NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N6064 **NAFO SCR Doc. 12/037**

SCIENTIFIC COUNCIL MEETING – JUNE 2012

Assessment of the Cod Stock in NAFO Division 3M
by

Diana González-Troncoso[1], Carsten Hvingel[2], Antonio Vázquez[3] and Fran Saborido[3]

[1] Instituto Español de Oceanografía,
[2]
[3] Instituto de Investigaciones Marinas

Abstract

An assessment of the cod stock in NAFO Division 3M is performed. A Bayesian model, as used in the last assessments, was used to perform the analysis. As there are inconsistencies with total catch of last year, a prior was added for 2011 catch. Results indicate a fairly substantial increase in SSB, reaching a value well above B_{lim}. The six-years retrospective plot shows that the recruitment is overestimated every year. Three year projections indicate that fishing at the $F_{statusquo}$ level should allow SSB to increase slowly, although abundance will remain at levels below those observed at the beginning of the series. If the fishing mortality were return to the levels seen before 1995, stock recovery would become improbable.

Introduction

This stock had been on fishing moratorium since 1999 to 2009 following its collapse, which has been attributed to three simultaneous circumstances: a stock decline due to overfishing, an increase in catchability at low abundance levels and a series of very poor recruitments starting in 1993. The assessments performed since the collapse of the stock confirmed the poor situation, with SSB at very low levels, well below B_{lim} (Vázquez and Cerviño, 2005). Nevertheless, Spawning Stock Biomass (SSB) was estimated to increase a bit in 2004, 2005 and 2006 (Fernández, *et al.*, 2007) and above average recruitment levels were estimated for 2005 and 2006. Another large increase in SSB in 2007-2009, largely due to the recruitments in 2005-2006, has happened, reaching in 2010 the highest value of the studied series (González-Troncoso and Vázquez, 2011).

Since 1974, when a TAC was established for the first time, estimated catches ranged from 48 000 tons in 1989 to a minimum value of 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. Since 1998 yearly catches have been less than 1 000 tons and from 2000 to 2005 they were under 100 tons, mainly attributed to by-catches from other fisheries. Estimated commercial catches in 2006, 2007, 2008 and 2009 are 339, 345, 889 and 1 161 tons (Table 1 and Figure 1), respectively, which represent more than a ten-fold increase over the average yearly catch during the period 2000-2005. The results of the 2009 assessment led to a reopening of the fishery with 5 500 tons of catch in 2010. With the results of the 2010-2011 assessments TACs of 10 000 tons in 2011 and 9 280 tons in 2012 were established. The estimated catch by the Scientific Council for 2010 was 9 291 tons, which almost double the TAC. In 2011 there are not available estimated catches by the Scientific Council. The STATLANT 21A catch was 9 794.

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, most recent catches 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 has been used to assess the stock since 2003. In 2007 results from an alternative Bayesian model were also presented (Fernández *et al.*, 2007) and in 2008 this Bayesian model was further developed and approved by the NAFO SC (Fernández *et al.*, 2008).

An assessment of this stock using the Bayesian model used last years is presented. A B_{lim} of 14 000 tons was proposed by the NAFO Scientific Council in 2000. The appropriateness of this value given the results from the new method used to assess the stock was examined in 2008, concluding that it is still an appropriate reference.

Material and Methods

Used data

Commercial data

Length distributions

In 2010 length sampling of catch was conducted by Canada (SCS 12/14), Estonia (SCR 12/06), Lithuania (*pers. com.*), Norway (*pers. com.* from Canada), Portugal (SCR 12/08), Russia (SCS 12/05), Spain (SCS 12/09) and UK (*pers. com.*). Length frequency distributions from the commercial catch and from the EU survey (Vázquez, 2012) are shown in Figure 2.

Canada has measured a total of 2195 individuals with a no clear mode, being the range of 62-93 cm the most caught. The total range caught was 35-123 cm. Estonia has measured 1298 individuals, with modal lengths 50 and 60 cm and a range of 25-130 cm. Lithuania has measured 398 individuals. This length distribution is bimodal at 44 and 48 cm, and has another smaller mode at 60 cm. with a range of 18-91 cm. Norway has a 1298 individuals sample in a range of 50-129. The modal range is 65-73. The number of sampled individuals for Portugal was 18540, the highest sample. The mode of this length distribution is at 54 cm, with a smallest mode at 45 cm and a range of 15-114 cm. For Russia the number of measured individuals was 998 in a range of 21-127 cm. The mode was at 63 cm. Spain had two different types of vessel in 2011 fishing cod in 3M, a trawl vessel and a twin trawl vessel. The sampled length distributions were taking into account separately. For the trawl vessel there are 1788 individuals measured in a range of 20-120 cm. the mode was at 64 cm. For the twin trawl vessel a total of 1071 individuals were measured in a range of 49-123 cm. The length distribution has a no clear mode, being most in the range 67-92 cm. And there are 8805 individuals measured for UK in a range of 34-138 cm, the higest measure in the total catch. With a no clear trend, the most fished range was 87-95 cm. The EU survey has a well-defined mode around 15 cm, following with another mode in 27. The range is from 3 to 105 cm.

Catch-at-age

Catch-at-age is presented in Table 2. As no age-length keys (ALK) were available for commercial catch from 1988 to 2008, each year the corresponding ALKs from the EU survey were applied in order to calculate annual catch-at-age. A commercial ALK was available for 2009-2011 for the Portuguese commercial data and was applied to the total commercial length distribution. In 2011, as no consistent catch is available, the percentage of each age is presented.

The range of ages in the catch goes 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.

Figure 3 shows a bubble plot of catch proportions at age over time (with larger bubbles corresponding to larger values), indicating that the bulk of the catch (including 2011 catch) is comprised of 3-5 years age cod. In years 2006 and 2009, catches containing mostly age 4 individuals. In 2007 there has been much more spread over the ages, and in 2008 the greatest presence was ages 2 to 4.

Figure 4 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. It is remarkable the recruitment (age 1) in the year 2010, that is the highest positive value in the series, following for the 2011 value.

Mean weight-at-age

Mean weight-at-age has been computed separately for the catch and for the stock, using length-weight relationships from the Portuguese commercial sampling and from the EU survey, respectively. Both are presenting in Figure 5. There are no significant differences between both. The Portuguese length-weight relationship was applied to the commercial data to calculate weight-at-age in the catch. Results are showed in Table 4.

The SOP (sum over ages of the product of catch weight-at-age and numbers at age) for the commercial catch only differs in 1.7% from the estimated total catch.

Survey data

The EU bottom trawl survey of Flemish Cap has been carried out since 1988, targeting the main commercial species down to 730 m of depth. The surveyed zone includes the complete distribution area for cod, 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. 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 1988-2011 are present in Vázquez, 2012.

Survey indices of abundance at age are presented in Table 3. Figure 6 displays the estimated biomass and abundance indices over time. Biomass and abundance show a high increase since 2005, higher in biomass than in abundance except for 2011, following an extremely low period starting in the mid 1990's. The large number in 2011 is due to a big presence of individuals of age 1. It must be noted that 2009-2010 biomass is at the level of the first years of the assessment but abundance in these years is roughly the same as in 1994. In 2010 the biomass has suffered a bit decrease, probably due to the opening of the fishery, but a new huge increase can be seen in 2011, reaching a value very near the highest of the series, that occurred in 1989. 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 onwards appear to be above average, especially 2011 one.

Mean weight-at-age in the stock shows a strong increasing trend since the late 1990's, although in 2008 all the ages decreased their mean weight-at-age, but still remain higher than at the beginning of the series. In 2009 youngest and oldest ages increased theirs mean weight-at-age with respect to 2008, while the ages 3-4 decreased them (see Table 5 and Figure 8). In 2011 all ages except 4 and 8+ decreased their mean weight-at-age with respect to 2009-2010.

Maturity at age

Maturity ogives from the EU survey are available for years 1990-1998, 2001-2006 and 2008-2011. For those years logistic regression models for proportion mature at age have 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. The median of the maturity ogives for the whole period are presented in the Table 6. It can be seen that the percentage of matures in each age decreased since 2010. This fact, together with the decreasing mean weight at age, is consistent with a stock in a recovery process, whit a slower growth and maduration.

Figure 9 displays the evolution of the a50 (age at which 50% of fish are mature) through the years (estimate and 90% uncertainty limits). The figure shows a continuous decline of the a50 through time, from above 5 years old in the late 1980's to just above 3 years old since about 2000. Since 2005 the a50 has increased slowly, especially in 2011, reaching 4.25 years old.

Assessment methodology

The Bayesian model used last years was updated with 2011 data. For years with catch-at-age data, it works starting from cohort survivors and reconstructing cohorts backwards in time using catch-at-age and the assumed mortality rate. When catch-at-age is not available for a year but an estimate of total catch in weight is available, this information can be incorporated in the model by means of an observation equation relating (stochastically) the estimated catch weight to the underlying population abundances (hence aiding in the estimation of fishing mortalities). An advantage of the model is that it allows combining years with catch-at-age and years where only total catch is available. Years with no information on commercial catch are also allowed. A detailed description of the model is in Fernandez *et al.*, 2008. The priors were chosen this year as last assessment.

This year there is a lack of information because estimated catch by the Scientific Council is not available and the available figure (from the STATLANT 21A) is no consistent with 2010 catch. For this reason, Scientific Council decided to incorporate a new prior for the total catch in 2011. *The effort in the major fleets has increased 40% approximately regarding 2010 effort* and the 2010 catch was 9 192 tons, so it was decided to fit a prior to 2011 catch with a median value of approximately 12 800 tons and a standard deviation that allows the catch to move between 9 905 and 16 630 tons (95% confidence interval). The chosen prior was a lognormal.

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

Catch data for 23 years, from 1988 to 2010

For 2011: $TotalCatch(2011) \sim LN(median = 9.46, sd = 0.1313)$

Years with catch-at-age: 1988-2001, 2006-2011

Tuning with EU survey for 1988 to 2011

Ages from 1 to 8+ in both cases

Catchability analysis

Catchability dependent on stock size for ages 1 and 2

Priors over parameters:

Priors over the survivors:

For (2011, a), a=1,…,7 and (y, 7), y=1988,…, 2010

$$surv(y,a) \sim LN\left(median = medrec \times e^{-medM - \sum_{age=1}^{a} medFsurv(age)}, cv = cvsurv\right),$$

where medrec=15000

medFsurv(1,…,7)={0.0001, 0.1, 0.5, 0.7, 0.7, 0.7, 0.7}

cvsurv=1

Prior over F for years with no catch-at-age:

For a=1,…,7 and y=2002,…,2005

$$F(y,a) \sim LN\left(median = medF(a),\ cv = cvF\right)$$

where medF=c(0.0001, 0.005, 0.01, 0.01, 0.01, 0.005, 0.005)

cvsurv=0.7

Prior over the total catch in the years with no catch-at-age data:

For y=2002,…,2005

$$CW(y) \sim LN\left(median = CW_{\text{mod}}(y),\ cv = cvCW\right)$$

where CW_{mod} is arised from the Baranov equation

cvCW=0.05

Prior over the EU survey abundance at age indices:

For a=1,…,8 and y=1988,…,2011

$$I(y) \sim LN\left(median = \mu(y,a),\ cv = \sqrt{e^{\frac{1}{\psi(a)}} - 1}\right)$$

$$\mu(y,a) = q(a)\left(N(y,a)\frac{e^{-\alpha Z(y,a)} - e^{-\beta Z(y,a)}}{(\beta-\alpha)Z(y,a)}\right)^{\gamma(a)}$$

$$\gamma(a)\begin{cases} \sim N(\text{mean} = 1, \text{variance} = 0.25),\ if\ a = 1,2 \\ = 1,\ if\ a \geq 3 \end{cases}$$

$$\log(q(a)) \sim N(\text{mean} = 0, \text{variance} = 5)$$

$$\psi(a) \sim gamma(shape = 2, rate = 0.07)$$

where I is the EU survey abundance index

q is the survey catchability at age

N is the commercial abundance index

$\alpha = 0.5$, $\beta = 0.58$ (survey made in July)

Z is the total mortality

Prior over natural mortality, M:

$$M \sim LN(\text{median} = 0.218, cv = 0.3)$$

In 2008 STACFIS recommended *that retrospective analysis be performed as a standard diagnostic of the assessment with the Bayesian model*. So, six year retrospective plot was made.

Three years projections were made with six different scenarios, as later described, in order to see the possible evolution of the stock. The settings and the results are explained above.

Results

Assessment results regarding to total biomass, SSB, recruitment and F_{bar} (ages 3-5) are presented in Table 7 and Figure 10. The SSB graph also includes the expected value at the beginning of the year 2012. To calculate it, weight-at-age and maturity-at-age random draws from the three last years with data were used (assuming always that maturity at age 1 is equal to 0, as there is no estimate of recruitment in 2011). The results indicate that there has been a substantial increase in SSB in the last few years, with the largest increase occurring from 2007 onwards. SSB in 2009 (and even its confidence intervals) are well above B_{lim}, and in 2011 is the highest value of the time series. The SSB at the beginning of 2012 is expected even above this value, although the uncertainty associated with this value is very high. It must be taking into account that to calculate this value the mean of the last three years maturity was used, but as the age of first maturation is decreasing it is expected that next year this value will remain at similar levels of 2011 value.

Recruitment in 2005-2011 have been above the mean of the period, although the actual recruitment levels for these years can not yet be precisely estimated (wide uncertainty limits in Figure 10 and Table 7). 2010-2011 recruitments are at the level of the first years assessment, only below the two strong year classes of 1990 and 1991.

F_{bar} (mean for ages 3-5) has been at very low levels in the period 2001-2009 (Figure 10), although an unusual high value has been estimated for 2006. In 2010, when the fishery was reopen, the F_{bar} has increased up to 0.29, although the 5 500 tons TAC corresponded to a target F_{bar} around 0.14 was established. In 2011, with a TAC of 10 000 tons corresponding to a target F_{bar} around 0.13, a F_{bar} of 0.33 was estimated. Table 8 and Figure 12 provide more detailed information on the estimated F-at-age values, indicating that the increase in F_{bar} in 2006 is mostly due to fishing mortality at age 3. In 2010 the highest fishing mortalities are in ages 4 and 6 and in 2011 in 5-8+.

Figure 11 shows total biomass and abundance by year. Except in the first years of the assessment, there is a good concordance between numbers and weight, although in last years biomass has increased more than abundance. It must be noted that, although SSB is in 2010 at the level of the beginning of the time series (Figure 10), total biomass and abundance have not reached yet the first years analysed level.

Estimates of stock abundance at age for 1988-2012 are presented in Table 9 and Figure 13. Abundance at age in 2012 are the survivors of the same cohort in 2011, the last assessment year, so only abundances of ages older than age 1 can be estimated.

Figure 14 depicts the prior and posterior distributions of survivors at age at the end of the final assessment year, where by survivors(2011, a) it is meant individuals of age a + 1 at the beginning of 2012 (in other words, survivors(2011, a) = N(2012, a + 1)). The plotting range for the horizontal axis is the 95% prior credible interval in all cases, to facilitate comparison between prior and posterior distributions; the same procedure will be followed in all subsequent prior-posterior plots. Except for ages 3 and 4, there has been very substantial updating of the prior distribution for survivors.

Figure 15 displays prior and posterior distributions for survivors of the last true age at the end of every year. By survivors(y, 7) it is meant individuals of age 8 (not 8+) at the beginning of year y + 1. Whereas the prior distribution is the same every year, posterior distributions vary substantially depending on the year, displaying particularly low values between 2002 and 2005 and in years 2008 and 2010.

In Figure 16 the prior and posterior for the total catch in 2011 is shown. Although there is a small update of the total catch, with a posterior value a little greater than the prior value, the update is no important.

Bubble plot of raw residuals (observed minus fitted values) for the EU survey abundance indices at age (in logarithmic scale) is presented in Figure 17. No obvious trends over time or any other particular patterns emerge from the residuals plot.

Bubble plot of standardised residuals (observed minus fitted values divided by estimated standard deviations and in logarithmic scale) for the EU survey abundance at age indices is displayed in Figure 18. As the residuals have been standardised, they should be mostly in the range (—2, 2) if model assumptions about variance are not contradicted by the data. This graph should highlight year effects, identified as years in which most of the residuals are above or below zero. In 1988 all residuals are negative except for the one for age 7, whereas the opposite happens in 1996 and 1997, suggesting year effects (i.e. survey catchabilities that are below average in 1988 and above average in 1996 and 1997). All residuals were positive in 2008-2010 except for ages 1 in 2008, 1 and 2 in 2009 and 5 and 7 (this last value is almost 0) in 2010. In 2011 all the standardized residuals are positive.

Biological Referent Points

Figure 19a shows a SSB-Recruitment plot and Figure 19b a SSB-F_{bar} plot, both with the 14 000 value of B_{lim} indicated with a vertical red line. The value of B_{lim} appears as a reasonable choice for B_{lim}: only low recruitments have been observed with SSB below this level whereas both high and low recruitments have been seen at higher SSB values. SSB is well above B_{lim} in 2011. In Figure 19a, we can see a very high uncertainty in the recruitment of year 2011. Figure 20 shows the Bayesian Yield per Recruit with respect to F_{bar}, in which the estimated values for $F_{0.1}$ (0.13), F_{max} (0.16) and F_{2010} (0.34) are indicated.

Retrospective pattern

A retrospective analysis of six years was made (Figure 21). Recruitment and biomass are over estimated year by year. SSB was over estimated in 2009 and 2010. No patterns are observed for F_{bar}.

Projections

Stochastic projections over a three years period (2013-2015) have been performed. The 2012 data were included in the tables in order to compare the results. Variability of input data was taken from the results of the Bayesian assessment. Input data were as follows:

Numbers aged 2 to 8+ in 2012: estimates from the assessment

Recruitments for 2012-2015: Recruits per spawner were estimated for each year (Figure 20). As the variability over the years of the assessment is very high, using just the last 3 years was not considered realistic. Hence, in the projections, recruits per spawner were drawn randomly from all years (1988-2011).

Maturity ogive: Drawn randomly from the maturity ogives (with their associated uncertainty) of the last three years of the assessment (2009-2011).

Weight-at-age in stock and weight-at-age in catch: Drawn randomly from the last 3 years (2009-2011) (Tables 4 and 5).

PR at age for 2012-2015: There are only two years of open fishery, so the PR was calculated as the mean of the PR of these two years (2010-2011).

F_{bar}(ages 3-5): Six options were considered. All Scenarios assumed that the 2012 catch is the TAC (9 192 tons):

1. Average of F_{bar} in 2008-2010 (median value at 0.128).
2. $F_{0.1}$ (median value at 0.130).
3. Average of F_{bar} in 1988-1995 (median value at 0.967), as these years correspond to the period when SSB was above B_{lim}.
4. F_{max} (median value at 0.210).
5. F=0.
6. $F_{statusquo}$ (median value at 0.280).

Results for the six options are presented in Tables 10-21 and Figures 22 and 23. They indicate that total biomass and SSB has a very high probability of reaching levels higher than the 1988-2011 estimated level for all options except option 3 (F_{bar} equal to the average of 1988-1995 F_{bar}). Depending of the projection, the number of matures has a variable probability of being above the level of the previous year, that indicates that the SSB increased more that the number of matures. This could be due to the fact that weight-at-age and maturity-at-age used for the projection period, namely random draws from the last 3 assessment years, are much higher than those assumed to have applied at the end of the 1980's.

Results indicate that fishing at the F_{bar} level currently estimated for 2011 should allow SSB to increase, although abundance will increase at a less degree. If the fishing mortality were return to the levels seen before 1995, stock recovery would become less probable.

The projected values for the period 2013-2015 are heavily reliant on the relatively abundant seven most recent cohorts, namely those recruited in 2005-2011.

References

Cerviño, S. and A. Vázquez, 2003. Re-opening criteria for Flemish Cap cod: a survey-based method. NAFO SCR Doc. 03/38. Serial Number N4856.

Fernández, C., S. Cerviño and A. Vázquez, 2007. A Survey-based assessment of cod in division 3M. NAFO SCR Doc. 07/39. Serial Number N5526.

Fernández, C., S. Cerviño and A. Vázquez, 2008. Assessment of the Cod Stock in NAFO Division 3M. NAFO SCR Doc. 08/26. Serial Number N5391.

González-Costas, F., D. González-Troncoso, G. Ramilo, E. Román , J. Lorenzo, M. Casas, C. Gonzalez, A. Vázquez, and M. Sacau. Spanish Research Report for 2010. NAFO SCS Doc. 11/07. Serial Number N5884

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. SCR Doc. 05/29, Serial Number N5115.

González-Troncoso, D. and A. Vázquez. Assessment of the 3M Cod Stock in NAFO Division 3M. NAFO SCR Doc. 11/38. Serial Number N5923.

Vázquez, A. and S. Cerviño, 2005. A review of the status of the cod stock in NAFO division 3M. NAFO SCR Doc. 05/38. Serial Number N5124.

Vázquez, A., 2012. 3M Survey. NAFO SCR Doc. 05/38. Serial Number N5124.

Vargas, J., R. Alpoim, E. Santos and A. M. Ávila de Melo, 2011. Portuguese research report for 2010. NAFO SCS Doc. 11/05. Serial Number N5881.

Statkus, R., 2011.Lithuania Research Report for 2010. NAFO SCS Doc. 11/04. Serial Number N5880

Acknowledges

Thanks to Fernando González-Costas for his valuable comments. The authors would like to thank too to all the people that make possible this type of works: onboard observers, both in commercial and survey vessels, who obtain the data, and lab people who have processed them.

This study was supported by the European Commission (Program for the Collection of Data in Fisheries Sector), the IEO, the CSIC and the INRB\IPIMAR.

Table 1.- Total commercial cod catch in Division 3M. Reported nominal catches since 1960 and estimated total catch since 1988 in tons

Year	Estimated[1]	Portugal	Russia	Spain	France	Faroes	UK	Poland	Norway	Germany	Cuba	Others	Total
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		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		0		458	34150
1969		7276	283	2681	11831					20		52	22143
1970		9847	494	1324	6239		3	53		0		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	0	24	76	29710
1980		3615	1056	706	301	3248		33	1080	355	1	62	10457
1981		3727	927	4100	79	3874			1154	0		12	13873
1982		3316	1262	4513	119	3121	33		375	0		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				0		269	10632
1988	28899	421	39	141		1100				0	3	14	1718
1989	48373	170	10	378						0		359	917
1990	40827	551	22	87		1262				0		840	2762
1991	16229	2838	1	1416		2472	26		897	0	5	1334	8989
1992	25089	2201	1	4215		747	5			0	6	51	7226
1993	15958	3132	0	2249		2931				0		4	8316
1994	29916	2590	0	1952		2249			1	0		93	6885
1995	10372	1641	0	564		1016				0		0	3221
1996	2601	1284	0	176		700	129			16		0	2305
1997	2933	1433	0	1			23			0		0	1457
1998	705	456	0							0		0	456
1999	353	2	0							0		0	2
2000	55	30	6							0		0	36
2001	37	56	0							0		0	56
2002	33	32	1							0		0	33
2003	16	7	0							0		9	16
2004	5	18	2							0		3	23
2005	19	16	0			7				0		3	26
2006	339	51	1	16						0		55	123
2007	345	58	6	33						0		28	125
2008	889	219	74	42		0				0		66	401
2009	1161	856	87	85		22				0		122	1172
2010	9192	1482	374			1183	761		519	0		85	4404
2011	n.a.	2412	655	1609	200	2211	1063		1117		185	342	9794

[1] Recalculated from NAFO Statistical data base using the NAFO 21A Extraction Tool

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	1219	25400	8273	386	185	14	182
1995	0	0	264	6553	2750	651	135	232
1996	0	81	714	311	1072	88	0	0
1997	0	0	810	762	143	286	48	0
1998	0	0	8	170	286	30	19	2
1999	0	0	15	15	96	60	3	1
2000	0	10	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[1]	0.003	0.098	0.293	0.126	0.198	0.161	0.063	0.056

[1] As there is no total catch available, the proportion of number per age is put

Table 3.- EU bottom trawl survey abundance at age (thousands)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1988	4850	78920	49050	13370	1450	210	220	60	0	0	0	0	0	0
1989	22100	12100	106400	63400	23800	1600	200	100	0	0	0	0	0	0
1990	2660	14020	5920	19970	18420	5090	390	170	90	30	0	0	0	0
1991	146100	29400	20600	2500	7800	2100	300	100	0	0	0	0	0	0
1992	75480	44280	6290	2540	410	1500	270	10	0	0	10	0	0	0
1993	4600	156100	35400	1300	1500	200	600	100	0	0	0	0	0	0
1994	3340	4550	31580	5760	150	70	10	120	0	10	0	0	0	0
1995	1640	13670	1540	4490	1070	40	30	0	20	10	0	0	0	0
1996	41	3580	7649	1020	2766	221	9	6	0	0	0	0	0	0
1997	42	171	3931	5430	442	1078	24	0	0	0	0	6	0	0
1998	27	94	106	1408	1763	87	165	0	6	0	0	0	0	0
1999	7	96	128	129	792	491	21	7	0	0	0	0	0	0
2000	186	16	343	207	100	467	180	11	17	0	0	5	0	5
2001	487	2048	15	125	81	15	146	101	6	6	6	0	0	0
2002	0	1340	609	24	68	36	28	96	33	0	6	0	0	0
2003	665	53	610	131	22	47	7	8	37	25	0	0	0	0
2004	0	3379	25	602	168	5	10	3	5	16	0	0	0	0
2005	8069	16	1118	78	708	136		17	8	8	0	0	0	0
2006	19710	3883	62	1481	86	592	115	7	0	7	14	0	7	0
2007	3910	11620	5020	21	1138	58	425	74	13	20	0	0	0	0
2008	6090	16670	12440	4530	70	940	60	230	80	0	10	0	0	0
2009	5139	7479	16150	14310	4154	26	1091	0	335	0	0	14	0	0
2010	66370	27689	8654	7633	4911	1780	8	442	46	251	26	0	0	0
2011	347674	142999	16993	6309	7739	3089	1191	0	215	0	89	0	0	0

Table 4.- 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		0.209	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		0.298	0.414	0.592	1.093	1.704	2.619	3.865
1993		0.210	0.509	0.894	1.829	2.233	3.367	4.841
1994		0.289	0.497	0.792	1.916	2.719	2.158	4.239
1995			0.415	0.790	1.447	2.266	3.960	5.500
1996		0.286	0.789	1.051	1.543	2.429		
1997			0.402	0.640	0.869	1.197	1.339	
1998			0.719	1.024	1.468	1.800	2.252	3.862
1999			0.92	1.298	1.848	2.436	3.513	4.893
2000		0.583	0.672	1.749	2.054	2.836	3.618	
2001		0.481		1.696	2.560		3.905	5.217
2002		0.588	1.323	1.388	2.572	3.770	5.158	5.603
2003		0.462	1.063	1.455	2.978	3.696	5.859	6.120
2004		0.839	1.677	2.009	3.353	5.576	6.241	8.273
2005		0.895	1.618	2.368	3.259	4.767	6.177	6.553
2006		1.081	1.462	2.283	3.966	5.035	6.332	
2007		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		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	0.938	1.517	2.211	3.551	6.062	9.086

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

	1	2	3	4	5	6	7	8+
1988	0.03	0.10	0.31	0.68	1.97	3.59	5.77	6.93
1989	0.04	0.24	0.54	1.04	1.60	2.51	4.27	6.93
1990	0.04	0.17	0.34	0.85	1.50	2.43	4.08	5.64
1991	0.05	0.17	0.50	0.86	1.61	2.61	4.26	7.69
1992	0.05	0.25	0.49	1.38	1.70	2.63	3.13	6.69
1993	0.04	0.22	0.66	1.21	2.27	2.37	3.45	5.89
1994	0.06	0.21	0.59	1.32	2.26	4.03	4.03	6.72
1995	0.05	0.24	0.47	0.96	1.85	3.16	5.56	8.48
1996	0.04	0.25	0.53	0.80	1.32	2.27	4.00	5.03
1997	0.08	0.32	0.64	1.00	1.31	2.10	2.00	9.57
1998	0.07	0.36	0.75	1.19	1.66	1.99	3.10	7.40
1999	0.10	0.37	0.92	1.30	1.85	2.44	3.51	4.89
2000	0.10	0.58	0.96	1.61	1.91	2.83	3.47	5.28
2001	0.08	0.48	1.25	1.70	2.56	3.42	3.91	5.22
2002	0.00	0.42	1.12	1.43	2.47	3.59	4.86	5.31
2003	0.05	0.33	0.90	1.50	2.86	3.52	5.52	5.80
2004	0.07	0.6	1.42	2.07	3.22	5.31	5.88	7.84
2005	0.02	0.64	1.37	2.44	3.13	4.54		6.21
2006	0.09	0.7	1.06	2.49	3.57	4.69	5.76	9.55
2007	0.05	0.59	1.60	3.40	4.01	5.69	6.27	8.76
2008	0.07	0.38	1.34	2.69	3.19	5.02	6.32	7.94
2009	0.08	0.41	0.98	2.07	3.88	6.96	6.58	9.46
2010	0.06	0.38	1.09	1.68	2.96	5.38	7.62	9.14
2011	0.04	0.23	0.97	1.70	2.45	3.74	6.26	9.67

Table 6.- Maturity at age (median values of ogives)

	1	2	3	4	5	6	7	8
1988	0.054	0.099	0.175	0.291	0.441	0.603	0.745	0.879
1989	0.054	0.099	0.175	0.291	0.441	0.603	0.745	0.879
1990	0.054	0.099	0.175	0.291	0.441	0.603	0.745	0.879
1991	0.016	0.044	0.108	0.247	0.462	0.698	0.867	0.962
1992	0.002	0.011	0.048	0.184	0.503	0.819	0.953	0.993
1993	0.001	0.007	0.049	0.282	0.751	0.959	0.994	1.000
1994	0.000	0.001	0.050	0.657	0.986	1.000	1.000	1.000
1995	0.000	0.000	0.006	0.803	1.000	1.000	1.000	1.000
1996	0.000	0.000	0.029	0.666	0.993	1.000	1.000	1.000
1997	0.000	0.008	0.111	0.670	0.971	0.998	1.000	1.000
1998	0.000	0.002	0.096	0.874	0.998	1.000	1.000	1.000
1999	0.000	0.001	0.131	0.902	0.999	1.000	1.000	1.000
2000	0.000	0.001	0.163	0.966	1.000	1.000	1.000	1.000
2001	0.000	0.001	0.315	0.998	1.000	1.000	1.000	1.000
2002	0.000	0.010	0.636	0.997	1.000	1.000	1.000	1.000
2003	0.001	0.024	0.513	0.978	0.999	1.000	1.000	1.000
2004	0.000	0.000	0.100	0.967	1.000	1.000	1.000	1.000
2005	0.041	0.171	0.502	0.830	0.959	0.991	0.998	1.000
2006	0.000	0.014	0.365	0.959	0.999	1.000	1.000	1.000
2007	0.000	0.014	0.365	0.959	0.999	1.000	1.000	1.000
2008	0.000	0.012	0.231	0.882	0.995	1.000	1.000	1.000
2009	0.000	0.010	0.181	0.830	0.991	1.000	1.000	1.000
2010	0.000	0.009	0.167	0.812	0.989	1.000	1.000	1.000
2011	0.001	0.008	0.072	0.428	0.878	0.986	0.999	1.000

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

	B quantiles			**SSB quantiles**			**R quantiles**			**F_{bar} quantiles**		
Year	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**
1988	64063	59650	70303	19065	15301	23852	13980	11620	17750	0.517	0.475	0.551
1989	103925	98243	112049	33446	27277	40641	18800	16100	23040	0.874	0.818	0.916
1990	63935	60577	68692	25312	21761	29405	23800	20640	28630	0.911	0.854	0.955
1991	43831	40801	48257	17741	14959	21383	60400	53380	71092	0.501	0.469	0.527
1992	57632	54671	61877	20920	18450	23765	54715	47880	65110	1.557	1.481	1.615
1993	45575	42793	49655	10522	8942	13187	2959	2601	3522	1.039	0.974	1.094
1994	49407	46281	54743	21527	18634	26433	4108	3154	5902	0.959	0.913	0.995
1995	22478	21253	24347	19218	18080	20888	2133	1786	2738	1.405	1.259	1.509
1996	5772	5140	6760	3516	3110	4170	128	86	204	0.654	0.544	0.751
1997	4934	4182	6112	3345	2748	4344	125	81	199	0.732	0.590	0.876
1998	3673	2670	5275	3465	2482	5049	190	138	280	0.299	0.222	0.408
1999	2614	1761	4012	2468	1628	3867	32	23	47	0.285	0.215	0.372
2000	2421	1488	4036	2277	1326	3872	322	196	528	0.192	0.133	0.268
2001	2005	1440	2838	1812	1245	2629	567	356	891	0.035	0.024	0.05
2002	2357	1779	3185	2055	1488	2870	67	42	107	0.014	0.007	0.028
2003	2648	2062	3447	2372	1808	3147	1194	802	1849	0.011	0.006	0.018
2004	4265	3459	5288	3536	2787	4496	78	58	111	0.003	0.002	0.005
2005	4662	3846	5626	3865	3154	4697	3618	2502	5589	0.006	0.004	0.011
2006	7195	5821	9003	4169	3328	5218	7536	5003	12391	0.214	0.165	0.27
2007	13323	10639	17185	5923	4572	7662	8976	6101	14120	0.029	0.022	0.038
2008	20513	16425	26498	10380	8262	13289	7272	4807	11901	0.073	0.056	0.096
2009	30856	25015	38774	19841	15817	25671	13070	7719	22892	0.042	0.032	0.053
2010	47003	38503	57813	32829	26600	41164	40120	18059	84205	0.293	0.220	0.381
2011	58766	45302	76073	34211	25560	46127	46015	16070	127905	0.332	0.212	0.541
2012				52507	35566	76280						

Table 8.- F at age (posterior median)

	F at age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1988	0.000	0.068	0.439	0.558	0.557	0.756	1.296	1.296
1989	0.000	0.005	0.444	0.870	1.312	0.884	1.199	1.199
1990	0.000	0.017	0.258	1.087	1.388	1.490	1.087	1.087
1991	0.000	0.030	0.525	0.368	0.613	0.792	1.034	1.034
1992	0.000	0.388	1.024	1.392	2.263	1.510	2.590	2.590
1993	0.000	0.063	0.724	1.280	1.120	1.827	1.216	1.216
1994	0.000	0.725	1.268	1.213	0.398	0.653	0.356	0.356
1995	0.000	0.000	0.312	1.454	2.465	3.266	1.532	1.532
1996	0.000	0.049	0.293	0.698	0.984	0.513	0.000	0.000
1997	0.000	0.000	0.866	0.551	0.781	0.738	0.554	0.554
1998	0.000	0.000	0.095	0.408	0.387	0.342	0.089	0.089
1999	0.000	0.000	0.192	0.246	0.401	0.122	0.049	0.049
2000	0.000	0.493	0.536	0.017	0.022	0.024	0.003	0.003
2001	0.000	0.036	0.000	0.063	0.040	0.000	0.014	0.014
2002	0.000	0.006	0.014	0.010	0.011	0.005	0.014	0.014
2003	0.000	0.005	0.010	0.010	0.010	0.005	0.004	0.004
2004	0.000	0.001	0.005	0.002	0.002	0.004	0.001	0.001
2005	0.000	0.005	0.004	0.009	0.005	0.004	0.003	0.003
2006	0.000	0.008	0.447	0.123	0.066	0.044	0.016	0.016
2007	0.000	0.000	0.012	0.022	0.052	0.048	0.074	0.074
2008	0.000	0.013	0.026	0.066	0.124	0.097	0.060	0.060
2009	0.000	0.004	0.008	0.050	0.067	0.000	0.099	0.099
2010	0.001	0.044	0.262	0.344	0.258	0.340	0.273	0.273
2011	0.000	0.018	0.227	0.259	0.470	0.526	0.607	0.607

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

	N at age									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**	**Total**	**Matures**
1988	13980	57540	77640	28130	3539	844	468	236	182377	31036
1989	18800	12040	46310	43090	13840	1736	340	312	136468	30736
1990	23800	16190	10320	25600	15550	3192	615	188	95455	21716
1991	60400	20490	13710	6864	7416	3334	617	126	112957	11834
1992	54715	52005	17120	6978	4092	3444	1293	535	140182	9594
1993	2959	47115	30390	5293	1492	366	652	321	88588	5815
1994	4108	2546	38110	12690	1267	417	51	653	59842	12759
1995	2133	3536	1061	9231	3246	731	186	313	20437	11928
1996	128	1838	3038	668	1849	237	24	1	7783	2670
1997	125	111	1508	1943	285	592	122	1	4687	2519
1998	190	107	95	547	960	112	242	25	2278	1888
1999	32	163	93	74	313	562	68	23	1328	1080
2000	322	28	140	66	50	181	428	1	1216	778
2001	567	277	14	71	56	42	152	151	1330	483
2002	67	487	230	12	57	46	36	257	1192	573
2003	1194	58	416	194	11	48	39	249	2209	771
2004	78	1028	49	353	164	9	41	247	1969	826
2005	3618	67	881	42	303	141	8	250	5310	1361
2006	7536	3114	57	755	36	258	120	22	11898	1251
2007	8976	6510	2661	31	574	29	212	71	19064	1795
2008	7272	7727	5601	2261	26	467	23	64	23441	4017
2009	13070	6254	6524	4688	1813	20	364	82	32815	7531
2010	40120	11250	5361	5565	3839	1455	17	464	68071	11563
2011	46015	34505	9259	3532	3382	2543	889	789	100914	10086
2012		39735	28854	6323	2339	1806	1283	781	81121[1]	16272

[1] Results without recruitment data

Table 10.- N-at-age in prediction years (medians) with F_{bar}=F_{bar}(mean 2009-2011)=0.223 including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2011	7741	39735	28854	6323	2339	1806	1283	781	88862	15788
2012	11638	6647	33535	22350	4749	1717	1277	1509	83422	30862
2013	23835	9903	5592	24137	15262	3118	1054	1744	84645	41098
2014	31541	20361	8295	3957	16400	10012	1905	1740	94211	41794

Table 11.- Projections results with F_{bar}=F_{bar}(mean 2009-2011)=0.223.

	Total Biomass quantiles			SSB quantiles			P(SSB<B_{lim})	Yield quantiles		
Year	5%	50%	95%	5%	50%	95%		5%	50%	95%
2011	62663	95434	144707	29477	47477	71850	0.0000		9192	
2012	88786	138024	218600	52449	82941	131645	0.0000	14217	24333	42272
2013	97834	168768	289228	73127	123292	212916	0.0000	16492	30245	55336
2014	107740	205805	388638	84720	154064	285084	0.0000	15915	33378	67708

Table 12.- N-at-age in prediction years (medians) with F_{bar}=$F_{0.1}$=0.095 including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2011	7144	39735	28854	6323	2339	1806	1283	781	88265	15738
2012	11637	6164	33539	22340	4749	1711	1267	1499	82906	30286
2013	22616	10039	5241	26603	17407	3633	1275	2110	88924	46604
2014	35361	19572	8517	4196	20750	13309	2679	2558	106942	52122

Table 13.- Projections results with F_{bar}=$F_{0.1}$=0.095.

	Total Biomass quantiles			SSB quantiles			P(SSB<B_{lim})	Yield quantiles		
Year	5%	50%	95%	5%	50%	95%		5%	50%	95%
2011	62309	95662	143517	29531	47824	71844	0.0000		9192	
2012	88442	137467	220501	51376	82611	130438	0.0000	6036	11219	20454
2013	112735	186581	318149	86067	141834	243433	0.0000	8007	15541	29741
2014	141012	256187	476895	115829	200808	365907	0.0000	8839	19422	39904

Table 14.- N-at-age in prediction years (medians) with F_{bar}=F_{bar}(mean 1988-1995)=0.970 including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2011	7942	39735	28854	6323	2339	1806	1283	781	89063	15822
2012	12093	6799	33563	22365	4750	1710	1277	1502	84059	30734
2013	24189	10306	5200	13113	7259	1293	357	603	62320	21450
2014	16116	20700	7933	2070	4282	2001	276	203	53581	13493

Table 15.- Projections results with F_{bar}=F_{bar}(mean 1988-1995)=0.970.

	Total Biomass quantiles			SSB quantiles			P(SSB<B_{lim})	Yield quantiles		
Year	5%	50%	95%	5%	50%	95%		5%	50%	95%
2011	62780	95632	144445	29778	47599	72462	0.0000		9192	
2012	88593	138172	220667	51394	82422	131492	0.0000	47448	73728	119530
2013	50114	92924	170467	32914	58399	105683	0.0000	25198	46619	85419
2014	30209	76693	185595	19048	38885	77766	0.0088	13264	33058	80080

Table 16.- N-at-age in prediction years (medians) with F_{max}=0.16 including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2011	7466	39735	28854	6323	2339	1806	1283	781	88587	15854
2012	11529	6374	33530	22385	4742	1714	1269	1506	83049	30806
2013	22692	9916	5369	25360	16334	3368	1160	1920	86119	43760
2014	33525	19646	8339	4061	18491	11541	2276	2115	99994	46784

Table 17.- Projections results with F_{bar}=F_{max}=0.16.

	Total Biomass quantiles			**SSB quantiles**			**P(SSB<B_{lim})**	**Yield quantiles**		
Year	5%	50%	95%	5%	50%	95%		5%	50%	95%
2011	61911	95308	145036	29407	47786	71886	0.0000		9192	
2012	88759	138017	220873	51470	83131	131481	0.0000	10017	17804	32196
2013	104601	178734	307866	79073	132719	230574	0.0000	12362	23503	43646
2014	122235	230952	431407	99253	176928	328706	0.0000	12959	27568	56561

Table 18.- 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
2011	7411	39735	28854	6323	2339	1806	1283	781	88532	15793
2012	11504	6393	33534	22388	4757	1712	1270	1502	83060	30507
2013	23879	9905	5453	28928	19222	4083	1473	2467	95410	51268
2014	38167	20554	8489	4712	24796	16487	3506	3446	120157	62166

Table 19.- Projections results with F_{bar}= 0.

	Total Biomass quantiles			**SSB quantiles**			**P(SSB<B_{lim})**	**Yield quantiles**		
Year	5%	50%	95%	5%	50%	95%		5%	50%	95%
2011	62414	95500	144654	29652	47535	72306	0.0000		9192	
2012	88584	138053	219138	51286	82528	131369	0.0000	0	0	0
2013	125595	206425	344985	95387	157847	271187	0.0000	0	0	0
2014	171332	304668	544345	144784	248494	440877	0.0000	0	0	0

Table 20.- N-at-age in prediction years (medians) with F_{bar}=$F_{statusquo}$=0.34 including total number and number of matures.

Year/Age	1	2	3	4	5	6	7	8+	Total	Matures
2011	7022	39735	28854	6323	2339	1806	1283	781	88143	15788
2012	12306	6010	33584	22366	4747	1715	1274	1509	83511	30666
2013	22859	10390	4984	21793	13482	2709	885	1472	78574	36891
2014	29107	19564	8561	3245	13180	7670	1385	1229	83941	33928

Table 21.- Projections results with F_{bar}= $F_{statusquo}$=0.34.

	Total Biomass quantiles			**SSB quantiles**			**P(SSB<B_{lim})**	**Yield quantiles**		
Year	5%	50%	95%	5%	50%	95%		5%	50%	95%
2011	62777	95507	143576	29752	47577	72198	0.0000		9192	
2012	88398	138383	219587	51451	83000	130249	0.0000	21233	35325	61230
2013	86131	150645	262638	63223	108642	189734	0.0000	20633	37856	68939
2014	83711	169736	340292	65163	121336	232777	0.0000	17975	38280	78869

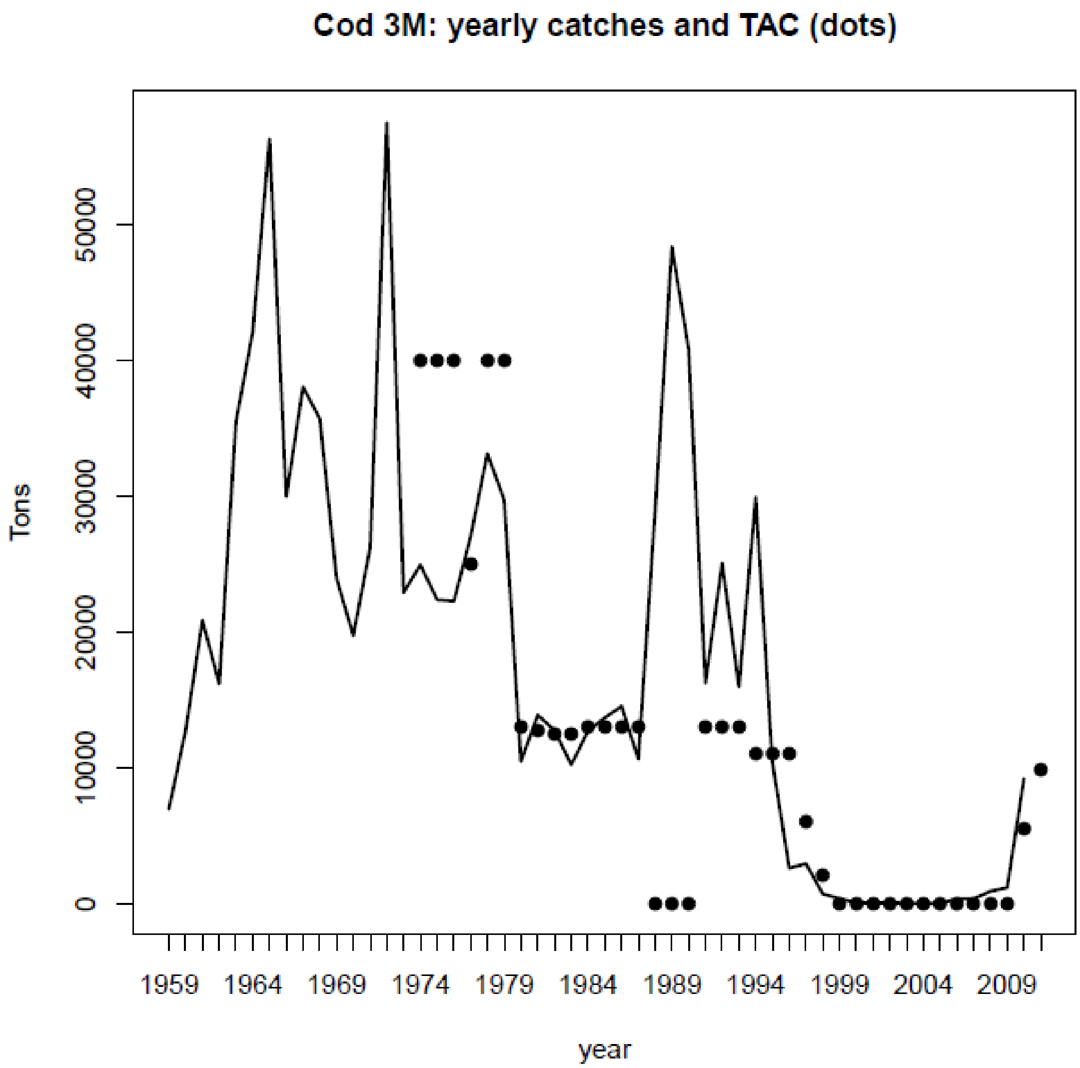

Figure 1.- Catch and TAC of the 3M cod for the period 1959-2011

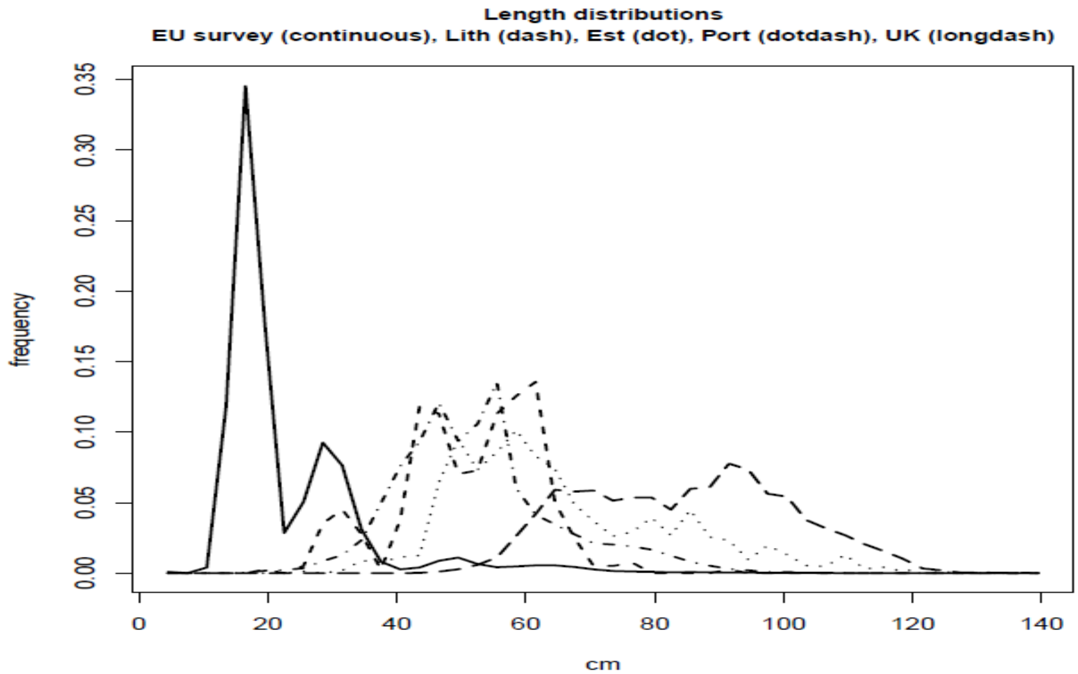

Figure 2.- Length frequencies in 2011. Lith: Lithuania; Est: Estonia; Port: Portugal; UK: United Kingdom; Norw: Norway; Sp_T: Spain trawl; Sp_P: Spain pair; Can: Canada; Rus: Russia

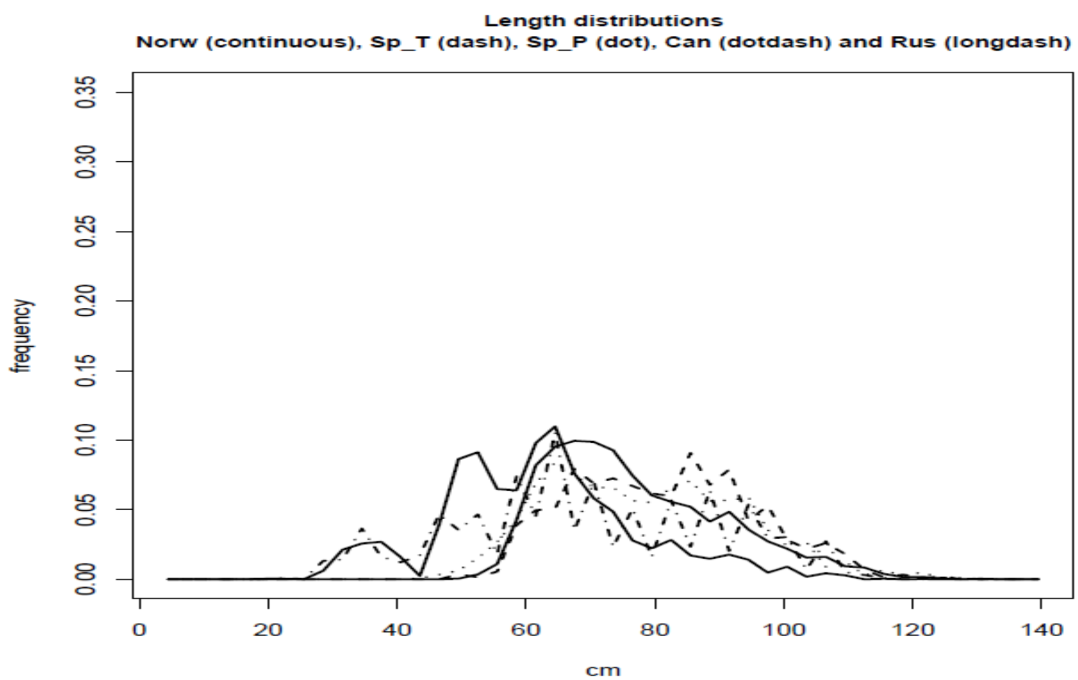

Figure 2 (cont.).- Length frequencies in 2011. Lith: Lithuania; Est: Estonia; Port: Portugal; UK: United Kingdom; Norw: Norway; Sp_T: Spain trawl; Sp_P: Spain pair; Can: Canada; Rus: Russia

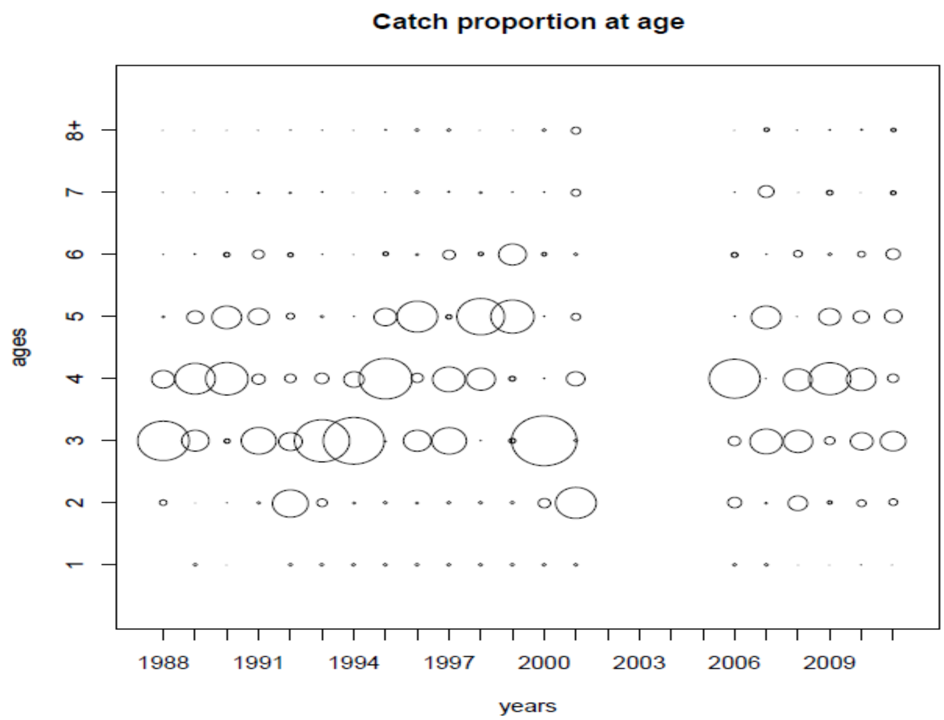

Figure 3.- Commercial catch proportions at age

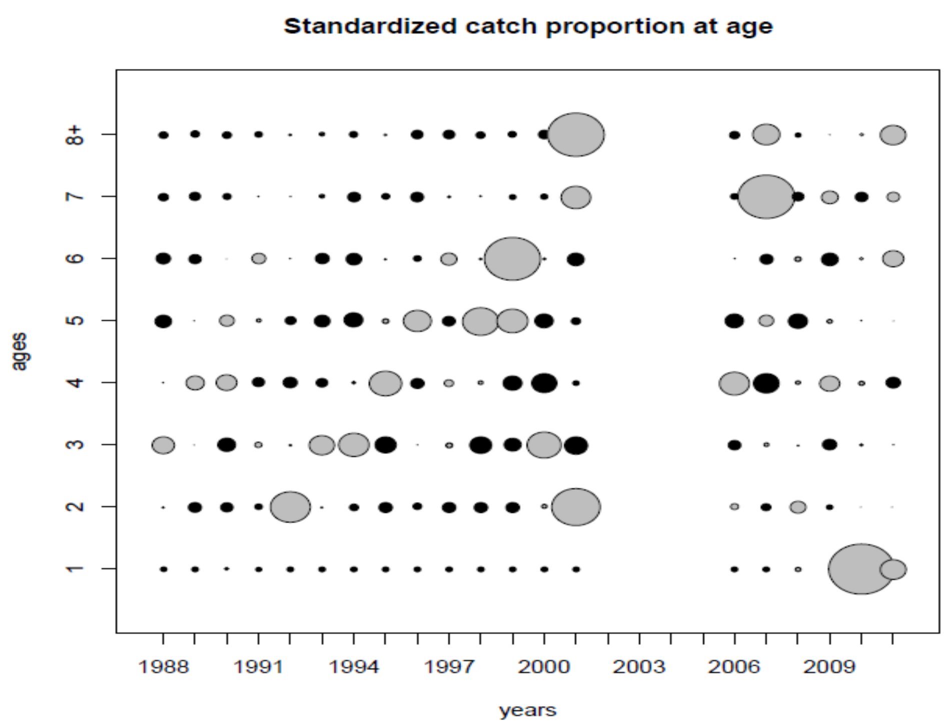

Figure 4.- Commercial catch standardised proportions at age. Grey and black values indicate values above and below the average. The larger the bubble size the larger the magnitude of the value.

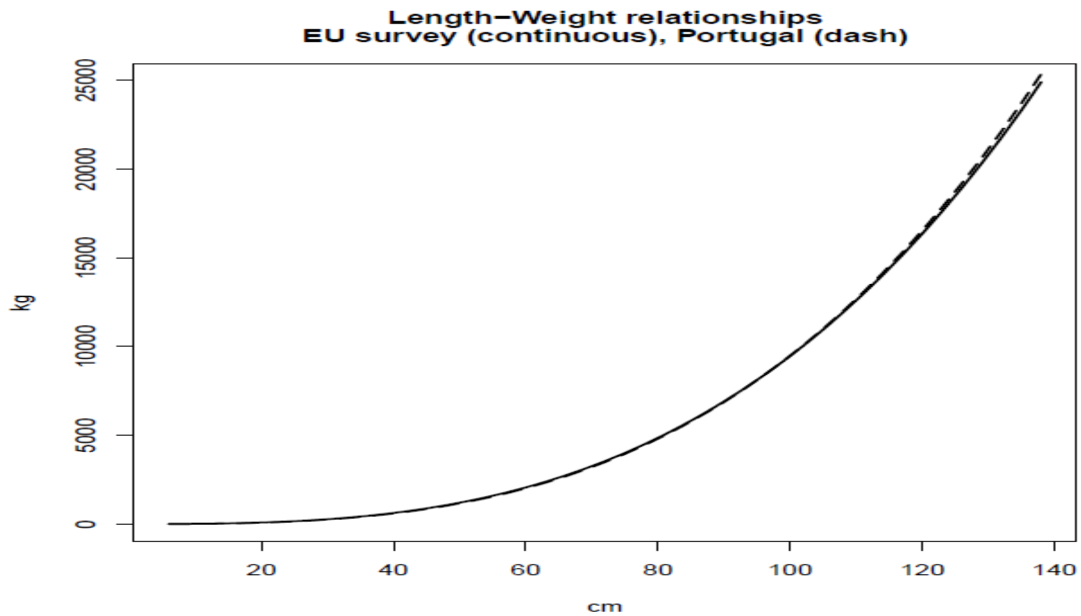

Figure 5.- Length-weight relationships for commercial and survey catches

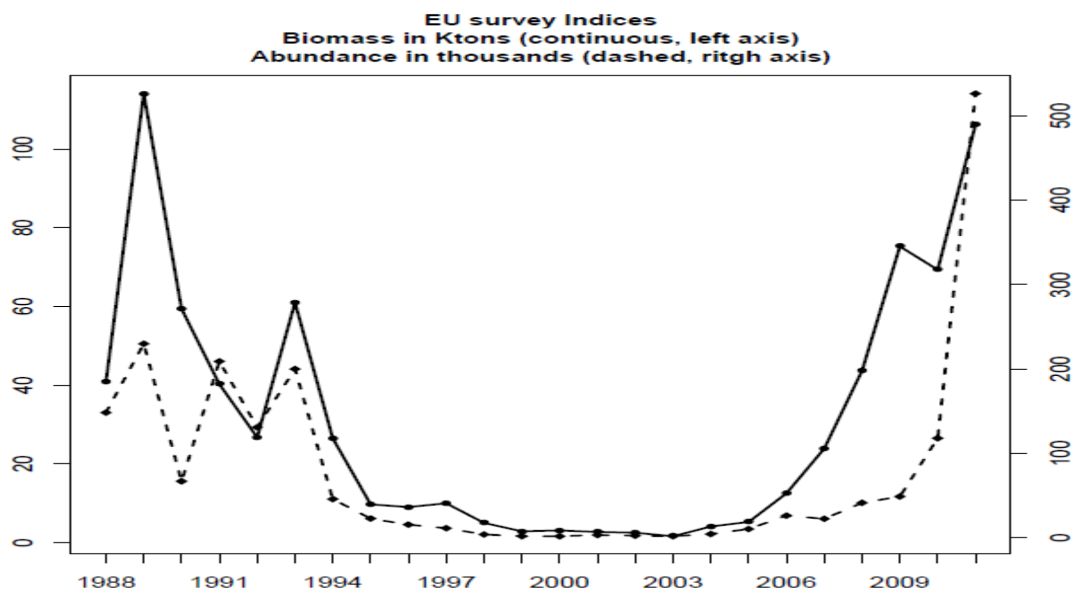

Figure 6.- Biomass and abundance from EU survey

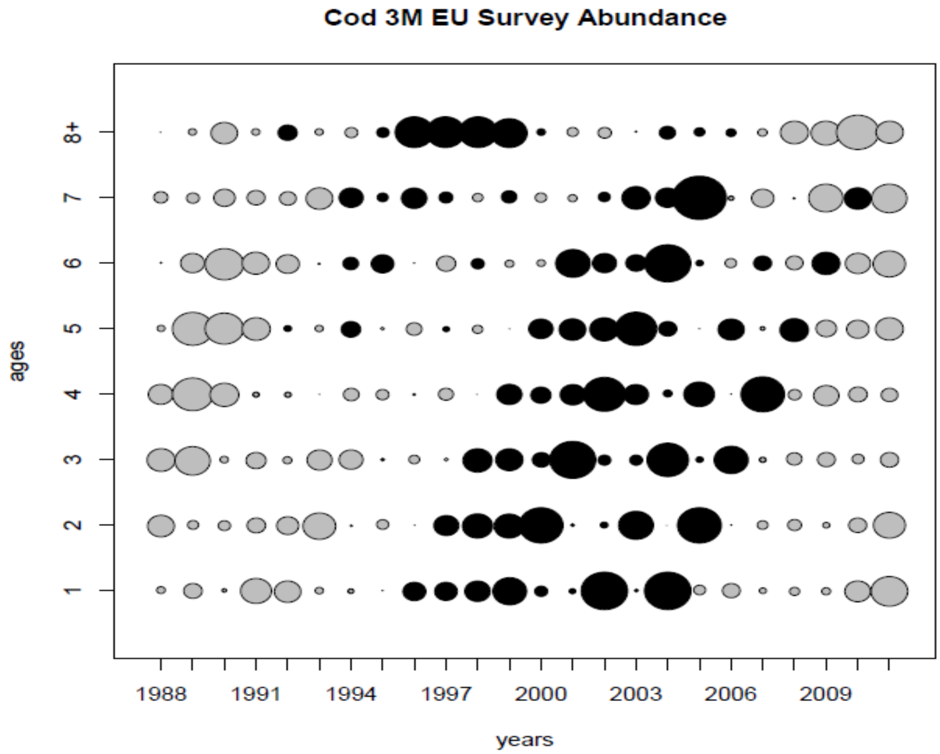

Figure 7.- Standardised log(1+Abundance at age) indices from EU survey. Grey and black values indicate values above and below the average. The larger the bubble size the larger the magnitude of the value.

Figure 8.- Stock mean weight at age

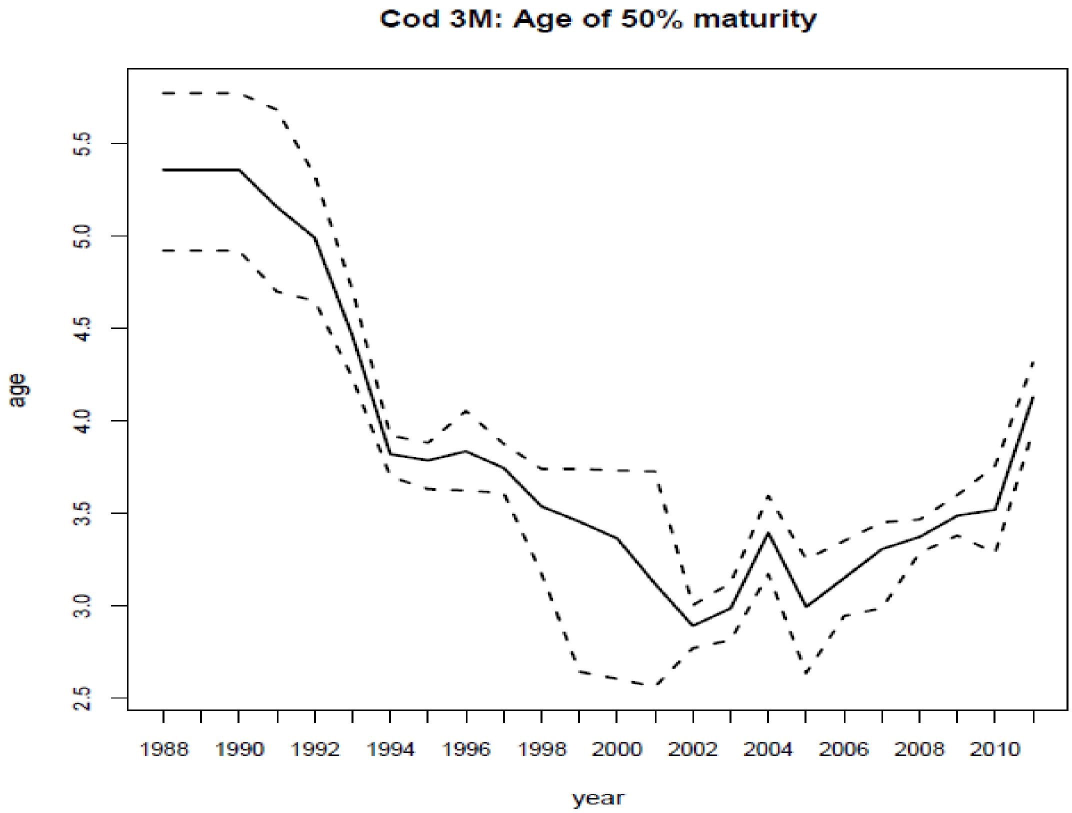

Figure 9.- Age at which 50% of fish are mature

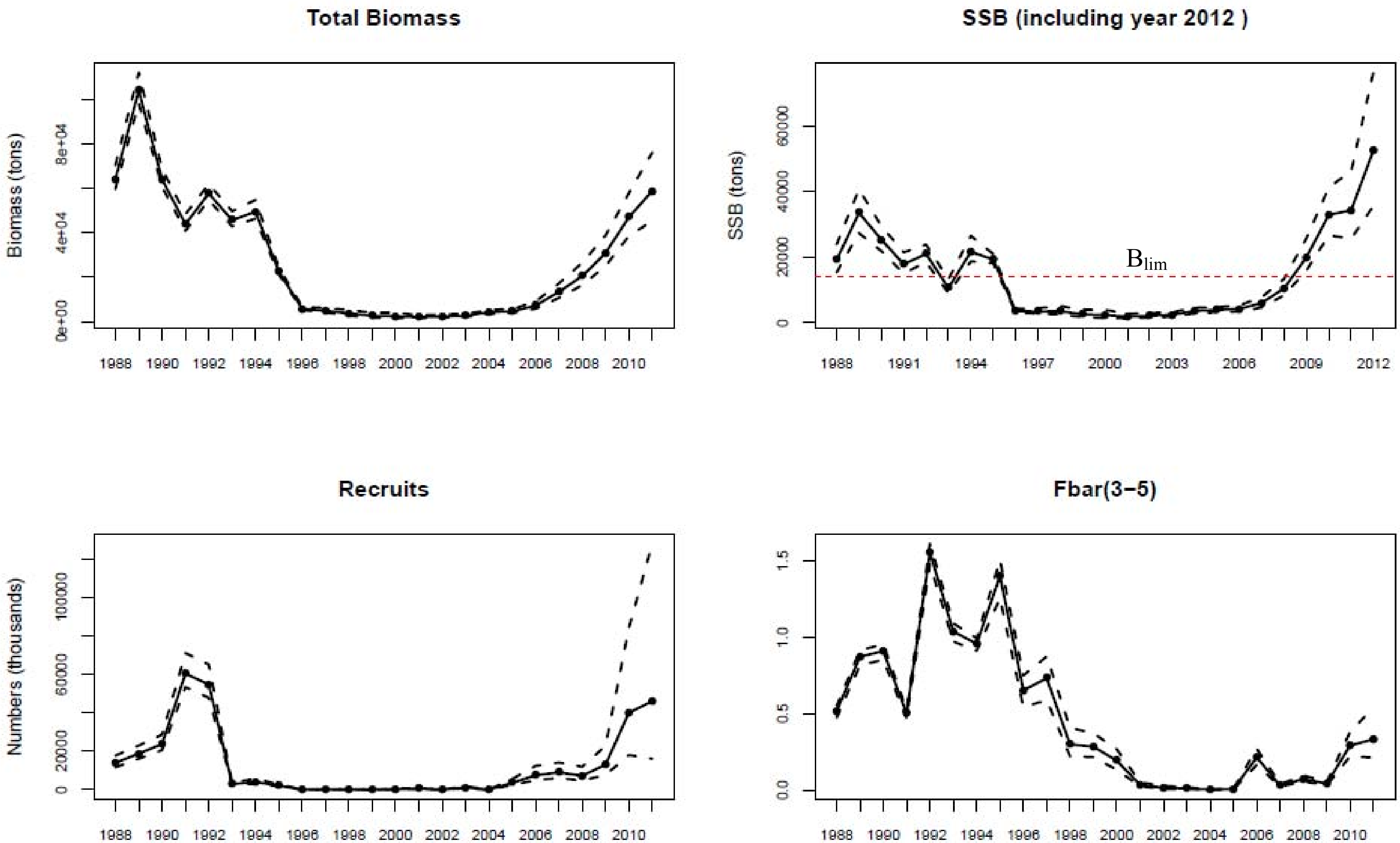

Figure 10.- Estimated trends in biomass, SSB, recruitment and Fbar. The solid lines are the posterior medians and the dashed lines show the limits of 90% posterior credible intervals. Red horizontal line in the SSB graph represents B_{lim} = 14000.

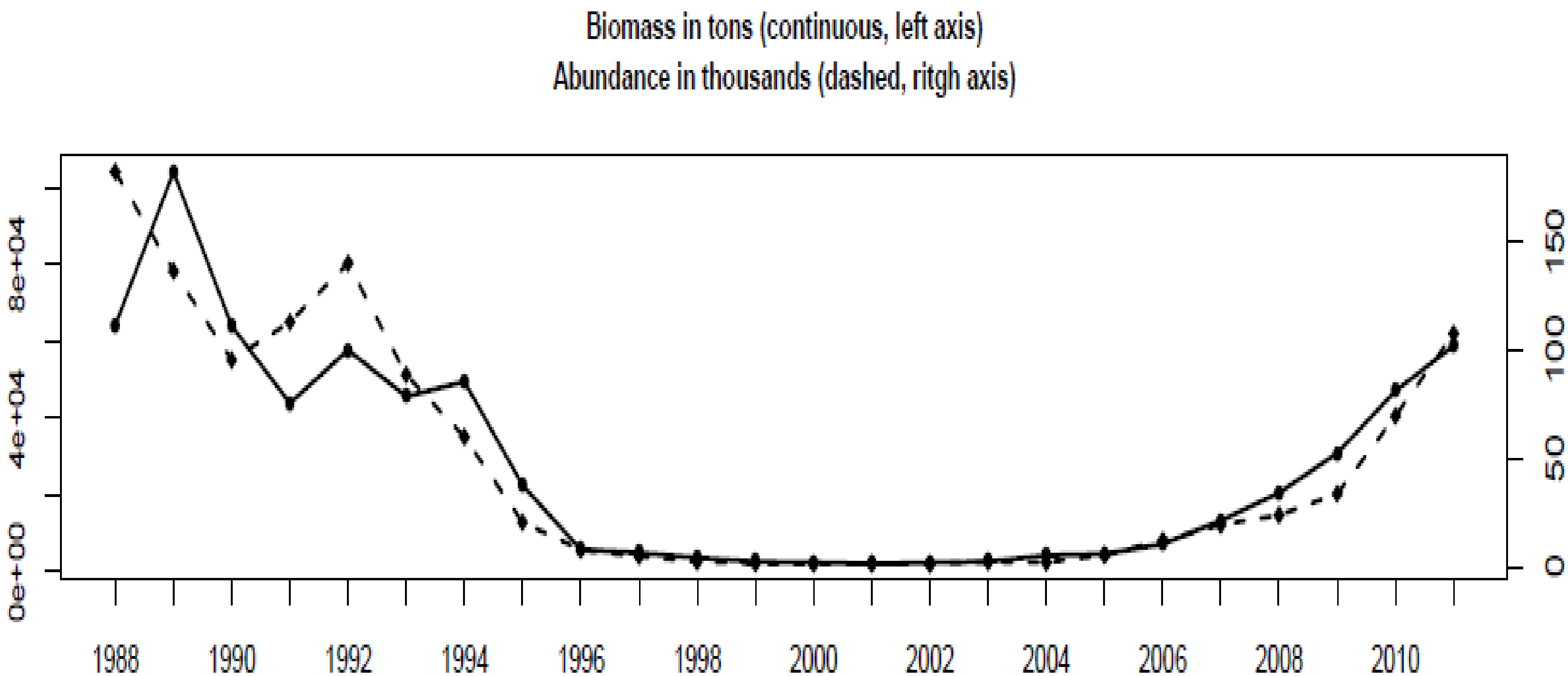

Figure 11.- Estimated trends in biomass and abundance.

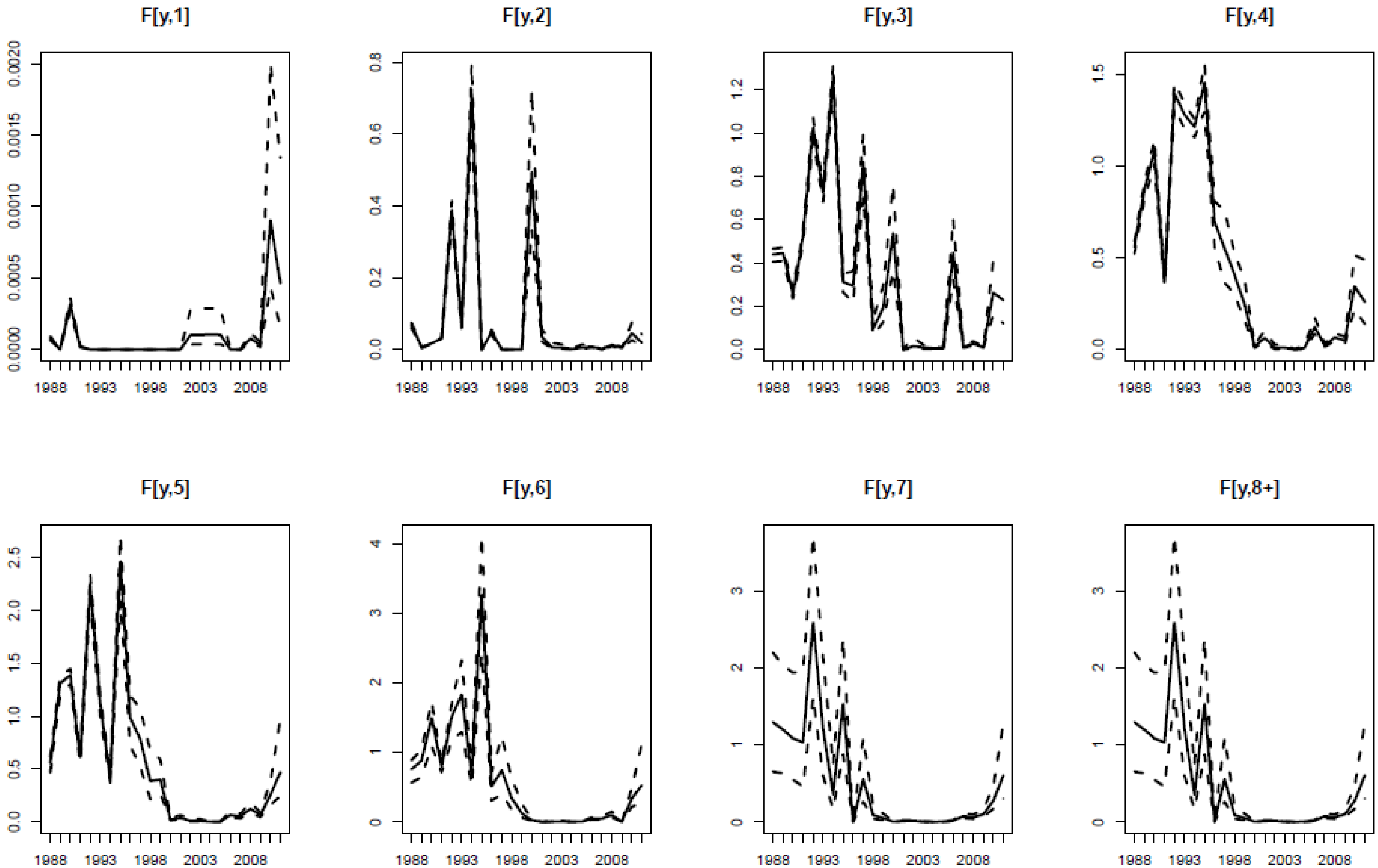

Figure 12.- Estimated fishing mortality at age.

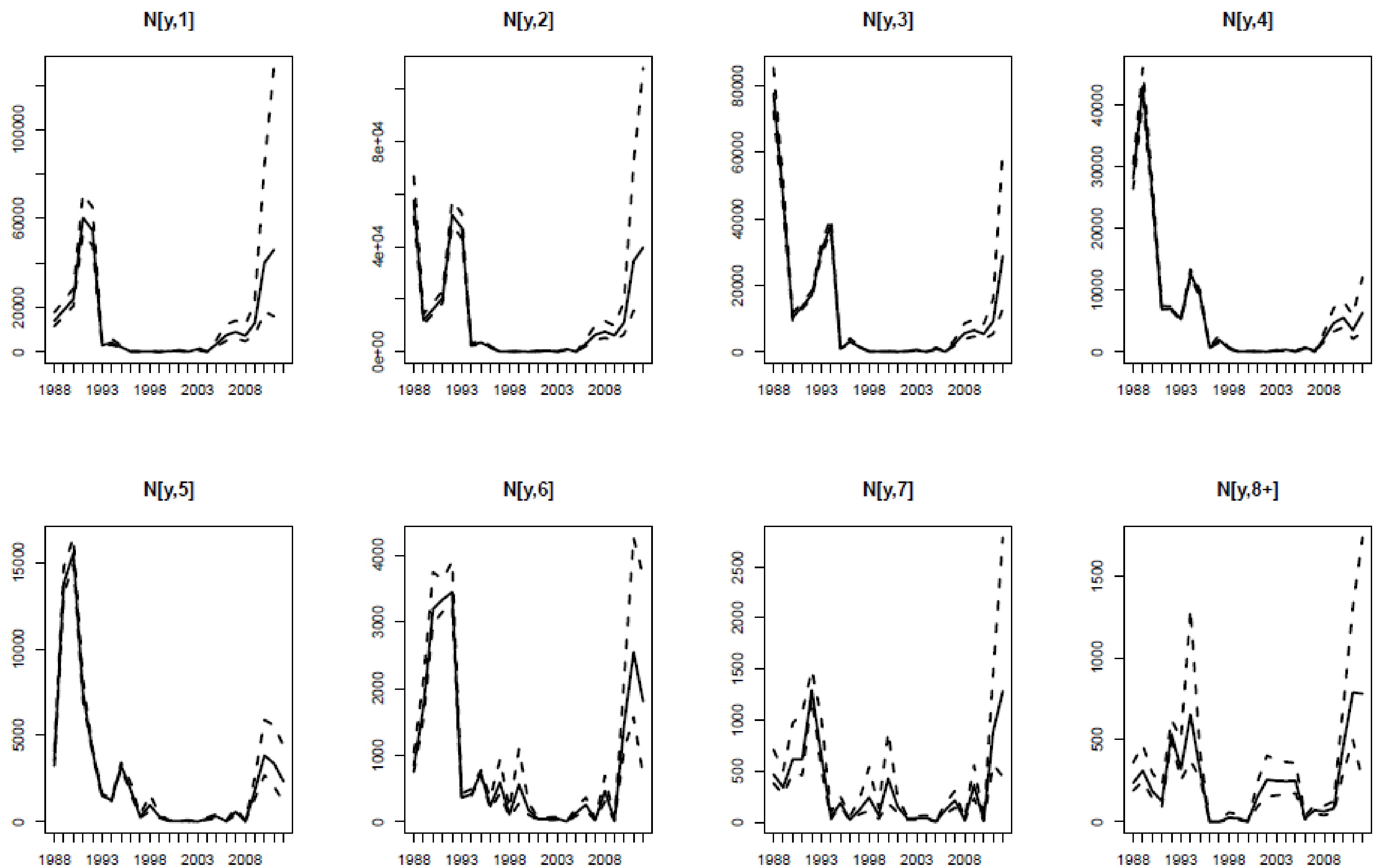

Figure 13.- Estimated numbers at age.

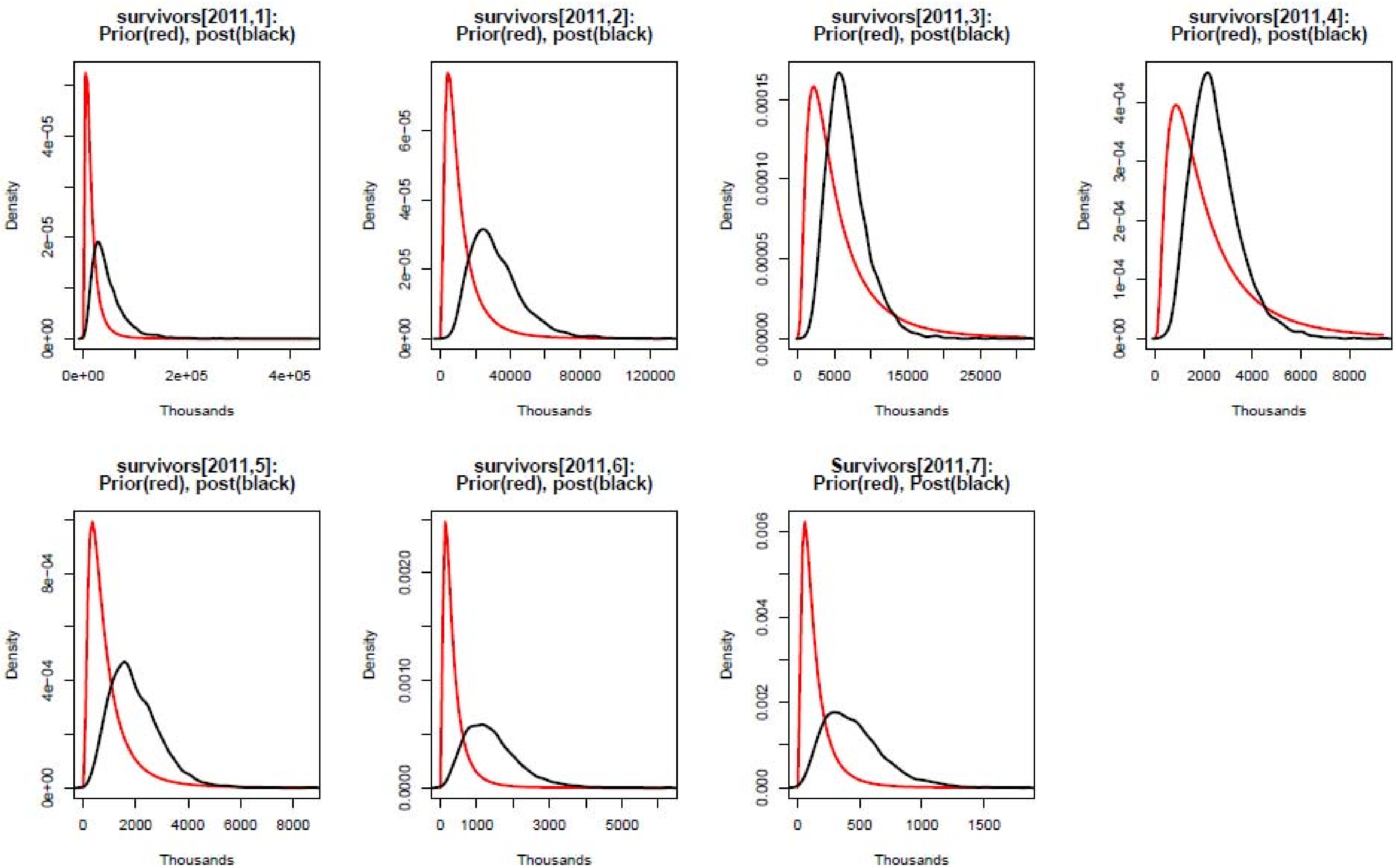

Figure 14.- Survivors at age at the end of 2011 (*survivors* (2011,a) are the number of individuals of age a+1 at the beginning of 2012).

Figure 15.- Survivors from age 7 in each year (*survivors* (y,7) are the individuals of age 8 at the beginning of year y+1).

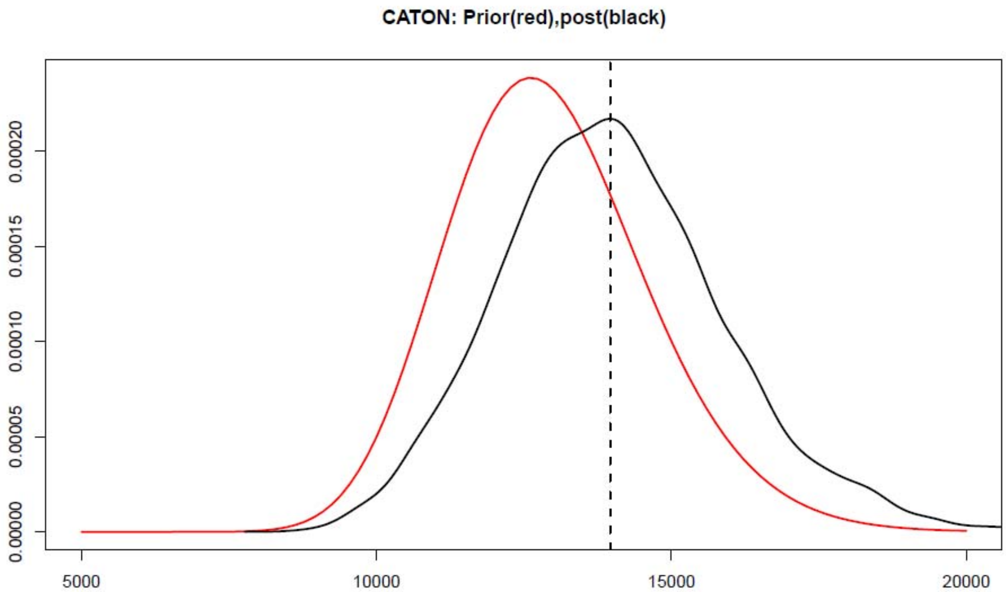

Figure 16.- Estimated total catch in 2011

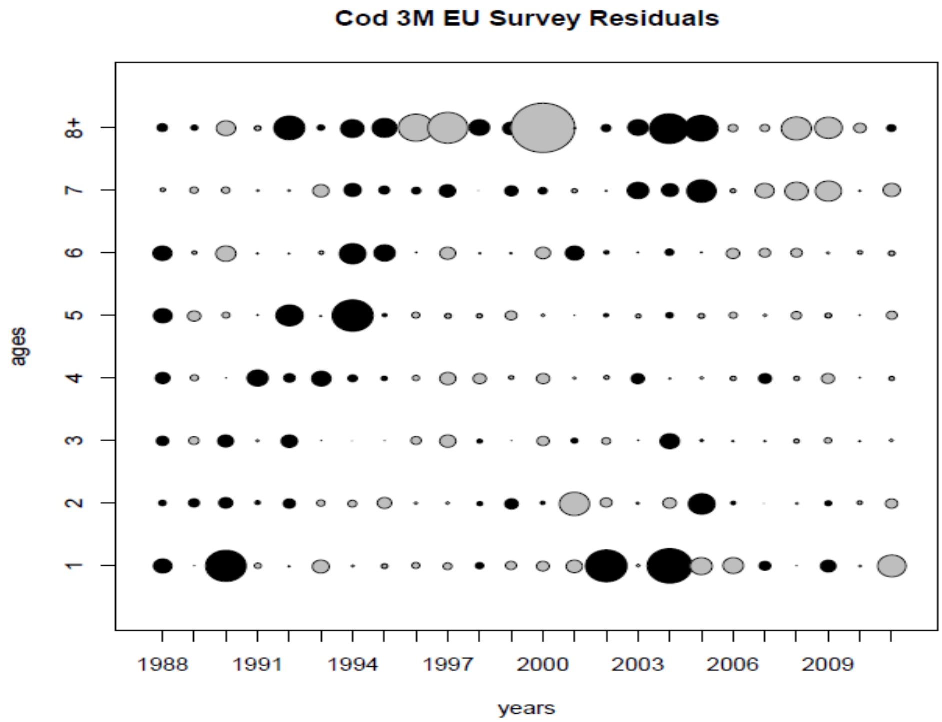

Figure 17.- Raw residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices at age. Grey and black values indicate values above and below the average. The larger the bubble size the larger the magnitude of the value.

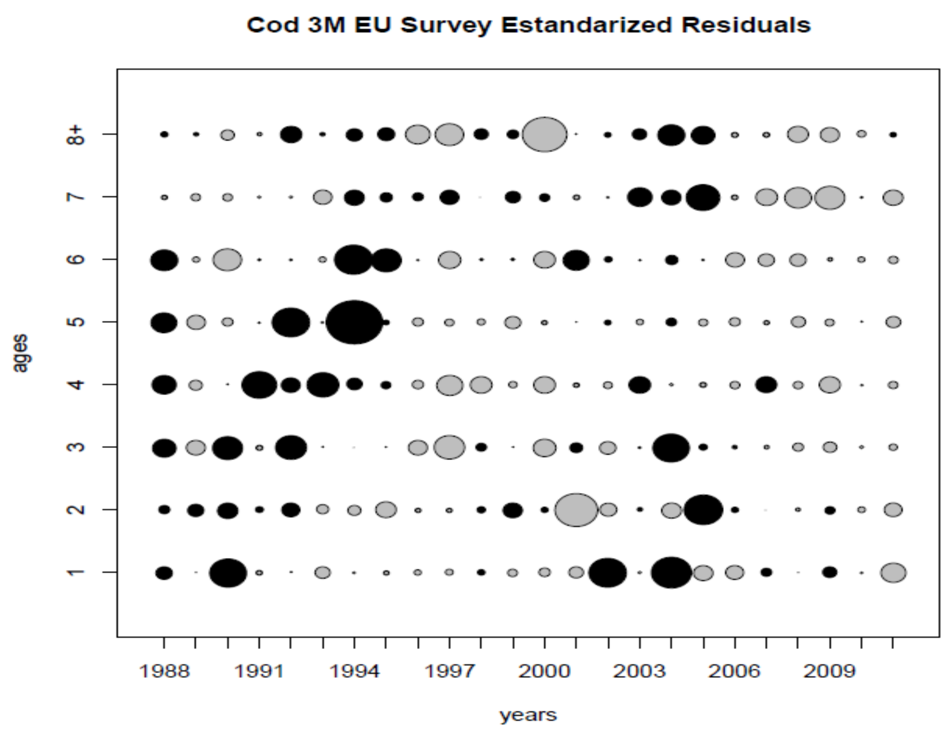

Figure 18.- Standardised residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices at age. Grey and black values indicate values above and below the average. The larger the bubble size the larger the magnitude of the value.

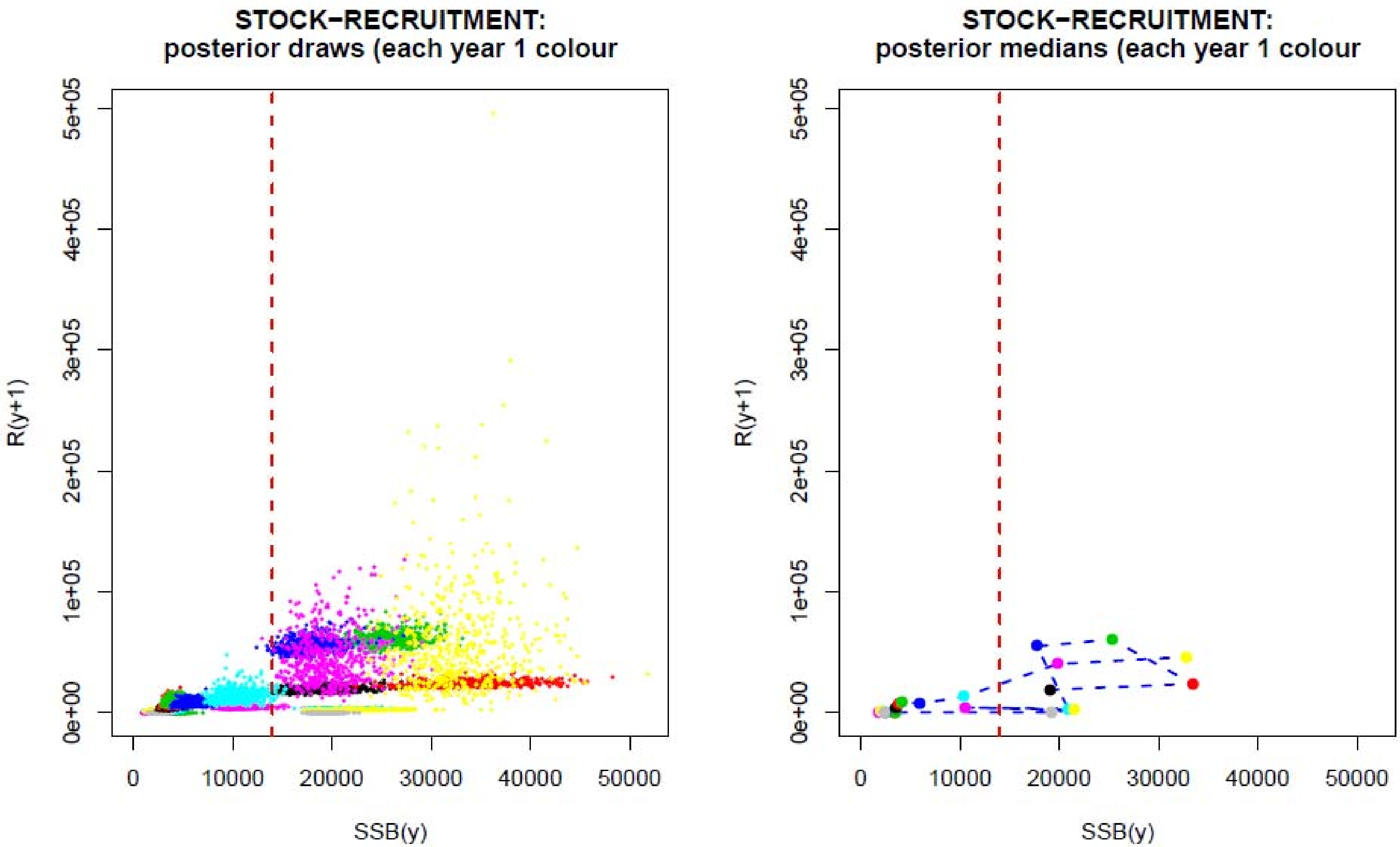

Figure 19a.- Stock-Recruitment plots. B_{lim}=14000 is shown as the red vertical line.

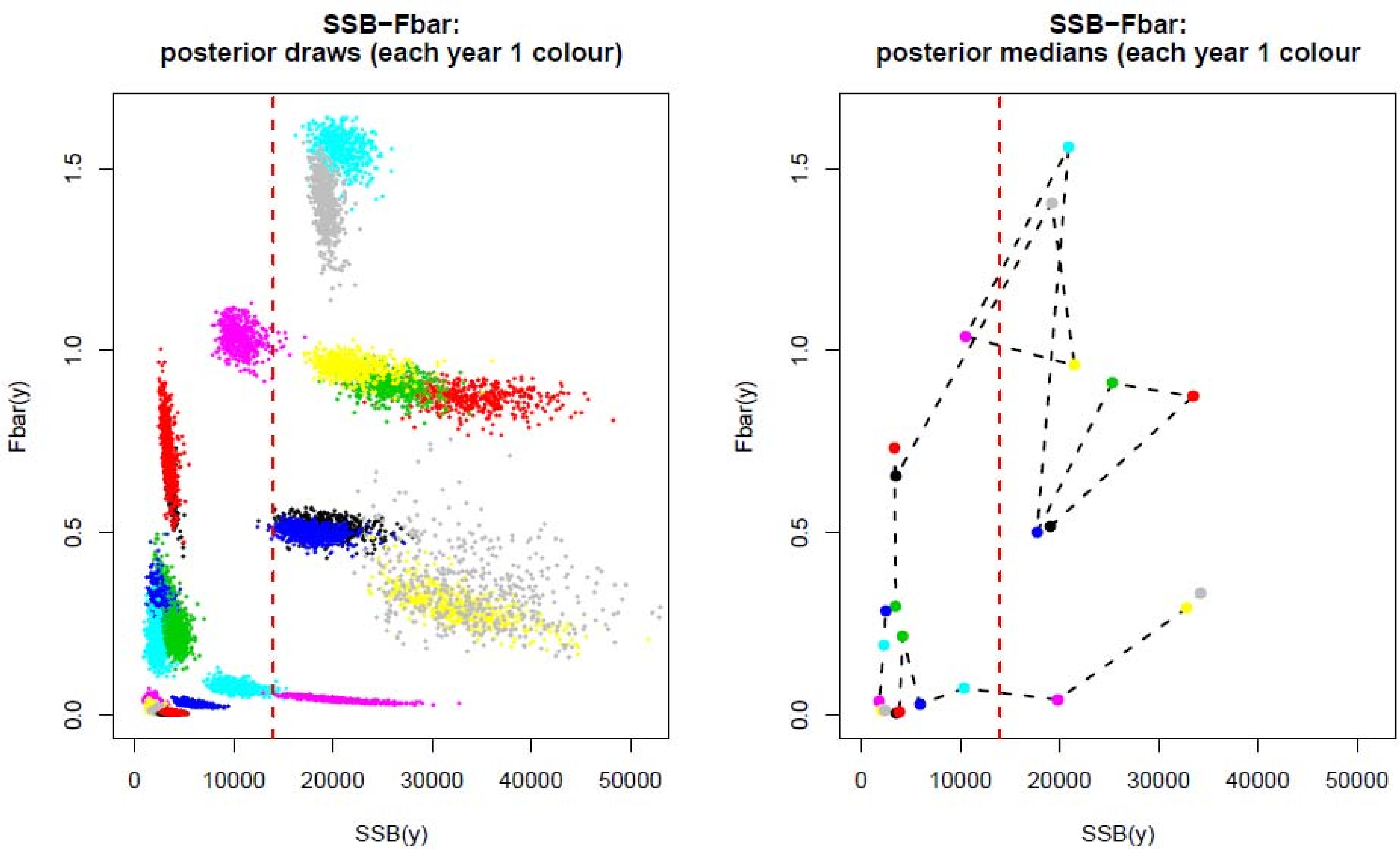

Figure 19b.- F_{bar} versus SSB plots. B_{lim}=14000 is shown as the red vertical line.

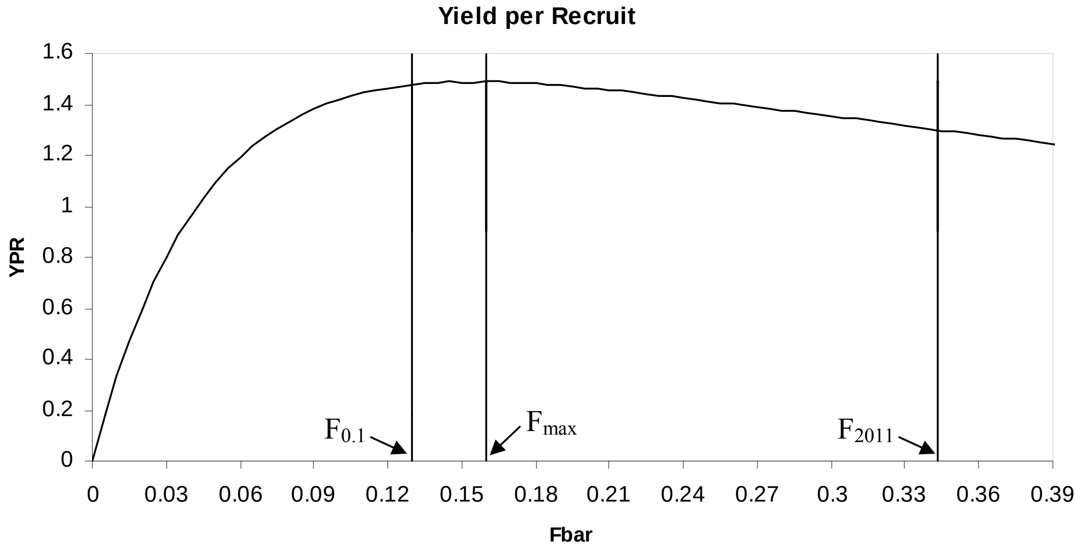

Figure 20.- Bayesian Yield per Recruit versus F_{bar}. The values of $F_{0.1}$, F_{max} and F_{2011} are indicated

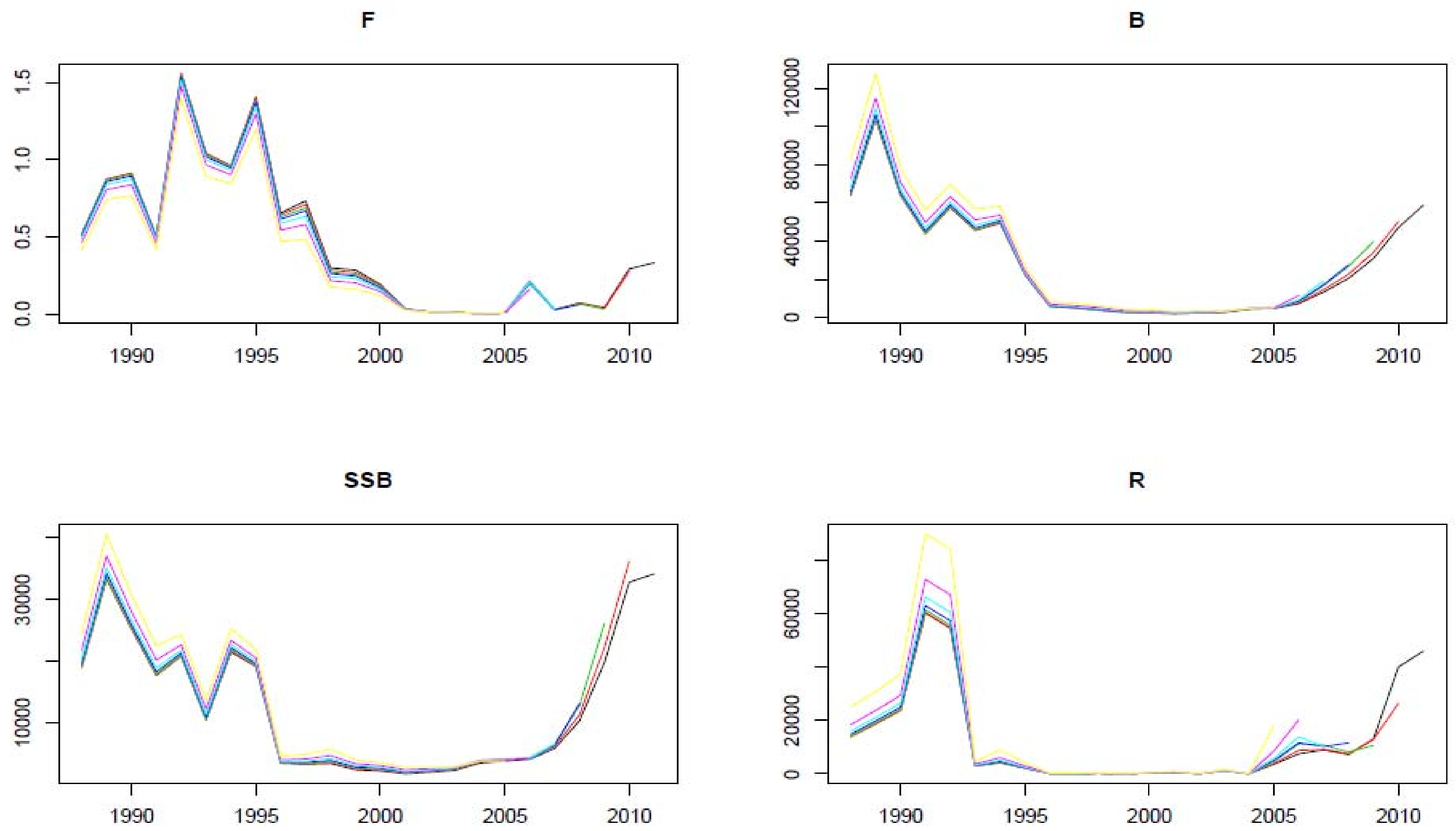

Figure 21.- Retrospective patterns.

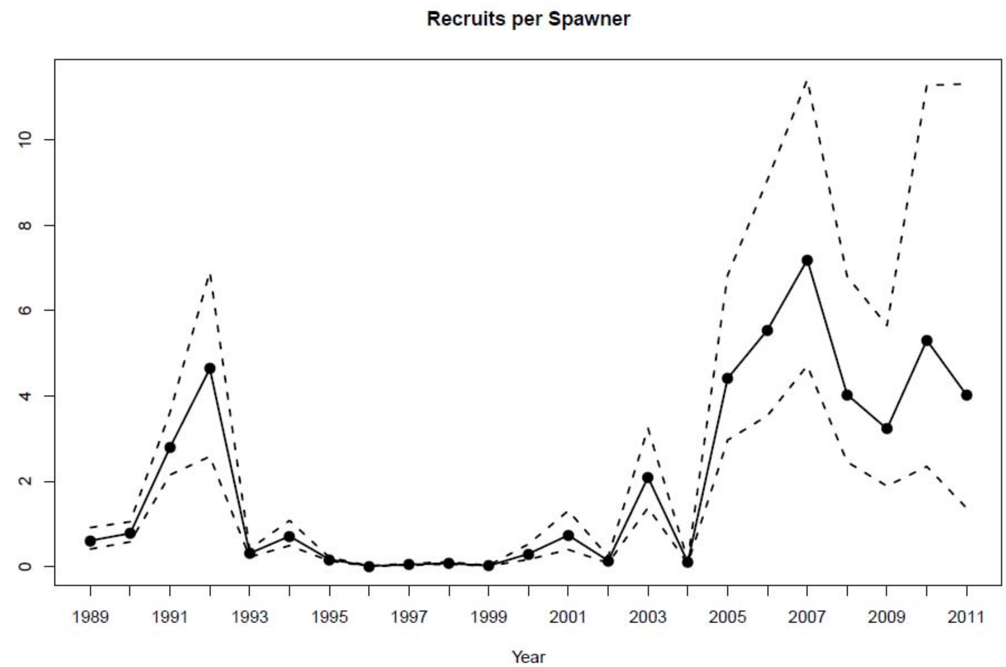

Figure 22.- Estimated recruits (age 1) per spawner.

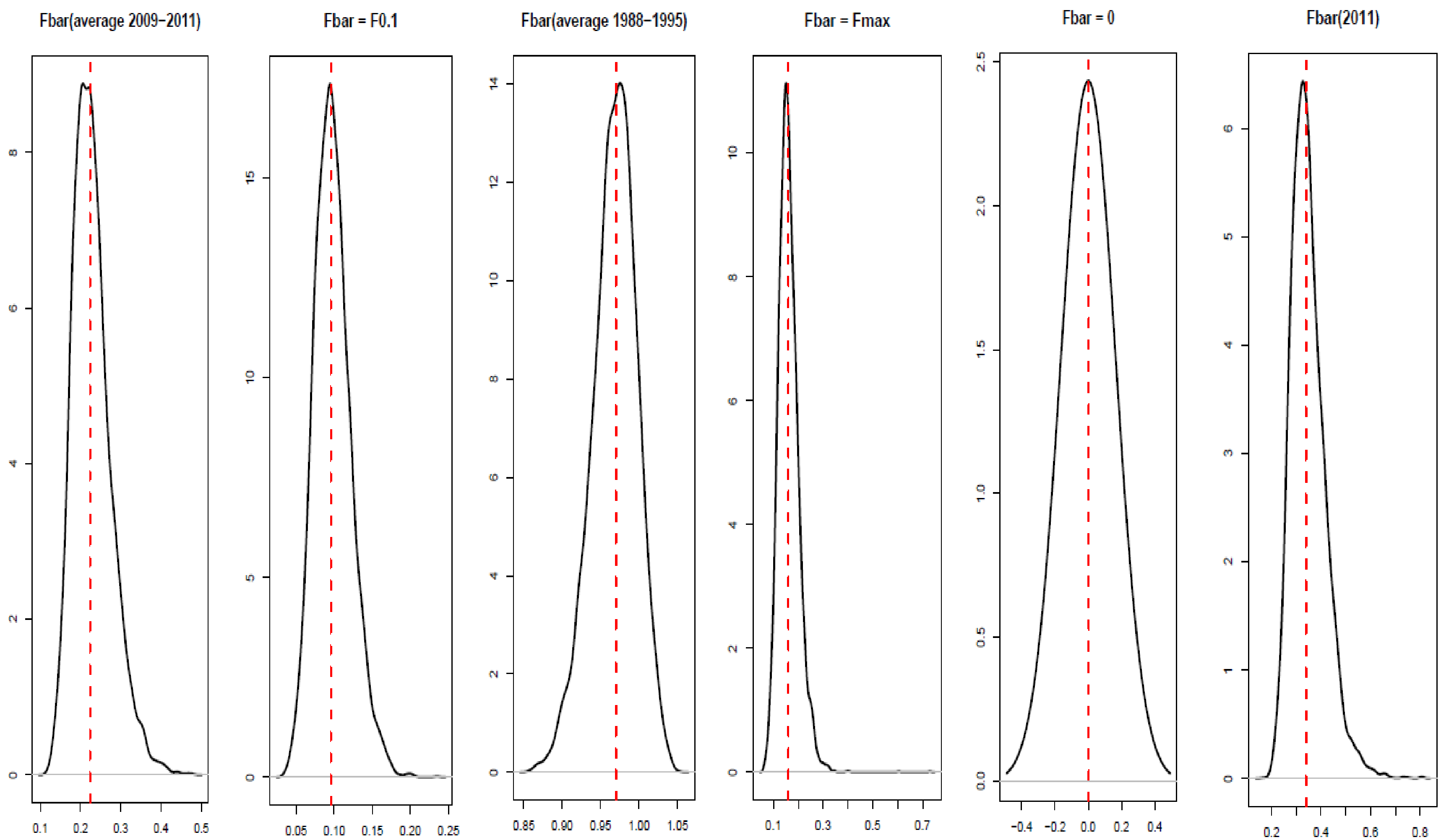

Figure 23.- Distribution and median values of F_{bar} over the different scenarios.

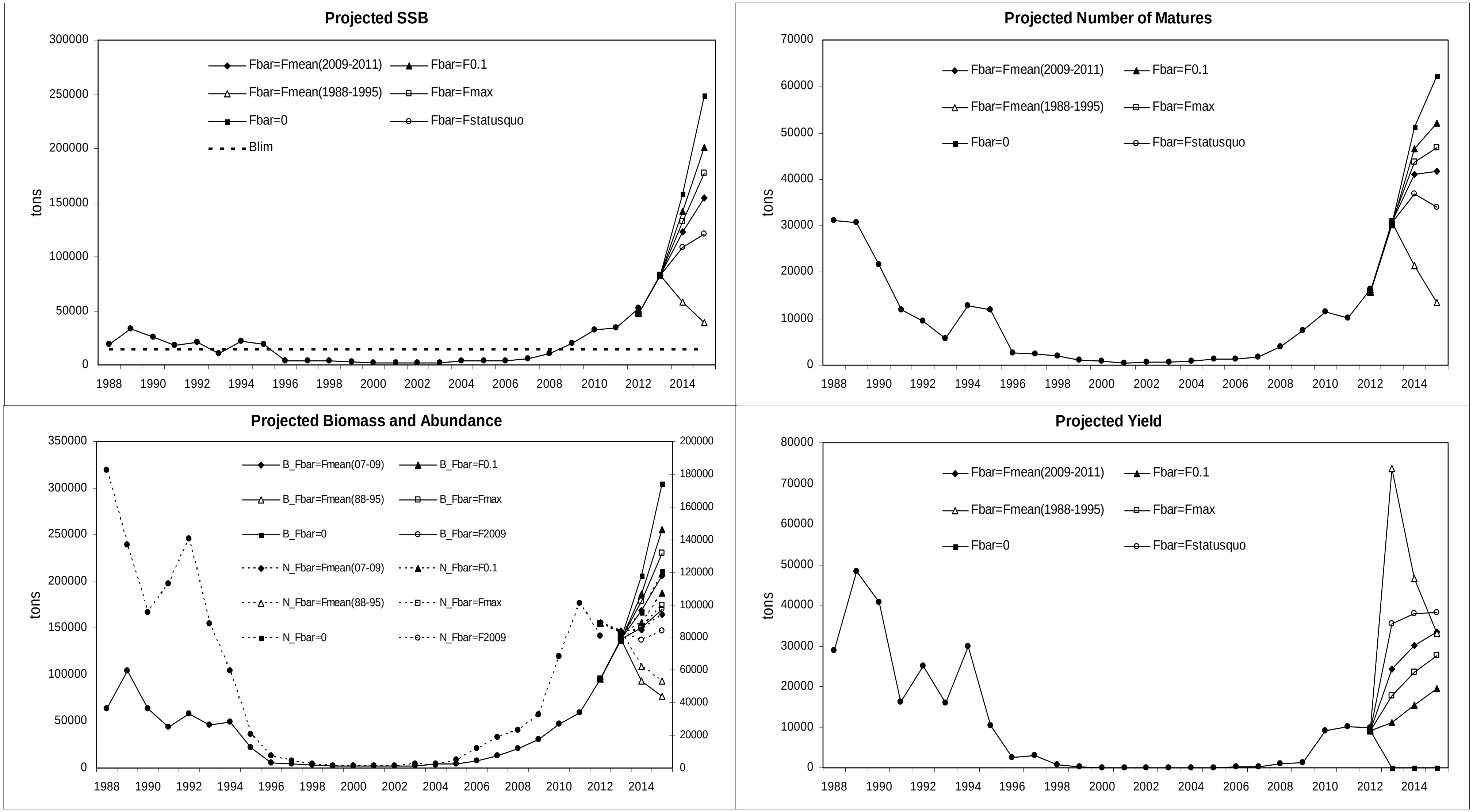

Figure 24.- Projections for SSB, number of matures, Total Biomass and Abundance and Yield with different scenarios.