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Assessment of the Cod Stock in NAFO Division 3M

by

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Abstract

An assessment of the status of the cod stock in NAFO Division 3M is performed. The same model used last year, a Bayesian model, is used to perform the assessment. Results indicate another reasonable recruitment value in 2008 and a fairly substantial increase in SSB, reaching a median value above the Blim for the first time since 1995. The six-years retrospective plot shows that the recruitment is over estimated year by year, and that if we assume a prior distribution under the natural mortality the retrospective pattern seems no to converge, so the model running with M constant equal to 2 is presented too. Its results are no significantly different as those assuming M with uncertainty. Three year projections indicate that fishing at the low Fbar level currently estimated for 2008 should allow SSB to increase to higher levels than estimated for the late 1980´s, although in terms of abundance the stock will remain at lower levels. If the fishing mortality were return to the levels seen until 1995, stock recovery would become very improbable.

Introduction

This stock is on fishing moratorium since 1999 following its collapse, which has been attributed to three possible factors: a stock decline due to overfishing, an increase in catchability at low abundance levels and a series of very poor recruitment levels 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, SSB was estimated to have increased a bit in 2004, 2005 and 2006 (Fernández, *et al.*, 2007) and above average recruitment levels were estimated for 2005 and 2006. The data from 2007 and 2008 indicate another increase in SSB in 2008 as well as a reasonable recruitment value in those years (Fernández *et al.*, 2008).

Since 1974, when a TAC was established for the first time, estimated catches ranged from 48000 tons in 1989 to a minimum value of 5 tons in 2004. Annual catches were about 30000 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 1000 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 and 2008 are 339, 345 and 889 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.

A VPA based (XSA) 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 based on catches and are quite sensitive to assumed natural mortality values 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 to calculate 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).

In year 2008 the stock had a full assessment, and the next full assessment had to be in 2011. But STACFIS noted that the short term development of this stock will be dependent on recent year classes and therefore is **recommended** *that the stock be fully assessed in 2009.*

So, this document presents a full assessment of the status of the stock using the Bayesian model approved last year. A B_{lim} value of 14000 tons was proposed in year 2000 for this stock by NAFO SC. In 2008 the appropriateness of this value given the results from the new method used to assess the stock was examined, reaching the conclusion that it is still an appropriate choice. Three year stochastic projections for several F_{bar} levels are presented. Results indicate that fishing at the low F_{bar} level seen in recent years should allow SSB to increase to higher levels than estimated for the late 1980's, although in terms of abundances the stock will remain at lower values. If fishing mortality were to return to the levels seen until 1995, stock recovery would become very improbable.

Material and Methods

Used data

Commercial data

Length distributions

In 2008 length sampling of catch was conducted by Portugal (Vargas *et al.*, 2009), Russia (Skryabin *et al.*, 2009) and Estonia (Sirp and Saat, 2009). As the length distribution of Estonia for the 3M cod was based only in 5 samples, we decided not to use it and included its catch in the rest of the countries. Length frequencies for Portugal and Russia, as for the EU survey, are shown in the top panel of Figure 2. The length distributions of Portugal and Russia are quite different. Portugal catches smaller individuals, having a tri-modal distribution in 36, 48 and 66 cm. Russia has a two-modal distribution between 54 and 75 cm. The combined commercial catch length frequencies, obtained by adding up the length frequencies of the two countries taking their respective landings into account, is shown on the bottom panel of Figure 2. These combined length frequencies are applied to catches from the countries with no length sampling, including Estonia.

Catch numbers-at-age

As no age-length keys (ALK) were available for the commercial catch, each year the corresponding ALK from the EU survey was applied in order to convert from the length to age distributions of catches. The range of ages in the catch goes from 1 to 8+. The result catch numbers-at-age are in Table 2. Note that between 2002 and 2005 we have no catch numbers-at-age 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 is comprised of individuals of 3-5 years of age. In year 2006, catches containing mostly age 4 individuals. In 2007 there has been much more spread over the ages, and in 2008 the greatest presence is between 2 and 4.

Figure 4 shows standardised catch proportions at age (each year standardised independently to have zero mean and standard deviation 1 over the range of years considered). Grey and black values indicate values above and below the average, respectively, and the larger the bubble size the larger the magnitude of the value. 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.

Mean weight-at-age

In past assessments, mean weight-at-age in the catch has been computed separately from mean weight-at-age in the stock. For the 2008 commercial catch we have only one length-weight relationships available, arising from Portuguese sampling. For the survey data, we have the length-weight relationship from the EU survey. Both are presenting in Figure 5. In general the commercial data calculate weights that are higher than those from the EU survey. 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.

Dividing the estimated total catch weight by the SOP (sum over ages of the product of catch weight-at-age and numbers at age), the result is practically 1 (1.0012).

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 at depths of more than 500 m. The fishing procedure has 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 survey indices of abundance at age are presented in Table 3. Figure 6 displays the time series of biomass and abundance indices. Biomass and abundance levels show some increase since 2005, highest in biomass than in abundance, following an extremely low period starting in the mid 1990's. Figure 7 displays 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 (age 1) failures from 1996 to 2004, leading to very weak cohorts. Cohorts recruited in or after 2005 appear to be a bit stronger than average.

Mean weight-at-age in the stock, derived from the survey data, shows a strong increasing trend since the late 1990's, although in 2008 all the ages decrease its mean weight-at-age (see Table 5 and Figure 8).

Maturity at age

There are available ogives data for years 1990-1998 and 2001-2006. For those years logistic regression models for proportion mature at age have been fitted independently for each of the years for which data are available. For 1988 and 1989 the same maturity ogive fitted for 1990 is used. For 2007 and 2008, for which no maturity data have yet been analysed, the ogive for 2006 is used. For 1999 and 2000, maturity ogives computed as mixtures of those fitted for 1998 and 2001 are used. The maturity data for 1991 was of poor quality and did not allow a good fit, so a mixture of the ogives for 1990 and 1992 is used for that year.

Figure 9 displays the evolution of the a50 (age at which 50% of fish are mature) through the years (estimate and 90% uncertainty limits), derived from the maturity ogives. The figure shows a continuous decline of the a50 through time, from above 5 years of age in the late 1980's to just above 3 years of age since about year 2000.

Figure 10 displays the evolution of the l50 (length at which 50% of fish are mature) through the years, estimated applying logistic regression to proportion mature at length data, separately for each year. The figure shows a steep decline of the l50 until the mid 1990's, followed by a slower increase since then. This is not inconsistent with the idea of fish growing faster (Figure 8) while maturing at younger ages (Figure 9).

Assessment methodology

The last year approved Bayesian model was used to update the results with data from 2008. The Bayesian model has been developed in a way that allows maximal incorporation of catch information. For the years with catch numbers-at-age, it works starting from cohort survivors and reconstructing cohorts backwards in time using catch numbers-at-age and the assumed natural mortality rate. For the other years, if an estimate of total catch 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 to combine years for which catch numbers-at-age are available with years where only estimates of total catch weight are had. Years with no information on commercial catch are also allowed. Of course, the more and the better the quality of the catch information, the more reliable the results will be. A detailed description of the model is in Fernandez *et al.*, 2008. The priors were chosen this year as last year assessment. The inputs of the assessment of this year are the following ones:

Catch data for 21 years, from 1988 to 2008

Years with catch numbers at age: 1988-2001, 2006-2008

Tuning with EU survey for 1988 to 2008

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 (2008, a), a=1,…,7 and (y, 7), y=1,…,2007

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

where medrec=15000

medFsurv=c(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 weight in the years with no catch-at-age data:

For y=2001,…,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,…,2008

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

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

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

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

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

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:

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

Last year 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. As the results seem not to fit appropriately the retrospective pattern, and looking for a reason for this lack of fit, we found out that when an uncertainty is given to the natural mortality, M, via a prior density, the results of the retrospective pattern are no as we could expect. So, in order to avoid this problem, a run with the M constant and equal to 0.2, which is a setting used commonly in stock assessment and was used for this stock until last year, was performed. The results for this additional run are given and compared with the ones of the run with M with uncertainty.

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

Results

Figure 11 displays the assessment results regarding to total biomass, SSB, recruitment and F_{bar} (ages 3-5). The continuous blacklines in the figure are the posterior medians and the dashed lines show the limits of 90% posterior credible intervals (capturing uncertainty in the estimates). The actual numbers leading this figure are presented in Table 7.

The panel relating to SSB includes also the projection value at the beginning of the year 2009. The results indicate that there has been a substantial increase in SSB in the last few years, with the largest increase happening during the year 2008, and for this year SSB is above B_{lim} for the first time since 1995, although the 5% credible interval is still below B_{lim}. The projected SSB at the beginning of 2009 is the maximum of the time series, although the uncertainty associated with this value is very high. This larger uncertainty arises from the fact that no information from the EU survey or commercial catch in 2009 is available at present. Neither is information yet had about weight-at-age or maturity-at-age for 2009 and random draws from the three last years for which there is weight and maturity information are used for 2009 (assuming always that maturity at age 1 is equal to 0, as there is no estimate of recruitment in 2009). The red horizontal line in the SSB panel represents B_{lim} = 14000.

Years 2005-2008 have seen an improvement in recruitment related to the period studied, although the actual recruitment levels for these years can not yet be precisely estimated (see the wide uncertainty limits in the figure and table). Recruitment estimates for these years will become more precise as information on more cohort ages is gathered during the next few years.

F_{bar} continues to be at very low levels, although an increase has been estimated for 2006. In 2007, F_{bar} had again fallen to a very low value, with a slight increase in 2008 but still below the 2006 value.

Figure 12 shows the abundance by year comparing with the biomass by year. Except in the first years of the assessment, there is a good concordance between numbers and weight, although in 2008 the biomass increased more than the abundance.

Table 8 and Figure 13 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 2008 the higher fishing mortalities are in ages 5 and 6.

Estimates of stock abundance at age for the assessment period and the following year (1988- 2009) are presented in Table 9 and Figure 14. For 2009, only abundances of ages $a \geq 2$ can be estimated, as they are the survivors from individuals in the last assessment year (2008).

Figure 15 depicts the prior distribution (in red) and posterior (in black) of survivors at age at the end of the final year of the assessment, where by survivors(2008, a) it is meant individuals of age a + 1 at the beginning of 2009 (in other words, survivors(2008, a) = N (2009, a + 1)). The plotting range for the horizontal axis is the 95% prior credible interval in all cases (the same procedure will be followed in all subsequent prior-posterior plots), to facilitate comparison between prior and posterior distributions. For survivors of ages 5 and older, there has been very substantial updating of the prior distribution. This is much less the case for younger ages, with prior and posterior distributions being much closer for those ages. Similarly to the comment made regarding uncertainty in recruitment estimates, the latter was to be expected as few ages of these cohorts have been observed to date.

Figure 16 displays prior distributions (in red) and posterior distributions (in black) 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 year 2008.

For the years without catch numbers-at-age, there are also prior distributions on F-at-age and the same prior distribution has been chosen in each of such years. Prior (in red) and posterior (in black) densities are displayed in Figure 17, indicating that there is enough information to update the prior distribution.

Bubble plot of raw residuals (observed minus fitted values) for the EU survey abundance indices at age in logarithmic scale are presented in Figure 18. 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) for the EU survey abundance at age indices in logarithmic scale, are displayed in Figure 19. 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. Most of the residuals are indeed in (—2, 2) range. 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). In 2008, all residuals are positive except the one for age 1.

Results regarding the EU survey's catchabilities are displayed in Figures 20 and 21. The first of these figures shows results for the parameter $\log(\varphi(a))$, which corresponds to log(catchability) for ages $a \geq 3$. For ages a = 1, 2 catchability depends also on stock abundance and this dependence is regulated via the parameter $\gamma(a)$, for which results are in Figure 21. The posterior probability that $\gamma(a) > 1$ for a = 1, 2 is very high, pointing towards an increase in survey catchabilities for the younger ages as abundance of those ages increases.

Figure 22 shows a stock-recruitment plot and Figure 23 a stock-F_{bar} plot, both with the 14000 value of B_{lim} indicated with a vertical red line.

Tables 10-12 and Figures 24-36 show the results of the model with M constant and equal 0.2. The results are virtually the same, although there are some minor differences. In general, the model with M constant estimates higher indices (biomass and abundance) and lower F_{bar}. But the principal difference is in the credible intervals, which in general are narrower for the case of M constant, especially for the numbers-at-age in the youngest ages, which comprise the principal amount of numbers in most of the years. For F-at-age, for the youngest individuals (age 1 and 2) the run with M constant estimates it to be a bit lowest, and no changes in the rest.

Retrospective pattern

Following the recommendation of the NAFO SC, a retrospective analysis of six years was made. The retrospective pattern shows as a very strange pattern in all the years. It seems that the model with M with uncertainty doesn't converge trough the years (Figure 38). If we put a constant M equal to 0.2, the pattern of the retrospective is the same for all the retrospective years (Figure 39). But the pattern for the two plots in the retrospective years is the same. The plot shows that the recruitment is over estimated year by year except in the last year that was underestimated. The SSB was overestimated in the first retrospective years, but not in the final. The pattern for biomass and F_{bar} seems to be stable.

Projections

Stochastic projections of the stock dynamics over a 3 year period (2010-2012) have been performed. The variability in the input data is taken from the results of the Bayesian assessment. Input data for the projections were chosen on the basis of the last three assessment years (2006-2008), except when there was some reason to consider this unrealistic. Input data are as follows:

Numbers aged 2 to 8+ in 2008: estimates from the assessment

Recruitments for 2009-2012: Recruits per spawner were estimated for each of the assessment years (Figure 39). As the last 3 years have a much higher value than the average over the assessment period, using just the last 3 years was not considered realistic. Hence, in the projections, recruits per spawner were drawn randomly from the values in all of the assessment years (1988-2008).

Maturity ogive: Drawn randomly from the maturity ogives (with their associated uncertainty) of years 2004, 2005 and 2006 (2007 and 2008 was not used since no data were available to estimate an ogive for that year).

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

PR at age for 2008-2011: Average of the PRs estimated for last 3 assessment years (Figure 40).

Fbar(ages 3-5): Three options were considered:

1. Average of F_{bar} in 2006-2008 (median value at 0.096).
2. $F_{0.1}$ (median value at 0.135).
3. Average of F_{bar} in 1988-1995 (median value at 0.951), as these years correspond to the period when SSB was above Blim.

Results for the 3 year projection period are presented in Tables 13-18 and Figures 41-43. They indicate that fishing at the very low F_{bar} value currently estimated for 2006-2008 or even fishing at $F_{0.1}$ (which is higher than the average F_{bar} over the last 3 years), SSB has a probability of 1 of reaching levels above than those estimated for the late 1980's. However, the huge increase seen in SSB does not have a counterpart in terms of population abundance of mature individuals, which is projected to remain at levels well below those of the late 1980's. This is largely 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. In order to know how much this fact affects the numbers and the SSB, we calculated the posterior results and the projection plots for the case in which we had now the same maturity ogive as in the first part of the assessment period. So, we run the model with the ogive at age and the weight-at-age as the mean of the ogive at age and weight-at-age from years 1988 and 1995, respectively. We only show here the result plots, which are the Figure 49 for the posterior results and Figures 50-52 for the three different projection scenarios. In this case the view of the stock is completely different, with SSB below B_{lim} in 2008 and even in the projected 2009. Nevertheless, the projection in the two scenarios with $F_{0.1}$ and F_{bar} the average of the three last years shows us that the SSB can be above the B_{lim} at the end of the projection period.

Projections option 3 corresponds to the level of fishing mortality seen during the late 1980's and beginning of the 1990's. Results indicate that recovery of the stock under such fishing pressure would be no too probable.

The projected values for the period 2010-2012 are heavily reliant on the relatively abundant three most recent cohorts, namely those recruited in 2005-2008, rather than on healthy population abundances across all ages, making the stock status much more fragile than suggested by SSB values alone.

As a redfish fishery has developed in recent years in depths shallower than 350 m, and as cod is a bycatch species of that fishery, it may be surmised that catch levels of cod will continue to rise during the next few years.

The projection results for the model run with M constant are given, too. In this case, for the first scenario, we have a median value of F_{bar} of 0.091. For the second, a value of 0.15, and for the third scenario, 0.924. So, the values are quite similar than the ones calculated with the model with M with uncertainty. And the results of the projections are virtually the same. So, we can say that, except for the retrospective pattern, there are no significant differences between the two models.

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Table 1.- Total cod catch in Flemish Cap. Reported nominal catches since 1959 and estimated total catch since 1988 in tons

Year	Estimated	Faroes	Japan	Korea	Norway	Portugal	Russia	Spain	UK	France	Poland	Others	Total
1959					11		6470	466				2	6949
1960		260			166	9	11595	607			2	96	12735
961		246			116	2155	12379	851	600	2626	336	1548	20857
1962		188	1		95	2032	11282	1234	93		888	363	16176
1963		969	35		212	7028	8528	4005	2476	9501	1875	853	35482
1964		1518	333		1009	3668	26643	862	2185	3966	718	1172	42074
1965		1561			713	1480	37047	1530	6104	2039	5073	771	56318
1966		891			125	7336	5138	4268	7259	4603	93	259	29972
1967		775			200	10728	5886	3012	5732	6757	4152	802	38044
1968		852	223		697	10917	3872	4045	1466	13321	71	235	35699
1969		750	30		1047	7276	283	2681		11831		42	23940
1970		379	34		1347	9847	494	1324	3	6239	53	1	19721
1971		708	6		926	7272	5536	1063		9006	19	1647	26183
1972		6902			952	32052	5030	5020	4126	2693	35	693	57503
1973		7754			417	11129	1145	620	1183	132	481	39	22900
1974		1872			383	10015	5998	2619	3093		700	258	24938
1975		3288			111	10430	5446	2022	265		677	136	22375
1976		2139			1188	10120	4831	2502		229	898	359	22266
1977		5664	24		867	6652	2982	1315	1269	5827	843	1576	27019
1978		7922	22		1584	10157	3779	2510	207	5096	615	1239	33131
1979		7484	74		1310	9636	4743	4907		1525	5	26	29710
1980		3259	37		1080	3615	1056	706		301	33	381	10468
1981		3874	9		1154	3727	927	4100		79		3	13873
1982		3121	10	4	375	3316	1262	4513	33	119			12753
1983		1499	1		111	2930	1264	4407				3	10215
1984		3058	9		47	3474	910	4745				459	12702
1985		2266	5		405	4376	1271	4914				438	13675
1986		2192	6			6350	1231	4384				355	14518
1987		916	269			2802	706	3639		2300			10632
1988	28899	1100	5	6		421	39	141				6	1718
1989	48373		38	321		170	10	378					917
1990	40827	1262	24	815		551	22	87				1	2762
1991	16229	2472	54	82	897	2,838	1	1416	26			1,203	8989
1992	25089	747	2	18		2,201	1	4215	5			6	7226
1993	15958	2931		3		3,132		2249				1	8316
1994	29916	2249			1	2,590		1952					6885
1995	10372	1016				1,641		564					3221
1996	2601	700				1,284		176	129			16	2305
1997	2933					1,433		1	23				1457
1998	705					456							456
1999	353					2							2
2000	55					30	6						36
2001	37					56							56
2002	33					32	1						33
2003	16					7						9	16
2004	5					18	2					3	23
2005	19	7				16						3	26
2006	339					51	1	16				55	123
2007	345		10			58	6	33				18	125
2008	889		25			214	74	43				42	398

Table 2.- Catch numbers-at-age for the assessment years

	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

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

Table 4.- Weight at age (kg) in stock for the assessment years

	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	5.82	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

Table 5.- Weight at age (kg) in catch for the assessment years

year	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	0.000	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	0.000	0.298	0.414	0.592	1.093	1.704	2.619	3.865
1993	0.000	0.210	0.509	0.894	1.829	2.233	3.367	4.841
1994	0.142	0.289	0.497	0.792	1.916	2.719	2.158	4.239
1995	0.000	0.000	0.415	0.790	1.447	2.266	3.960	5.500
1996	0.000	0.286	0.789	1.051	1.543	2.429	4.000	5.025
1997	0.000	0.000	0.402	0.640	0.869	1.197	1.339	
1998	0.000	0.337	0.719	1.024	1.468	1.800	2.252	3.862
1999	0.000	0.000	0.92	1.298	1.848	2.436	3.513	4.893
2000	0.000	0.583	0.672	1.749	2.054	2.836	3.618	
2001	0.000	0.481	1.253	1.696	2.560	3.419	3.905	5.217
2002	0.000	0.588	1.323	1.388	2.572	3.770	5.158	5.603
2003	0.000	0.462	1.063	1.455	2.978	3.696	5.859	6.120
2004	0.000	0.839	1.677	2.009	3.353	5.576	6.241	8.273
2005	0.000	0.895	1.618	2.368	3.259	4.767	6.177	6.553
2006	0.000	1.081	1.462	2.283	3.966	5.035	6.332	10.397
2007	0.000	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

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

	1	2	3	4	5	6	7	8
1988	0.046	0.088	0.161	0.276	0.432	0.602	0.751	0.887
1989	0.046	0.088	0.161	0.276	0.432	0.602	0.751	0.887
1990	0.046	0.088	0.161	0.276	0.432	0.602	0.751	0.887
1991	0.015	0.041	0.103	0.236	0.453	0.689	0.863	0.959
1992	0.003	0.011	0.047	0.181	0.492	0.811	0.95	0.992
1993	0.001	0.007	0.050	0.278	0.739	0.955	0.994	0.999
1994	0.000	0.003	0.067	0.649	0.979	0.999	1.000	1.000
1995	0.000	0.000	0.026	0.796	0.998	1.000	1.000	1.000
1996	0.000	0.001	0.036	0.630	0.987	1.000	1.000	1.000
1997	0.001	0.009	0.118	0.663	0.967	0.998	1.000	1.000
1998	0.000	0.007	0.180	0.870	0.995	1.000	1.000	1.000
1999	0.000	0.004	0.182	0.888	0.998	1.000	1.000	1.000
2000	0.000	0.003	0.188	0.906	0.999	1.000	1.000	1.000
2001	0.000	0.002	0.195	0.967	1.000	1.000	1.000	1.000
2002	0.000	0.020	0.615	0.992	1.000	1.000	1.000	1.000
2003	0.003	0.053	0.519	0.955	0.998	1.000	1.000	1.000
2004	0.000	0.001	0.148	0.961	1.000	1.000	1.000	1.000
2005	0.04	0.170	0.499	0.828	0.958	0.991	0.998	1.000
2006	0.000	0.016	0.366	0.953	0.999	1.000	1.000	1.000
2007	0.000	0.016	0.366	0.953	0.999	1.000	1.000	1.000
2008	0.000	0.016	0.366	0.953	0.999	1.000	1.000	1.000

Table 7.- Posterior results: total biomass, SSB, Recruitment and F_{bar}. M with uncertainty.

	B quantiles			SSB quantiles			R quantiles			F_{bar} quantiles		
Year	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**
1988	66026	60922	73561	18948	15189	23683	14930	12110	19531	0.504	0.456	0.542
1989	106453	99591	116010	33088	26929	40514	19880	16630	25020	0.857	0.796	0.904
1990	65514	61446	71306	25325	21606	29691	25020	21300	30790	0.893	0.829	0.944
1991	45206	41669	50394	18003	15030	22009	63150	54790	75842	0.491	0.454	0.521
1992	58951	55440	63956	21175	18639	24263	57405	49340	69913	1.534	1.449	1.599
1993	46858	43481	51772	10955	9089	13931	3122	2690	3878	1.019	0.944	1.079
1994	50701	47163	56924	22504	19270	28235	4647	3407	6967	0.945	0.892	0.985
1995	23061	21636	25299	19590	18275	21550	2329	1886	3109	1.373	1.214	1.481
1996	6150	5363	7395	3671	3195	4472	155	101	250	0.615	0.498	0.717
1997	5374	4466	6814	3649	2931	4777	147	93	245	0.669	0.521	0.816
1998	4209	3024	6111	3970	2811	5830	216	153	331	0.262	0.189	0.356
1999	3072	2082	4857	2903	1923	4672	36	26	56	0.246	0.183	0.327
2000	2881	1795	4805	2693	1618	4622	367	222	615	0.170	0.116	0.242
2001	2314	1656	3270	2081	1418	3026	644	402	1054	0.031	0.021	0.045
2002	2680	2018	3617	2335	1678	3244	79	49	135	0.014	0.007	0.029
2003	2956	2319	3837	2652	2019	3510	1225	796	2001	0.010	0.006	0.017
2004	4624	3799	5741	3869	3088	4936	89	62	138	0.003	0.002	0.005
2005	5004	4201	6016	4151	3458	5081	5110	2911	9211	0.006	0.004	0.010
2006	8572	6620	11415	4285	3426	5360	11635	6172	22070	0.197	0.144	0.265
2007	17171	12557	24151	6942	5167	9287	10275	4828	22411	0.028	0.021	0.039
2008	27616	19748	39656	15332	10702	22343	11640	4283	32830	0.061	0.042	0.088
2009				33805	22452	53260						

Table 8.- F at age (posterior median). M with uncertainty.

	F at age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1988	0.000	0.066	0.430	0.547	0.540	0.720	1.202	1.202
1989	0.000	0.004	0.434	0.856	1.286	0.849	1.089	1.089
1990	0.000	0.017	0.252	1.064	1.366	1.426	1.013	1.013
1991	0.000	0.029	0.515	0.362	0.597	0.775	0.921	0.921
1992	0.000	0.379	1.008	1.369	2.233	1.446	2.414	2.414
1993	0.000	0.061	0.712	1.257	1.092	1.745	1.075	1.075
1994	0.000	0.695	1.248	1.198	0.391	0.629	0.323	0.323
1995	0.000	0.000	0.296	1.416	2.418	3.122	1.427	1.427
1996	0.000	0.046	0.267	0.655	0.929	0.490	0.000	0.000
1997	0.000	0.000	0.804	0.487	0.701	0.663	0.524	0.524
1998	0.000	0.000	0.082	0.366	0.328	0.292	0.077	0.077
1999	0.000	0.000	0.168	0.209	0.349	0.101	0.041	0.041
2000	0.000	0.438	0.474	0.014	0.019	0.021	0.002	0.002
2001	0.000	0.032	0.000	0.055	0.035	0.000	0.012	0.012
2002	0.000	0.006	0.015	0.010	0.011	0.005	0.012	0.012
2003	0.000	0.005	0.009	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	0.008	0.005	0.003	0.003	0.003
2006	0.000	0.005	0.400	0.127	0.059	0.042	0.016	0.016
2007	0.000	0.000	0.009	0.019	0.055	0.044	0.071	0.071
2008	0.000	0.011	0.018	0.049	0.111	0.104	0.055	0.055

Table 9.- N at age (posterior median). M with uncertainty.

	N at age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1988	14930	59960	79665	28810	3651	878	490	248
1989	19880	12640	47570	43900	14100	1794	360	330
1990	25020	16840	10650	26130	15800	3279	647	197
1991	63150	21180	14020	7017	7624	3408	664	135
1992	57405	53470	17420	7095	4141	3545	1323	546
1993	3122	48620	30990	5386	1526	374	703	346
1994	4647	2646	38730	12880	1297	431	55	712
1995	2329	3923	1118	9415	3287	742	193	326
1996	155	1970	3317	704	1927	247	28	1
1997	147	131	1595	2146	309	643	128	1
1998	216	125	111	603	1114	129	280	29
1999	36	184	106	86	354	681	82	27
2000	367	31	155	76	59	212	520	1
2001	644	310	17	82	63	49	176	175
2002	79	545	253	14	65	51	42	294
2003	1225	67	458	211	12	54	43	282
2004	89	1039	56	385	176	10	46	275
2005	5110	75	878	48	324	148	8	273
2006	11635	4328	63	741	40	273	125	23
2007	10275	9801	3646	36	553	32	221	73
2008	11640	8676	8286	3058	30	442	26	70
2009		9828	7274	6877	2459	22	337	76

Table 10.- Posterior results: total biomass, SSB, Recruitment and F_{bar}. M constant.

	B quantiles			SSB quantiles			R quantiles			F_{bar} quantiles		
Year	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**
1988	69159	67602	72223	19662	15964	24437	17010	16930	17200	0.487	0.456	0.504
1989	110680	109092	113417	34123	27998	41189	22210	22110	22460	0.834	0.793	0.852
1990	67695	66202	70625	26098	22393	30215	27690	27640	27820	0.866	0.840	0.878
1991	47030	45517	50371	18593	15790	22328	69030	68860	69410	0.476	0.456	0.485
1992	60979	59973	63039	21623	19028	24647	63110	62580	64220	1.503	1.450	1.530
1993	48595	47449	51468	11225	9415	14190	3424	3278	3727	0.988	0.948	1.010
1994	51956	49588	57334	23027	19991	28509	5395	4410	7134	0.921	0.902	0.933
1995	23708	22791	25487	20033	18924	21776	2633	2383	3028	1.336	1.196	1.432
1996	6510	5852	7514	3813	3356	4574	182	129	261	0.588	0.482	0.681
1997	5685	4791	7057	3836	3116	4977	174	121	253	0.629	0.506	0.756
1998	4477	3248	6346	4220	3003	6051	250	191	343	0.242	0.180	0.330
1999	3301	2236	5065	3121	2065	4853	42	32	58	0.232	0.175	0.305
2000	3046	1916	4966	2836	1704	4756	431	286	633	0.157	0.110	0.221
2001	2415	1681	3499	2146	1430	3238	781	532	1129	0.029	0.020	0.041
2002	2752	2032	3790	2352	1642	3389	94	63	139	0.014	0.007	0.028
2003	2985	2288	3955	2638	1965	3581	1437	992	2071	0.010	0.006	0.017
2004	4672	3748	5849	3829	2984	4963	101	75	144	0.003	0.002	0.004
2005	5055	4144	6111	4130	3351	5057	5836	3529	9561	0.006	0.004	0.010
2006	9153	7158	11778	4393	3476	5522	13015	7309	23281	0.187	0.139	0.249
2007	18254	13605	24720	7139	5281	9540	11740	5619	24950	0.027	0.020	0.038
2008	28861	21037	40298	15807	11126	22614	12310	4746	34460	0.060	0.041	0.087
2009				34225	22835	53277						

Table 11.- F at age (posterior median). M constant.

	F at age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1988	0.000	0.061	0.411	0.530	0.522	0.703	1.190	1.190
1989	0.000	0.004	0.416	0.830	1.260	0.830	1.086	1.086
1990	0.000	0.016	0.238	1.031	1.334	1.397	1.003	1.003
1991	0.000	0.028	0.497	0.351	0.582	0.761	0.911	0.911
1992	0.000	0.362	0.976	1.335	2.204	1.425	2.430	2.430
1993	0.000	0.059	0.690	1.218	1.062	1.731	1.083	1.083
1994	0.000	0.655	1.216	1.173	0.380	0.615	0.328	0.328
1995	0.000	0.000	0.281	1.378	2.367	3.077	1.415	1.415
1996	0.000	0.042	0.246	0.628	0.898	0.474	0.000	0.000
1997	0.000	0.000	0.753	0.452	0.675	0.643	0.518	0.518
1998	0.000	0.000	0.075	0.340	0.304	0.284	0.076	0.076
1999	0.000	0.000	0.154	0.198	0.327	0.095	0.041	0.041
2000	0.000	0.393	0.439	0.014	0.018	0.020	0.002	0.002
2001	0.000	0.029	0.000	0.051	0.034	0.000	0.012	0.012
2002	0.000	0.006	0.014	0.010	0.011	0.005	0.012	0.012
2003	0.000	0.005	0.008	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	0.005	0.376	0.121	0.058	0.042	0.016	0.016
2007	0.000	0.000	0.008	0.019	0.054	0.044	0.073	0.073
2008	0.000	0.010	0.017	0.048	0.110	0.106	0.058	0.058

Table 12.- N at age (posterior median). M constant.

	N at age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1988	17010	64990	83870	29995	3803	906	500	252
1989	22210	13930	50040	45510	14460	1848	367	336
1990	27690	18180	11350	27040	16240	3357	660	201
1991	69030	22670	14660	7323	7896	3503	680	138
1992	63110	56510	18050	7297	4222	3614	1340	551
1993	3424	51670	32230	5566	1573	381	712	349
1994	5395	2803	39900	13240	1348	445	55	714
1995	2633	4417	1192	9683	3354	754	197	330
1996	182	2156	3616	737	1998	257	28	1
1997	174	149	1692	2315	322	666	131	1
1998	250	142	122	652	1206	134	287	30
1999	42	205	116	92	380	728	83	28
2000	431	34	168	82	62	224	542	1
2001	781	353	19	89	66	50	180	180
2002	94	639	281	15	69	52	41	291
2003	1437	77	520	226	12	56	42	270
2004	101	1176	63	422	183	10	45	256
2005	5836	83	962	51	345	149	8	248
2006	13015	4778	67	784	41	281	122	23
2007	11740	10655	3892	38	569	32	221	73
2008	12310	9608	8722	3160	30	441	25	68
2009		10077	7785	7016	2468	22	325	72

Table 13.- N-at-age in prediction years (medians) with $F_{bar}=F_{bar}$(mean 2006-2008). M with uncertainty.

Year/Age	1	2	3	4	5	6	7	8
2009	4159	9828	7274	6877	2459	22	337	76
2010	7664	3509	8229	5641	5427	1816	17	313
2011	10342	6482	2918	6370	4449	4007	1362	248
2012	12953	8793	5465	2261	4996	3293	2996	1213

Table 14.- Projections results with $F_{bar}=F_{bar}$(average 2006-2008). M with uncertainty.

	SSB quantiles			**P(SSB<B_{lim})**	**Yield quantiles**		
Year	5%	50%	95%		5%	50%	95%
2009	22470	34014	53131	0.0000	2315	3703	5994
2010	35759	52779	79514	0.0000	3752	6092	10017
2011	47234	72043	119464	0.0000	4518	7982	15210
2012	52676	91122	194496	0.0000	5401	10868	24922

Table 15.- N-at-age in prediction years (medians) with $F_{bar}=F_{0.1}$. M with uncertainty.

Year/Age	1	2	3	4	5	6	7	8
2009	4059	9828	7274	6877	2459	22	337	76
2010	7506	3467	8187	5454	5262	1717	16	297
2011	10149	6329	2925	6112	4155	3679	1224	224
2012	12116	8610	5261	2175	4646	2904	2626	1041

Table 16.- Projections results with $F_{bar}=F_{0.1}$. M with uncertainty.

	SSB quantiles			**P(SSB<B_{lim})**	**Yield quantiles**		
Year	5%	50%	95%		5%	50%	95%
2009	22418	33979	53143	0.0000	3176	5157	8369
2010	34128	51030	77397	0.0000	4899	8173	13800
2011	43499	67372	113316	0.0000	5671	10335	19982
2012	46992	82485	181975	0.0000	6573	13904	32655

Table 17.- N-at-age in prediction years (medians) with $F_{bar}=F_{bar}$(average 1988-1995). M with uncertainty.

Year/Age	1	2	3	4	5	6	7	8
2009	4150	9828	7274	6877	2459	22	337	76
2010	8080	3498	7670	2651	2893	565	6	112
2011	6075	6781	2695	2785	1119	664	150	31
2012	4743	5104	5320	974	1165	257	176	49

Table 18.- Projections results with $F_{bar}=F_{bar}$(average 1988-1995). M with uncertainty.

	SSB quantiles			**P(SSB<B_{lim})**	**Yield quantiles**		
Year	5%	50%	95%		5%	50%	95%
2009	22662	33971	52899	0.0002	17294	25241	37556
2010	17140	26421	42654	0.0070	14230	22026	37195
2011	11469	20598	47332	0.1508	8251	15941	49849
2012	6694	19497	74239	0.3500	5390	18103	84936

Table 19.- N-at-age in prediction years (medians) with $F_{bar}=F_{bar}$(average 2006-2008). M constant.

Year/Age	1	2	3	4	5	6	7	8
2009	4677	10077	7785	7016	2468	22	325	72
2010	8818	3829	8199	5877	5368	1776	16	290
2011	10853	7220	3112	6151	4486	3861	1293	223
2012	13518	8886	5870	2341	4704	3238	2799	1108

Table 20.- Projections results with $F_{bar}=F_{bar}$(average 2006-2008). M constant.

	SSB quantiles			**P(SSB<B_{lim})**	**Yield quantiles**		
Year	5%	50%	95%		5%	50%	95%
2009	22975	34453	53105	0.0002	2228	3562	5745
2010	35780	52362	79444	0.0000	3623	5774	9503
2011	46044	70528	116993	0.0000	4346	7540	14225
2012	50818	87360	191774	0.0000	5127	10050	22781

Table 21.- N-at-age in prediction years (medians) with $F_{bar}=F_{0.1}$. M constant.

Year/Age	1	2	3	4	5	6	7	8
2009	4992	10077	7785	7016	2468	22	325	72
2010	8803	4087	8153	5563	5135	1636	15	269
2011	11138	7207	3310	5821	4068	3407	1103	191
2012	12284	9119	5833	2350	4249	2702	2286	874

Table 22.- Projections results with $F_{bar}=F_{0.1}$. M constant.

	SSB quantiles			P(SSB<B_{lim})	Yield quantiles		
Year	5%	50%	95%		5%	50%	95%
2009	22975	34329	53337	0.0000	3598	5734	9030
2010	33801	50031	75869	0.0000	5577	8847	14174
2011	41642	64109	107496	0.0000	6281	10967	21423
2012	43444	76826	172860	0.0000	7161	14271	32791

Table 23.- N-at-age in prediction years (medians) with $F_{bar}=F_{bar}$(average 1988-1995). M constant.

Year/Age	1	2	3	4	5	6	7	8
2009	4673	10077	7785	7016	2468	22	325	72
2010	8657	3824	7680	2838	2914	564	6	101
2011	6396	7087	2892	2802	1169	664	144	27
2012	5322	5235	5417	1046	1166	268	169	43

Table 24.- Projections results with $F_{bar}=F_{bar}$(average 1988-1995). M constant.

	SSB quantiles			P(SSB<B_{lim})	Yield quantiles		
Year	5%	50%	95%		5%	50%	95%
2009	23056	34380	53258	0.0000	17254	24921	36876
2010	17567	26752	42351	0.0068	14183	21716	36212
2011	11797	21113	47259	0.1338	8086	15856	50594
2012	6694	19409	79256	0.3594	5243	17520	85137

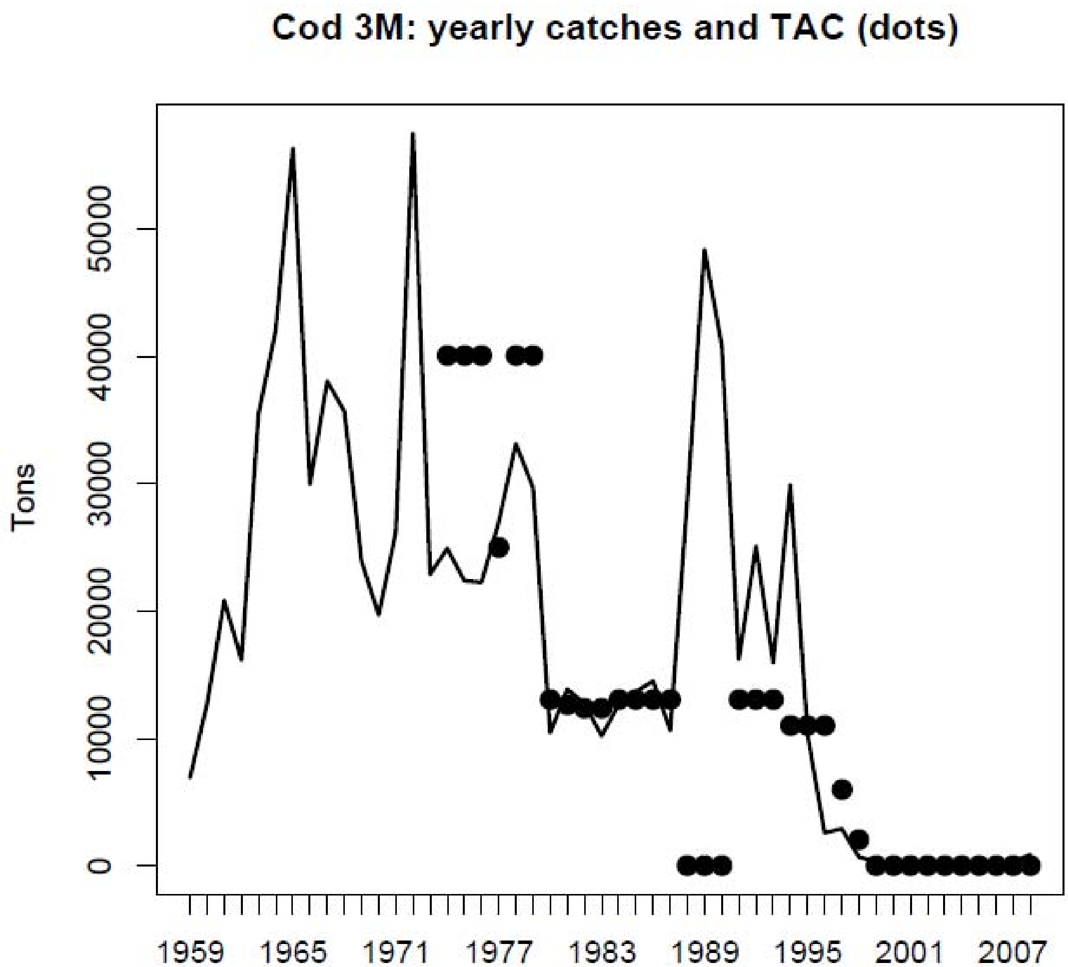

Figure 1.- Catch and TAC of the 3M cod

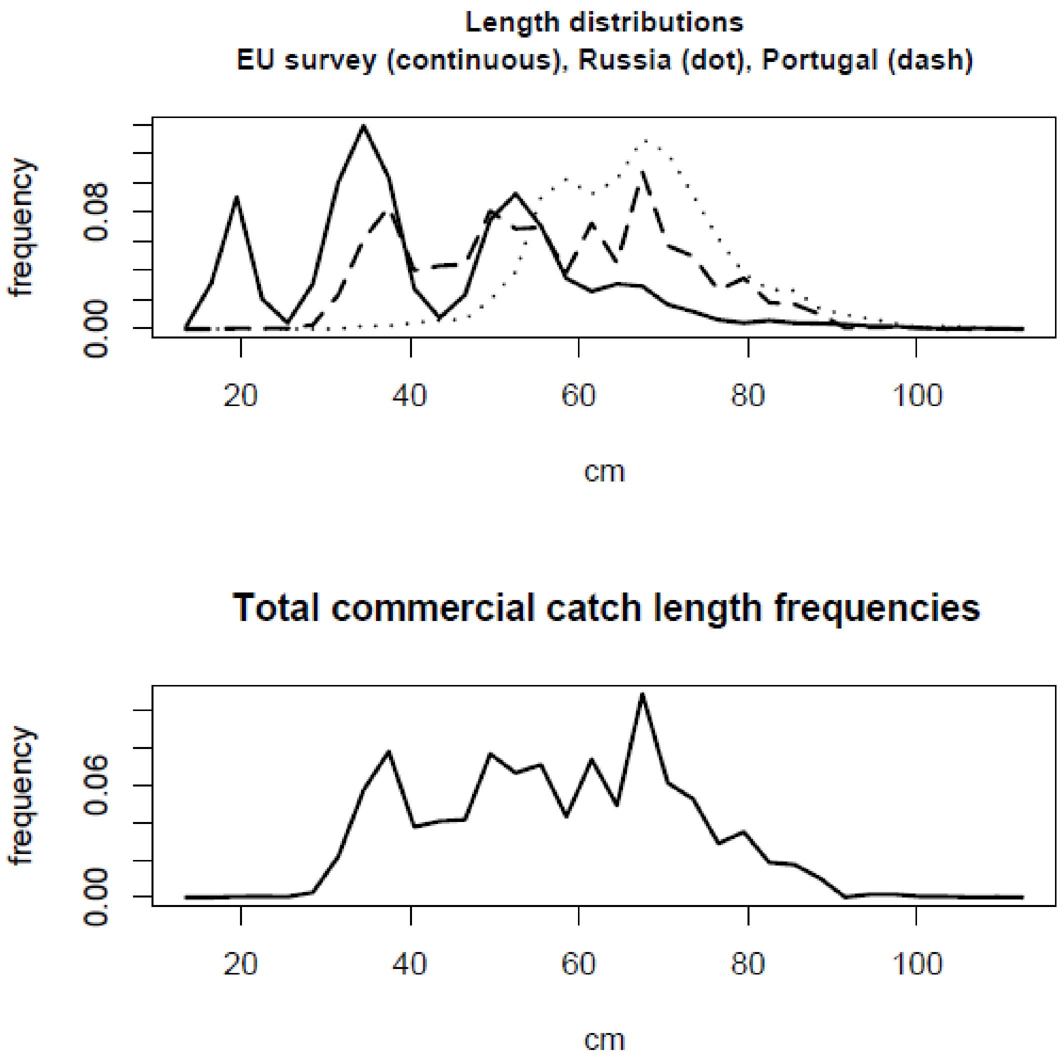

Figure 2.- Length frequencies in 2008

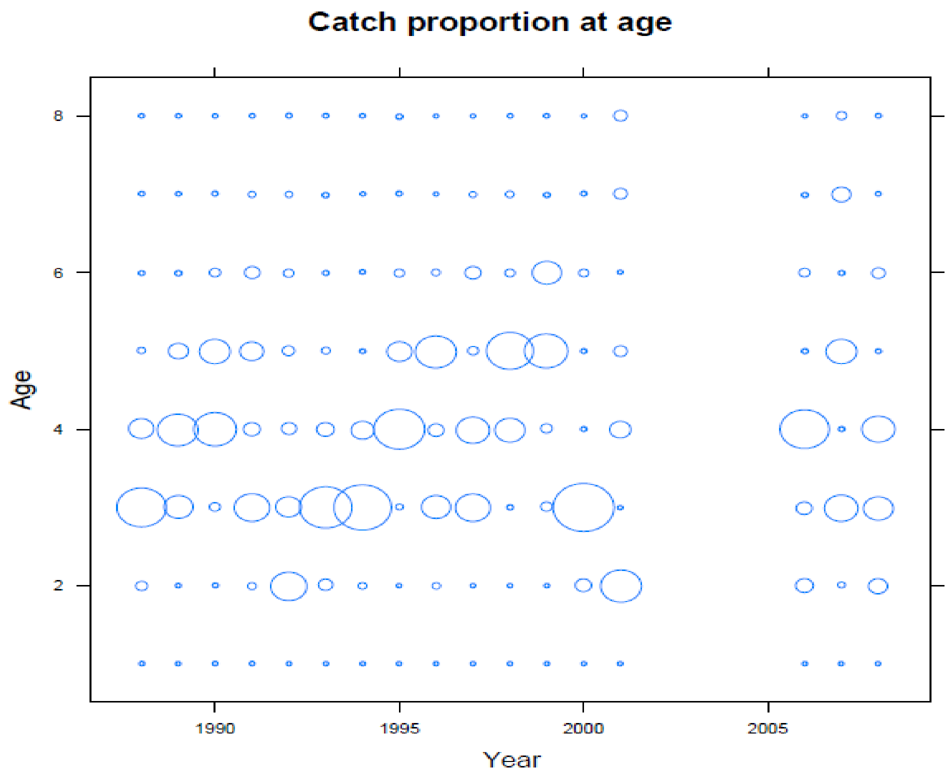

Figure 3.- Commercial catch proportions at age

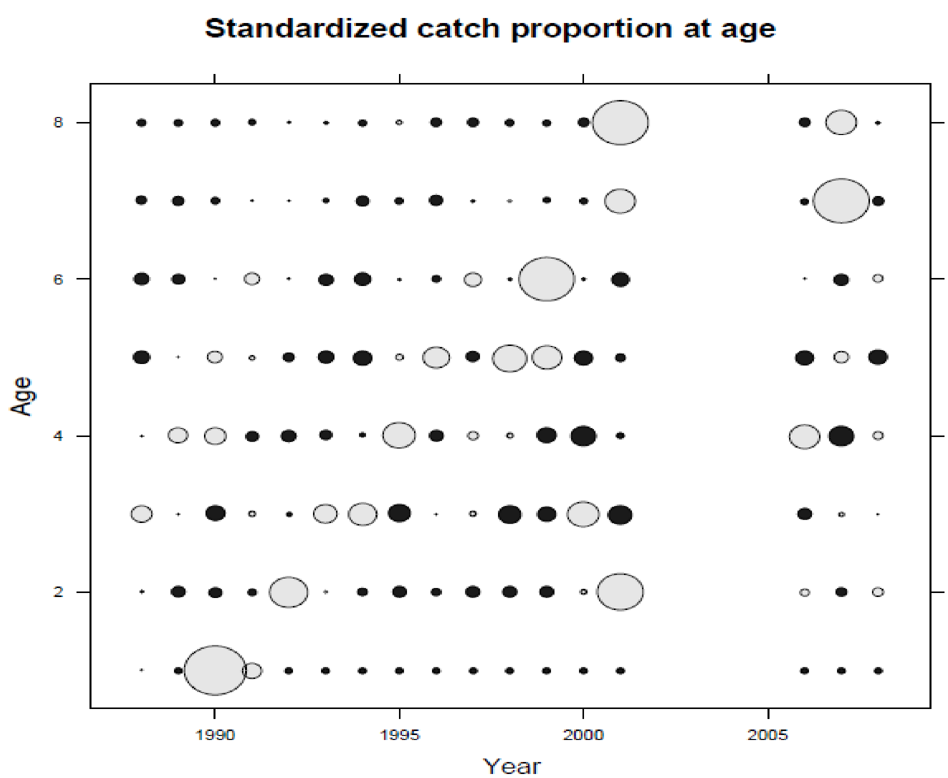

Figure 4.- Commercial catch standardised proportions at age

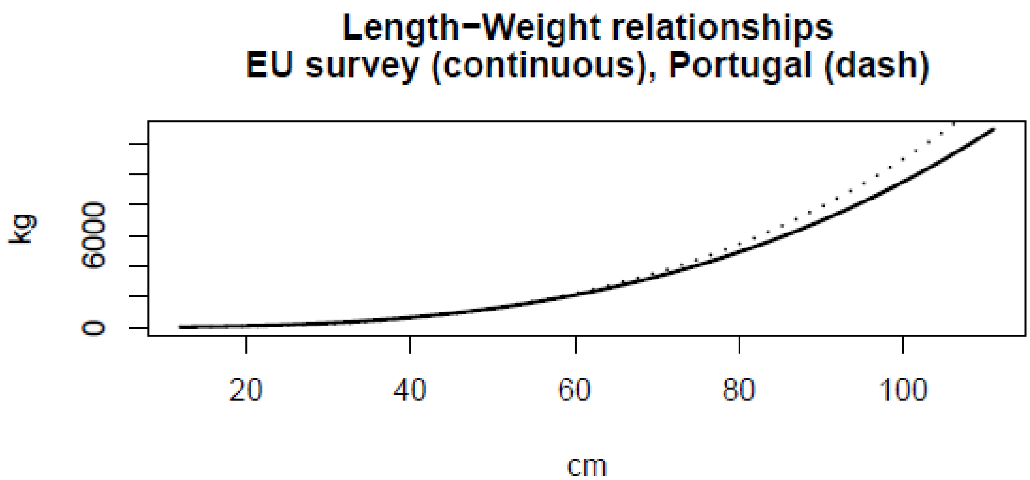

Figure 5.- Length-weight relationship

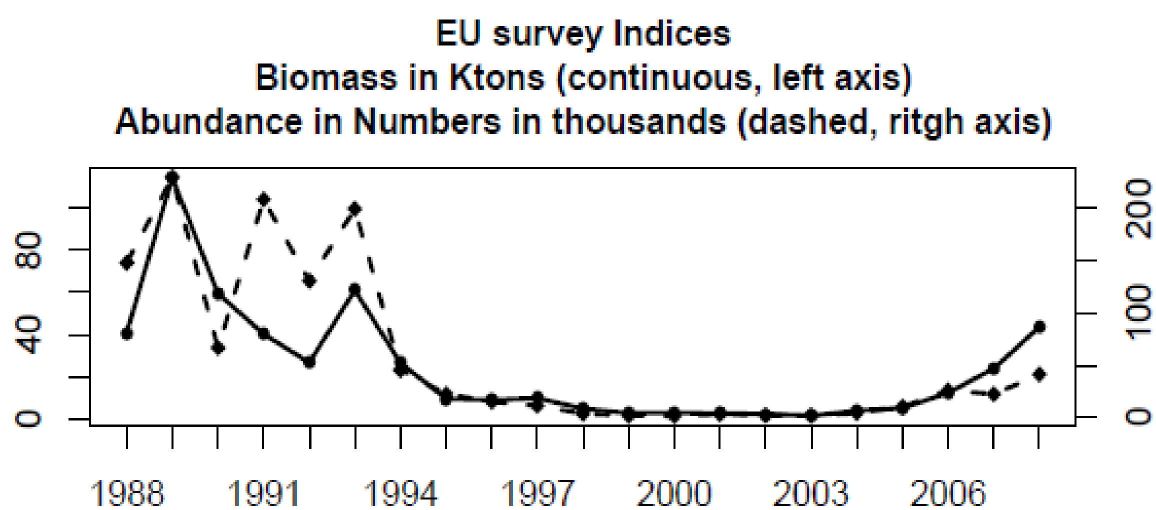

Figure 6.- Indices from EU survey

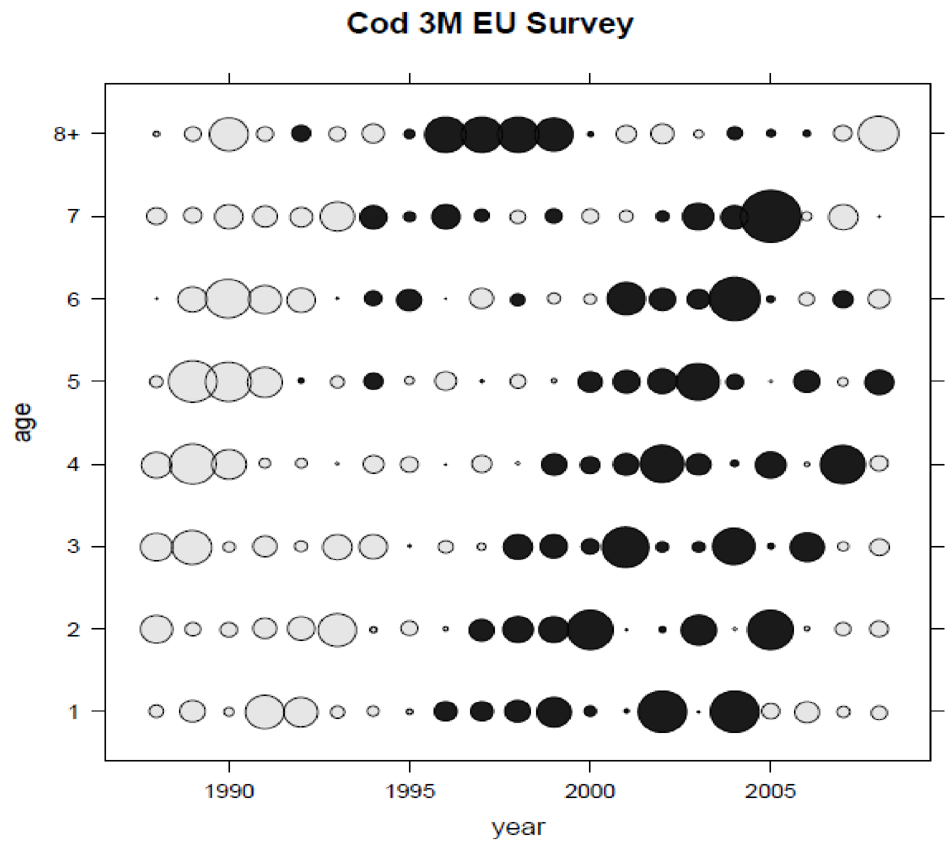

Figure 7.- Standardised log(1+Abundance at age) indices from EU survey

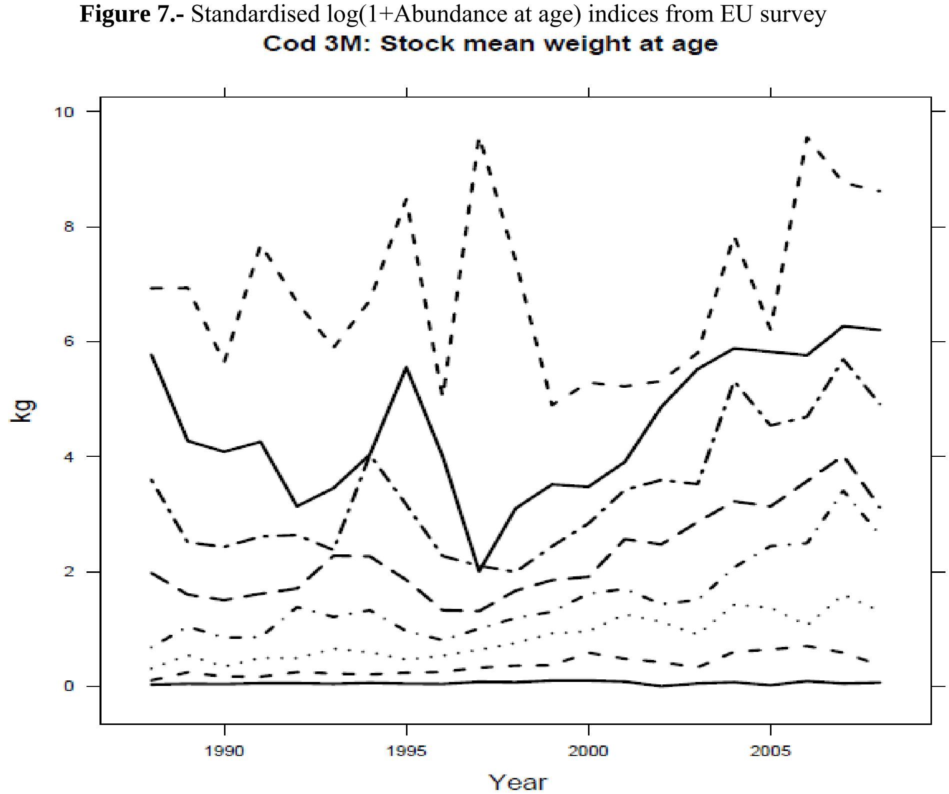

Figure 8.- Stock mean weight at age

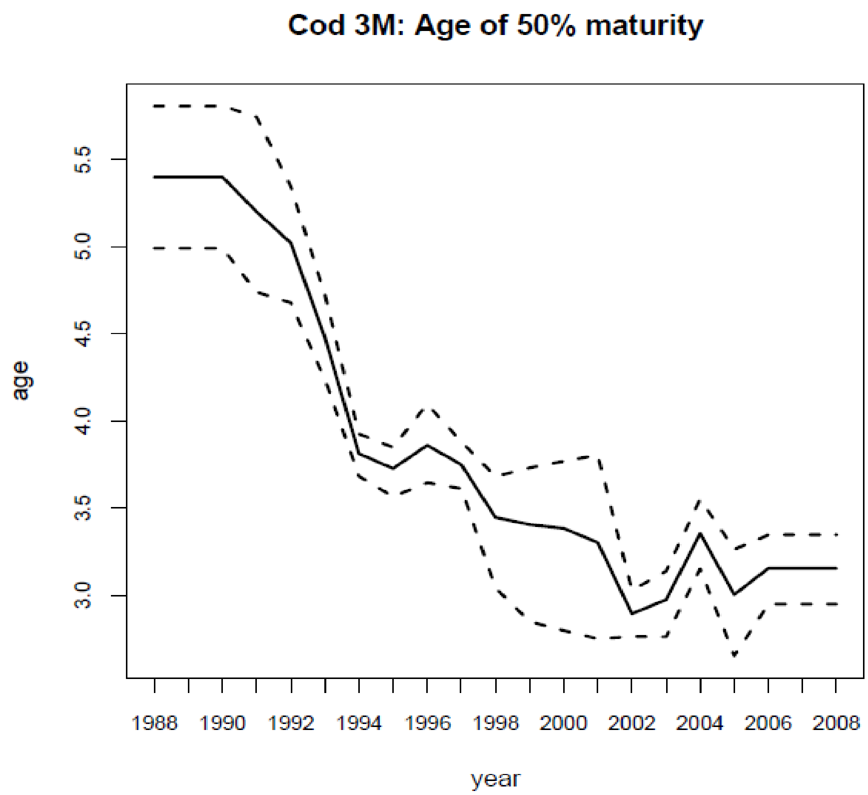

Figure 9.- Age at which 50% of fish are mature

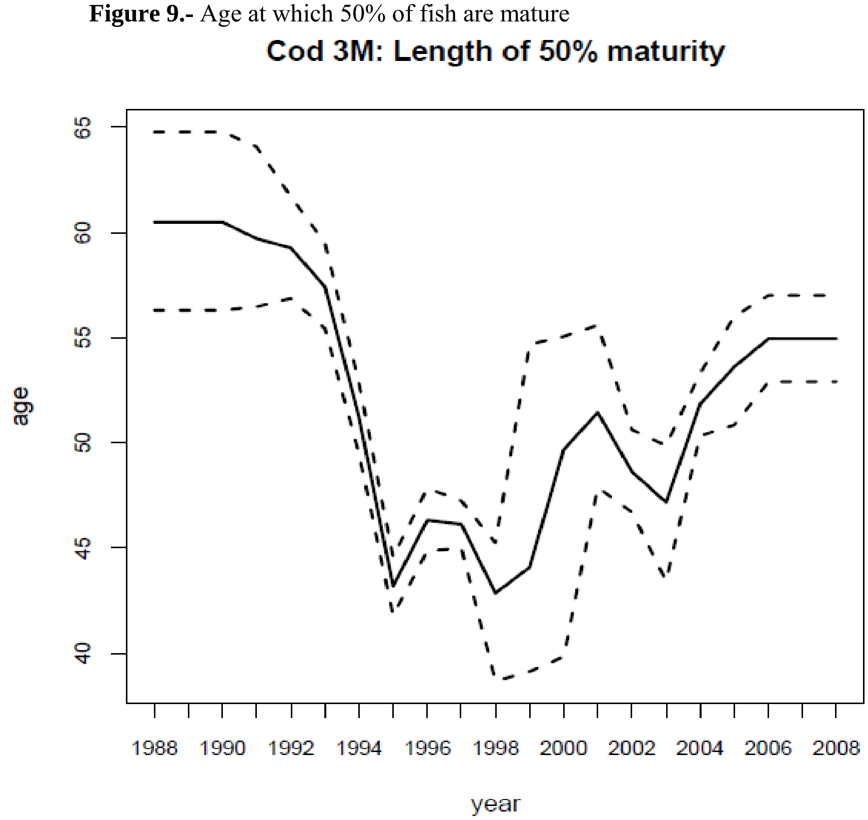

Figure 10.- Length at which 50% of fish are mature

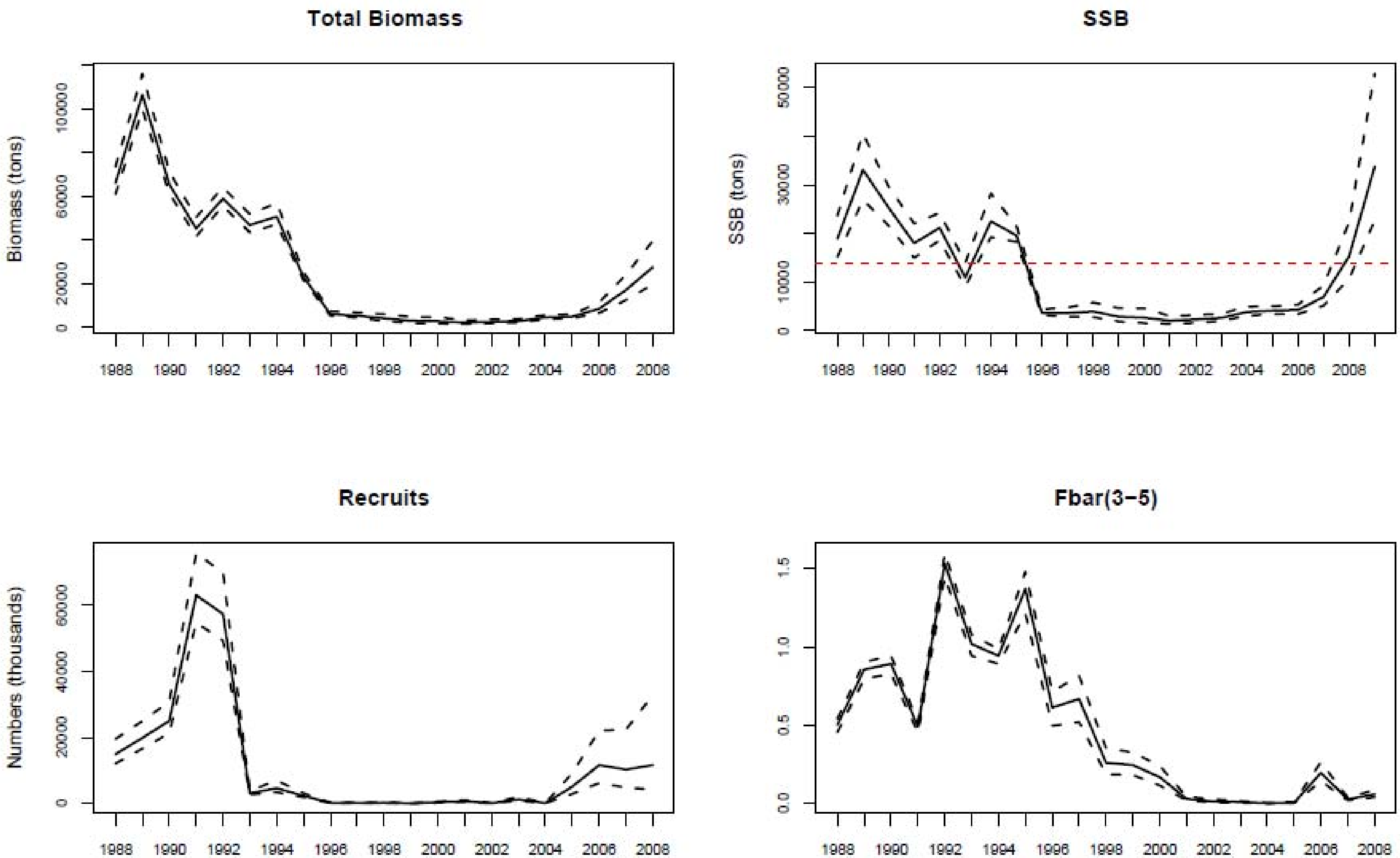

Figure 11.- Estimated trends in Biomass, SSB, recruitment and F_{bar}. M with uncertainty.

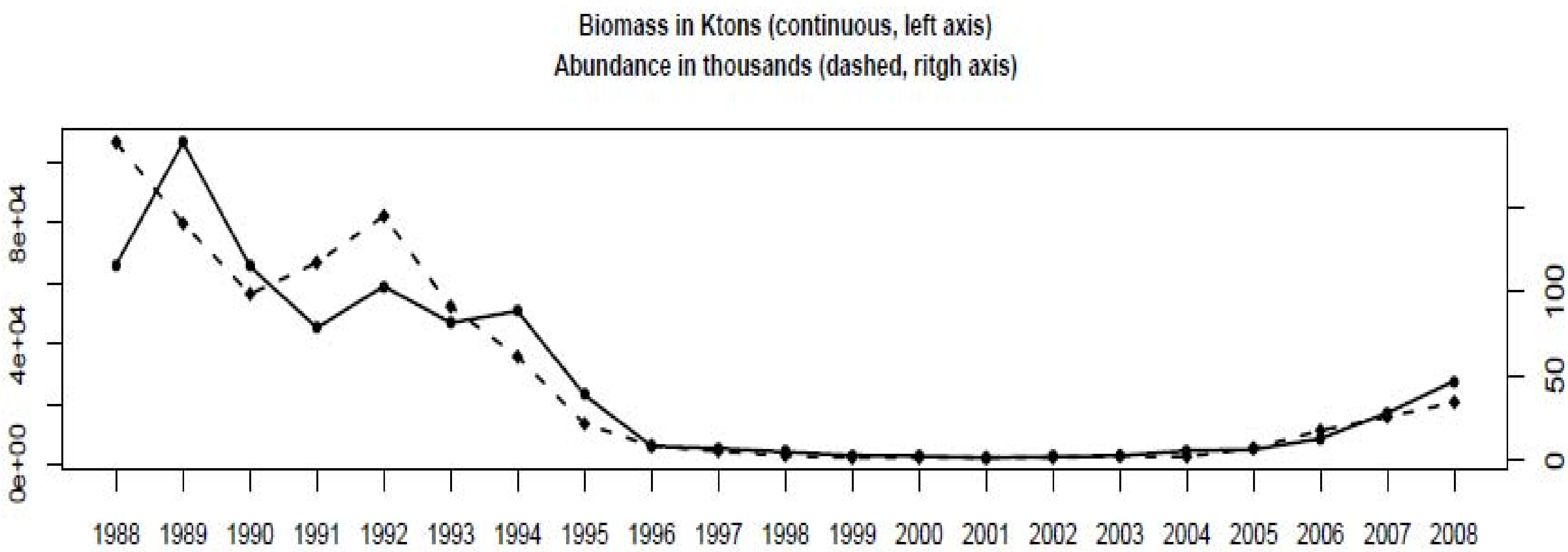

Figure 12.- Estimated trends in biomass and abundance. M with uncertainty.

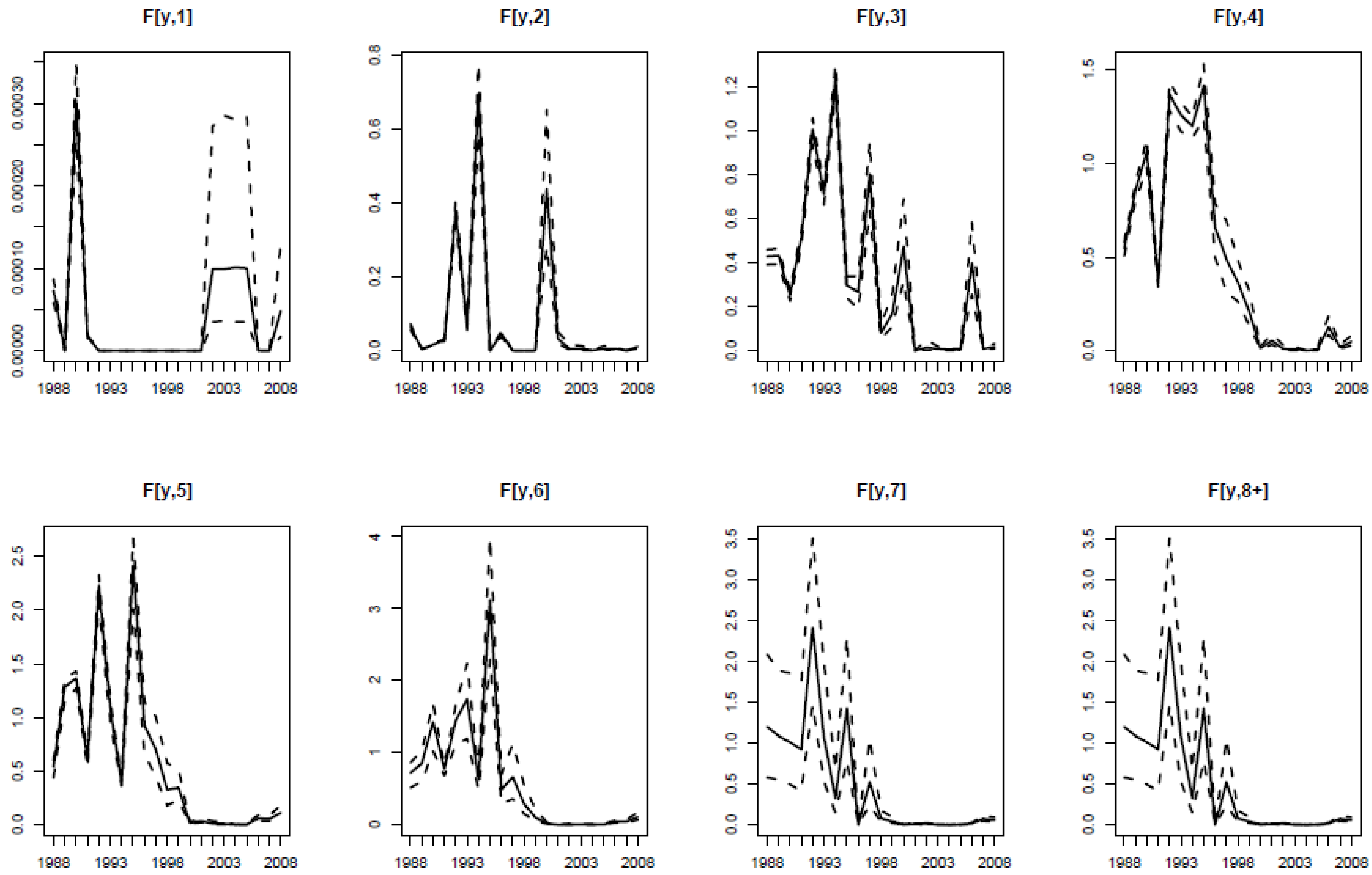

Figure 13.- Estimated fishing mortality at age. M with uncertainty.

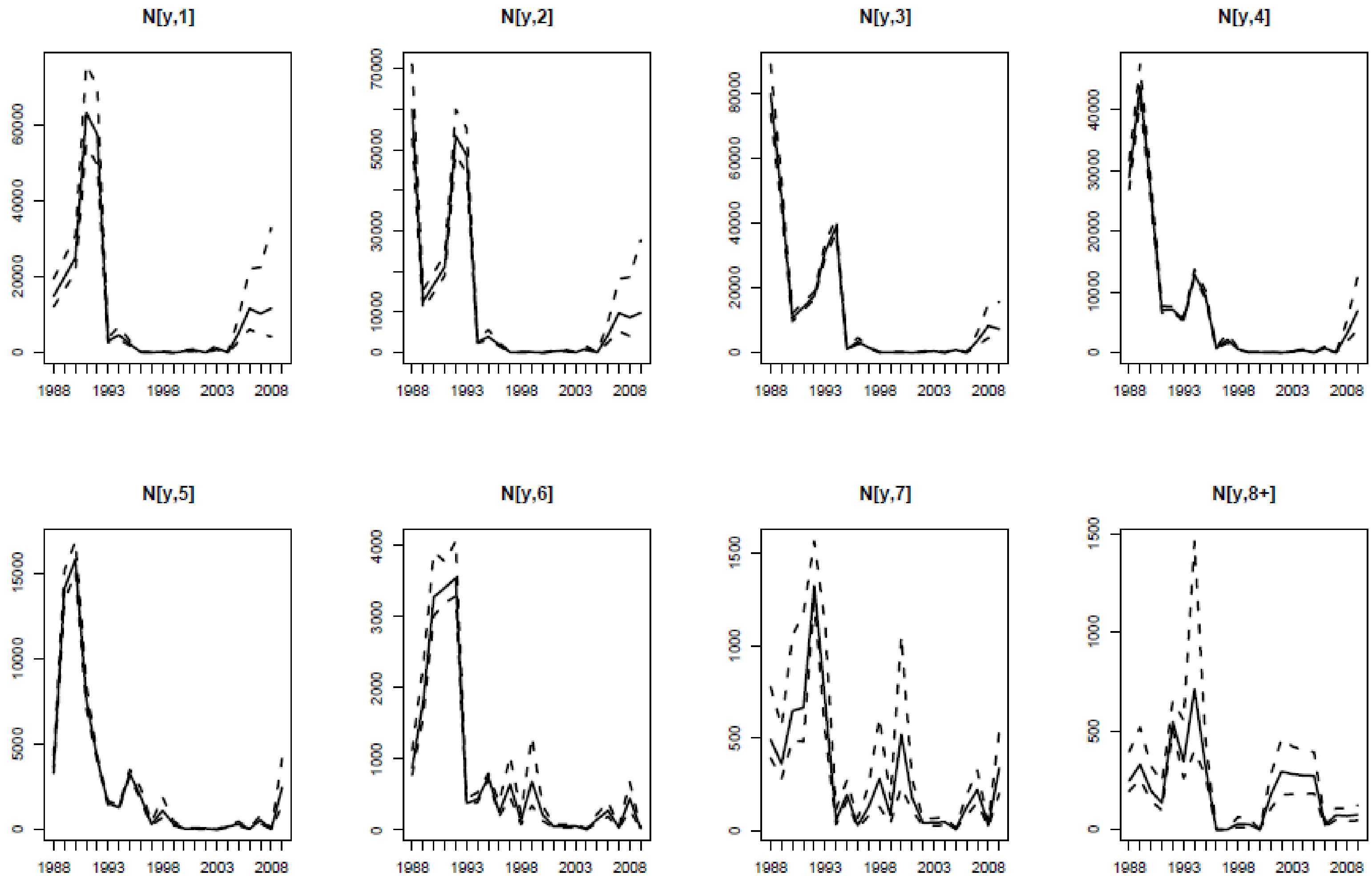

Figure 14.- Estimated numbers at age. M with uncertainty.

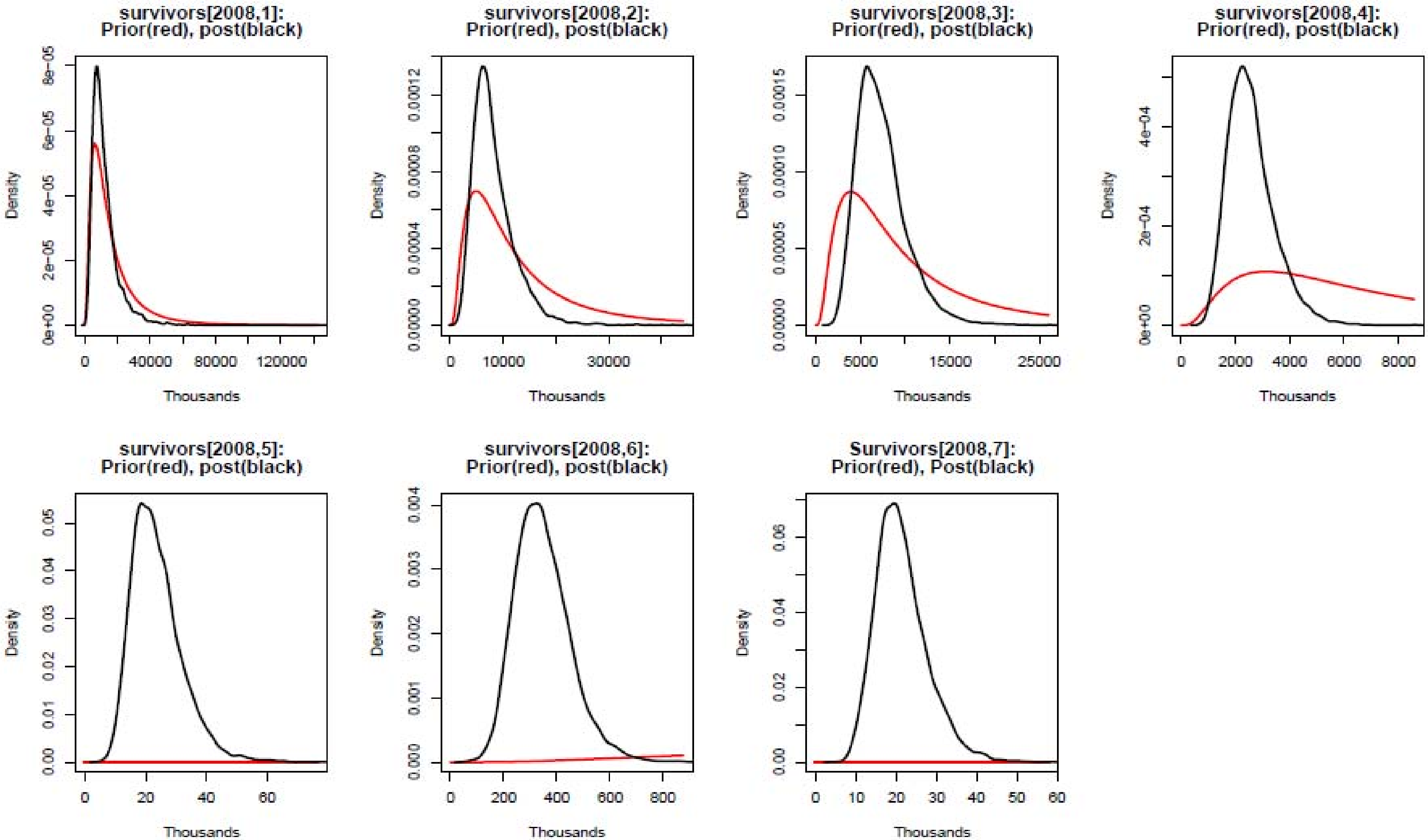

Figure 15.- Survivors at age at the end of 2008 (*survivors* (2008,a) are the number of individuals of age a+1 at the beginning of 2009). M with uncertainty.

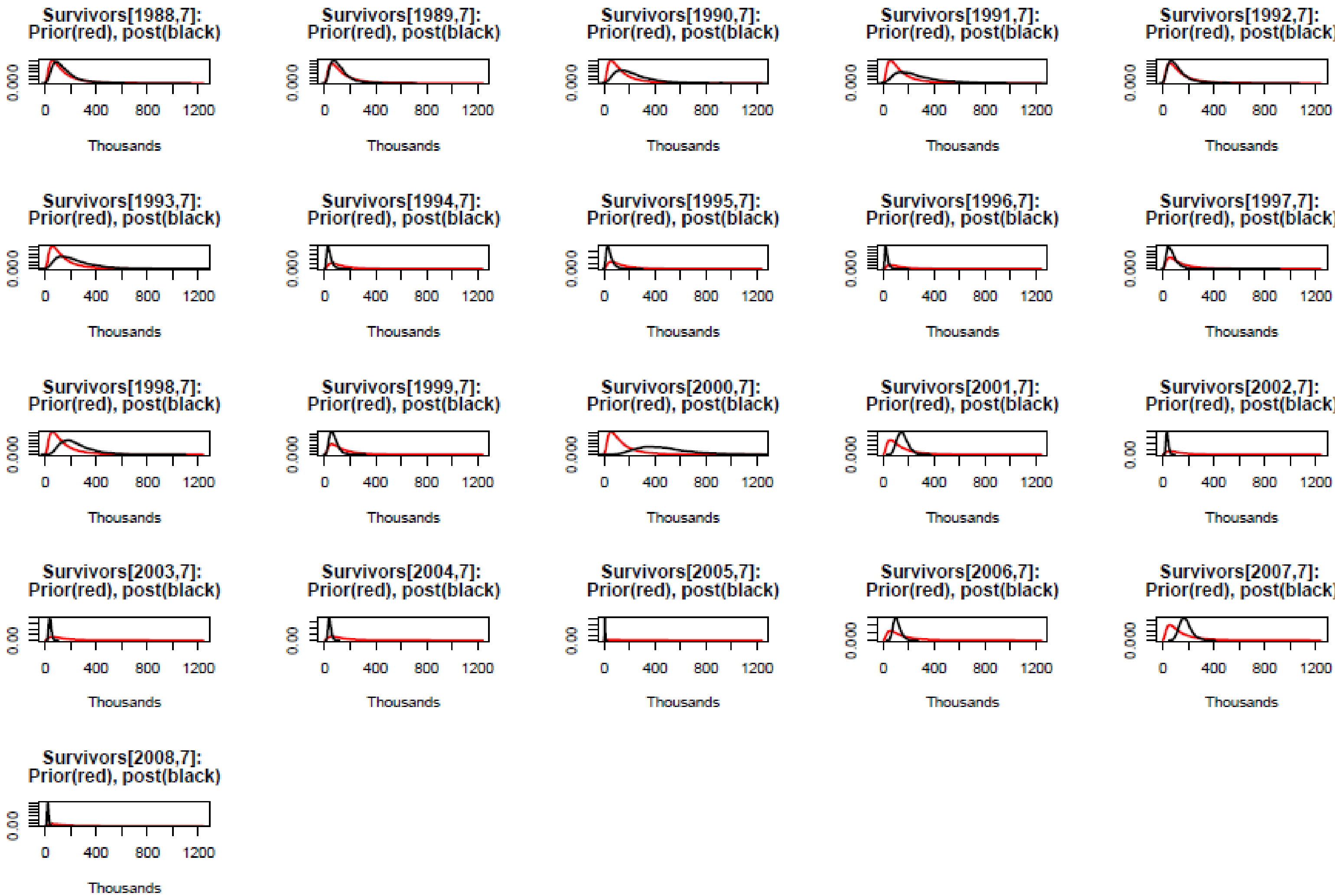

Figure 16.- Survivors from age 7 in each year (*survivors* (y,7) are the individuals of age 8 at the beginning of year y+1). M with uncertainty.

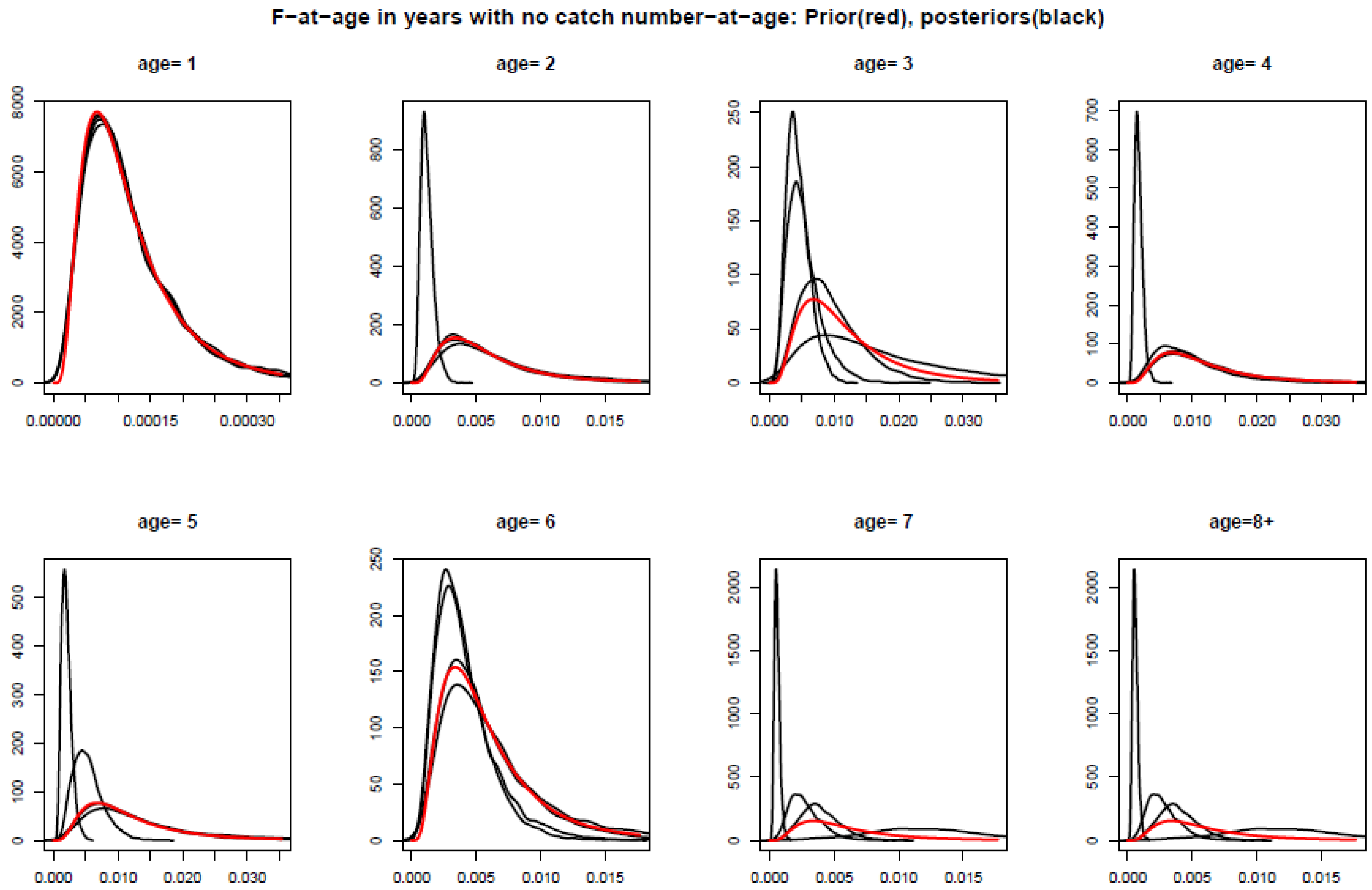

Figure 17.- F at age in years without catch numbers at age. M with uncertainty.

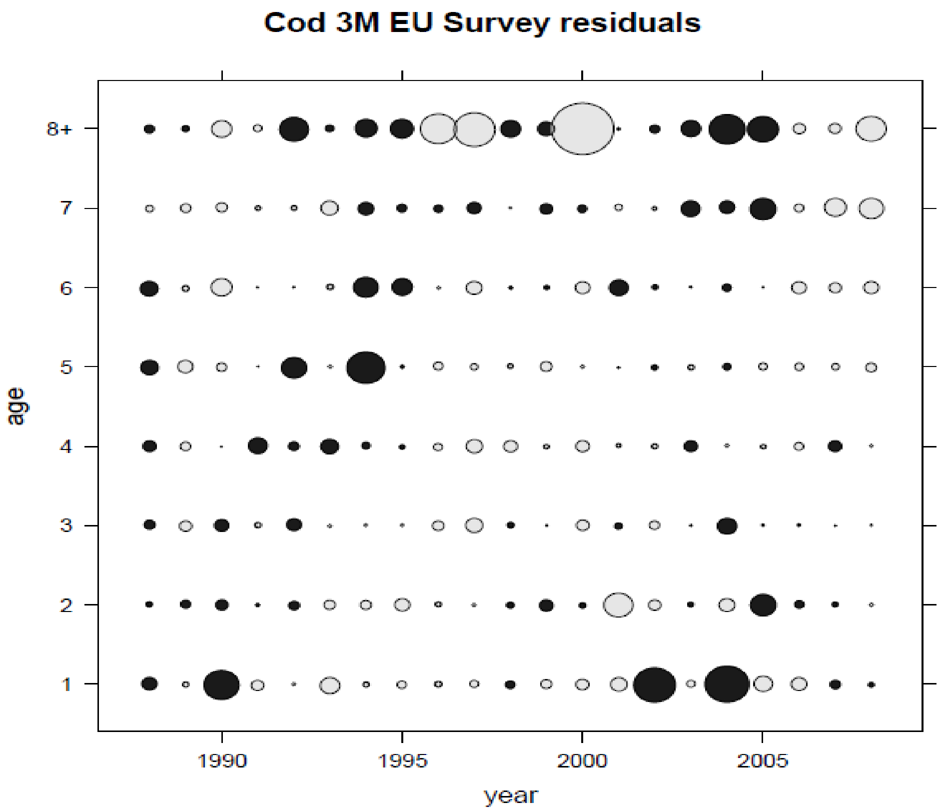

Figure 18.- Raw residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices at age. M with uncertainty.

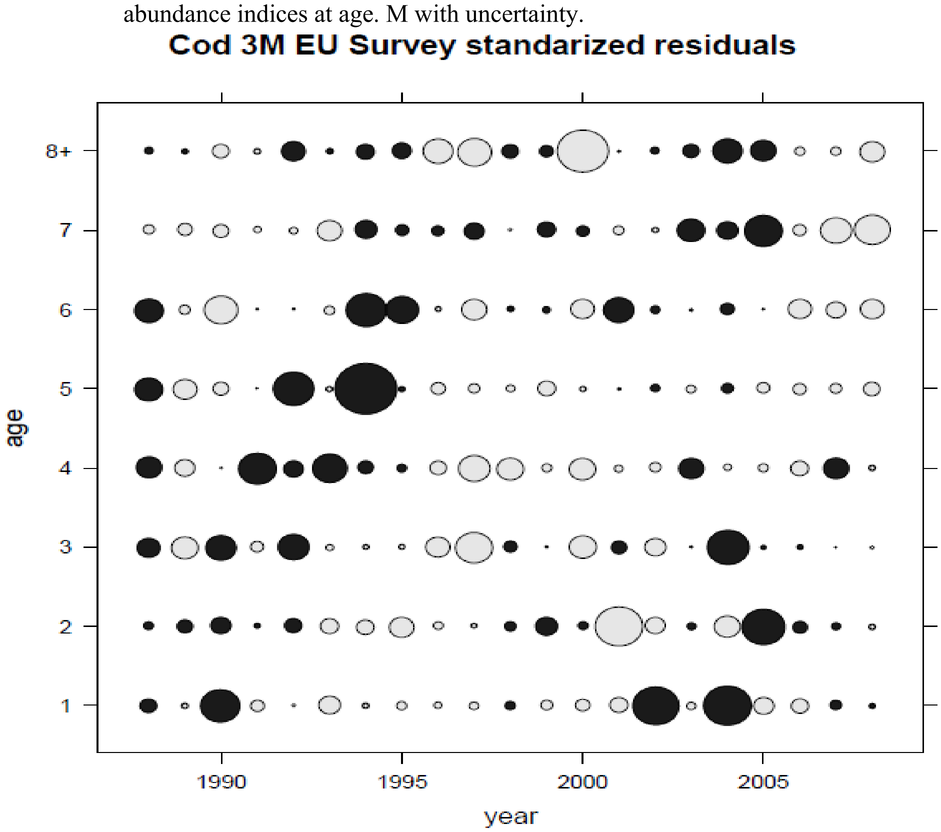

Figure 19.- Standardised residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices at age. M with uncertainty.

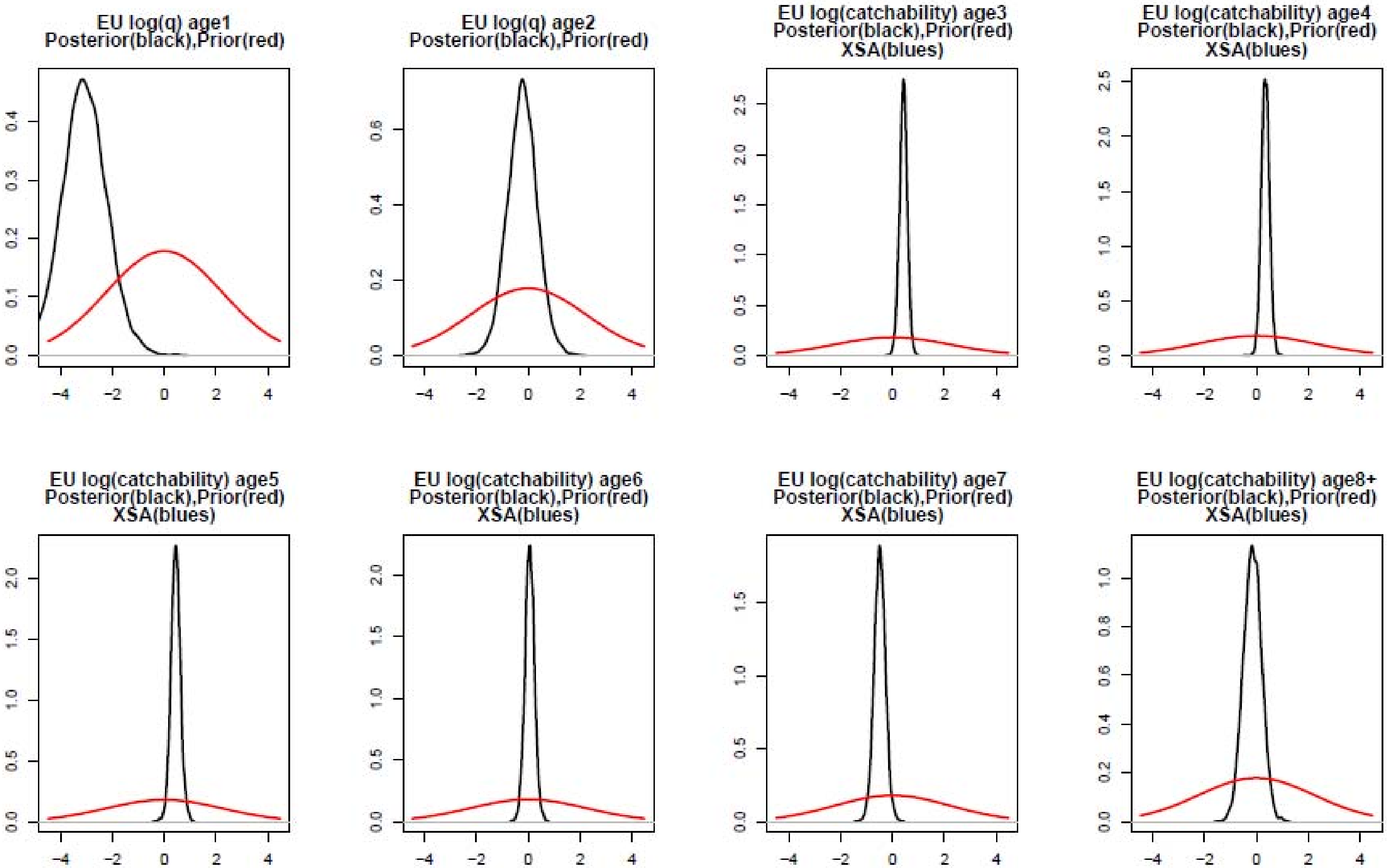

Figure 20.- Results for log(q(a)) of EU abundance at age indices. M with uncertainty.

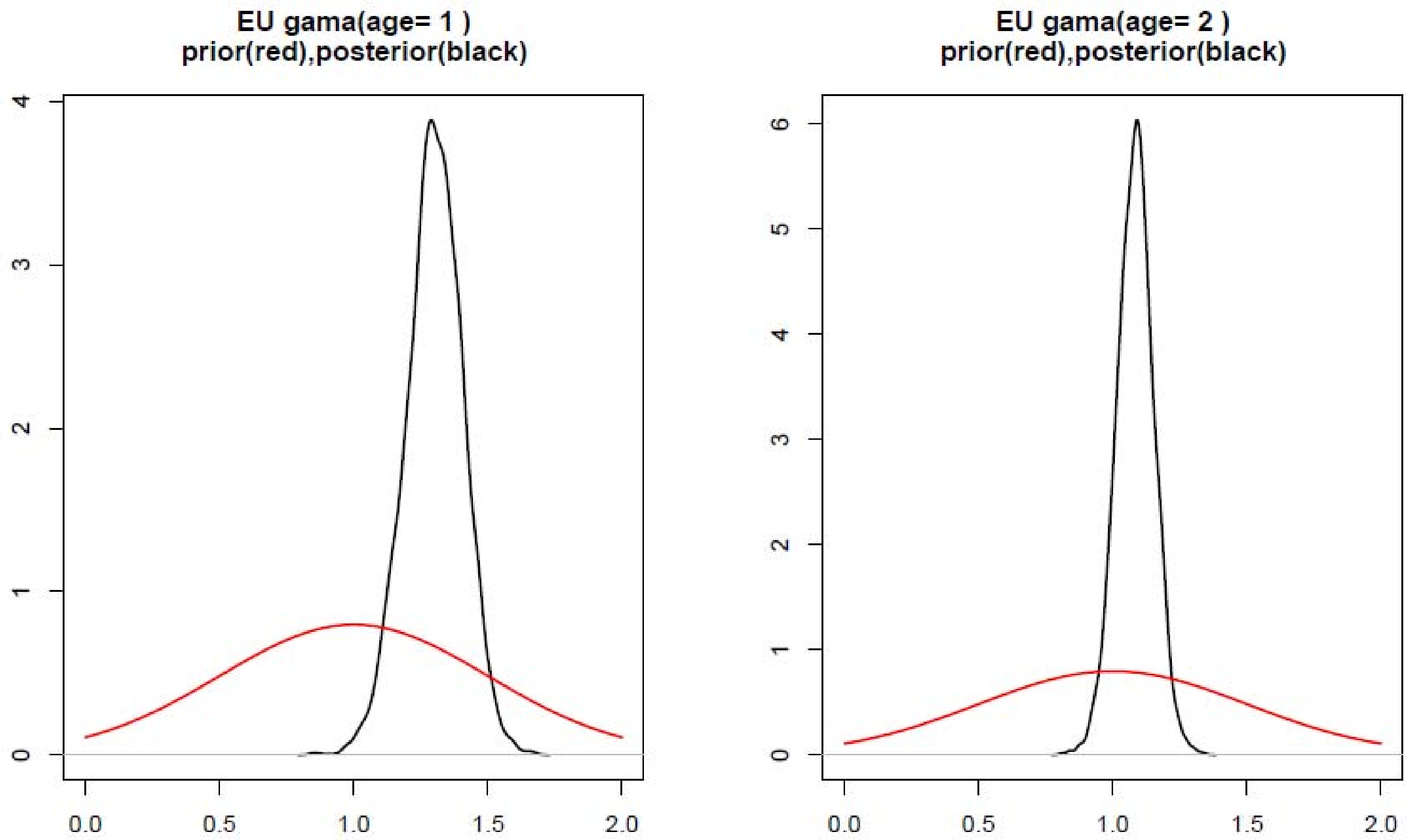

Figure 21.- Results for γ(a) of EU abundance at age indices. M with uncertainty.

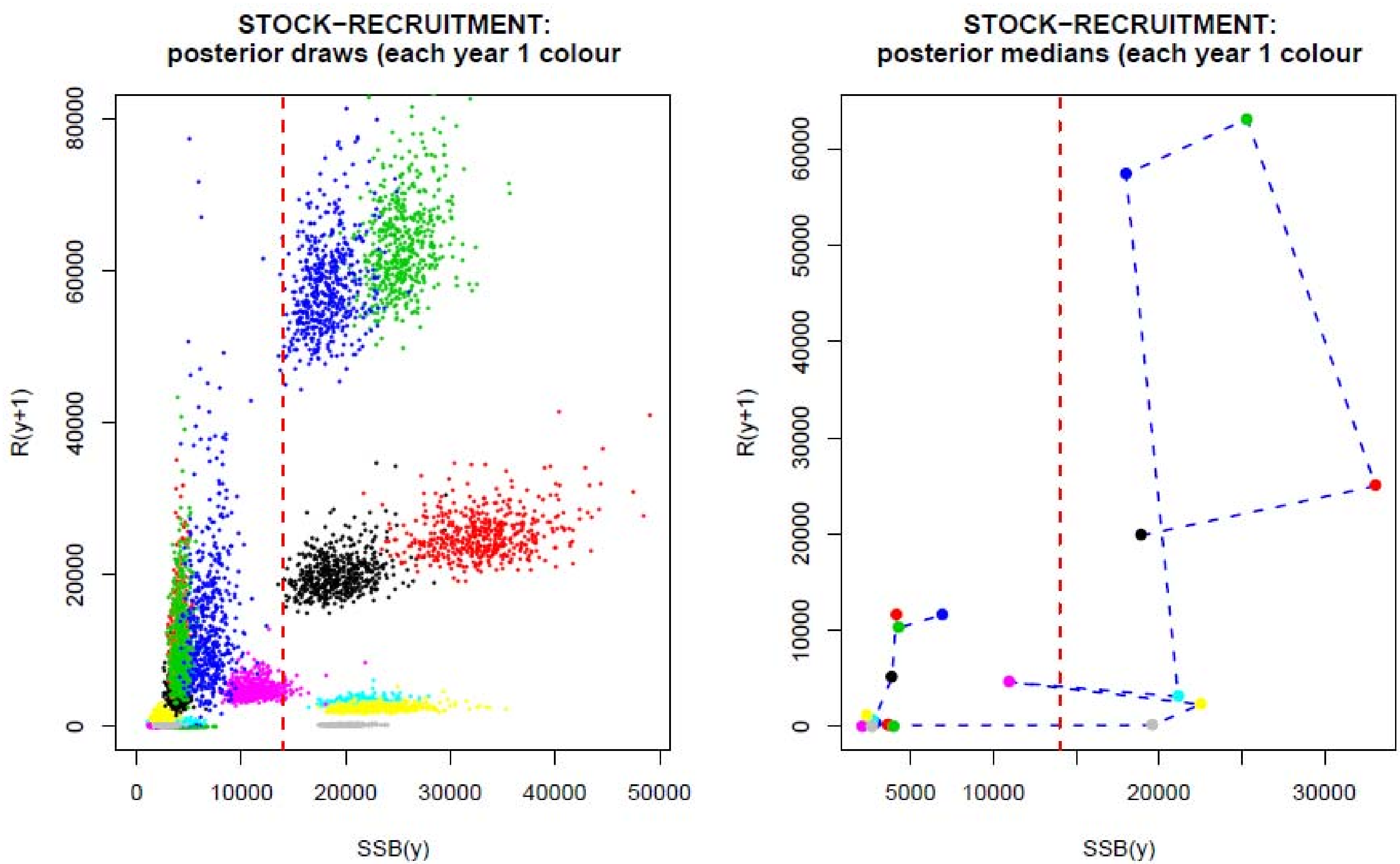

Figure 22.- Stock-Recruitment plots. B_{lim}=14000 is shown as the red vertical line. M with uncertainty.

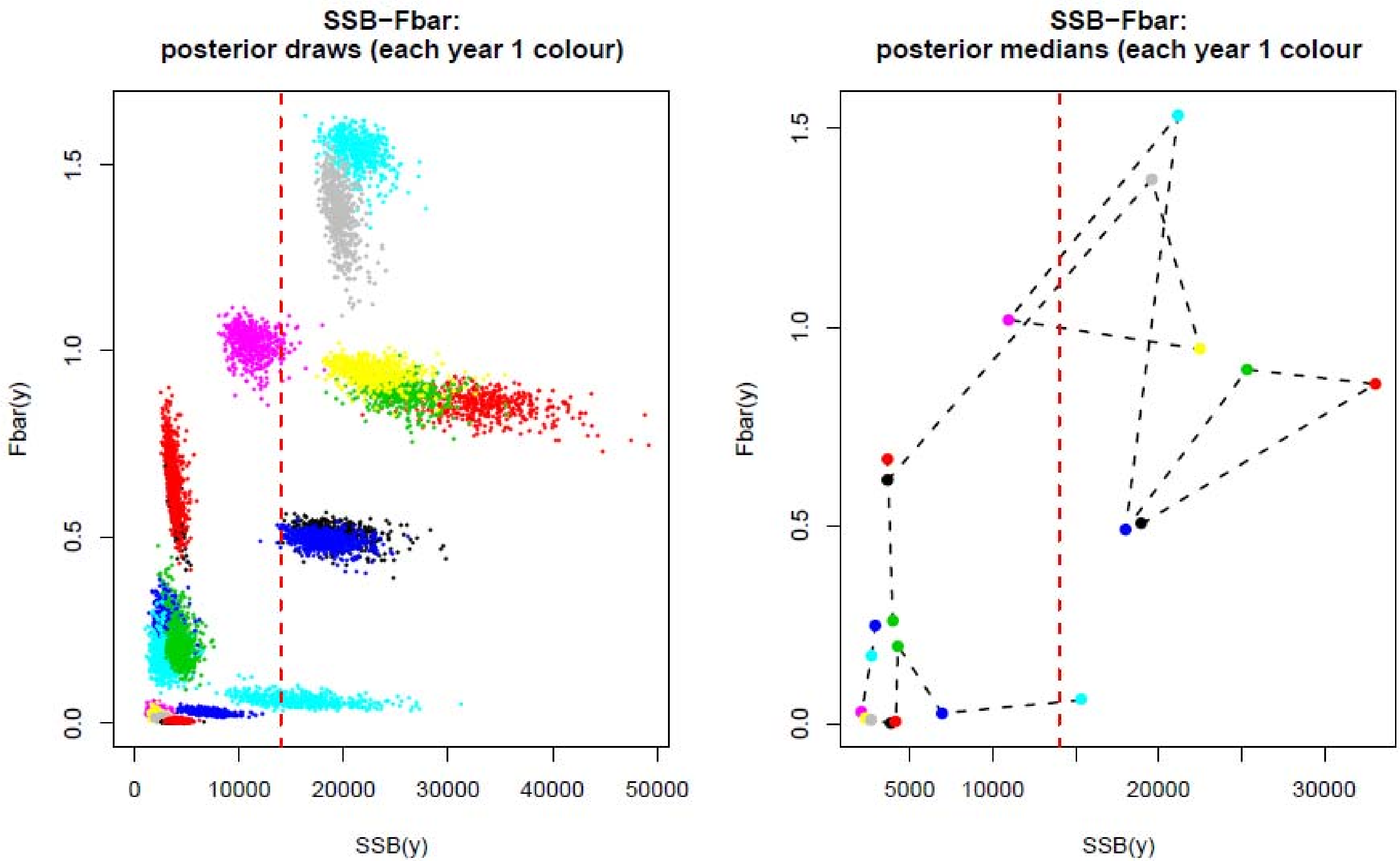

Figure 23.- F_{bar} versus SSB plots. B_{lim}=14000 is shown as the red vertical line. M with uncertainty.

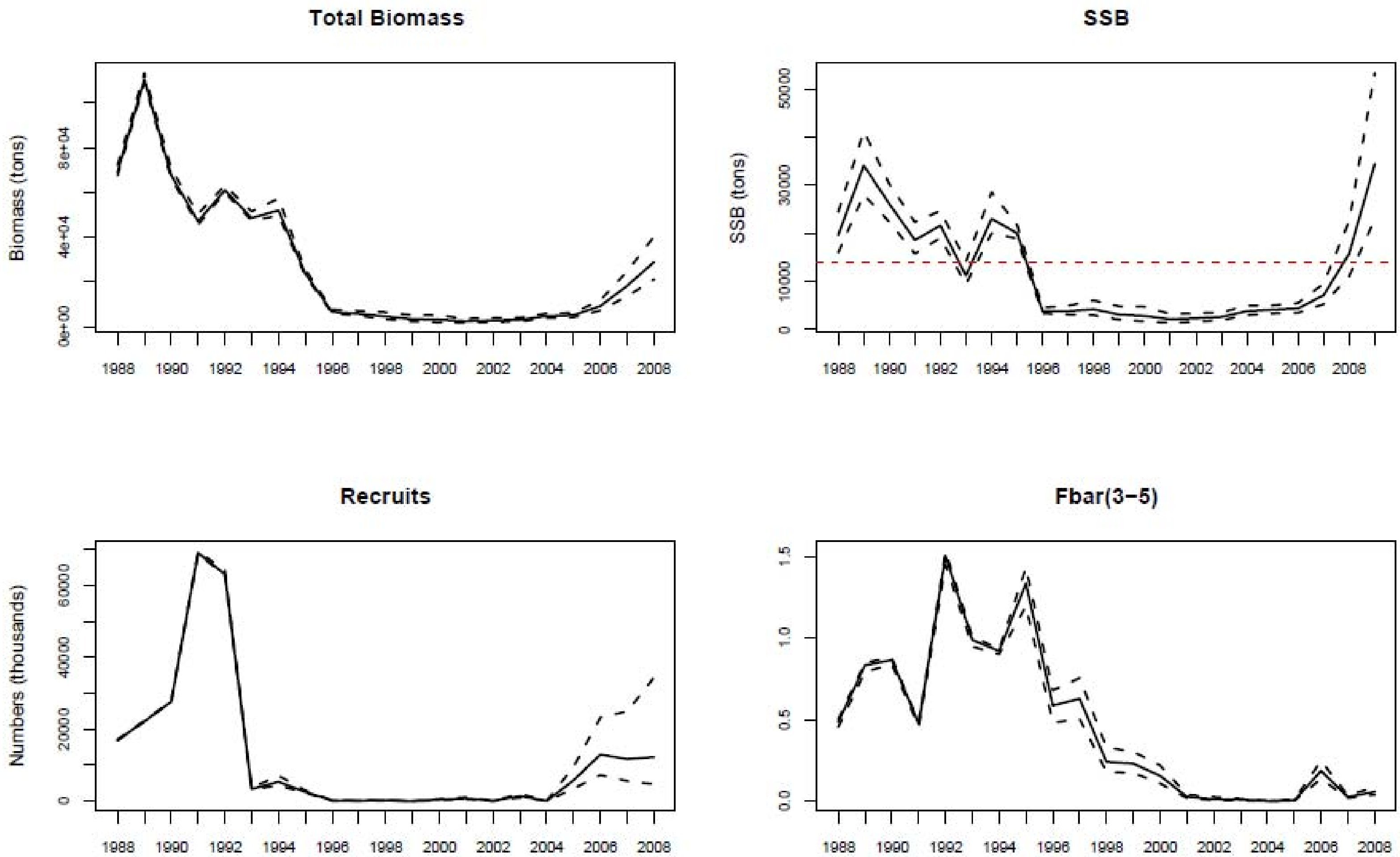

Figure 24.- Estimated trends in Biomass, SSB, recruitment and F_{bar}. M constant.

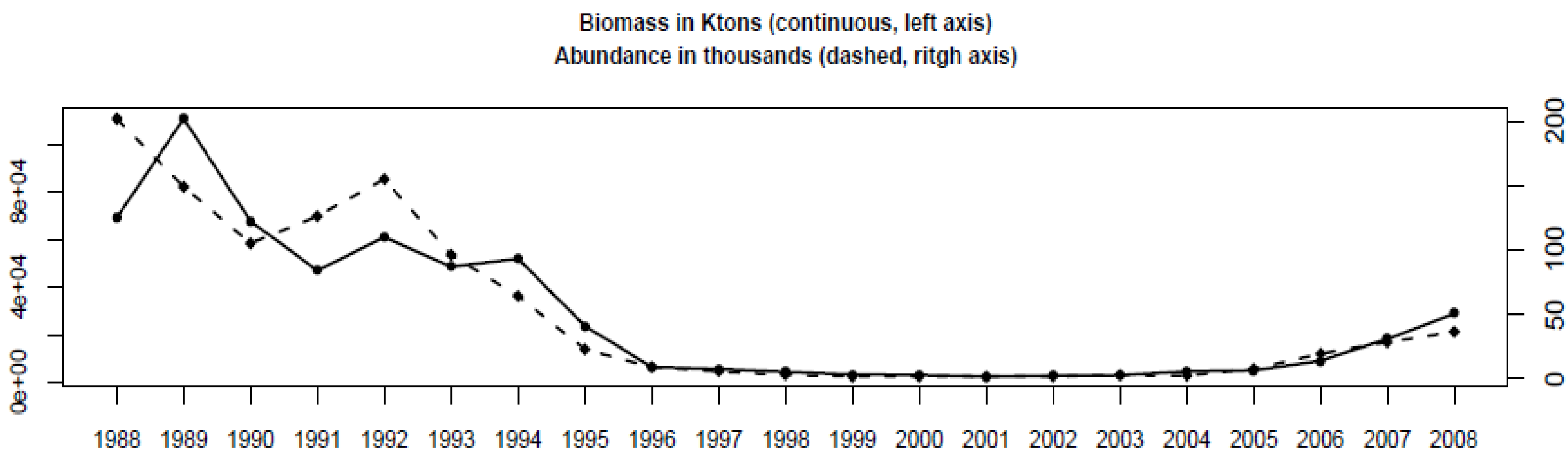

Figure 25.- Estimated trends in biomass and abundance. M constant.

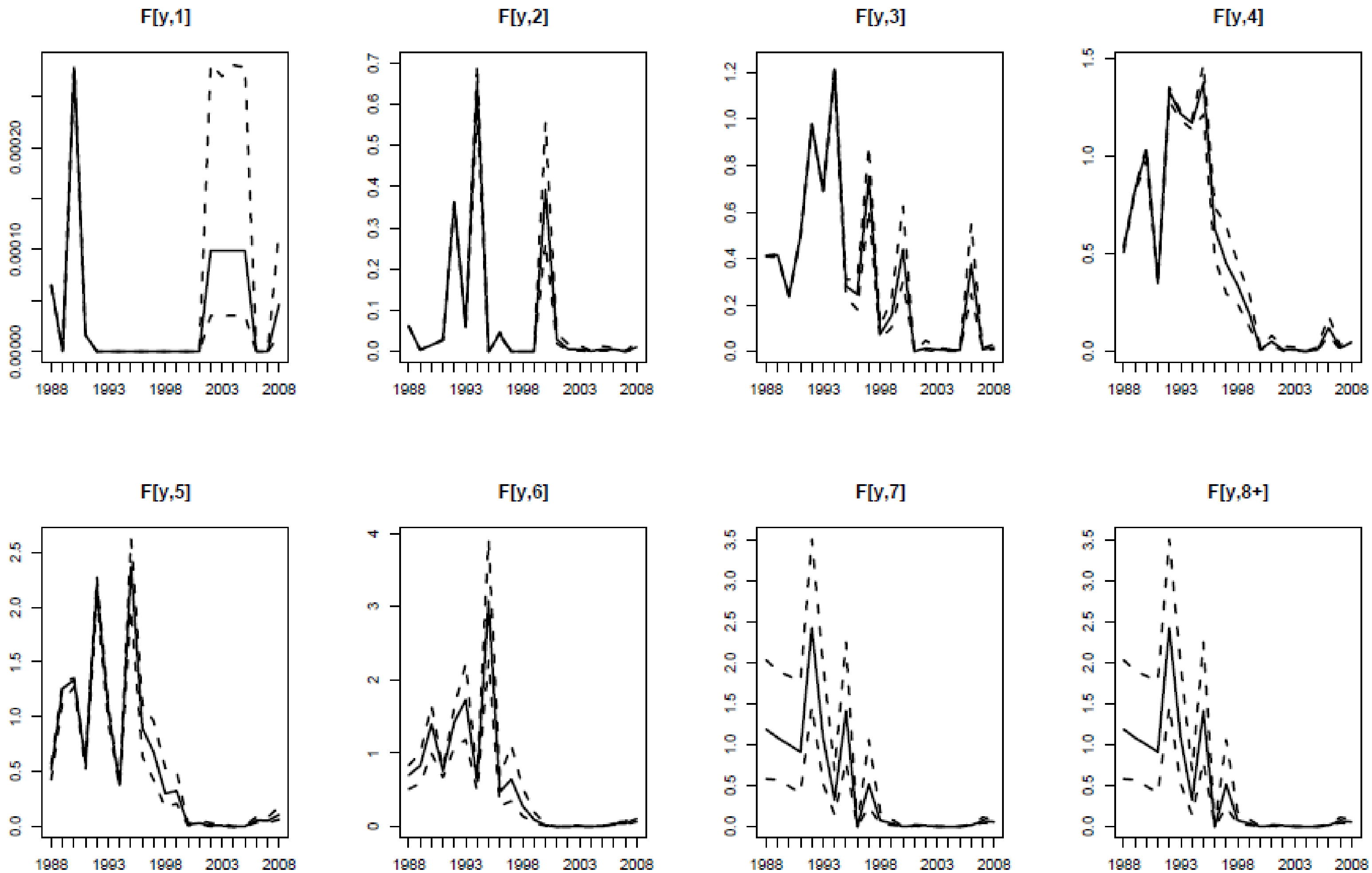

Figure 26.- Estimated fishing mortality at age. M constant.

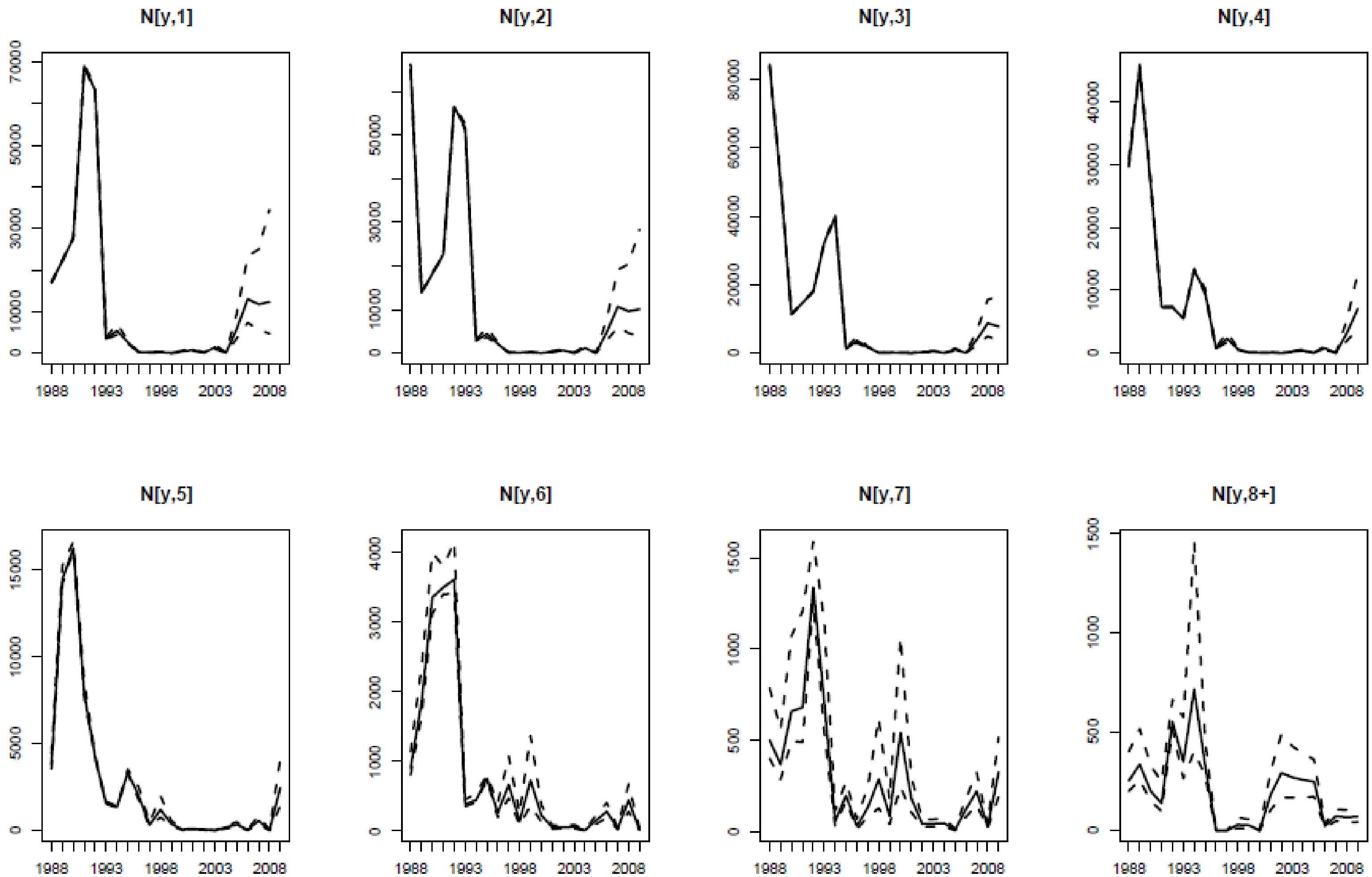

Figure 27.- Estimated numbers at age. M constant.

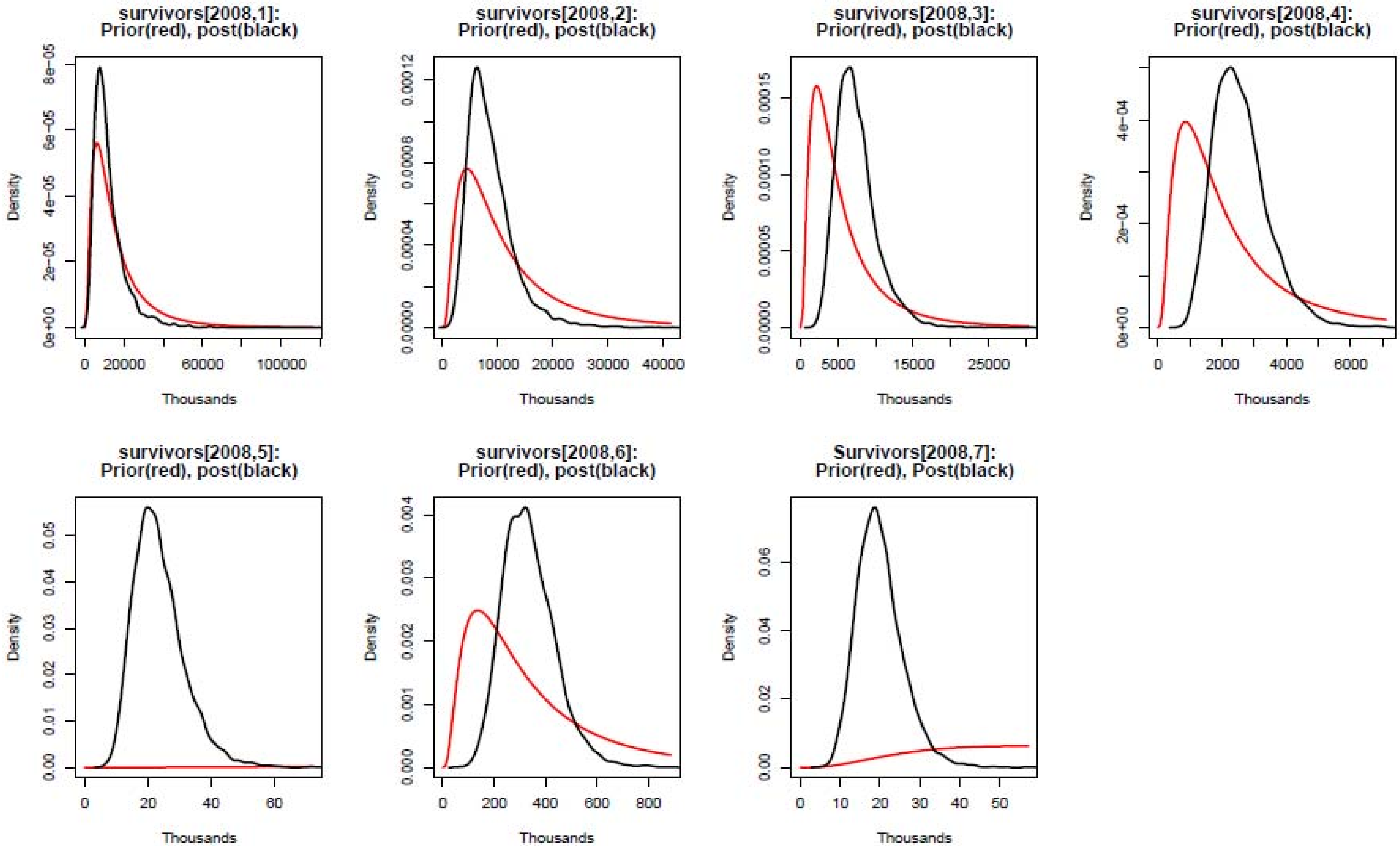

Figure 28.- Survivors at age at the end of 2008 (*survivors* (2008,a) are the number of individuals of age a+1 at the beginning of 2009). M constant.

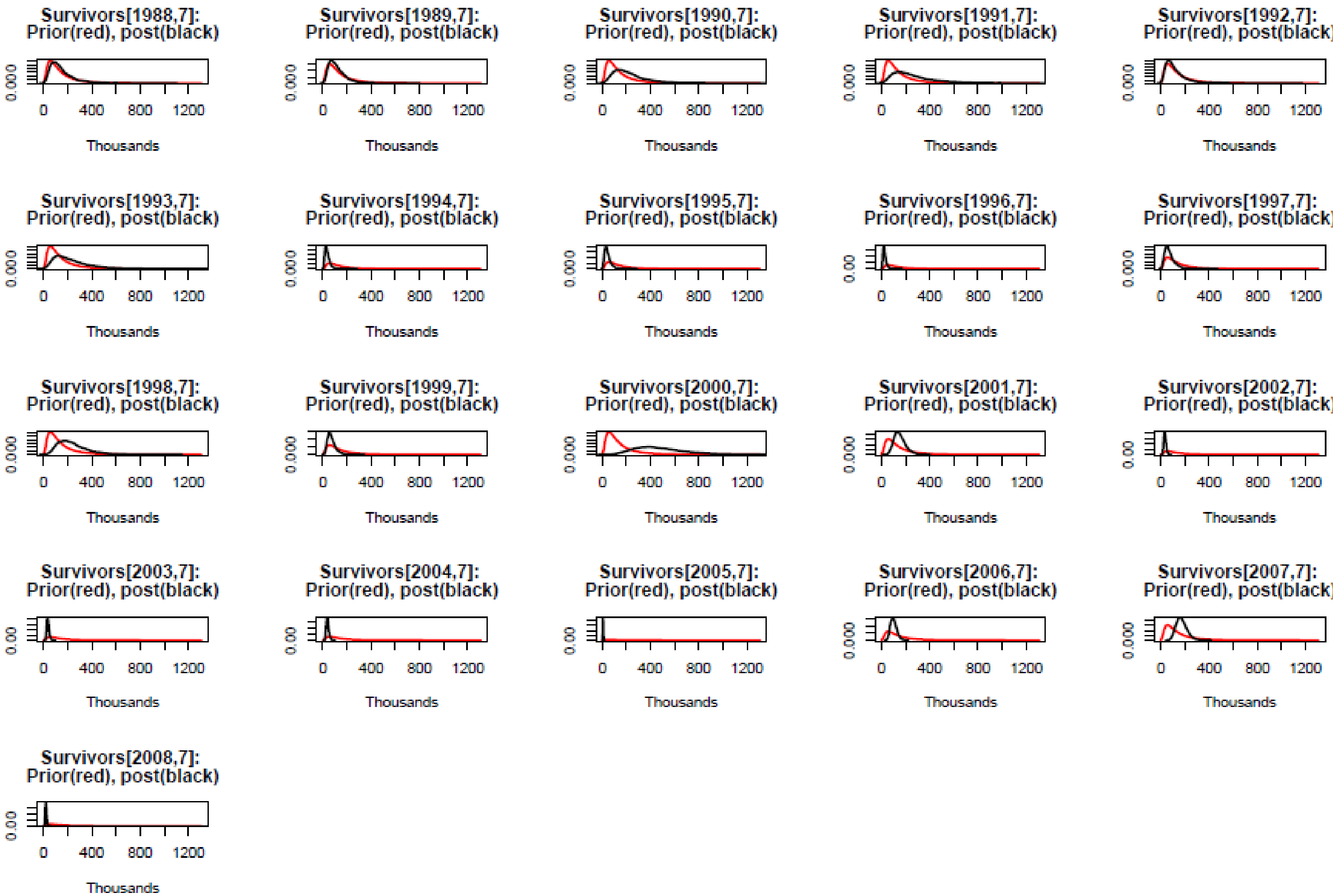

Figure 29.- Survivors from age 7 in each year (*survivors* (y,7) are the individuals of age 8 at the beginning of year y+1). M constant.

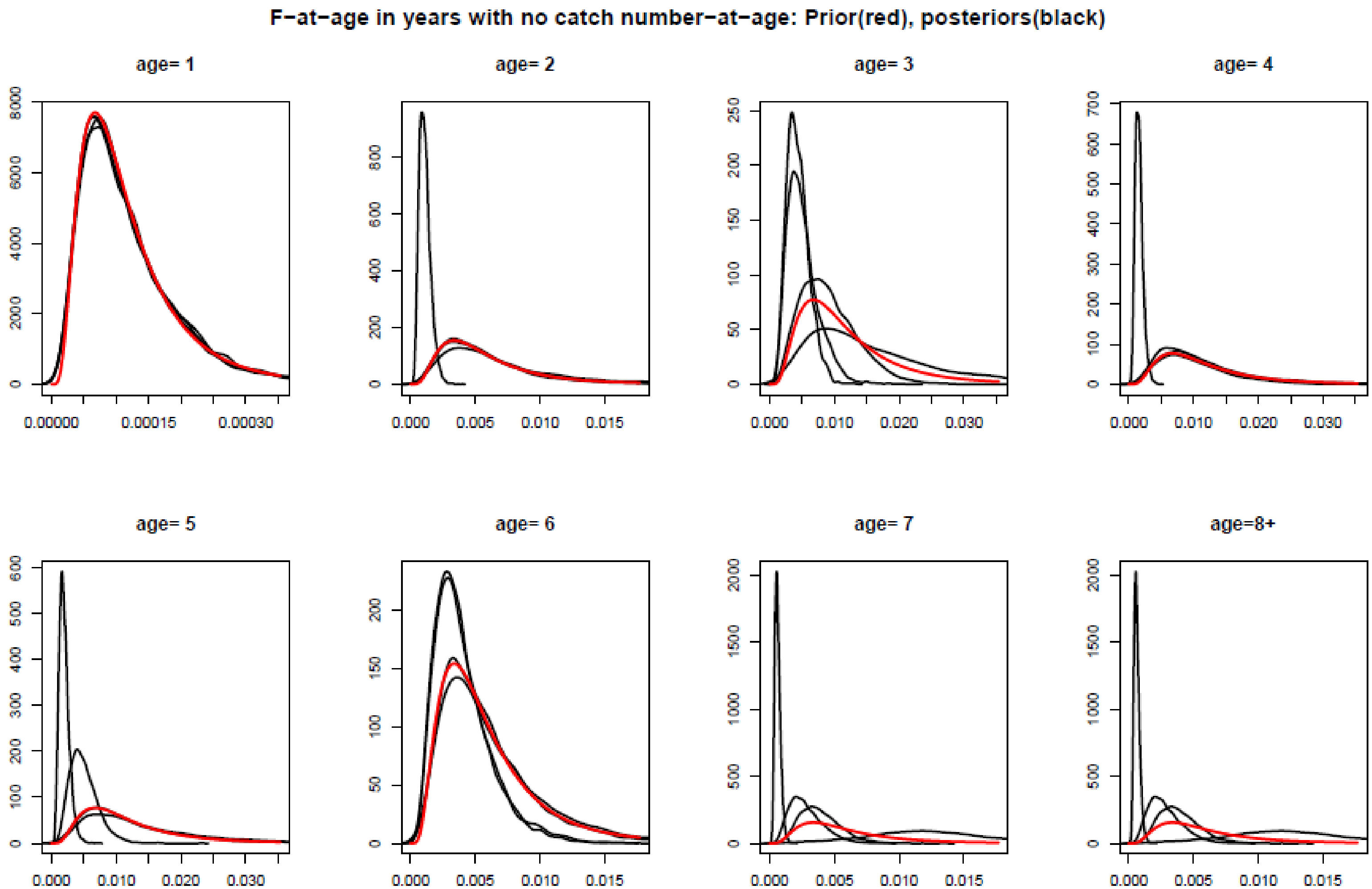

Figure 30.- F at age in years without catch numbers at age. M constant.

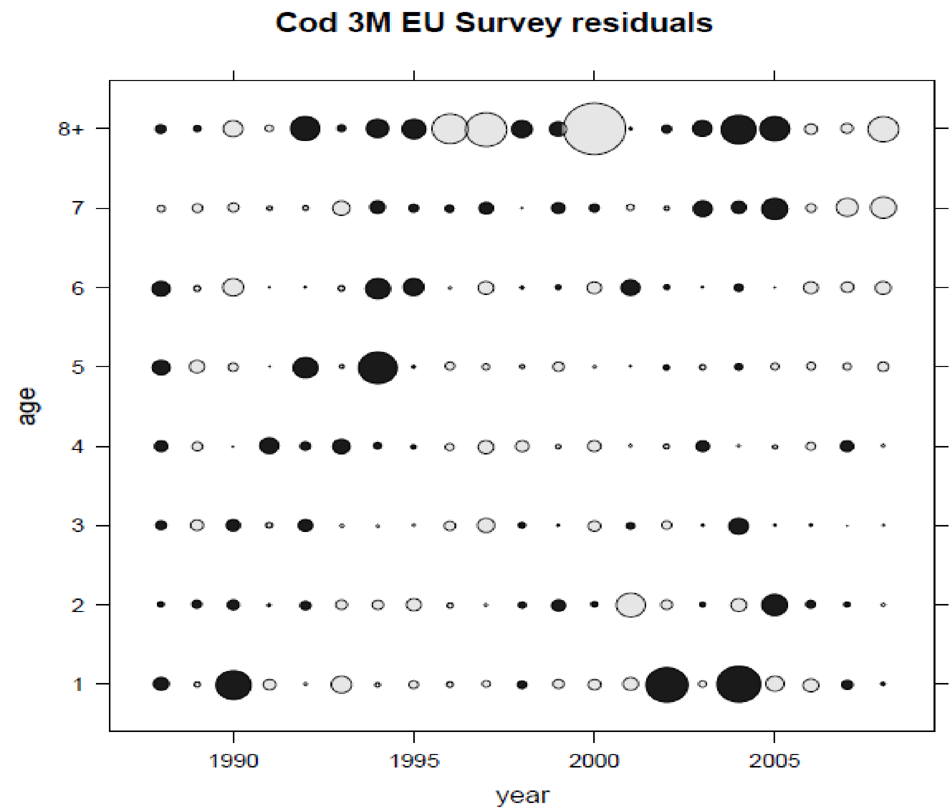

Figure 31.- Raw residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices at age. M constant.

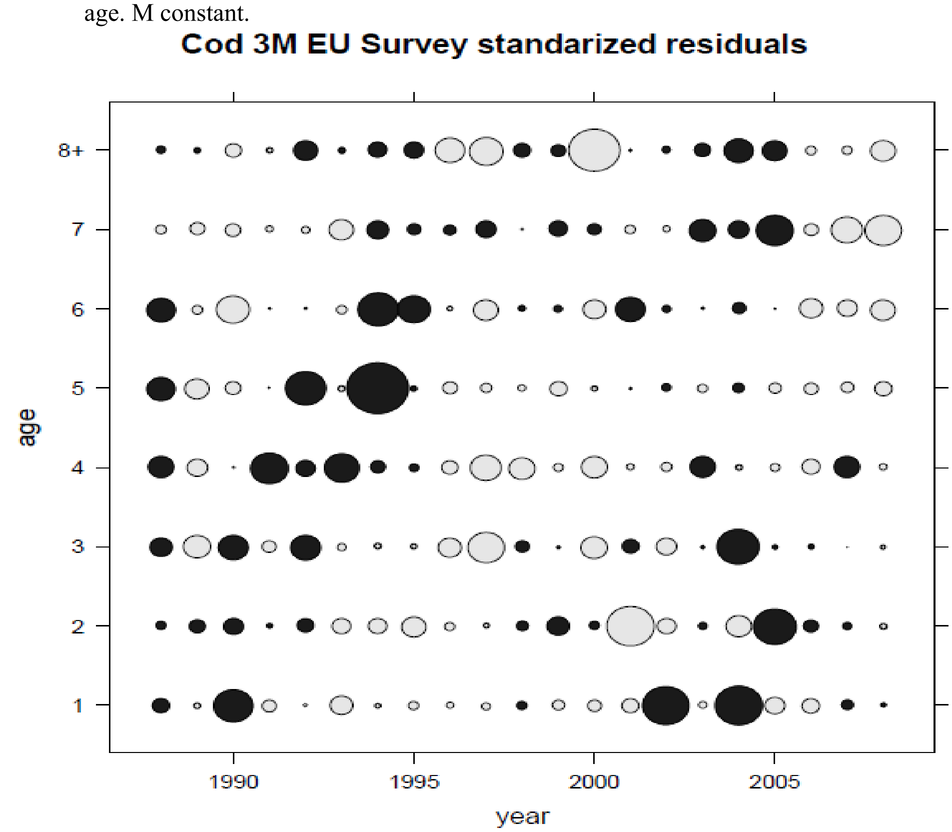

Figure 32.- Standardised residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices at age. M constant..

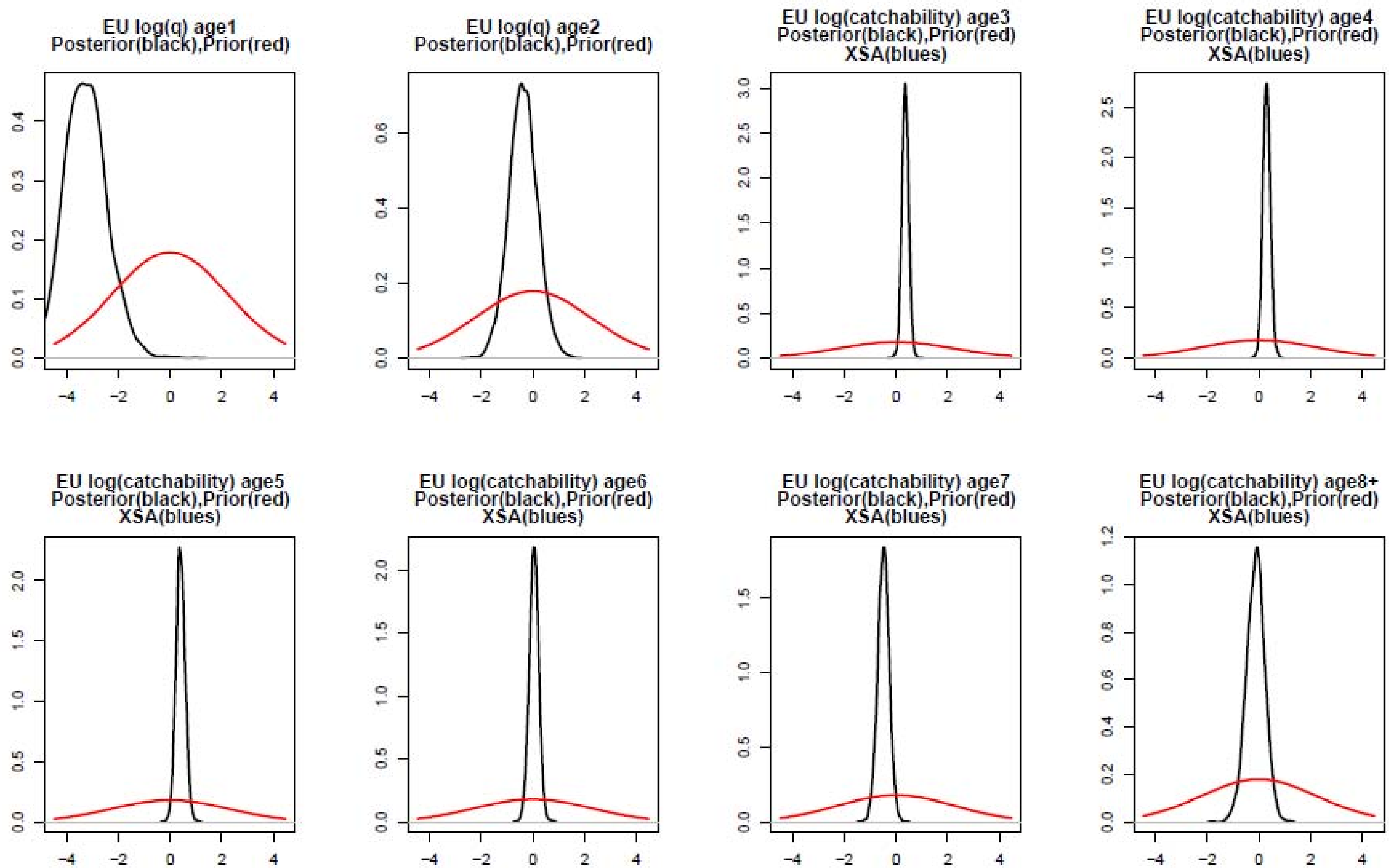

Figure 33.- Results for log(q(a)) of EU abundance at age indices. M constant.

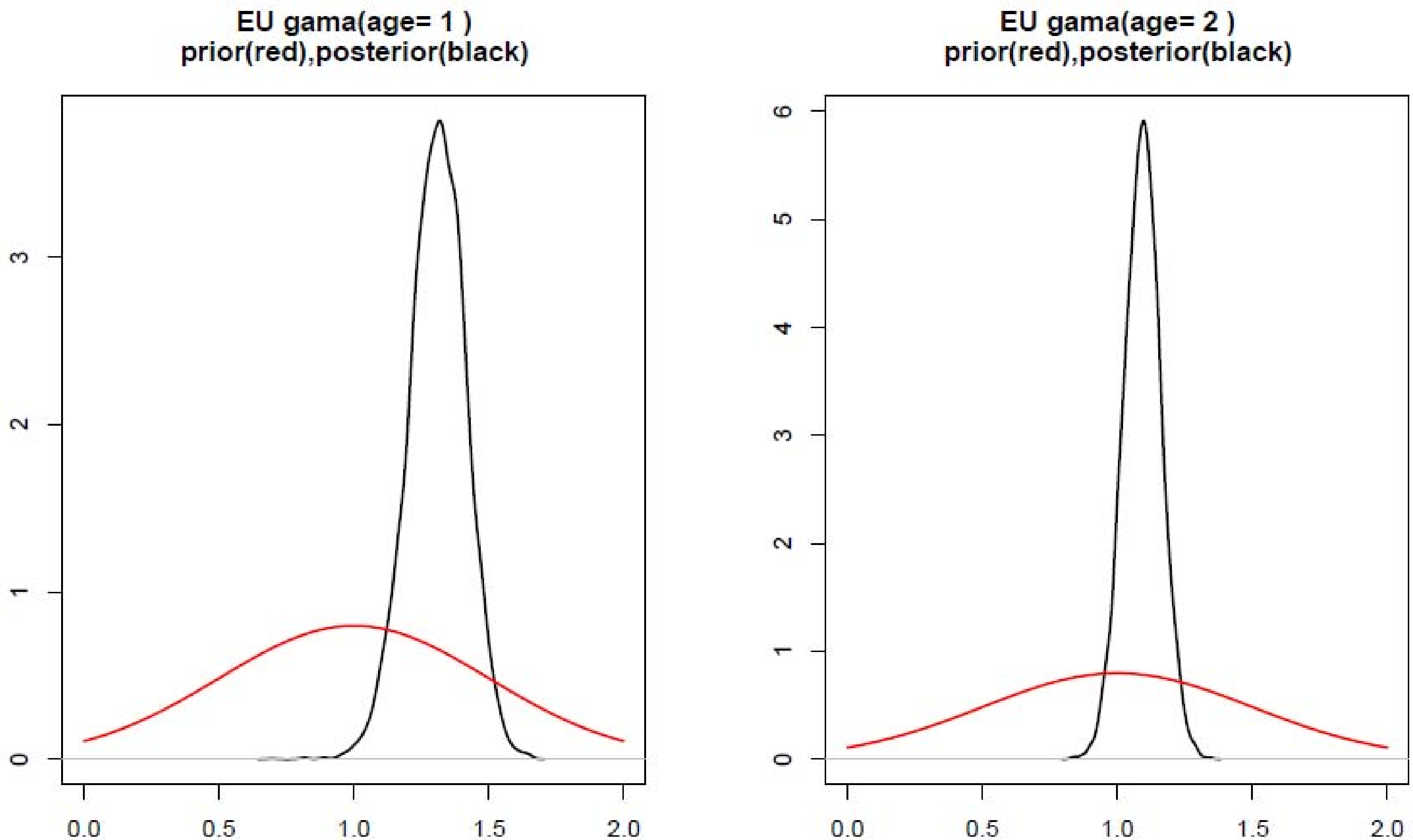

Figure 34.- Results for γ(a) of EU abundance at age indices. M constant.

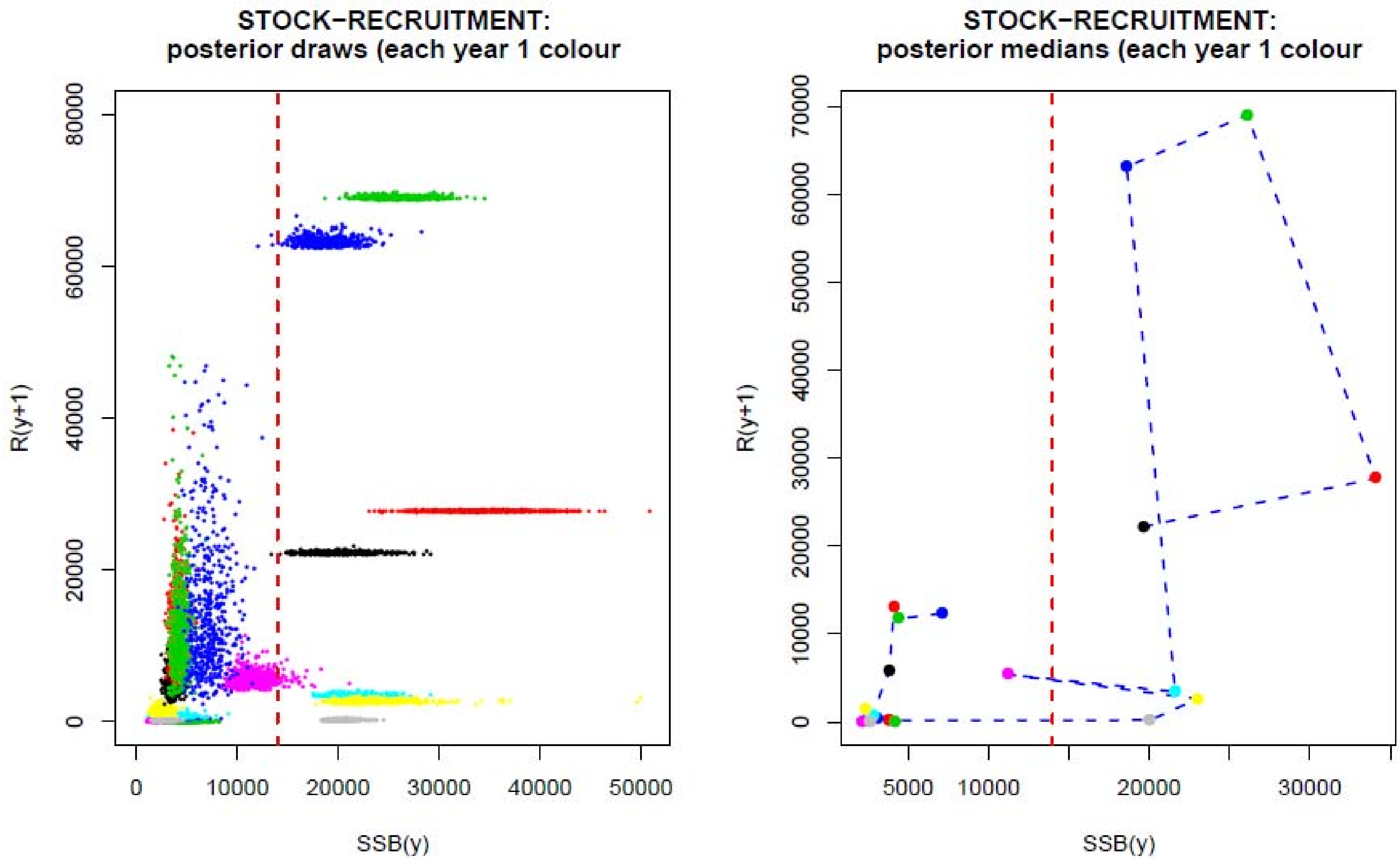

Figure 35.- Stock-Recruitment plots. B_{lim}=14000 is shown as the red vertical line. M constant.

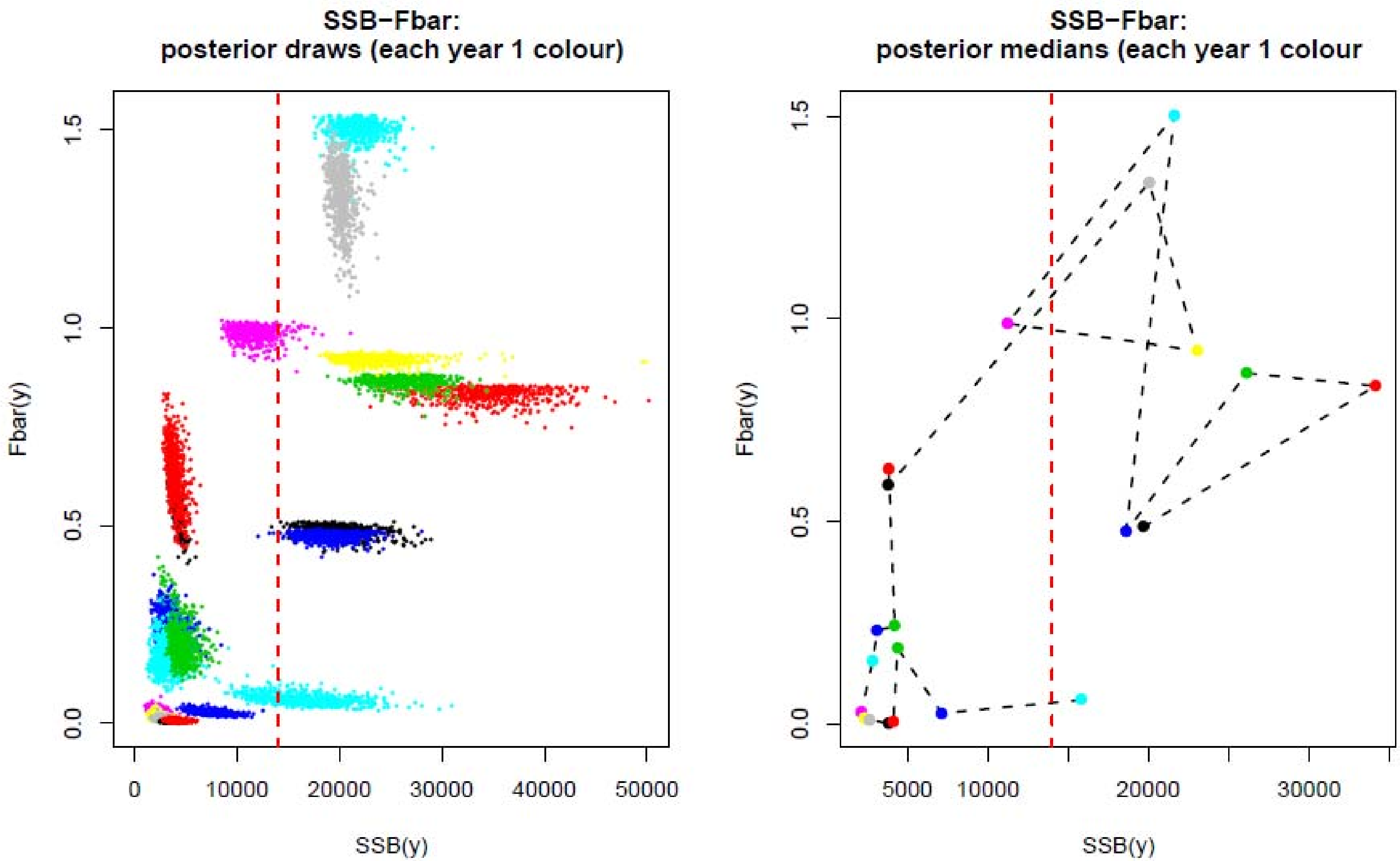

Figure 36.- F_{bar} versus SSB plots. B_{lim}=14000 is shown as the red vertical line. M constant.

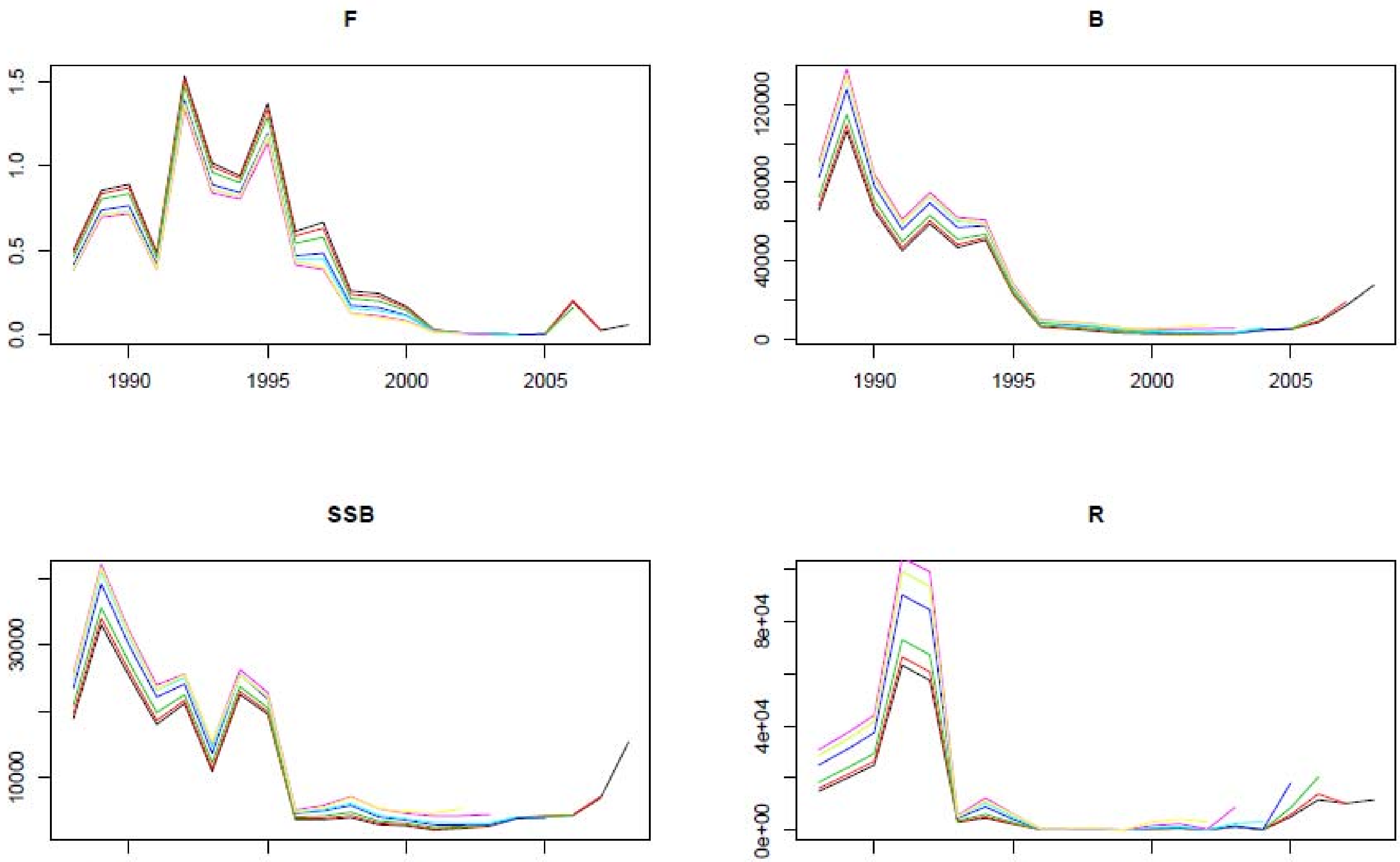

Figure 37.- Retrospective patterns. M with uncertainty.

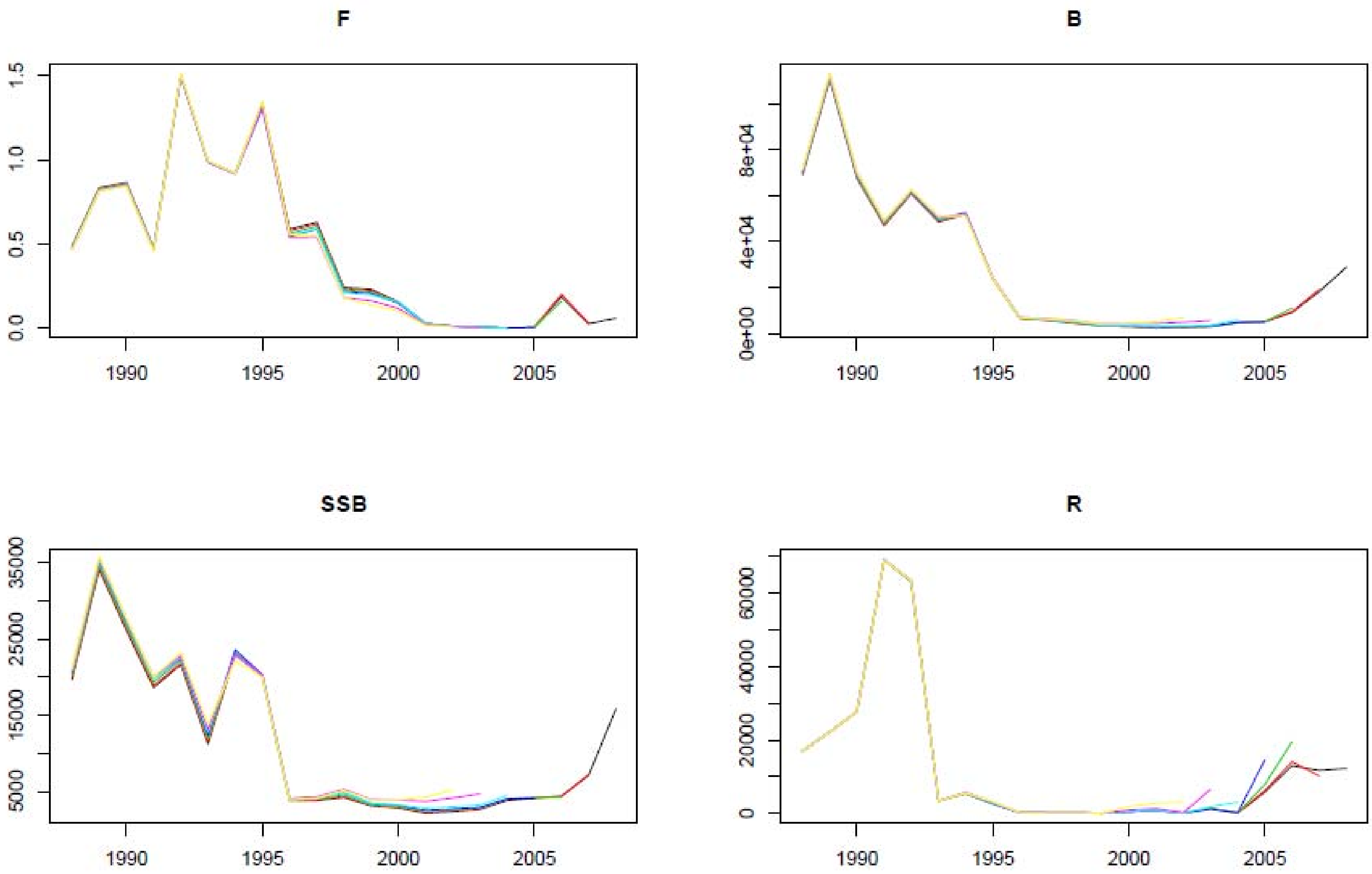

Figure 38.- Retrospective patterns. M constant.

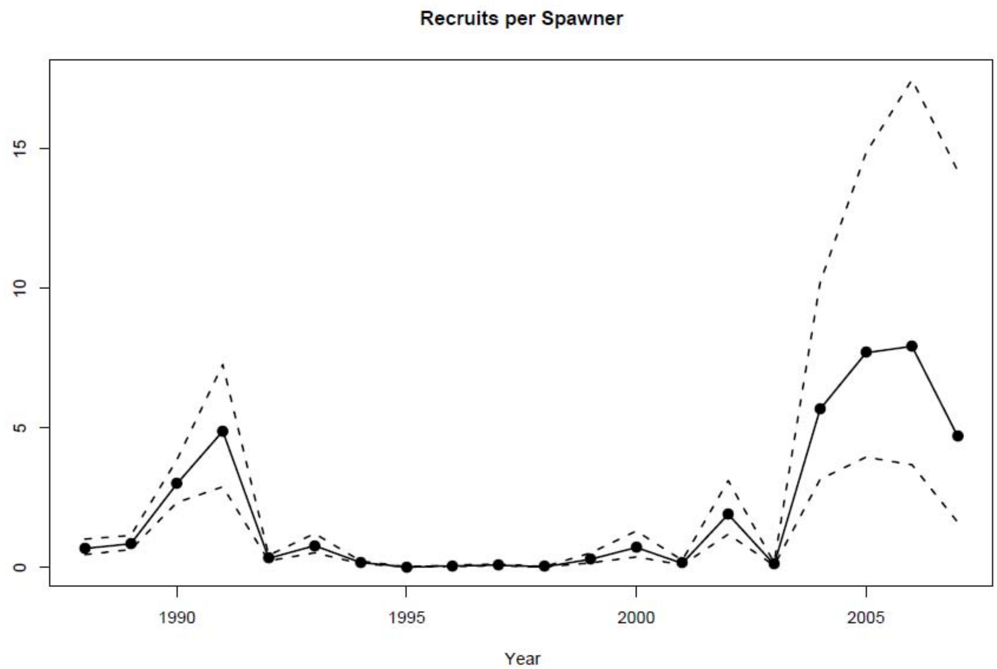

Figure 39.- Estimated recruits per spawner. M with uncertainty.

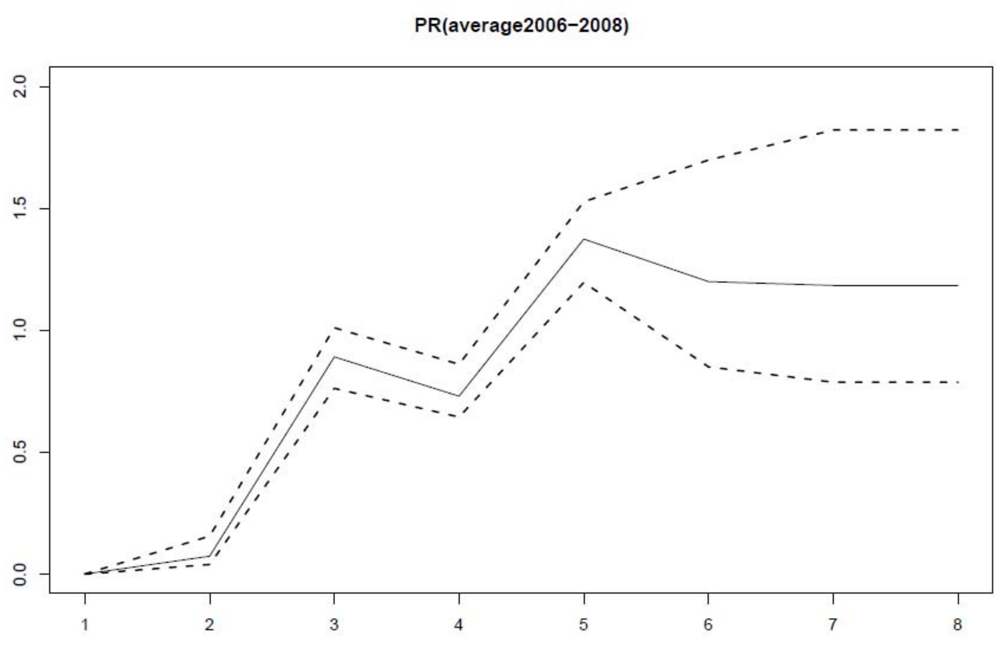

Figure 40.- Estimated PR, averaged over the years 2006-2008. M with uncertainty.

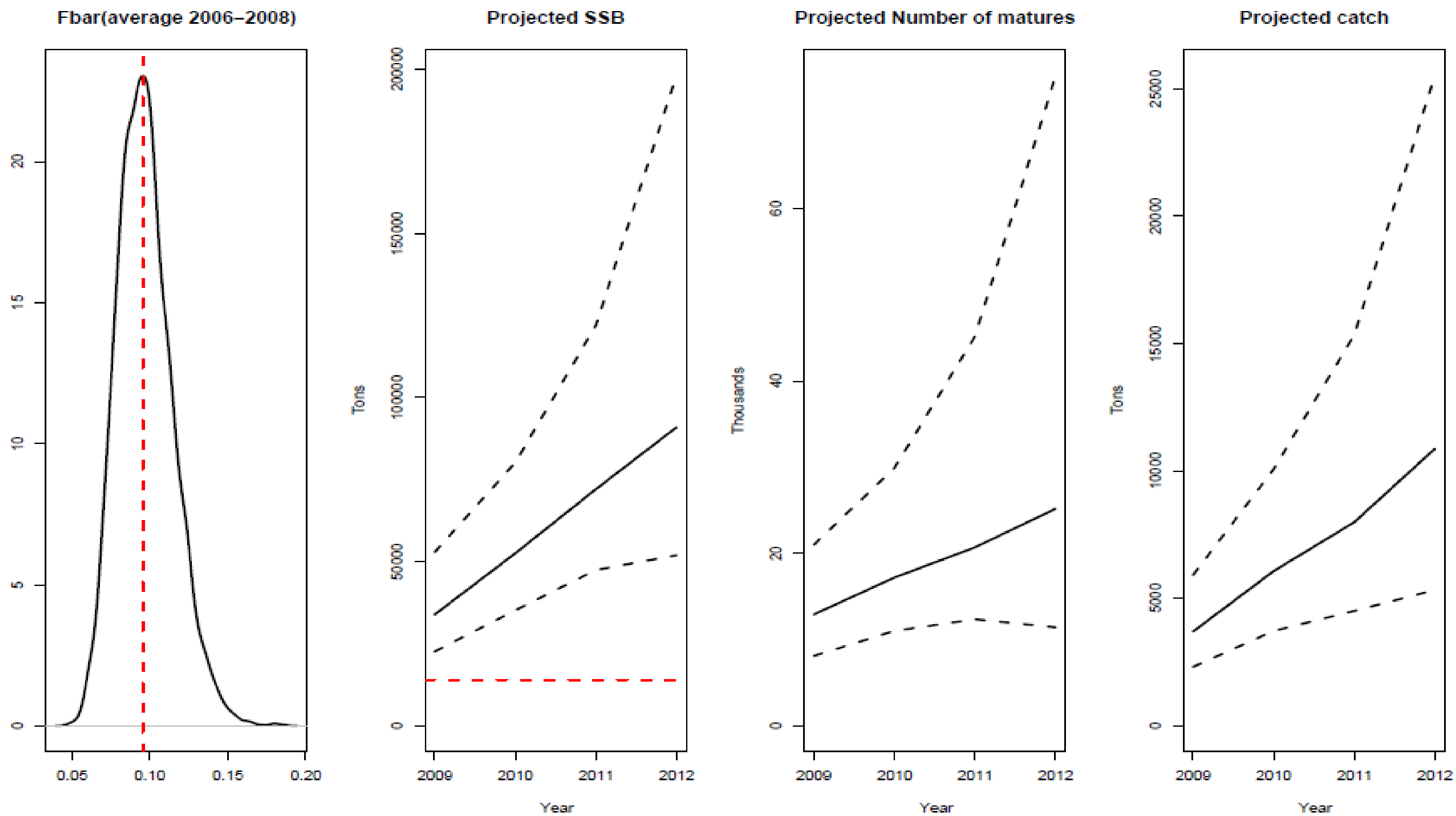

Figure 41.- Projections with F_{bar}=F_{bar}(average of 2006-2008). M with uncertainty.

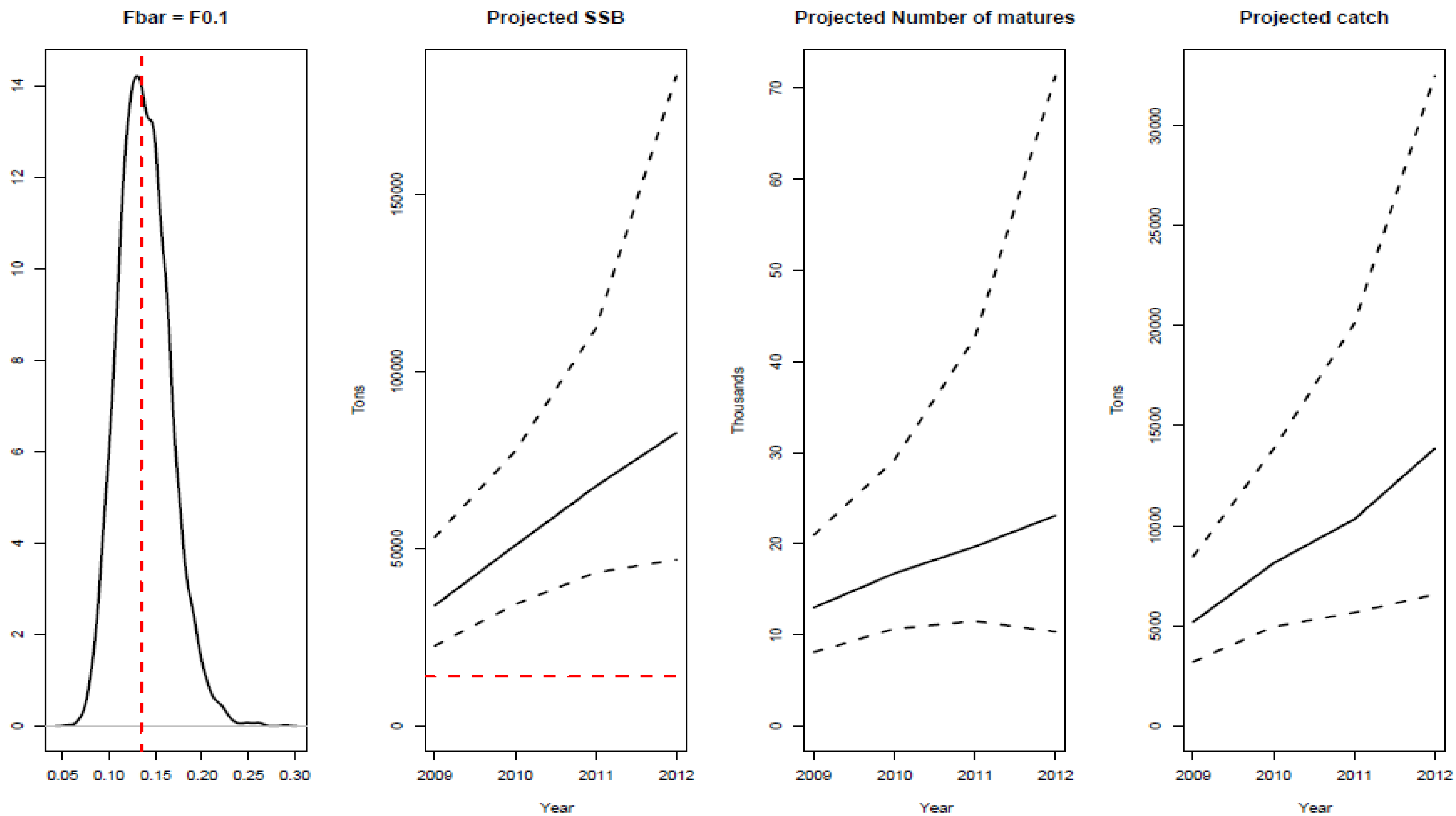

Figure 42.- Projections with F_{bar}=$F_{0.1}$. M with uncertainty.

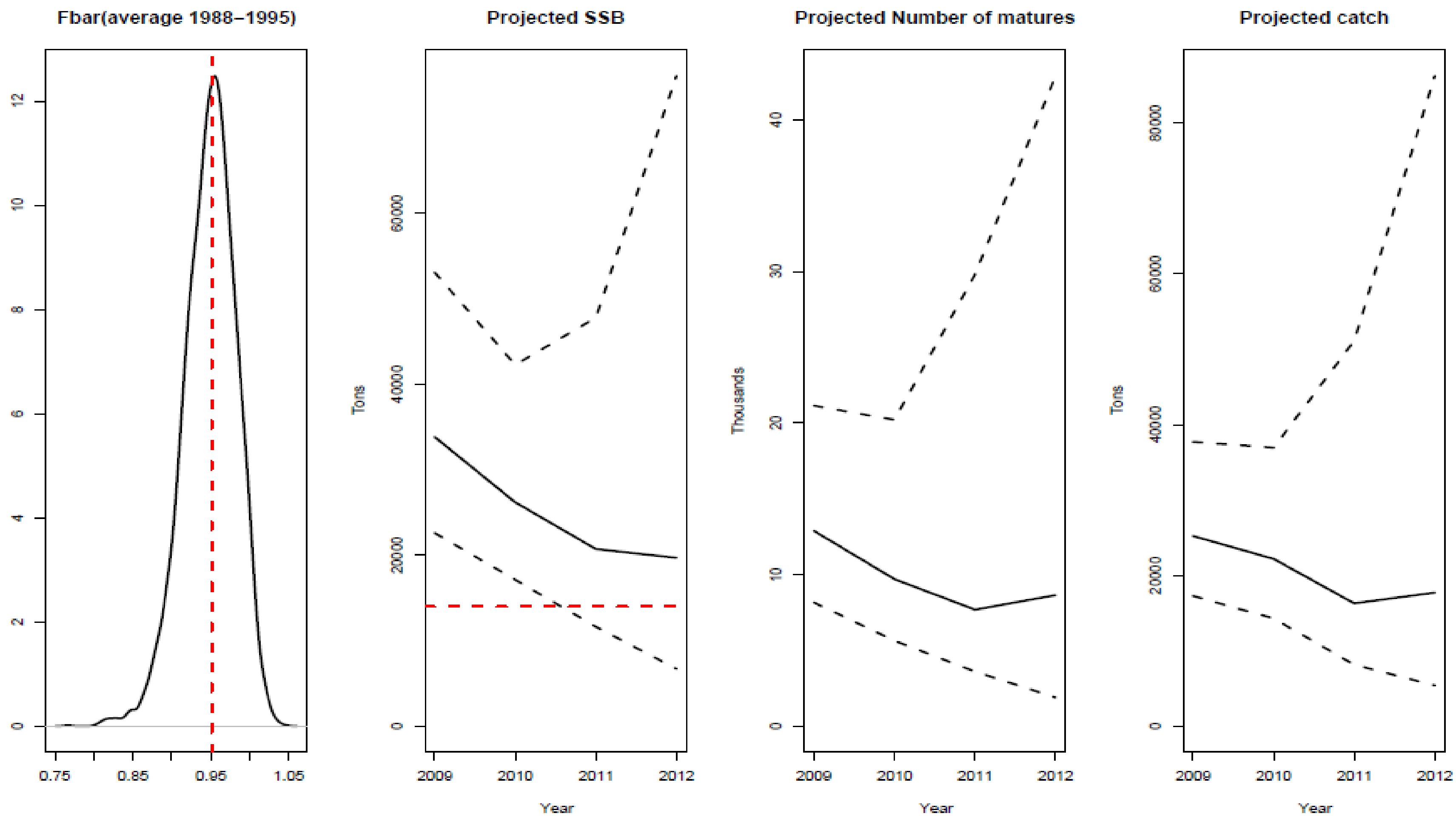

Figure 43.- Projections with F_{bar}=F_{bar}(average of 1988-1995). M with uncertainty.

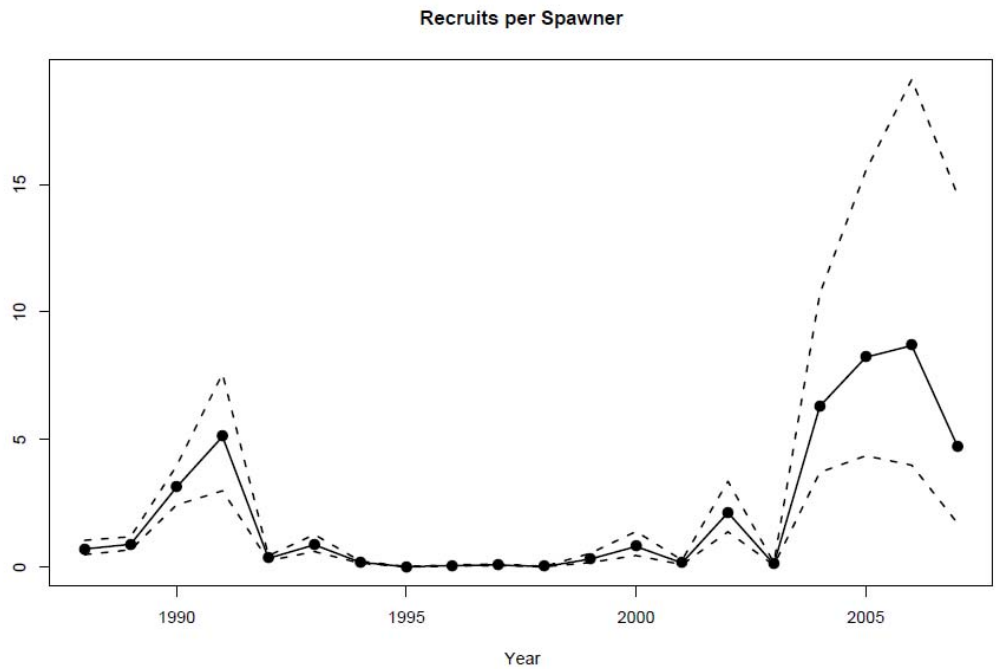

Figure 44.- Estimated recruits per spawner. M constant.

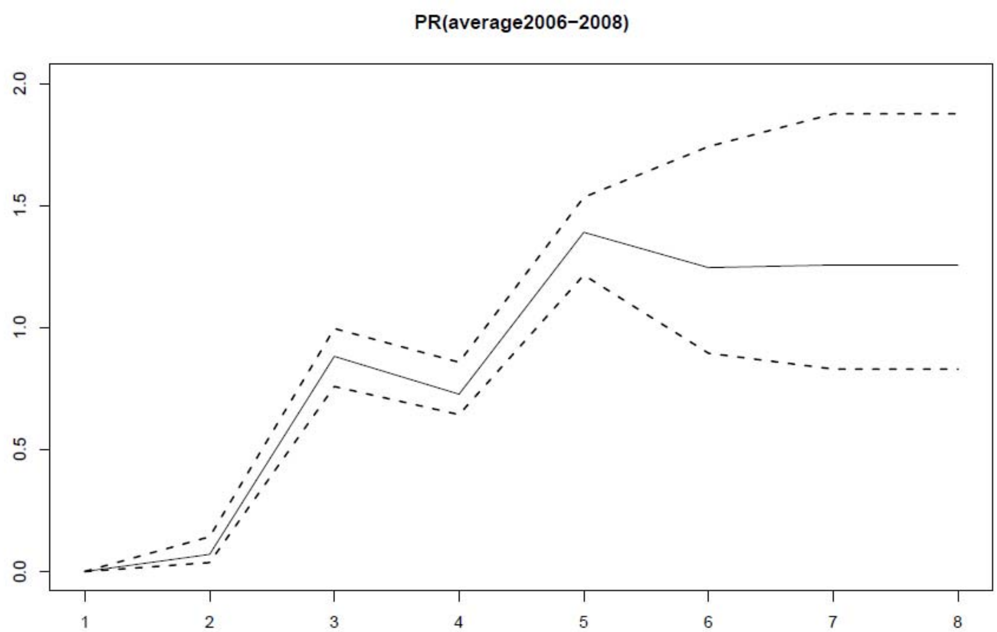

Figure 45.- Estimated PR, averaged over the years 2006-2008. M constant.

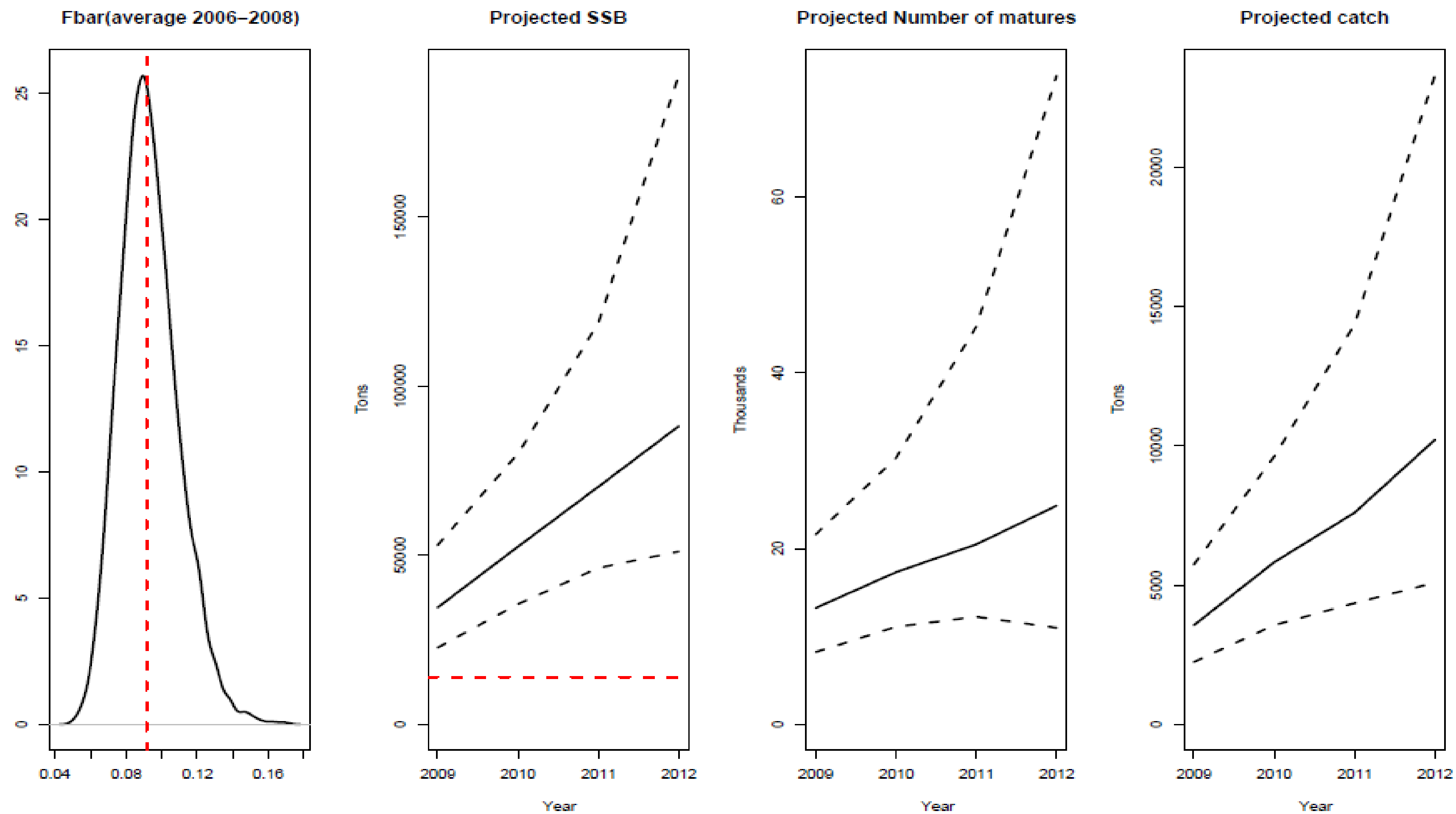

Figure 46.- Projections with F_{bar}=F_{bar}(average of 2006-2008). M constant.

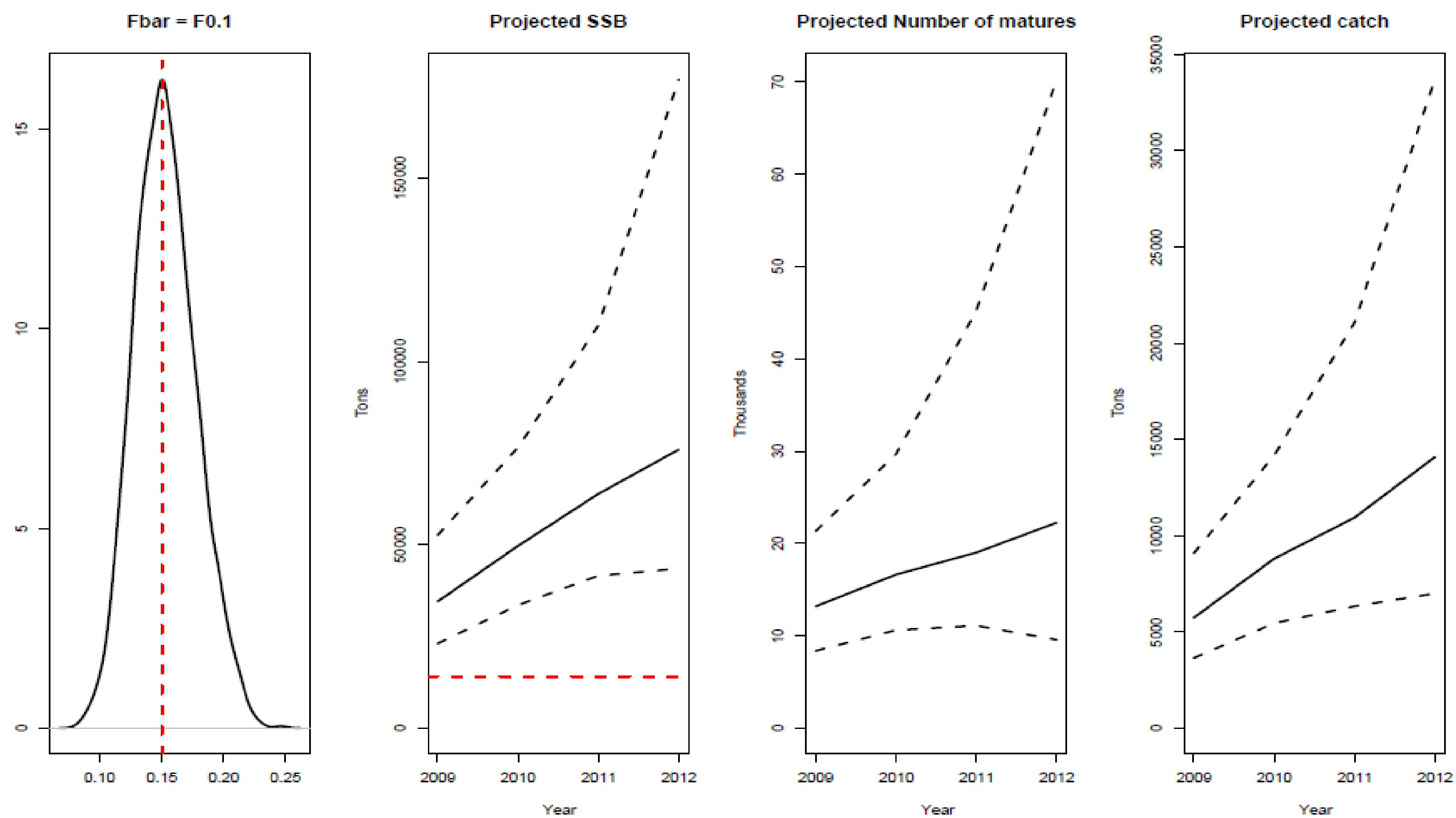

Figure 47.- Projections with $F_{bar}=F_{0.1}$. M constant.

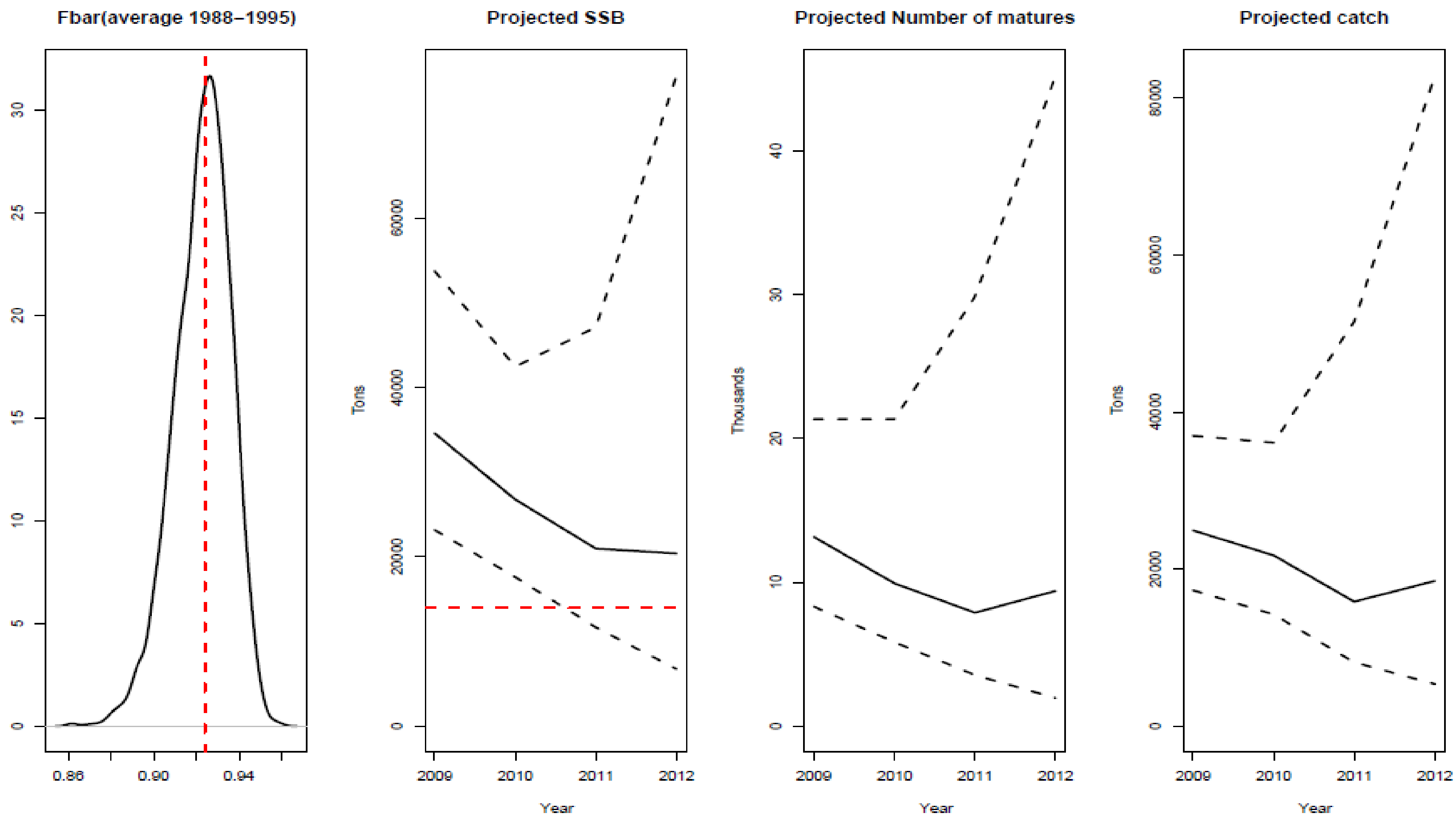

Figure 48.- Projections with F_{bar}=F_{bar}(average of 1988-1995). M constant.

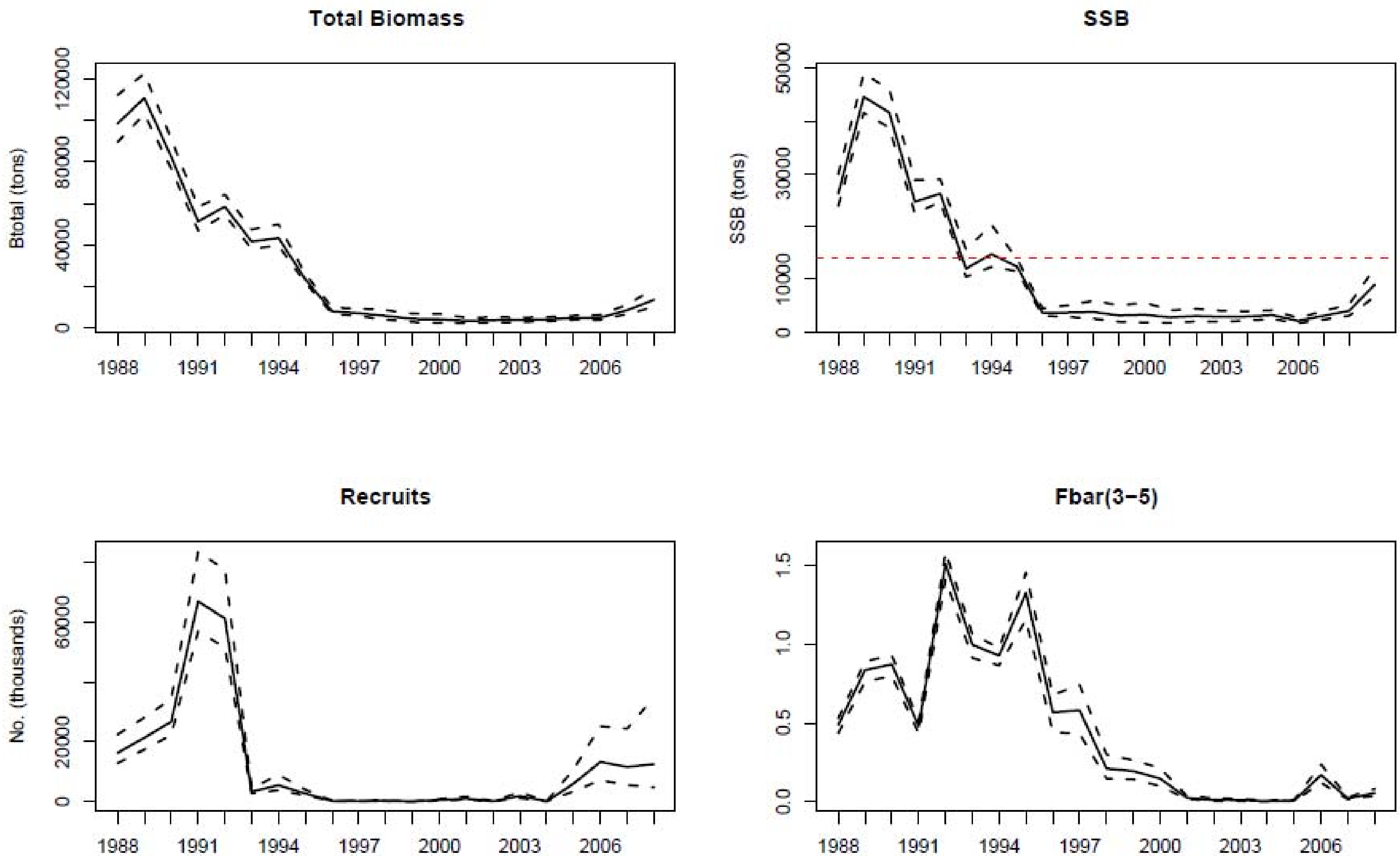

Figure 49.- Results with the maturity ogive and weight-at-age constant and equal to the mean of years 1988-1995. M with uncertainty.

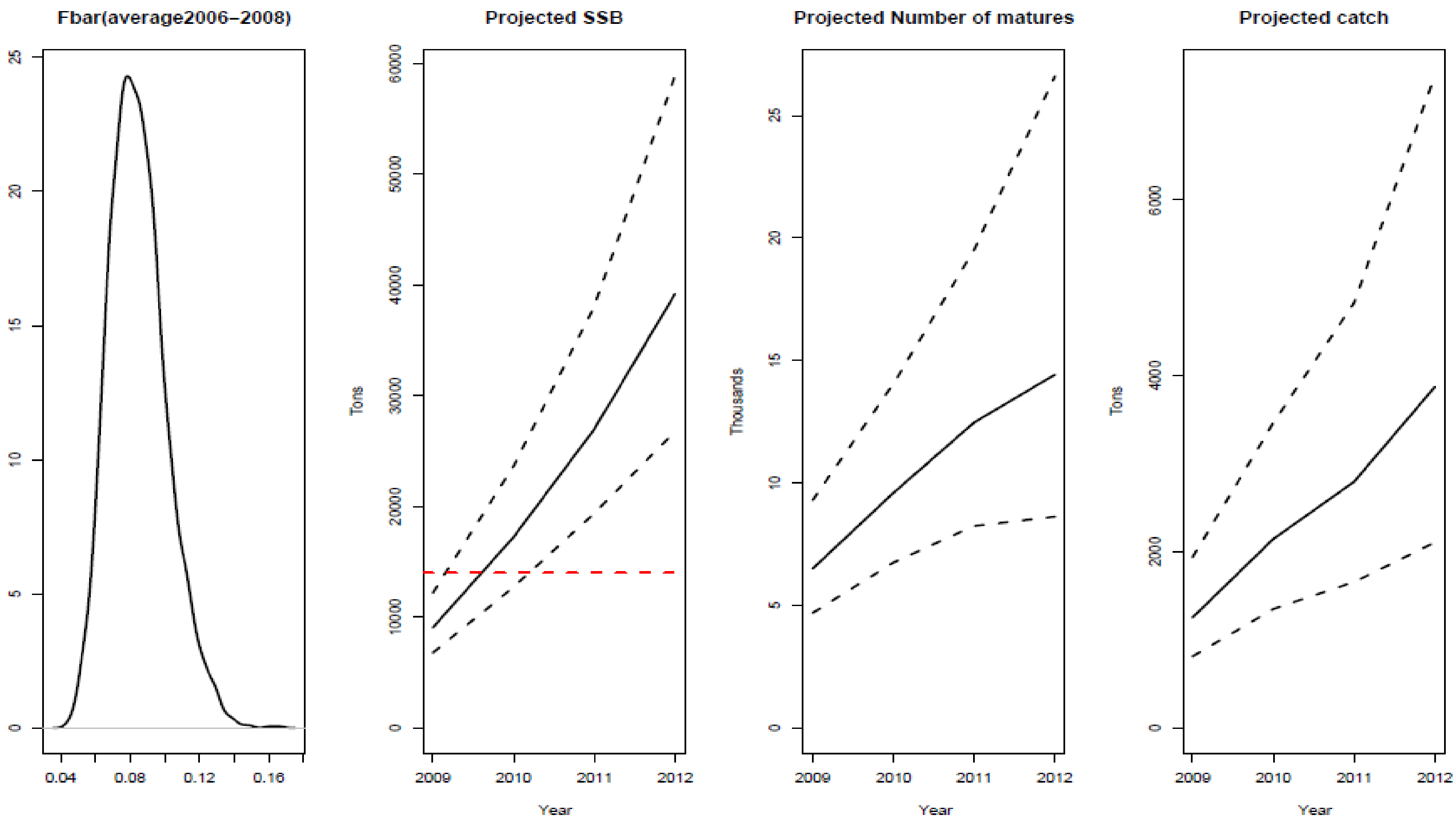

Figure 50.- Projections for F_{bar}=F_{bar}(average of 2006-2008) with the maturity ogive and weight-at-age constant and equal to the mean of years 1988-1995. M with uncertainty.

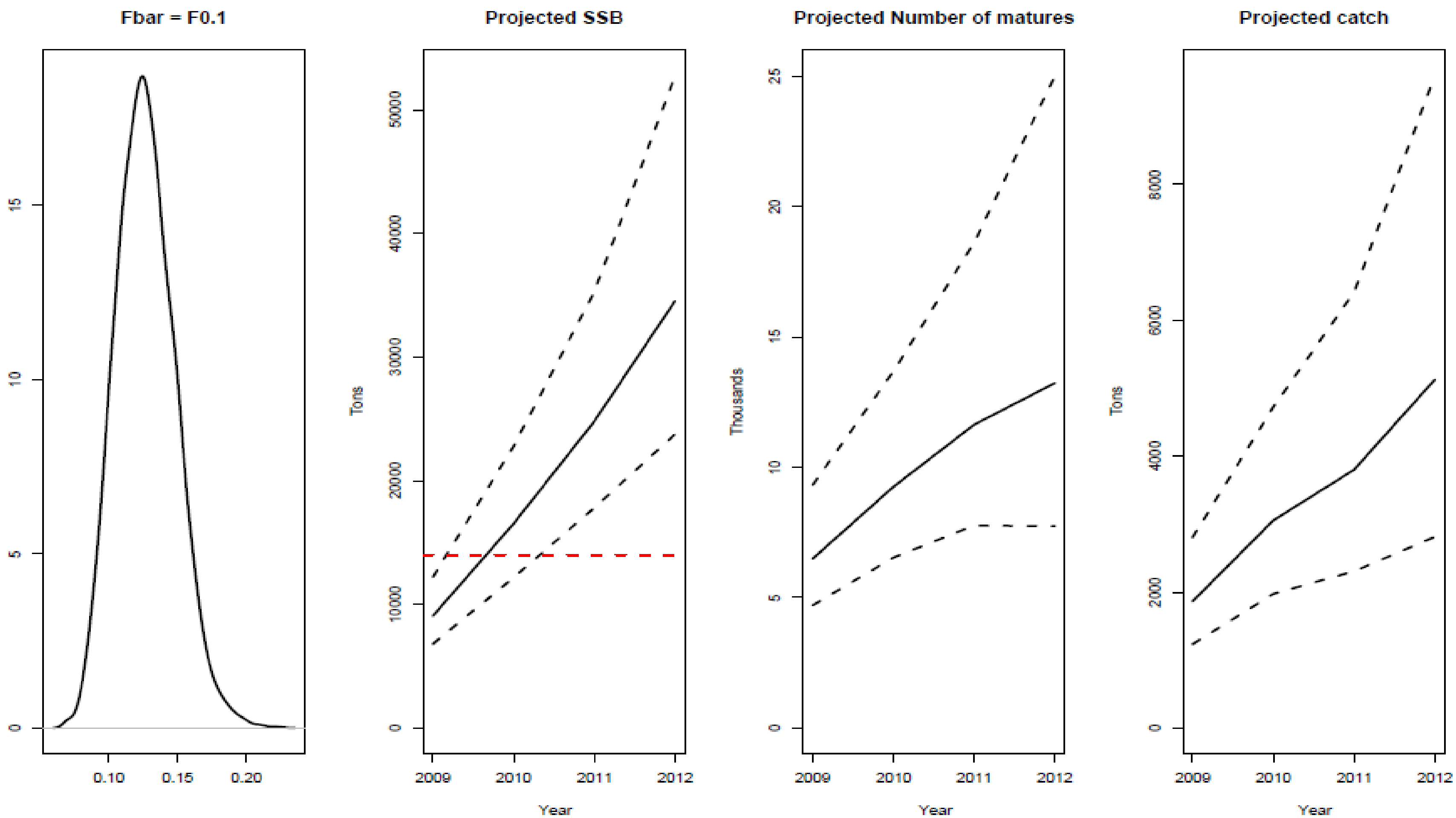

Figure 51.- Projections for F_{bar}=$F_{0.1}$ with the maturity ogive and weight-at-age constant and equal to the mean of years 1988-1995. M with uncertainty.

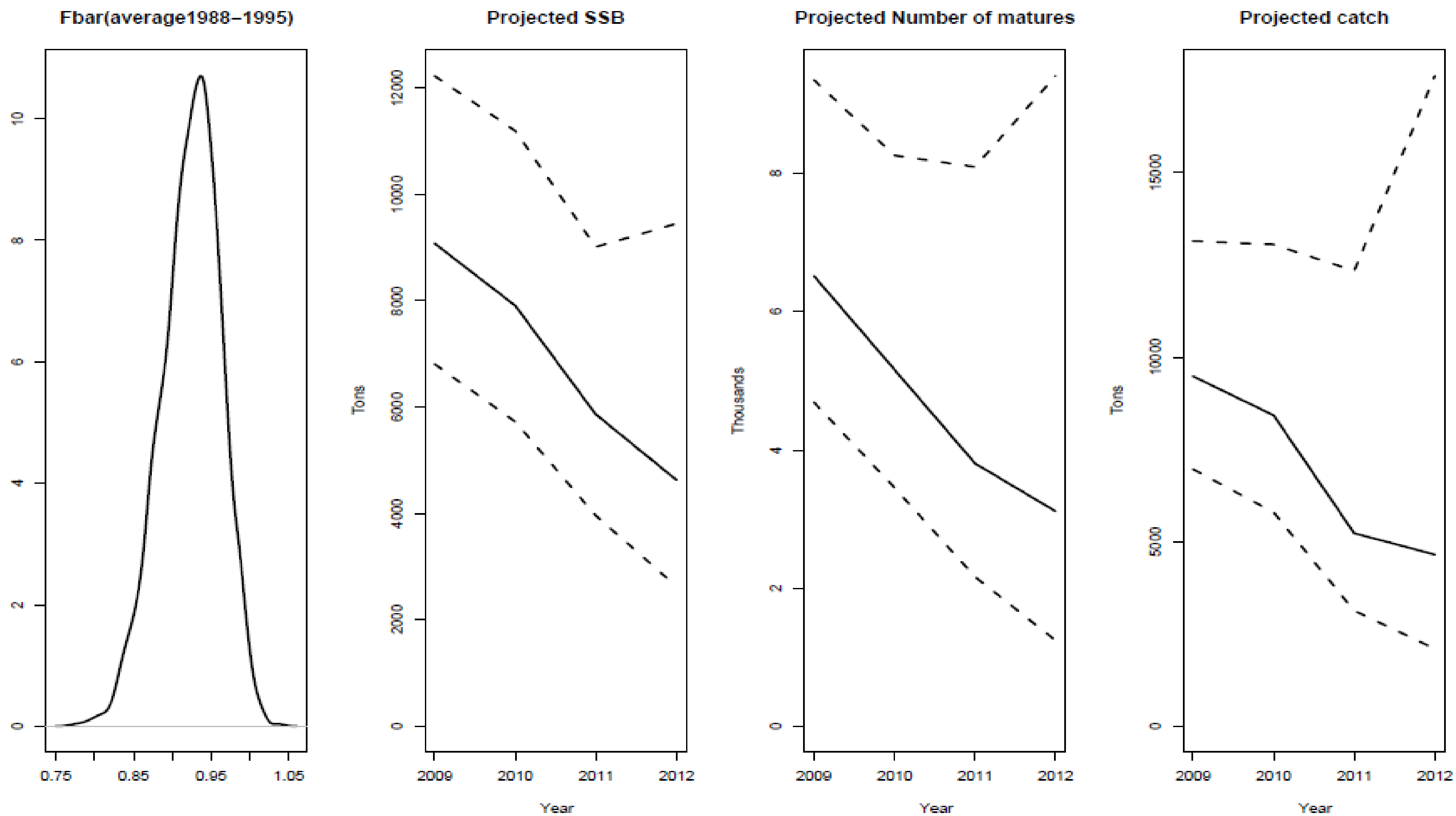

Figure 52.- Projections for F_{bar}=F_{bar}(average of 1988-1995) with the maturity ogive and weight-at-age constant and equal to the mean of years 1988-1995. M with uncertainty.