Northwest Atlantic Fisheries Organization

Serial No. N6699 **NAFO SCR Doc. 17/043**

SCIENTIFIC COUNCIL MEETING – JUNE 2017

An Assessment of American Plaice (*Hippoglossoides platessoides*) in NAFO Division 3M

by

R. Alpoim[1], D. González-Troncoso[2] and A. M. Ávila de Melo[1]

[1] Instituto Português do Mar e da Atmosfera, IPMA
Av. Brasília 1449-006 Lisboa, Portugal.

[2] Instituto Español de Oceanografía,
P.O. Box 1552. Vigo, Spain.

Abstract

The present assessment evaluates the status of the 3M American plaice stock. The catch at age matrix, EU survey abundance at age and the respective mean weights were updated. The surveys and models indicate that the stock suffered a continuous decline, even with catches kept at a low level since 1996. A general decrease is observed in the biomass and abundance estimated by the several surveys. All of the 1991 to 2005 year-classes are estimated to be weak. Since 2006 the recruitment improved, particularly the 2006, 2012 and 2013 year classes. SSB recorded a minimum in the second half of the 2000's; in recent years SSB indices increase with the income of the good recruitments but in 2013 this increase seems to halt mainly as there were fewer older fish (ages 16+). There are no changes in the perception of the stock status from last assessment (2014). This stock continues to be in a poor condition, despite the apparent improvement of the recruitment since 2006. Although the level of catches is low since 1996, this stock has been kept at a relatively low level.

Introduction

General considerations

On Flemish Cap American plaice mainly occurs at depths shallower than 600 m. The last full assessment was done in 2014 (Alpoim *et al.*, 2014).

Catch trends and TAC regulation

In the early-1960's catches were relatively low with the exception of 1961 (nominal catches recalculated from NAFO statistical data base using the NAFO STATLANT 21A Extraction Tool on June 1th 2017). Catches were high between 1964 and 1966, with a peak in 1965 of 5 341 tonnes. Till the end of the 1960's catches remained at a low level within 80 tonnes and 150 tonnes, jumping to a higher 600-1 100 tonnes level on the early-1970's. Since 1974 this stock became regulated and catches ranged from 600 tonnes (1981) to 5 600 tonnes (1987). After 1987 catches declined to 300 tonnes (1996), following the fast decline of the stock biomass and the reduction of the Spanish directed effort (1992). From 1986 to 1989 and in 1995 catches exceed the TAC. Since 1997 catches have remained low and declined to a historical minimum in 2012 (63 tonnes). Catches increased in recent years, oscillating between 120 and 270 tonnes and are taken as bycatch partially in the Div. 3M cod fishery (Table 1 and Fig.1).

Since 1974 till 1993 a TAC of 2 000 tonnes has been in effect for this stock with the exception of 1978 (TAC of 4 000 tonnes). A reduction to 1 000 tonnes was agreed for 1994 and 1995, and finally a moratorium was agreed thereafter (Table 1 and Fig.1).

In the recent year catches of 3M American plaice by Contracting Parties are mainly a by-catch of trawl fisheries directed to other species.

Survey data

The plan of stratification of the Flemish Cap (Bishop, 1994) used by the surveys is presented in Fig. 2.

In the 2002 assessment (Alpoim *et al.,* 2002 - SCR 02/62) and in the 2003 update (Alpoim, 2003 - SCR 03/44) of the status of the stock several historical survey data were analysed, this analysis is resume in Fig 3. Since 2003 only EU-Spain/Portugal survey was conducted. This was the only survey updated and used in this assessment.

EU-Spain/Portugal Survey (1988-2016) (Casas and González Troncoso, 2017 - SCR 17/024).

EU- Spain/Portugal has conducted a random bottom trawl survey up to a depth of 730 metres (400 fathoms) on Flemish Cap since 1988. All surveys had a stratified design following NAFO specifications. The surveys were conducted in June-July of each year. Towing speed was around 3.5 knots. Trawling effective time is 30 min. The fishing gear used was a Lofoten gear with effective 30 mm mesh size in the codend. The full description of the survey could be found in the survey protocol (Vazquez *et al.*, 2013 – SCR 13/21).

In June 2003 a new Spanish research vessel, the RV "Vizconde de Eza" (VE), replaced the RV "Cornide de Saavedra" (CS) that had carried out the whole EU survey series, with the exception of the years of 1989 and 1990. In order to preserve the full use of the 1988-2002 survey indices available for several target species, the original time series needed to be converted to the new RV units.

During 2003 and 2004 Flemish Cap surveys, 130 pairs of parallel hauls (selected at random from the annual coverage of the bank) were performed simultaneously by the two vessels, at depths less than 730 m. Those pairs of parallel hauls were distributed over the swept area trying in one hand to maximize the sampled area and on the other to guarantee a large enough number of hauls with acceptable catches of all target species, namely the ones from severely depleted stocks (cod and American plaice). Both vessels were fishing with the same gear, a Lofoten trawl gear with 35 mm mesh size at the codend, which remained unchanged throughout the series. With the comparative fishing trials concluded and the conversion factors estimated, the indices from R/V Cornide de Saavedra were transformed to the R/V Vizconde de Eza scale to make them comparable. The results of the calibration shown that the new RV Vizconde de Eza is 33% more efficient than the former RV Cornide de Saavedra as regards American plaice (González Troncoso and Casas, 2005 – SCR 05/29). 1988-2002 data are transformed R/V Cornide de Saavedra data, 2003-2016 data are original from R/V Vizconde de Eza (Casas and González Troncoso, 2017 - SCR 17/024).

The methodological aspects and results of the calibration are presented in SCR 05/29 (González Troncoso and Casas, 2005).

Biomass and abundance estimates

Estimates for biomass and abundance are presented in Table 2 and Fig. 3.

Stock length composition

The stock length composition matrix was updated since the last assessment (Alpoim *et al*, 2014; Casas and González-Troncoso, 2015; Alpoim and González-Troncoso, 2016; Casas and González-Troncoso, 2017). Length compositions (Table 3) from 1988 to 2016 were given by the EU survey.

Length weight relationships

Length weight relationships for the 3M American plaice (1988-2016) were calculated with EU survey length/weight data from both males and females (González-Troncoso, *pers. comm*. 2017) and used in this assessment on an annual basis (Table 4).

Stock abundance-at-age

The EU survey series presents different age reading criteria due to changes in the age reader along the series. The series can be split in two periods: the first from 1988 to 1992 that follows the criteria of one age reader and a second period from 1993 to 2001 in which several age readers have a very good agreement between them. Some effort has been spent in order to revisit the otoliths from the former years under the present accepted criteria, but, due to the size of the otoliths collections from several years and to the deterioration of some sets due to the enhancing methods used before, this work is difficult to achieve. In order to have the same criteria for all the series a combined age length key from 1993 to 2001 was used backwards over 1988-1992. Since 2001 both age reader and criteria used are the same.

The age-length keys used in 2003 and 2004 became from the sampling of the two RV (Vizconde de Eza and Cornide Saavedra) in order to have a more complete AL key.

Abundance-at-age of the stock is presented in Table 5.

Stock mean weights at age

The annual EU survey length weight relationships were used to calculate mean weights at age in the 3M American plaice stock for the period 1988-2016 (Table 6). For assessment purposes, on the years/ages where weight at age data are missing, the average mean weights at age for all the period were used.

Maturity ogive

The criterion applied in this work was the same applied in previous years. The spawning stock biomass was calculated as 50% of age 5 and age 6 plus.

Commercial Data

Length composition of the commercial catch and by-catch

The length compositions presented in the 2014 Portuguese, Russian, Estonian and Spanish Research Reports (Vargas *et al*., 2015; Fomin *et al*, 2015; Tõrra and Sirp, 2015; González-Costas *et al*, 2015) was used to estimate the length composition of the 2014 total catch. The length compositions presented in the 2015 Portuguese Research Report (Vargas *et al*., 2016) was used to estimate the length composition of the 2015 total catch. The length compositions presented in the 2016 Portuguese and Spanish Research Reports (Vargas *et al*., 2017; González-Costas *et al*, 2017) were used to estimate the length composition of the 2016 total catch. The length compositions presented in the 2016 Russian Research Report (Fomin and Pochtar, 2017) was not used to estimate the length composition of the 2016 total due to the low level of sample.

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

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

where N_{LC} is the number observed in length-class *LC* and $\overline{W}_{LC}$ is the mean weight of the length-class *LC*. Mean weights at length were given by the length/weight relationships from the EU bottom trawl survey series (Table 4).

The breakdown of the total catch is presented in Table 7. The commercial catch at length matrix (Alpoim *et al*, 2014) was updated with the 2014, 2015 and 2016 data (Table 8).

Catch at age

The catch-at-age was given by the same age length keys already used to get survey abundance-at-age (Table 9).

Catch mean weights-at-age

The annual EU survey length weight relationships were used to calculate mean weights-at-age in the catch of 3M American plaice for the period 1988-2016 (Table 10). Missing weights were filled with the respective average catch mean weight-at-age for all the period. Average mean weight at age 1 from the stock was also assumed on the commercial catch for that age.

Partial recruitment vector

In order to generate an observed partial recruitment vector, an F index was first derived from the 1988-2016 ratios at each age between the sum of the annual permilles on the commercial catch and the correspondent sum of permilles for the EU survey abundance. Those indicators of F at age were then standardised to its highest value, recorded at age 4. Assuming a flat top recruitment curve this observed partial recruitment vector was adjusted to a general logistic curve (Table 11, Fig. 4). The expected values were used in the yield per recruit analysis.

Vectors used in yield-per-recruit analysis

A yield-per-recruit analysis was conducted incorporating the following sets of vectors (Table 12A), all of them considered to be representative, in terms of growth and maturity, of 3M American plaice:

1) Mean weights at age in the commercial catch.
2) Mean weights at age in the stock.
3) Female maturity ogive at age.
4) Expected partial recruitment vector.
5) Natural mortality set at 0.2.

Assessment Results

Comments on trends on stock indicators

The two former USSR-Russian survey series showed a decreasing trend in biomass and abundance between 1976 and 1993. The Russian surveys in 2001-2002 show very low estimates of biomass and abundance. From 1978 till 1985 Canadian series is stable, with survey biomass and abundance around 6 700 tonnes and 10 million fish. A continuous decline in abundance and biomass is observed since the beginning of EU survey till 2007 when the abundance and biomass reached the lowest values of this series (1 053 tonnes and 1.4 millions fishes). After 2007, due to recruitment improvement (in particular the 2006 year class), the biomass and abundance indices increased, but in 2012 this increase was halted. The biomass and abundance indices decrease until 2014 but in recent years both recovered to the levels of 2012, however still at low levels. Results of the 1996 Canadian survey are comparable with the 1996 EU survey (Table 2, Fig. 3) (Alpoim *et al.*, 2002; Alpoim, 2003; Casas and González Troncoso, 2017).

A proxy to fishing mortality has been giving by the ratio between catch and EU survey biomass for ages fully recruited to the fishery (ages 8-11). Despite the variability, this index decreased, from high values in the beginning of the series, to 0.011 in 2005. Since 2000 fluctuated at or below 0.1. F has decreased slightly in recent years (Table 13, Fig. 6).

The 1990 year-class, that was the best represented in the EU survey till 2005 (Table 5) is now in the 16+ group and lost its strength. In the period between 1991 and 2005, all the recruiting year-classes were poorly represented in the EU survey. The 2006 year class (age 10 in 2016) was strong but not as the 1990 year class. 2011, 2012 and 2013 year classes in recent years appear to be strong. Survey spawning biomass (SSB) declined since 1988 reaching a minimum in 2007, but after 2011, as the new recruitment enters in the SSB, the SSB indices stabilised around 3 500 tonnes (Table 14).

Age 3 is the first age to appear in all the years of the EU survey series, so it was used to evaluate the stock/recruitment relationship (26 points). With the addition of recent recruitment (2006-2009 and 2012-2013) no apparent relation can be seen, without these year classes very poor recruitment for an SSB less than 9 000 t is observed (Table 14, Fig. 7).

In Fig 8 it is plotted an EU survey index of stock reproductive potential, the log of the R/SSB ratio for each year class and with both sexes included in spawning biomass. Before 1991 an average of 0.121 recruits at age 3 were produced per kg of SSB, from 1991 till 2000 this average was reduced to only 0.011 recruits per kg of SSB. The 2001 and 2002 mean (0.086 recruits per kg of SSB) although was higher than the previous period didn't generated good recruitments due to the poor level of SSB. The 2003 - 2005 mean is at the level of the period 1991-2000. 2006-2009 values were the highest of the time series (0.489 recruits per kg of SSB) but in 2010 the index decreased to 10% of the previous value. Since 2011 this index has been increasing again to high levels (Table 14, Fig.8). This recruitment failure seems not to be caused by the shrimp fishery developed in Flemish Cap since the beginning of 1990´s, because estimation of by-catch gives very low figures for American plaice (Kulka, 1999).

Yield-per-recruit analyses

A yield-per-recruit analysis was conducted, incorporating the sets of vectors already described. This analysis give a $F_{0.1}$ = 0.153 and an F_{max} = 0.302 (Tab. 12, Fig. 5).

XSA

The XSA, using the Lowestoft VPA Suite (Darby and Flatman, 1994), was updated by adding the 2014, 2015 and 2016 data. The month with a peak of spawning for 3M American plaice is May (Serebryakov *et al.*, 1987) and was used to estimate the proportion of F and M before spawning. The ratios between annual catches and EU survey bottom biomass were considered to be a proxy of mean fishing mortalities from 1988 to 2016. The survey biomass can be considered representative of the mean annual biomass (EU survey is conducted around the middle of the year). The 2016 F index was multiplied by the observed PR to have a starting guess of F at age in the terminal year. In order to get the F's for the last age through 1988-2016 the selection at age 15 was multiplied by the F index of each year. The rest of the data were already described above.

Table 15 presents the input data files, for XSA analysis, with all years and ages available and natural mortality (M) assumed constant at 0.2.

Further analyses were conducted to investigate the impact of changing:

1) the first age in the assessment (age 1 or 4);
2) the first age that *q* is independent of age;
3) the first year of the tuning fleet (1998 or 1994);
4) splitting the tuning series in two (1988-1993 and 1994-2016);
5) or changing M from 0.2 to 0.15.

Several XSA frameworks have been tested. Table 16 summarises the changes in the input and the settings of XSA frameworks that showed better fit. All these runs have the following settings:

- No year weights were applied, due to the short time series.
- Final estimates not shrunk towards mean F.
- Minimum Log (S.E.) for the terminal population estimates derived from each fleet (Threshold se) was 0.5.

A summary of the XSA runs diagnostics and plots of the log catchability residuals are presented in Table 16 and in Fig. 9. The XSA with age 4 onwards, M=0.15 and splitting the tuning fleet (Run *a4_t-split_q14_m015)* showed better diagnostics (taken into account the mean squared residuals by age, the sum square of the Log catchability residuals and number of interactions) but they are highly dependent on the input sets and show a strong retrospective pattern (Fig. 10). Run *a4_t-split_q14_m015* full diagnostic output is presented in Table 17 and the results in Table 18 and Fig. 11.

XSA 4+ Biomass and Spawning stock biomass (SSB) show a steady decline, but since 2009 (2010 for SSB) show an extremely rapid increase (maybe unrealistic). All of the 1991 to 2005 year-classes are estimated to be weak. Since 2006 the recruitment improved, particularly the 2006, 2012 and 2013 year classes, and is pushing the 4+ biomass up.
The increase in the spawning biomass has halted in 2013 and has been stable since then. Fishing mortality declined from the mid-1980s to the mid-2000s and since 2000 fluctuated at very low levels. In recent years F has decreased.

Bayesian Model

A VPA-type Bayesian model, the same used for the Div. 3M cod and in the American plaice in previous assessments, was applied. As in XSA, some varieties of combinations of the input data and in the values of M were tested. All model runs performed the following input sets:

Catch data: catch numbers and mean weight at age for 1988-2016.
Catchability analysis: dependent on stock size for the age 4.
Priors: for survivors at age at the end of the final assessment year, for survivors from the last true age at the end of every year, for numbers at age of the survey and for the natural mortality.

The VPA-type Bayesian model results are highly dependent of the chosen priors and its distribution. The VPA-type Bayesian model with all data (ages 1-16+, tuning from 1988-2016) and with variability on M (0.2 with a c.v. of 0.05) was the one that showed better fit, its full diagnostic and results output is presented in Table 19 and Fig. 12-21.

Conclusions

All of the 1991 to 2005 year-classes are estimated to be weak. Since 2006 the recruitment improved, particularly the 2006, 2012 and 2013 year classes.

SSB recorded a minimum in the second half of the 2000's due to consistent year-to-year recruitment failure from the 1991 to 2005 year-classes. In recent years SSB indices increase with the income of the good recruitments but in 2013 this increase seems to halt mainly as there were fewer older fish (ages 16+). Stock biomass also increased in recent years due to the improved recruitment since 2006. Nevertheless SSB and stock biomass are still at low level.

Fishing mortality indices declined from the mid-1980s to the mid-2000s and since 2000 fluctuated at or below 0.1. In recent years F has decreased.

Stock status

Although the stock has increased slightly in recent years due to improved recruitment since 2006, it continues to be in a poor condition. Although the level of catches since 1996 is low, all the analysis indicates that this stock remains at a relatively low level.

Acknowledgements

This study was supported by the European Commission (DG Mare), IPMA, CSIC and IEO.

References

Alpoim R., C. Darby and A. M. Ávila de Melo - 2002. An assessment of American Plaice (*Hippoglossoides platessoides*) in NAFO Division 3M. NAFO SCR Doc. 02/62. N4674. 37p.

Alpoim R. - 2003. A stock status update of American Plaice (*Hippoglossoides platessoides*) in NAFO Division 3M. NAFO SCR Doc. 03/44. N4862. 12p.

Alpoim R., González-Troncoso, D. and Ávila de Melo, A. M., 2014. An assessment of American Plaice (*Hippoglossoides platessoides*) in NAFO Division 3M. NAFO SCR Doc. 14/036. N6332. 39p.

Alpoim R. and González-Troncoso, D., 2016. Results from Bottom Trawl Survey on Flemish Cap of June-July 2015. NAFO SCR Doc. 16/024, N6567. 61p.

Bishop C.A., - 1994. Revisions and additions to stratification schemes used during research vessel surveys in NAFO Subareas 2 and 3. NAFO SCR Doc 94/43. N2413, 23p.

Casas, J.M. and González-Troncoso, D., 2015. Results from Bottom Trawl Survey on Flemish Cap of June-July 2014. NAFO SCR Doc. 15/017 Rev, N6438. 59p.

Casas, J.M. and González-Troncoso, D., 2017. Results from Bottom Trawl Survey on Flemish Cap of June-July 2016. NAFO SCR Doc. 17/024, N6676. 62p.

Darby, C. and S. Flatman, 1994. Virtual population analysis: version 3.1 (Windows/Dos) user guide. *Info. Tech. Ser., MAFF Direct. Fish. Res*., Lowestoft, (1): 85p.

Fomin, K. and M. Pochtar, 2017. Russian research report for 2016. NAFO SCS Doc. 17/11, Serial No. N6686, 31 p.

Fomin, K. , Khlivnoy, V., Mishin T. and Zavoloka, P., 2015. Russian research report for 2014. NAFO SCS Doc. 15/07, N6433, 29 p.

González-Costas, F., Ramilo, G., Gago, A., Román, E., González-Troncoso, D., Casas, M., Sacau M., Guijarro E. and Lorenzo, L., 2015. Spanish Research Report for 2014. NAFO SCS Doc. 15/05. N6423. 47p.

González-Costas, F., Ramilo, G., Román, E., Gago, A., Casas, M., Sacau M., Guijarro E., González-Troncoso, D. and Lorenzo, L., 2017. Spanish Research Report for 2016. NAFO SCS Doc. 17/04. N6656. 54p.

González Troncoso, D. and Casas, J.M., 2005. Calculation of the Calibration Factors from the Comparative Experience between the R/V *Cornide de Saavedra* and the R/V *Vizconde de Eza* in Flemish Cap in 2003 and 2004. NAFO SCR Doc.05/29. N5115. 8p.

Kulka, D. W., 1999. Update on the By-catch in the shrimp fisheries in Davis Strait to Flemish Cap. NAFO SCR Doc. 99/96. N4168. 15p.

Serebryakov V.P., A.V. Astafjeva and V.K. Aldonov, 1987. USSR Ichthyoplankton Investigations on Flemish Cap, 1978-83. NAFO Sci. Coun. Studies, 11. 7-21p

Tõrra T. and Sirp. S. 2015. Estonian research report for 2014. NAFO SCS Doc. 15/04, N6420, 14 p.

Vargas J., Alpoim, R., Santos E. and Ávila de Melo A. M., 2015. Portuguese research report for 2014. NAFO SCS Doc. 15/06. N6426. 40p.

Vargas J., Alpoim, R., Santos E. and Ávila de Melo A. M., 2016. Portuguese research report for 2015. NAFO SCS Doc. 16/09. N6555. 45p.

Vargas J., Alpoim, R., Santos E. and Ávila de Melo A. M., 2017. Portuguese research report for 2015. NAFO SCS Doc. 17/05. N6658. 38p.

Vázquez, A., Casas, J.M., Alpoim, R., 2013. Protocols of the EU bottom trawl survey of Flemish Cap. NAFO SCR Doc.13/21. N6174. 51p.

TABLE 1 - Nonimal catches (t) from 1960-2016, STACFIS catches (t) from 1988-2016 and TAC (t) from 1974-2017 of American plaice from NAFO Division 3M.

Year	Nominal catches (1)														
	Country										Flatfishes (NS)	Yellowtail f.	GRAND	STACFIS	TAC
	Canada	Japan	USSR/SUN	Poland	E/ESP	E/GBR	E/PRT	E/DEU	Other	Total	Total	Total	TOTAL	catches	
1960	-	-	-	-	-	-	-	-	-	0	316	-	316	-	-
1961	-	-	-	-	-	-	-	-	-	0	2282	-	2282	-	-
1962	14	-	-	-	-	-	-	-	-	14	707	-	721	-	-
1963	-	-	51	108	-	20	-	-	-	179	-	-	179	-	-
1964	-	-	1831	8	-	37	-	-	-	1876	-	-	1876	-	-
1965	19	-	4964	216	-	83	-	-	2	5284	57	-	5341	-	-
1966	-	-	4003	17	-	53	-	-	-	4073	-	-	4073	-	-
1967	57	-	-	63	-	33	-	-	1	154	-	-	154	-	-
1968	100	-	121	-	-	4	-	-	-	225	6	-	231	-	-
1969	12	-	113	-	-	-	-	-	-	125	-	-	125	-	-
1970	-	-	62	-	-	-	-	-	-	62	17	-	79	-	-
1971	-	-	1079	-	-	-	-	-	-	1079	-	-	1079	-	-
1972	-	-	665	8	17	65	-	-	106	861	-	-	861	-	-
1973	68	-	312	39	-	85	-	-	-	504	3	127	634	-	-
1974	211	-	1110	-	-	607	-	-	-	1928	3	12	1943	-	2000
1975	140	-	958	-	8	80	522	-	-	1708	5	31	1744	-	2000
1976	191	-	809	15	28	-	149	-	-	1192	-	137	1329	-	2000
1977	30	-	987	7	18	-	457	1	118	1618		10	1628	-	2000
1978	7	49	581	21	36	2	486	100	51	1333	3		1336	-	4000
1979	10	63	457	2	16	-	248	-	-	796	4	-	800	-	2000
1980	1	1	909	5	3	-	232	34		1185	64		1249	-	2000
1981	-	47	309	-	276	-	-	-	-	632	-	-	632	-	2000
1982	-	53	1002	-	17	-	-	-	-	1072	3	-	1075	-	2000
1983	-	9	1238	-	434	-	208	-	-	1889	3	-	1892	-	2000
1984	-	1	711	-	204	-	196	190		1302	1		1303	-	2000
1985	-	2	971	-	163	-	266	318		1720			1720	-	2000
1986	-	3	962	-	1048	-	1741	-	-	3754	-	3	3757	-	2000
1987	-	-	501	-	4137	-	969	-	-	5607	20	-	5627	-	2000
1988	-	78	228	-	1608	-	941	-	6	2861	127	1	2989	2800	2000
1989	-	402	88	-	2166	-	1238	-	-	3894	72	-	3966	3500	2000
1990	-	308	-	-	102	-	359	-	21	790	38	94	922	790	2000
1991	-	450	5	-	605	2	996	-	24	2082	3	1	2086	1600	2000
1992	-	50	-	-	390	-	314	-	11	765	-	1	766	765	2000
1993	-	49	-	-	244	-	231	-	181	705	46	20	771	275	2000
1994	-	-	-	-	3	-	251	-	-	254	-	84	338	669	1000
1995	-	-	-	-	125	-	118	-	-	243	14	-	257	1300	1000
1996	-	-	-	-	105	-	29	-	8	142	2	28	172	300	0
1997	-	-	-	-	56	-	52	-	-	108	-	-	108	208	0
1998	-	-	-	-	140	-	47	-	1	188	3	2	193	294	0
1999	-	-	4	-	220	-	18	-	1	243	5	-	248	255	0
2000	-	-	55	-	169	-	27	-	1	252	1	6	259	133	0
2001	-	-	14	-	89	-	162	-	3	268	24	135	427	149	0
2002	-	5	4	-	74	-	73	-	1	157	66	32	255	128	0
2003	-	3	7	-	75	-	28	-	17	130	-	15	145	131	0
2004	-	4	4	-	39	-	58	-	3	108	-	-	108	81	0
2005	-	-	-	-	59	-	11	-	14	84	1	3	88	45	0
2006	-	-	5	-	32	-	34	-	12	83	-	-	83	46	0
2007	-	-	-	-	41	-	32	-	5	78	-	34	112	76	0
2008	-	-	1	-	15	-	16	-	33	65	-	1	66	68	0
2009	-	-	24	-	17	-	35	-	11	87	-	6	93	70	0
2010	-	-	22	-	10	-	26	-	4	62	3	-	65	65	0
2011	1	-	-	-	13	-	32	-	17	63	-	-	63	63	0
2012	-	-	24	-	21	-	66	-	10	121	-	1	122	123	0
2013	-	-	22	-	66	-	146	-	12	246	-	-	246	246	0
2014	-	-	23	2	69	-	113	-	39	246	-	-	246	247	0
2015	-	-	23	-	68	-	111	-	18	220	-	-	220	268	0
2016	-	-	16	-	25	2	109	-	7	159	-	-	159	161	0
2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0

(1) - Recalculated from NAFO statistical data base using the NAFO STATLANT 21A Extraction Tool, on 1-6-2017.

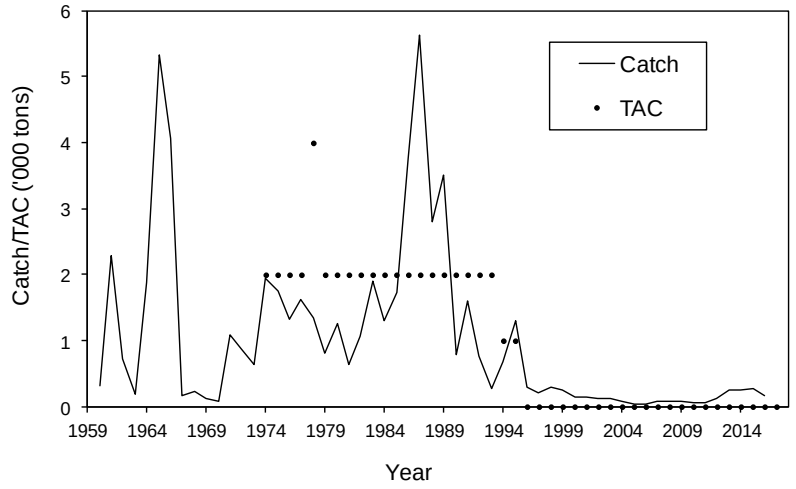


Fig. 1. American plaice in Div. 3M: nominal catches and agreed TAC's

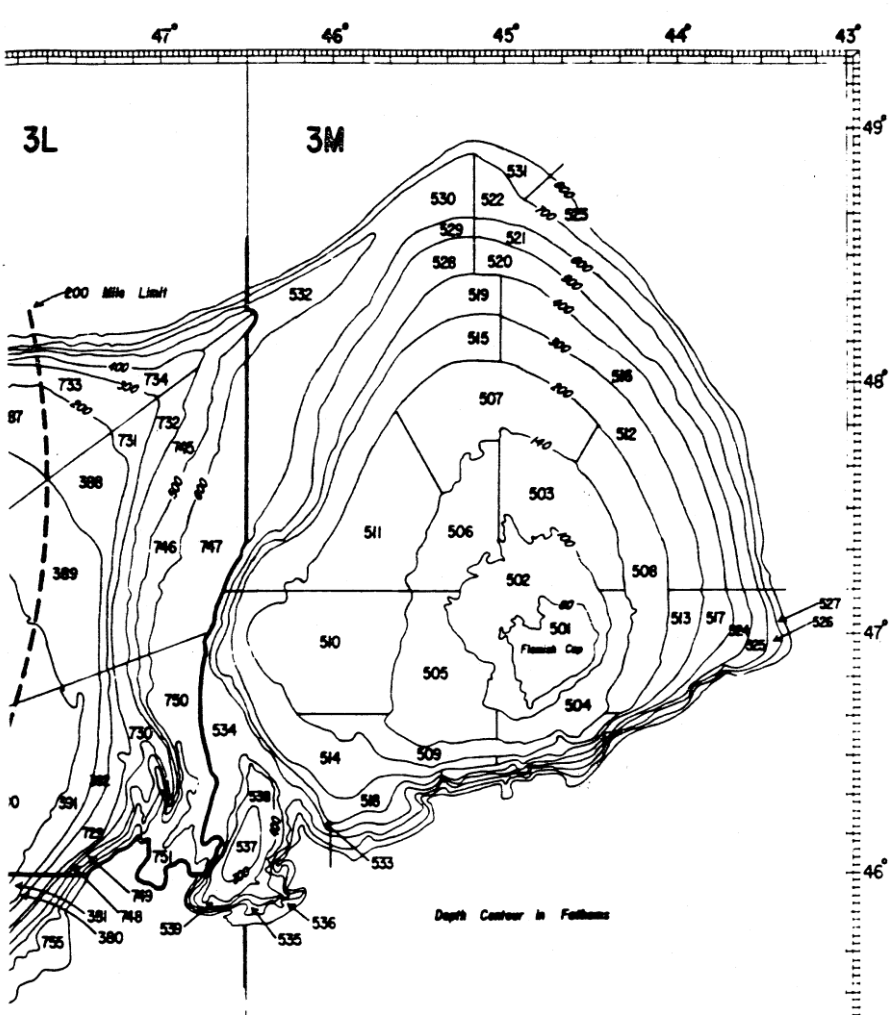


Fig. 2. Stratification scheme for stratified- random groundfish surveys in Div 3M (Bishop 1994).

Table 2 - EU - surveys in Div.3M from 1988-2016: estimates of biomass (t) and abundance (000's) of A.plaice.

Stratum	Depth range (m)	Area (sq. n. mi.)	Year 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
501	128-146	342	1306	1000	505	1078	709	1079	661	2230	1462	381	156	372	345	1043	141
502	148-183	838	2845	3602	1375	2663	1714	1267	1199	1335	943	740	1587	1810	976	835	1262
503	185-256	628	1367	1118	1668	1247	631	444	325	252	168	495	284	97	21	93	75
504	185-256	348	2199	461	817	320	557	572	853	489	268	203	343	53	100	85	128
505	185-256	703	2599	3093	1830	1407	837	1291	1230	549	500	619	744	73	56	112	189
506	185-256	496	479	1130	954	501	601	305	808	123	32	13	35	40	25	37	63
507	258-366	822	1174	531	837	389	639	319	316	249	72	83	47	19	15	28	52
508	258-366	646	417	164	263	251	727	487	171	132	56	123	165	3		45	43
509	258-366	314	103	163	343		373	205	20	500	55	36					1
510	258-366	951	2323	1491	2000	1308	1406	1459	2236	708	415	287	36	72	45	95	36
511	258-366	806	1186	1168	1316	401	372	292	303	109	68	32	29	37	23	27	59
512	367-549	670	9	19	45	17	11	15	33	12	32	7				4	
513	367-549	249	3		20					3							
514	367-549	602	8	8	7	389	29		24	15	4		4	9			
515	367-549	666	23	99	3	97	37	109	40	68	23	7	7				
516	550-731	634	5			4	9	12	5								
517	550-731	216															
518	550-731	210															
519	550-731	414				15	4	5	3	11							
total biomass			16046	14047	11983	10087	8656	7861	8227	6785	4098	3026	3437	2585	1606	2404	2049
s.e.			1845	2048	1276	1180	954	1040	1373	1083	912	708	751	869	332	429	729
mean catch per tow (kg)			19.95	17.47	14.90	12.55	10.76	9.79	10.23	8.44	5.09	3.76	4.27	3.21	2.00	2.99	2.55
s.e.			2.29	2.55	1.59	1.47	1.19	1.29	1.71	1.35	1.13	0.88	0.93	1.08	0.41	0.53	0.91
total abundance (000's)			27410	27391	20946	17643	13728	11648	11247	9376	5658	3770	3800	2672	2132	3168	1971
mean number per tow			34.09	34.01	26.05	21.79	17.05	14.47	13.96	11.66	7.02	4.69	4.73	3.32	2.65	3.94	2.45

Stratum	Depth range (m)	Area (sq. n. mi.)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
501	128-146	342	1292	1507	1038	714	284	144	548	716	693	462	329	181	410	219
502	148-183	838	713	768	796	354	209	513	370	1084	1141	1272	1202	1872	1248	1307
503	185-256	628	17	427	101	74	101	147	74	103	364	468	266	223	462	488
504	185-256	348		395	359	109	153	440	36	91	1201	749	671	258	376	178
505	185-256	703	82	72	45	63	81	88	72	200	190	716	267	328	443	592
506	185-256	496	29	26	71	61	99	37	57	34	160	185	341	187	309	282
507	258-366	822	30	84	31	37	20	47	32	28	160	156	166	208	117	253
508	258-366	646	14	55	175	163	58	128	47	49	65	187	156	249	220	346
509	258-366	314	9	77	18				77			30	25		2	12
510	258-366	951	54	45	87	97	24	163	54	115	35	123	153	105	86	325
511	258-366	806	29	69	35	19	22	50	64	26	33	121	121	185	124	308
512	367-549	670	11						11			11				
513	367-549	249														2
514	367-549	602									32				3	3
515	367-549	666	6		4		3	7	1		10	13		5	22	10
516	550-731	634														
517	550-731	216														
518	550-731	210														
519	550-731	414														
total biomass			2286	3525	2760	1691	1053	1766	1442	2446	4084	4491	3698	3800	3821	4325
s.e.			748	740	684	342	159	300	327	526	780	534	439	671	556	481
mean catch per tow (kg)			2.86	4.38	3.43	2.10	1.31	2.20	1.79	3.04	5.08	5.59	4.61	4.73	4.76	5.37
s.e.			0.93	0.92	0.85	0.43	0.20	0.37	0.41	0.65	0.96	0.67	0.54	0.84	0.70	0.60
total abundance (000's)			2769	4015	3326	2188	1401	3263	2839	4962	6917	6614	4670	4477	4951	6525
mean number per tow			3.44	4.99	4.14	2.72	1.74	4.06	3.53	6.17	8.60	8.23	5.81	5.57	6.16	8.11

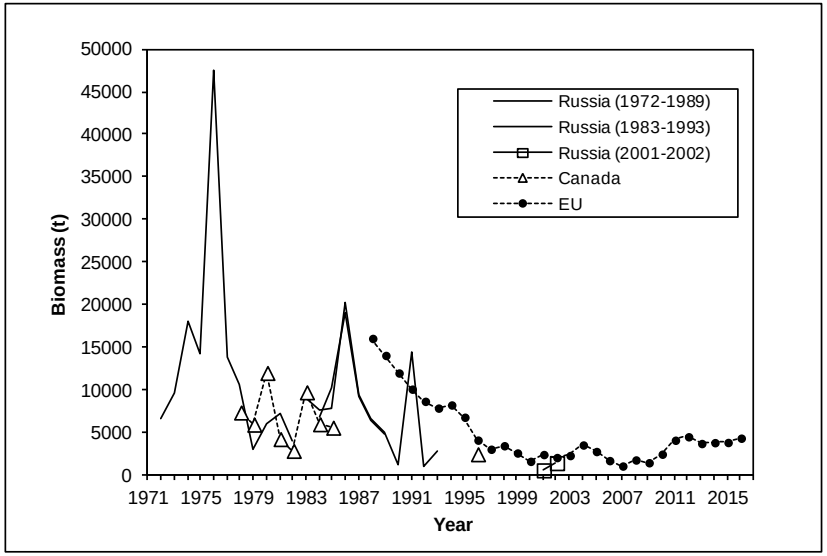


Fig.3A. American plaice in Div. 3M: trends in biomass in the surveys.

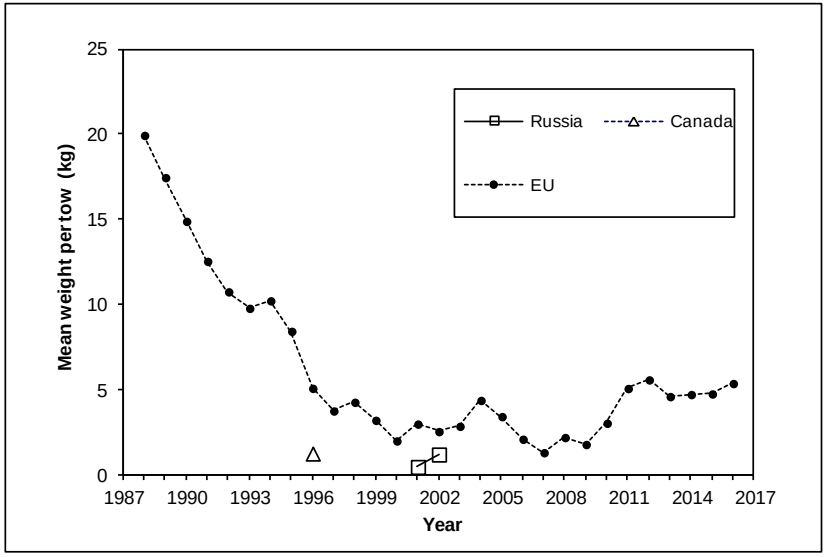


Fig.3C. American plaice in Div. 3M: mean weight per tow in the surveys.

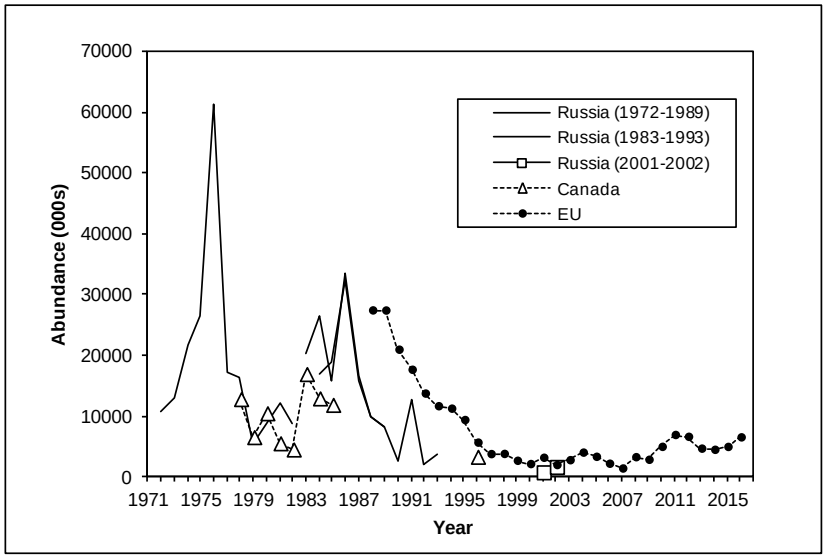


Fig.3B. American plaice in Div. 3M: trends in abundance in the surveys.

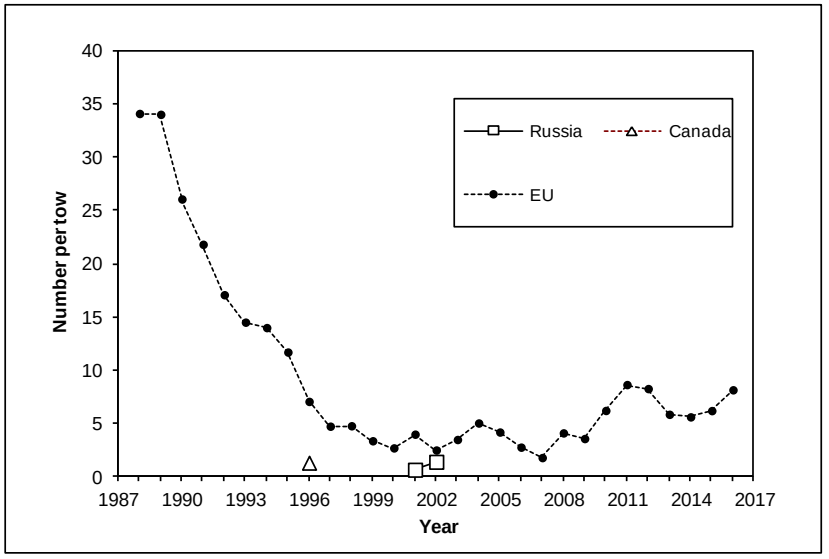


Fig.3D. American plaice in Div. 3M: mean number per tow in the surveys.

Table 3: Length composition (absolute frequencies in '000) of the 3M american plaice stock, EU survey 1988-2016.

Length group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Length group
4							7																							4
6				20																										6
8				20																20										8
10		41	8	27								7	8							174	16	6				13	8		34	10
12	68	14		46					8	8			7			7			7	13	19	13	10		7	13	7	7	21	12
14	555	14		48	48																16	6	10				7	7	8	14
16	1274	104	149	136	230		8	14	7	8						6	13				45	13		29		14	132	7	14	16
18	295	327	411	101	443	19	31	15	32	16			7	8			7	8			383	46	54	155		27	129	55	48	18
20	55	1205	146	77	253	37	33				16		8	31		7	22	8	14	13	838	146	169	161	30	105	47	186	102	20
22	166	2836	188	461	131	191	31		14		16		16			14	66	39	7		243	101	117	86	38	52	35	268	62	22
24	295	3199	391	828	272	565	44	45	38	30	8	8	8	8	9	13	109	24	14		52	171	177	100	67	7	88	68	260	24
26	575	1602	690	469	360	619	129	45	24	60	8	15	8	31	8	7	127	40	7	7		589	340	240	80		108	62	594	26
28	932	499	1301	456	392	360	297	113	68	44	45	31	44	54	32	27	73	48	31		16	361	605	574	195	13	95	286	834	28
30	1434	637	2964	782	452	657	729	212	111	30	15	8	31	23	24	72	69	149	49		8	121	580	805	376	40	63	361	376	30
32	2459	998	2836	1625	568	563	965	639	286	189	77	54	69	68	32	64	57	178	62	41	8	20	660	741	606	140	87	387	247	32
34	3019	2020	1600	2522	1105	595	864	663	352	181	219	121	133	200	73	129	122	138	90	59	62	27	465	583	849	350	192	144	409	34
36	3582	3495	1726	2749	2251	1302	1161	1292	757	426	413	256	250	365	109	336	403	250	230	106	83	55	304	561	843	663	581	61	566	36
38	2651	2627	1790	2269	2042	1397	1710	1688	1040	678	401	258	258	682	145	482	404	419	387	121	225	151	219	607	682	604	648	123	467	38
40	2740	1959	1427	1384	1576	1439	1511	1420	979	456	500	316	289	443	195	413	459	420	364	202	242	185	277	672	657	564	552	299	339	40
42	2873	1680	1282	787	1266	1178	594	930	594	321	379	209	250	265	106	376	455	370	221	148	192	160	296	535	768	554	488	380	405	42
44	2663	2017	1492	1020	630	936	708	472	356	295	375	205	130	172	96	136	263	227	123	87	95	126	78	178	519	462	411	475	308	44
46	788	1165	1318	883	604	705	803	451	232	216	339	218	221	138	189	123	134	139	98	67	64	138	80	87	251	533	313	267	181	46
48	467	527	763	582	602	349	729	405	312	285	285	327	156	177	289	136	197	177	169	81	67	93	76	118	130	133	192	285	299	48
50	203	191	291	184	331	397	419	468	233	317	330	260	133	211	310	206	344	203	97	101	157	83	151	139	108	86	88	397	314	50
52	162	164	101	117	120	236	273	279	104	153	235	271	76	187	233	142	412	261	91	61	156	97	138	252	153	121	95	413	347	52
54	72	47	46	28	40	62	117	183	66	29	90	60	21	98	77	45	208	109	35	60	174	82	58	151	117	93	48	189	180	54
56	55	15	21	14	7	24	76	31	34	21	44	35	7		44	21	54	104	85	33	91	34	97	142	81	48	56	95	67	56
58	28	6	6	7		16		6	6	7	6	6		6		8	20	16				14			44	20	7	48	15	58
60								6	6			6							7	7	9				15	14		48	14	60
62							6																					35		62
64																													14	64
66					6																									66
Total	27410	27391	20946	17643	13728	11648	11247	9376	5658	3770	3800	2672	2132	3168	1971	2769	4015	3326	2188	1401	3263	2839	4962	6917	6614	4670	4477	4951	6525	Total
mean length	36.6	34.3	36.4	36.6	37.5	38.6	40.0	40.8	40.7	41.7	43.3	44.3	41.6	41.8	45.8	41.8	42.5	42.3	42.1	38.9	33.3	34.7	34.9	36.7	39.3	40.9	39.1	40.7	37.5	

Table 4: Length weight relationships of 3M American plaice.

Year	a	b	n
1988	0.0048	3.2121	1211
1989	0.0055	3.1810	1192
1990	0.0043	3.2420	1314
1991	0.0043	3.2404	1032
1992	0.0048	3.2130	1296
1993	0.0030	3.3362	1036
1994	0.0029	3.3373	1065
1995	0.0027	3.3474	772
1996	0.0048	3.1978	571
1997	0.0046	3.2116	435
1998	0.0044	3.2260	442
1999	0.0043	3.2294	452
2000	0.0082	3.0444	411
2001	0.0044	3.2074	570
2002	0.0029	3.3242	225
2003	0.0044	3.2292	400
2004	0.0064	3.1222	602
2005	0.0043	3.2177	345
2006	0.0058	3.1403	312
2007	0.0042	3.2301	209
2008	0.0062	3.1235	410
2009	0.0051	3.1802	420
2010	0.0037	3.2660	398
2011	0.0033	3.3053	528
2012	0.0037	3.2771	752
2013	0.0042	3.2452	672
2014	0.0038	3.2786	617
2015	0.0038	3.2772	718
2016	0.0042	3.2521	946

Table 5: Population abundance (000s) at age (yrs) of A. plaice from surveys in Div. 3M during EU survey 1988-2016.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1988	483	1339	1619	3955	3725	3423	5016	3004	1802	1157	669	418	230	358	138	74	27410
1989	55	1827	6621	2682	2787	2544	3794	2548	1616	1089	672	429	221	332	117	57	27391
1990	8	665	1581	5311	2456	1802	2785	2066	1427	995	648	432	242	337	128	62	20946
1991	154	353	1628	2530	2796	1945	2645	1855	1283	879	575	378	186	262	91	83	17643
1992	24	795	886	1210	1544	1682	2433	1642	1142	813	541	363	187	287	108	71	13728
1993		27	1536	1082	775	447	4116	467	782	367	257	299	354	1065	32	42	11648
1994	7	47	45	2134	1034	878	983	3425	322	654	224	221	252	519	490	9	11247
1995		29	115	741	2127	1368	1377	913	1536	161	181	145	145	292	219	28	9376
1996	8	39	116	260	585	1666	894	545	403	630	144	78	82	109	69	28	5658
1997	8	16	110	25	122	419	1204	270	413	293	487	129	25	93	47	110	3770
1998		25	31	47	72	266	622	903	526	356	301	288	88	113	57	105	3800
1999	7		23	65	79	80	241	472	510	255	338	207	121	117	59	98	2672
2000	16	25	7	84	106	153	119	153	392	427	231	185	74	56	46	59	2132
2001		40	52	58	104	56	111	268	438	581	478	420	190	162	111	99	3168
2002			32	65	17	89	66	126	159	190	297	221	249	142	131	187	1971
2003	7	6	32	93	80	58	79	147	300	258	431	426	272	272	148	160	2769
2004		117	280	73	79	107	105	127	246	316	285	598	426	404	327	525	4015
2005		31	111	288	106	106	126	102	224	206	225	252	353	403	252	540	3326
2006	7	28	37	107	133	139	72	57	123	163	200	193	192	211	200	326	2188
2007	207	7	13	35	106	119	49	49	35	47	76	122	143	82	75	236	1401
2008	43	1501	69		32	127	120	108	104	111	63	47	118	110	150	561	3263
2009	26	292	1108	147	29	21	78	56	92	90	132	120	63	106	120	357	2839
2010	20	341	605	2004	301	187	72	139	122	70	56	176	125	114	134	497	4962
2011		396	599	1384	2467	454	94	49	90	176	144	55	107	148	82	672	6917
2012	7	60	447	629	980	2833	447	84	111	143	125	115	45	133	130	324	6614
2013	27	198	76	311	718	866	1596	138	64	94	109	108	55	61	54	195	4670
2014	8	344	219	144	135	510	816	1569	190	65	55	62	46	64	50	200	4477
2015	20	578	695	599	101	109	328	609	1320	140	49	33	41	47	55	228	4951
2016	70	179	1179	1273	936	263	240	406	518	1079	77	49	21	27	34	175	6525

Table 6 - Weights at age of the 3M American plaice stock (Kg) from EU surveys, 1988-2016.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1988	0.027	0.048	0.152	0.338	0.495	0.620	0.721	0.786	0.801	0.820	0.876	0.959	1.201	1.208	1.537	1.742
1989	0.013	0.090	0.151	0.295	0.523	0.630	0.725	0.815	0.839	0.856	0.912	0.991	1.181	1.186	1.462	1.646
1990	0.010	0.062	0.189	0.312	0.425	0.564	0.709	0.829	0.857	0.893	0.956	1.029	1.179	1.200	1.412	1.578
1991	0.015	0.070	0.157	0.341	0.478	0.563	0.660	0.770	0.799	0.829	0.886	0.953	1.141	1.157	1.417	1.634
1992	0.029	0.063	0.158	0.315	0.516	0.616	0.684	0.758	0.807	0.832	0.910	1.000	1.182	1.190	1.408	1.712
1993		0.061	0.160	0.295	0.407	0.579	0.727	0.755	0.798	0.874	0.906	0.932	1.075	1.218	1.839	1.628
1994	0.001	0.062	0.162	0.316	0.490	0.568	0.650	0.808	0.954	0.917	1.025	1.025	1.271	1.228	1.540	1.895
1995		0.044	0.191	0.330	0.488	0.624	0.668	0.789	0.888	1.222	1.279	1.468	1.518	1.515	1.563	2.082
1996	0.017	0.055	0.190	0.332	0.469	0.589	0.708	0.823	0.929	0.864	1.081	1.390	1.307	1.519	1.649	1.777
1997	0.017	0.049	0.171	0.236	0.427	0.559	0.673	0.643	0.859	0.998	1.007	1.215	1.275	1.437	1.607	1.515
1998		0.090	0.174	0.260	0.384	0.514	0.652	0.778	0.826	1.027	1.239	1.322	1.501	1.513	1.606	1.650
1999	0.010		0.166	0.315	0.440	0.546	0.568	0.773	0.849	0.998	1.178	1.275	1.462	1.705	1.563	1.587
2000	0.016	0.091	0.115	0.245	0.409	0.522	0.614	0.673	0.756	0.748	0.848	0.939	1.222	1.177	1.295	1.386
2001		0.072	0.210	0.245	0.374	0.434	0.528	0.603	0.622	0.702	0.703	0.853	1.076	1.321	1.427	1.487
2002			0.191	0.287	0.398	0.444	0.668	0.757	0.711	0.871	1.098	1.151	1.298	1.415	1.486	1.524
2003	0.017	0.041	0.134	0.327	0.361	0.457	0.543	0.669	0.674	0.735	0.794	0.858	0.886	1.028	1.314	1.499
2004		0.110	0.182	0.307	0.457	0.565	0.594	0.691	0.710	0.754	0.785	0.837	0.999	1.092	1.240	1.490
2005		0.094	0.180	0.295	0.396	0.527	0.643	0.620	0.747	0.792	0.795	0.827	0.885	0.920	1.048	1.413
2006	0.018	0.119	0.212	0.350	0.475	0.600	0.711	0.673	0.715	0.679	0.792	0.845	0.769	0.876	0.925	1.294
2007	0.010	0.079	0.128	0.354	0.588	0.621	0.695	0.987	0.912	0.949	0.783	0.767	0.913	0.874	0.873	1.537
2008	0.018	0.081	0.123		0.304	0.613	0.729	0.749	0.930	0.846	0.880	0.824	0.907	0.971	0.944	1.410
2009	0.018	0.085	0.191	0.240	0.383	0.735	0.735	0.776	0.887	0.853	0.817	0.940	0.804	0.878	0.923	1.385
2010	0.021	0.086	0.199	0.301	0.427	0.478	0.590	0.661	0.940	0.878	0.892	0.834	0.798	1.012	0.982	1.388
2011		0.073	0.195	0.301	0.521	0.635	0.713	0.854	0.986	1.119	1.041	0.956	1.046	1.249	1.161	1.541
2012	0.017	0.111	0.244	0.369	0.485	0.679	0.774	0.818	0.958	1.253	1.267	1.073	1.132	1.036	1.493	1.548
2013	0.014	0.084	0.313	0.474	0.570	0.736	0.877	1.089	0.979	1.255	1.338	1.143	1.188	1.528	1.204	1.539
2014	0.010	0.081	0.227	0.317	0.654	0.824	0.891	0.964	1.041	1.072	1.692	1.432	1.336	1.140	1.457	1.667
2015	0.023	0.078	0.225	0.301	0.521	0.755	0.955	1.050	1.152	1.380	1.364	1.295	1.316	1.483	1.526	1.511
2016	0.017	0.080	0.201	0.308	0.513	0.594	0.929	1.148	1.105	1.263	1.605	1.717	1.383	1.281	1.179	1.605
mean	0.016	0.076	0.182	0.311	0.461	0.593	0.701	0.797	0.863	0.941	1.026	1.064	1.147	1.219	1.348	1.575

Table 7: Criteria applied to convert total catches in weight to total catches in number, 2014-2016.

YEAR	TOTAL CATCH (ton)	BREAKDOWN TOTAL CATCH (ton)	LENGTHS COMPOSITION				Mean Weight (Kg)	TOTAL CATCH IN NUMBER (000's)
			Country	Source	Gear	Paper		
2014	247.0	116.0	Portugal	Commercial	OTB	scs 15/06	0.370	313.5
		23.0	Russia	Commercial	OTB	scs 15/07	1.210	19.0
		39.0	Estonia	Commercial	OTB	scs 15/04	1.100	35.4
		69.0	Espanha	Commercial	OTB	scs 15/05	0.751	91.9
2015	268.0	268.0	Portugal	Commercial	OTB	scs 16/09	0.538	497.9
2016	160.9	135.8	Portugal	Commercial	OTB	scs 17/05	0.348	390.4
		25.2	Espanha	Commercial	OTB	scs 17/04	1.259	20.0
		0.0	Russia	Commercial	OTB	scs 17/11	1.209	0.0

Table 8: Length composition (absolute frequencies in '000) of the 3M American plaice catches, 1988-2016.

length group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
14																							0.5				0.1	0.1	
16		19.3	0.8				0.7	3.0															0.2				1.1		
18		60.5	3.9				2.9	3.2																1.6		0.3	3.6	2.2	1.3
20	6.9	126.5	2.0		5.3	1.8	3.3																0.9	4.7	0.4	1.3	8.9	4.8	4.3
22	10.4	88.0	8.2	5.8	1.3	6.9	3.2						0.3	0.1			0.1						1.0	6.3	0.9	9.3	30.2	11.3	10.8
24	65.6	35.8	10.4	6.6	1.4	14.3	4.8	9.7	5.1		0.2			0.2			0.1						3.1	7.9	1.4	10.1	34.1	25.3	19.5
26	186.5	41.3	20.2	0.0	7.4	16.1	18.3	9.7	0.4		0.2		0.7	0.5	0.3	0.02				1.9			2.9	20.4	1.5	25.9	32.1	35.9	24.6
28	345.3	131.2	43.2	23.2	23.7	17.1	30.6	24.3	10.0		0.5		9.4	3.0	1.1	0.1	1.3		0.2	3.3	1.0		2.3	47.1	4.0	36.9	53.8	53.6	46.2
30	276.2	226.7	91.7	28.2	37.5	23.2	71.1	45.4	31.6		0.7		16.3	10.0	2.2	0.5	2.3		2.4	7.9	1.6		7.9	51.0	5.0	43.3	49.3	73.5	85.8
32	303.9	365.4	131.9	109.7	36.7	23.0	94.4	136.9	63.4		1.8	5.2	21.5	18.1	5.1	2.5	4.2		2.9	16.4	1.0	3.7	10.0	39.9	17.3	75.1	31.2	60.6	84.9
34	611.2	569.3	96.5	203.1	61.0	19.9	81.3	142.1	98.4	14.6	4.0	10.4	23.4	22.5	17.9	3.0	4.5	0.2	11.2	17.3	3.1	2.4	19.0	16.8	17.3	37.2	31.9	47.2	58.3
36	621.5	603.5	86.9	283.0	90.5	28.5	88.0	225.2	86.5	13.0	6.2	25.9	23.6	29.7	27.9	10.8	7.9	0.5	7.8	21.3	5.7	15.9	11.7	7.2	18.1	43.2	16.3	33.3	27.8
38	372.9	477.8	71.1	147.1	122.7	37.5	128.1	294.5	74.7	24.4	15.6	51.9	24.5	31.1	24.7	15.2	12.8	1.5	10.9	19.4	5.7	14.7	13.7	3.0	27.1	39.2	31.2	26.9	15.3
40	372.9	356.7	70.6	146.2	108.2	29.4	112.6	249.8	47.4	37.8	22.6	15.6	23.0	28.9	24.1	25.1	12.8	3.9	11.2	11.6	5.2	23.2	5.9	5.5	23.3	23.6	34.6	29.0	11.9
42	473.1	696.1	82.1	147.7	57.1	34.6	44.9	166.2	47.2	22.8	17.8	20.8	17.1	22.2	22.9	22.1	9.8	3.6	8.4	15.3	5.2	12.2	3.5	0.7	20.3	21.7	25.4	19.4	4.6
44	397.1	630.2	125.0	320.8	67.8	32.6	55.2	86.1	23.3	8.1	44.0	36.3	12.9	18.1	12.8	5.5	12.3	1.5	3.9	6.4	2.1	3.7	2.5		21.7	18.7	22.1	14.7	3.4
46	158.8	405.0	132.8	295.7	79.8	25.6	63.3	84.6	14.1	17.2	36.5	31.1	11.6	14.3	10.7	16.0	7.1	2.7	4.3	4.5	4.1	4.9	2.9		10.9	11.7	14.6	9.3	1.6
48	76.0	97.4	73.9	120.1	86.9	23.0	59.4	78.4	12.7	33.5	30.9	46.7	9.8	12.6	9.8	10.9	6.0	5.4	1.3	2.2	4.1	4.9	1.4	0.4	3.5	12.9	19.6	14.6	1.9
50	62.2	68.0	30.3	106.6	63.2	22.0	35.4	94.0	8.4	24.4	37.8	25.9	6.5	6.5	6.4	14.8	6.5	8.0	1.8	2.2	5.2	8.6	2.0	0.4	2.4	10.4	7.5	14.4	3.0
52	72.5	35.8	9.6	9.1	33.1	12.7	24.3	58.5	2.8	16.3	36.1	10.4	6.9	3.6	5.4	6.9	5.6	6.6	0.4	0.4	6.2		1.7		1.3	3.9	3.6	10.0	2.3
54	34.5	27.5	6.7	3.0	10.3	3.8	10.8	40.2	0.6	4.1	5.3		0.8	1.5	1.9	3.0	2.4	3.4	1.1	0.6	6.2		0.7		0.8	4.2	2.9	5.3	1.4
56	17.3	13.8	3.4	0.004	5.4	1.6	7.4	7.2	0.3	1.7	4.4		0.4	0.5	0.2	0.2	0.2	0.5	0.2	0.2	2.1		1.9		0.5	3.4	1.1	3.6	0.7
58	3.5		0.8	0.002	4.8	0.7		1.5			0.03			0.1			0.04				2.6		2.6		0.0	2.1	4.8	1.2	0.6
60					0.01	0.1		1.5						0.04					0.1		2.1		1.3			0.2	0.03	1.3	0.1
62			0.1			0.001	0.6							0.1		1.0										0.1		0.5	0.1
64														0.01									0.5						0.03
66																							0.2						
68																			0.1										
Total ('000)	4468.2	5075.7	1102.2	1955.9	904.0	374.5	940.5	1762.1	527.0	218.0	264.8	280.2	208.7	223.8	173.5	137.5	95.8	37.7	68.3	131.1	63.1	94.1	100.3	212.8	177.7	434.7	459.9	497.9	410.3
mean length	37.9	38.7	39.5	41.6	41.8	39.6	39.5	40.8	37.9	44.6	46.7	43.9	39.3	40.3	41.3	44.1	42.8	48.4	40.2	38.2	46.1	41.6	38.0	30.8	39.6	36.2	34.7	35.2	32.7

Table 9 - Catch at age (000s) of the 3M American plaice, 1988-2016.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1988		7	311	731	549	440	720	532	386	265	173	118	65	102	43	25	4468
1989		175	209	573	527	482	886	715	520	356	230	148	80	118	39	19	5076
1990		7	49	183	112	87	158	147	110	78	55	39	24	33	13	7	1102
1991		1	19	133	185	168	342	331	243	174	124	84	50	68	23	12	1956
1992		4	17	76	75	76	136	124	100	77	60	46	31	45	23	14	904
1993			47	42	26	11	112	13	24	12	9	11	15	49	2	2	375
1994		4	6	219	98	77	75	254	24	48	16	17	20	40	43	1	941
1995		6	24	167	458	235	231	155	250	31	35	30	30	58	45	7	1762
1996			13	60	101	173	63	41	23	34	6	3	3	3	2	0.4	527
1997					4	17	61	12	28	23	35	13	3	9	4	10	218
1998			0.3	1	2	7	28	57	36	31	32	33	8	14	7	10	265
1999				4	6	8	27	59	60	35	40	21	9	5	3	5	280
2000		0.2	0.1	19	25	25	12	13	33	35	17	13	6	3	3	4	209
2001			5	6	16	8	10	21	30	41	35	29	10	6	3	3	224
2002			1	8	4	17	13	21	22	23	24	17	12	4	3	5	174
2003			0.02	2	2	2	3	6	13	12	23	25	16	15	9	10	138
2004		0.1	1	2	3	3	4	4	8	10	8	16	10	9	7	9	96
2005				0	0	0	1	1	2	2	2	3	5	5	4	12	38
2006			1	5	7	4	2	3	4	7	7	5	6	6	5	6	68
2007			2	22	22	17	6	4	3	3	8	14	11	8	6	5	131
2008					2	6	4	4	4	4	2	1	4	3	4	23	63
2009				1	4	2	7	5	6	8	11	7	6	14	9	14	94
2010	0.5	2	6	35	10	7	2	5	3	2	1	5	4	2	3	13	100
2011		12	45	86	63	4	0	0	0	1	0	0	0	0	0	1	213
2012		1	9	16	26	79	14	3	4	4	4	3	1	4	3	7	178
2013		11	109	70	67	56	79	6	3	4	5	6	2	3	2	11	435
2014		62	107	69	15	37	43	91	9	6	2	3	3	3	2	9	460
2015		26	122	145	37	11	28	32	66	8	2	2	2	3	2	12	498
2016		10	88	167	84	17	10	6	9	13	1	1	0.2	0.3	1	2	410

Table 10 - Mean weight at age of the 3M American plaice catch (Kg), 1988-2016.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1988		0.097	0.200	0.312	0.449	0.572	0.684	0.762	0.790	0.823	0.886	0.981	1.215	1.271	1.590	1.736
1989		0.079	0.165	0.342	0.479	0.617	0.750	0.842	0.860	0.882	0.928	0.985	1.136	1.185	1.484	1.717
1990		0.072	0.191	0.320	0.424	0.558	0.738	0.889	0.924	0.963	1.031	1.095	1.223	1.262	1.481	1.618
1991		0.115	0.189	0.367	0.480	0.598	0.763	0.891	0.929	0.962	1.035	1.087	1.188	1.206	1.361	1.477
1992		0.086	0.210	0.327	0.487	0.606	0.723	0.855	0.919	0.966	1.074	1.169	1.373	1.381	1.574	1.666
1993			0.162	0.296	0.394	0.580	0.756	0.813	0.865	0.979	1.039	1.059	1.179	1.339	1.819	1.627
1994		0.061	0.155	0.314	0.487	0.562	0.653	0.824	0.969	0.954	1.068	1.065	1.318	1.289	1.561	1.895
1995		0.044	0.190	0.335	0.494	0.626	0.684	0.816	0.925	1.244	1.320	1.474	1.532	1.547	1.571	2.108
1996			0.225	0.331	0.425	0.535	0.671	0.733	0.852	0.825	1.002	1.302	1.202	1.385	1.539	1.333
1997					0.445	0.639	0.726	0.682	0.949	1.059	1.097	1.270	1.261	1.509	1.508	1.513
1998			0.185	0.269	0.396	0.554	0.776	0.889	0.950	1.140	1.337	1.380	1.461	1.509	1.589	1.613
1999				0.365	0.495	0.536	0.581	0.786	0.872	0.943	1.109	1.194	1.337	1.445	1.439	1.389
2000		0.115	0.115	0.268	0.359	0.444	0.566	0.637	0.706	0.692	0.782	0.891	1.225	1.140	1.290	1.389
2001			0.263	0.283	0.340	0.401	0.471	0.595	0.615	0.691	0.703	0.805	0.975	1.150	1.298	1.534
2002			0.231	0.341	0.398	0.436	0.622	0.692	0.658	0.734	0.813	0.850	0.992	1.349	1.378	1.470
2003			0.232	0.419	0.419	0.554	0.613	0.754	0.746	0.786	0.868	0.949	0.968	1.084	1.311	1.567
2004		0.125	0.242	0.331	0.432	0.539	0.554	0.704	0.716	0.788	0.795	0.815	0.926	0.998	1.100	1.333
2005				0.436	0.573	0.721	0.902	0.806	0.928	0.977	0.941	1.045	1.116	1.181	1.292	1.442
2006			0.275	0.377	0.438	0.596	0.674	0.534	0.678	0.627	0.719	0.747	0.692	0.732	0.790	1.144
2007			0.177	0.306	0.472	0.567	0.614	0.778	0.604	0.816	0.612	0.691	0.723	0.653	0.716	1.203
2008					0.307	0.554	0.760	0.717	0.946	0.853	0.967	0.898	0.939	0.986	1.026	1.567
2009				0.341	0.429	0.653	0.622	0.668	0.752	0.619	0.705	0.816	0.737	0.745	0.787	1.018
2010	0.026	0.095	0.193	0.355	0.466	0.502	0.615	0.601	0.865	0.726	0.807	0.747	0.758	0.996	0.906	1.732
2011		0.093	0.196	0.281	0.384	0.552	0.669	0.773	0.874	0.923	0.712	0.834	0.744	1.021	0.987	0.980
2012		0.117	0.251	0.389	0.514	0.721	0.781	0.802	0.866	0.976	1.009	0.876	0.927	0.908	1.267	1.106
2013		0.107	0.250	0.372	0.486	0.619	0.854	1.069	0.959	1.371	1.418	1.155	1.282	1.595	1.247	1.613
2014		0.118	0.225	0.308	0.551	0.680	0.836	0.874	0.977	0.867	1.613	1.469	1.536	1.093	1.363	1.682
2015		0.119	0.239	0.330	0.467	0.614	0.733	0.938	1.063	1.214	1.439	1.303	1.170	1.489	1.478	1.485
2016		0.094	0.224	0.328	0.437	0.488	0.543	0.926	0.879	1.079	1.581	1.965	1.356	1.276	0.853	1.494
mean	0.026	0.096	0.208	0.335	0.446	0.573	0.687	0.781	0.849	0.913	1.014	1.066	1.120	1.197	1.297	1.498

Table11: American plaice exploitaion pattern given by the generalized logit of the 1988-16 observed partial recruitment (See text).

Age	F at age index	Observed PR	Logit PR	Squared difference
1	0.019	0.015	0.076	0.004
2	0.291	0.222	0.222	0.000
3	0.847	0.647	0.647	0.000
4	1.309	1.000	0.999	0.000
5	1.152	0.880	1.000	0.014
6	0.989	0.756	1.000	0.060
7	0.902	0.689	1.000	0.097
8	0.994	0.759	1.000	0.058
9	1.003	0.766	1.000	0.055
10	1.057	0.808	1.000	0.037
11	1.135	0.867	1.000	0.018
12	1.128	0.861	1.000	0.019
13	1.058	0.808	1.000	0.037
14	1.106	0.845	1.000	0.024
15	1.025	0.783	1.000	0.047
16	0.948	0.724	1.000	0.076
		Minimum sum of squares		0.542

Curve parameters	*a*	*b*	*m*
	-31.012	9.113	0.118

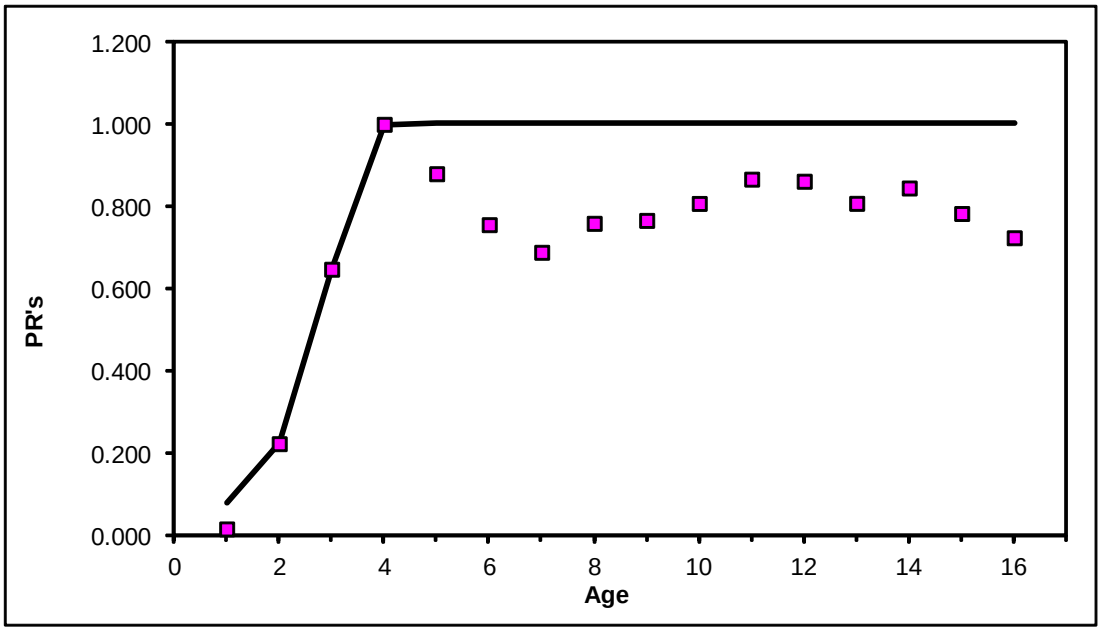


Fig. 4: PR curve for 3M American plaice

Table 12 A: Yield per recruit parameters for 3M American plaice.

Age	mean weights 1988-16		og mat (%)	PR 88-16	Ref. M
	stock	catch			
1	0.016	*0.026*	0.000	0.076	0.20
2	0.076	*0.096*	0.000	0.222	0.20
3	0.182	*0.208*	0.000	0.647	0.20
4	0.311	*0.335*	0.000	0.999	0.20
5	0.461	*0.446*	0.500	1.000	0.20
6	0.593	*0.573*	1.000	1.000	0.20
7	0.701	*0.687*	1.000	1.000	0.20
8	0.797	*0.781*	1.000	1.000	0.20
9	0.863	*0.849*	1.000	1.000	0.20
10	0.941	*0.913*	1.000	1.000	0.20
11	1.026	*1.014*	1.000	1.000	0.20
12	1.064	*1.066*	1.000	1.000	0.20
13	1.147	*1.120*	1.000	1.000	0.20
14	1.219	*1.197*	1.000	1.000	0.20
15	1.348	*1.297*	1.000	1.000	0.20
16+	1.575	*1.498*	1.000	1.000	0.20

Table 12 B: Yield per recruit results for 3M American plaice.

	Ref F	B	Y	SSB	Slope
	0.000	2500	0	2025	2,142
	0.000	2500	0	2025	1,687
	0.030	2010	51	1548	1,048
	0.060	1664	82	1214	667
	0.090	1410	102	972	431
	0.120	1218	115	792	280
F0.1	**0.153**	**1056**	**124**	**642**	**214**
	0.180	950	129	546	112
	0.210	854	132	460	66
	0.240	776	134	391	33
	0.270	710	135	335	10
Fmax	**0.302**	**650**	**135**	**285**	**0**
	0.330	607	135	250	-18
	0.360	566	135	217	-26
	0.390	531	134	190	-32
	0.420	499	133	166	-36
	0.450	472	132	146	-39
	0.480	447	131	129	-41

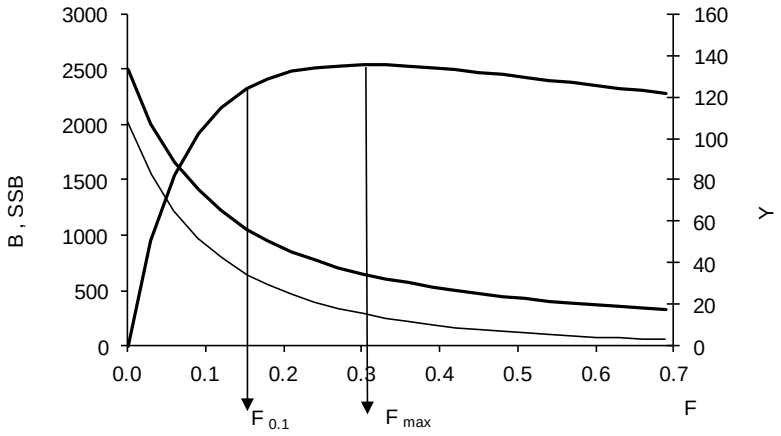


Fig.5 - Yield, B and SSB per recruit curve for 3M American plaice

Table 13 - Trend of the 3M American plaice F index based in EU survey series (ages 8-11).

Year	Catch (tons)	Survey (tons)	C/B
1988	1082	5338	0.203
1989	1576	4979	0.317
1990	364	4443	0.082
1991	817	3692	0.221
1992	336	3335	0.101
1993	53	1531	0.034
1994	295	3903	0.076
1995	443	2512	0.176
1996	84	1525	0.055
1997	97	1311	0.074
1998	163	1874	0.087
1999	176	1450	0.121
2000	69	915	0.076
2001	84	1178	0.072
2002	65	700	0.093
2003	44	833	0.053
2004	23	724	0.032
2005	6	573	0.011
2006	13	395	0.033
2007	13	184	0.071
2008	12	327	0.036
2009	21	310	0.068
2010	8	318	0.025
2011	1	477	0.002
2012	13	513	0.025
2013	22	478	0.046
2014	96	1873	0.051
2015	114	2420	0.047
2016	29	2523	0.011

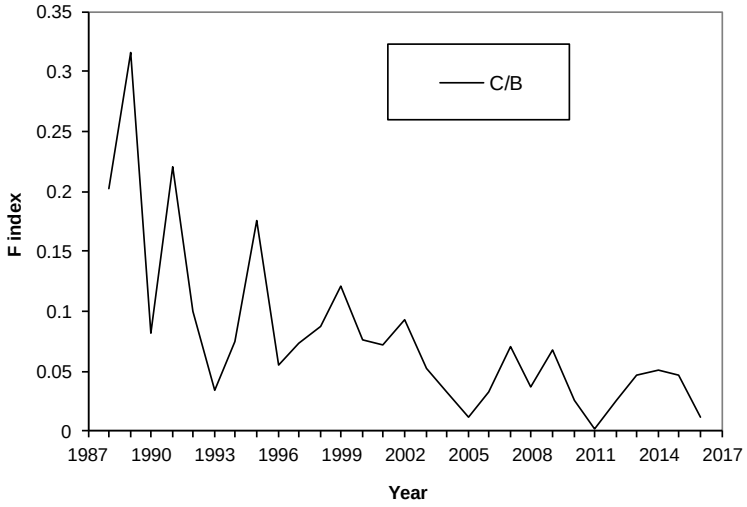


Fig. 6. Trend of the 3M American plaice F index based in EU survey.

Table 14. Evolution of Recruit ('000) and SSB ('000 tons) EU survey index during the period 1988-2016.

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
SSB	13.5	11.4	9.4	8.3	7.6	7.0	7.3	6.1	3.8	2.9	3.4	2.5	1.6	2.4	2.0	2.2	3.4	2.6	1.7	1.0	1.7	1.3	1.7	3.0	4.0	3.4	3.7	3.4	3.6
Age 3 recruits	1619	6621	1581	1628	886	1536	45	115	116	110	31	23	7	52	32	32	280	111	37	13	69	1108	605	599	447	76	219	695	1179
R age 3/SSB *	0.121	0.078	0.164	0.005	0.015	0.016	0.015	0.005	0.006	0.002	0.015	0.013	0.020	0.118	0.054	0.016	0.004	0.026	0.665	0.577	0.356	0.357	0.045	0.074	0.172	0.350			
Ln(R age 3/SSB) *	-2.1	-2.6	-1.8	-5.2	-4.2	-4.1	-4.2	-5.3	-5.1	-6.1	-4.2	-4.4	-3.9	-2.1	-2.9	-4.1	-5.5	-3.7	-0.4	-0.5	-1.0	-1.0	-3.1	-2.6	-2	-1			

(*) recruits per Kg of SSB index

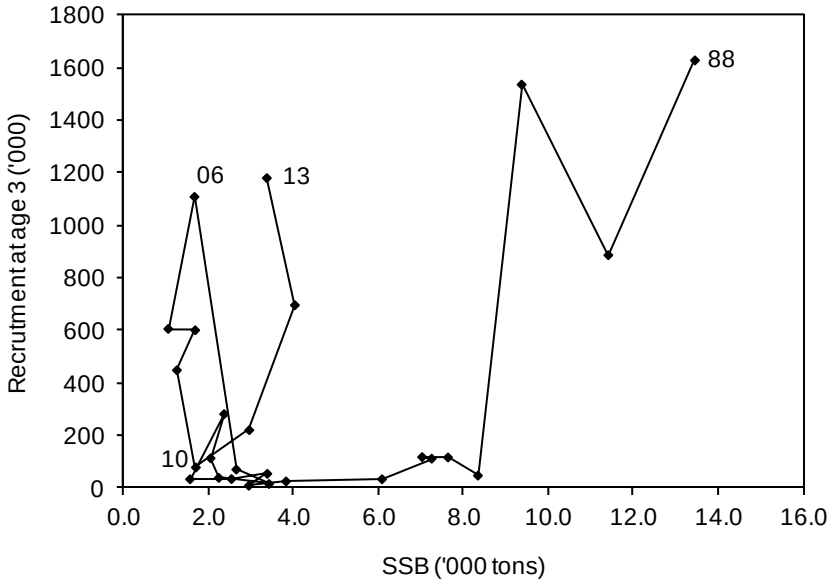


Fig. 7. SSB-Recruitment scatter plot based in EU survey series.

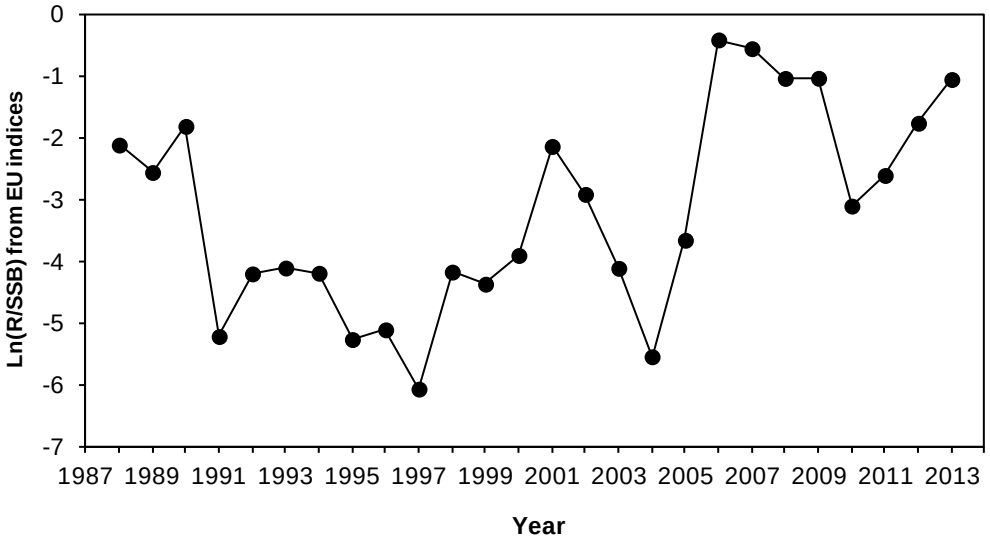


Fig. 8. Recruit at age 3 produced per kg of SSB index from EU indices.

Table 15: Lowestoft XSA input files for 3M American plaice (2017 assessment)

AMERICAN PLAICE NAFO DIVISION 3M INDEX OF INPUT FILES JUNE 2017

1
pla3mla.txt
pla3mcn.txt
pla3mcw.txt
pla3msw.txt
pla3mnm.txt
pla3mmo.txt
pla3mpf.txt
pla3mpm.txt
pla3mfo.txt
pla3mfn.txt
pla3mtun.txt

AMERICAN PLAICE NAFO 3M LANDINGS tons

1 1
1988 2016
1 16
5

	Catches Age 4+
2989.0	2737.19
3966.0	3451.55
922.0	780.2341
2086.0	1596.34
766.0	761.1594
771.0	267.4481
338.0	667.9048
257.0	1295.152
172.0	296.9714
108.0	208
193.0	293.9426
248.0	255
259.0	132.9688
427.0	147.5654
255.0	127.6969
145.0	130.9957
108.0	80.73676
88.0	45
83.0	45.56191
112.0	76.06186
66.0	68
93.0	70.055
65.0	63.68851
63.0	53.01707
122.0	119.5648
246.0	217.501
247.0	215.5237
268.0	235.8118
160.9	140.3026

AMERICAN PLAICE NAFO 3M CATCH NUMBERS thousands

1 2
1988 2016
1 16
1

0.000	7.173	311.143	730.939	549.470	439.632	720.274	532.354	386.160	264.927	173.455	117.634	64.944	102.356	42.774	24.999
0.000	175.482	209.362	573.039	526.509	481.596	886.452	715.483	519.799	355.616	229.522	147.672	80.390	117.524	38.517	18.755
0.000	6.843	48.514	183.081	112.480	86.964	158.021	146.640	109.896	78.140	55.217	39.041	24.185	33.081	13.221	6.859
0.000	0.826	18.908	132.757	185.009	168.106	341.718	331.450	242.806	173.529	124.320	84.203	49.967	67.842	22.925	11.569
0.000	4.055	16.669	75.811	75.174	76.423	135.610	123.772	99.740	76.833	60.036	46.126	31.165	45.422	22.935	14.216
0.000	0.000	46.566	42.316	26.310	10.898	111.805	13.051	23.865	12.333	8.865	10.874	14.948	48.678	1.740	2.265
0.000	3.947	5.540	218.845	97.846	77.178	75.464	253.952	23.683	47.534	16.248	16.864	20.150	39.615	42.826	0.830
0.000	6.202	24.070	167.228	457.569	234.940	230.745	154.915	250.209	31.301	34.815	29.966	29.784	58.238	45.446	6.630
0.000	0.000	13.477	60.135	101.313	172.912	63.443	41.371	23.070	34.003	6.211	2.755	3.395	2.958	1.545	0.411
0.000	0.000	0.000	0.000	4.127	16.665	61.358	12.153	27.868	22.766	34.742	13.361	2.599	8.714	3.699	9.932
0.000	0.000	0.311	0.795	1.779	6.961	27.531	56.541	36.400	30.980	31.954	32.958	7.613	13.894	6.838	10.197
0.000	0.000	0.000	3.687	5.715	7.562	26.536	58.790	60.383	34.501	40.136	20.555	9.220	4.569	3.244	5.283
0.000	0.163	0.109	19.370	24.736	25.180	11.505	13.399	33.195	34.508	17.427	13.385	5.704	3.081	2.956	3.939
0.000	0.000	5.460	6.313	15.595	7.634	10.087	20.963	30.316	41.413	35.175	28.772	10.327	5.885	3.041	2.790
0.000	0.000	1.310	7.507	3.971	17.199	13.147	20.828	22.316	22.896	23.896	16.694	12.272	3.689	3.027	4.771
0.000	0.000	0.018	1.635	1.813	1.740	3.117	6.465	13.057	12.298	22.889	24.817	15.526	15.103	8.891	10.150
0.000	0.061	1.466	1.742	2.988	3.077	4.142	4.227	8.421	9.758	8.405	15.530	10.408	9.371	7.340	8.877
0.000	0.000	0.000	0.058	0.235	0.407	0.927	0.626	1.871	2.474	1.950	2.846	5.218	5.262	4.246	11.595
0.000	0.000	0.859	5.373	7.441	4.493	2.172	2.958	3.848	6.616	6.628	5.314	6.224	5.512	4.797	6.065
0.000	0.000	1.907	21.572	21.764	16.798	5.993	3.843	3.390	3.482	8.444	13.666	11.297	8.045	6.109	4.742
0.000	0.000	0.000	0.000	2.455	6.414	4.467	4.481	3.637	3.953	1.955	1.467	3.783	3.076	4.468	22.900
0.000	0.000	0.000	1.223	4.025	1.578	7.177	5.241	5.725	8.491	11.223	7.417	5.582	13.544	9.302	13.620
0.477	2.373	5.560	34.550	10.171	7.328	1.994	5.473	2.976	1.529	1.388	4.977	3.664	1.939	2.831	13.098
0.000	11.518	45.437	86.191	62.826	3.961	0.433	0.180	0.349	0.508	0.231	0.019	0.147	0.258	0.190	0.585
0.000	1.010	9.217	15.712	25.937	79.389	13.729	2.954	3.793	3.739	3.574	3.414	1.407	4.375	2.773	6.725
0.000	10.933	109.460	70.014	67.198	55.911	78.871	5.779	2.844	4.399	5.078	5.629	2.399	2.657	2.464	11.038
0.000	62.482	107.082	69.427	14.845	37.196	42.768	90.752	8.573	5.515	2.363	2.667	2.801	2.693	1.938	8.814
0.000	25.697	121.859	145.115	37.145	10.964	27.830	31.630	66.257	8.395	2.335	1.648	2.039	2.759	2.390	11.880
0.000	10.087	88.022	167.365	84.256	17.468	10.421	6.268	8.873	13.075	0.631	0.616	0.154	0.275	0.570	2.256

AMERICAN PLAICE NAFO 3M CATCH WEIGHT AT AGE kg

1 3
1988 2016
1 16
1

0.026	0.097	0.200	0.312	0.449	0.572	0.684	0.762	0.790	0.823	0.886	0.981	1.215	1.271	1.590	1.736
0.026	0.079	0.165	0.342	0.479	0.617	0.750	0.842	0.860	0.882	0.928	0.985	1.136	1.185	1.484	1.717
0.026	0.072	0.191	0.320	0.424	0.558	0.738	0.889	0.924	0.963	1.031	1.095	1.223	1.262	1.481	1.618
0.026	0.115	0.189	0.367	0.480	0.598	0.763	0.891	0.929	0.962	1.035	1.087	1.188	1.206	1.361	1.477
0.026	0.086	0.210	0.327	0.487	0.606	0.723	0.855	0.919	0.966	1.074	1.169	1.373	1.381	1.574	1.666
0.026	*0.096*	0.162	0.296	0.394	0.580	0.756	0.813	0.865	0.979	1.039	1.059	1.179	1.339	1.819	1.627
0.026	0.061	0.155	0.314	0.487	0.562	0.653	0.824	0.969	0.954	1.068	1.065	1.318	1.289	1.561	1.895
0.026	0.044	0.190	0.335	0.494	0.626	0.684	0.816	0.925	1.244	1.320	1.474	1.532	1.547	1.571	2.108
0.026	*0.096*	0.225	0.331	0.425	0.535	0.671	0.733	0.852	0.825	1.002	1.302	1.202	1.385	1.539	1.333
0.026	*0.096*	*0.208*	*0.335*	0.445	0.639	0.726	0.682	0.949	1.059	1.097	1.270	1.261	1.509	1.508	1.513
0.026	*0.096*	0.185	0.269	0.396	0.554	0.776	0.889	0.950	1.140	1.337	1.380	1.461	1.509	1.589	1.613
0.026	*0.096*	*0.208*	0.365	0.495	0.536	0.581	0.786	0.872	0.943	1.109	1.194	1.337	1.445	1.439	1.389
0.026	0.115	0.115	0.268	0.359	0.444	0.566	0.637	0.706	0.692	0.782	0.891	1.225	1.140	1.290	1.389
0.026	*0.096*	0.263	0.283	0.340	0.401	0.471	0.595	0.615	0.691	0.703	0.805	0.975	1.150	1.298	1.534
0.026	*0.096*	0.231	0.341	0.398	0.436	0.622	0.692	0.658	0.734	0.813	0.850	0.992	1.349	1.378	1.470
0.026	*0.096*	0.232	0.419	0.419	0.554	0.613	0.754	0.746	0.786	0.868	0.949	0.968	1.084	1.311	1.567
0.026	0.125	0.242	0.331	0.432	0.539	0.554	0.704	0.716	0.788	0.795	0.815	0.926	0.998	1.100	1.333
0.026	*0.096*	*0.208*	0.436	0.573	0.721	0.902	0.806	0.928	0.977	0.941	1.045	1.116	1.181	1.292	1.442
0.026	*0.096*	0.275	0.377	0.438	0.596	0.674	0.534	0.678	0.627	0.719	0.747	0.692	0.732	0.790	1.144
0.026	*0.096*	0.177	0.306	0.472	0.567	0.614	0.778	0.604	0.816	0.612	0.691	0.723	0.653	0.716	1.203
0.026	*0.096*	*0.208*	*0.335*	0.307	0.554	0.760	0.717	0.946	0.853	0.967	0.898	0.939	0.986	1.026	1.567
0.026	*0.096*	*0.208*	0.341	0.429	0.653	0.622	0.668	0.752	0.619	0.705	0.816	0.737	0.745	0.787	1.018
0.026	0.095	0.193	0.355	0.466	0.502	0.615	0.601	0.865	0.726	0.807	0.747	0.758	0.996	0.906	1.732
0.026	0.093	0.196	0.281	0.384	0.552	0.669	0.773	0.874	0.923	0.712	0.834	0.744	1.021	0.987	0.980
0.026	0.117	0.251	0.389	0.514	0.721	0.781	0.802	0.866	0.976	1.009	0.876	0.927	0.908	1.267	1.106
0.026	0.107	0.250	0.372	0.486	0.619	0.854	1.069	0.959	1.371	1.418	1.155	1.282	1.595	1.247	1.613
0.026	0.118	0.225	0.308	0.551	0.680	0.836	0.874	0.977	0.867	1.613	1.469	1.536	1.093	1.363	1.682
0.026	0.119	0.239	0.330	0.467	0.614	0.733	0.938	1.063	1.214	1.439	1.303	1.170	1.489	1.478	1.485
0.026	0.094	0.224	0.328	0.437	0.488	0.543	0.926	0.879	1.079	1.581	1.965	1.356	1.276	0.853	1.494

Table 15: cont.

AMERICAN PLAICE NAFO 3M STOCK WEIGHT AT AGE kg

1	4														
1988	2016														
1	16														
1															
0.027	0.048	0.152	0.338	0.495	0.620	0.721	0.786	0.801	0.820	0.876	0.959	1.201	1.208	1.537	1.742
0.013	0.090	0.151	0.295	0.523	0.630	0.725	0.815	0.839	0.856	0.912	0.991	1.181	1.186	1.462	1.646
0.010	0.062	0.189	0.312	0.425	0.564	0.709	0.829	0.857	0.893	0.956	1.029	1.179	1.200	1.412	1.578
0.015	0.070	0.157	0.341	0.478	0.563	0.660	0.770	0.799	0.829	0.886	0.953	1.141	1.157	1.417	1.634
0.029	0.063	0.158	0.315	0.516	0.616	0.684	0.758	0.807	0.832	0.910	1.000	1.182	1.190	1.408	1.712
0.016	0.061	0.160	0.295	0.407	0.579	0.727	0.755	0.798	0.874	0.906	0.932	1.075	1.218	1.839	1.628
0.001	0.062	0.162	0.316	0.490	0.568	0.650	0.808	0.954	0.917	1.025	1.025	1.271	1.228	1.540	1.895
0.016	0.044	0.191	0.330	0.488	0.624	0.668	0.789	0.888	1.222	1.279	1.468	1.518	1.515	1.563	2.082
0.017	0.055	0.190	0.332	0.469	0.589	0.708	0.823	0.929	0.864	1.081	1.390	1.307	1.519	1.649	1.777
0.017	0.049	0.171	0.236	0.427	0.559	0.673	0.643	0.859	0.998	1.007	1.215	1.275	1.437	1.607	1.515
0.016	0.090	0.174	0.260	0.384	0.514	0.652	0.778	0.826	1.027	1.239	1.322	1.501	1.513	1.606	1.650
0.010	*0.076*	0.166	0.315	0.440	0.546	0.568	0.773	0.849	0.998	1.178	1.275	1.462	1.705	1.563	1.587
0.016	0.091	0.115	0.245	0.409	0.522	0.614	0.673	0.756	0.748	0.848	0.939	1.222	1.177	1.295	1.386
0.016	0.072	0.210	0.245	0.374	0.434	0.528	0.603	0.622	0.702	0.703	0.853	1.076	1.321	1.427	1.487
0.016	*0.076*	0.191	0.287	0.398	0.444	0.668	0.757	0.711	0.871	1.098	1.151	1.298	1.415	1.486	1.524
0.017	0.041	0.134	0.327	0.361	0.457	0.543	0.669	0.674	0.735	0.794	0.858	0.886	1.028	1.314	1.499
0.016	0.110	0.182	0.307	0.457	0.565	0.594	0.691	0.710	0.754	0.785	0.837	0.999	1.092	1.240	1.490
0.016	0.094	0.180	0.295	0.396	0.527	0.643	0.620	0.747	0.792	0.795	0.827	0.885	0.920	1.048	1.413
0.018	0.119	0.212	0.350	0.475	0.600	0.711	0.673	0.715	0.679	0.792	0.845	0.769	0.876	0.925	1.294
0.010	0.079	0.128	0.354	0.588	0.621	0.695	0.987	0.912	0.949	0.783	0.767	0.913	0.874	0.873	1.537
0.018	0.081	0.123	*0.311*	0.304	0.613	0.729	0.749	0.930	0.846	0.880	0.824	0.907	0.971	0.944	1.410
0.018	0.085	0.191	0.240	0.383	0.735	0.735	0.776	0.887	0.853	0.817	0.940	0.804	0.878	0.923	1.385
0.021	0.086	0.199	0.301	0.427	0.478	0.590	0.661	0.940	0.878	0.892	0.834	0.798	1.012	0.982	1.388
0.016	0.073	0.195	0.301	0.521	0.635	0.713	0.854	0.986	1.119	1.041	0.956	1.046	1.249	1.161	1.541
0.017	0.111	0.244	0.369	0.485	0.679	0.774	0.818	0.958	1.253	1.267	1.073	1.132	1.036	1.493	1.548
0.014	0.084	0.313	0.474	0.570	0.736	0.877	1.089	0.979	1.255	1.338	1.143	1.188	1.528	1.204	1.539
0.010	0.081	0.227	0.317	0.654	0.824	0.891	0.964	1.041	1.072	1.692	1.432	1.336	1.140	1.457	1.667
0.023	0.078	0.225	0.301	0.521	0.755	0.955	1.050	1.152	1.380	1.364	1.295	1.316	1.483	1.526	1.511
0.017	0.080	0.201	0.308	0.513	0.594	0.929	1.148	1.105	1.263	1.605	1.717	1.383	1.281	1.179	1.605

AMERICAN PLAICE NAFO 3M NATURAL MORTALITY

1	5
1988	2016
1	16
3	
0.2	

AMERICAN PLAICE NAFO 3M PROPORTION MATURE AT AGE

1	6															
1988	2016															
1	16															
2																
0.00	0.00	0.00	0.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	

AMERICAN PLAICE NAFO 3M PROPORTION OF F BEFORE SPAWNING

1	7
1988	2016
1	16
3	
0.42	

AMERICAN PLAICE NAFO 3M PROPORTION OF M BEFORE SPAWNING

1	8
1988	2016
1	16
3	
0.42	

AMERICAN PLAICE NAFO 3M F ON OLDEST AGE GROUP BY YEAR

1	9
1988	2016
1	16
5	
0.159	
0.248	
0.064	
0.173	
0.079	
0.027	
0.059	
0.138	
0.043	
0.058	
0.068	
0.095	
0.059	
0.056	
0.073	
0.042	
0.025	
0.009	
0.026	
0.056	
0.029	
0.053	
0.020	
0.002	
0.020	
0.036	
0.040	
0.037	
0.009	

Table 15: cont.

```
AMERICAN PLAICE NAFO 3M F AT AGE IN LAST YEAR
     1     10
  1988   2016
     1     16
     2
 0.000 0.003 0.007 0.011 0.010 0.009 0.008 0.009 0.009 0.009 0.010 0.010 0.009 0.010 0.009 0.008

AMERICAN PLAICE NAFO 3M SURVEY TUNNING DATA
   101
EU BOTTOM TRAWL SURVEY
  1988   2016
     1      1    0.5    0.6
     1     15
 10555  483.2 1338.8 1618.6 3955.0 3725.0 3423.3 5016.5 3003.7 1802.1 1156.9  669.2  417.7  230.1  357.9  138.1
 10555   55.0 1826.7 6621.2 2681.7 2786.6 2544.4 3794.3 2547.7 1615.7 1088.6  672.3  428.6  221.5  332.5  117.5
 10555    7.6  665.1 1581.3 5311.4 2455.6 1802.2 2784.7 2066.0 1427.1  994.9  647.8  432.2  242.3  337.2  128.1
 10555  153.6  353.2 1627.9 2530.3 2795.7 1944.8 2645.4 1855.1 1282.8  878.9  575.3  378.4  185.9  261.8   90.7
 10555   23.5  795.4  885.5 1210.3 1544.0 1681.7 2432.7 1642.2 1141.8  813.1  541.5  362.9  187.2  286.8  108.4
 10555    0.0   27.2 1535.5 1082.4  775.0  446.8 4115.8  467.5  781.9  366.6  257.5  299.0  354.4 1064.7   32.2
 10555    7.5   47.2   45.4 2133.9 1033.6  878.2  983.2 3425.5  321.8  654.2  224.2  221.4  252.0  519.2  490.4
 10555    0.0   28.6  114.6  741.1 2127.1 1367.6 1376.8  913.0 1535.9  161.3  180.8  145.1  145.0  292.1  219.0
 10555    8.0   39.1  115.9  259.7  585.5 1666.2  894.1  545.4  403.4  630.4  144.3   77.9   82.2  109.4   69.0
 10555    8.1   16.1  110.0   24.9  122.4  418.8 1203.8  269.8  413.4  292.5  487.5  128.9   24.9   92.9   46.6
 10555    0.0   24.7   31.5   46.5   71.9  266.5  622.2  902.6  525.8  355.8  301.0  288.5   88.0  113.4   56.7
 10555    7.4    0.0   23.2   65.4   78.7   79.5  241.0  471.6  509.9  254.8  337.8  207.1  121.3  117.1   59.1
 10555   15.6   25.1    6.8   84.2  105.7  153.0  118.7  153.5  391.6  427.0  231.1  185.0   74.0   55.6   46.3
 10555    0.0   39.8   52.2   58.2  104.1   56.1  111.0  267.6  437.9  580.7  478.5  419.8  189.9  161.6  111.4
 10555    0.0    0.0   32.2   65.5   16.5   88.8   65.9  126.3  158.6  189.6  297.4  221.4  248.7  141.8  131.4
 10555    7.1    6.2   31.6   93.3   79.8   58.2   79.3  147.4  299.7  258.0  431.4  425.5  271.9  272.2  148.0
 10555    0.0  117.2  279.7   73.5   79.1  106.9  104.5  127.0  246.3  315.8  285.2  598.0  426.1  404.0  326.6
 10555    0.0   31.5  111.4  287.8  106.3  105.9  125.9  101.5  224.4  206.4  225.1  251.5  353.0  403.2  252.3
 10555    7.3   28.2   36.7  106.5  132.7  139.0   72.2   56.6  123.0  163.2  199.8  193.4  192.4  211.3  200.2
 10555  207.2    6.7   13.4   35.2  105.8  119.4   49.3   48.6   34.5   47.3   75.8  122.0  143.2   82.1   74.9
 10555   43.0 1501.3   68.6    0.0   32.0  126.8  119.8  108.0  104.0  111.1   62.6   46.9  117.9  109.9  150.0
 10555   25.9  292.3 1107.7  147.1   29.4   20.8   78.2   55.8   92.2   90.4  132.3  119.8   63.3  105.9  120.5
 10555   20.2  341.3  604.5 2003.6  301.1  186.8   71.8  139.4  121.6   70.1   56.2  175.6  124.6  113.8  134.4
 10555    0.0  395.7  599.4 1384.4 2467.0  454.3   93.5   49.3   89.6  175.9  144.1   55.1  106.9  148.1   82.3
 10555    7.2   59.7  446.9  629.0  979.9 2833.3  447.2   84.1  110.8  142.7  125.5  115.3   44.7  133.0  130.1
 10555   26.6  197.7   76.4  310.7  717.8  865.9 1596.4  138.2   64.1   94.0  109.3  108.3   54.7   60.9   53.8
 10555    8.2  343.5  218.6  144.4  135.5  510.3  815.5 1569.1  190.1   64.6   55.4   61.7   46.1   63.6   49.9
 10555   20.0  577.7  694.8  598.7  101.4  108.6  328.0  609.2 1319.7  139.6   49.0   33.2   41.1   47.0   54.8
 10555   70.0  178.5 1179.2 1272.6  936.5  263.3  239.9  405.9  517.5 1078.6   76.8   49.3   20.6   27.4   34.1
```

Table 16: XSA runs. Summary of the settings and diagnostics.

		XSA settings				Log catchability residuals		
	Run	M	First age	years range tunning	First age q is indep of age.	All ages and time period sumSq	Ages 4-15, 1994-2016 sumSq	Iterations
1	all data_q12	0.2	1	1988-2016	12	226.21	88.10	110
2	all data_q14	0.2	1	1988-2016	14	197.64	76.12	57
3	all data_t94_q14	0.2	1	1994-2016	14	112.92	63.64	116
4	A4_t88_q12	0.2	4	1988-2016	12	142.01	88.08	101
5	A4_t88_q14	0.2	4	1988-2016	14	114.80	75.52	55
6	A4_t94_q14	0.2	4	1994-2016	14	68.04	62.63	104
7	A4_t94_q12_m015	0.15	4	1988-2016	12	70.36	63.82	93
8	A4_t94_q14_m015	0.15	4	1994-2016	14	65.82	61.58	89
9	A4_t-split_q14_m02	0.2	4	1988-1993; 1994-2016	14	79.25	62.85	111
10	A4_t-split_q14_m015	0.15	4	1988-1993; 1994-2016	14	76.75	61.70	95

Fig 9. Log catchability residuals

All data_q12

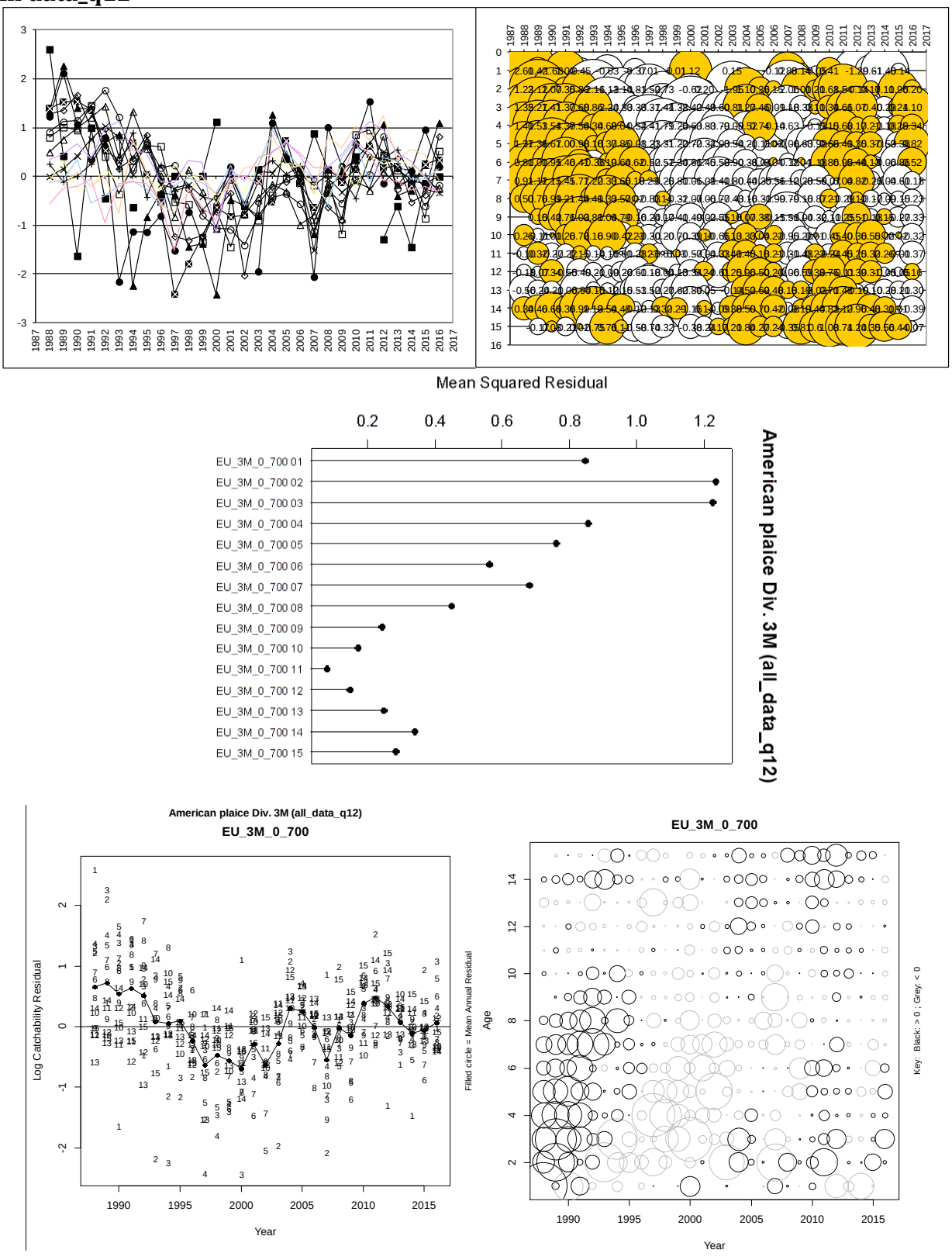
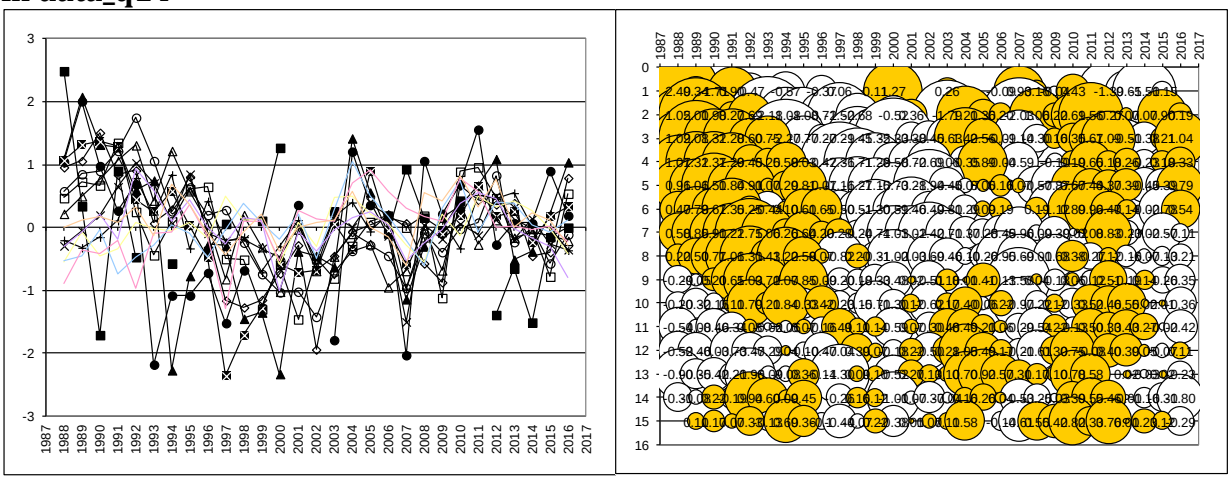
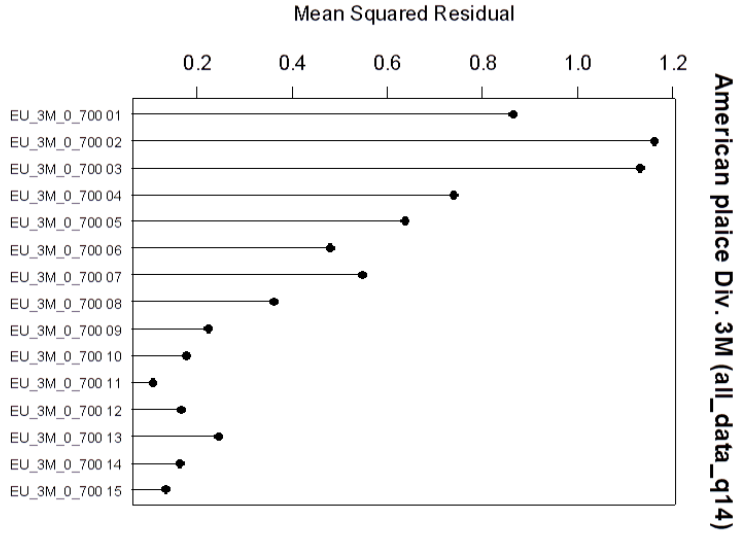
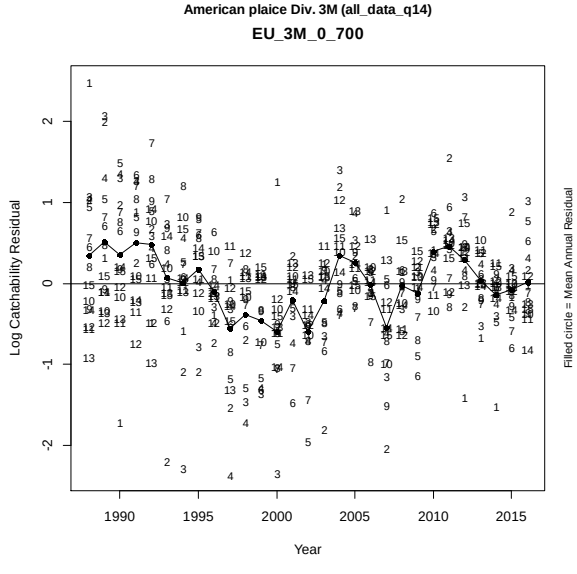


Fig 9. Cont.

All data_q14







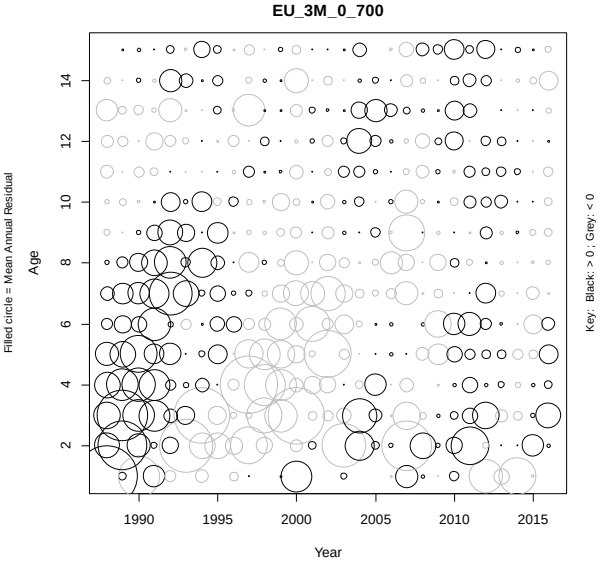
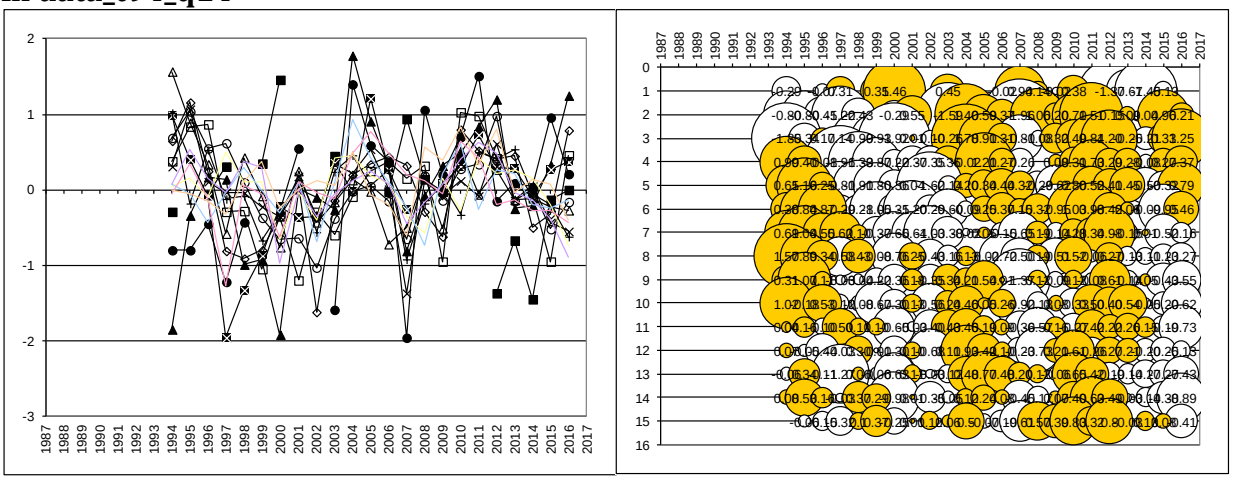
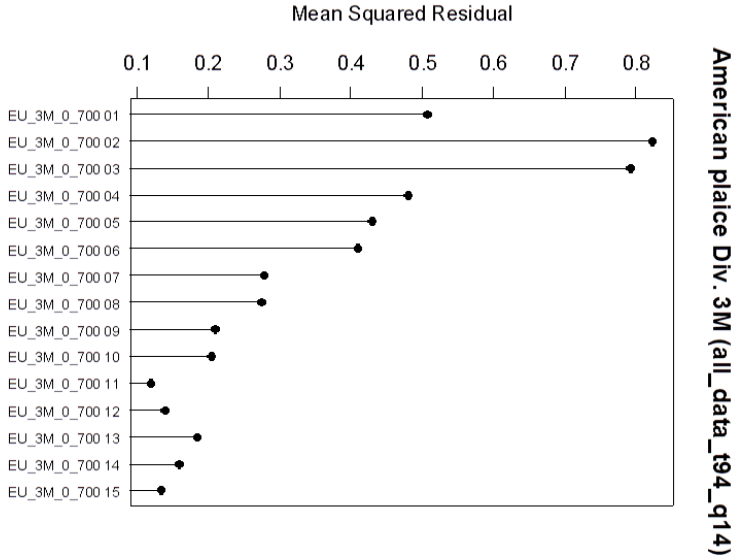
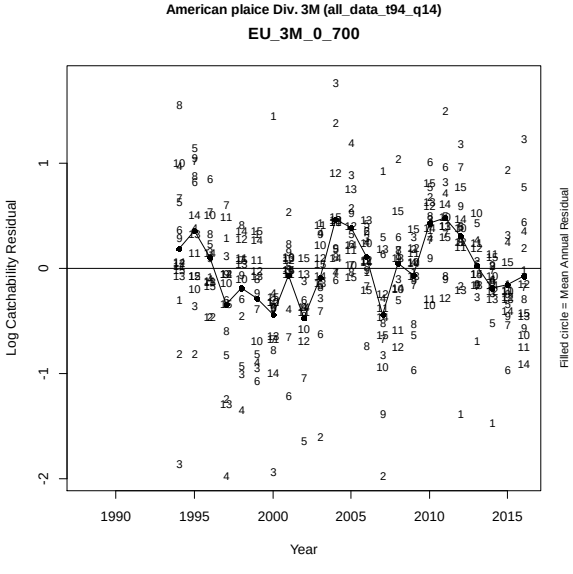


Fig 9. Cont.

All data_t94_q14







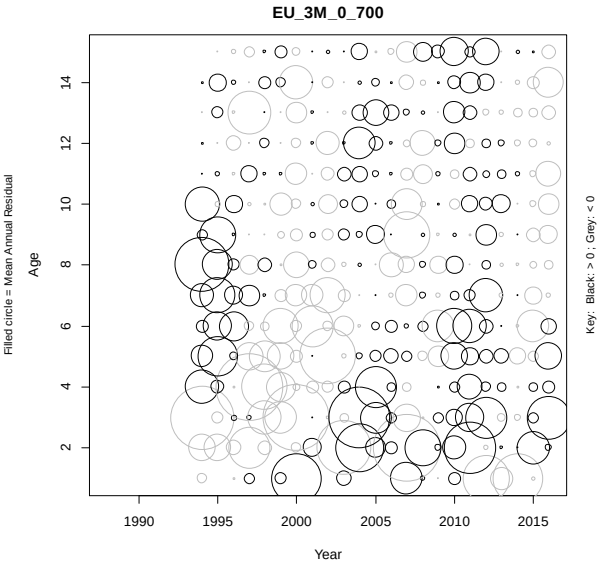
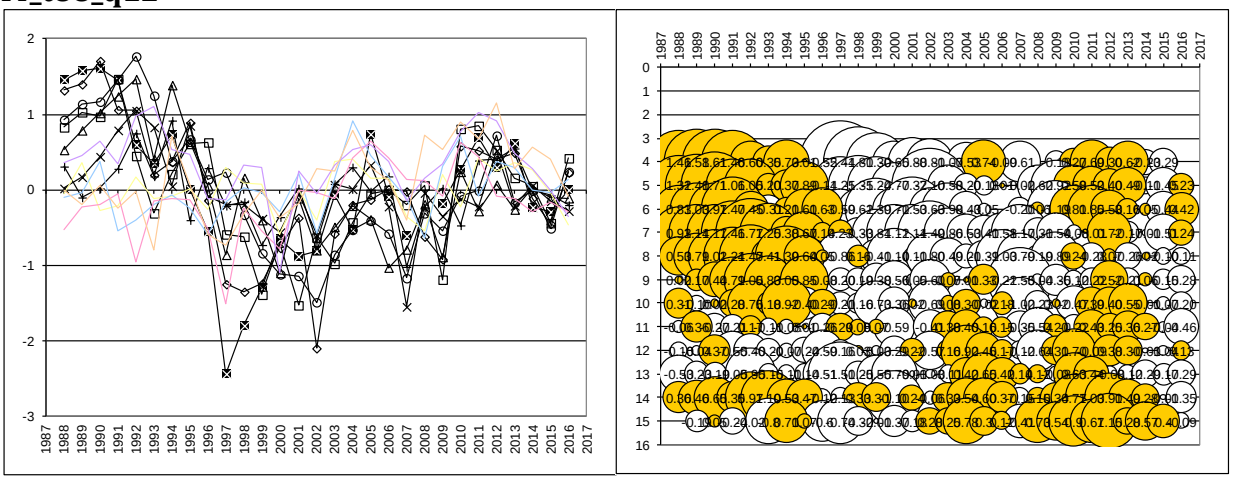
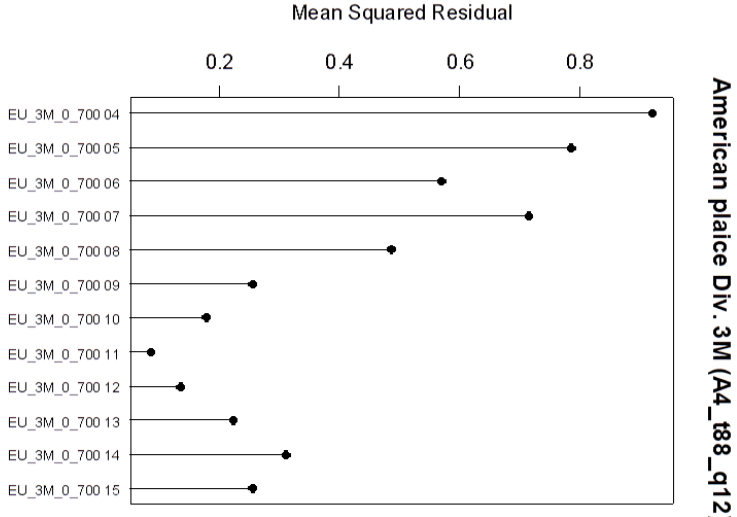
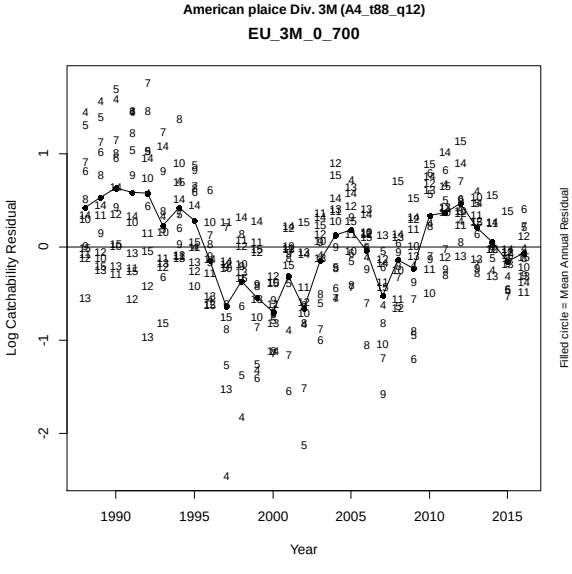


Fig 9. Cont.

A4_t88_q12







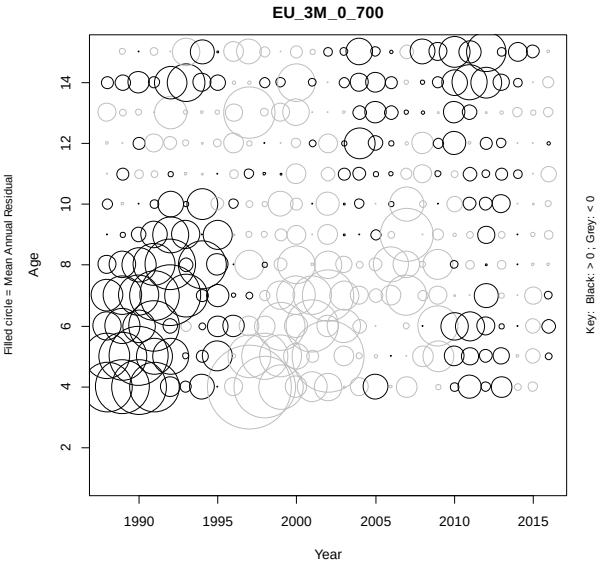
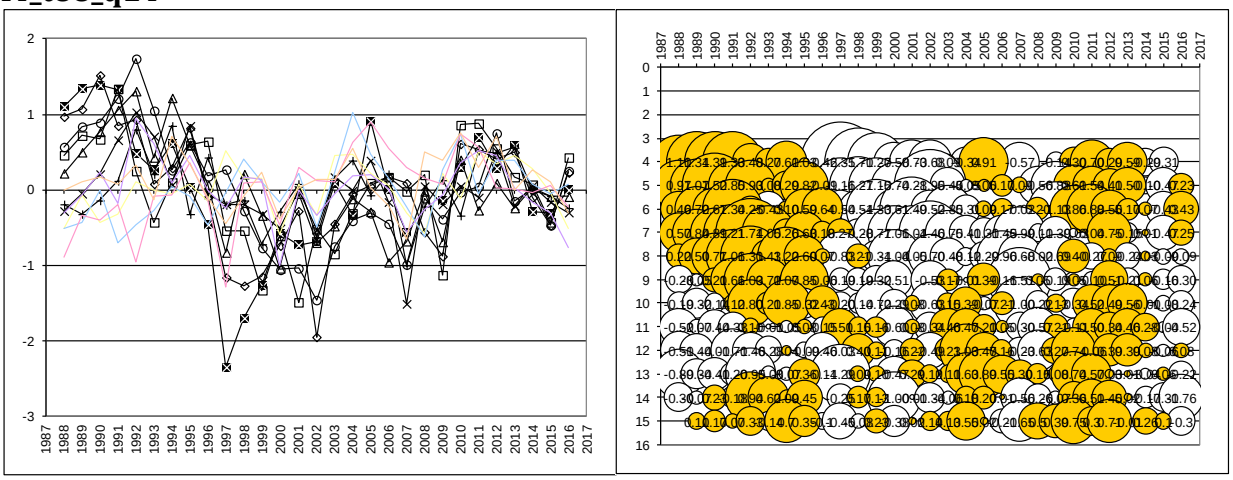
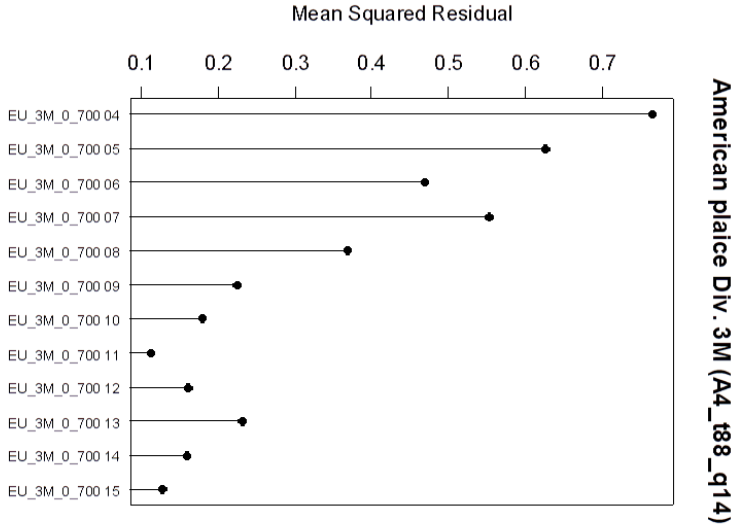


Fig 9. Cont.

A4_t88_q14





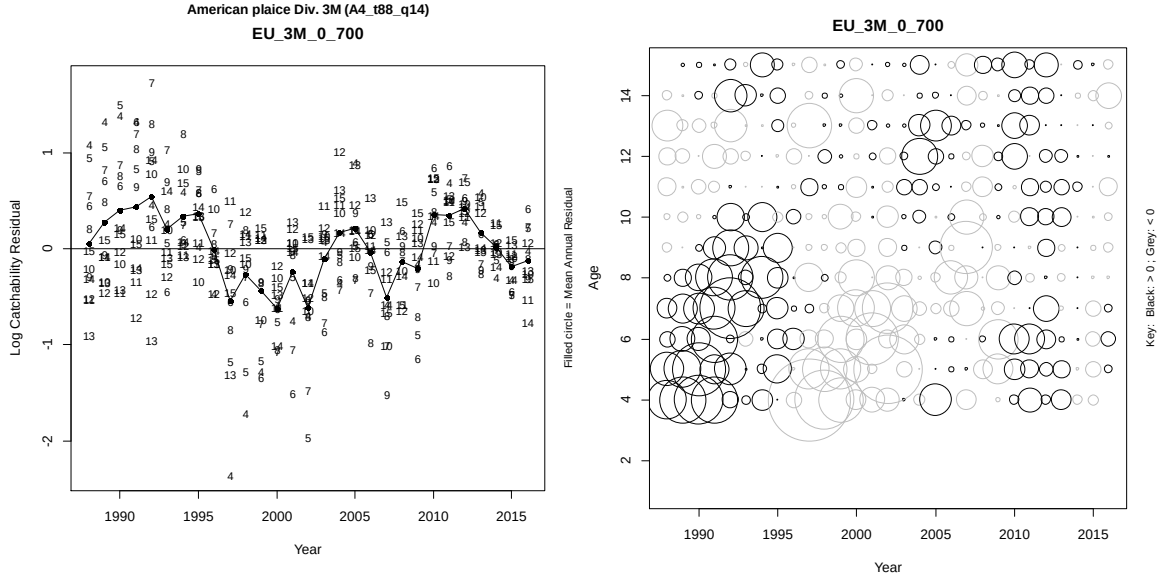
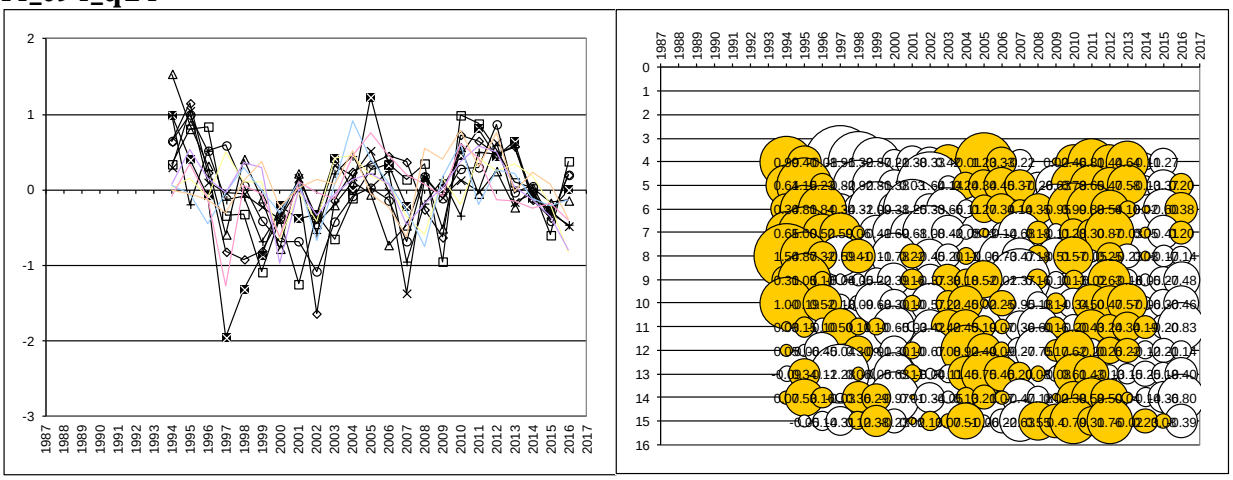
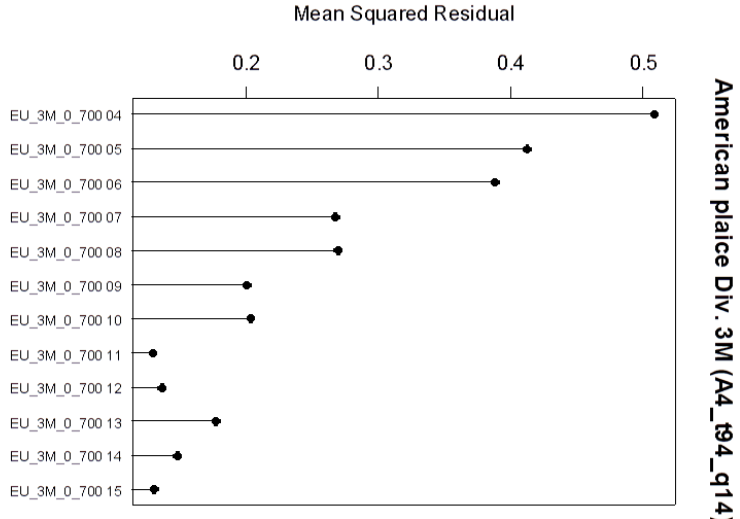
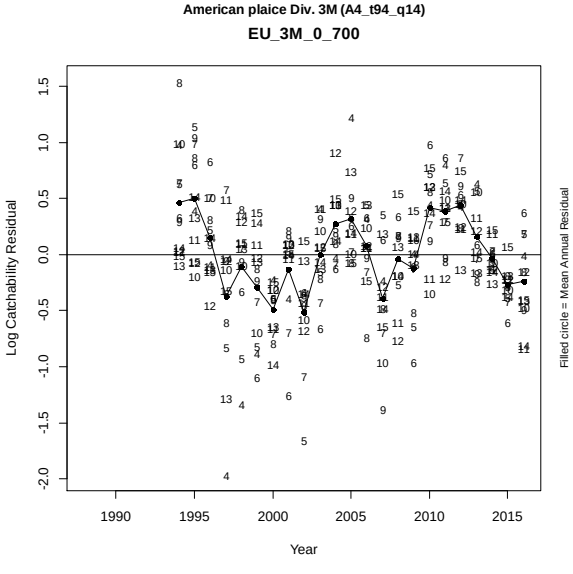


Fig 9. Cont.

A4_t94_q14







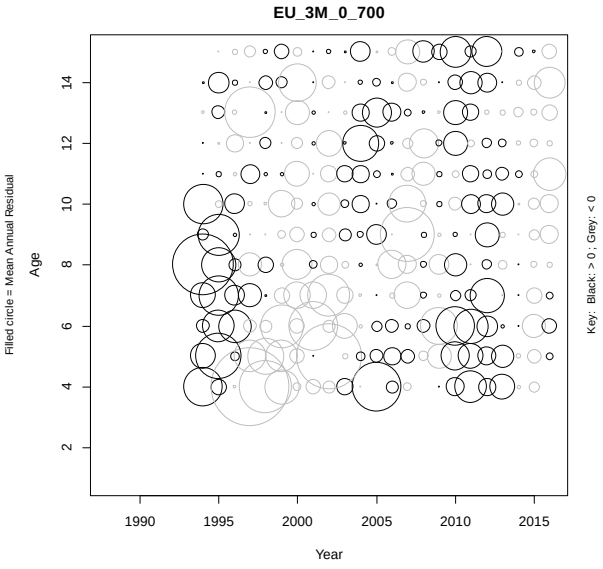


Fig 9. Cont.

A4_t94_q12_M0.15

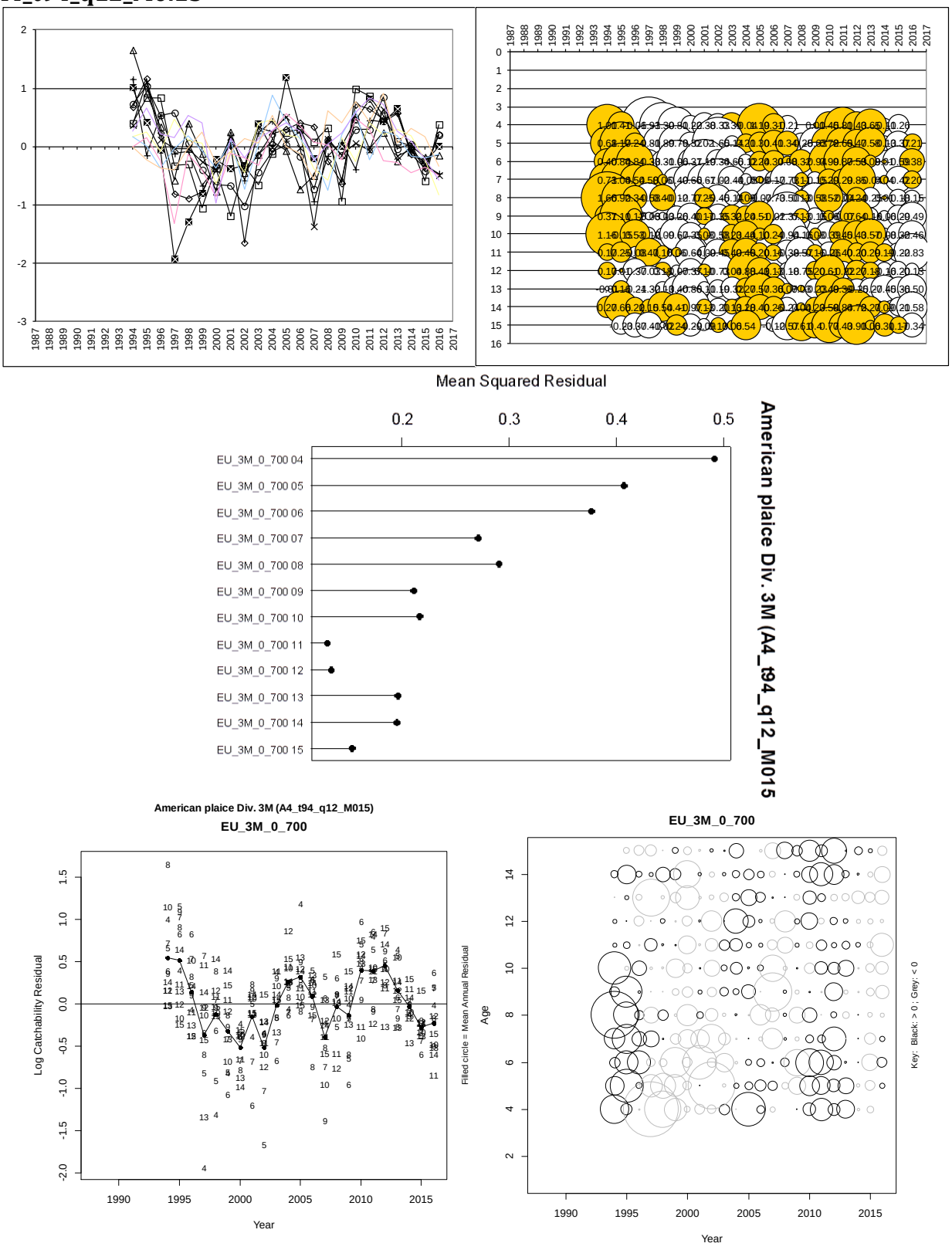


Fig 9. Cont.

A4_t94_q14_M0.15

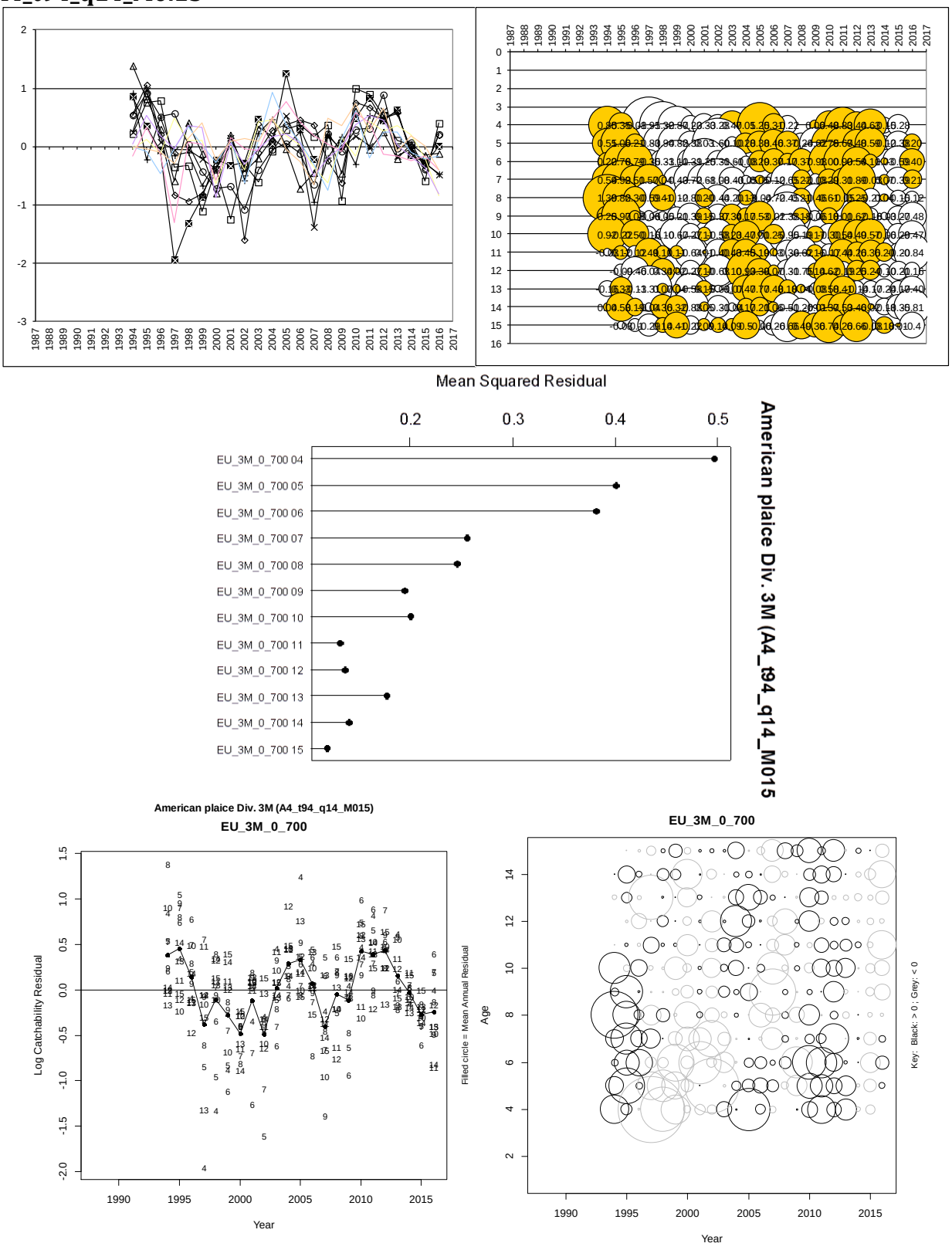
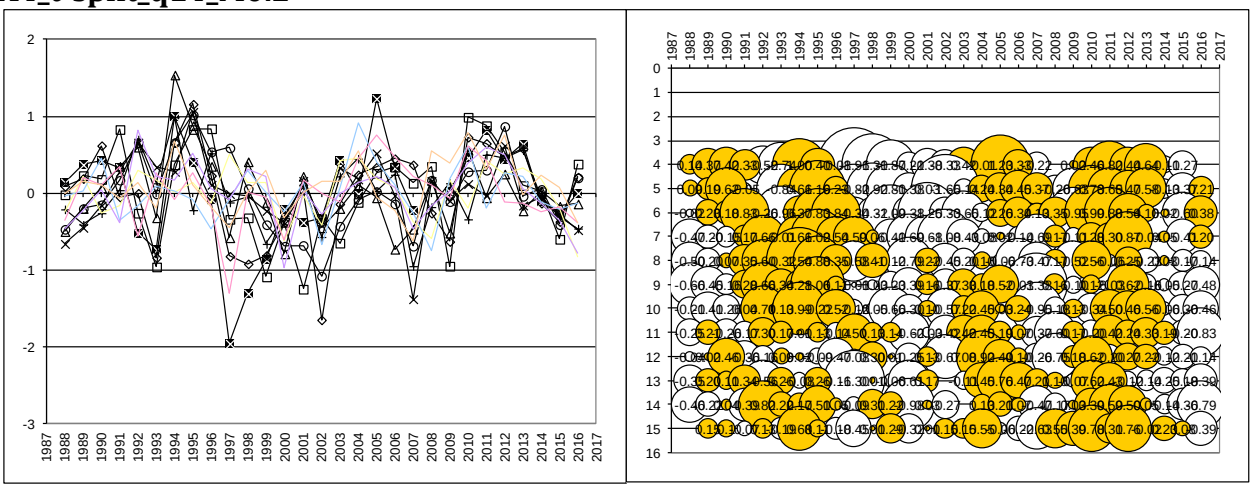
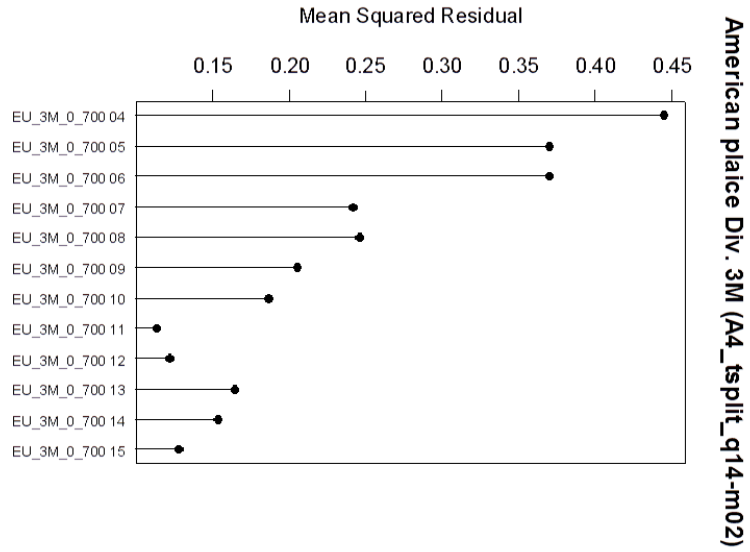


Fig 9. Cont.

A4_t-split_q14_M0.2





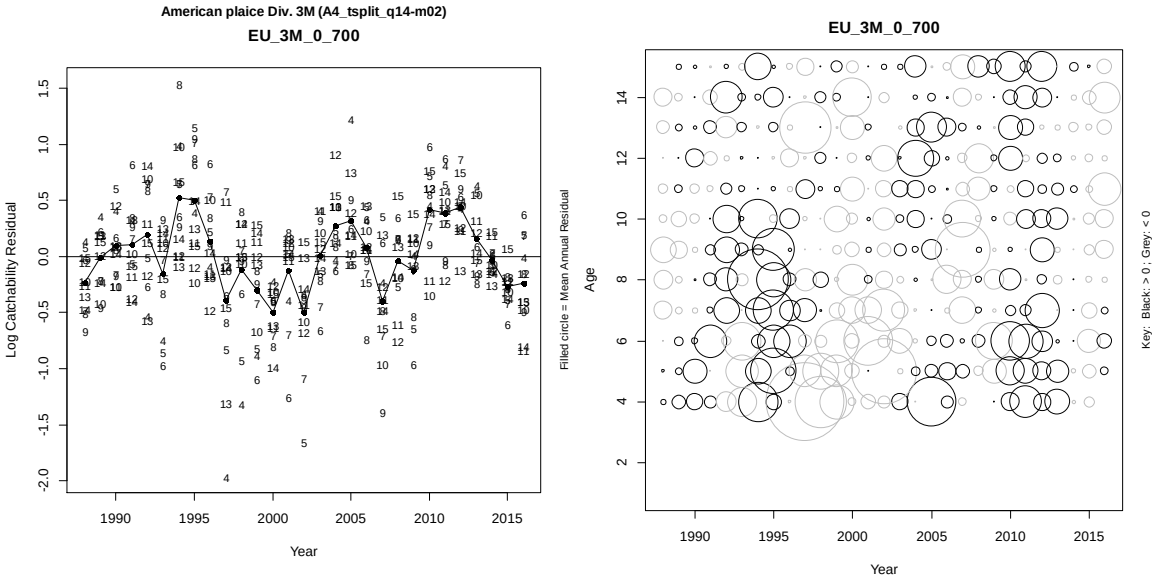
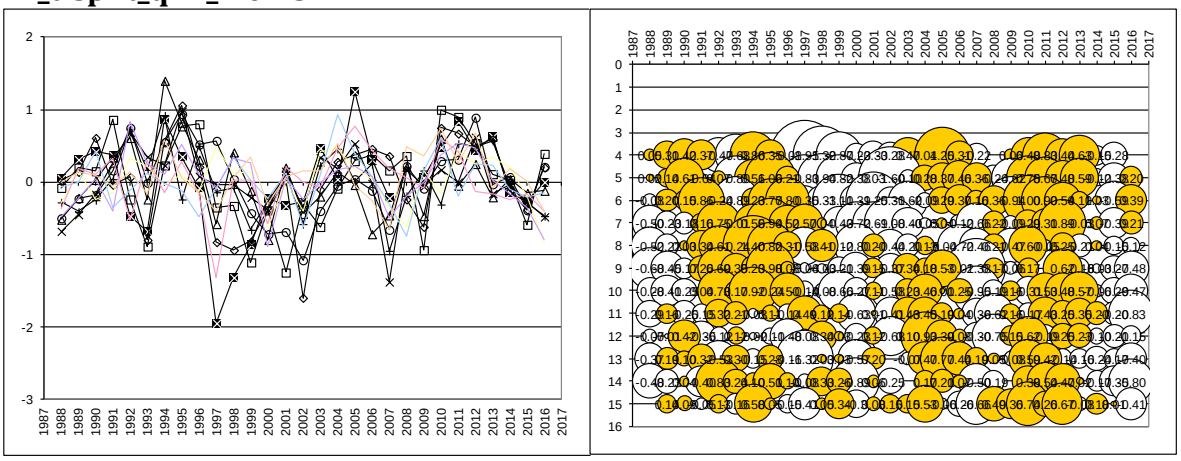
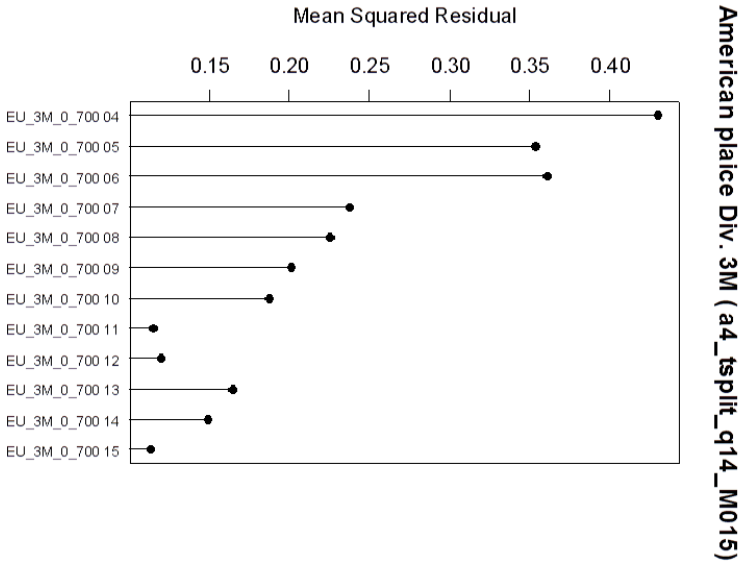


Fig 9. Cont.

A4_t-split_q14_M0.15





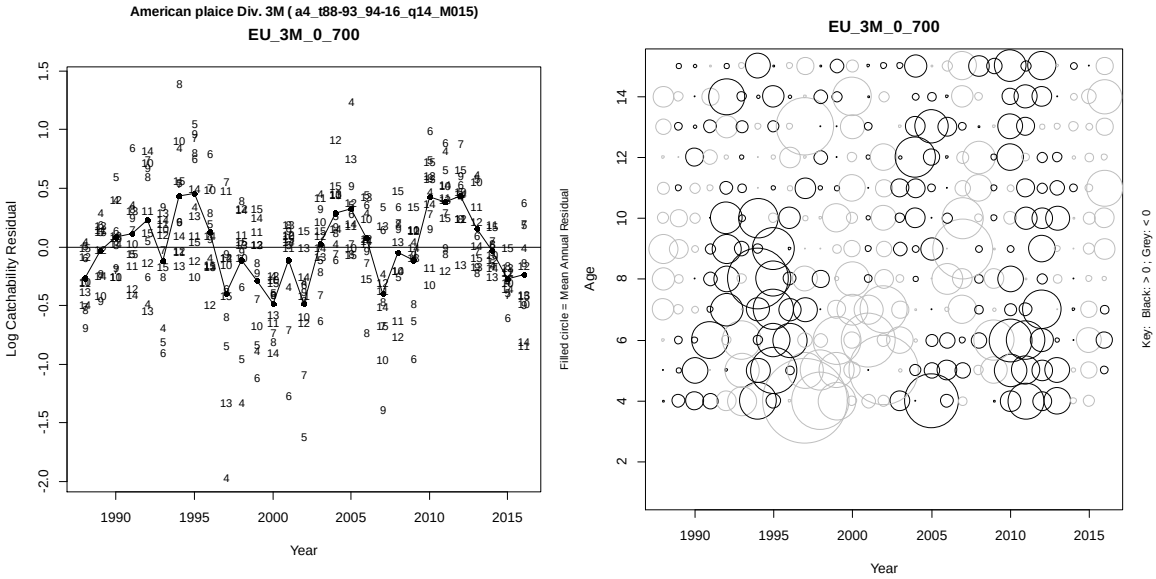


Table 17: Extended Survivor Analysis diagnostics (Lowestoft VPA Version 3.1) (run A4_t-split_q14_m015)

AMERICAN PLAICE NAFO DIVISION 3M INDEX OF INPUT FILES JUNE 2017
CPUE data from file pla3mtun.txt

Catch data for 29 years. 1988 to 2016. Ages 4 to 16.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU SURVEY 1988-1993	1988	1993	4	15	0.5	0.6
EU SURVEY 1994-2016	1994	2016	4	15	0.5	0.6

Time series weights :
Tapered time weighting not applied

Catchability analysis :
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 14

Terminal population estimation :
Final estimates not shrunk towards mean F
Minimum standard error for population estimates derived from each fleet = .500
Prior weighting not applied

Tuning converged after 95 iterations

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
4	0.236	0	0.004	0.014	0.069	0.019	0.204	0.2	0.089	0.064
5	0.174	0.036	0.043	0.042	0.029	0.025	0.1	0.057	0.148	0.065
6	0.153	0.067	0.028	0.099	0.02	0.045	0.067	0.07	0.052	0.091
7	0.071	0.052	0.095	0.042	0.007	0.084	0.054	0.063	0.065	0.061
8	0.065	0.066	0.076	0.092	0.005	0.058	0.044	0.077	0.058	0.018
9	0.046	0.077	0.107	0.053	0.007	0.117	0.07	0.08	0.071	0.02
10	0.063	0.065	0.243	0.036	0.011	0.094	0.183	0.178	0.1	0.017
11	0.199	0.043	0.252	0.054	0.006	0.094	0.169	0.134	0.1	0.009
12	0.252	0.045	0.218	0.16	0.001	0.117	0.2	0.12	0.123	0.033
13	0.268	0.097	0.23	0.151	0.006	0.079	0.107	0.137	0.12	0.014
14	0.262	0.102	0.548	0.11	0.013	0.232	0.198	0.159	0.184	0.02
15	0.187	0.215	0.477	0.195	0.013	0.184	0.188	0.205	0.195	0.05

XSA population numbers (Thousands)

AGE YEAR \AGE	4	5	6	7	8	9	10	11	12	13	14	15
2007	1.11E+02	1.47E+02	1.28E+02	9.42E+01	6.59E+01	8.18E+01	6.13E+01	5.04E+01	6.62E+01	5.17E+01	3.76E+01	3.87E+01
2008	1.19E+02	7.53E+01	1.06E+02	9.45E+01	7.55E+01	5.32E+01	6.72E+01	4.95E+01	3.56E+01	4.43E+01	3.40E+01	2.49E+01
2009	3.08E+02	1.02E+02	6.25E+01	8.54E+01	7.72E+01	6.08E+01	4.24E+01	5.42E+01	4.08E+01	2.93E+01	3.46E+01	2.64E+01
2010	2.76E+03	2.64E+02	8.41E+01	5.24E+01	6.68E+01	6.16E+01	4.70E+01	2.86E+01	3.63E+01	2.82E+01	2.00E+01	1.72E+01
2011	1.39E+03	2.34E+03	2.18E+02	6.56E+01	4.32E+01	5.25E+01	5.03E+01	3.91E+01	2.34E+01	2.66E+01	2.09E+01	1.54E+01
2012	9.05E+02	1.11E+03	1.96E+03	1.84E+02	5.61E+01	3.70E+01	4.48E+01	4.28E+01	3.34E+01	2.01E+01	2.27E+01	1.78E+01
2013	4.10E+02	7.64E+02	9.34E+02	1.61E+03	1.45E+02	4.55E+01	2.83E+01	3.51E+01	3.35E+01	2.56E+01	1.60E+01	1.55E+01
2014	4.14E+02	2.88E+02	5.95E+02	7.52E+02	1.31E+03	1.20E+02	3.65E+01	2.03E+01	2.55E+01	2.36E+01	1.98E+01	1.13E+01
2015	1.83E+03	2.92E+02	2.34E+02	4.78E+02	6.08E+02	1.05E+03	9.50E+01	2.63E+01	1.53E+01	1.95E+01	1.77E+01	1.45E+01
2016	2.91E+03	1.44E+03	2.17E+02	1.91E+02	3.85E+02	4.94E+02	8.38E+02	7.40E+01	2.05E+01	1.16E+01	1.49E+01	1.27E+01

Estimated population abundance at 1st Jan 2017

0.00E+00	2.35E+03	1.16E+03	1.70E+02	1.55E+02	3.26E+02	4.17E+02	7.10E+02	6.31E+01	1.71E+01	9.88E+00	1.26E+01

Taper weighted geometric mean of the VPA populations:

5.80E+02	4.56E+02	3.68E+02	3.15E+02	2.55E+02	1.95E+02	1.43E+02	1.02E+02	7.59E+01	5.78E+01	4.49E+01	2.63E+01

Standard error of the weighted Log(VPA populations) :

1.0918	1.0637	1.0621	1.0939	1.0731	1.0391	0.9809	0.9052	0.8692	0.8105	0.7489	0.6479

Table 17: Cont.

Log catchability residuals.
Fleet : EU SURVEY 1988-1993

Age	1988	1989	1990	1991	1992	1993	1994-2016
4	0.05	0.31	0.42	0.37	-0.47	-0.68	99.99
5	0.02	0.14	0.61	-0.04	0.07	-0.8	99.99
6	-0.08	0.2	0.15	0.86	-0.24	-0.89	99.99
7	-0.5	-0.23	-0.18	0.16	0.75	-0.01	99.99
8	-0.52	-0.22	0.03	0.34	0.61	-0.24	99.99
9	-0.68	-0.45	-0.17	0.26	0.69	0.35	99.99
10	-0.28	-0.41	-0.25	0.04	0.73	0.17	99.99
11	-0.29	0.16	-0.25	-0.15	0.32	0.21	99.99
12	-0.07	-0.01	0.42	-0.35	-0.12	0.12	99.99
13	-0.37	0.19	0.1	0.32	-0.53	0.3	99.99
14	-0.48	-0.23	0.04	-0.4	0.83	0.24	99.99
15	0	0.14	0.09	-0.05	0.13	-0.16	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	4	5	6	7	8	9	10	11	12	13	14	15
Mean Log q	-8.7154	-8.6444	-8.7186	-7.8167	-8.0754	-8.1341	-8.3159	-8.533	-8.5936	-8.7349	-7.3337	-7.3337
S.E(Log q)	0.4684	0.454	0.5766	0.4285	0.4174	0.5222	0.4179	0.263	0.258	0.3625	0.4891	0.121

Regression statistics :
Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	0.69	0.731	8.31	0.58	6	0.34	-8.72
5	1.05	-0.1	8.72	0.47	6	0.53	-8.64
6	1.1	-0.164	8.88	0.42	6	0.7	-8.72
7	2.58	-6.095	9.14	0.79	6	0.39	-7.82
8	1.3	-1.057	8.52	0.76	6	0.53	-8.08
9	2.58	-5.194	10.96	0.73	6	0.54	-8.13
10	1.79	-2.67	10.09	0.74	6	0.5	-8.32
11	1.44	-2.01	9.74	0.84	6	0.3	-8.53
12	2.19	-2.205	12.24	0.46	6	0.43	-8.59
13	-7.67	-2.953	-22.04	0.03	6	1.74	-8.73
14	3.53	-1.81	13.95	0.11	6	1.43	-7.33
15	0.9	1.908	6.92	0.99	6	0.09	-7.31

Table 17: Cont.

Fleet : EU SURVEY 1994-2016

Age	1988-1994	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4	99.99	0.86	0.35	-0.08	-1.95	-1.32	-0.87	-0.23	-0.33	-0.28	0.47	0.04
5	99.99	0.56	1.06	0.21	-0.83	-0.94	-0.82	-0.38	0.03	-1.6	-0.1	0.28
6	99.99	0.23	0.77	0.8	-0.35	-0.33	-1.11	-0.39	-1.25	-0.31	-0.62	-0.09
7	99.99	0.55	0.94	0.52	0.57	0.04	-0.43	-0.72	-0.69	-1.08	-0.4	-0.05
8	99.99	1.4	0.82	0.31	-0.58	0.41	-0.12	-0.8	0.2	-0.44	-0.2	0.13
9	99.99	0.23	0.98	0.08	-0.04	-0.03	-0.21	-0.39	0.15	-0.37	0.34	0.18
10	99.99	0.92	-0.24	0.5	-0.14	-0.08	-0.66	-0.27	0.11	-0.58	0.23	0.46
11	99.99	-0.03	0.11	-0.14	0.49	0.12	0.14	-0.63	0.01	-0.41	0.43	0.45
12	99.99	-0.02	-0.11	-0.48	-0.08	0.34	0.03	-0.23	0.12	-0.63	0.1	0.93
13	99.99	-0.15	0.28	-0.16	-1.32	0.03	0.03	-0.57	0.2	0	-0.07	0.47
14	99.99	0.1	0.51	0.1	-0.08	0.33	0.26	-0.89	0.06	-0.25	0	0.17
15	99.99	0.58	0.05	-0.15	-0.41	0.05	0.34	-0.3	0.08	0.15	0.15	0.53

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
4	1.25	0.31	-0.22	99.99	0.06	0.48	0.83	0.44	0.63	-0.15	-0.28	0
5	0.37	0.46	0.36	-0.24	-0.62	0.75	0.67	0.48	0.59	-0.12	-0.38	0.2
6	0.29	0.37	0.16	0.36	-0.94	1	0.9	0.54	0.11	0.03	-0.59	0.39
7	0.04	-0.12	-0.66	0.22	-0.09	0.29	0.31	0.89	-0.03	0.07	-0.39	0.21
8	-0.04	-0.72	-0.46	0.21	-0.47	0.6	-0.05	0.25	-0.21	0.04	-0.15	-0.12
9	0.53	-0.02	-1.38	0.17	-0.06	0.17	0	0.62	-0.16	-0.03	-0.27	-0.48
10	0.01	0.25	-0.95	-0.19	0.16	-0.31	0.53	0.48	0.57	-0.06	-0.29	-0.47
11	0.19	0.04	-0.36	-0.62	0.16	-0.17	0.43	0.25	0.35	0.2	-0.2	-0.83
12	0.39	0.08	-0.3	-0.75	0.15	0.62	-0.19	0.25	0.23	-0.1	-0.21	-0.15
13	0.77	0.44	0.19	0.05	-0.08	0.59	0.42	-0.14	-0.16	-0.24	-0.17	-0.4
14	0.21	0.07	-0.5	-0.19	0	0.38	0.54	0.47	0.02	-0.17	-0.35	-0.8
15	-0.06	-0.26	-0.66	0.49	0.36	0.74	0.26	0.67	-0.08	0.18	0.01	-0.41

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	4	5	6	7	8	9	10	11	12	13	14	15
Mean Log q	-9.9733	-9.7783	-9.3311	-9.1321	-8.9963	-8.643	-8.455	-8.3067	-8.1332	-8.2025	-7.7592	-7.7592
S.E(Log q)	0.7218	0.6477	0.6334	0.5202	0.5083	0.4513	0.4558	0.3697	0.3784	0.4317	0.3772	0.382

Regression statistics :
Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	0.88	0.866	9.53	0.73	22	0.64	-9.97
5	0.79	2.125	8.93	0.82	23	0.47	-9.78
6	0.88	0.953	8.89	0.75	23	0.56	-9.33
7	0.9	0.95	8.76	0.81	23	0.47	-9.13
8	0.88	1.19	8.56	0.83	23	0.45	-9
9	1.05	-0.45	8.83	0.79	23	0.48	-8.64
10	1.19	-1.376	9.17	0.72	23	0.53	-8.46
11	1.04	-0.337	8.47	0.76	23	0.39	-8.31
12	0.94	0.505	7.89	0.77	23	0.36	-8.13
13	0.85	1.195	7.54	0.75	23	0.36	-8.2
14	0.89	0.931	7.3	0.78	23	0.34	-7.76
15	0.98	0.158	7.57	0.76	23	0.37	-7.66

Table 17: Cont.

Terminal year survivor and F summaries :

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2012

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	2348	0.738	0	0	1	1	0.064

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2348	0.74	0	1	0	0.064

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	1160	0.493	0.236	0.48	2	1	0.065

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1160	0.49	0.24	2	0.479	0.065

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 2010

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	170	0.395	0.246	0.62	3	1	0.091

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
170	0.4	0.25	3	0.622	0.091

Age 7 Catchability constant w.r.t. time and dependent on age
Year class = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	155	0.317	0.233	0.74	4	1	0.061

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
155	0.32	0.23	4	0.736	0.061

Age 8 Catchability constant w.r.t. time and dependent on age
Year class = 2008

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	326	0.271	0.172	0.64	5	1	0.018

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
326	0.27	0.17	5	0.636	0.018

Age 9 Catchability constant w.r.t. time and dependent on age
Year class = 2007

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	417	0.238	0.175	0.73	6	1	0.02

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
417	0.24	0.17	6	0.734	0.02

Table 17: Cont.

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	710	0.215	0.157	0.73	7	1	0.017

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
710	0.22	0.16	7	0.728	0.017

Age 11 Catchability constant w.r.t. time and dependent on age
Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	63	0.199	0.226	1.14	8	1	0.009

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
63	0.2	0.23	8	1.138	0.009

Age 12 Catchability constant w.r.t. time and dependent on age
Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	17	0.192	0.134	0.7	8	1	0.033

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17	0.19	0.13	8	0.697	0.033

Age 13 Catchability constant w.r.t. time and dependent on age
Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	10	0.178	0.14	0.79	10	1	0.014

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10	0.18	0.14	10	0.79	0.014

Age 14 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	13	0.169	0.138	0.81	11	1	0.02

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13	0.17	0.14	11	0.813	0.02

Age 15 Catchability constant w.r.t. time and age (fixed at the value for age) 14
Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU SURVEY 1988-1993	1	0	0	0	0	0	0
EU SURVEY 1994-2016	10	0.162	0.119	0.73	12	1	0.05

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10	0.16	0.12	12	0.734	0.05

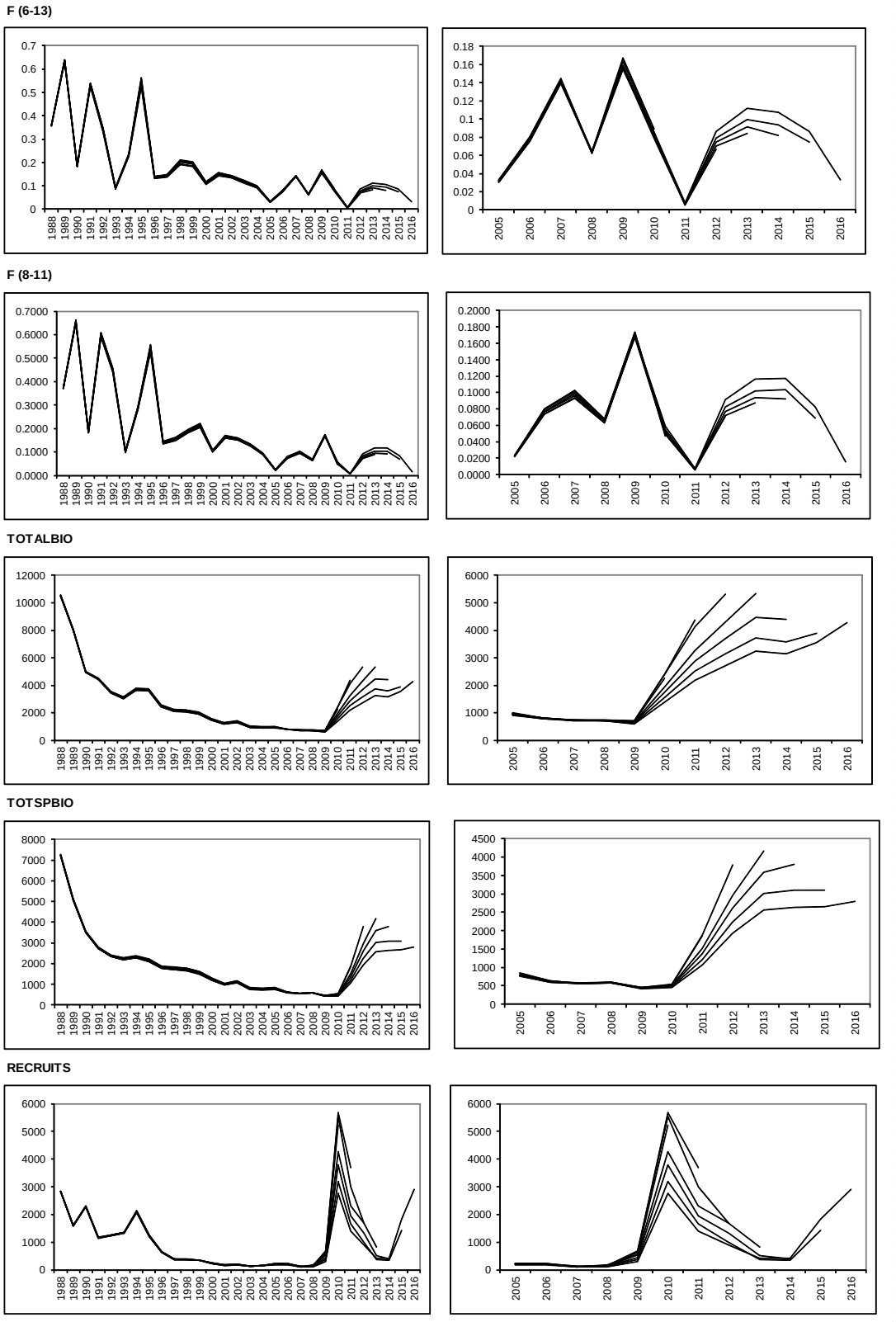


Fig 10: XSA retrospective analysis (run A4_t-split_q14_m015), last year 2016-2010: average fishing mortality (ages 6-13), average fishing mortality (ages 8-11), biomass, spawning stock biomass and recruitment (age 4).

Table 18: Extended Survivor Analysis results (run A4_t-split_q14_m015).

YEAR	RECRUITS Age 4 (Thousands)	TOTAL BIOMASS (Tonnes)	SPAWNING BIOMASS (Tonnes)	FBAR 6-13	FBAR 8-11
1988	2834	10565	7273	0.357	0.3700
1989	1604	8083	5131	0.633	0.6512
1990	2307	5011	3559	0.183	0.1811
1991	1174	4517	2787	0.527	0.5907
1992	1266	3543	2416	0.334	0.4377
1993	1360	3140	2272	0.087	0.0983
1994	2132	3770	2384	0.225	0.2816
1995	1252	3751	2208	0.524	0.5270
1996	657	2572	1883	0.132	0.1348
1997	388	2245	1833	0.137	0.1491
1998	383	2195	1782	0.191	0.1815
1999	347	2037	1625	0.182	0.2048
2000	245	1562	1296	0.106	0.0990
2001	182	1270	1050	0.143	0.1588
2002	195	1414	1182	0.134	0.1501
2003	130	1017	833	0.111	0.1248
2004	156	968	803	0.091	0.0880
2005	182	996	844	0.030	0.0220
2006	176	799	637	0.075	0.0733
2007	111	718	562	0.140	0.0932
2008	119	706	589	0.064	0.0629
2009	308	586	424	0.156	0.1697
2010	2756	1382	446	0.086	0.0588
2011	1387	2174	1068	0.008	0.0073
2012	905	2711	1930	0.086	0.0910
2013	410	3233	2568	0.112	0.1165
2014	414	3136	2642	0.107	0.1174
2015	1828	3547	2656	0.086	0.0823
2016	2908	4272	2788	0.033	0.0159

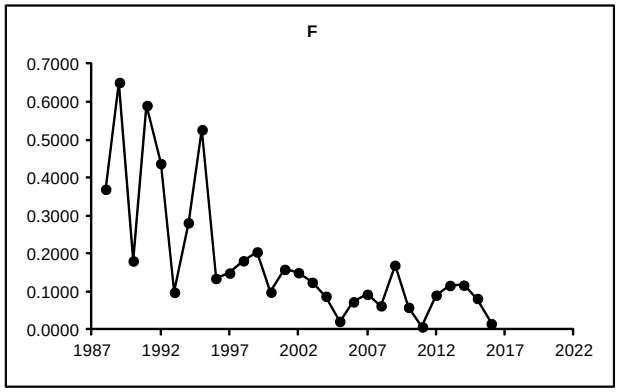


Fig.11 A. Extended Survivor Analysis results for F (age 8-11)

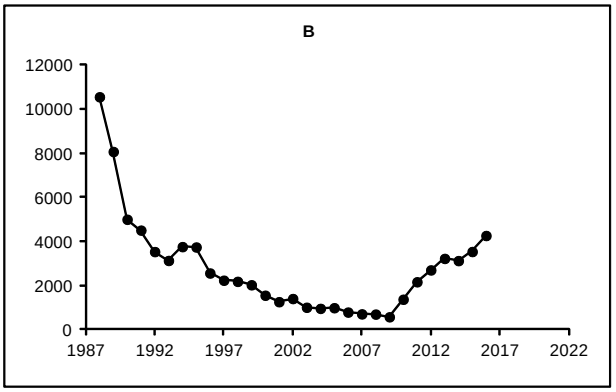


Fig. 11 B. Extended Survivor Analysis results for 4+ biomass (tons)

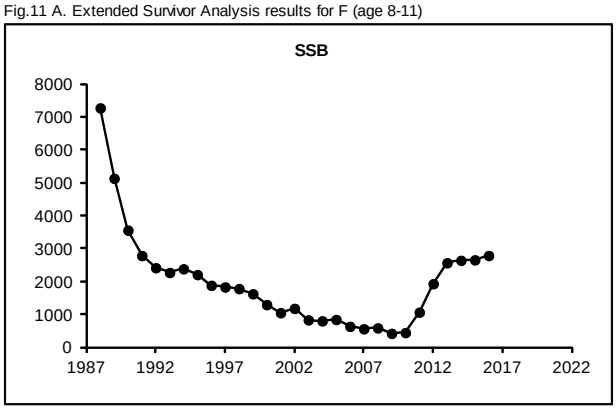


Fig. 11 C: Extended Survivor Analysis results for spawning biomass (tons)

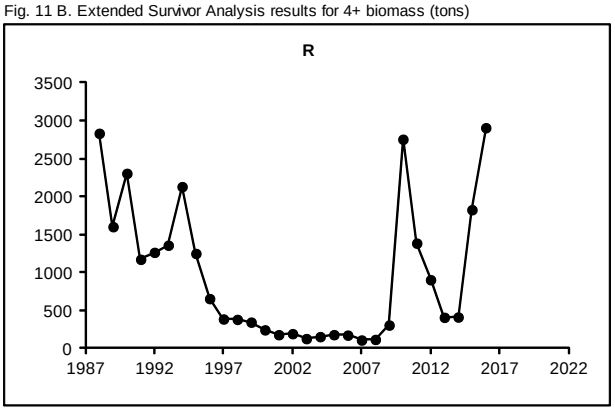


Fig.11 D: Extended Survivor Analysis results for recruits at age 4 ('000)

Table 19: VPA-type Bayesian model results.

	B quantiles			SSB quantiles			R quantiles			F_{bar} quantiles		
Year	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**	**50%**	**5%**	**95%**
1988	13160	12534	13848	10672	10180	11244	3042	2669	3507	0.310	0.291	0.326
1989	10528	10005	11171	8603	8197	9121	3026	2609	3562	0.522	0.482	0.557
1990	7086	6617	7684	5373	5011	5847	3401	2875	4170	0.140	0.128	0.151
1991	6538	6081	7096	4817	4484	5208	4798	4127	5544	0.453	0.405	0.490
1992	5692	5236	6261	4098	3746	4513	3086	2643	3714	0.305	0.268	0.338
1993	5300	4830	5861	3686	3351	4067	2020	1633	2608	0.066	0.057	0.074
1994	5771	5289	6373	4028	3686	4441	1245	1006	1568	0.195	0.175	0.217
1995	5727	5179	6402	4261	3866	4734	1226	979	1544	0.338	0.298	0.384
1996	4412	3884	5010	3446	3045	3908	1021	844	1266	0.082	0.071	0.094
1997	3974	3482	4532	3401	2979	3876	705	574	888	0.086	0.073	0.101
1998	3910	3444	4434	3410	2999	3876	570	455	741	0.110	0.096	0.127
1999	3662	3210	4151	3212	2803	3640	637	497	798	0.125	0.107	0.144
2000	2872	2503	3266	2560	2228	2909	409	320	519	0.061	0.053	0.071
2001	2462	2136	2790	2182	1900	2467	493	391	651	0.095	0.082	0.111
2002	2712	2351	3082	2460	2125	2783	551	438	701	0.083	0.072	0.097
2003	1992	1726	2290	1786	1543	2046	522	414	662	0.064	0.054	0.077
2004	1985	1701	2309	1716	1472	2015	323	254	416	0.046	0.039	0.054
2005	1953	1658	2293	1712	1443	2027	320	252	414	0.012	0.010	0.014
2006	1569	1348	1788	1301	1115	1495	665	504	895	0.042	0.036	0.049
2007	1494	1287	1706	1212	1045	1387	6044	4275	8451	0.052	0.044	0.061
2008	1934	1650	2253	1345	1141	1578	2918	1977	4488	0.036	0.031	0.042
2009	2146	1800	2564	944	816	1085	2287	1496	3600	0.093	0.080	0.110
2010	2742	2287	3362	977	819	1144	1254	761	2094	0.032	0.027	0.038
2011	3447	2839	4253	1713	1434	2064	1054	741	1699	0.004	0.003	0.005
2012	4067	3344	4975	2833	2303	3560	2568	1488	4896	0.052	0.045	0.061
2013	4945	4085	6123	3780	3027	4700	3598	1814	7406	0.068	0.057	0.081
2014	5021	4117	6329	3920	3163	4979	3539	1602	7952	0.081	0.067	0.097
2015	5462	4444	6806	3946	3141	5046	2390	850	5945	0.067	0.053	0.082
2016	5634	4469	7071	3818	3081	4908	2828	922	9367	0.014	0.010	0.018
2017				4440	3461	5662						

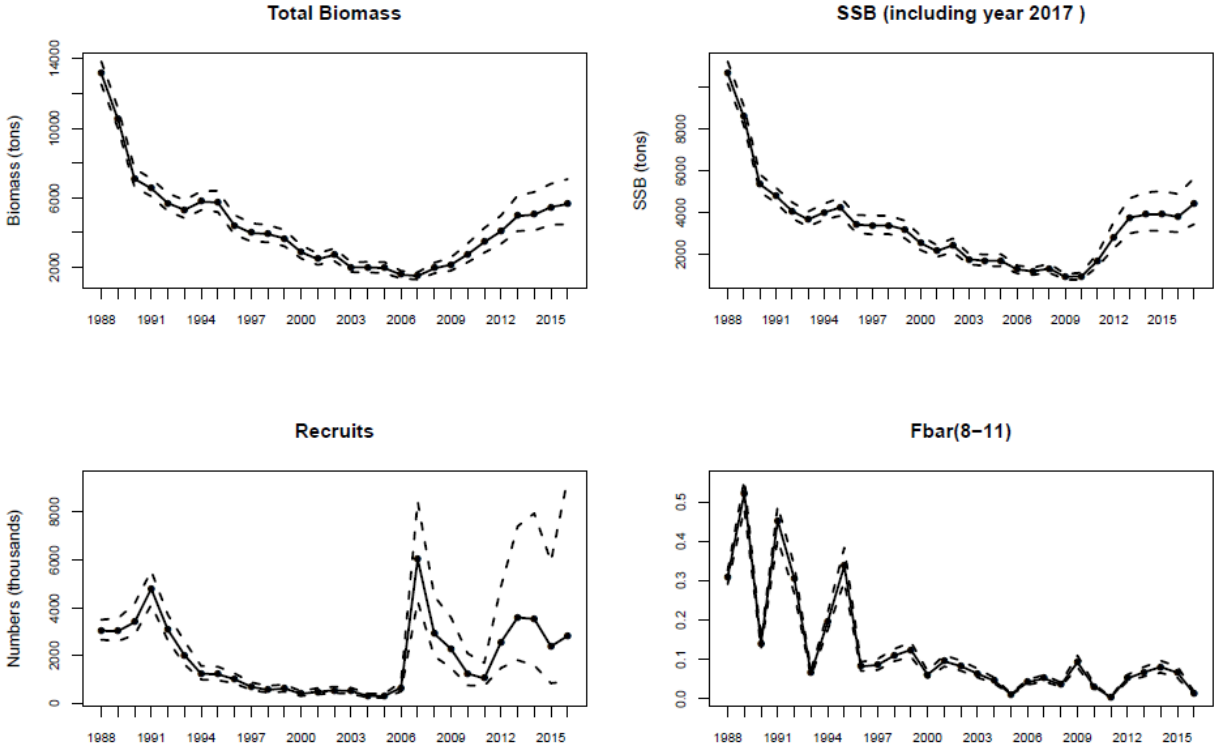


Fig.12: VPA type Bayesian model results with the 90 confidence intervals (recruits at age 1)

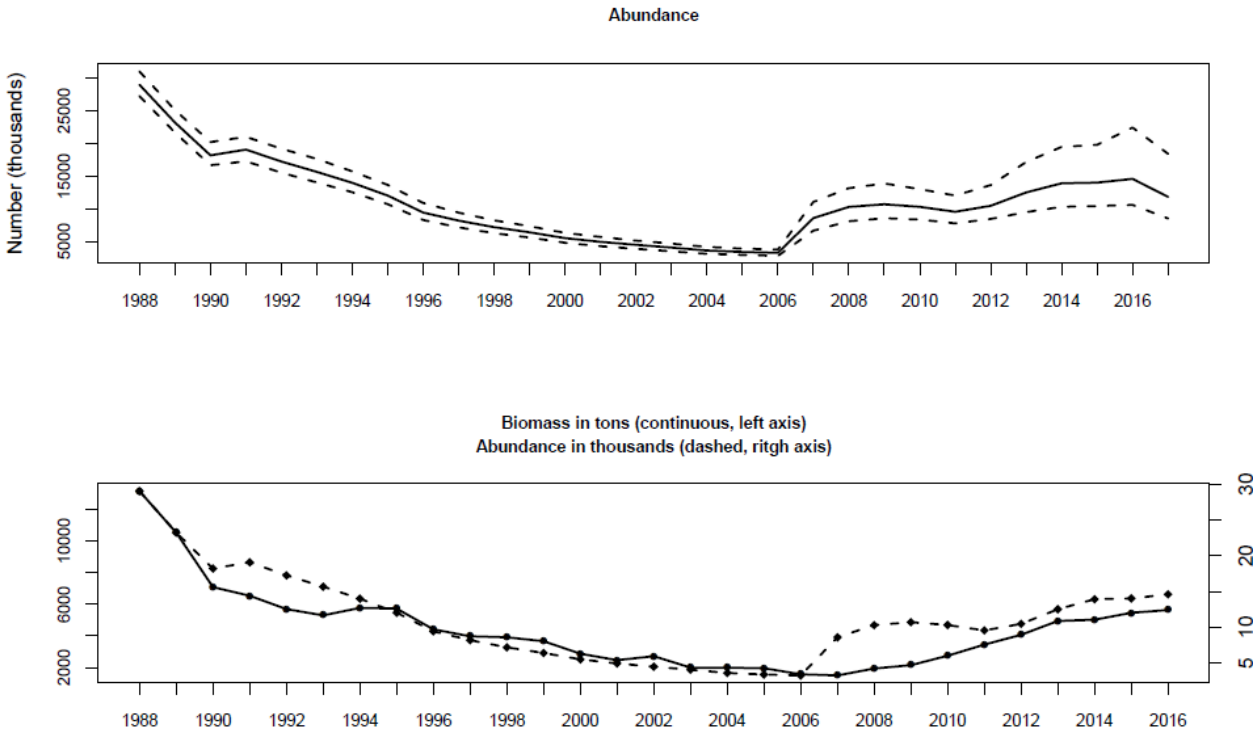


Fig.13: VPA type Bayesian model: trends in the Abundance and biomass.

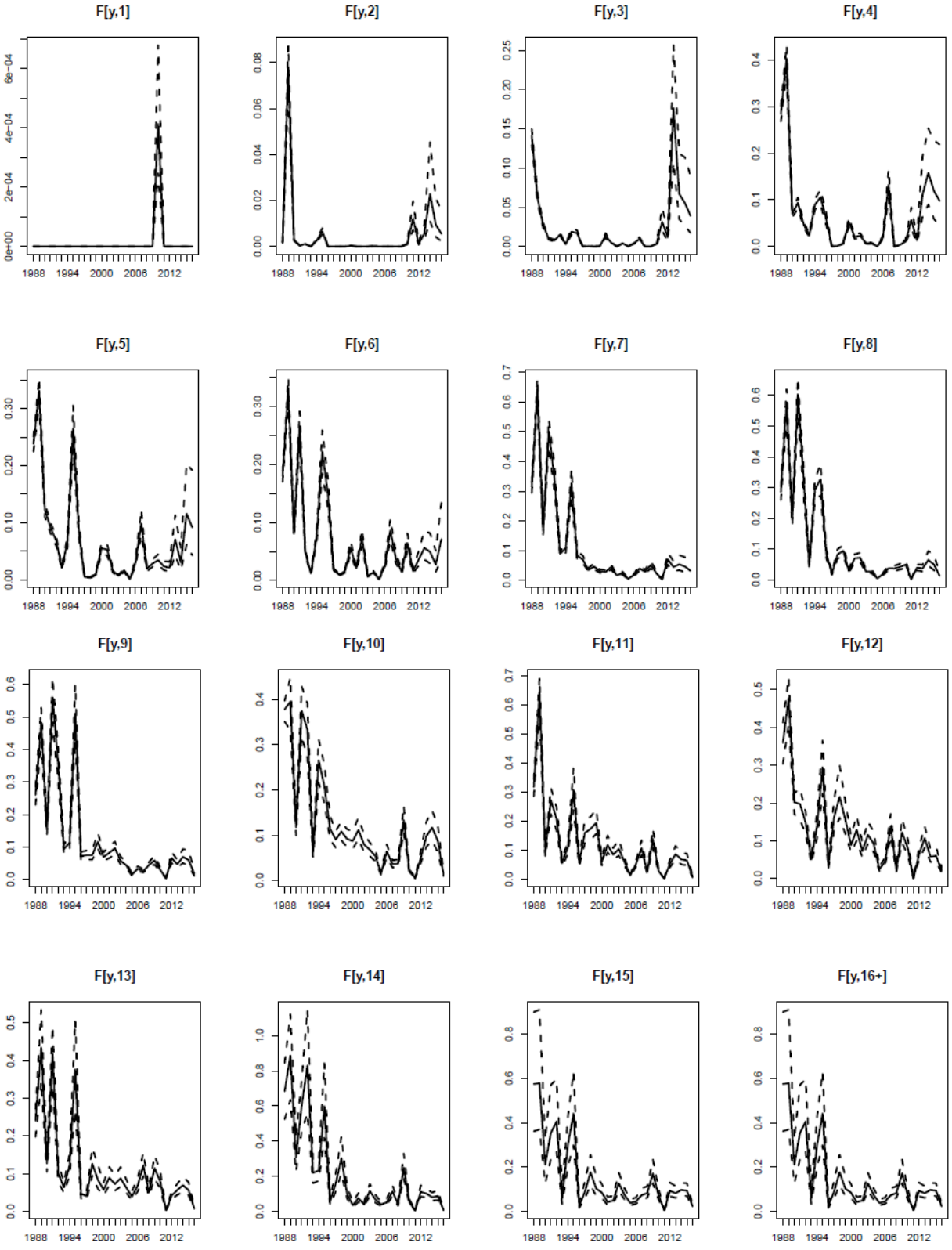


Fig.14: VPA type Bayesian model results: Estimated fishing mortality at age.

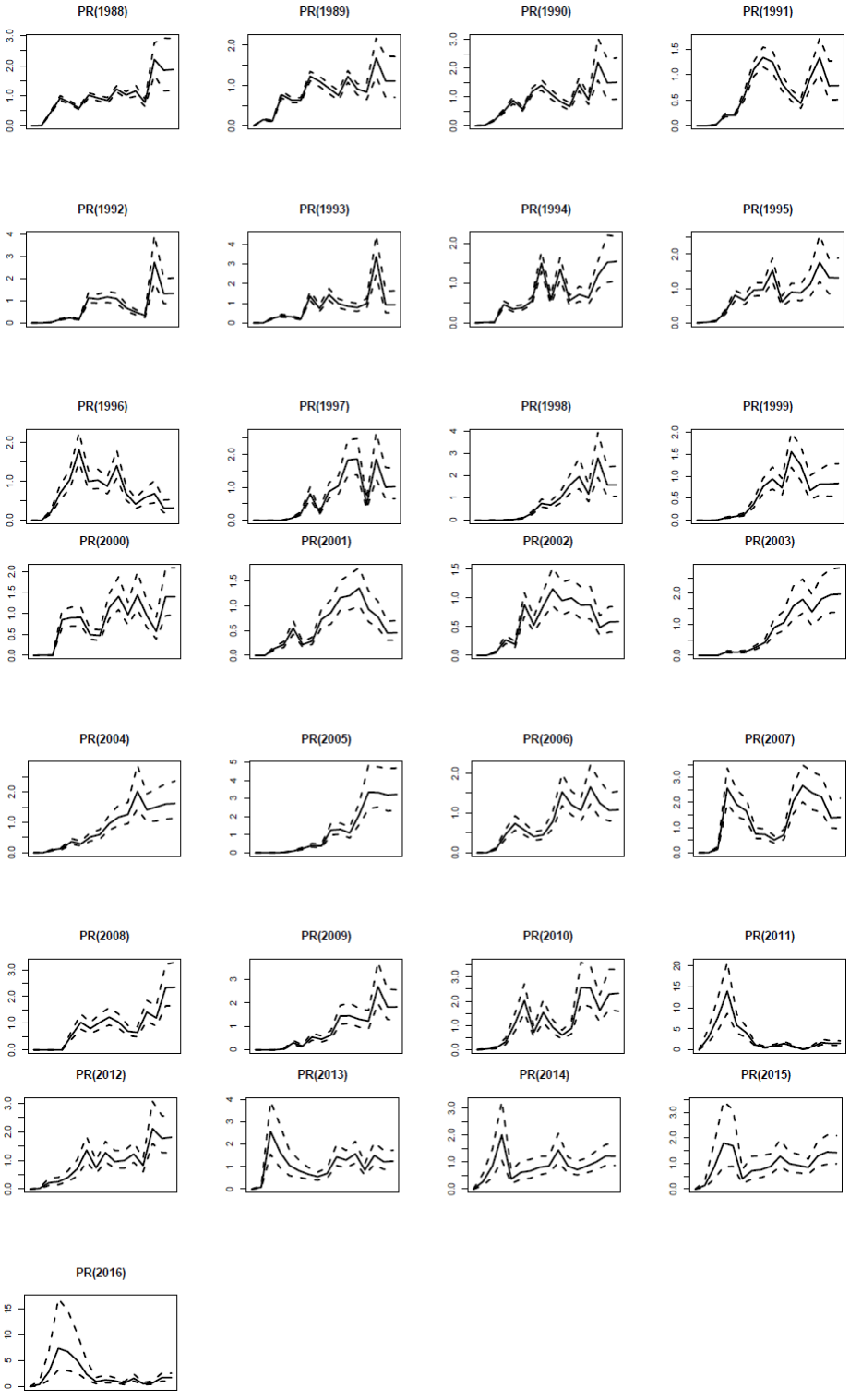


Fig.15: VPA type Bayesian model results: Estimated PR(F/Fbar) per age and year.

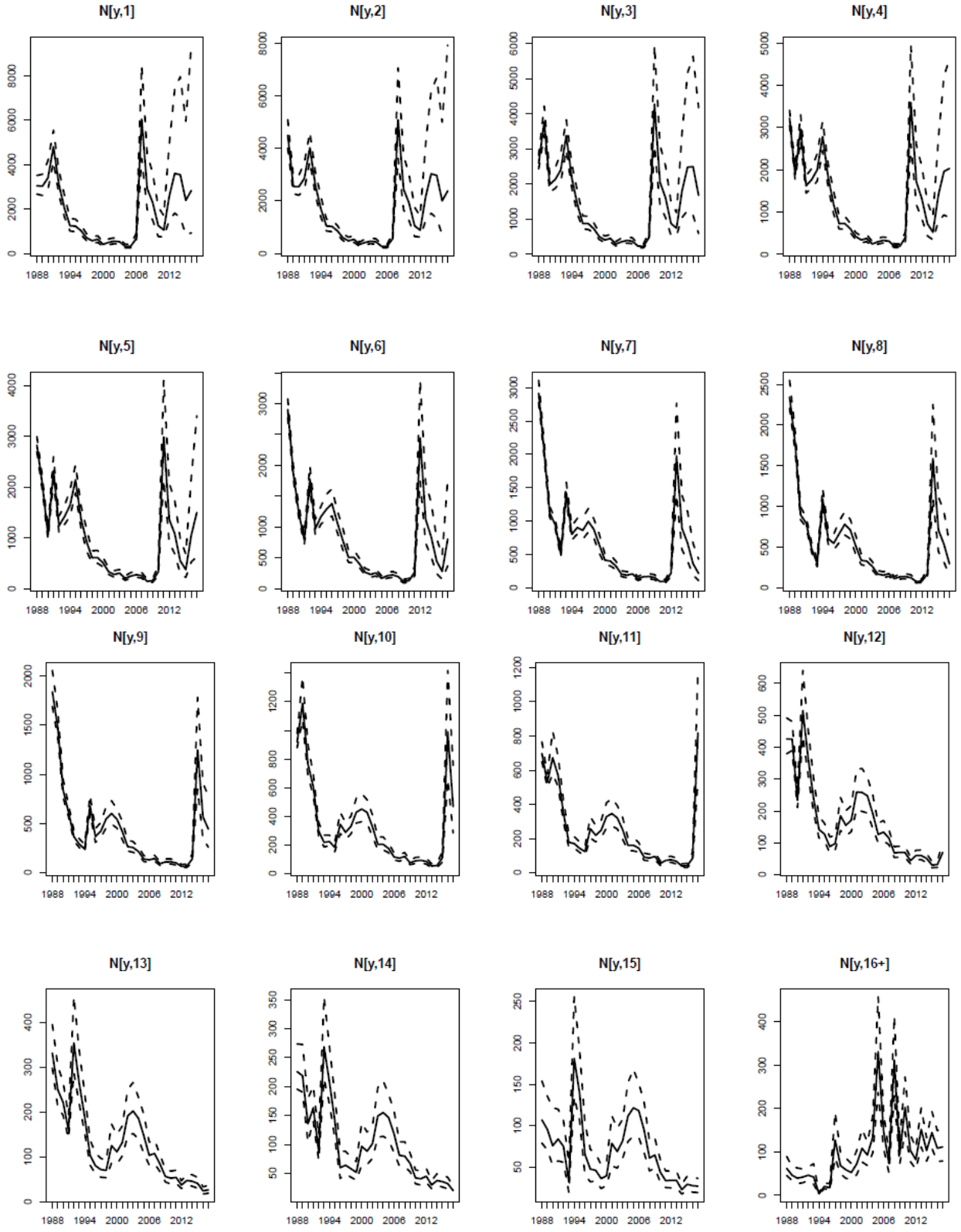


Fig.16: VPA type Bayesian model results: Estimated numbers at age.

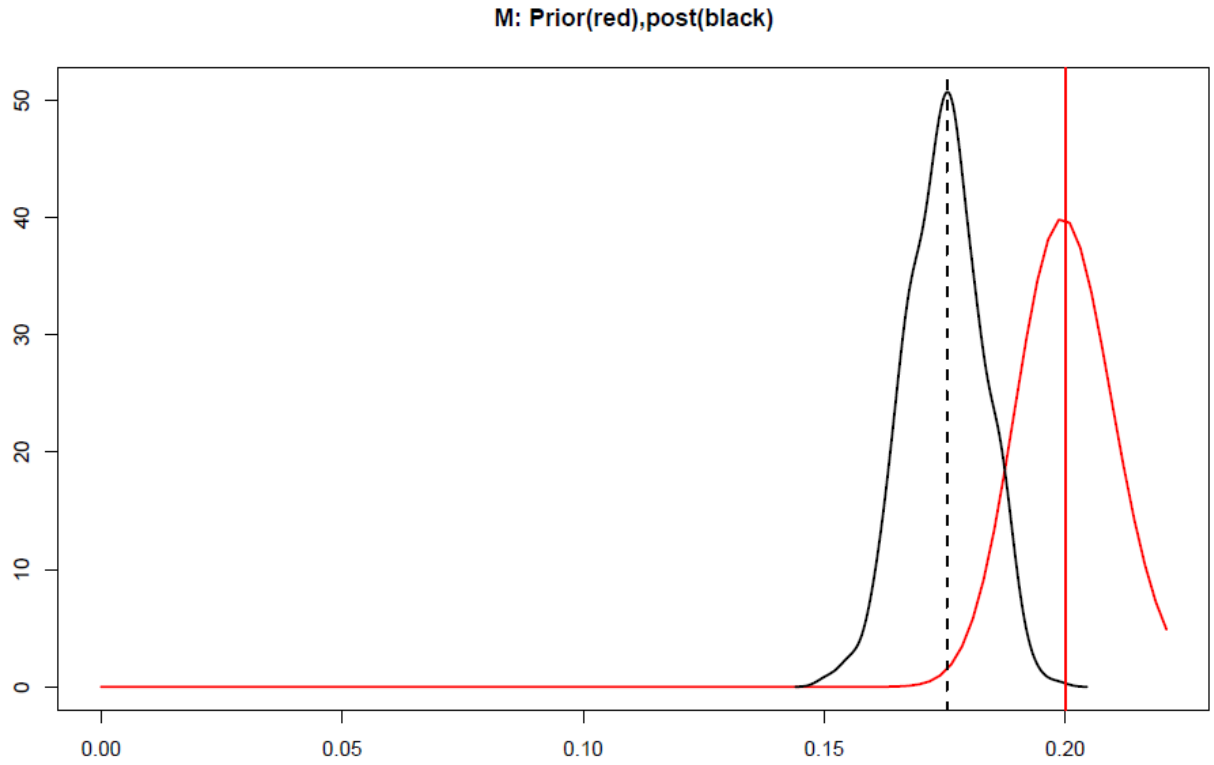


Fig.17: VPA type Bayesian model results: Estimated natural mortality.

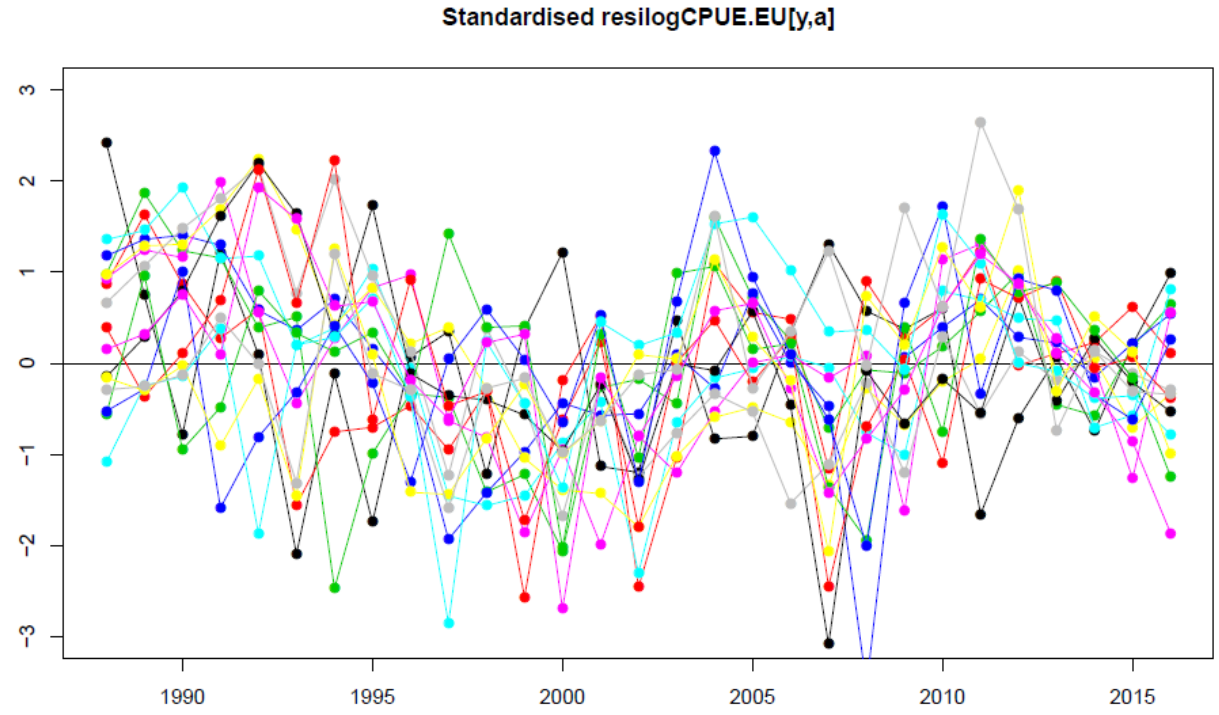


Fig.18: VPA type Bayesian model results: Standardised residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices by age.

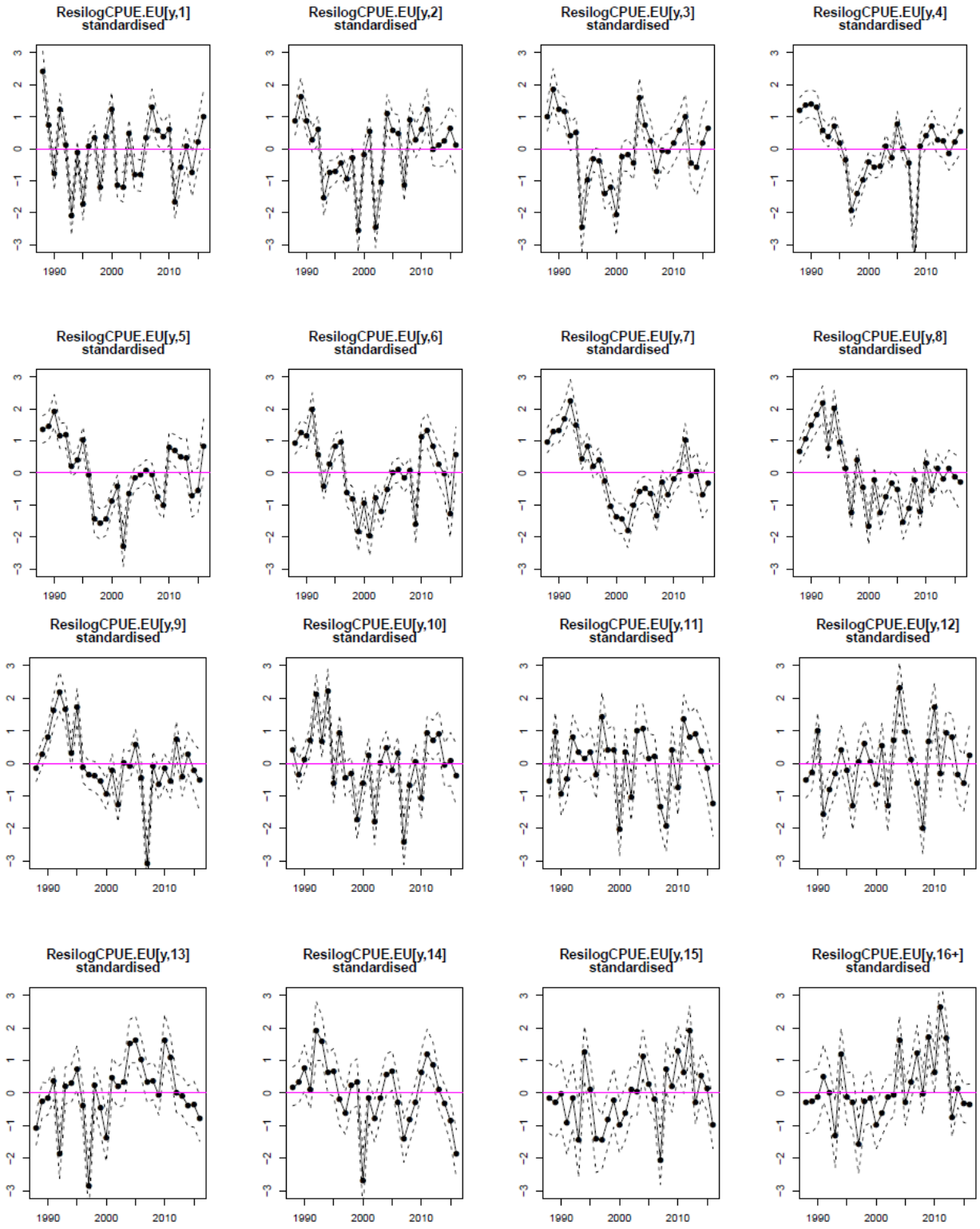


Fig.19: VPA type Bayesian model results: Standardised residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices by age.

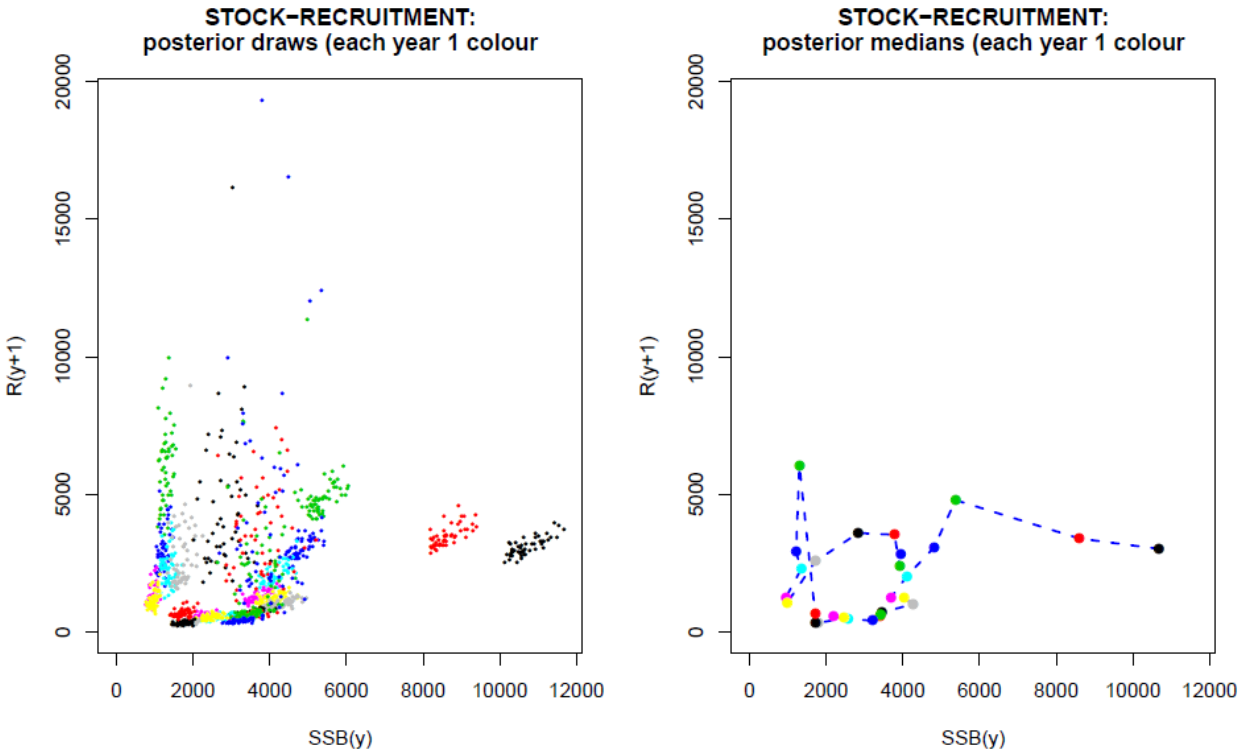


Fig.20: VPA type Bayesian model results: Stock- Recruitment plots.

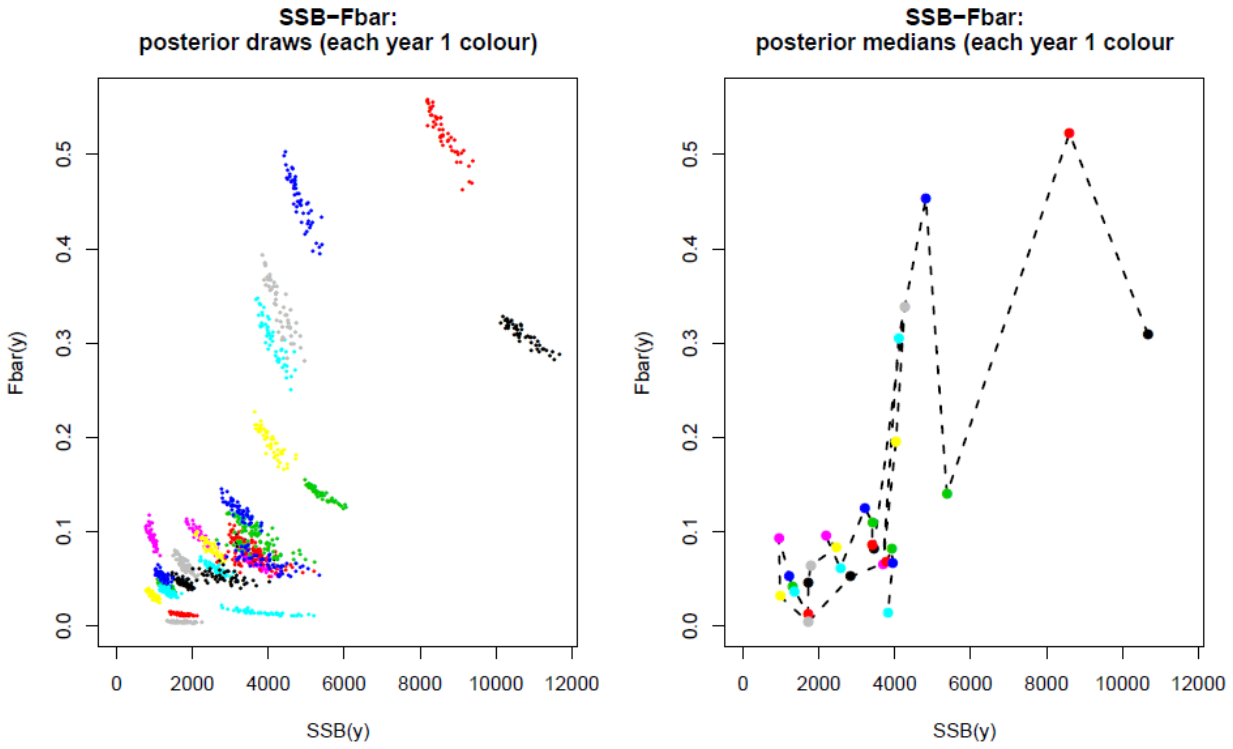


Fig.21: VPA type Bayesian model results: Fbar versus SSB plots.