian SCAA (statistical catch-at-age), that has been used since then. Another important change introduced at the benchmark is the prior median value of the natural mortality, which the benchmark agreed to base on biological and multi-species considerations; this has resulted in considerably higher values of M than estimated in previous assessments. The results of the Bayesian SCAA model are presented here, including the updated input data until 2025.

In 2020 the Commission adopted technical measures, in force since January 2021 (NAFO, 2021), to try to protect the productivity of Division 3M cod stock. These measures included the closure of the directed fishery of the 3M cod during the first quarter of the year, as well as the mandatory use of sorting grids when using a net having a mesh size of 130 mm in this fishery.

Besides these technical measures, no vessel shall fish cod in Division 3M with a net having a mesh size smaller than 155 mm when not using sorting grids, and the minimum landing size for this stock is 41 cm (fork length) (NAFO, 2025).

Material and Methods

Data used

Commercial data

Total Catch

In 2010 the fishery on this stock was reopened after the moratorium period between 1999 and 2009. Since then, STACFIS/ CESAG estimated catches were used for the stock assessment (González-Costas *et al.*, 2018; NAFO, 2018a). Between 2010 and 2012, only trawler vessels were present in the fishery; since 2013, longliners from Faroes and Norway were also periodically active. Since 2017, the Faroese fishery has been exclusively conducted by longliners. Since 2016, Norwegian vessels alternate the use of trawl and longline, depending on the year. This causes the proportion of trawlers and longliners to be variable among the years, ranging between 16% and 53% (Table 1B).

In 2025 the CESAG estimated catch was 12 485 tons (Table 1A, Figure 1). Information on cod catches from the following countries were available for the estimation in 2025: EU-Portugal, EU-Spain, Faroe Islands (Denmark), Norway, Russia and United Kingdom. The proportion of longline catches in 2025 was 22% (Faroe Islands catches).

Length distributions

In 2025 there were commercial length distributions from EU-Portugal (Alpoim *et al.*, 2026), EU-Spain (González-Costas *et al.*, 2026), Russia (Fomin and Pochtar, 2026), United Kingdom (NAFO Secretariat communication), Faroes (Ridao-Cruz, 2026) and Norway (Nedreaas, personal communication). Length sampling data by EU-Portugal were available only after the assessment was performed; therefore, this information was not considered. The available length distributions for trawlers weighted to the total trawl catch, on one hand, and the length distribution for the longliners weighted to the total longliner catch, on the other hand, were added to get the total commercial length distribution. The length frequency distributions in 2025 from the commercial catch by country and total and from the EU survey (González-Troncoso *et al.*, 2026) are shown in Figure 2A.

Table 1C shows the number of individuals measured as well as the length range, the mean and the mode for each of the countries with samples and for the total commercial length distribution, and Table 1D the mean and mode of the final total commercial length distributions and the survey length distribution for 2010-2025.

Figure 2B shows the total commercial length distribution since 2010. In 2021 there is a main mode in the length distribution between 63-70 cm and a secondary mode, much weaker, between 45-50 cm. In 2022, there are two modes at the same level, one around 51-55 cm and another around 66 cm. Since 2023, the length distribution shows a unimodal shape, with the mode being around 54 cm. The mean length (Figure 2C) in the 2021-2025 period was fairly constant around 60 cm.

<u>Indices by age</u>

As no age-length keys (ALK) were available for commercial catch from 1988 to 2008, each year the corresponding ALKs from the EU survey (read by the IIM in Vigo) were applied in order to calculate annual catch-at-age. An ALK was available for 2009-2011 only from the Portuguese fishery and was applied to the total commercial catch length distribution to derive the total age distribution of the commercial catches.

Since 2012 the ALK from the EU survey has been used for both commercial and survey indices, although some years ALK from the Portuguese and/or the Spanish catches were available. The reason not to use the commercial ALKs to the commercial distribution is that these commercial ALKs have not been validated and more research is needed to completely identify the source of discrepancies observed.

Due to administrative problems, the ALK from the EU survey since 2023 has not been available for the assessment. The ALK resulting from the average of the last 3 available years (2020-2022) was used to derive both commercial and survey indices in 2023, 2024 and 2025.

<u>Catch-at-age</u>

Catch-at-age in numbers for 1988 to 2025 is presented in Table 2. These numbers were obtained by applying the ALK to the total commercial catch length distribution each year.

The catch-at-age ranges from 1 to 8+. No catch-at-age was available for 2002-2005 due to the lack of length distribution information because of low catches. Catch proportions at age over time (Figure 3A) indicate that the bulk of the catch was comprised of 3-5 years age cod until 2015, although between 2006 and 2014 the catches contained mostly ages 3 and 4 individuals; in the period 2015-2023, ages 5 to 8+ were the most dominant in the catches. Since 2024, the most fished ages were 4 and 5.

Figure 3B shows standardised catch proportions at age (each age standardised independently to have zero mean and standard deviation 1 over the range of years considered). Assuming that the selection pattern at age is not too variable over time, it should be possible to follow cohorts from such figure. Some strong and weak cohorts can be followed, although the pattern is not too evident. The 2009 and 2010 cohorts can be easily followed, reaching age 8+ in 2019 and 2020. Cohort from 2011 started with a good recruitment in 2012 but then disappeared until age 5, in 2016. The cohorts since 2012 were poor. As a consequence, since 2015 all the values of the ages less than 4 have been negative. The 2011 cohort show a recruitment over the average in 2012, but remains below the average for all the other ages. Since then, low recruitments have been observed as well as low abundances until age 4. It is remarkable the big catches starting at age 6 for these cohorts, except for the one from 2015, recruited in 2016, which has all the values negative until 8+.

Mean weight-at-age

For 2025, there are two commercial length-weight relationships available: EU-Spain and Faroes. Both are presented in Figure 4 alongside the 2025 EU bottom survey one. This year, the length-weight relationship from the EU bottom trawl survey has proved to be the one that better characterizes the length distribution of the commercial fleet and, for this reason, was the one used to obtain the mean weight-at-age in the catch. The SoP (sum over ages of the product of catch weight-at-age and numbers at age) for the commercial catch differs around 1% from the estimated total catch in 2025.

Mean weight-at-age in the catch for 1988-2025 is showed in Table 3 and Figure 5. In the period 2007-2018 there is a general decrease in the trend of the mean weight for the ages older than 2, especially since 2010. Since 2020, the average weights of almost all ages have fluctuated around intermediate levels.

EU survey data

The EU bottom trawl survey on Flemish Cap has been carried out since 1988 using a *Lofoten* type gear, targeting the main commercial species down to 730 m of depth. The surveyed zone includes the complete distribution area of this stock, which rarely occurs deeper than 500 m. The survey procedures have been kept constant throughout the entire period, although in 1989 and 1990 a different research vessel was used (Vázquez *et al.*, 2014). Since 2003, the survey has been carried out with a new research vessel (R/V *Vizconde de Eza*, replacing R/V *Cornide de Saavedra*) and conversion factors to transform the values from the years before 2003 have been implemented (González-Troncoso and Casas, 2005). The results of the survey for the years 1988-2025 are presented in González-Troncoso *et al.*, (2026).

The survey abundance by age and by year, as well as total abundance and total biomass, is presented in Table 4. Figure 6 displays the series of total abundance and total biomass indices. Biomass showed a high increase since 2005, following an extremely low period starting in the mid 1990’s. Since 2009 biomass remains at the level of the first years of the assessment, or higher, reaching the maximum of the series in 2014. This high biomass is due to a big increase in the number of individuals of 3 and 4 years old, those from the 2010-2011 cohorts. Since 2014, a general decreasing trend is observed until 2019, when a shift in the trend occurs. In 2023 and 2024, a steep increase can be seen, reaching in 2024 the second highest in the series. The abundance follows a similar trend until the reopening of the fishery. The increase in abundance is more gradual until 2009, followed by a sharped increase until 2011, when the maximum of the series is reached. This large abundance in 2011 is due to a big presence of individuals of age 1. The maximum was followed by a steep decline until 2019, when values lower than those observed in the precollapse period were reached. Since then, an increase is observed, reaching in 2024 the precollapse levels. In 2025, both indices show a slight decrease.

Figure 7 shows a bubble plot of the abundances at age, in logarithmic scale, with each age standardised separately (each age to have mean 0 and standard deviation 1 over the range of survey years). Grey and black bubbles indicate values above and below average, respectively, with larger sized bubbles corresponding to larger magnitudes. The plot indicates that the survey is able to detect strength of recruitment and to track cohorts through time very well. It clearly shows a series of consecutive recruitment failures from 1996 to 2004, leading to very weak cohorts. Cohorts recruited from 2005 to 2014 appear to be above average, especially those from 2010-2012. In 2019-2021, good signals of recruitment can be seen, being at the level of the 2006 recruitment, that allowed the recovery of the stock. Recruitment in 2022 is weaker, but it is still above the mean. Since 2023, negative recruitments are observed again. Note that the cohort values since the 2018 cohort of the EU survey are all positive (except for age 1 in 2023 and ages 1 and 2 in 2024 and 2025), even for those ages that correspond to the bad recruitments in 2015-2018.

Mean weight-at-age

Results are showed in Table 5 and Figure 8. The length-weight relationship from the EU survey (Figure 4) was used to calculate the mean weight-at-age in the stock.

Mean weight-at-age in the stock showed a strong increasing trend from the late 1990's until 2007 for ages 1 to 5, until 2009 for age 6 and until 2010 for age 7. Since then, a deceasing trend was observed for all age groups, being very steep in some cases, until 2017 for ages 1 to 5 and until 2019 for ages 6, 7 and 8+. In those years the mean weights in stock for ages 1-7 decreased between 38% and 75% and all of them are among the minimum of the entire series. After that, the mean weights remained fairly stable in the last years at low or intermediate levels.

Maturity at age

Maturity ogives are available from the EU survey for years 1990-1998, 2001-2006 and 2008-2022. For those years a Bayesian logistic regression model for proportion mature at age with 1000 iterations has been fitted independently for each year. For 1988 and 1989 the 1990 maturity ogive was applied. For 1999 and 2000 maturity ogive was computed as a mixture of 1998 and 2001 data, and for 2007 as a mixed of 2006 and 2008 maturity ogive. Maturity data for 1991 were of poor quality and did not allow a good fit, so a mixture of the ogives for 1990 and 1992 was used. As it occurred with the ALK, the maturity ogive has not been available since 2023 for the assessment due to administrative issues. The average of the last three available years (2020-2022) was used.

The median of the maturity ogives for the whole period are presented in Table 6 and Figure 9A. It can be seen that the percentage of matures in all ages generally decreased since 2002 to 2016,. This fact, along with the decreasing mean weight at age, is consistent with a stock in a recovery process, with a slower growth and maturing. Since 2016-2017, the percentage of matures at age oscillated around low levels compared to those between 1995-2010.

Figure 9B displays the evolution of the a_{50} (age at which 50% of fish are mature) through the years (estimate and 90% uncertainty limits) and the median value is presented in Table 6. The figure shows a continuous decline of the a_{50} through time, from above 5 years old in the late 1980's to below 3 years old in 2002 and 2003. An upward trend is present in a_{50} from 2005 to 2016, remaining since then quite stable oscillating around 5 years old.

Assessment methodology

A Bayesian SCAA model was fitted to the data. Ages are from 1 to 8+ and years are from 1988 to 2025. The cohorts are modelled forward in time, starting from the recruits (age 1) in each year and abundance of each age 2-8+ in the first assessment year, considering the natural and fishing mortality. The model equations are listed in Annex I. The model run was made in Jags called from R via the package rjags.

The input data, configuration and settings of this model were chosen during the 2018 benchmark on 3M cod (NAFO, 2018a, 2018b). The natural mortality, M, is estimated by the model via a prior to be constant by year but variable through the ages.

Given the very low catch numbers observed at age 1 (Table 2), the catch at age 1 data was set equal to zero in all years and it was assumed in the model that F at age 1 is equal to zero. The zeros observed in the survey abundance indices at age and those observed in the catch at age matrix for ages > 1 are treated as NAs.

The inputs of the assessment of this year are as follow:

Catch data for 38 years, from 1988 to 2025

Catch in tonnes in all years; years with catch-at-age: 1988-2001, 2006-2025

Tuning with EU survey from 1988 to 2025

Ages from 1 to 8+ in all cases (catch-at-age and survey indices at age)

Catchability analysis

Survey catchability dependent on stock size for age 1

Priors over parameters: See Annex I for further details. The values used in the priors are:

Recruitment: *medrec* = 45 000, *cvrev* = 10

N in the first assessment year: *medF*[a] = c(0.0001,0.1,0.5,0.7,0.7,0.7,0.7,0.7), cvyear1 = 10

f: *medf* = 0.2, *cvf* = 4

rC: *aref* = 5, *medrC*[a] = c(0.001,0.3,0.6,0.9,1,1,1), *cvrC*[a] = c(4,4,4,4,4,4,4), *cvrCcond*=0.2

Catch in tonnes: *cvCW* = 0.077 (95% probability of no more than 15% deviation)

Catch numbers-at-age: *psi.C* corresponds to CV=0.2 on catch numbers-at-age (in original, not log-scale)

Survey index: *psi.EU* corresponds to CV=0.3 on abundance index at age (in original, not log-scale)

Survey catchability: *medlogphi* = 0, *taulogphi* = 1/5

Survey catchability exponent at age 1: *medgama* = 1, *taugama* = 1/0.25

M: *medM*[a]= c(1.26,0.65,0.44,0.35,0.30,0.27,0.24,0.24), *cvM* = 0.15

A five-year retrospective analysis was run. Projections were carried out with different scenarios, as later described, in order to see the possible evolution of the stock in the medium term under different fishing mortality levels. The settings and the results are explained below.

Results

Assessment results regarding total biomass, SSB, recruitment and F_{bar} (ages 3-5) are presented in Table 7 and Figure 10.

Total biomass had a sharp increase from 2006 to 2012, reaching a higher level than before the collapse of the stock in the mid 1990´s. After 2012, a decreasing trend can be observed until 2020, and since then the biomass remains stable below the level of the beginning of the series.

The results for SSB indicate that there was a substantial increase from the early 2000s to the mid-2010s, after which it decreased until the early 2020s, remaining relatively stable since then. The stock was above $B_{trigger}$ (Healthy Zone) from 2009 to 2019. Since then, SSB has been below $B_{trigger}$ but it is still above B_{lim} (Cautious Zone).

Recruitment had an increasing trend from 2004 to 2012, being above the average recruitment of the period between 2007 and 2012. Since 2013 the recruitment has oscillated around intermediate levels. In 2021 and 2022, good recruitments were observed, while since 2023 has been at a very low level.

F_{bar} (mean for ages 3-5) was estimated at very low levels in the period 2001-2009. In 2010, with the reopening of the fishery, the F_{bar} increased although it was below F_{target}. In 2011 the F_{bar} was above F_{target} but still below F_{lim}. In 2021, the minimum level of fishing mortality since the re-opening was reached, increasing since then, but remaining below F_{target}. Table 8 and Figure 11 provide more detailed information on the estimated F-at-age values. With the reopening of the fishery, the F-at-age increased for all the ages, and with the age. Since 2024, the F has increased in all ages above 3 with respect to 2023. Figure 12 shows the median PR and its confidence intervals since year 2000, calculated as the ratio of fishing mortalities to F_{bar}, and Figure 13A the median PR since the reopening of the fishery together for comparative purposes. Figure 13B shows the 2025 PR and the mean of the last three years (2023-2025) PR. It is notable that for the period 2018-2021 age 6 was the one with the highest F, especially in 2021, while in 2022-2025 the PR follows the shape observed before that period, in which the PR increases with the age, having 7 the highest F.

The results for the two components of F, the year effect (*f*) and the selectivity by year and age (*rC*), are presented in Figure 14. It can be seen a clear different level of *f* before and after year 2000, being higher at the beginning of the series. In the case of *rC*, for age 1 was set as 0, the age of reference is 5 and for age 8+ is the same as for age 7. During the period on which the fishery was closed (1999-2009) *rC* of ages 2 and 3 increased to high levels probably because the catches came from bycatches of other fisheries. Age 4 shows a general decreasing trend for the period, with local sharp increases in 2018 or 2023. Ages 6 and 7 show a general increasing trend since 2000, with a slight decrease in age 6 since 2021 and age 7 since 2022.

Figure 15 shows total biomass and abundance by year, as well as the mean of both indices in all the series. In general, there is a good concordance between biomass and abundance trends, with an increase between 2005 and 2012 followed by a decrease. Since 2020 the biomass remained stable around the series average. Abundance has been below the series average since 2016; except in 2021 and 2022, when high recruitments were observed.

Estimates of stock abundance at age for 1988-2025 are presented in Table 9 and Figure 16. The maximum numbers-at-age since 2005 in all the ages correspond to the 2010 cohort (reaching 7 years old in 2017 and being incorporated to the 8+ group since 2018), followed by the 2020 cohort (reaching 5 years old in 2025). Between those cohorts, all the numbers at age have remained unstable, with ups and downs around intermediate levels. To note the big value of ages 6+ in 2014-2016, which is the driver to the huge increase in the SSB in those years.

Figure 17 depicts the prior and posterior distributions of the recruitment in all the years. Although in some years there has been substantial updating on the prior distribution for recruitment, in general the posterior is placed in the prior distribution.

Figure 18 displays prior and posterior distributions for the numbers in the first year (1988) for ages 2 to 8+. Whereas the prior distribution is the same, posterior distributions vary depending on the age. For all the ages, the updated posterior numbers are higher than the prior median.

In Figure 19, observed versus estimated total catches by year are presented. No clear patterns can be observed in the whole period.

Figure 20 shows the prior and the posterior distributions of the natural mortality, M, by age. The prior and posterior medians can be seen in Table 10. For ages 2 to 5, the posterior median of M is lower than the prior median. Overall, the priors on M are not much updated by the posteriors for any of the ages; this is as intended by the Benchmark, who considered the stock assessment has little ability to estimate M and decided to use a relatively tight prior distribution (CV=15%) around median values of M derived from biological considerations, including multi-species interactions.

Bubble plot of standardised residuals (observed minus fitted values divided by estimated standard deviations and in logarithmic scale) for the catch number-at-age and the EU survey abundance at age indices are displayed in Figure 21. This graph should highlight year effects, identified as years in which most of the residuals are above or below zero. No clear trends can be seen in the graphs. In general, the residuals are quite high both in the catch numbers at age and in the EU survey indices.

Figure 22 illustrates the distribution of the catchabilities for the EU survey by group of ages (1, 2, 3, 4+). The catchability at age 1 is very low. Age 2 catchability is lower than age 3 catchability, which is quite similar to the catchabilities of ages 4+.

<u>Biological Referent Points</u>

In 2025, SC approved the Reference Points to be applied under the approved NAFO Precautionary Approach Framework (NAFO, 2025). B_{msy} is defined for this stock as the equilibrium SSB that corresponds to the $F_{35\%SPR}$ estimated with the mean values of the biological parameters and recruitment of the 2007-2023 period. B_{lim} is 30% B_{msy} (B_{lim} = 15 724 t). $B_{trigger}$ was approved to be 75% B_{msy} ($B_{trigger}$ = 39 310 t). F_{lim} corresponds to $F_{35\%SPR}$

(F_{lim} = 0.171) estimated with the mean values of the biological parameters of the 2007-2023 period. F_{target} is the 85% of F_{lim} (F_{target} = 0.145).

Figure 23 represents the SSB-F_{bar} (3-5) (posterior medians) plot in the NAFO Precautionary Approach Framework including the 3M cod approved reference points. Points plotted are from years 2000-2025. Figure 24 shows the SSB-F_{bar} scatter plot for all the assessment years. The stock-recruit scatter plot can be seen in Figure 25.

Figure 26 shows the Yield per Recruit and the Spawner per Recruit versus F_{bar} curve calculated with the mean of the data of years 2007-2023 (years used for calculating the reference points) as well as the value of F_{lim} = $F_{35\%SPR}$ and $F_{statusquo}$ (defining the latter as the mean fishing mortality over 2023-2025).

Retrospective pattern

A five-years retrospective analysis was conducted by eliminating successive years of catch and survey data (Figure 27). No retrospective pattern is evident in the F estimates, although the 2018 and 2019 ones were revised to lower values. The retrospective analysis shows revisions in the recruitment, mainly regarding the highest values of recruitment in the years 2009 to 2011 and 2021. These revisions lead to subsequent revisions in the SSB. No directional patterns in retrospective analysis are evident in recent years. There is very little evidence of a retrospective pattern in F.

Recruits per Spawner

Figure 28 displays the Recruits per Spawner. The variability over the years of the assessment is very high. Between 2007 and 2013 a decreasing trend can be seen. Since then, it remained at low values except for 2021 and 2022, when the value was quite high, at the 2012 level.

Projections

To calculate projections and risk, the method presented by Fernández *et al.* (2017) was used. Stochastic projections of the stock dynamics were conducted. The variability in the input data is taken from the results of the Bayesian assessment. Input data for the projections are as follows:

Numbers aged 2 to 8+ in 2026: estimated from the assessment.

Recruitments for 2026-2027: Recruits per spawner were drawn randomly from 2022-2024 (corresponding to the recruitment of 2022-2024 and number of matures of 2021-2023). The 2025 value of recruits per spawner was omitted due to uncertainty in estimating the recruitment.

Maturity ogive for 2026-2028: Mean of the last three years available (2020-2022) maturity ogive.

Natural mortality for 2026-2027: Natural mortality from the 2025 assessment results.

Weight-at-age in stock and weight-at-age in catch for 2026-2028: Mean of the last three years (2023-2025) weight-at-age.

PR at age for 2026-2027: Mean of the last three years (2023-2025) PRs.

F_{bar}(ages 3-5) scenarios: F_{bar} = 0 and the three levels defined for stocks in the Cautious Zone (fishing mortality along the lower, midrib and upper edge leaf). These scenarios are based on the stock status at the start of 2027, assuming the results of this assessment.

All scenarios assumed that the Yield for 2026 is the established TAC (15 360 t).

Results for the F_{bar} options are presented in Tables 11-18 and Figures 29 and 30. The stock is projected to be in the Cautious Zone starting in 2027. Under all the scenarios (including F=0) during the projected years, the stock will remain in the Cautious Zone (below $B_{trigger}$) with a probability of at least 60%; furthermore, the median biomass at the beginning of 2028 is projected to be lower relative to 2026.

Under all scenarios, the probability of F_{bar} exceeding F_{lim} is less than or equal to 15% in 2027.

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Table 1A. Total commercial cod catch in Division 3M. Reported nominal catches since 1960 and estimated total catch from 1988 to 2025 in t.

Year	Estimated[2]	Portugal	Russia	Spain	France	Faroes	UK	Poland	Norway	Germany	Cuba	Others	Total[1]
1960		9	11595	607					46	86		10	12353
1961		2155	12379	851	2626		600	336		1394		0	20341
1962		2032	11282	1234			93	888	25	4		349	15907
1963		7028	8528	4005	9501		2476	1875				0	33413
1964		3668	26643	862	3966		2185	718	660	83		12	38797
1965		1480	37047	1530	2039		6104	5073	11	313		458	54055
1966		7336	5138	4268	4603		7259	93		259		0	28956
1967		10728	5886	3012	6757		5732	4152		756		46	37069
1968		10917	3872	4045	13321		1466	71				458	34150
1969		7276	283	2681	11831					20		52	22143
1970		9847	494	1324	6239		3	53				35	17995
1971		7272	5536	1063	9006			19		1628		25	24549
1972		32052	5030	5020	2693	6902	4126	35	261	506		187	56812
1973		11129	1145	620	132	7754	1183	481	417	21		18	22900
1974		10015	5998	2619		1872	3093	700	383	195		63	24938
1975		10430	5446	2022		3288	265	677	111	28		108	22375
1976		10120	4831	2502	229	2139		898	1188	225		134	22266
1977		6652	2982	1315	5827	5664	1269	843	867	45	1002	553	27019
1978		10157	3779	2510	5096	7922	207	615	1584	410	562	289	33131
1979		9636	4743	4907	1525	7484		5	1310		24	76	29710
1980		3615	1056	706	301	3248		33	1080	355	1	62	10457
1981		3727	927	4100	79	3874			1154			12	13873
1982		3316	1262	4513	119	3121	33		375			14	12753
1983		2930	1264	4407		1489			111	3		1	10205
1984		3474	910	4745		3058			47	454	5	9	12702
1985		4376	1271	4914		2266			405	429	9	5	13675
1986		6350	1231	4384		2192				345	3	13	14518
1987		2802	706	3639	2300	916						269	10632
1988	28899	421	39	141		1100					3	14	1718
1989	48373	170	10	378								359	917
1990	40827	551	22	87		1262						840	2762
1991	16229	2838	1	1416		2472	26		897		5	1334	8989
1992	25089	2201	1	4215		747	5				6	51	7226
1993	15958	3132	0	2249		2931						4	8316
1994	29916	2590	0	1952		2249			1			93	6885
1995	10372	1641	0	564		1016						0	3221
1996	2601	1284	0	176		700	129			16		0	2305
1997	2933	1433	0	1			23					0	1457
1998	705	456	0									0	456
1999	353	2	0									0	2
2000	55	30	6									0	36
2001	37	56	0									0	56
2002	33	32	1									0	33
2003	16	7	0									9	16
2004	5	18	2									3	23
2005	19	16	0			7						3	26
2006	339	51	1	16								55	123
2007	345	58	6	33								28	125
2008	889	219	74	42	3	0						63	401
2009	1161	856	87	85		22						122	1172
2010	9192	1345	374	921		1183	761		514			147	5245
2011	12836	2412	655	1610		2211	1063		1301		185	540	9977
2012	12836	2593	745	1597		2045	868		809		172	239	9068
2013	13985	4427	896	2380		2723	1328		1322			445	13521
2014	14290	5345	950	2099		3370		393	1344			855	14356
2015	13785	4680	893	1999		3319			1296			641	12828
2016	14023	5484	893	1232		3124	1198		1336			72	13339
2017	13928	5245	900	900		3165	1148		1240			1322	13920
2018	11481	4690	705	726		2972			1043			1040	11176
2019	17520	6319	1132	2296		4371			1643			1620	17381
2020	8458	4234	545	477		2263			786			204	8509
2021	2055	571	92	86		961			138			73	1921
2022	3997		241	339		1078			561			44	2263
2023	6027		377	606.9		1624.4			850.7			0	3459
2024	10582		319	2202		2567	856		1121				7065
2025	12485		816	2362			1118		1168			41	5505

[1]Recalculated from NAFO Statistical data base using the NAFO 21A Extraction Tool. In 2022-2025, STATLANT 21 information is incomplete
[2]STACFIS estimates
[3]Includes 2021 Faroese survey catches

Table 1B. Trawlers and longliners catches since the reopening of the fishery in 2010.

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Total catch	9192	9794	9003	13985	14290	13785	14023	13928	6447	17520
Total trawler	9192	9794	9003	10095	12034	10125	10208	10762	4210	12968
Total longliner	0	0	0	3889	2256	3659	3814	3166	3166	4552
% longliner	0	0	0	28	16	27	27	23	49	26

Year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Total catch	8458	2055	3997	6027	10582	12485
Total trawler	5416	961	2338	4408	7071	9709
Total longliner	3042	1094	1658	1619	3511	2775
% longliner	36	53	41	27	33	22

Table 1C. Summary of the length distributions in 2025 of each country with samples, the total commercial and the survey.

Country	**EU-Portugal**	**EU-Spain**	**Faroes**	**Norway**	**UK**	**Russia**	**Total commercial**
Sampled individuals		6191	5350	5891	4050	5618	27100
Gear	Trawl	Trawl	Longline	Trawl	Trawl	Trawl	
Range (cm)		28-101	41-137	43-120	41-177	36-119	27-170
Mean (cm)		56	69	68	58	57	60
Mode (cm)		54	57	54	54	51	57

Table 2. Catch-at-age (thousands).

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1988	1	3500	25593	11161	1399	414	315	162
1989	0	52	15399	23233	9373	943	220	205
1990	7	254	2180	15740	10824	2286	378	117
1991	1	561	5196	1960	3151	1688	368	76
1992	0	15517	10180	4865	3399	2483	1106	472
1993	0	2657	14530	3547	931	284	426	213
1994	0	1358	28303	9218	430	206	16	203
1995	0	0	192	4773	2003	474	98	169

1996	0	81	714	311	1072	88	0	0
1997	0	0	1016	956	179	359	60	0
1998	0	0	8	170	286	30	19	2
1999	0	0	15	15	96	60	3	1
2000	0	0	54	1	1	4	1	0
2001	0	9	0	4	2	0	2	2
2002								
2003								
2004								
2005								
2006	0	22	19	81	2	10	2	0
2007	0	2	30	1	27	1	14	5
2008	1	89	136	133	3	40	1	3
2009	0	23	51	210	108	0	32	7
2010	34	452	1145	1498	808	388	4	103
2011	18	537	1608	701	1144	961	354	275
2012	39	389	1443	834	1013	739	357	344
2013	22	646	4169	962	1124	755	521	388
2014	7	13	730	4131	1464	871	556	405
2015	0	94	402	1548	1457	2596	602	480
2016	0	40	883	731	1822	1167	939	757
2017	1	2	73	407	256	1954	1553	961
2018	0	77	33	206	800	408	1392	1357
2019	0	2	676	191	1752	2656	188	2044
2020	0	0	41	541	440	734	616	687
2021	0	1	14	60	134	70	90	240
2022	0	0	2	396	315	380	80	365
2023	0	3	70	651	661	371	194	523
2024	0	1	109	1674	1406	660	275	687
2025	0	0	88	1987	1654	819	376	864

Table 3. Weight-at-age (kg) in catch.

	1	2	3	4	5	6	7	8+
1988	0.058	0.198	0.442	0.821	2.190	3.386	5.274	7.969
1989	0.069	0.209	0.576	0.918	1.434	2.293	4.721	7.648
1990	0.080	0.153	0.500	0.890	1.606	2.518	3.554	7.166
1991	0.118	0.229	0.496	0.785	1.738	2.622	3.474	6.818
1992	0.115	0.298	0.414	0.592	1.093	1.704	2.619	3.865
1993	0.115	0.210	0.509	0.894	1.829	2.233	3.367	4.841
1994	0.112	0.248	0.649	0.973	1.686	2.331	3.008	4.898
1995	0.112	0.248	0.649	0.973	1.686	2.331	3.008	4.898
1996	0.110	0.286	0.789	1.051	1.543	2.429	2.730	4.653
1997	0.107	0.360	0.754	1.038	1.506	2.115	2.451	4.408
1998	0.098	0.472	0.719	1.024	1.468	1.800	2.252	3.862
1999	0.098	0.472	0.920	1.298	1.848	2.436	3.513	4.893
2000	0.098	0.583	0.672	1.749	2.054	2.836	3.618	5.055
2001	0.098	0.481	0.998	1.696	2.560	3.303	3.905	5.217
2002	0.098	0.588	1.323	1.388	2.572	3.770	5.158	5.603
2003	0.098	0.462	1.063	1.455	2.978	3.696	5.859	6.120
2004	0.098	0.839	1.677	2.009	3.353	5.576	6.241	8.273
2005	0.098	0.895	1.618	2.368	3.259	4.767	6.177	6.553
2006	0.098	1.081	1.462	2.283	3.966	5.035	6.332	7.997
2007	0.098	0.974	1.858	3.388	4.062	6.128	6.809	9.440
2008	0.088	0.448	1.364	3.037	3.498	5.248	6.643	8.251
2009	0.172	0.507	1.026	2.087	3.727	4.810	5.900	9.534
2010	0.162	0.700	1.279	1.829	2.764	4.372	4.199	8.575
2011	0.086	0.396	0.939	1.522	2.228	3.560	5.980	8.753
2012	0.086	0.374	0.990	1.491	2.136	3.583	6.183	9.183
2013	0.097	0.284	0.762	1.305	2.112	2.990	4.530	8.564
2014	0.108	0.203	0.538	1.108	1.809	2.874	4.087	7.671
2015	0.085	0.261	0.531	0.857	1.370	1.938	3.570	6.252
2016	0.082	0.191	0.550	0.787	1.237	2.157	3.439	6.719
2017	0.078	0.192	0.399	0.813	1.348	1.949	2.784	5.080
2018	0.078	0.313	0.561	0.942	1.571	1.974	2.550	4.166
2019	0.078	0.365	0.802	1.158	1.528	1.940	2.150	4.056
2020	0.078	0.266	0.735	1.346	1.843	2.551	2.991	4.636
2021	0.062	0.264	0.772	1.147	2.284	2.751	3.452	5.283
2022	0.062	0.234	0.475	1.160	1.619	2.587	3.268	4.804
2023	0.000	0.294	0.553	1.203	1.647	2.269	2.899	4.590
2024	0.135	0.243	0.712	1.187	1.619	2.201	2.732	5.545
2025	0.000	0.186	0.812	1.223	1.674	2.341	2.912	5.291

Table 4. EU bottom trawl survey abundance at age and total (thousands) and total biomass (tons).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total Abundance	Total Biomass
1988	4868	79905	49496	13448	1457	211	225	72	0	0	0	0	0	0	0	0	0	0	0	149683	40839
1989	19604	10800	91303	54613	20424	1336	143	126	6	7	0	0	0	0	0	0	0	0	0	198363	114050
1990	2303	12348	5121	16952	15834	4492	340	146	77	25	0	0	0	0	0	0	0	0	0	57637	59362
1991	129032	26220	16903	2125	6757	1731	299	68	32	4	10	0	0	0	0	0	0	0	0	183181	40248
1992	71533	41923	5578	2385	385	1398	244	14	0	0	8	0	0	0	0	0	0	0	0	123468	26719
1993	4075	138357	31096	1099	1317	173	489	87	0	0	0	0	0	0	0	0	0	0	0	176693	60963
1994	3017	4130	27756	5097	130	67	7	111	0	5	0	0	0	0	0	0	0	0	0	40319	26463
1995	1425	11901	1338	3892	928	33	23	0	21	5	0	0	0	0	0	0	0	0	0	19567	9695
1996	36	3121	6659	892	2407	192	8	5	0	0	0	0	0	0	0	0	0	0	0	13320	9013
1997	37	150	3478	4803	391	952	21	0	0	0	0	4	0	0	0	0	0	0	0	9837	9966
1998	23	83	95	1256	1572	78	146	0	6	0	0	0	0	0	0	0	0	0	0	3259	4986
1999	5	84	116	117	717	444	19	5	0	0	0	0	0	0	0	0	0	0	0	1507	2854
2000	178	16	327	198	96	446	172	11	17	0	0	5	0	5	0	0	0	0	0	1470	3062
2001	473	1990	13	122	79	15	142	99	6	6	6	0	0	0	0	0	0	0	0	2951	2695
2002	0	1330	641	29	70	33	26	96	30	0	5	0	0	0	0	0	0	0	0	2261	2496
2003	684	54	628	134	22	42	7	8	39	24	0	0	0	0	0	0	0	0	0	1642	1593
2004	14	3380	25	600	168	5	10	3	5	15	0	0	0	0	0	0	0	0	0	4226	4071
2005	8069	16	1118	78	709	136		17	16	8	0	0	0	0	0	0	0	0	0	10166	5242
2006	19709	3886	62	1481	85	592	115	7	0	7	14	0	7	0	0	0	0	0	0	25965	12505
2007	3917	11620	5022	21	1138	58	425	74	13	20	0	0	0	0	0	0	0	0	0	22308	23886
2008	6096	16671	12433	4530	72	946	56	231	76	0	14	0	0	0	0	0	0	0	0	41124	43676
2009	5139	7479	16150	14310	4154	26	1091	0	335	0	0	14	0	0	0	0	0	0	0	48697	75228
2010	66370	27689	8654	7633	4911	1780	8	442	46	251	26	0	0	0	0	0	0	0	0	117810	69295
2011	347674	142999	16993	6309	7739	3089	1191	0	215	0	89	0	0	0	0	0	0	0	0	526300	106151
2012	103494	128087	10942	11721	4967	4781	1630	832	24	93	30	101	0	17	0	0	0	0	0	266720	113227
2013	5525	67521	32339	4776	4185	2782	1807	963	278	40	29	32	5	0	0	0	0	0	0	120280	72289
2014	7282	2372	48564	43168	17861	6842	3447	1931	1551	600	79	54	8	0	0	0	0	0	0	133760	159939
2015	1141	12952	7250	25614	14107	21854	3434	1426	762	366	194	14	21	21	0	7	0	0	0	89164	114807
2016	56	4485	14356	2230	14540	12375	4814	1157	522	303	145	28	20	0	0	0	0	0	0	55032	80583
2017	2010	314	6516	16645	3267	15842	8519	2765	789	345	137	53	27	6	7	0	0	0	0	57241	89414
2018	366	4308	309	6082	12996	3447	7090	3933	1046	306	165	59	10	0		11	8	0	0	40139	75795
2019	11896	1742	5208	311	3301	5688	400	1470	1970	832	125	30	14	8	0	0	0	0	8	33002	42460
2020	7063	5008	24696	13732	5593	4271	3326	675	623	938	573	140	47	14	39	0	0	8	0	66744	67130
2021	18966	9031	9263	19122	3958	943	1064	1040	283	562	639	192	29	36	0	7	0	0	0	65149	51501
2022	3871	16954	14132	19178	7043	2525	514	1248	496	206	380	498	119	34	7	0	0	0	0	67204	62206
2023	260	14403	38718	34925	12952	4193	1590	1092	487	558	575	322	73	31	10	1	0	0	0	110192	100474
2024	1641	3420	51720	83446	14924	3921	1393	798	341	352	408	253	58	34	5	1	0	0	0	162716	143325
2025	1786	1800	14947	64878	16786	3860	1436	806	310	315	304	161	45	16	5	3	0	0	0	107464	120129

Table 5. Weight-at-age (kg) in stock.

	1	2	3	4	5	6	7	8+
1988	0.032	0.106	0.308	0.664	1.970	3.500	5.742	6.954
1989	0.036	0.101	0.330	0.836	1.293	2.118	4.199	7.360
1990	0.043	0.181	0.354	0.868	1.566	2.507	4.132	6.572
1991	0.056	0.171	0.501	0.865	1.594	2.593	3.423	6.182
1992	0.056	0.247	0.485	1.394	1.723	2.578	3.068	9.406
1993	0.043	0.227	0.657	1.216	2.279	2.381	3.373	5.731
1994	0.063	0.214	0.599	1.321	2.132	4.054	4.119	6.555
1995	0.048	0.243	0.479	0.969	1.851	2.680	5.532	7.309
1996	0.044	0.260	0.544	0.813	1.331	2.252	4.079	5.118
1997	0.081	0.333	0.652	1.020	1.327	2.092	1.997	9.717
1998	0.073	0.371	0.773	1.206	1.684	2.015	3.070	7.525
1999	0.108	0.398	0.946	1.329	1.866	2.444	3.461	4.987
2000	0.106	0.606	0.971	1.638	1.940	2.860	3.461	7.985
2001	0.084	0.493	1.281	1.724	2.588	3.488	3.893	5.137
2002	0.071	0.440	1.191	1.540	2.661	3.916	5.302	5.672
2003	0.058	0.337	0.926	1.566	3.047	3.769	5.721	6.451
2004	0.071	0.620	1.488	2.098	3.332	4.808	6.207	7.886
2005	0.084	0.580	1.256	2.242	2.875	4.187	6.033	8.148
2006	0.096	0.720	1.096	2.549	3.644	4.777	5.858	9.691
2007	0.053	0.609	1.640	3.478	4.097	5.787	6.373	8.315
2008	0.068	0.382	1.344	2.695	3.191	5.015	6.324	7.938
2009	0.078	0.407	0.976	2.072	3.881	6.958	6.583	9.461
2010	0.061	0.384	1.089	1.677	2.956	5.379	7.616	9.144
2011	0.038	0.211	0.913	1.618	2.339	3.594	6.050	9.396
2012	0.074	0.369	0.726	1.349	1.988	2.656	4.933	7.812
2013	0.071	0.175	0.687	1.159	2.004	2.750	4.206	7.614
2014	0.048	0.169	0.354	1.059	1.623	2.536	3.846	8.444
2015	0.049	0.156	0.469	0.747	1.216	1.847	3.434	6.775
2016	0.044	0.169	0.412	0.783	1.304	2.024	2.883	6.905
2017	0.044	0.205	0.385	0.709	1.204	1.831	2.573	5.111
2018	0.049	0.277	0.656	0.981	1.497	1.937	2.646	4.493
2019	0.076	0.278	0.776	1.275	1.733	2.151	2.389	4.043
2020	0.054	0.209	0.364	1.015	1.667	2.470	2.982	4.703
2021	0.045	0.188	0.665	0.842	1.604	2.428	3.134	5.021
2022	0.046	0.150	0.294	1.067	1.500	2.610	3.532	4.981
2023	0.060	0.238	0.394	0.864	1.523	2.130	2.711	4.331
2024	0.063	0.235	0.519	0.781	1.394	2.112	2.546	4.662
2025	0.055	0.215	0.638	0.967	1.430	2.247	2.736	4.488

Table 6. Maturity at age and age of first maturation (median values of ogives).

	1	2	3	4	5	6	7	8+	a50
1988	0.053	0.097	0.172	0.286	0.438	0.599	0.742	0.878	5.38
1989	0.053	0.097	0.172	0.286	0.438	0.599	0.742	0.878	5.38
1990	0.053	0.097	0.172	0.286	0.438	0.599	0.742	0.878	5.38
1991	0.016	0.042	0.106	0.245	0.462	0.692	0.855	0.958	5.15
1992	0.002	0.011	0.046	0.181	0.499	0.818	0.953	0.993	5.00
1993	0.001	0.006	0.047	0.280	0.750	0.959	0.995	1.000	4.47
1994	0.000	0.001	0.049	0.655	0.986	1.000	1.000	1.000	3.82
1995	0.000	0.000	0.005	0.801	1.000	1.000	1.000	1.000	3.79
1996	0.000	0.000	0.028	0.666	0.993	1.000	1.000	1.000	3.84
1997	0.000	0.007	0.109	0.670	0.972	0.998	1.000	1.000	3.75
1998	0.000	0.001	0.087	0.872	0.998	1.000	1.000	1.000	3.55
1999	0.000	0.001	0.122	0.903	0.999	1.000	1.000	1.000	3.46
2000	0.000	0.001	0.156	0.975	1.000	1.000	1.000	1.000	3.36
2001	0.000	0.000	0.271	0.997	1.000	1.000	1.000	1.000	3.15
2002	0.000	0.010	0.633	0.997	1.000	1.000	1.000	1.000	2.90
2003	0.000	0.022	0.515	0.979	1.000	1.000	1.000	1.000	2.99
2004	0.000	0.000	0.092	0.966	1.000	1.000	1.000	1.000	3.41
2005	0.038	0.165	0.500	0.830	0.959	0.991	0.998	1.000	3.00
2006	0.000	0.013	0.354	0.959	0.999	1.000	1.000	1.000	3.16
2007	0.000	0.012	0.266	0.919	0.997	1.000	1.000	1.000	3.30
2008	0.000	0.012	0.232	0.883	0.995	1.000	1.000	1.000	3.37
2009	0.000	0.010	0.181	0.829	0.991	1.000	1.000	1.000	3.49
2010	0.000	0.009	0.164	0.810	0.989	1.000	1.000	1.000	3.53
2011	0.001	0.008	0.071	0.424	0.877	0.986	0.999	1.000	4.14
2012	0.000	0.000	0.016	0.572	0.991	1.000	1.000	1.000	3.94
2013	0.003	0.035	0.283	0.802	0.977	0.998	1.000	1.000	3.40
2014	0.000	0.003	0.044	0.397	0.901	0.992	0.999	1.000	4.16
2015	0.000	0.000	0.004	0.113	0.790	0.991	1.000	1.000	4.60
2016	0.000	0.000	0.004	0.046	0.388	0.892	0.991	1.000	5.18
2017	0.000	0.000	0.000	0.017	0.829	0.999	1.000	1.000	4.72
2018	0.000	0.001	0.007	0.067	0.425	0.880	0.986	0.999	5.13
2019	0.000	0.000	0.005	0.083	0.615	0.966	0.998	1.000	4.84
2020	0.000	0.000	0.003	0.041	0.402	0.908	0.993	1.000	5.15
2021	0.000	0.002	0.017	0.117	0.498	0.883	0.983	0.998	5.00
2022	0.000	0.001	0.008	0.109	0.656	0.967	0.998	1.000	4.76
2023	0.000	0.001	0.010	0.095	0.523	0.919	0.992	0.999	4.96
2024	0.000	0.001	0.010	0.095	0.523	0.919	0.992	0.999	4.96
2025	0.000	0.001	0.010	0.095	0.523	0.919	0.992	0.999	4.96

Table 7. Posterior results: total biomass, SSB, recruitment (tons) and F_{bar}.

	B quantiles			SSB quantiles			R quantiles			F_{bar} quantiles		
Year	**50%**	**10%**	**90%**	**50%**	**10%**	**90%**	**50%**	**10%**	**90%**	**50%**	**10%**	**90%**
1988	82841	78520	87289	22457	18874	26672	62082	47786	81202	0.533	0.493	0.582
1989	93923	89298	99110	28382	24054	33263	124955	94974	162744	0.635	0.591	0.685
1990	87026	82605	91354	31711	28051	35823	113911	85513	151872	0.751	0.697	0.805
1991	73830	67950	81053	24298	21409	27588	377529	287761	492438	0.453	0.413	0.499
1992	87015	80486	94032	24667	22196	27449	311551	239392	411233	1.463	1.370	1.560
1993	60913	57058	64947	9988	8774	11221	20398	15662	26959	0.992	0.920	1.071
1994	53740	50411	57269	20565	18094	23257	37044	28781	49249	1.395	1.316	1.472
1995	19242	18017	20458	13193	12122	14238	15081	11457	20188	1.335	1.258	1.416
1996	6992	6604	7400	3471	3148	3805	930	691	1212	0.492	0.448	0.540
1997	5928	5592	6322	3836	3523	4173	801	604	1066	0.990	0.916	1.072
1998	2774	2569	3019	2393	2207	2628	1358	1023	1799	0.371	0.325	0.419
1999	2151	1923	2420	1906	1690	2166	204	148	275	0.240	0.207	0.279
2000	2342	2070	2674	1789	1547	2053	3662	2775	4930	0.072	0.060	0.085
2001	2998	2652	3376	1767	1554	2014	8680	6603	11558	0.082	0.065	0.103
2002	3308	2981	3653	2054	1836	2304	831	633	1115	0.022	0.019	0.026
2003	4532	4068	5056	2556	2320	2829	23042	17596	30153	0.006	0.006	0.008
2004	7855	7144	8702	4020	3666	4394	705	533	938	0.002	0.002	0.002
2005	12507	11157	14064	6147	5509	6810	51561	38831	67534	0.002	0.002	0.003
2006	27726	24746	31304	10168	9323	11096	82747	63535	109005	0.056	0.049	0.065
2007	41578	37773	45602	14431	12945	16735	113058	86525	148767	0.015	0.013	0.017
2008	56487	51859	61089	25315	23329	27497	100146	75370	132925	0.029	0.025	0.032
2009	76820	70806	82984	39844	36977	42816	140612	107891	186500	0.021	0.019	0.024
2010	103336	95672	111367	58317	54038	62966	240706	185242	316786	0.135	0.121	0.151
2011	106089	98138	113865	50938	47187	55029	381855	294421	502921	0.148	0.131	0.167
2012	142229	130370	154568	52478	48509	56852	306637	238046	403981	0.102	0.090	0.116
2013	131121	121996	140551	83135	76306	90166	45723	34667	60120	0.105	0.093	0.118
2014	129089	120505	138944	80599	73691	87849	146343	110392	193303	0.081	0.071	0.092
2015	112681	104915	121081	74737	68130	82013	61060	46563	80429	0.090	0.080	0.102
2016	115725	107551	124886	80084	72781	88106	14148	10666	18764	0.093	0.081	0.106
2017	97318	90430	105479	79428	73008	86668	79065	60415	104492	0.051	0.044	0.058
2018	93336	86863	100778	69066	63284	75687	43359	33172	57640	0.073	0.064	0.083
2019	83131	77151	89987	59444	54525	64839	94569	71726	125080	0.135	0.120	0.152
2020	60326	55627	65846	39021	35149	43228	94794	72639	125006	0.091	0.080	0.105
2021	63262	58015	69370	31966	28698	35628	226649	168644	300125	0.019	0.017	0.022
2022	65420	60414	71136	34348	31411	37637	164137	122442	221544	0.033	0.029	0.038
2023	65638	60657	70639	28611	26280	31100	32435	23634	44586	0.062	0.054	0.072
2024	69189	63843	74713	32749	29962	35951	22320	16177	31880	0.095	0.082	0.109
2025	70872	65002	77634	39216	35452	43204	31134	20750	46218	0.115	0.097	0.136

Table 8. F at age (posterior median).

	F at age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1988	0.000	0.018	0.352	0.600	0.638	0.653	0.819	0.819
1989	0.000	0.011	0.373	0.806	0.717	0.776	0.894	0.894
1990	0.000	0.018	0.402	0.934	0.910	1.206	1.091	1.091
1991	0.000	0.023	0.317	0.494	0.544	0.567	0.696	0.696
1992	0.000	0.148	1.064	1.542	1.781	1.426	2.000	2.000
1993	0.000	0.088	0.717	1.172	1.078	1.537	0.884	0.884
1994	0.000	0.202	1.049	1.752	1.373	1.330	1.030	1.030
1995	0.000	0.201	0.588	1.530	1.878	2.349	2.255	2.255
1996	0.000	0.051	0.266	0.513	0.695	0.898	0.837	0.837
1997	0.000	0.126	0.634	0.920	1.409	2.078	1.948	1.948
1998	0.000	0.053	0.225	0.365	0.516	0.614	0.482	0.482
1999	0.000	0.029	0.261	0.203	0.256	0.268	0.102	0.102
2000	0.000	0.006	0.142	0.028	0.046	0.037	0.012	0.012
2001	0.000	0.009	0.151	0.038	0.058	0.045	0.016	0.016
2002	0.000	0.002	0.038	0.011	0.017	0.013	0.005	0.005
2003	0.000	0.000	0.010	0.004	0.005	0.004	0.002	0.002
2004	0.000	0.000	0.003	0.001	0.002	0.001	0.001	0.001
2005	0.000	0.000	0.003	0.001	0.002	0.001	0.001	0.001
2006	0.000	0.002	0.080	0.040	0.047	0.034	0.030	0.030
2007	0.000	0.000	0.011	0.016	0.019	0.018	0.024	0.024
2008	0.000	0.002	0.015	0.031	0.040	0.038	0.031	0.031
2009	0.000	0.002	0.008	0.025	0.030	0.030	0.034	0.034
2010	0.000	0.012	0.074	0.136	0.193	0.198	0.222	0.222
2011	0.000	0.012	0.094	0.117	0.231	0.286	0.390	0.390
2012	0.000	0.007	0.064	0.080	0.161	0.210	0.305	0.305
2013	0.000	0.007	0.070	0.081	0.164	0.222	0.303	0.303
2014	0.000	0.003	0.036	0.091	0.115	0.179	0.246	0.246
2015	0.000	0.003	0.049	0.089	0.131	0.213	0.251	0.251
2016	0.000	0.003	0.038	0.105	0.134	0.161	0.248	0.248
2017	0.000	0.001	0.015	0.044	0.093	0.165	0.215	0.215
2018	0.000	0.002	0.020	0.053	0.144	0.278	0.224	0.224
2019	0.000	0.001	0.034	0.111	0.261	0.507	0.370	0.370
2020	0.000	0.000	0.010	0.084	0.180	0.363	0.247	0.247
2021	0.000	0.000	0.001	0.019	0.038	0.092	0.068	0.068
2022	0.000	0.000	0.001	0.039	0.060	0.130	0.140	0.140
2023	0.000	0.000	0.002	0.073	0.111	0.203	0.203	0.203
2024	0.000	0.000	0.006	0.105	0.172	0.258	0.295	0.295
2025	0.000	0.000	0.013	0.129	0.202	0.270	0.331	0.331

Table 9. N at age (posterior median), with the total number and number of matures (posterior median) by year.

				N at age					
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**	**Matures**
1988	62082	137466	93166	29627	4304	953	680	263	328541	44574
1989	124955	15572	74581	47287	12743	1723	327	292	277481	41951
1990	113911	31140	8447	36913	16584	4701	525	180	212401	31930
1991	377529	28720	16863	4053	11351	5071	944	169	444699	20802
1992	311551	94785	15416	8871	1941	5036	1927	391	439917	11510
1993	20398	78251	44817	3810	1487	252	809	219	150044	6081
1994	37044	5082	39372	15756	929	386	36	301	98905	14100
1995	15081	9356	2281	9944	2127	179	67	85	39120	10478
1996	930	3792	4197	909	1697	249	12	11	11798	2689
1997	801	229	1989	2312	427	646	67	7	6479	2915
1998	1358	201	111	758	721	79	54	7	3289	1535
1999	204	340	104	64	412	329	29	26	1508	882
2000	3662	51	182	58	41	245	167	36	4442	591
2001	8680	917	28	114	44	30	157	141	10111	498
2002	831	2183	501	17	86	32	19	208	3878	709
2003	23042	209	1200	348	13	65	21	161	25059	1259
2004	705	5757	115	857	272	10	43	130	7889	1304
2005	51561	177	3178	83	672	208	7	123	56008	4685
2006	82747	12847	98	2283	65	516	139	92	98787	3263
2007	113058	20807	7088	65	1732	47	332	159	143288	4557
2008	100146	28270	11434	5061	50	1295	31	339	146625	9248
2009	140612	25011	15492	8129	3845	37	835	256	194216	14879
2010	240706	35323	13779	11082	6245	2858	24	746	310763	21557
2011	381855	60497	19295	9191	7618	3925	1563	439	484383	18712
2012	306637	95725	32770	12684	6442	4622	1967	959	461806	21977
2013	45723	76942	52250	22173	9169	4198	2506	1522	214483	52821
2014	146343	11392	42172	35151	16078	5959	2237	2108	261440	40976
2015	61060	36484	6274	29377	25334	10973	3323	2414	175237	40093
2016	14148	15227	20039	4294	21107	16947	5894	3156	100811	32523
2017	79065	3548	8379	13953	3040	14161	9613	4993	136753	31574
2018	43359	19826	1954	5966	10473	2123	8000	8337	100038	23074
2019	94569	10856	10912	1379	4439	6940	1066	9260	139420	20036
2020	94794	23612	5985	7585	973	2620	2779	5088	143437	10993
2021	226649	23687	13049	4262	5477	622	1210	4378	279333	9811
2022	164137	56455	13101	9351	3295	4042	378	3725	254484	11390
2023	32435	41004	30965	9414	7084	2369	2365	2537	128172	12072
2024	22320	8094	22499	22264	6861	4864	1293	2839	91456	14583
2025	31134	5631	4430	16134	15747	4421	2490	2187	82174	18618

Table 10. Prior and posterior median for M

Age	1	2	3	4	5	6	7	8+
Prior	1.26	0.65	0.44	0.35	0.30	0.27	0.24	0.24
Posterior	1.38	0.60	0.32	0.24	0.27	0.40	0.35	0.34

Table 11. N-at-age in prediction years (medians) with F_{bar}=0 including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2026	42689	7793	3086	3158	11194	9849	2247	2392	83354	19796
2027	45274	10699	4310	2207	2142	6735	4526	2174	78633	14245
2028	31634	11314	5923	3106	1740	1639	4496	4744	65664	11984

Table 12. Projections results (median and 80% CI) with F_{bar}=0.

Year	Total Biomass		SSB		P(SSB<B_{lim})	P(SSB<$B_{trigger}$)	Yield	P(F>F_{lim})	P(F>F_{target})	P(SSB_{2028}>SSB_{2026})	(SSB_{2028} - SSB_{2026}) /SSB_{2026}
2026	63228	(56629 - 70987)	44861	(39607 - 51065)	<1%	9%	15360	6%	30%	<1%	-16%
2027	49128	(42537 - 56774)	36982	(31283 - 43310)	<1%	70%	0	<1%	<1%		
2028	50035	(43290 - 57882)	38095	(32621 - 44667)	<1%	60%	-	-	-		

Table 13. N-at-age in prediction years (medians) with F_{bar}=lower edge leaf (median=0.109), including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2026	42689	7793	3086	3158	11194	9849	2247	2392	83354	19796
2027	45274	10699	4310	2207	2142	6735	4526	2174	78633	14245
2028	31634	11314	5922	3083	1533	1347	3313	3374	62625	9105

Table 14. Projections results (median and 80% CI) with F_{bar}=lower edge leaf (median=0.109).

Year	Total Biomass		SSB		P(SSB<B_{lim})	P(SSB<$B_{trigger}$)	Yield	P(F>F_{lim})	P(F>F_{target})	P(SSB_{2028}>SSB_{2026})	(SSB_{2028} - SSB_{2026}) /SSB_{2026}
2026	63228	(56629 - 70987)	44861	(39607 - 51065)	<1%	9%	15360	6%	30%	<1%	-38%
2027	49128	(42537 - 56774)	36982	(31283 - 43310)	<1%	70%	10086	0.01	7%		
2028	39829	(33191 - 47629)	28119	(22761 - 34600)	<1%	99%	-	-	-		

Table 15. N-at-age in prediction years (medians) with F_{bar} = F midrib leaf (median=0.131) including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2026	42689	7793	3086	3158	11194	9849	2247	2392	83354	19796
2027	45274	10699	4310	2207	2142	6735	4526	2174	78633	14245
2028	31634	11314	5922	3079	1497	1296	3118	3153	62117	8618

Table 16. Projections results (median and 80% CI) with F_{bar} = F midrib leaf (median=0.131).

Year	Total Biomass	SSB	$P(SSB<B_{lim})$	$P(SSB<B_{trigger})$	Yield	$P(F>F_{lim})$	$P(F>F_{target})$	$P(SSB_{2028}>SSB_{2026})$	$(SSB_{2028} - SSB_{2026}) / SSB_{2026}$
2026	63228 (56629 - 70987)	44861 (39607 - 51065)	<1%	9%	15360	6%	30%		
2027	49128 (42537 - 56774)	36982 (31283 - 43310)	<1%	70%	11756	0.08	28%	<1%	-41%
2028	38119 (31525 - 45943)	26489 (21186 - 32970)	<1%	>99%	-	-	-		

Table 17. N-at-age in prediction years (medians) with F_{bar} = F upper edge leaf (median=0.140) including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2026	42689	7793	3086	3158	11194	9849	2247	2392	83354	19796
2027	45274	10699	4310	2207	2142	6735	4526	2174	78633	14245
2028	31634	11314	5922	3077	1478	1276	3040	3061	61904	8421

Table 18. Projections results (median and 80% CI) with $F_{bar}=0.85F_{lim}=0.145$.

Year	Total Biomass	SSB	$P(SSB<B_{lim})$	$P(SSB<B_{trigger})$	Yield	$P(F>F_{lim})$	$P(F>F_{target})$	$P(SSB_{2028}>SSB_{2026})$	$(SSB_{2028} - SSB_{2026}) / SSB_{2026}$
2026	63228 (56629 - 70987)	44861 (39607 - 51065)	<1%	9%	15360	6%	30%		
2027	49128 (42537 - 56774)	36982 (31283 - 43310)	<1%	70%	12452	0.15	42%	<1%	-43%
2028	37423 (30828 - 45239)	25809 (20489 - 32230)	<1%	>99%	-				

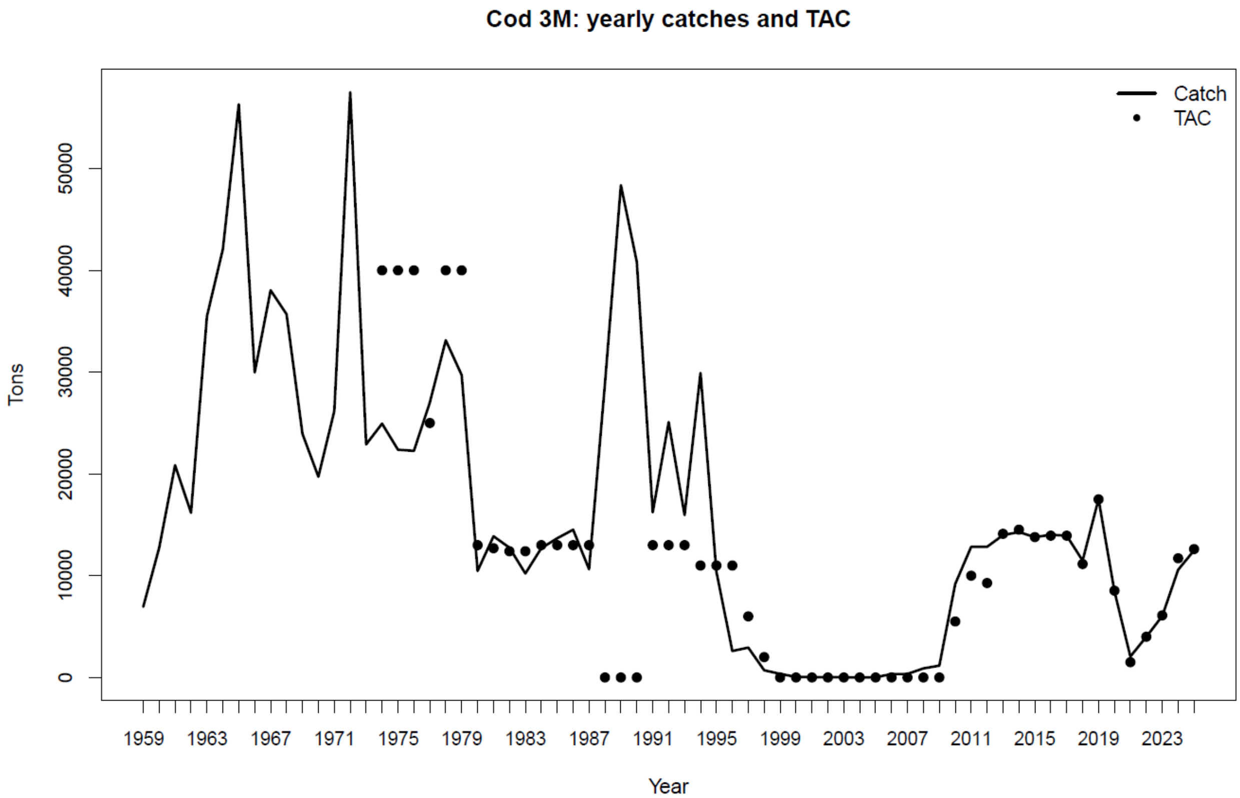


Figure 1. Catch and TAC of the 3M cod for the period 1959-2025.

A

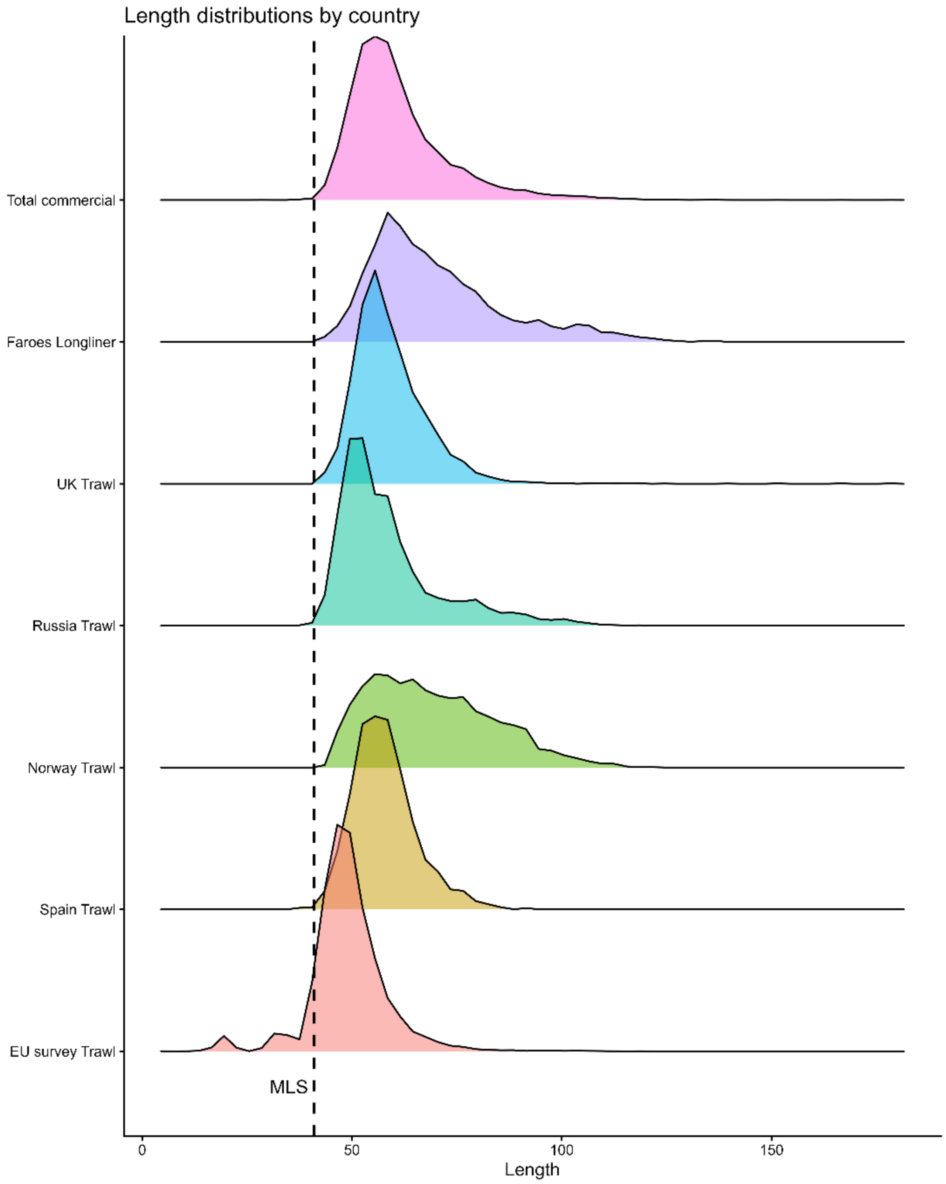
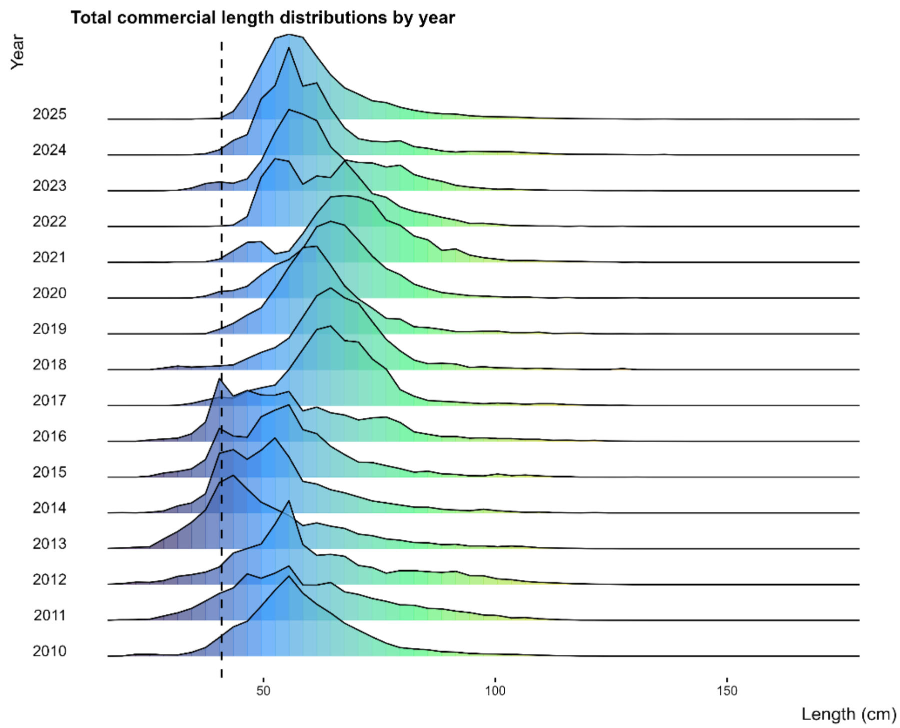


Figure 2. Length distributions in commercial catches and EU survey in 2025 (A), and the total commercial since 2010 (B). In (C), the mean and the mode length of the commercial length distribution is shown (2010-2025).

B



C

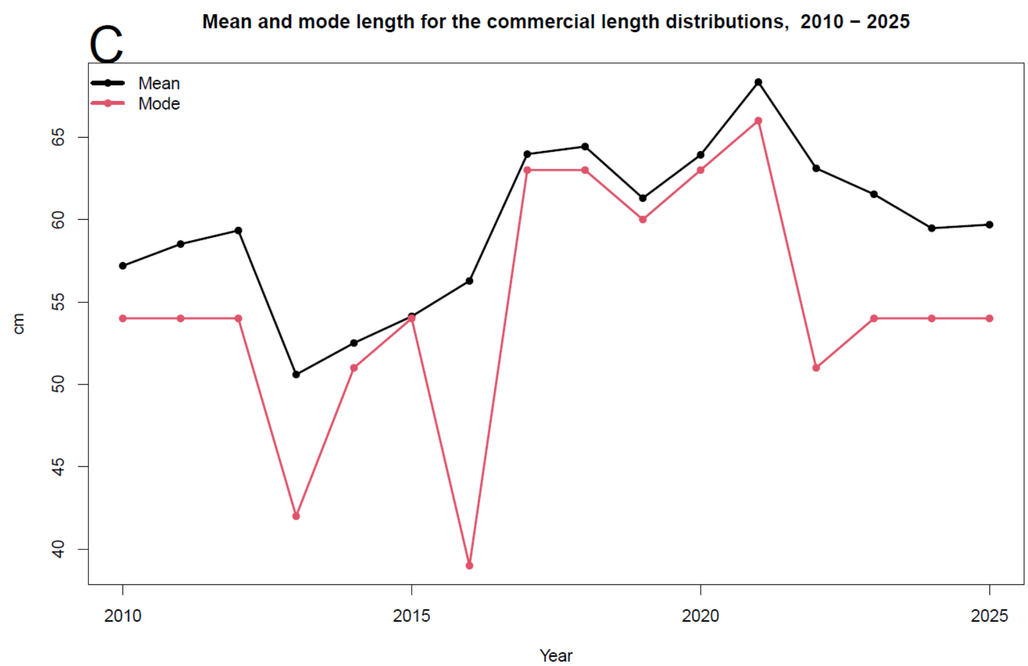


Figure 2 (cont.). Length distributions in commercial catches and EU survey in 2025 (A), and the total commercial since 2010 (B). In (C), the mean and the mode length of the commercial length distribution is shown (2010-2025).

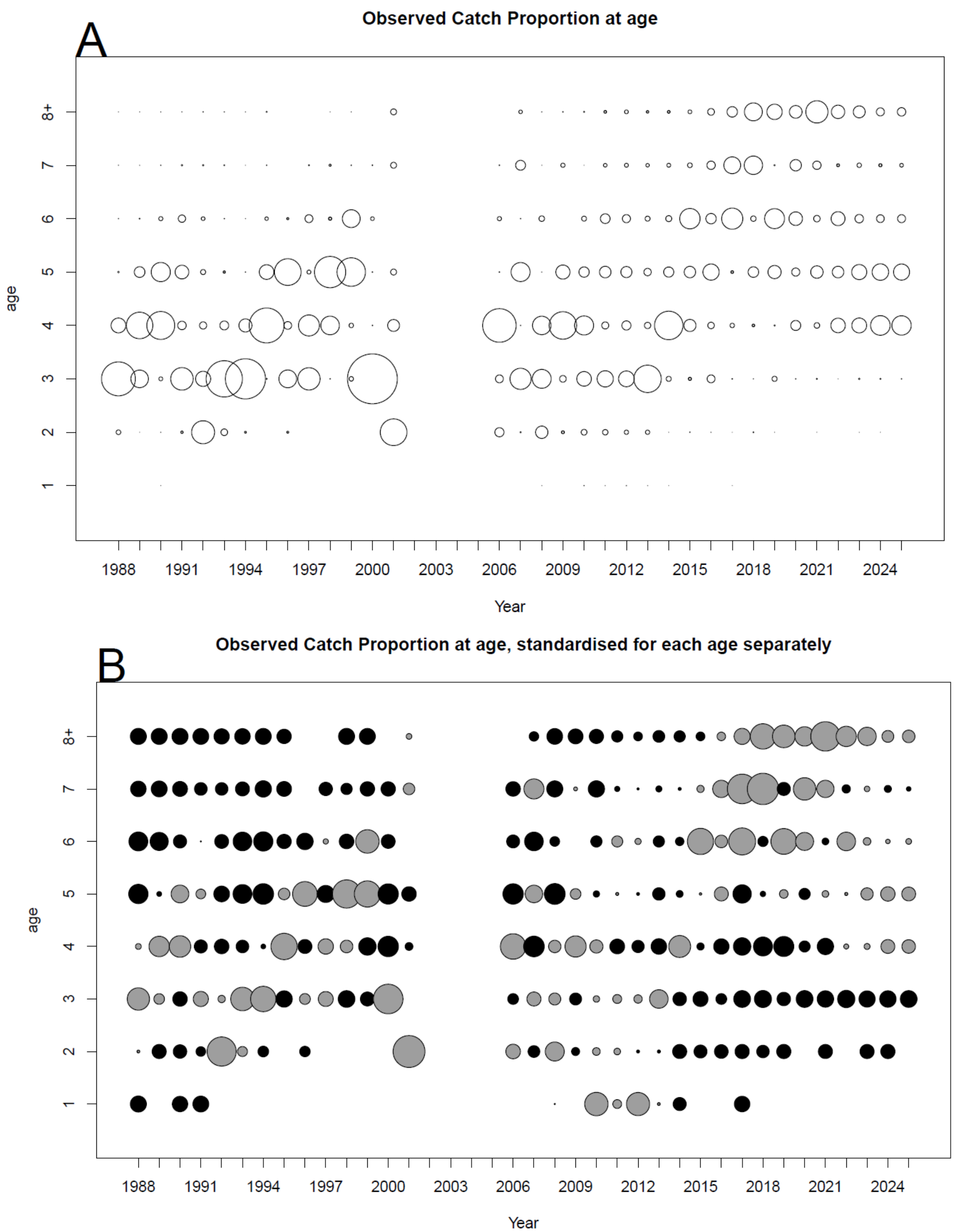


Figure 3. Commercial catch proportions at age (A) and standardised proportions at age (B). In B, grey and black values indicate values above and below the average. The larger the bubble size the larger the magnitude of the value.

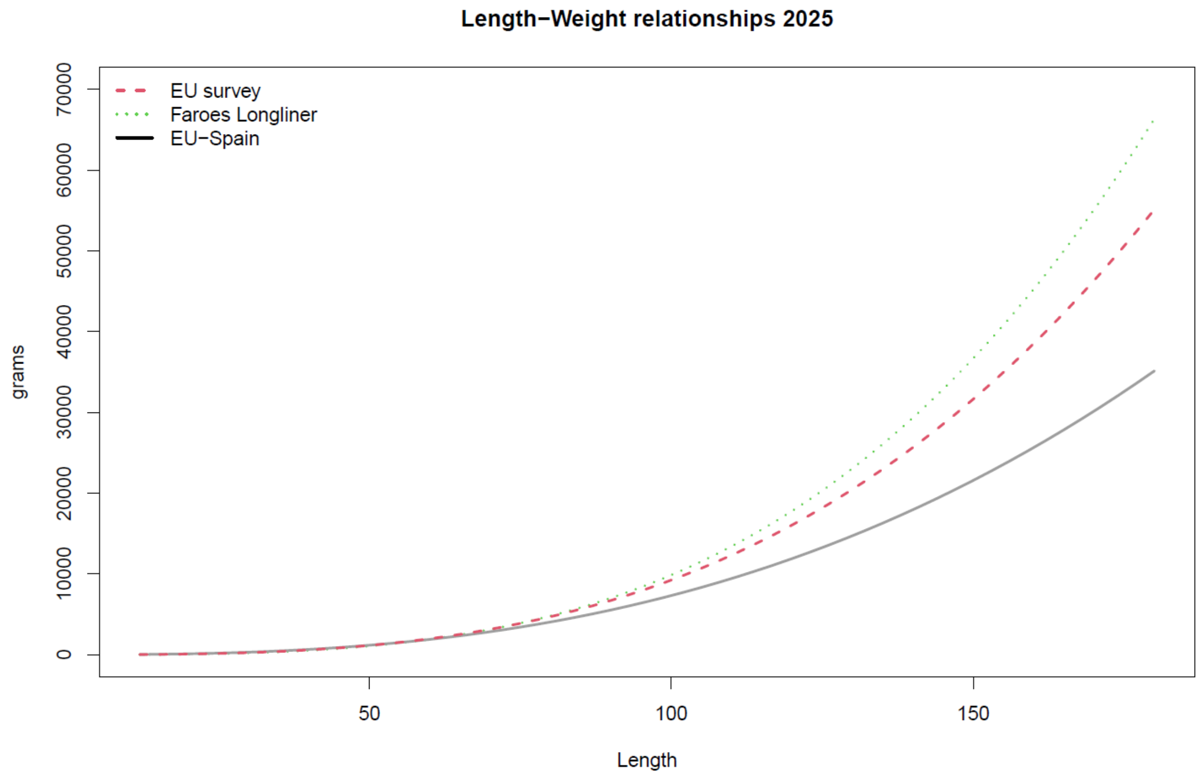


Figure 4. Length-weight relationships for commercial catches and EU survey.

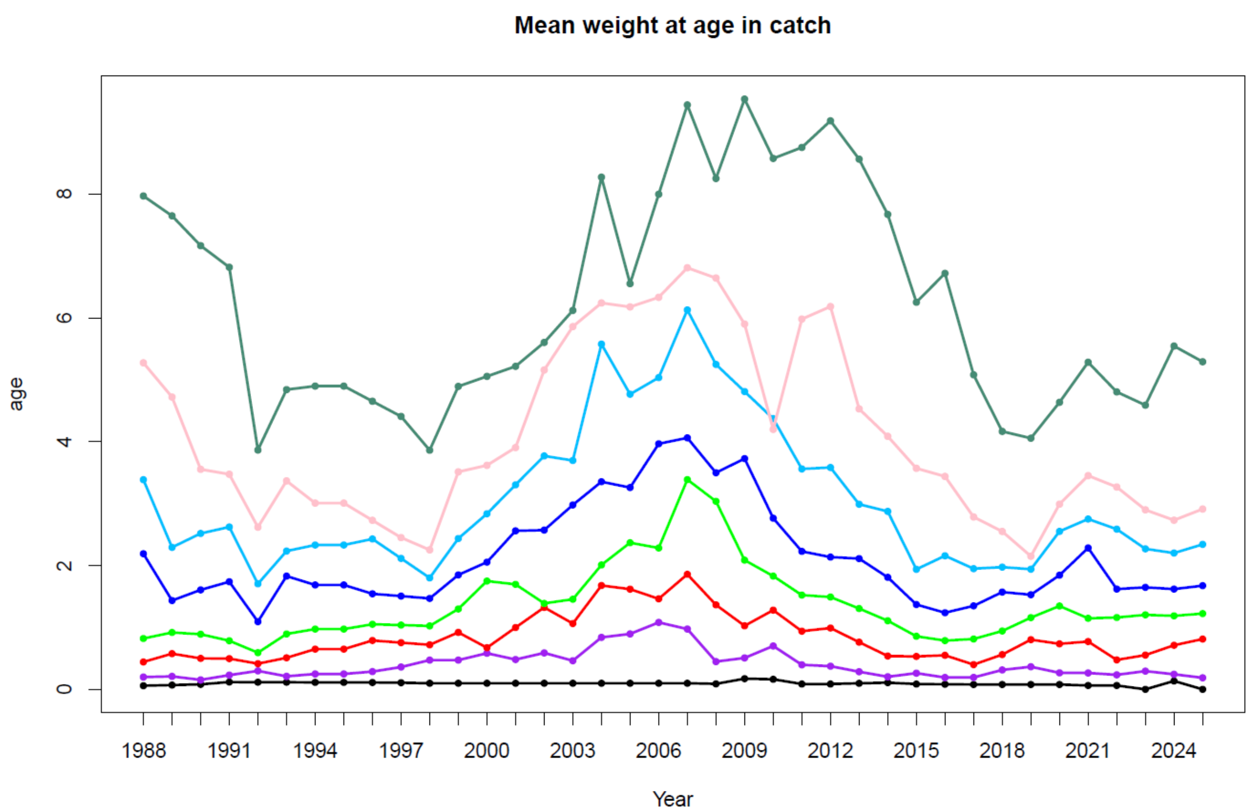


Figure 5. Mean weight at age in catch.

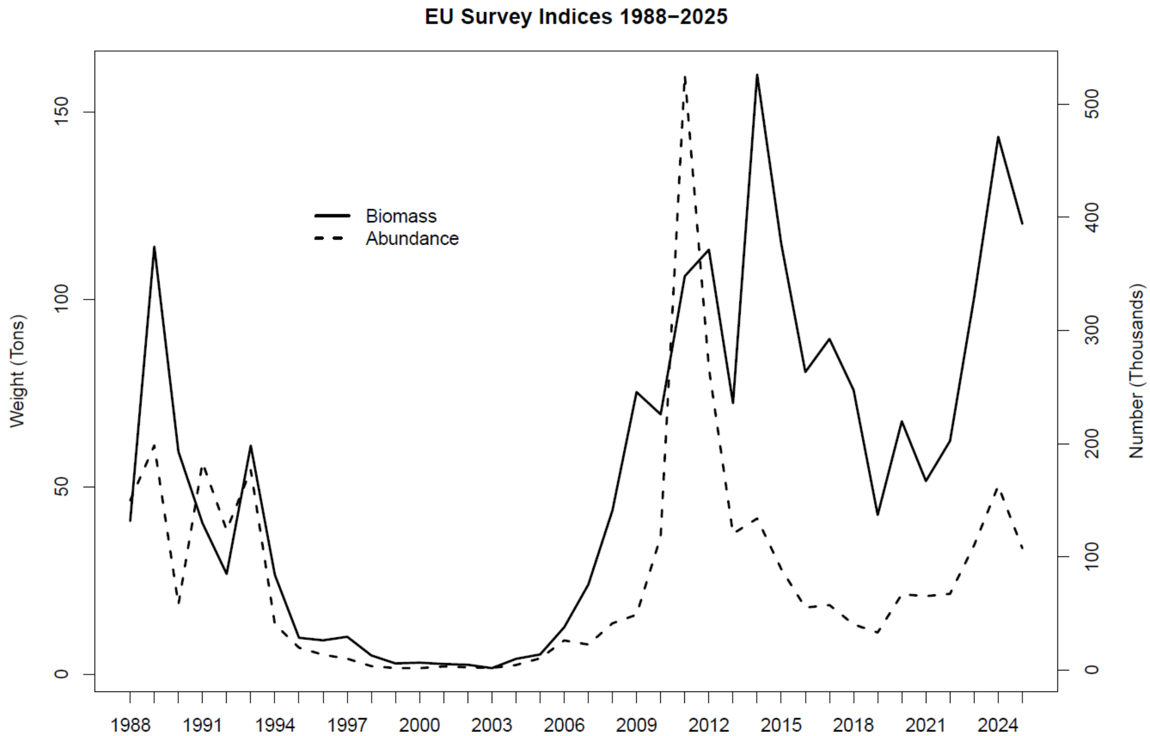


Figure 6. Biomass and abundance from EU surveys.

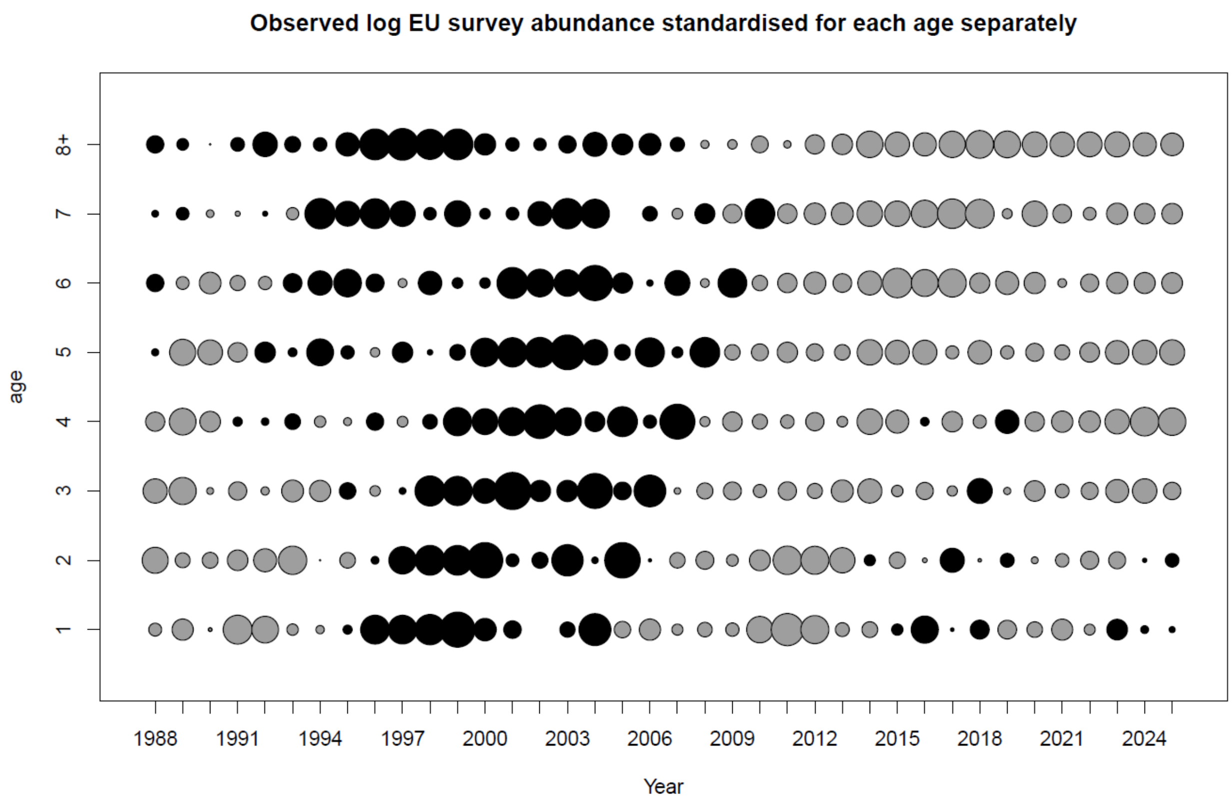


Figure 7. Standardised log(Abundance at age) indices from EU survey. Grey and black values indicate values above and below the average. The larger the bubble size the larger the magnitude of the value.

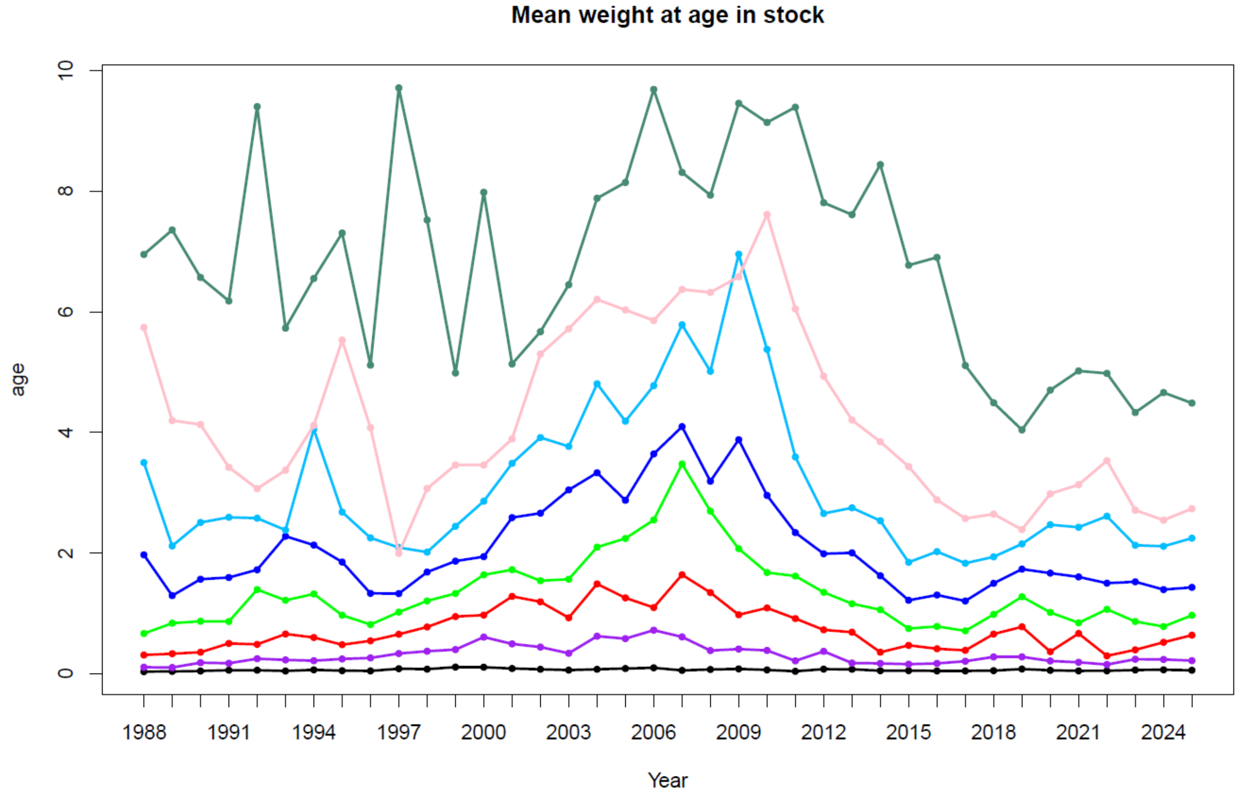


Figure 8. Mean weight at age in stock.

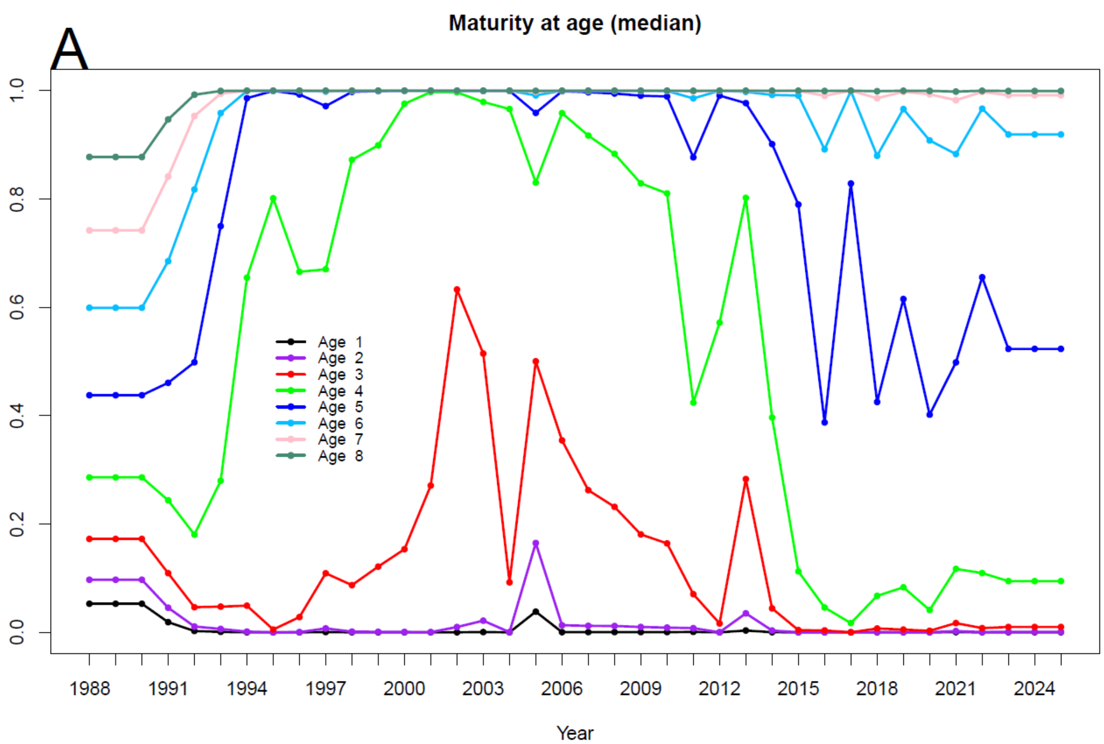


Figure 9. Maturity ogive by age (A) and age at which 50% of fish are mature (B).

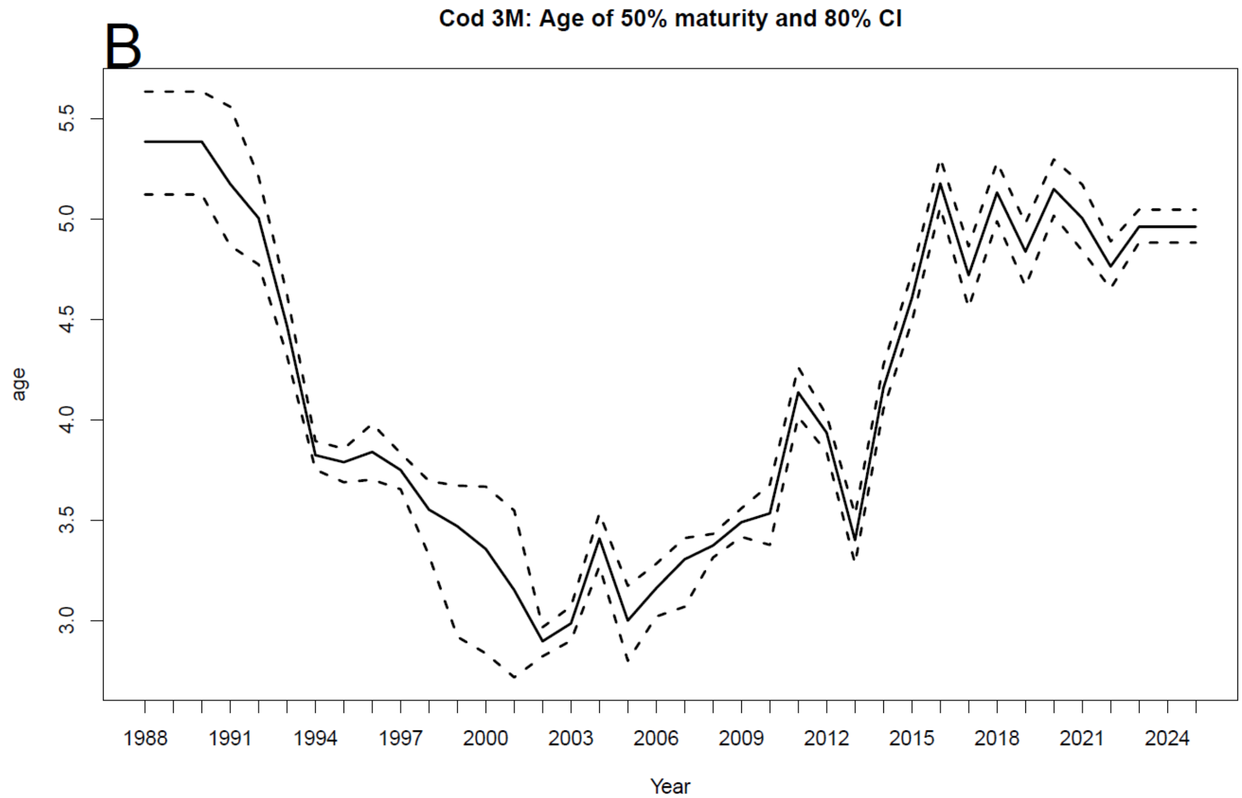


Figure 9 (cont.). Maturity ogive by age (A) and age at which 50% of fish are mature (B).

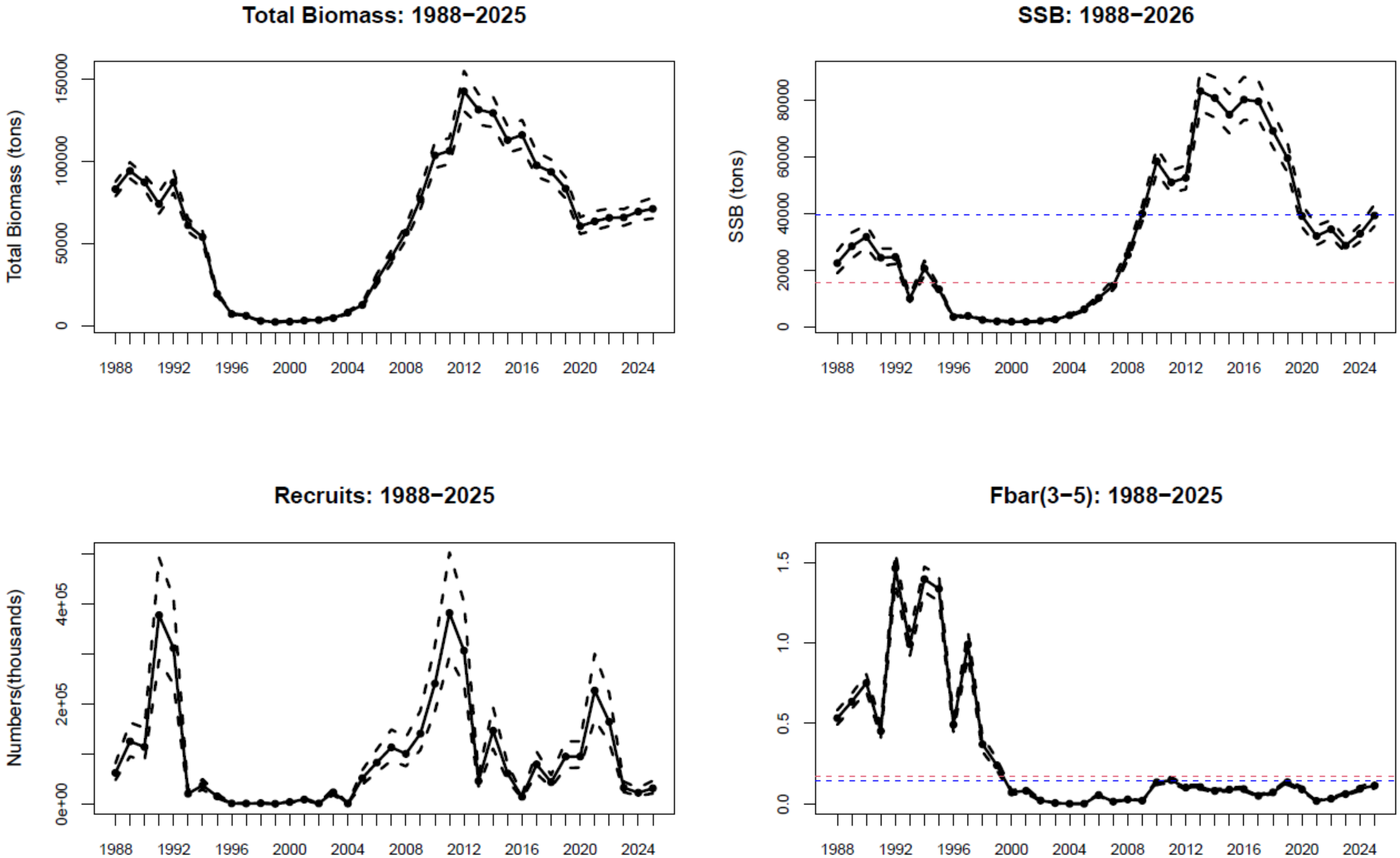


Figure 10. Estimated trends in biomass, SSB, recruitment and F_{bar}. The solid lines are the posterior medians and the dashed lines show the limits of 80% posterior confidence intervals. Red horizontal line in the SSB graph represents B_{lim} = 15 724 tons and blue horizontal lines $B_{trigger}$ = 39 310 tons. Red horizontal line in the F_{bar} graph represents F_{lim} = 0.171 and blue horizontal line F_{target} = 0.145.

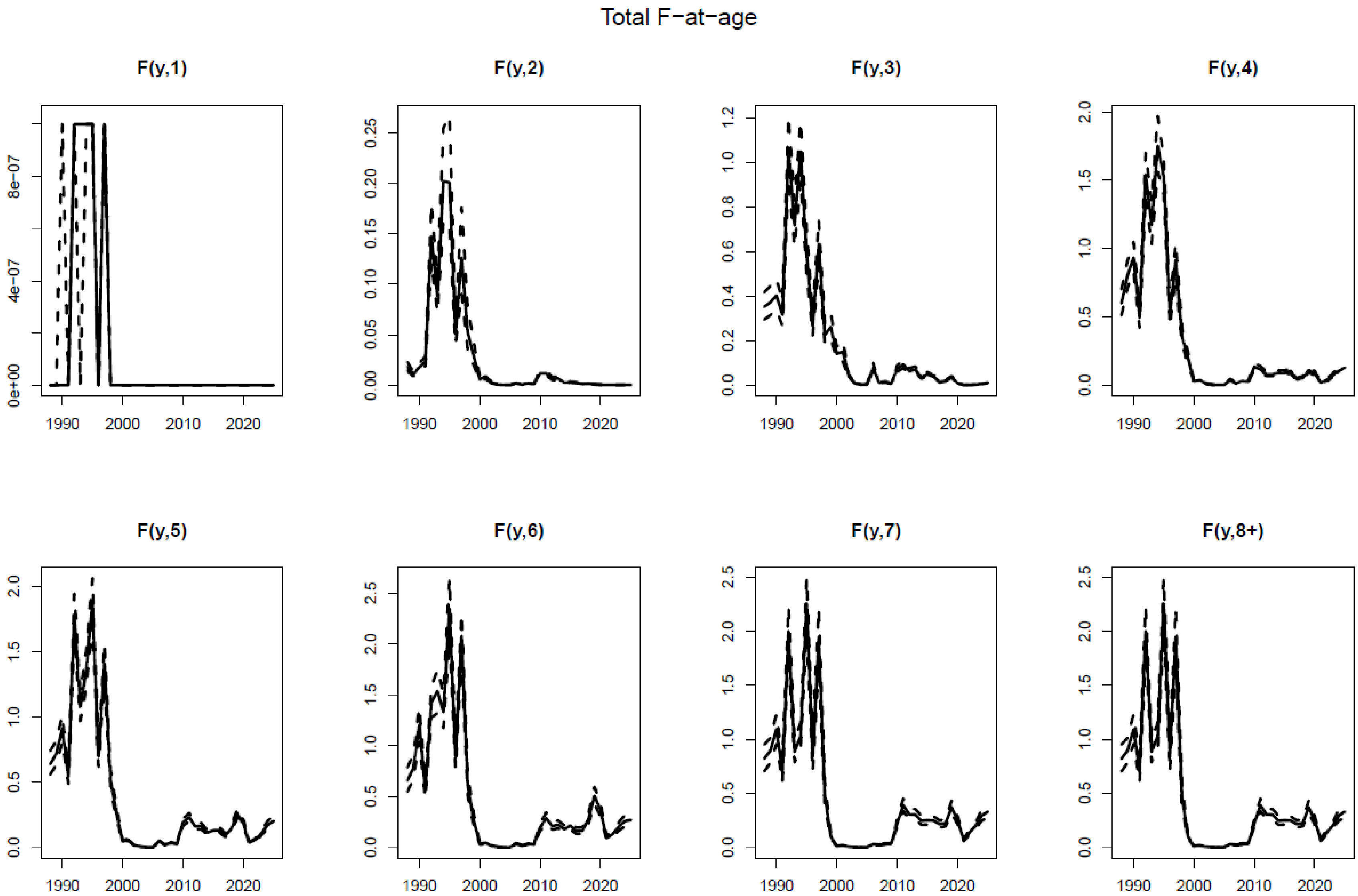


Figure 11. Estimated fishing mortality at age. The y-axis scale is different in all the graphs.

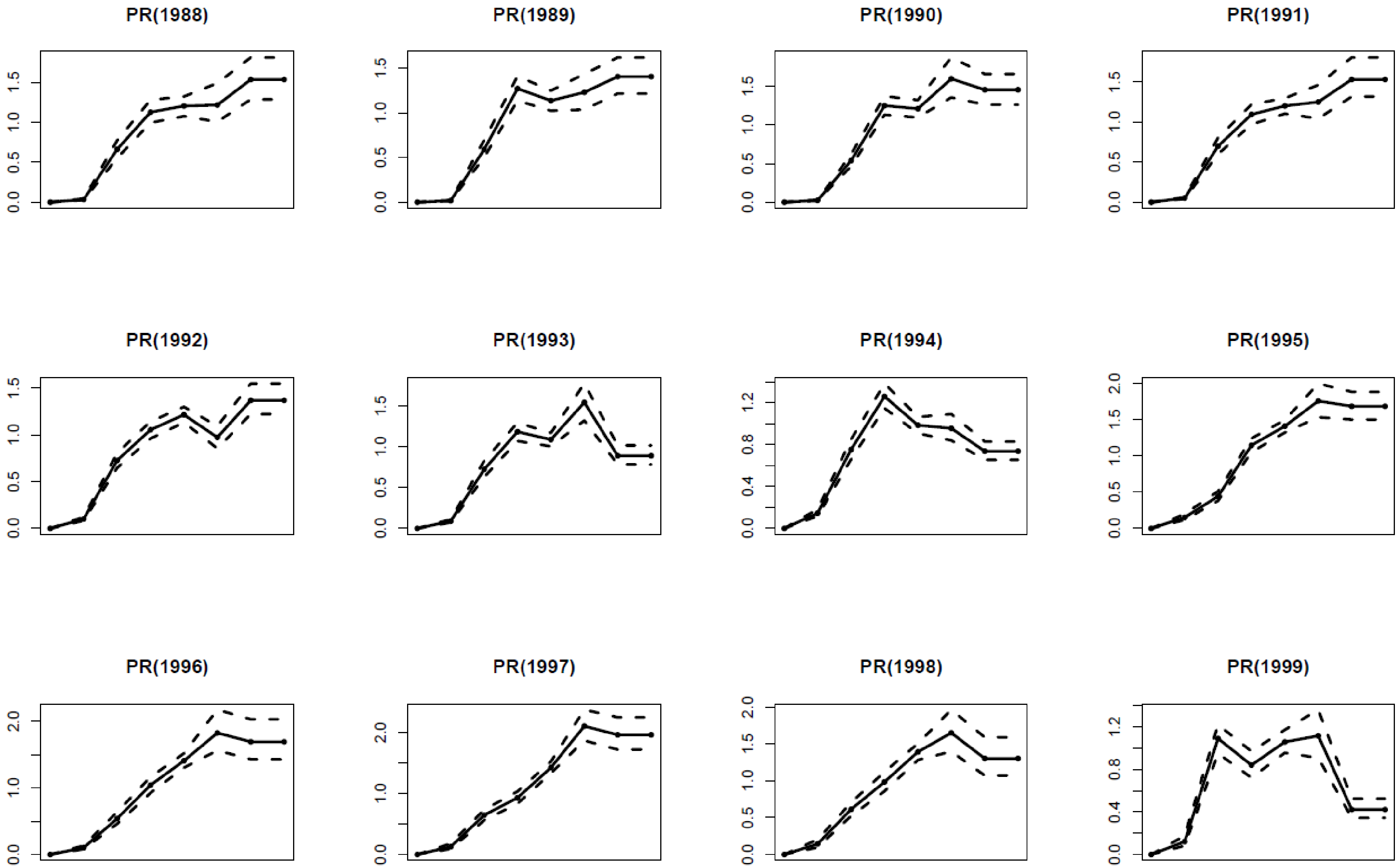


Figure 12. Estimated PR (F/F_{bar}) per age and year.

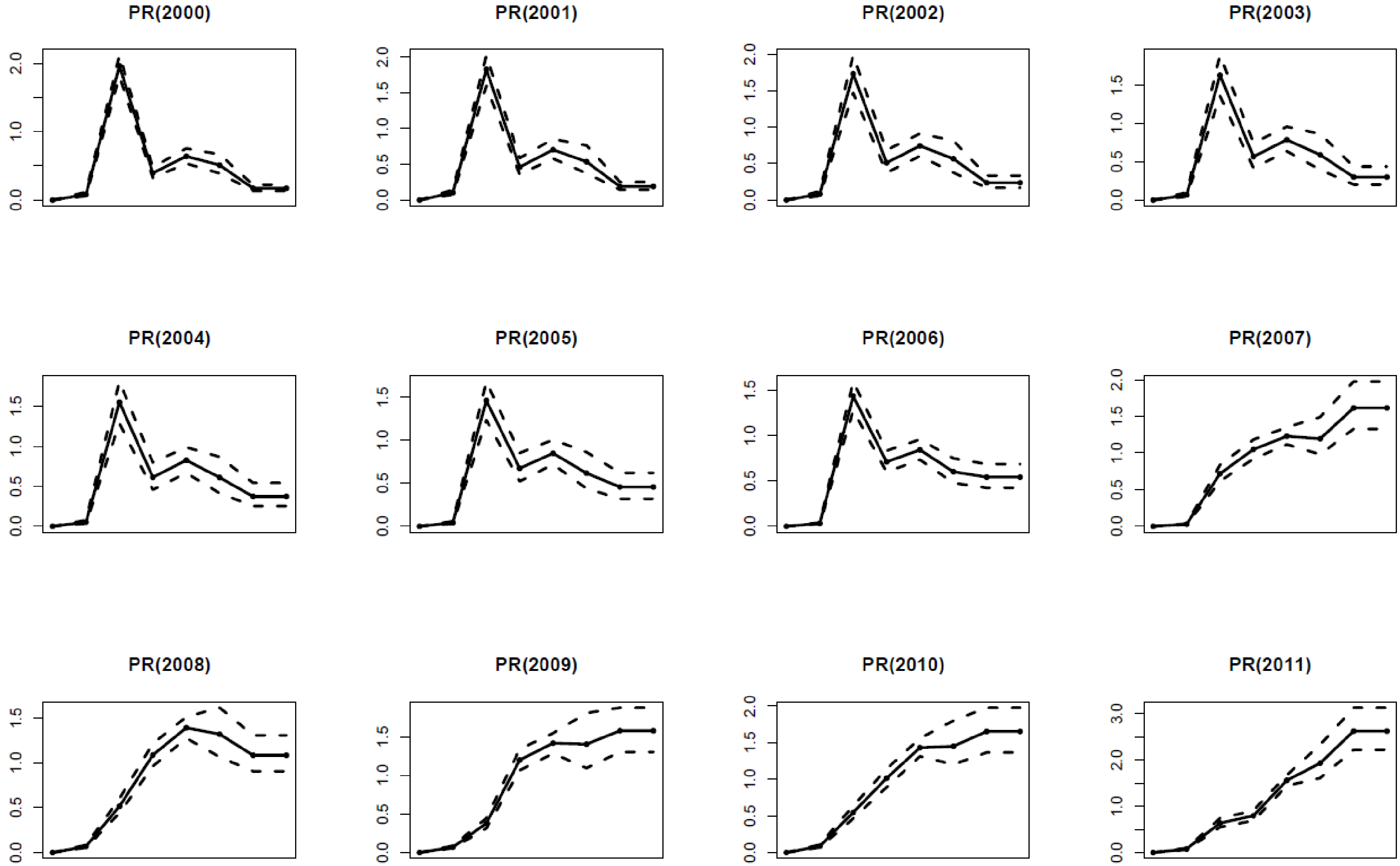


Figure 12 (cont.). Estimated PR (F/F_{bar}) per age and year.

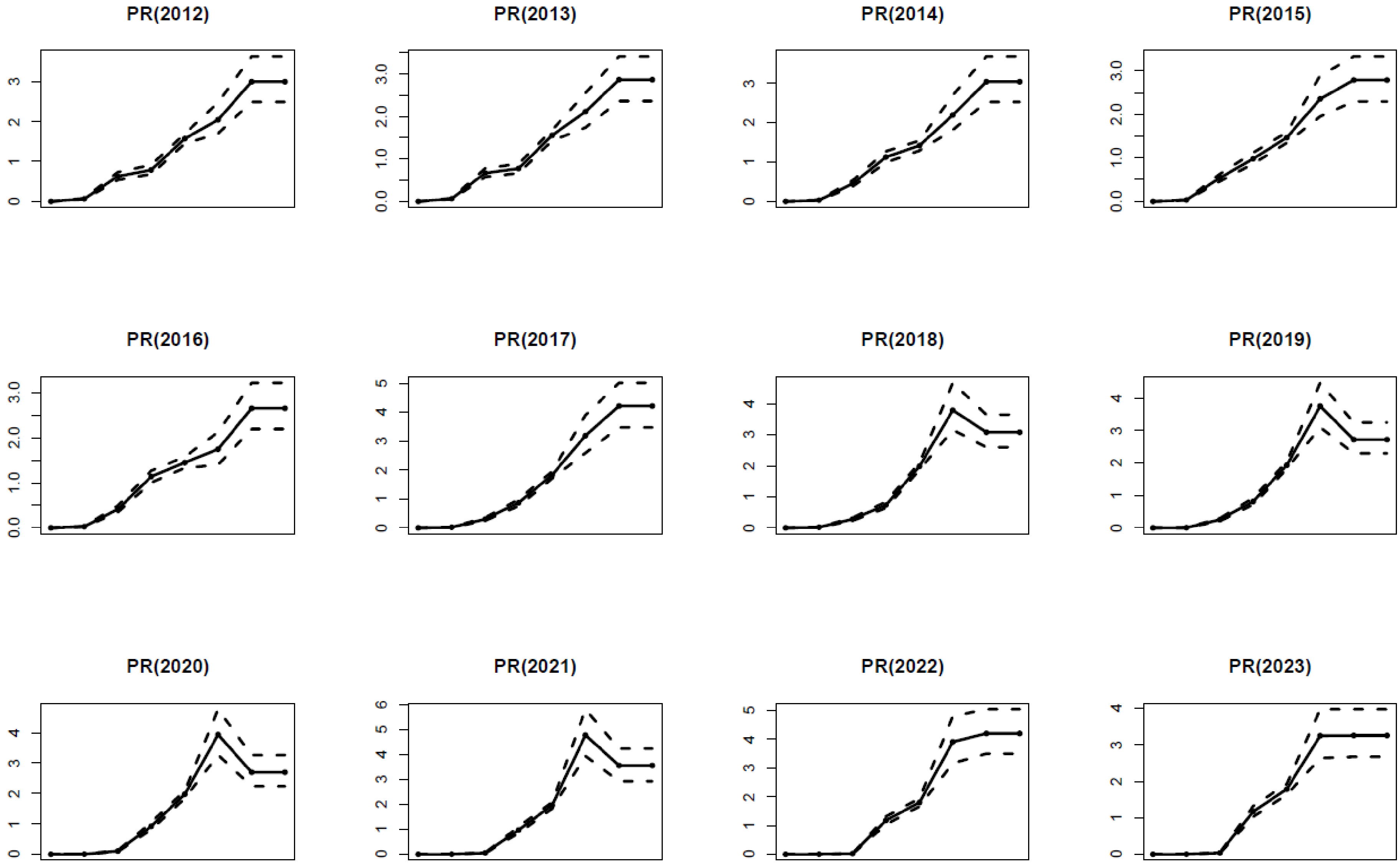
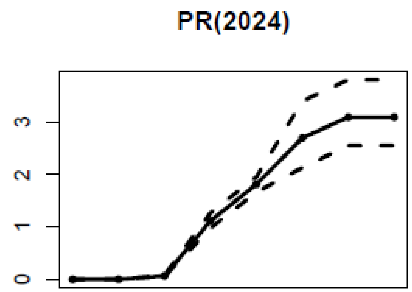


Figure 12 (cont.). Estimated PR (F/F_{bar}) per age and year.



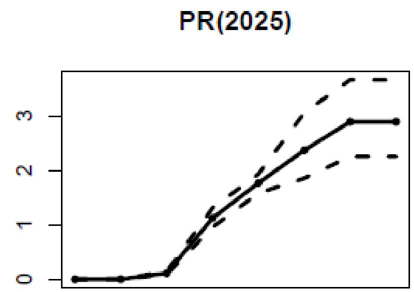


Figure 12 (cont.). Estimated PR (F/F_{bar}) per age and year.

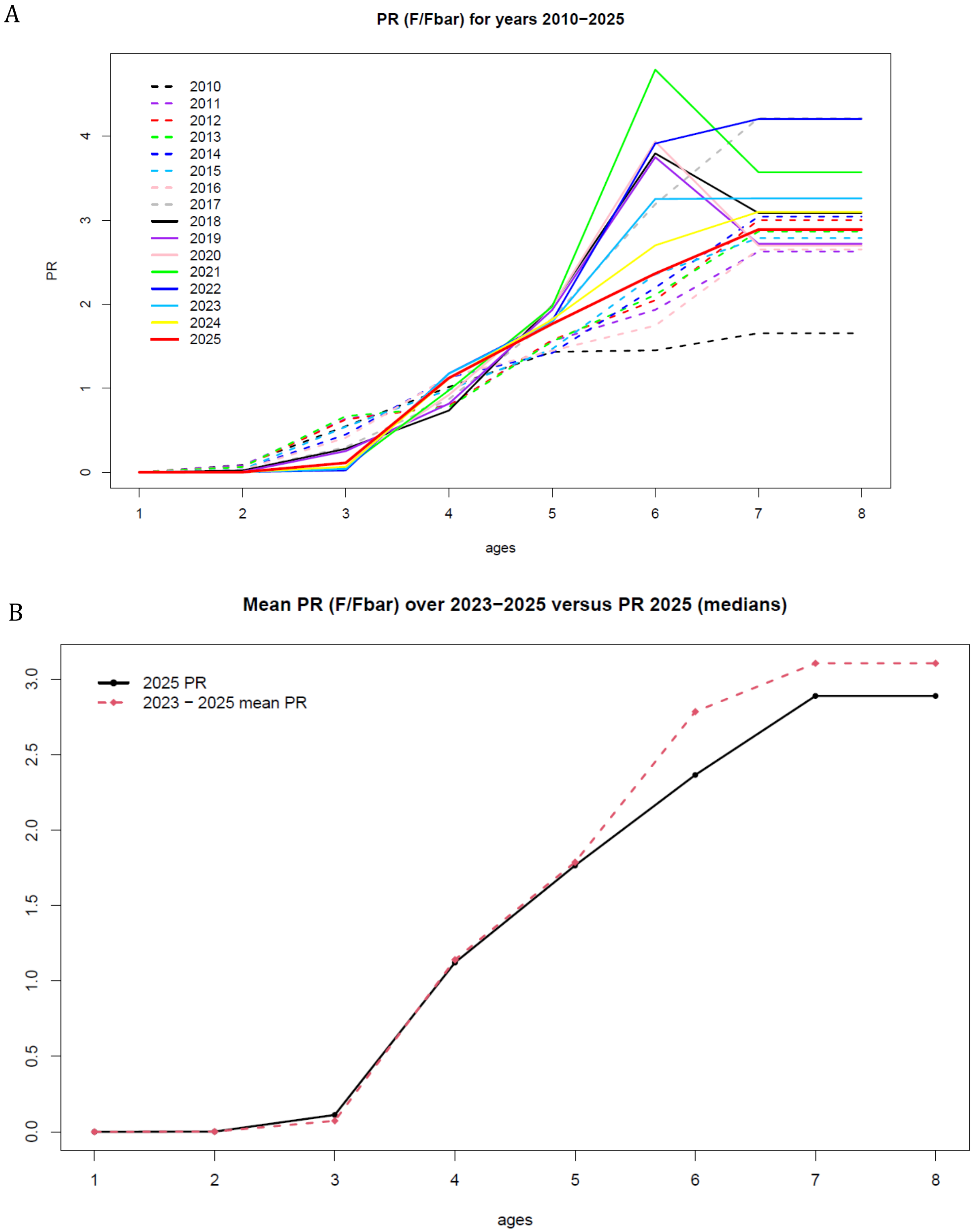
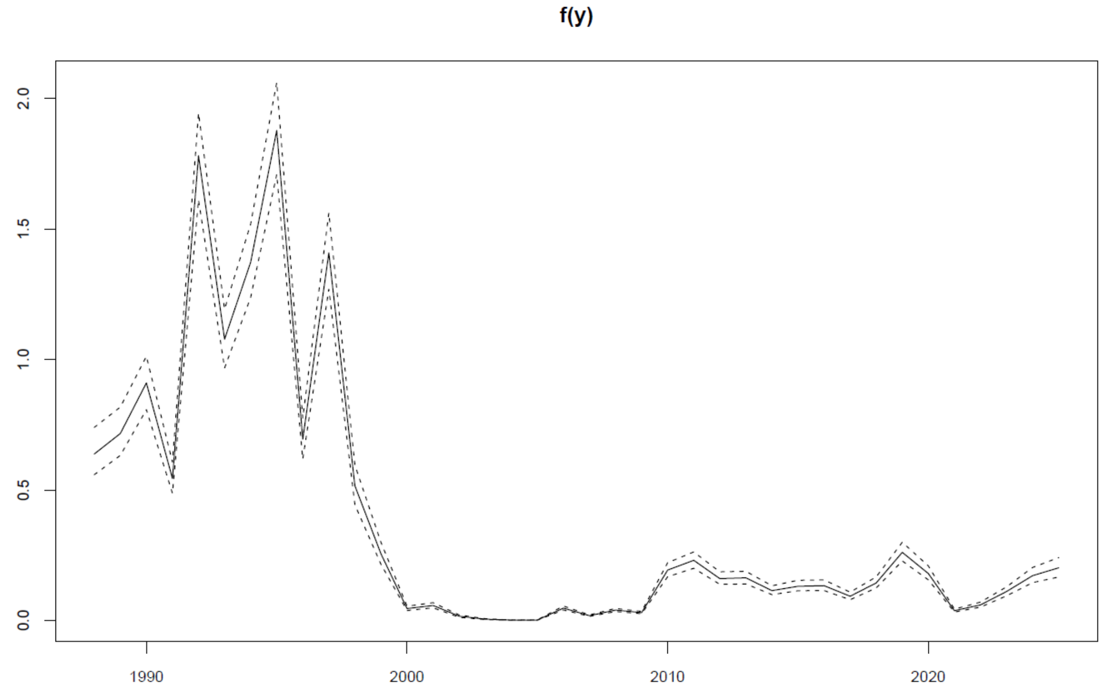


Figure 13. A) Estimated PR (F/F_{bar}) per age since the reopening of the fishery and (B) mean of 2023-2025 PR versus 2025 PR (posterior medians).

A



B

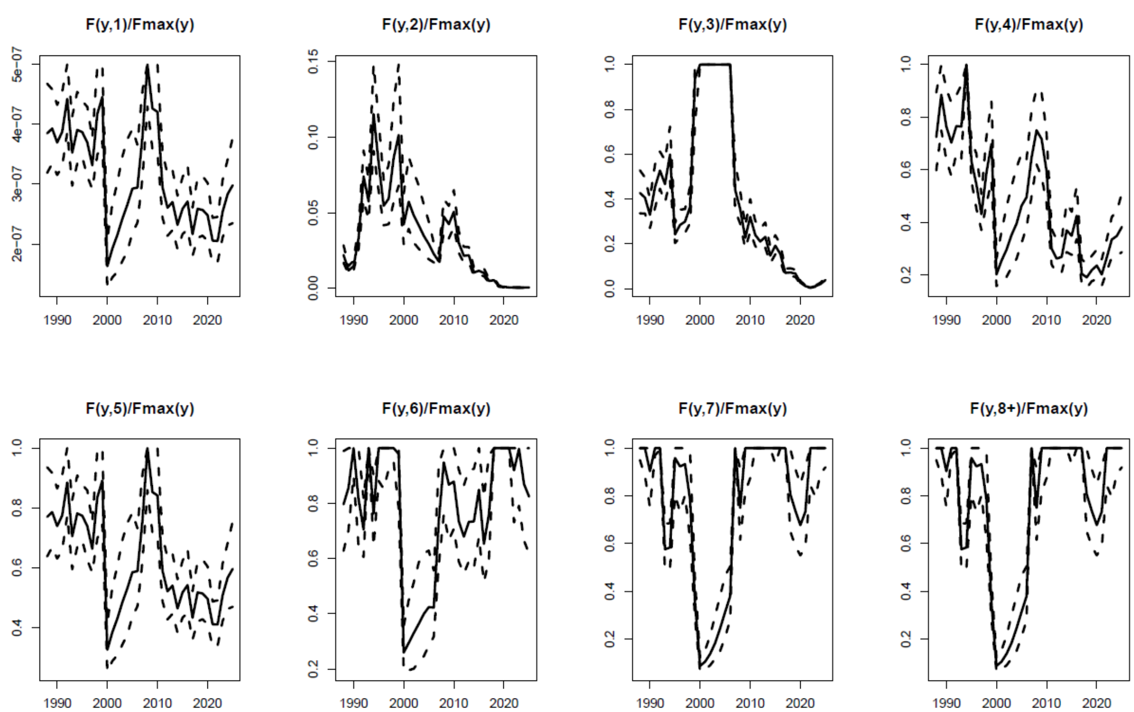


Figure 14. Components of the semi-separable model for Fishing Mortality: F[y,a]=*f*[y]**rC*[y,a].

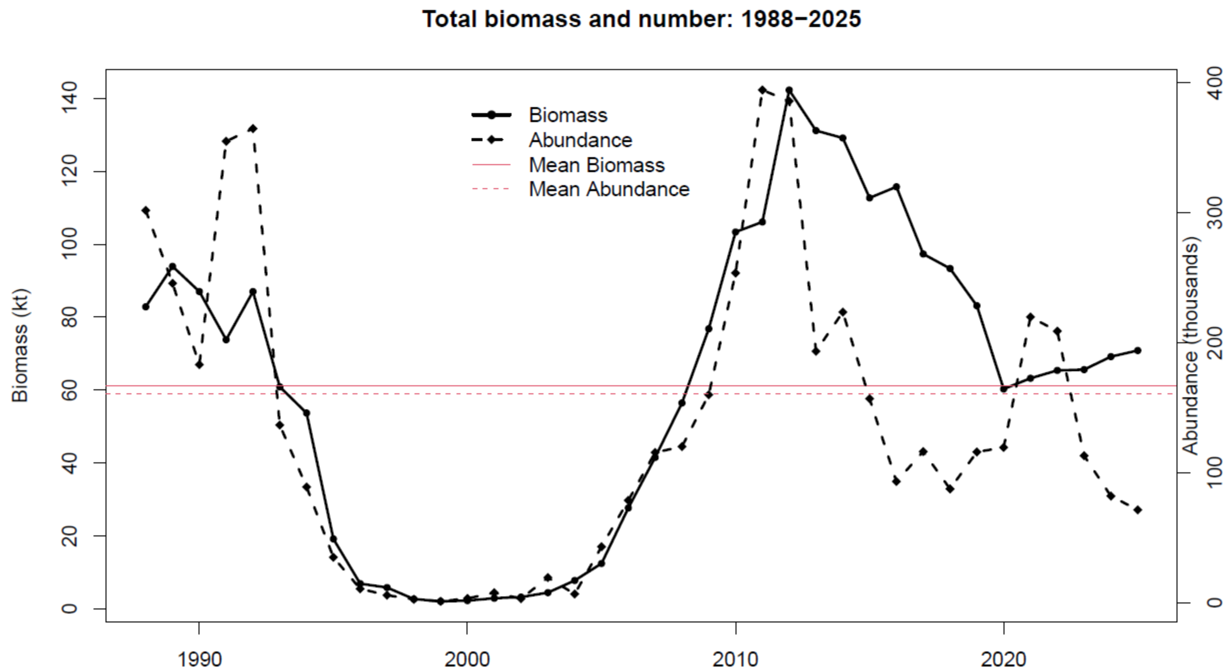


Figure 15. Estimated trends in biomass and abundance. The red lines indicate the means over the whole period.

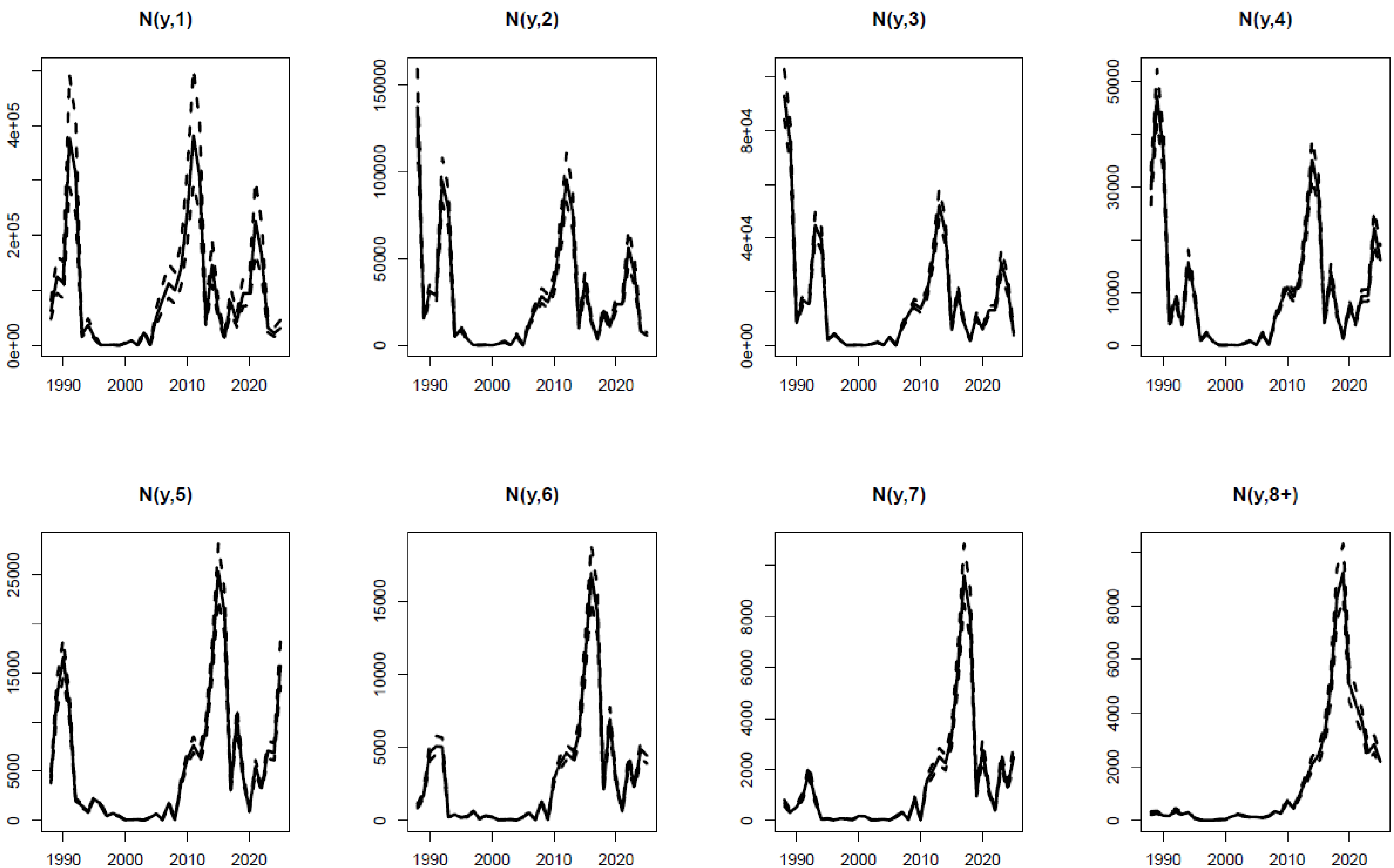


Figure 16. Estimated numbers at age. The y-axis scale is different in all the graphs.

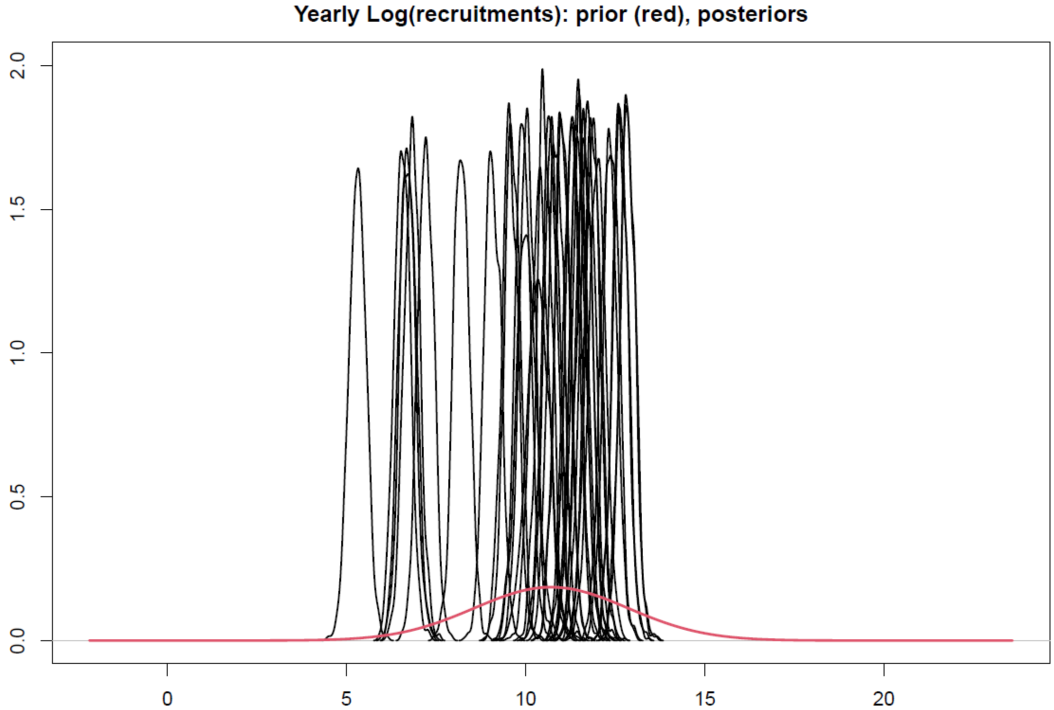


Figure 17. Prior and posterior of recruitment by year.

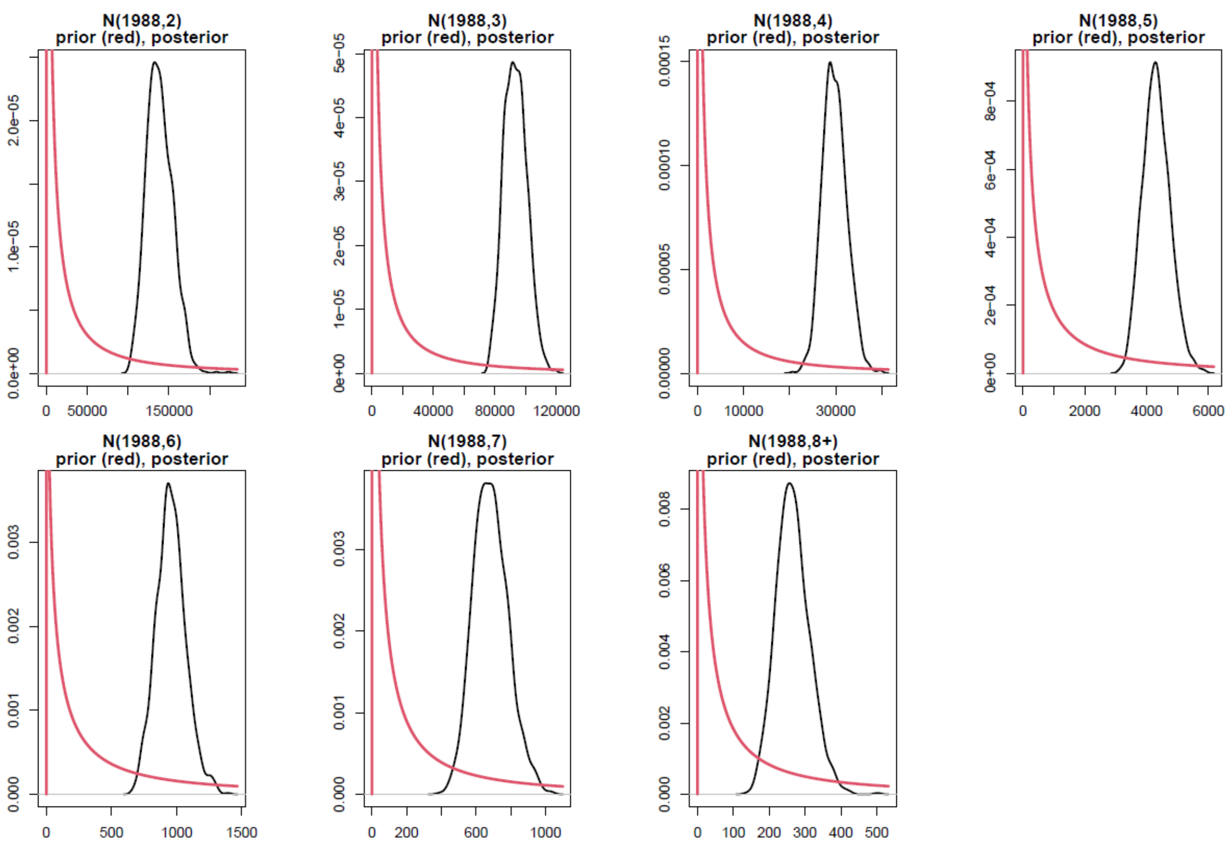


Figure 18. Prior and posterior of the numbers in the first year (1988) from age 2 to 8+.The x- and y-axis scales are different in all the graphs.

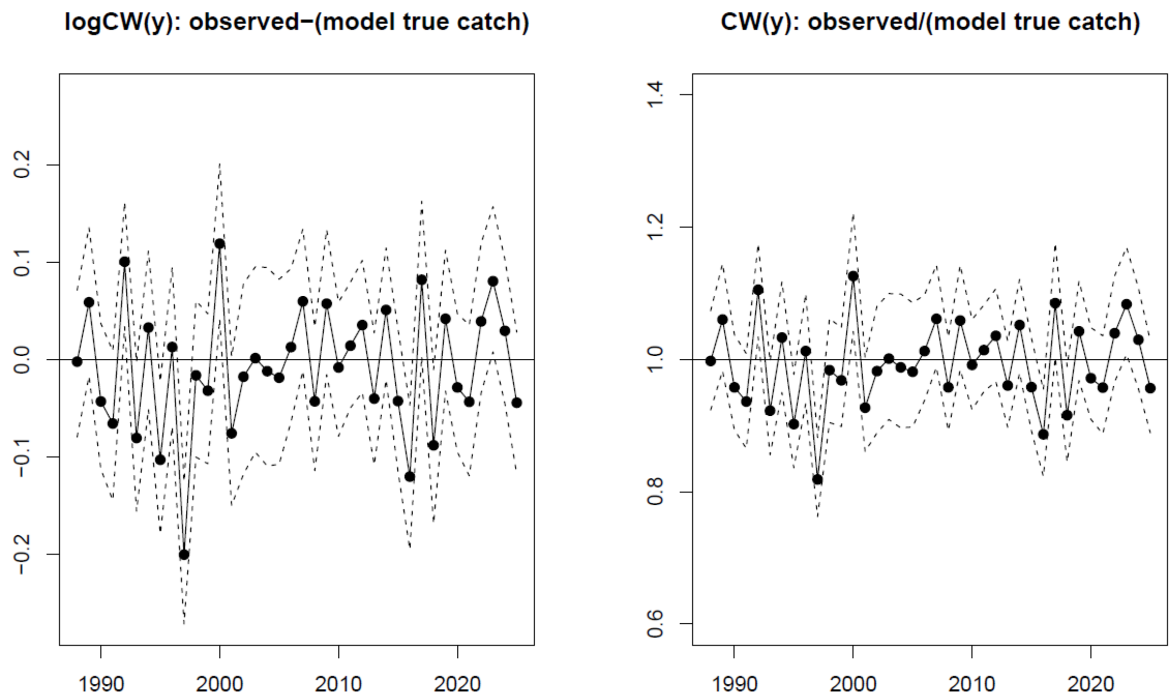


Figure 19. Observed versus estimated total catches by year.

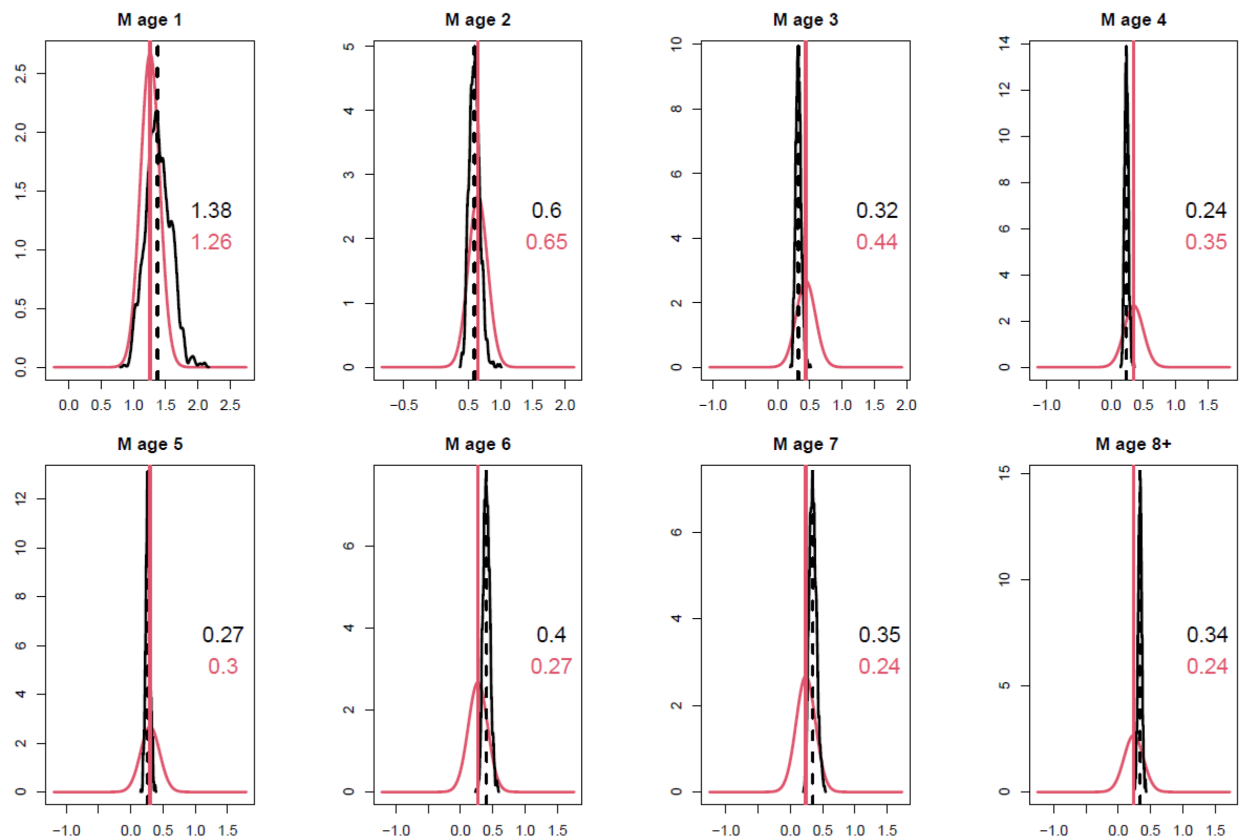


Figure 20. Estimated natural mortality by age in 2025. In red, the prior distribution; in black, the posterior distribution. The numbers inside the graph represent the median value of the distribution in each case.

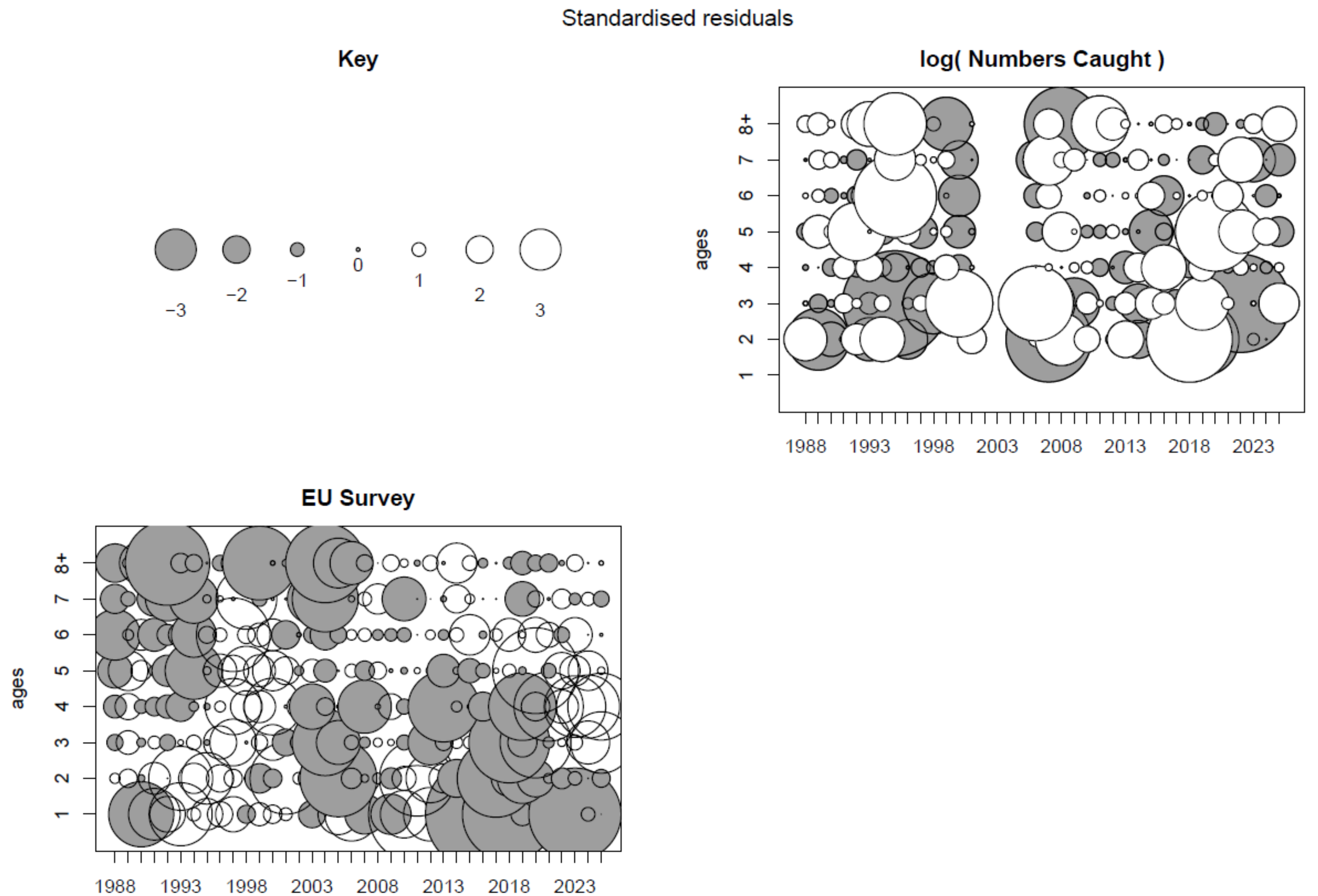


Figure 21. Standardised residuals (observed minus fitted value) in logarithmic scale of catch numbers at age and EU survey abundance indices at age. White and grey values indicate values above and below the average. The larger the bubble size the larger the magnitude of the value.

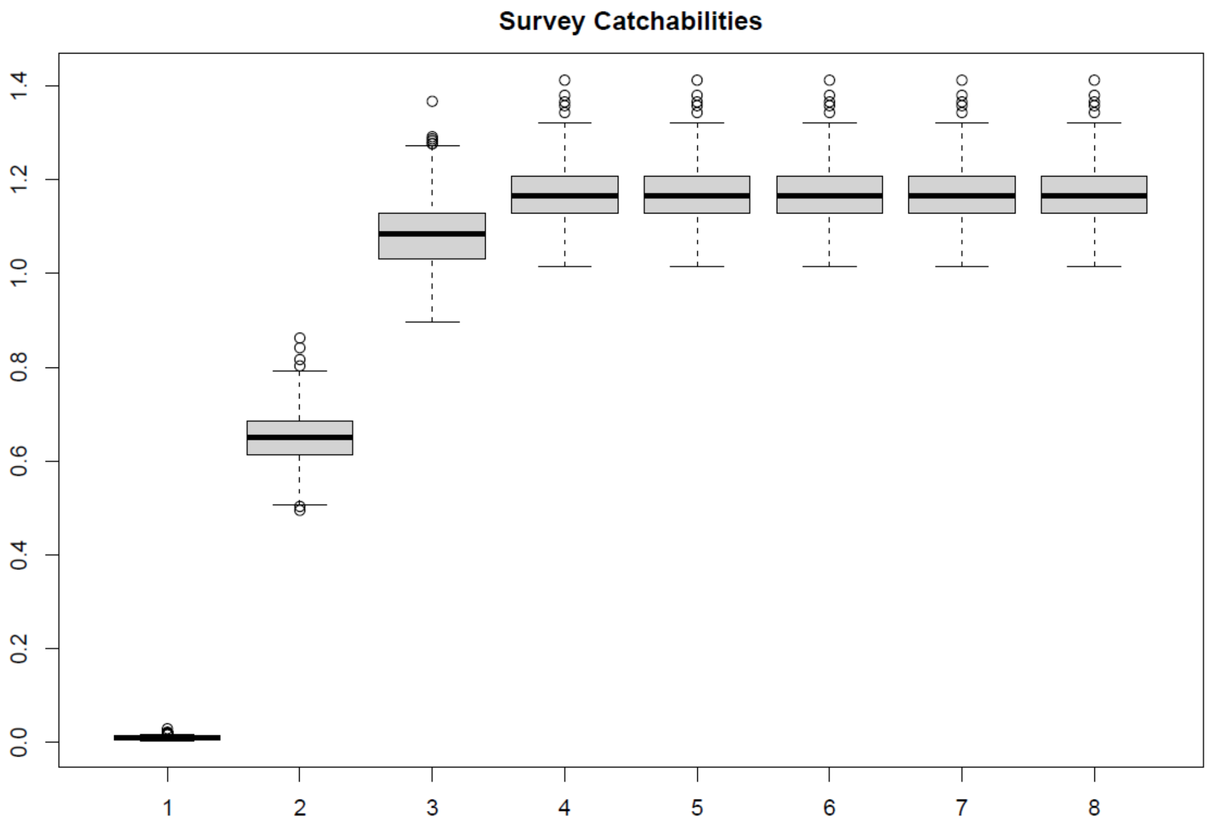


Figure 22. EU survey catchabilities distribution.

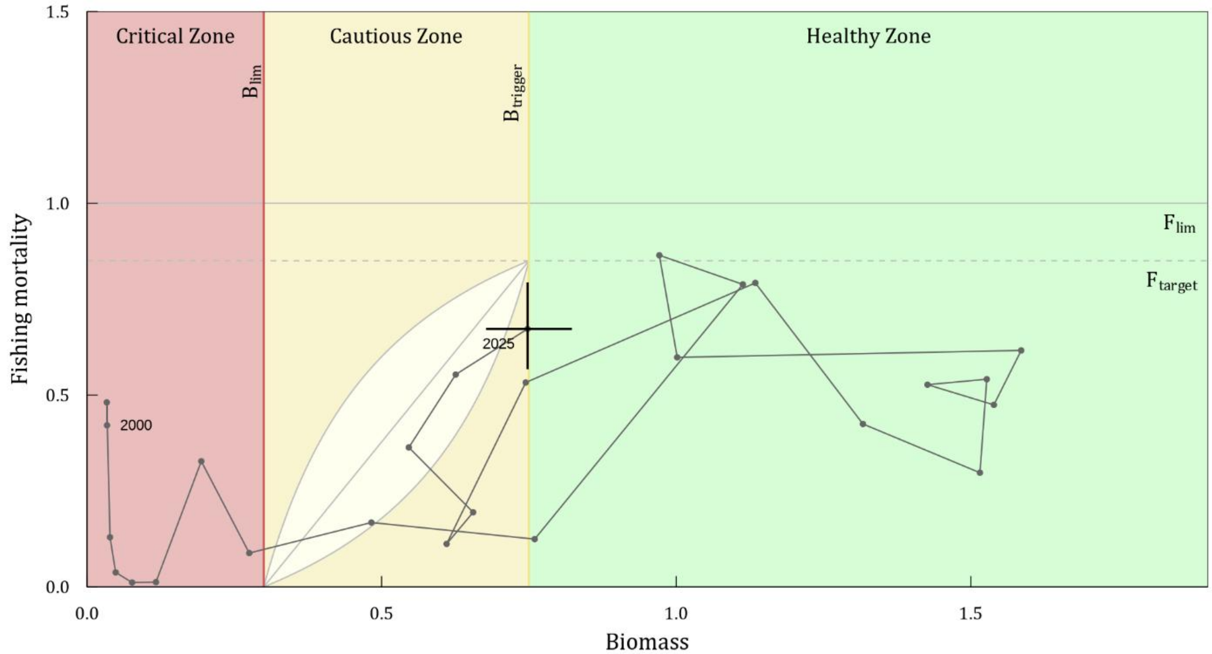


Figure 23. Stock versus F_{bar} plot, including the 3M cod approved reference points in the current NAFO PAF. The 2025 SSB/F_{bar} point includes the confidence intervals. Points plotted are from years 2000-2025.

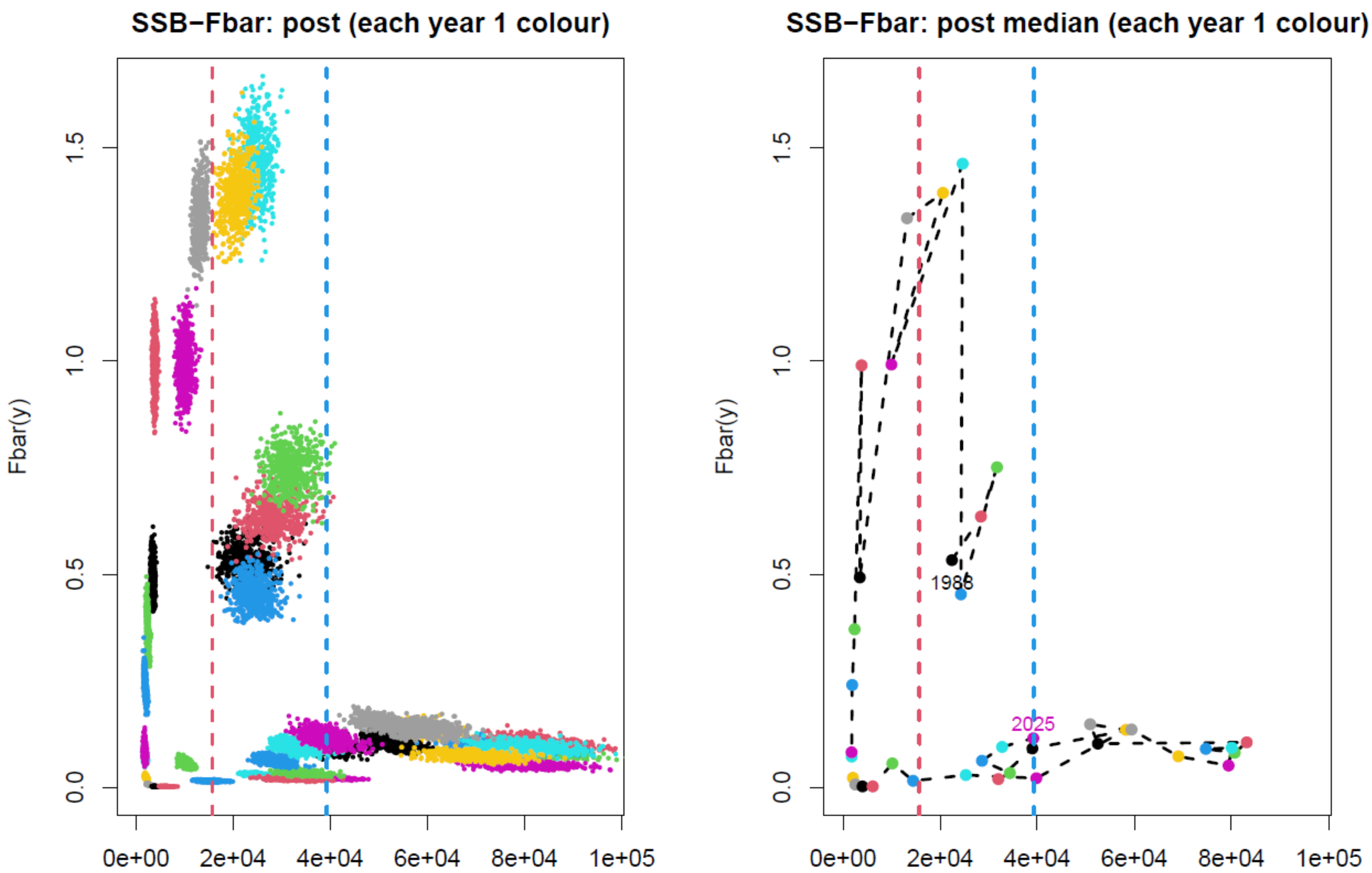


Figure 24. F_{bar} versus SSB plots. The values of B_{lim} = 15 724 t and $B_{trigger}$ = 39 310 are shown as the red and blue vertical lines, respectively.

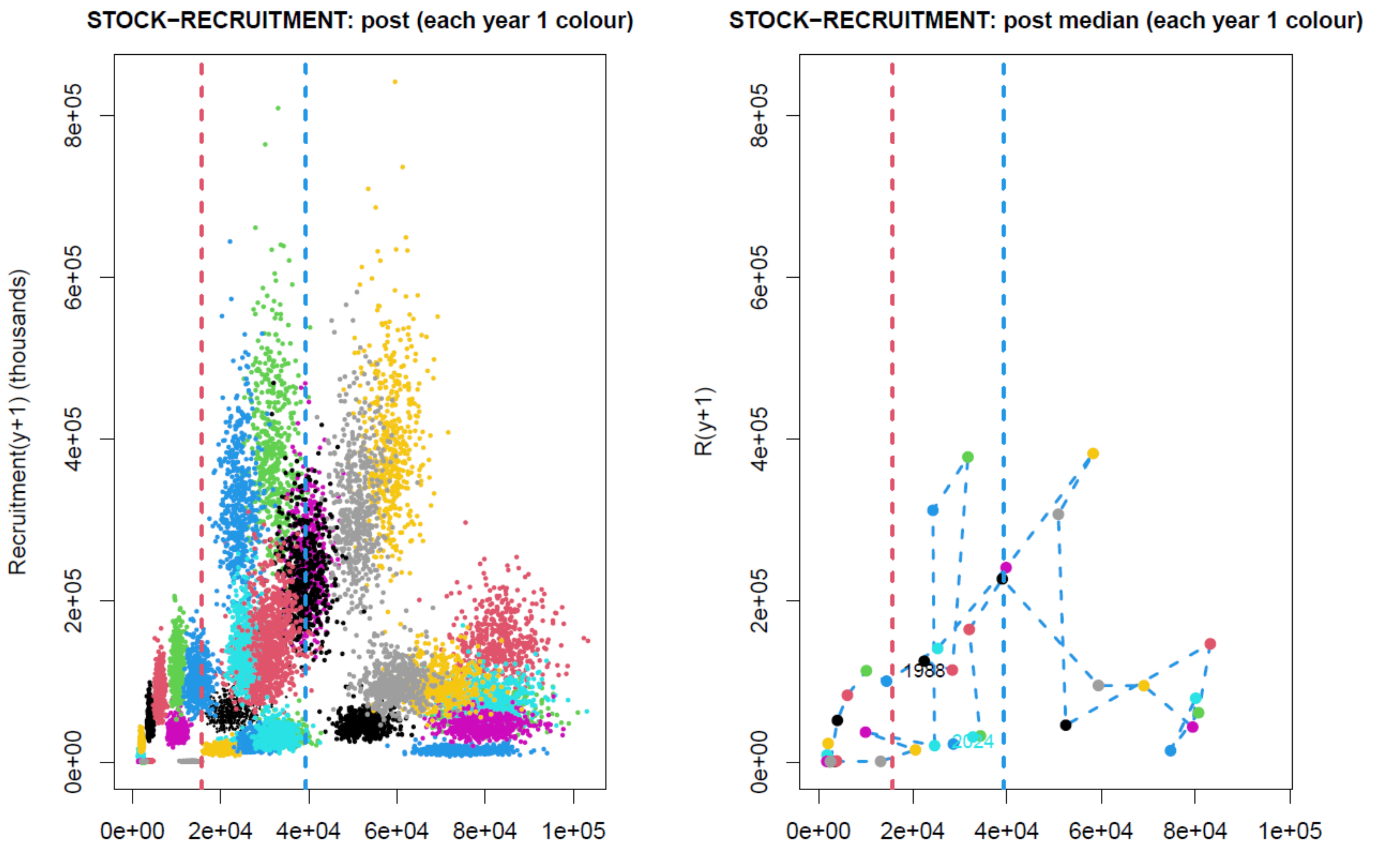


Figure 25. Stock-Recruitment plots. The values of B_{lim} = 15 724 t and $B_{trigger}$ = 39 310 are shown as the red and blue vertical lines, respectively.

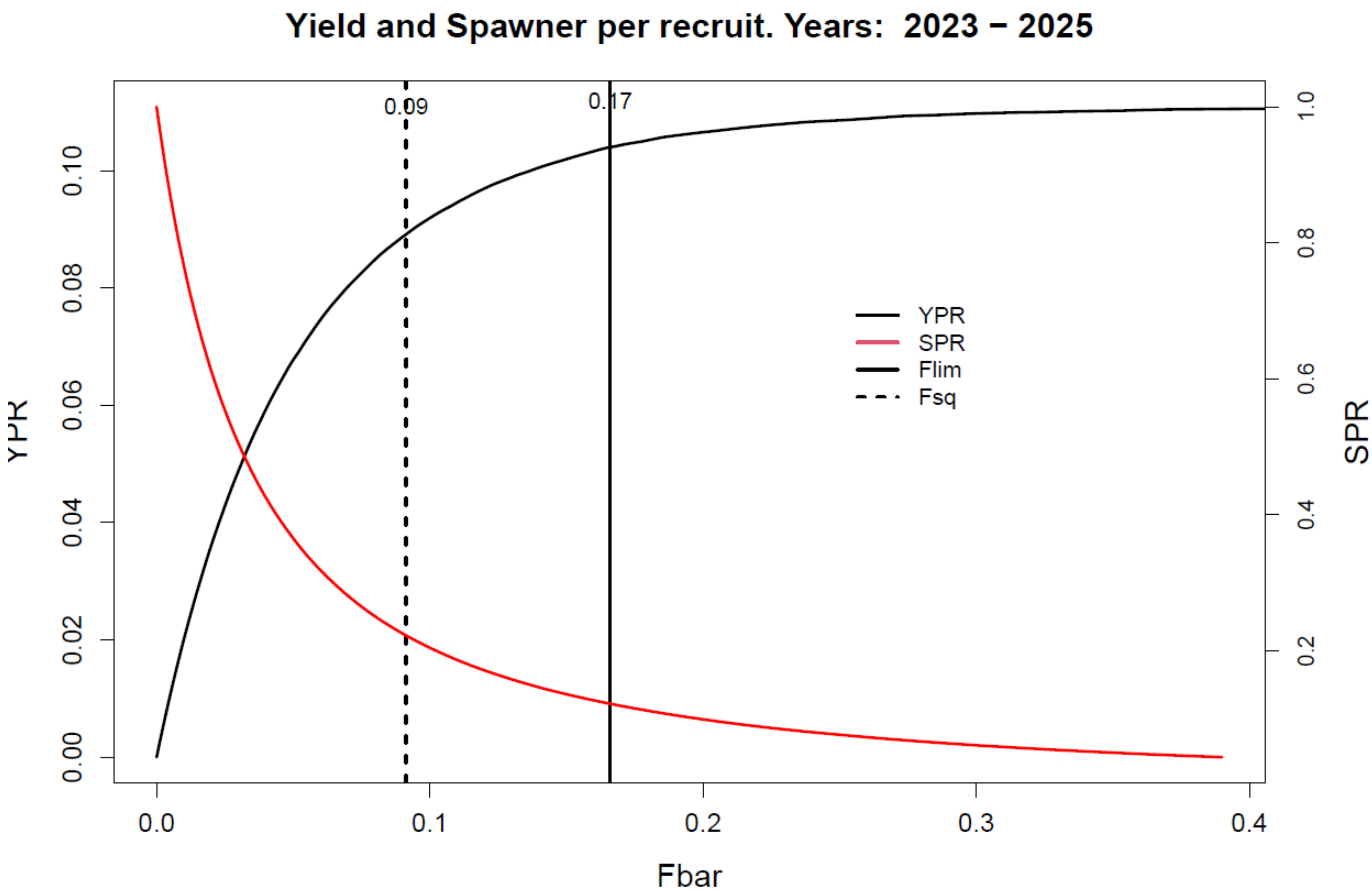


Figure 26. Yield per Recruit and SSB per Recruit (2007-2023) versus F_{bar}. The values of F_{lim} ($F_{30\%SPR}$) and $F_{statusquo}$ (mean F over 2023-2025) are indicated.

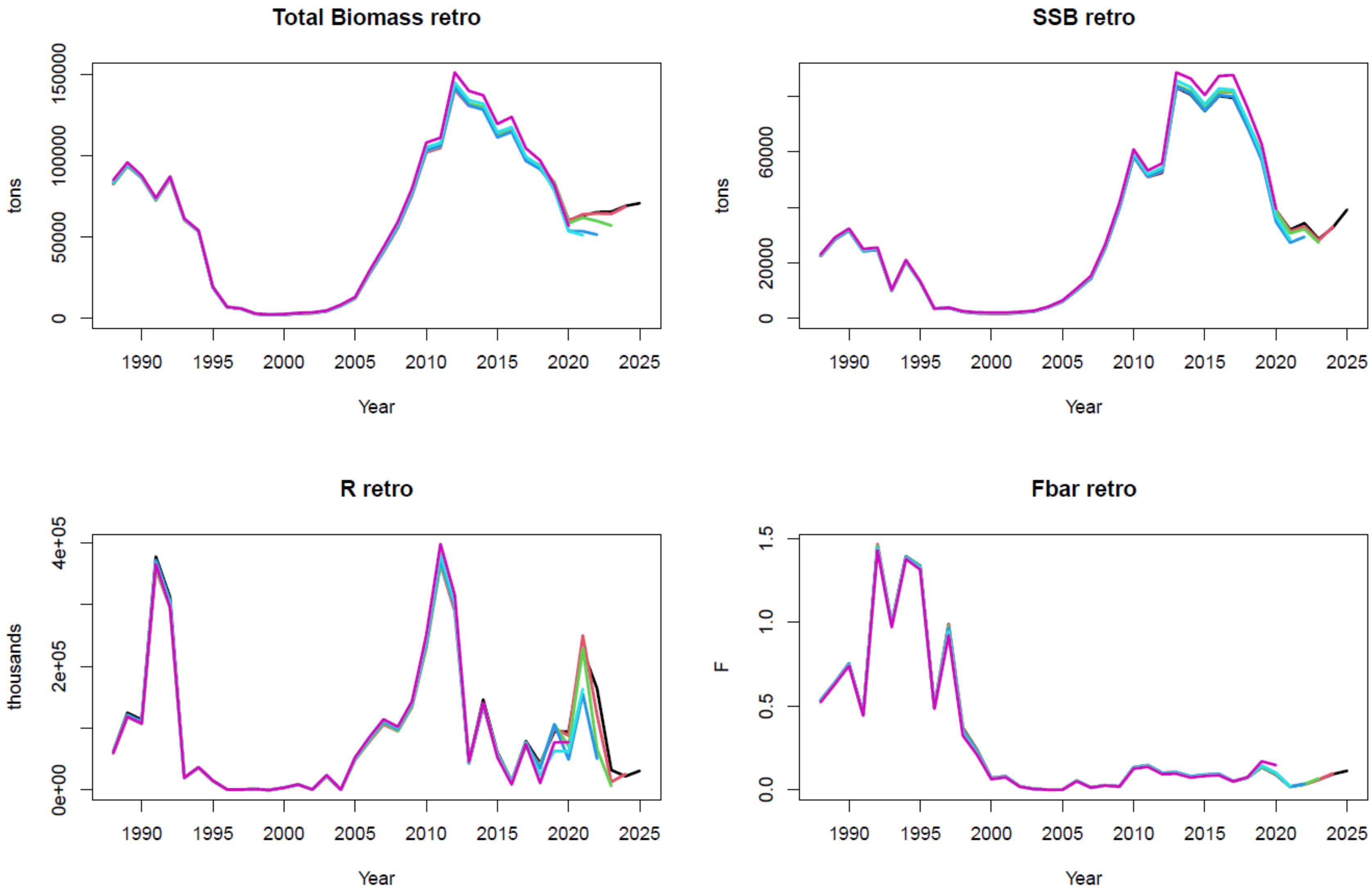


Figure 27. Retrospective patterns.

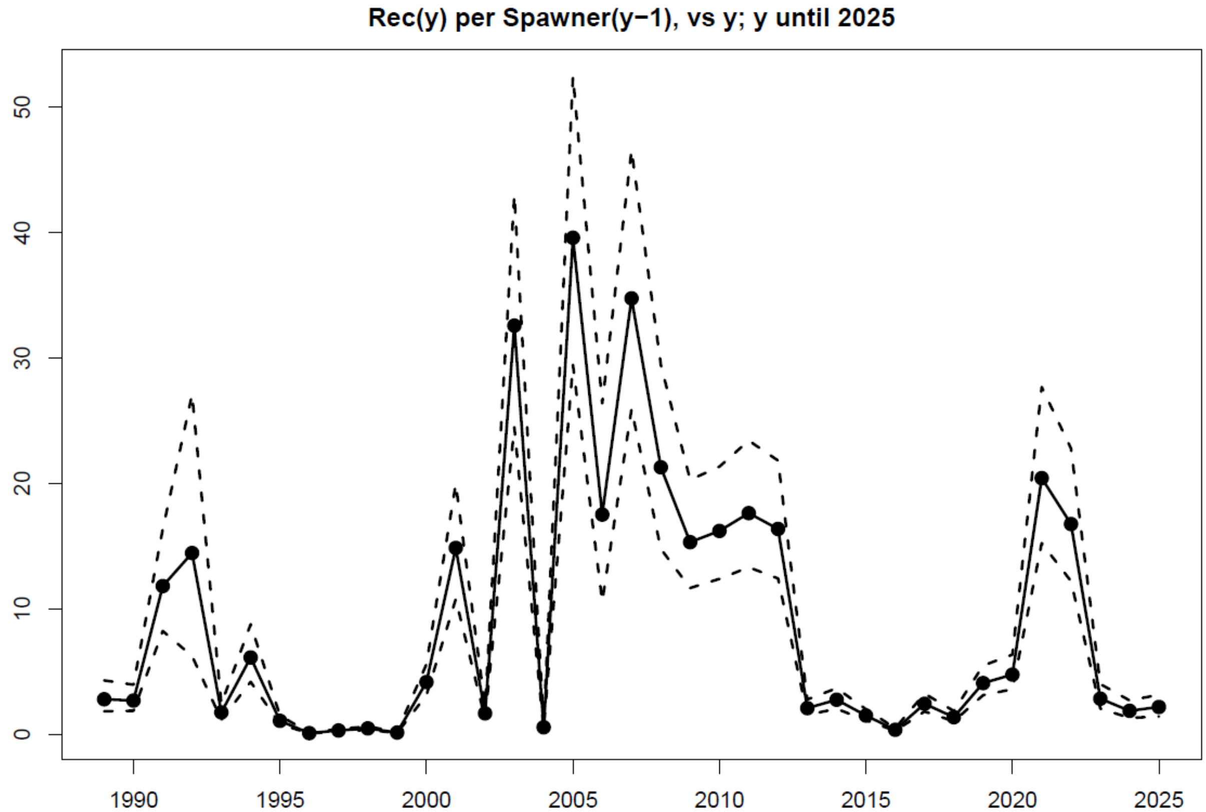


Figure 28. Estimated recruits (age 1) per spawner. First point: R_{1989}/SSB_{1988}.

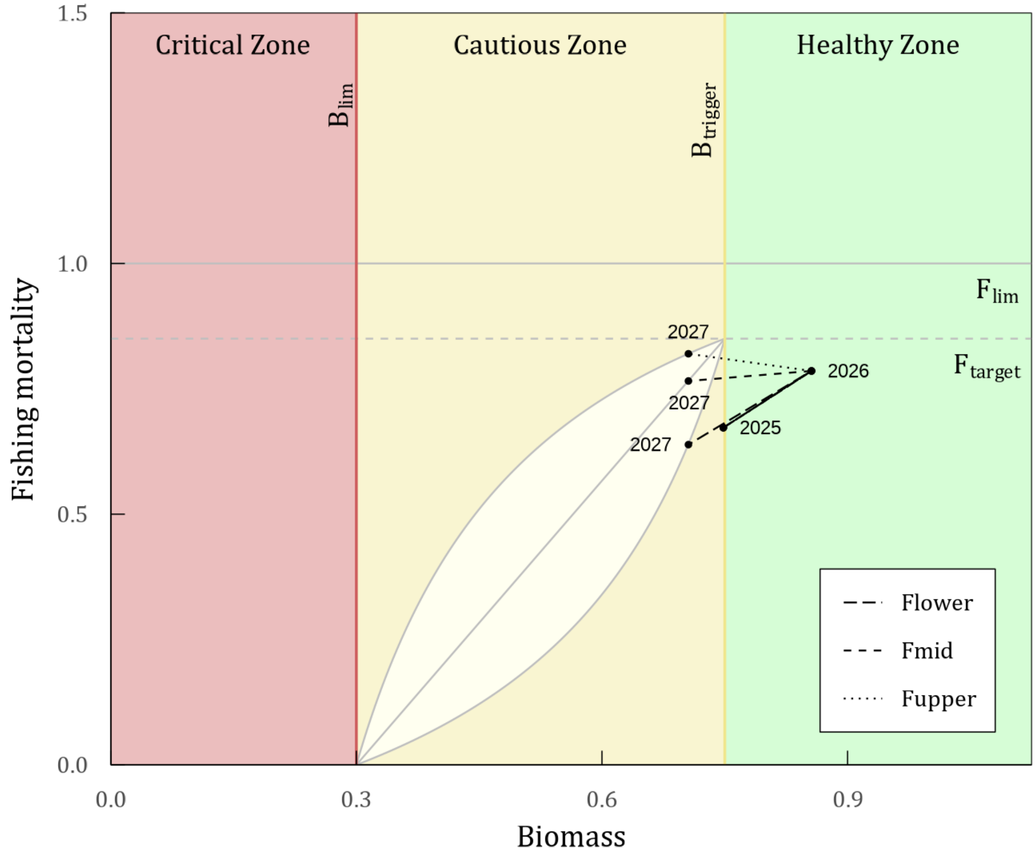


Figure 29. SSB and F_{bar} projections in the PAF leaf for the 3M cod.

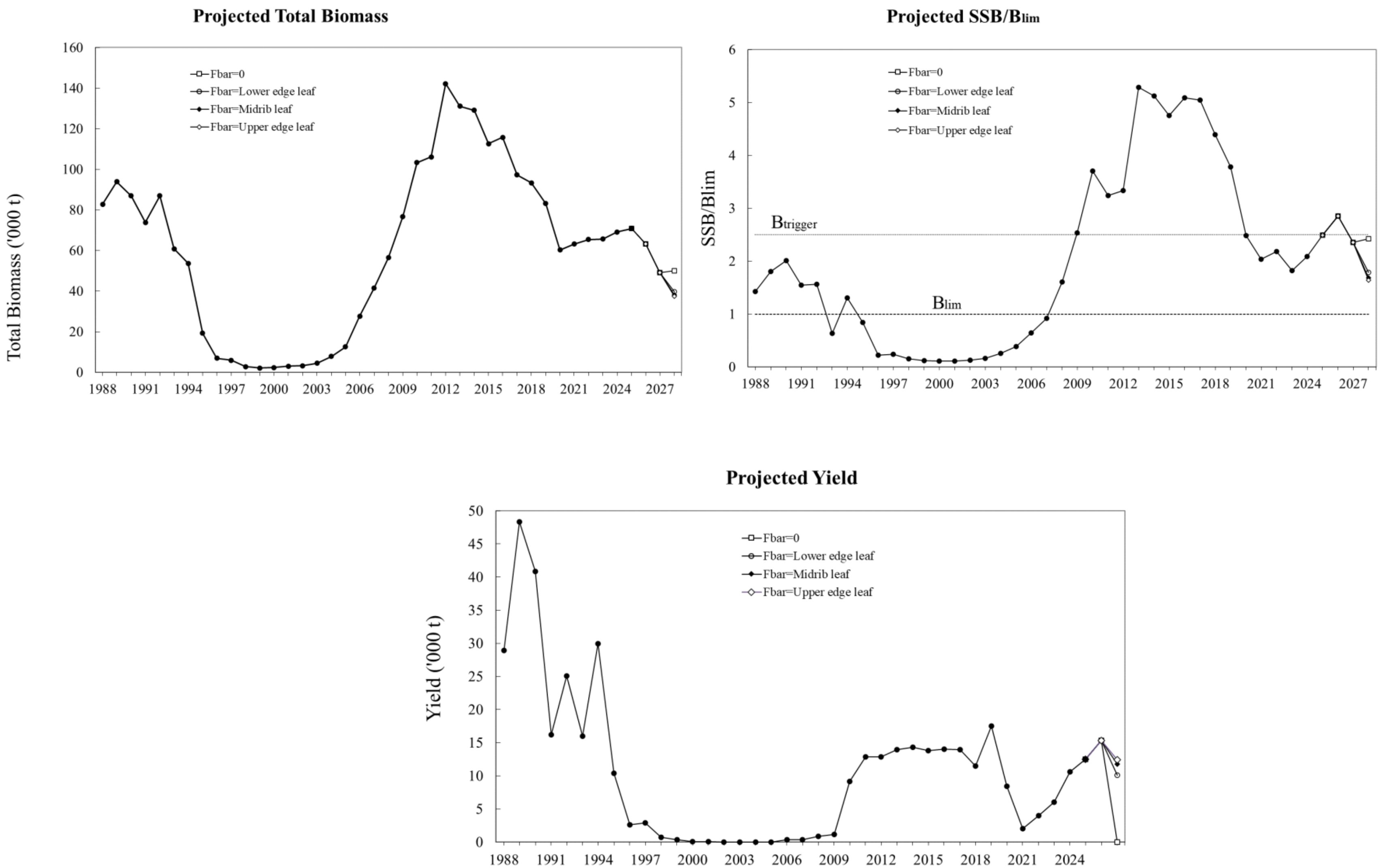


Figure 30. Projections for total Biomass, SSB/B_{lim} and Yield under different F scenarios.

ANNEX I

The settings of the Bayesian SCAA model with ages *a* from 1 to A+ and years *y* from 1 (i.e. 1988) to Y (i.e. 2025) are:

1. **Recruits (age 1) each year**, N[y,1], for y=1,...,Y. The following prior is taken:

$$N[y,1] \sim LogN\ (\ median = medrec, CV = cvrec\ ),$$

- *medrec* and *cvrec* are some suitably chosen values.

2. **Numbers at age in the first year**, N[1,a], for a=2,...,A+. The following priors are taken:

$$N[1,a] \sim LogN\ (\ median = medrec\ \times\ e^{-\sum_{i=1}^{a-1}(M[1,i]+medF\ [i])}, CV = cvyear1\ ), \text{ for } a=2,\ldots,A\text{-}1,$$

$$N[1,A+] \sim LogN\ (\ median = medrec\ \times\ \frac{e^{-\sum_{i=1}^{A-1}(M[1,i]+medF\ [i])}}{1-e^{-\,(M[1,A+]+medF\ [A+])}}, CV = cvyear1\ ) \quad \text{, for } a=A+,$$

- *medF[a]*, a=1,…A+, and *cvyear1* are some suitably chosen values.

3. **Forward population each year and age**, N[y,a], for y=2,...,Y and a=2,...,A+. Standard exponential decay equations:

$$N[y,a]\ =\ N[y-1,a-1]\ e^{-Z[y-1,a-1]} \qquad \text{, for } a=2,\ldots,A\text{-}1,$$

$$N[y,A+]\ =\ N[y-1,A-1]\ e^{-Z[y-1,A-1]} + N[y-1,A+]\ e^{-Z[y-1,A+]} \text{, for } a=A+,$$

$$Z[y,a] = M[y,a] + F[y,a].$$

4. **Fishing mortality is modeled as** *F[y,a]=f[y]*rC[y,a]*, for y=1,…,Y and a=1,…,A+.

   It is assumed that *rC(y,A+) = rC(y,A-1)* and that *rC(y, a=aref) =1*, for a chosen reference age *aref*.

   The factors *f[y]* and *rC(y,a)* are modelled as follows:

   a. ln(*f[y]*) is modeled as an AR(1) process over the years, with autocorrelation parameter *rhof*. The median and CV of the marginal prior distribution of *f[y]* in each year are *medf* and *cvf*, respectively.

   - *rhof* is assigned a Uniform(0,1) prior distribution,
   - *medf* and *cvf* are some suitably chosen values

   b. For each age different from *aref* and A+, ln(*rC[y,a]*) is modeled as random walk over the years, independently from age to age.

   The distribution in the first assessment year (y=1) is:

$$rC[1,a] \sim LogN(median = medrC[a], CV = cvrC[a])$$

   - *medrC[a]* and *cvrC[a]* are some suitably chosen values.

   The distribution in subsequent years (y>1) is given by a random walk in log scale:

$$\ln(\ rC[y,a]\ ) \sim N(mean = \ln(\ rC[y-1,a]\ )\ , CV = cvrCcond)$$

   - *cvrCcond*is a suitable chosen value.

5. **Observation equation for annual commercial total catch in weight**, Cton[y], for y=1,...,Y:

$$Cton[y] \sim LogN\left(median = \sum_{a=1}^{A+} mu.C[y,a] \times wcatch[y,a]\,, CV = cvCW, \right)$$

$$mu.C[y,a] = N[y,a]\left(1 - e^{-Z[y,a]}\right)\frac{F[y,a]}{Z[y,a]}$$ is the standard Baranov catch equation,

- *cvCW* is some suitably chosen value.

6. **Observation equations for commercial catch numbers-at-age**, C[y,a], for each year y, excluding 2002 -2005, and age a=1,…,A+:

$$\ln(\, C[y,a]\,) \sim N(\, mean = \ln(\, mu.C[y,a]\,)\,, CV = psi.C\,)$$

- *psi.C is some suitable value chosen*

7. **Observation equations for survey indices**, CPUE.EU[y,a], y=1,…,Y and a=1,…,A+:

$$\ln(\, CPUE.EU[y,a]\,) \sim N(\, mean = \ln(\, mu.CPUE.EU[y,a]\,)\,, CV = psi.EU)$$

where

$mu.CPUE.EU[y,a]$

$$= phi.EU[a]\left\{N[y,a]\,\frac{\exp(-alpha.EU * Z[y,a]) - \exp(-beta.EU * Z[y,a])}{(beta.EU - alpha.EU) * Z[y,a]}\right\}^{gama.EU[a]}$$

- *alpha.EU=0.50* and *beta.EU=0.58* correspond to the timing of the survey (July),
- *psi.EU is some suitable value chosen*

Prior on *phi.EU[a]*:

$$\ln(\, phi.EU[a]\,) \sim N(\, mean = medlogphi, \frac{1}{variance} = taulogphi\,),$$

- *medlogphi* and *taulogphi* are some suitably chosen values,

Prior on*gama.EU[a]*:

For ages *a* in the set*adep*, *gama.EU[a]*= 1, whereas for other ages *a*:

$$gama.EU[a] \sim N(\, mean = medgama, \frac{1}{variance} = taugama)$$

- *medgama* and *taugama*are some suitably chosen values

8. **Natural Mortality** is assumed to be age-dependent but the same in all years, i.e.*M[y,a]=M[a]*, a=1,…,A+, with the following prior distribution by age:

$$\ln(M[a]\,) \sim N(\, mean = \ln(medM[a]), CV = cvM)$$

- *medM* and *cvM* are some suitably chosen values