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

by

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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 XSA and a VPA-type Bayesian model were applied to this stock, but the XSA presented unrealistic results. 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. The EU survey and VPA-type Bayesian model indicates only poor recruitment from 1991 to 2005 year class. SSB recorded a minimum in 2009, in recent years SSB indices increase with the income of the strong 2006 year class in the SSB 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 (2011). This stock continues to be in a poor condition, despite the apparent improvement of the recruitment since 2006 (mainly due to the 2006 year class). Although the level of catches is low since 1996, this stock has been kept at a 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 2011 (Alpoim *et al*., 2011).

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). Catches were high between 1964 and 1966, with a peak in 1965 of 5 341 tons. Till the end of the 1960's catches remained at a low level within 80 tons and 150 tons, jumping to a higher 600-1 100 tons level on the early-1970's. Since 1974 this stock became regulated and catches ranged from 600 tons (1981) to 5 600 tons (1987). From 1986 to 1989 catches exceed the TAC. Catches declined to 275 tons in 1993, following the fast decline of the stock biomass and the 1992 reduction of the Spanish directed effort. Catches increased from 1992 to 1995 reaching 1 300 tons, in 1996 catches dropped to 300 tons and since then have been decreasing to historical minimums. Catches, recalculated from NAFO statistical data base using the NAFO STATLANT 21A Extraction Tool on May 30th 2014, . for 2010, 2011, 2012 and 2013 were 65, 63, 122 and 246 tons respectively (Table 1 and Fig.1).

Since 1974 till 1993 a TAC of 2 000 tons has been in effect for this stock with the exception of 1978 (TAC of 4 000 tons). A reduction to 1 000 tons 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 (1988-2013), (Mandado, 2014 - SCR 14/17).

EU- Spain/Portugal 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 35 min. The fishing gear used was a Lofoten gear with effective 30mm 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 has 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 1988-02 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 730m. 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 35mm 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). 1988-2002 data are transformed R/V Cornide de Saavedra data, 2003-2013 data are original from R/V Vizconde de Eza (Mandado, 2014 - SCR 14/17).

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 length composition matrix was updated since the last assessment (Alpoim *et al*, 2011; Casas and González Troncoso, 2013; Mandado, 2014). Length compositions (Table 3) from 1988 to 2013 were given by the EU survey.

Length weight relationships

Length weight relationships for the 3M American plaice (1988-2013) were calculated with EU survey length/weight data from both males and females (Mandado, *pers. comm*. 2014) 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 have 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 1988-2010 (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 2010 Portuguese and Lithuanian Research Reports (Vargas *et al.*, 2011; Statkus, 2011) was used to estimate the length composition of the 2010 total upadated catch. The length compositions presented in the 2011 Portuguese and Russian Research Reports (Vargas *et al*., 2012; Pochtar *et al*, 2012) was used to estimate the length composition of the 2011 total catch. The length compositions presented in the 2012 Portuguese Research Report (Vargas *et al*., 2013) was used to estimate the length composition of the 2012 total catch. The length compositions presented in the 2013 Portuguese, Spanish and Russian Research Reports (Vargas *et al*., 2014; González-Costas *et al*, 2014; Fomin and Khlivnoy, 2014) were used to estimate the length composition of the 2013 total catch.

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*, 2011) was updated with the 2010, 2011 2012 and 2013 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 1988-2013 (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 1988-2013 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 5. 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

An 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 tons 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 tons 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. In 2013 these indices decreased again and are at a low level. Results of the 1996 Canadian survey are comparable with the 1996 EU survey (Fig. 3) (Alpoim *et al.*, 2002; Alpoim, 2003; Mandado, 2014).

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 2006 till 2010 this index oscillated between 0.025 and 0.071. In 2011 this index reached the minimal value, but with the slight decreased of the stock biomass and the increase of the catches, the f index increased again and in 2013 is 0.046 (Table 13 and 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 is 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 7 in 2013) for the seventh consecutive year appears to be strong. Survey spawning biomass 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 t.

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. 23 points are available, showing, with the exception of 2006-2009, very poor recruitment for an SSB less than 9 000 t (Tab.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 is 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 1991-2000 period. 2006-2010 values were are highest in the time series (0.459 recruits per Kg of SSB) but in 2011 the index decreased to 10% of the previous value (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

An yield-per-recruit analysis was conducted, incorporating the sets of vectors already described. This analysis give a $F_{0.1} = 0.163$ and an $F_{max} = 0.347$ (Tab. 12, Fig. 5).

XSA

An XSA was performed using the Lowestoft VPA Suite (Darby and Flatman, 1994). The month with a peak of spawning for 3M American plaice is May (Serebryakov *et al.*, 1987) and was used to estimate of 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 2013. The survey biomass can be considered representative of the mean annual biomass (EU survey is conducted around the middle of the year). The 2013 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 1988-2013 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, runs were done with all data or decreasing the range of data set or changing M.

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

- No year weights were applied, due to the short time series.
- Age 12 was considered to be the first age at which *q* is independent of age.
- 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. Taken in account the sum square of the Log catchability residuals and number of interactions Run *a4_t94_m015* has the best fit, its full diagnostic output is presented in Table 17 and the results in Table 18 and Fig. 10.

XSA 4+ Biomass and Spawning stock biomass (SSB) show a steady decline, but since 2009 (2010 for SSB) show an extremely rapid and unrealistic increase. From 1991 till 2006 recruitment was at a very low level, the 2006 year class, as in the EU survey, was strong, and is pushing the both 4+ and spawning biomass up. The rate of exploitation decreased till 2005, since then has fluctuated at very low levels.

Bayesian Model

A VPA-type Bayesian model, the same used for the Div. 3M cod and in the American plaice last assessment, was applied. As in XSA some variety 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 1988-2013.
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 showed better diagnostics and results, but they are highly dependent of the chosen priors and its distribution. The VPA-type Bayesian model with all data (ages 1-16+, tuning from 1988-2013) 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. 11-20.

Conclusions

The EU survey and VPA-type Bayesian model indicates only poor recruitment from 1991 to 2005 year class. SSB recorded a minimum in 2009, in recent years SSB indices increase with the income of the strong 2006 year class in the SSB but in 2013 this increase seems to halt mainly as there were fewer older fish (ages 16+). Stock biomass increased in recent years due to the improved recruitment since 2006 (mainly due to the 2006 year class). SSB and stock biomass are still at low level.

Both fishing mortality index (C/B) and VPA-type Bayesian model fishing mortality declined from the mid-1980s to the mid-2000s and since 2000 fluctuated at or below 0.1. F has increased slightly in recent years.

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 low level.

Acknowledgements

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TABLE 1 - Nonimal catches (t) from 1960-2011, Stacfis estimates (t) from 1988-2010 and TAC (t) from 1974-2014 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	estimates	
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		0
2012	-	-	24	-	21	-	66	-	10	121	-	1	122		0
2013		-	22	-	66	-	146	-	12	246	-	-	246		0
2014	-	-	-	-	-	-	-	-	-	0	-	-	0		0

(1) - Recalculated from NAFO statistical data base using the NAFO STATLANT 21A Extraction Tool, on 30-5-2014.

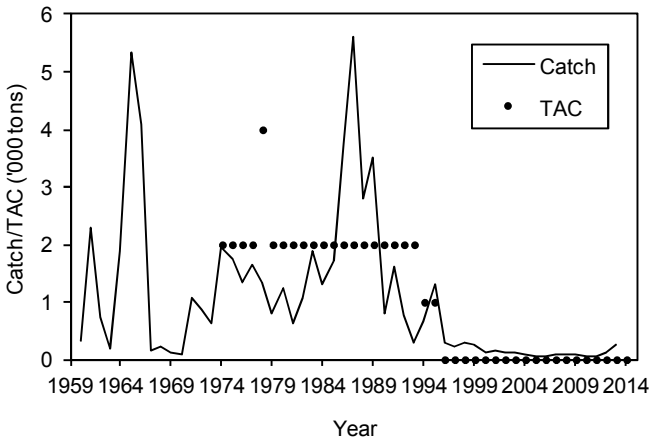


Fig. 1. American plaice in Div.3M: nominal catches and agreed TAC's

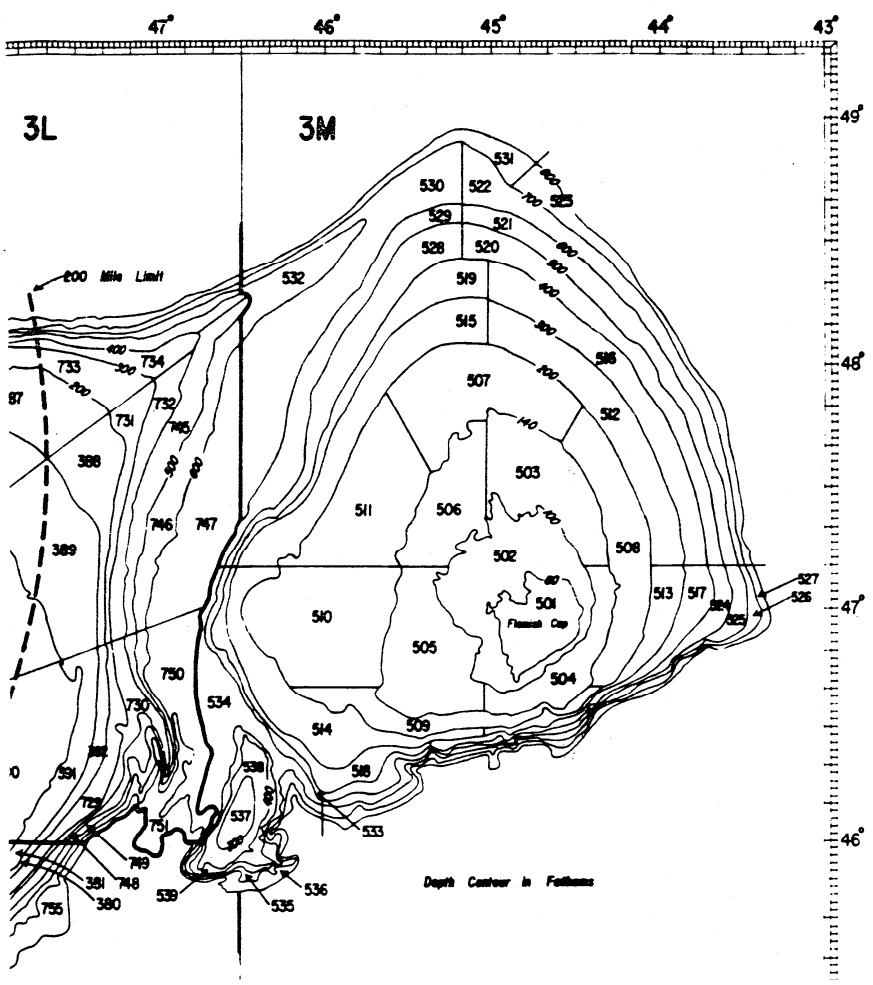


Fig. 2. Stratification scheme for stratified- randowm groundfish surveys in Div 3M. (Bishop 1994).

Table 2 - EU - surveys in Div.3M from 1988-2013: estimates of biomass (t) and abundance (000's) of A.plaice.

	Depth range	Area	Year																										
Stratum	(m)	(sq. n. mi.)	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
501	128-146	342	1306	1000	505	1078	709	1079	661	2230	1462	381	156	372	345	1043	141	1292	1507	1038	714	284	144	548	716	693	462	329
502	148-183	838	2845	3602	1375	2663	1714	1267	1199	1335	943	740	1587	1810	976	835	1262	713	768	796	354	209	513	370	1084	1141	1272	1202
503	185-256	628	1367	1118	1668	1247	631	444	325	252	168	495	284	97	21	93	75	17	427	101	74	101	147	74	103	364	468	266
504	185-256	348	2199	461	817	320	557	572	853	489	268	203	343	53	100	85	128		395	359	109	153	440	36	91	1201	749	671
505	185-256	703	2599	3093	1830	1407	837	1291	1230	549	500	619	744	73	56	112	189	82	72	45	63	81	88	72	200	190	716	267
506	185-256	496	479	1130	954	501	601	305	808	123	32	13	35	40	25	37	63	29	26	71	61	99	37	57	34	160	185	341
507	258-366	822	1174	531	837	389	639	319	316	249	72	83	47	19	15	28	52	30	84	31	37	20	47	32	28	160	156	166
508	258-366	646	417	164	263	251	727	487	171	132	56	123	165	3		45	43	14	55	175	163	58	128	47	49	65	187	156
509	258-366	314	103	163	343		373	205	20	500	55	36					1	9	77	18				77			30	25
510	258-366	951	2323	1491	2000	1308	1406	1459	2236	708	415	287	36	72	45	95	36	54	45	87	97	24	163	54	115	35	123	153
511	258-366	806	1186	1168	1316	401	372	292	303	109	68	32	29	37	23	27	59	29	69	35	19	22	50	64	26	33	121	121
512	367-549	670	9	19	45	17	11	15	33	12	32	7				4		11						11			11	
513	367-549	249	3		20					3																		
514	367-549	602	8	8	7	389	29		24	15	4		4	9												32		
515	367-549	666	23	99	3	97	37	109	40	68	23	7	7					6		4		3	7	1		10	13	
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	2286	3525	2760	1691	1053	1766	1442	2446	4084	4491	3698
s.e.			1845	2048	1276	1180	954	1040	1373	1083	912	708	751	869	332	429	729	748	740	684	342	159	300	327	526	780	534	439
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	2.86	4.38	3.43	2.10	1.31	2.20	1.79	3.04	5.08	5.59	4.61
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	0.93	0.92	0.85	0.43	0.20	0.37	0.41	0.65	0.96	0.67	0.54
total abundance (000's)			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
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	3.44	4.99	4.14	2.72	1.74	4.06	3.53	6.17	8.60	8.23	5.81

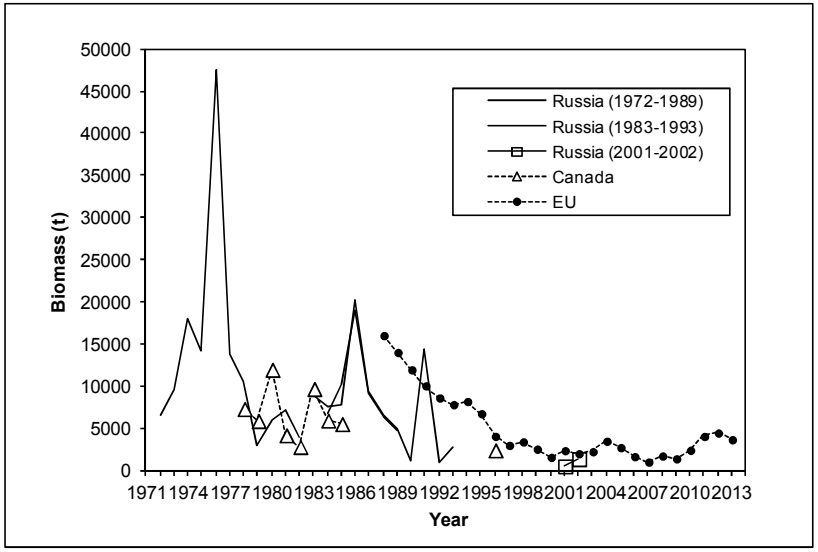


Fig.3A. American plaice in Div. 3M: trends in biomass in the surveys.

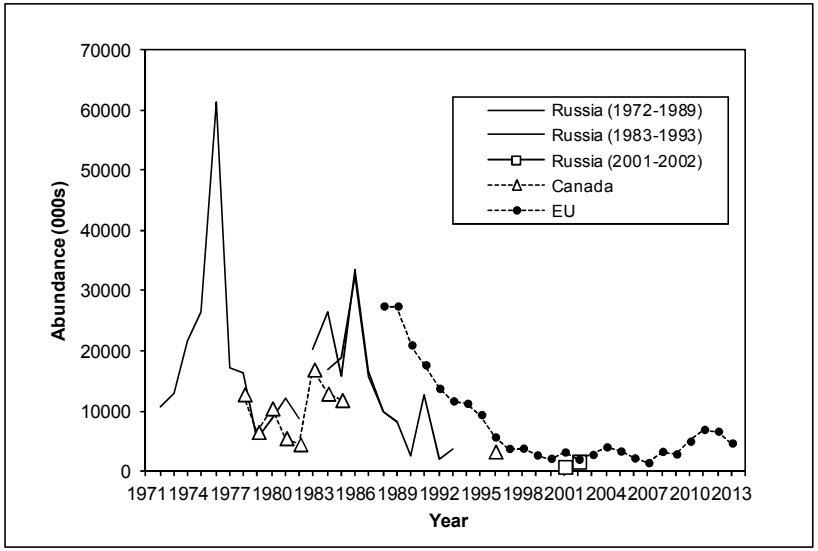


Fig.3B. American plaice in Div. 3M: trends in abundance in the surveys.

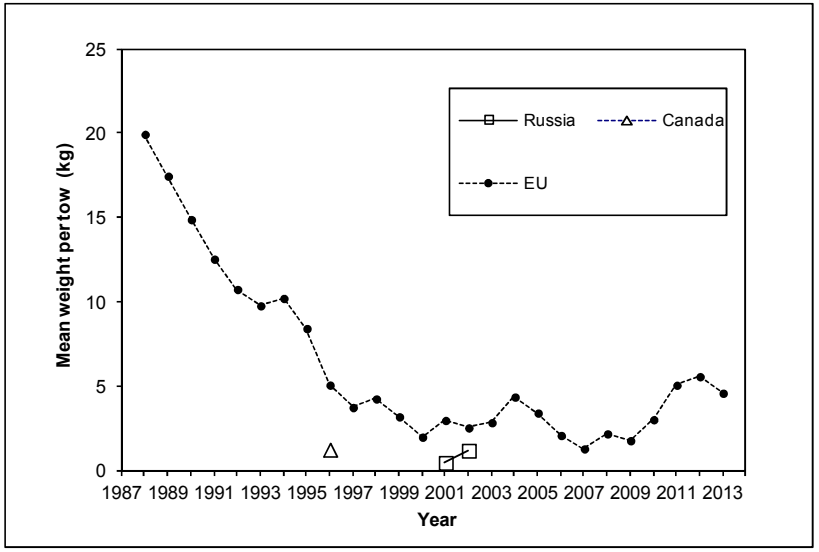


Fig.3C. American plaice in Div. 3M: mean weight per tow in the surveys.

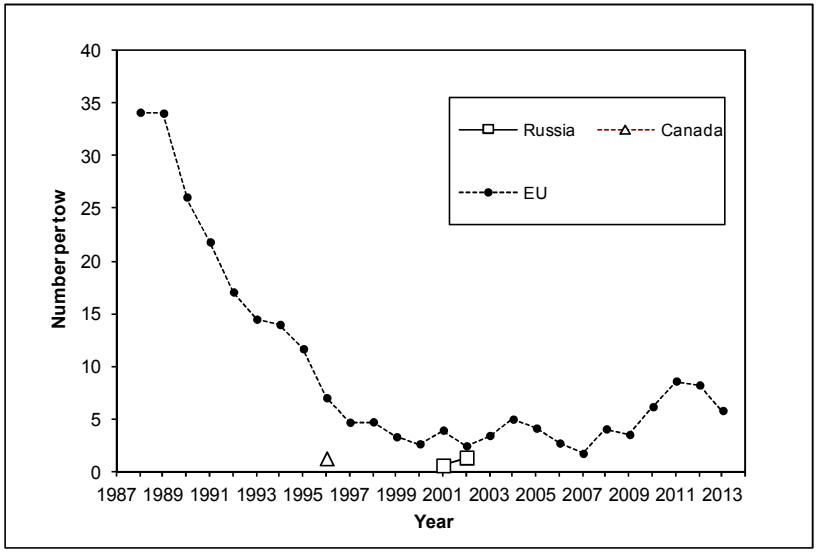


Fig.3D. American plaice in Div. 3M: mean number per tow in the surveys.

Table 3: Length composition (absolute frequencies in '000) of the 3M american plaice stock, EU survey 1988-2013.

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	Length group
4							7																				4
6				20																							6
8				20																20							8
10		41	8	27								7	8							174	16	6				13	10
12	68	14		46					8	8			7			7			7	13	19	13	10		7	13	12
14	555	14		48	48																16	6	10				14
16	1274	104	149	136	230		8	14	7	8						6	13				45	13		29		14	16
18	295	327	411	101	443	19	31	15	32	16			7	8			7	8			383	46	54	155		27	18
20	55	1205	146	77	253	37	33				16		8	31		7	22	8	14	13	838	146	169	161	30	105	20
22	166	2836	188	461	131	191	31		14		16		16			14	66	39	7		243	101	117	86	38	52	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	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		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	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	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	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	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	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	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	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	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	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	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	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	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	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	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
58	28	6	6	7		16		6	6	7	6	6		6		8	20	16				14			44	20	58
60								6	6			6							7	7	9				15	14	60
62							6																				62
64																											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	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	

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

Table 5: Population abundance (000s) at age (yrs) of A. plaice from surveys in Div. 3M during EU survey 1988-2013.

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

Table 6 - Weights at age of the 3M American plaice stock (Kg) from EU surveys, 1988-2013.

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
mean	0.016	0.076	0.178	0.311	0.450	0.578	0.675	0.767	0.836	0.906	0.965	1.016	1.124	1.210	1.343	1.573

Table 7: Criteria applied to convert total catches in weight to total catches in number, 2010-2013.

YEAR	TOTAL CATCH (ton)	BREAKDOWN TOTAL CATCH (ton)	LENGTHS COMPOSITION				Mean Weight (Kg)	TOTAL CATCH IN NUMBER (000's)
			Country	Source	Gear	Paper		
2010	65.0	37.0	Portugal	Commercial	OTB	scs 11/5	0.703	52.7
		28.0	Lithuania	Commercial	OTB	scs 11/4	0.587	47.7
2011	63.0	8.0	Russia	Commercial	OTB	scs 12/5	0.599	13.4
		55.0	Portugal	Commercial	OTB	scs 12/8	0.276	199.5
2012	122.0	122.0	Portugal	Commercial	OTB	scs 13/5	0.686	177.7
2013	246.0	22.0	Russia	Commercial	OTB	scs 14/13	1.274	17.3
		66.0	Espanha	Commercial	OTB	scs 14/6	1.052	62.7
		158.0	Portugal	Commercial	OTB	scs 14/10	0.445	354.7

Table 8: Length composition (absolute frequencies in '000) of the 3M American plaice catches, 1988-2013.

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
14																							0.5			
16		19.3	0.8				0.7	3.0															0.2			
18		60.5	3.9				2.9	3.2																1.6		0.3
20	6.9	126.5	2.0		5.3	1.8	3.3																0.9	4.7	0.4	1.3
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
60					0.01	0.1		1.5						0.04					0.1		2.1		1.3			0.2
62			0.1			0.001	0.6							0.1		1.0										0.1
64														0.01									0.5			
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
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

Table 9 - Catch at age (000s) of the 3M American plaice, 1988-2013.

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

Table 10 - Mean weight at age of the 3M American plaice catch (Kg), 1988-2013.

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
mean	0.026	0.093	0.205	0.337	0.441	0.571	0.686	0.766	0.835	0.897	0.953	1.007	1.093	1.187	1.304	1.492

Table11: American plaice exploitaion pattern given by the generalized logit of the 1988-13 observed partial recruitment (See text).

Age	F at age index	Observed PR	Logit PR	Squared difference
1	0.021	0.018	0.032	0.000
2	0.153	0.133	0.133	0.000
3	0.615	0.534	0.534	0.000
4	1.138	0.987	0.987	0.000
5	1.112	0.965	1.000	0.001
6	1.001	0.869	1.000	0.017
7	0.930	0.807	1.000	0.037
8	1.117	0.969	1.000	0.001
9	1.113	0.966	1.000	0.001
10	1.151	0.999	1.000	0.000
11	1.152	1.000	1.000	0.000
12	1.143	0.992	1.000	0.000
13	1.070	0.928	1.000	0.005
14	1.123	0.974	1.000	0.001
15	1.048	0.909	1.000	0.008
16	0.989	0.858	1.000	0.020
		Minimum sum of squares		0.092

Curve parameters	*a*	*b*	*m*
	-17.847	5.213	0.272

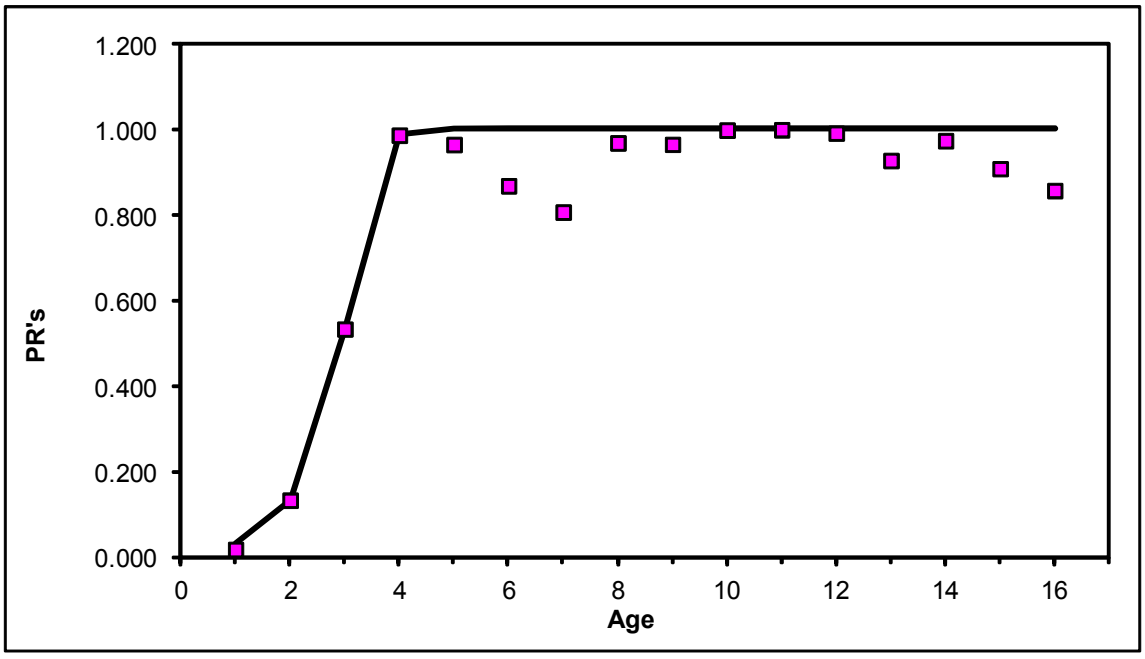


Fig. 4: PR curve for 3M American plaice

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

Age	mean weights 1988-13		og mat (%)	PR 88-13	Ref. M
	stock	catch			
1	0.016	*0.026*	0.000	0.032	0.20
2	0.076	*0.093*	0.000	0.133	0.20
3	0.178	*0.205*	0.000	0.534	0.20
4	0.311	*0.337*	0.000	0.987	0.20
5	0.450	*0.441*	0.500	1.000	0.20
6	0.578	*0.571*	1.000	1.000	0.20
7	0.675	*0.686*	1.000	1.000	0.20
8	0.767	*0.766*	1.000	1.000	0.20
9	0.836	*0.835*	1.000	1.000	0.20
10	0.906	*0.897*	1.000	1.000	0.20
11	0.965	*0.953*	1.000	1.000	0.20
12	1.016	*1.007*	1.000	1.000	0.20
13	1.124	*1.093*	1.000	1.000	0.20
14	1.210	*1.187*	1.000	1.000	0.20
15	1.343	*1.304*	1.000	1.000	0.20
16+	1.573	*1.492*	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	2443	0	1973	2,088
	0.000	2443	0	1973	1,655
	0.030	1978	50	1519	1,043
	0.060	1649	81	1200	678
	0.090	1408	101	968	449
	0.120	1226	115	795	302
F0.1	**0.163**	**1033**	**127**	**615**	**209**
	0.180	971	130	557	136
	0.210	880	134	474	89
	0.240	804	137	407	56
	0.270	741	138	351	32
	0.300	688	139	305	14
	0.330	643	140	267	1
Fmax	**0.347**	**619**	**140**	**248**	**0**
	0.360	603	140	234	-9
	0.390	569	139	206	-16
	0.420	539	139	183	-21
	0.450	512	138	162	-25
	0.480	488	138	144	-28

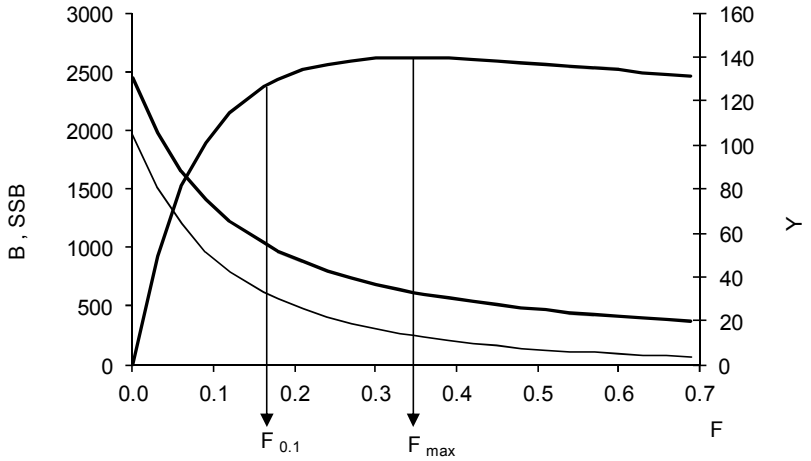


Fig.5 - Yield, B and SSB per recruit curve for 3M American plaice

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

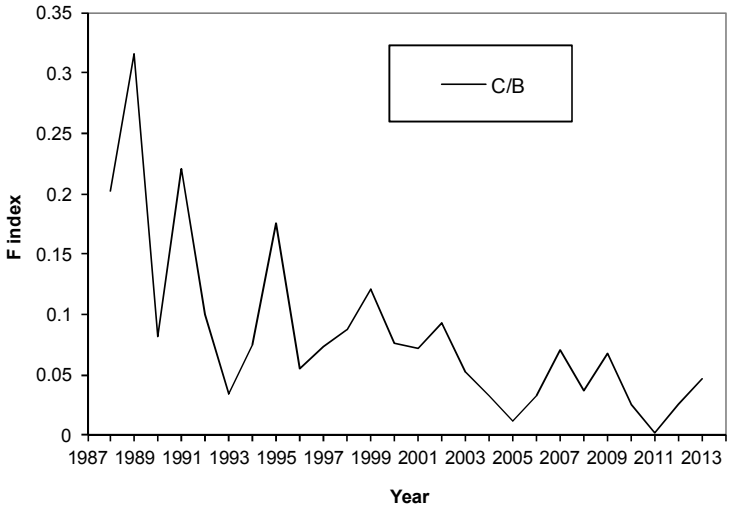


Fig. 6. Trend of the 3M American plaice F index based in EU survey.

Table 14. Evolution of Recruit ('000) and SSB ('000 tons) EU survey index during the period 1988-2013.

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
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
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
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			

(*) recruits per Kg of SSB index

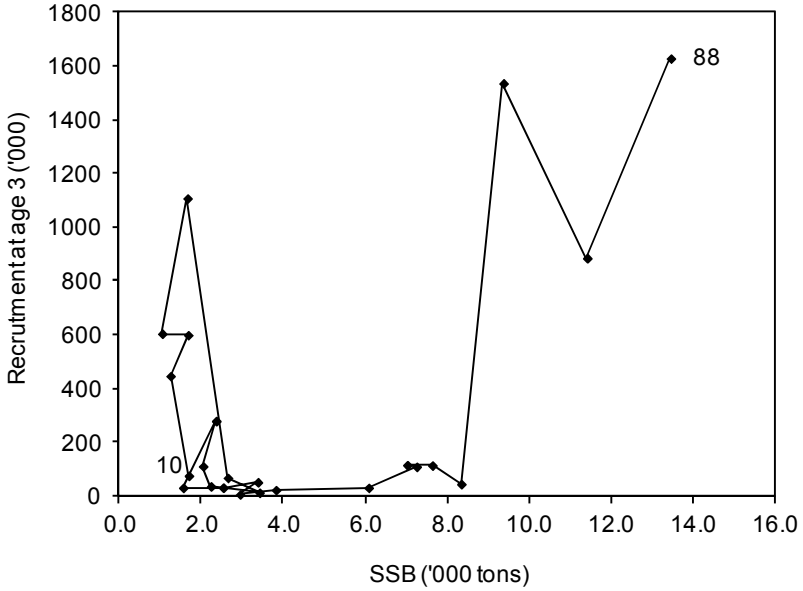


Fig. 7. SSB-Recruitment scatter plot based in EU survey series.

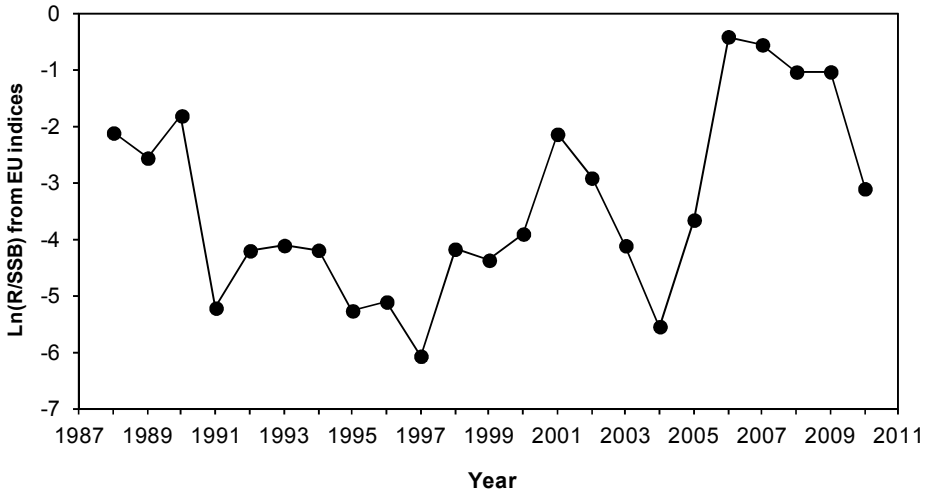


Fig. 8. Recruit at age 3 produced per kg of SSB index from EU indices.

Table 15: Lowestoft XSA input files for 3M American plaice (2014 assessment)

AMERICAN PLAICE NAFO DIVISION 3M INDEX OF INPUT FILES JUNE 2014

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 2013
1 16
5
2989.0
3966.0
922.0
2086.0
766.0
771.0
338.0
257.0
172.0
108.0
193.0
248.0
259.0
427.0
255.0
145.0
108.0
88.0
83.0
112.0
66.0
93.0
65.0
63.0
122.0
246.0

AMERICAN PLAICE NAFO 3M CATCH NUMBERS thousands

1 2
1988 2013
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

AMERICAN PLAICE NAFO 3M CATCH WEIGHT AT AGE kg

1 3
1988 2013
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	*0.093*	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	*0.093*	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	*0.093*	*0.205*	*0.337*	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	*0.093*	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	*0.093*	*0.205*	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	*0.093*	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	*0.093*	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	*0.093*	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	*0.093*	*0.205*	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	*0.093*	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	*0.093*	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	*0.093*	*0.205*	*0.337*	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	*0.093*	*0.205*	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

Table 15: cont.

AMERICAN PLAICE NAFO 3M STOCK WEIGHT AT AGE kg

1	4														
1988	2013														
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
0.01604	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
0.01604	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
0.01604	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
0.01604	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
0.01604	*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
0.01604	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
0.01604	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	*0.178*	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
0.01604	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

AMERICAN PLAICE NAFO 3M NATURAL MORTALITY

1 5
1988 2013
1 16
3
0.2

AMERICAN PLAICE NAFO 3M PROPORTION MATURE AT AGE

1	6														
1988	2013														
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	2013
1	16
3	
0.42	

AMERICAN PLAICE NAFO 3M PROPORTION OF M BEFORE SPAWNING

1	8
1988	2013
1	16
3	
0.42	

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

1	9
1988	2013
1	16
5	
0.184	
0.288	
0.074	
0.201	
0.092	
0.031	
0.069	
0.160	
0.050	
0.067	
0.079	
0.110	
0.069	
0.065	
0.085	
0.048	
0.029	
0.010	
0.030	
0.065	
0.033	
0.061	
0.023	
0.002	
0.023	
0.042	

Table 15: cont.

AMERICAN PLAICE NAFO 3M F AT AGE IN LAST YEAR

1	10														
1988	2013														
1	16														
2															
0.001	0.006	0.025	0.046	0.045	0.040	0.037	0.045	0.045	0.046	0.046	0.046	0.043	0.045	0.042	0.040

AMERICAN PLAICE NAFO 3M SURVEY TUNNING DATA

101															
EU BOTTOM TRAWL SURVEY															
1988	2013														
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

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

		XSA settings			2013						Log catchability residuals			
Run	M	first age	First tunning	First age q is indep of age	RECRUITS (first age)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 6-13	min	max	sumQua	Iterations
a4_t94 (2012 settings)	0.2	4	1994	12	7623	49651	38779	246	0.0063	0.0086	-1.7	2.1	68.4771	437
all data	0.2	1	1988	12	3064	9124	6588	246	0.0373	0.0593	-2.32	2.55	194.004	121
a4_t94_m015	0.15	4	1994	12	1383	9584	7647	246	0.0322	0.041	-1.75	1.78	61.8747	116

Fig 9. Log catchability residuals

2012set

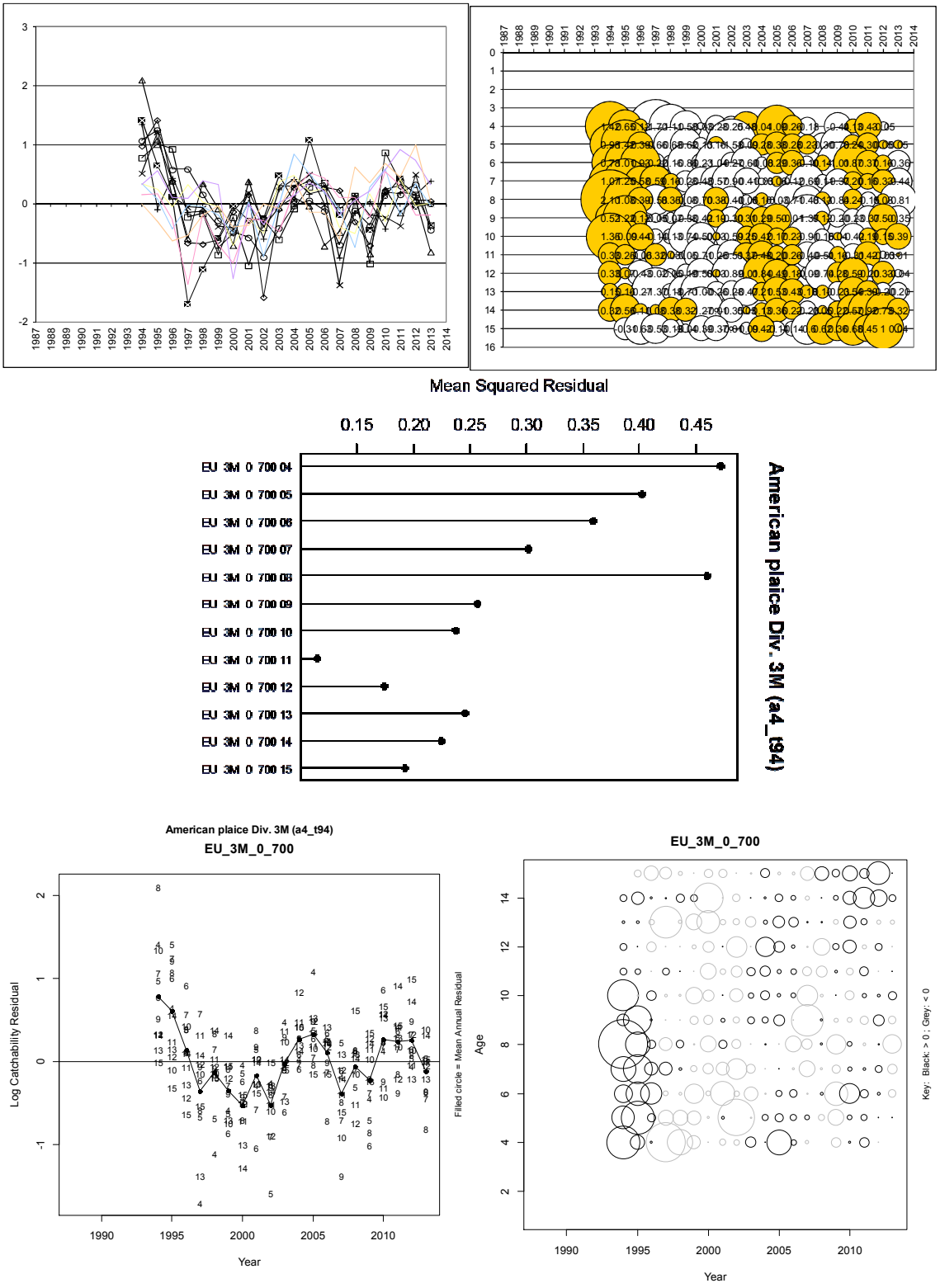


Fig 9. Cont.

All data

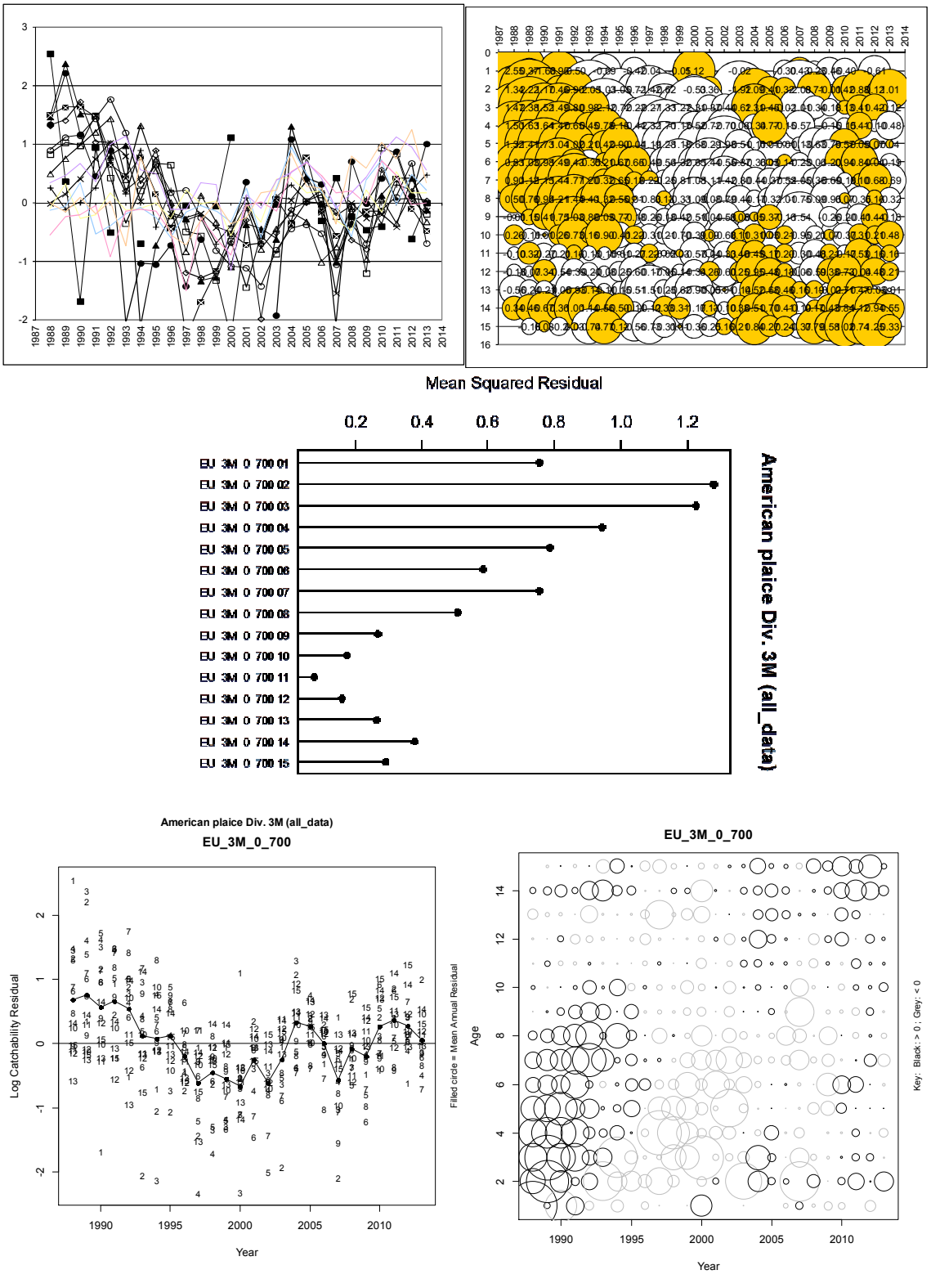
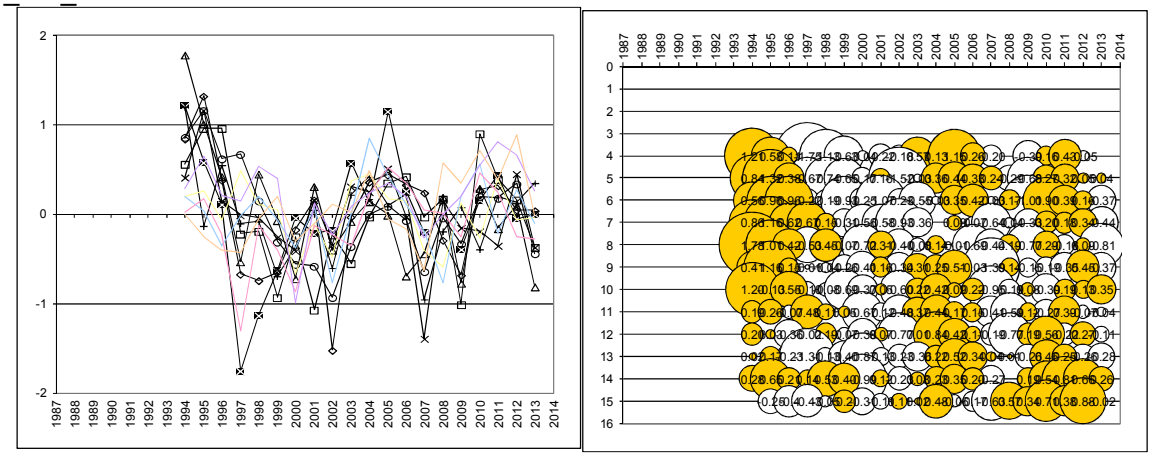
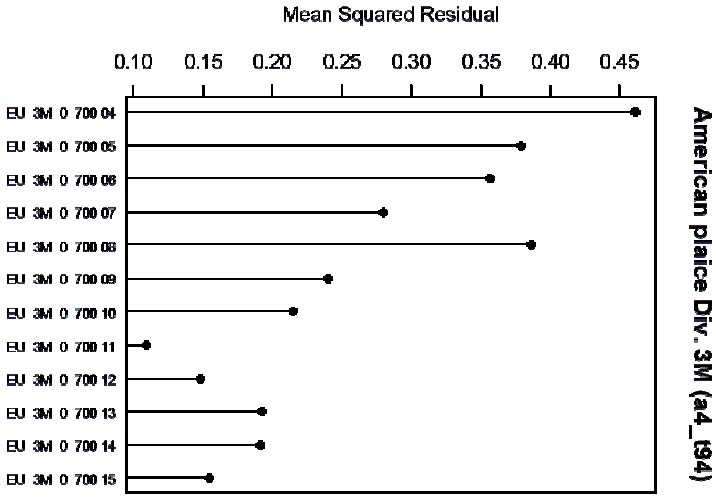


Fig 9. Cont.

a4_t94_m0.15





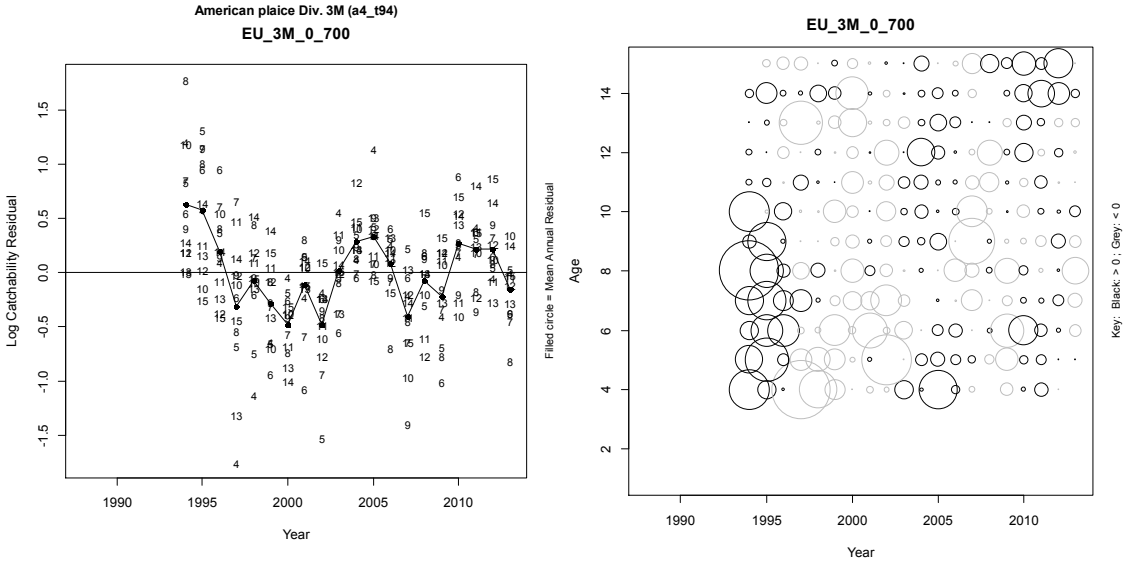


Table 17: Extended Survivor Analysis diagnostics (Lowestoft VPA Version 3.1)

AMERICAN PLAICE NAFO DIVISION 3M INDEX OF INPUT FILES JUNE 2014
CPUE data from file pla3mtun.txt

Catch data for 26 years. 1988 to 2013. Ages 4 to 16.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU BOTTOM TRAWL SURV	1994	2013	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 >= 12

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 116 iterations

Regression weights	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
4	0.007	0	0.016	0.124	0	0.001	0.005	0.024	0.006	0.056
5	0.017	0.001	0.024	0.08	0.018	0.021	0.014	0.011	0.009	0.03
6	0.014	0.003	0.024	0.066	0.029	0.013	0.047	0.006	0.016	0.022
7	0.023	0.005	0.017	0.038	0.021	0.039	0.02	0.003	0.025	0.019
8	0.026	0.004	0.018	0.035	0.034	0.03	0.036	0.002	0.026	0.013
9	0.043	0.014	0.03	0.024	0.04	0.053	0.02	0.003	0.053	0.03
10	0.054	0.015	0.059	0.033	0.034	0.117	0.017	0.004	0.034	0.077
11	0.058	0.013	0.049	0.094	0.022	0.121	0.024	0.003	0.034	0.057
12	0.084	0.024	0.042	0.128	0.02	0.103	0.069	0	0.053	0.065
13	0.042	0.035	0.063	0.113	0.045	0.094	0.064	0.002	0.034	0.046
14	0.041	0.026	0.044	0.103	0.039	0.212	0.04	0.005	0.088	0.078
15	0.05	0.022	0.028	0.06	0.073	0.149	0.059	0.005	0.071	0.062

XSA population numbers (Thousands)

YEAR \ AGE	4	5	6	7	8	9	10	11	12	13	14	15
2004	280.0	196.0	247.0	193.0	176.0	214.0	199.0	160.0	209.0	271.0	254.0	162.0
2005	393.0	240.0	166.0	210.0	162.0	148.0	176.0	162.0	130.0	165.0	224.0	210.0
2006	359.0	338.0	206.0	142.0	179.0	139.0	125.0	149.0	138.0	110.0	138.0	188.0
2007	199.0	304.0	284.0	173.0	120.0	152.0	116.0	102.0	122.0	114.0	88.5	113.0
2008	240.0	151.0	241.0	229.0	143.0	100.0	127.0	96.8	79.8	92.7	87.4	68.7
2009	943.0	206.0	128.0	202.0	193.0	119.0	82.8	106.0	81.5	67.3	76.3	72.3
2010	7410.0	810.0	174.0	108.0	167.0	161.0	97.4	63.4	80.8	63.3	52.8	53.1
2011	3920.0	6340.0	688.0	143.0	91.5	139.0	136.0	82.4	53.3	65.0	51.0	43.6
2012	2870.0	3300.0	5400.0	589.0	122.0	78.6	119.0	116.0	70.7	45.8	55.8	43.7
2013	1380.0	2450.0	2810.0	4580.0	494.0	103.0	64.1	98.9	96.9	57.7	38.2	44.0

Estimated population abundance at 1st Jan 2014

0.0	1130.0	2050.0	2370.0	3870.0	420.0	85.7	51.1	80.4	78.2	47.4	30.4

Taper weighted geometric mean of the VPA populations:

933.0	780.0	636.0	513.0	385.0	311.0	257.0	215.0	172.0	137.0	110.0	72.1

Standard error of the weighted Log(VPA populations) :

1.028	1.031	1.013	0.993	0.880	0.878	0.807	0.733	0.686	0.654	0.652	0.871

Table 17: Cont.

Log catchability residuals.
Fleet : EU BOTTOM TRAWL SURV

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
4	1.21	0.58	0.11	-1.75	-1.13	-0.63	-0.04	-0.22	-0.18	0.57
5	0.84	1.32	0.38	-0.67	-0.74	-0.65	-0.17	0.16	-1.52	-0.03
6	0.56	0.96	0.96	-0.22	-0.19	-0.93	-0.25	-1.07	-0.23	-0.55
7	0.86	1.16	0.62	0.67	0.15	-0.31	-0.56	-0.58	-0.93	-0.36
8	1.78	1.01	0.42	-0.53	0.45	-0.07	-0.72	0.31	-0.4	-0.08
9	0.41	1.16	0.15	-0.01	-0.04	-0.26	-0.41	0.16	-0.34	0.31
10	1.2	-0.13	0.55	-0.1	-0.08	-0.69	-0.37	0.05	-0.6	0.22
11	0.19	0.26	-0.07	0.48	0.11	0.05	-0.67	-0.12	-0.48	0.37
12	0.2	0.03	-0.36	-0.02	0.19	-0.07	-0.38	0.07	-0.77	0.01
13	0.02	0.17	-0.23	-1.31	-0.13	-0.4	-0.87	-0.13	-0.23	-0.36
14	0.28	0.65	0.21	0.14	0.53	0.4	-0.99	0.12	-0.23	0.08
15	0	-0.25	-0.4	-0.43	-0.05	0.2	-0.31	-0.11	0.11	0.02

Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
4	0.13	1.15	0.26	-0.2	99.99	-0.39	0.16	0.43	-0.05	0
5	0.36	0.44	0.33	0.24	-0.29	-0.68	0.27	0.32	0.05	0.04
6	-0.03	0.35	0.42	-0.03	0.17	-1.01	0.9	0.39	0.16	-0.37
7	0	0.09	-0.07	-0.64	-0.04	-0.33	0.2	0.18	0.34	-0.44
8	0.14	-0.01	-0.69	-0.44	0.19	-0.77	0.29	-0.16	0.09	-0.81
9	0.25	0.51	-0.03	-1.39	0.14	-0.15	-0.19	-0.35	0.45	-0.37
10	0.42	0.09	0.22	-0.95	-0.19	0.08	-0.39	0.19	0.13	0.35
11	0.44	0.17	0.15	-0.41	-0.59	0.12	-0.27	0.39	-0.07	-0.04
12	0.84	0.42	0.11	-0.19	-0.77	0.19	0.56	-0.22	0.27	-0.11
13	0.22	0.52	0.34	0.04	0.01	-0.26	0.46	0.25	-0.26	-0.28
14	0.23	0.35	0.2	-0.27	0	0.19	0.54	0.81	0.66	0.26
15	0.48	-0.06	-0.17	-0.63	0.57	0.34	0.71	0.38	0.88	-0.02

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	-10.6447	-10.4368	-9.9831	-9.7799	-9.6344	-9.2623	-9.1091	-9.0154	-8.9284	-8.9284	-8.9284	-8.9284
S.E(Log q)	0.698	0.633	0.6132	0.5424	0.638	0.5031	0.4764	0.3405	0.3946	0.4511	0.4491	0.4033

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	0.886	10.16	0.76	19	0.62	-10.64
5	0.81	1.782	9.69	0.84	20	0.49	-10.44
6	0.88	0.981	9.54	0.79	20	0.54	-9.98
7	0.86	1.25	9.25	0.82	20	0.46	-9.78
8	0.77	1.618	8.74	0.74	20	0.47	-9.63
9	0.9	0.667	8.89	0.72	20	0.46	-9.26
10	1.11	-0.595	9.54	0.6	20	0.54	-9.11
11	1.04	-0.271	9.17	0.73	20	0.36	-9.02
12	1.04	-0.209	9.07	0.65	20	0.42	-8.93
13	0.94	0.322	8.81	0.65	20	0.42	-9.05
14	1.19	-1.049	9.49	0.63	20	0.47	-8.72
15	1.21	-1.309	9.8	0.68	20	0.47	-8.87

Table 17: Cont.

Terminal year survivor and F summaries :

Age 4 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 BOTTOM TRAWL SURV	1126	0.716	0	0	1	1	0.056

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1126	0.72	0	1	0	0.056

Age 5 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 BOTTOM TRAWL SURV	2050	0.481	0.046	0.1	2	1	0.03

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2050	0.48	0.05	2	0.097	0.03

Age 6 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 BOTTOM TRAWL SURV	2371	0.382	0.227	0.59	3	1	0.022

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2371	0.38	0.23	3	0.595	0.022

Age 7 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 BOTTOM TRAWL SURV	3866	0.315	0.182	0.58	4	1	0.019

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3866	0.31	0.18	4	0.578	0.019

Age 8 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 BOTTOM TRAWL SURV	420	0.284	0.238	0.84	5	1	0.013

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
420	0.28	0.24	5	0.84	0.013

Age 9 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 BOTTOM TRAWL SURV	86	0.265	0.254	0.96	5	1	0.03

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
86	0.27	0.25	5	0.96	0.03

Table 17: Cont.

Age 10 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 BOTTOM TRAWL SURV	51	0.223	0.188	0.84	7	1	0.077

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
51	0.22	0.19	7	0.844	0.077

Age 11 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 BOTTOM TRAWL SURV	80	0.204	0.092	0.45	8	1	0.057

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
80	0.2	0.09	8	0.449	0.057

Age 12 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	78	0.189	0.138	0.73	9	1	0.065

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
78	0.19	0.14	9	0.73	0.065

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 12
Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	47	0.177	0.12	0.68	10	1	0.046

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
47	0.18	0.12	10	0.679	0.046

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 12
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	30	0.167	0.087	0.52	11	1	0.078

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
30	0.17	0.09	11	0.52	0.078

Age 15 Catchability constant w.r.t. time and age (fixed at the value for age) 12
Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	36	0.159	0.161	1.01	12	1	0.062

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
36	0.16	0.16	12	1.009	0.062

Table 18: Extended Survivor Analysis results.

YEAR	RECRUITS Age 4 (Thousands)	TOTAL BIOMASS (Tonnes)	SPAWNING BIOMASS (Tonnes)	FBAR 6-13	FBAR 8-11
1988	2975	12114	8680	0.3173	0.3157
1989	1780	9557	6487	0.5309	0.5205
1990	2679	6453	4778	0.1505	0.1285
1991	1509	5963	3990	0.4150	0.4440
1992	1690	5159	3748	0.2255	0.3120
1993	1940	4780	3584	0.0576	0.0665
1994	2874	5815	3979	0.1515	0.1974
1995	1888	5740	3770	0.3082	0.3304
1996	1045	4394	3354	0.0739	0.0759
1997	616	4054	3416	0.0706	0.0779
1998	622	4009	3397	0.0887	0.0937
1999	534	3846	3230	0.0837	0.1015
2000	392	3044	2624	0.0508	0.0496
2001	317	2610	2257	0.0678	0.0808
2002	343	3025	2634	0.0671	0.0784
2003	229	2227	1919	0.0517	0.0631
2004	280	2194	1901	0.0431	0.0455
2005	393	2400	2084	0.0140	0.0115
2006	359	1736	1417	0.0377	0.0389
2007	199	1502	1226	0.0664	0.0465
2008	240	1592	1406	0.0307	0.0326
2009	943	1371	1001	0.0713	0.0803
2010	7408	3690	1189	0.0371	0.0243
2011	3925	5918	2886	0.0030	0.0030
2012	2868	7668	5408	0.0346	0.0370
2013	1383	9584	7647	0.0410	0.0442

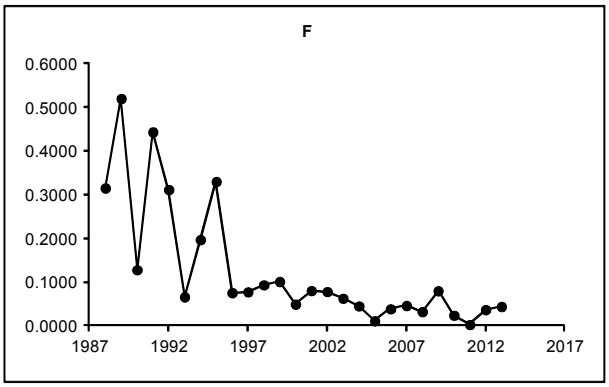


Fig.10 A. Extended Survivor Analysis results for F (age 8-11)

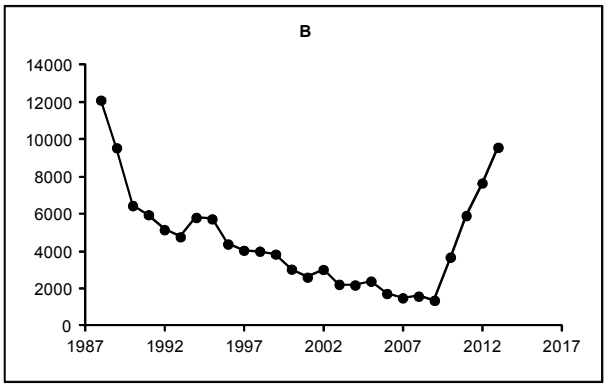


Fig. 10 B. Extended Survivor Analysis results for 4+ biomass (tons)

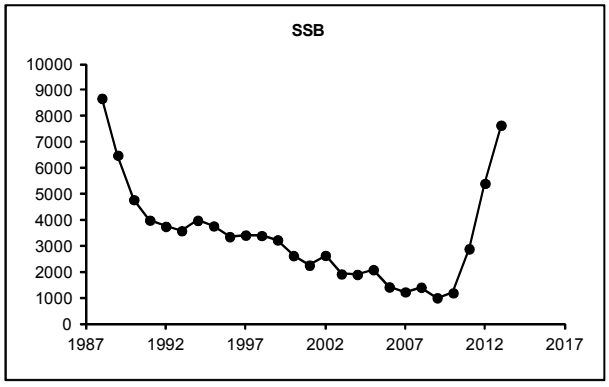


Fig. 10 C: Extended Survivor Analysis results for spawning biomass (tons)

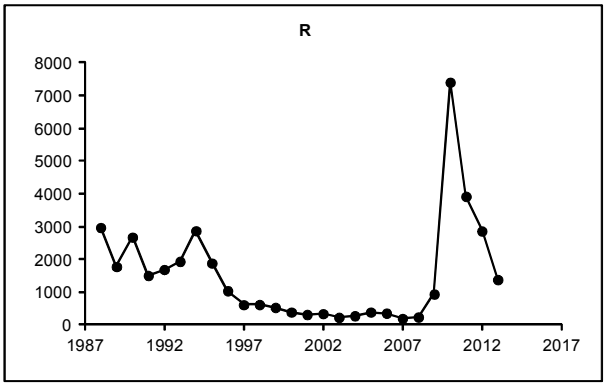


Fig.10 D: Extended Survivor Analysis results for recruits at age 4 ('000)

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	11542	11185	11954	9298	9031	9605	2361	2152	2627	0.318	0.309	0.327
1989	9007	8730	9338	7350	7152	7583	2252	2031	2532	0.532	0.514	0.548
1990	5606	5379	5875	4220	4073	4393	2438	2174	2776	0.155	0.150	0.161
1991	5081	4878	5322	3749	3629	3892	3637	3313	4051	0.404	0.389	0.417
1992	4141	3941	4383	2954	2835	3096	2015	1795	2300	0.262	0.250	0.273
1993	3720	3534	3946	2538	2430	2669	1115	979	1295	0.073	0.069	0.076
1994	4062	3872	4296	2800	2684	2936	713	615	839	0.188	0.179	0.196
1995	3865	3677	4093	2881	2759	3029	708	607	840	0.466	0.436	0.492
1996	2613	2444	2824	2054	1930	2209	649	562	768	0.126	0.117	0.134
1997	2212	2062	2397	1887	1766	2037	444	382	525	0.113	0.105	0.120
1998	2175	2032	2350	1877	1760	2021	314	262	385	0.165	0.151	0.180
1999	1976	1839	2143	1697	1583	1833	327	279	389	0.160	0.145	0.175
2000	1485	1377	1615	1298	1207	1409	214	176	268	0.105	0.096	0.114
2001	1213	1122	1322	1061	983	1154	242	190	314	0.137	0.125	0.149
2002	1297	1192	1420	1160	1069	1269	342	271	446	0.118	0.108	0.129
2003	932	853	1024	821	751	902	361	286	462	0.106	0.095	0.117
2004	920	834	1021	768	693	854	211	164	279	0.087	0.078	0.097
2005	863	774	975	711	631	810	169	121	237	0.028	0.024	0.032
2006	762	693	844	585	532	648	492	318	766	0.066	0.060	0.073
2007	771	701	856	587	535	648	3487	2098	5755	0.140	0.126	0.153
2008	957	820	1138	605	537	684	1724	1041	2995	0.053	0.047	0.058
2009	1205	978	1544	481	432	542	1353	747	2460	0.135	0.121	0.150
2010	1545	1218	2024	468	411	540	986	491	1984	0.080	0.071	0.090
2011	2017	1555	2710	958	756	1278	408	253	754	0.024	0.018	0.032
2012	2384	1815	3196	1631	1191	2322	538	186	1373	0.080	0.069	0.094
2013	2766	2086	3722	2114	1546	2971	494	144	1612	0.170	0.135	0.228
2014				1986	1384	2914						

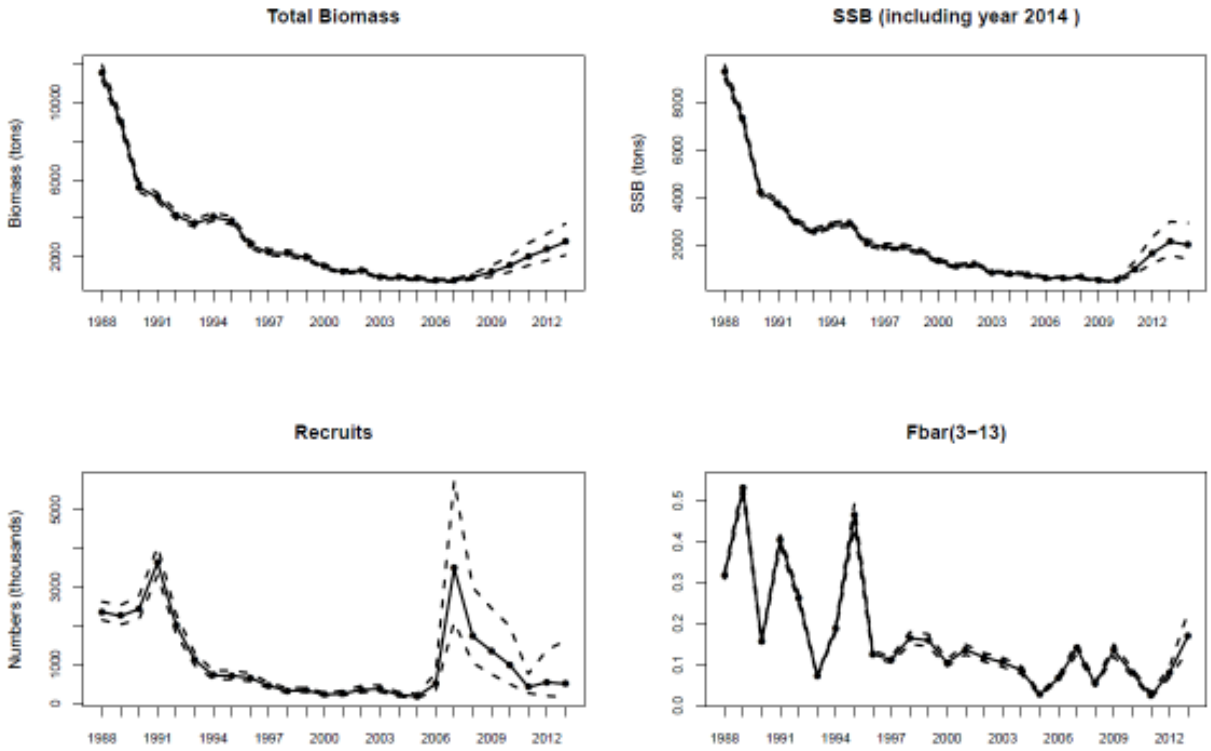


Fig.11: VPA type Bayesian model results with the 90 confidence intervals (recruits at age 1)

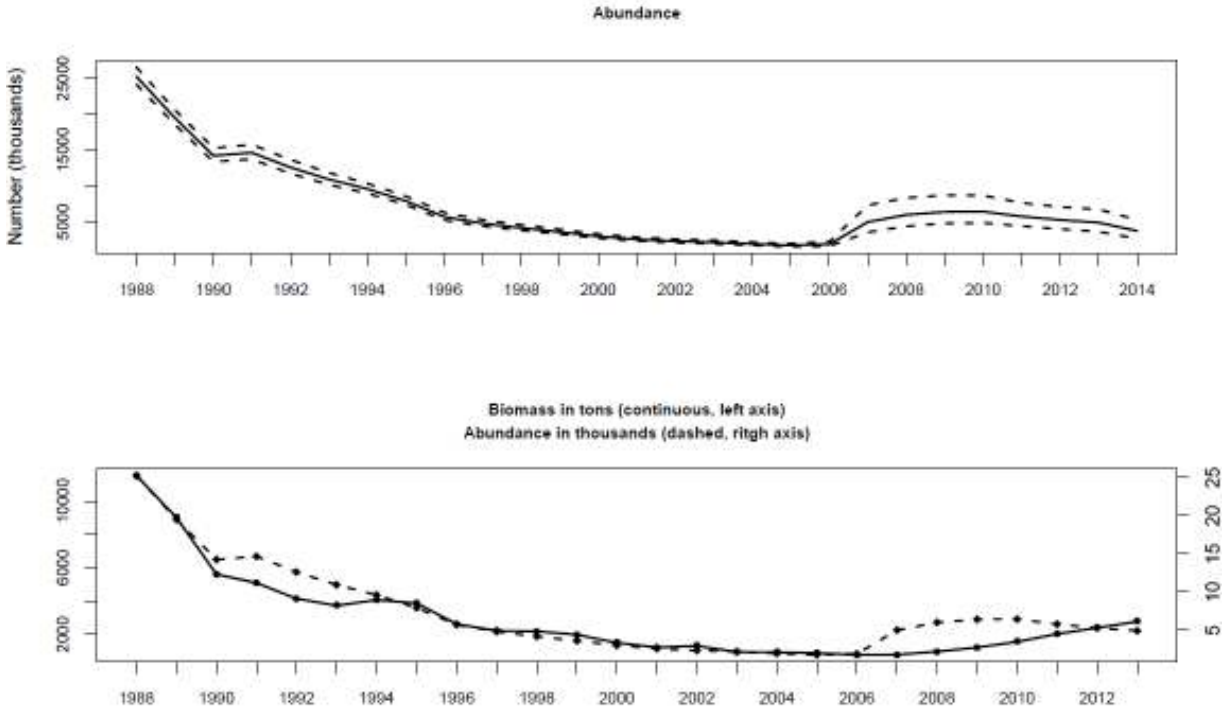


Fig.12: VPA type Bayesian model: trends in the Abundance and biomass.

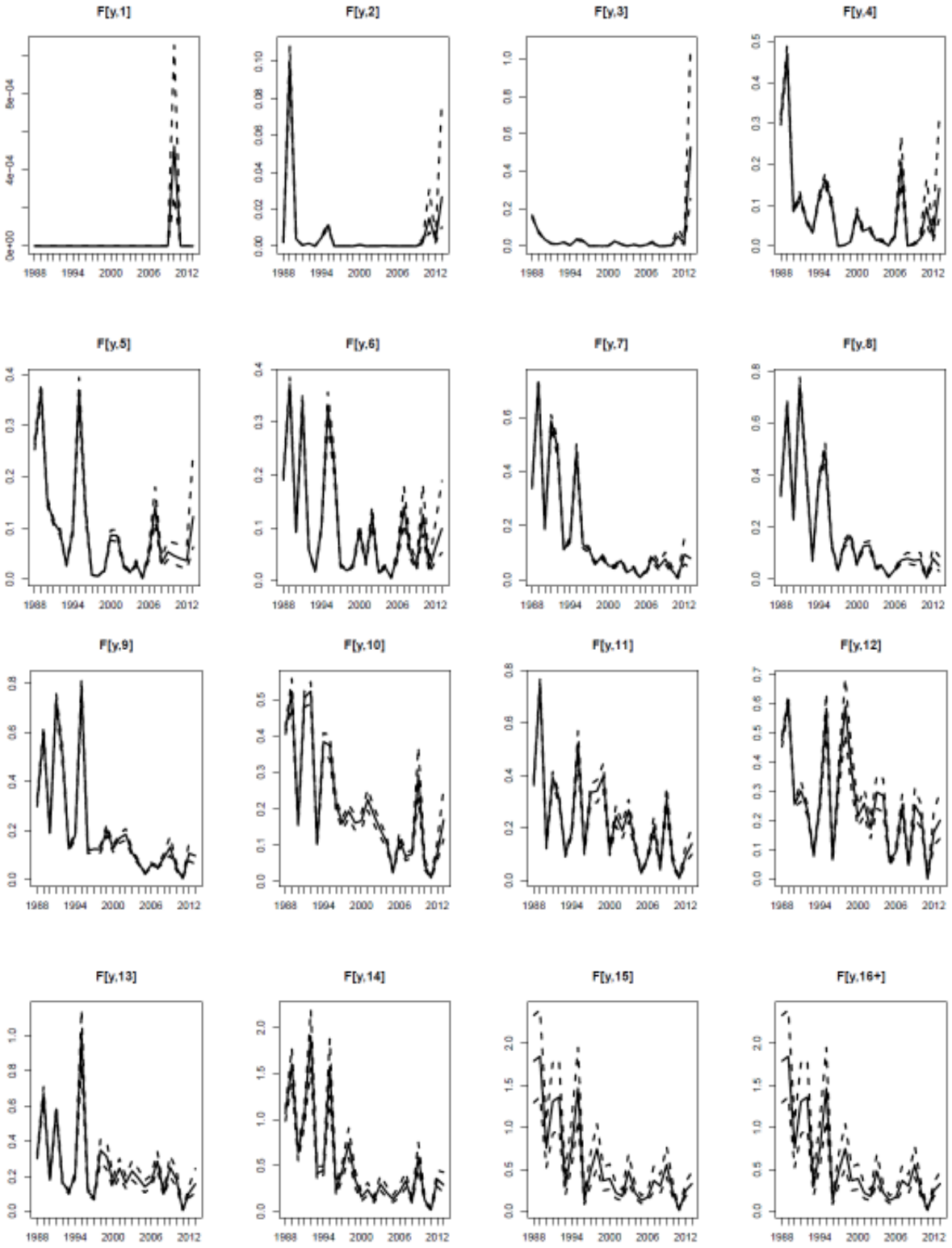


Fig.13: VPA type Bayesian model results: Estimated fishing mortality at age.

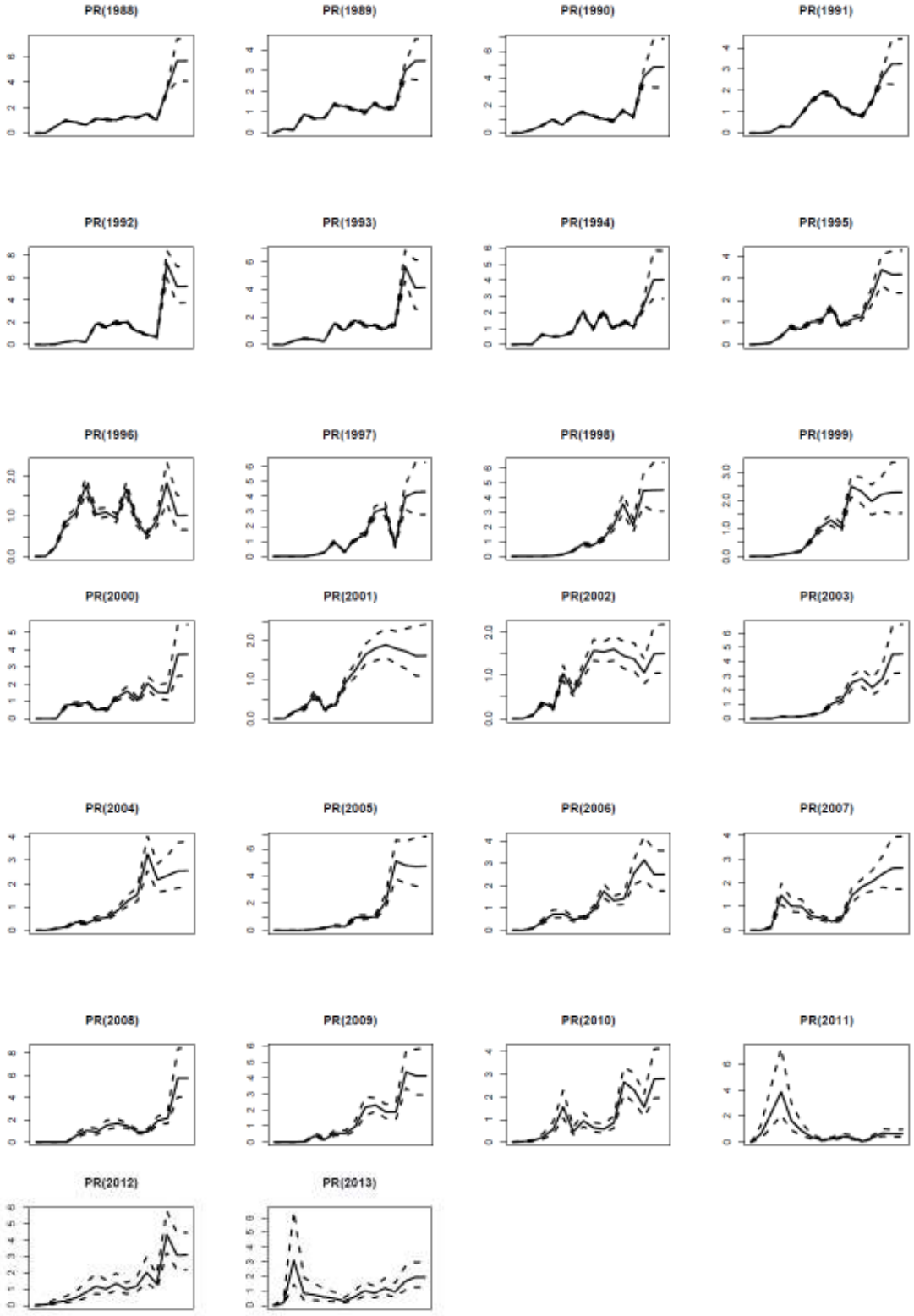


Fig.14: VPA type Bayesian model results: Estimated PR(F/Fbar) per age and year.

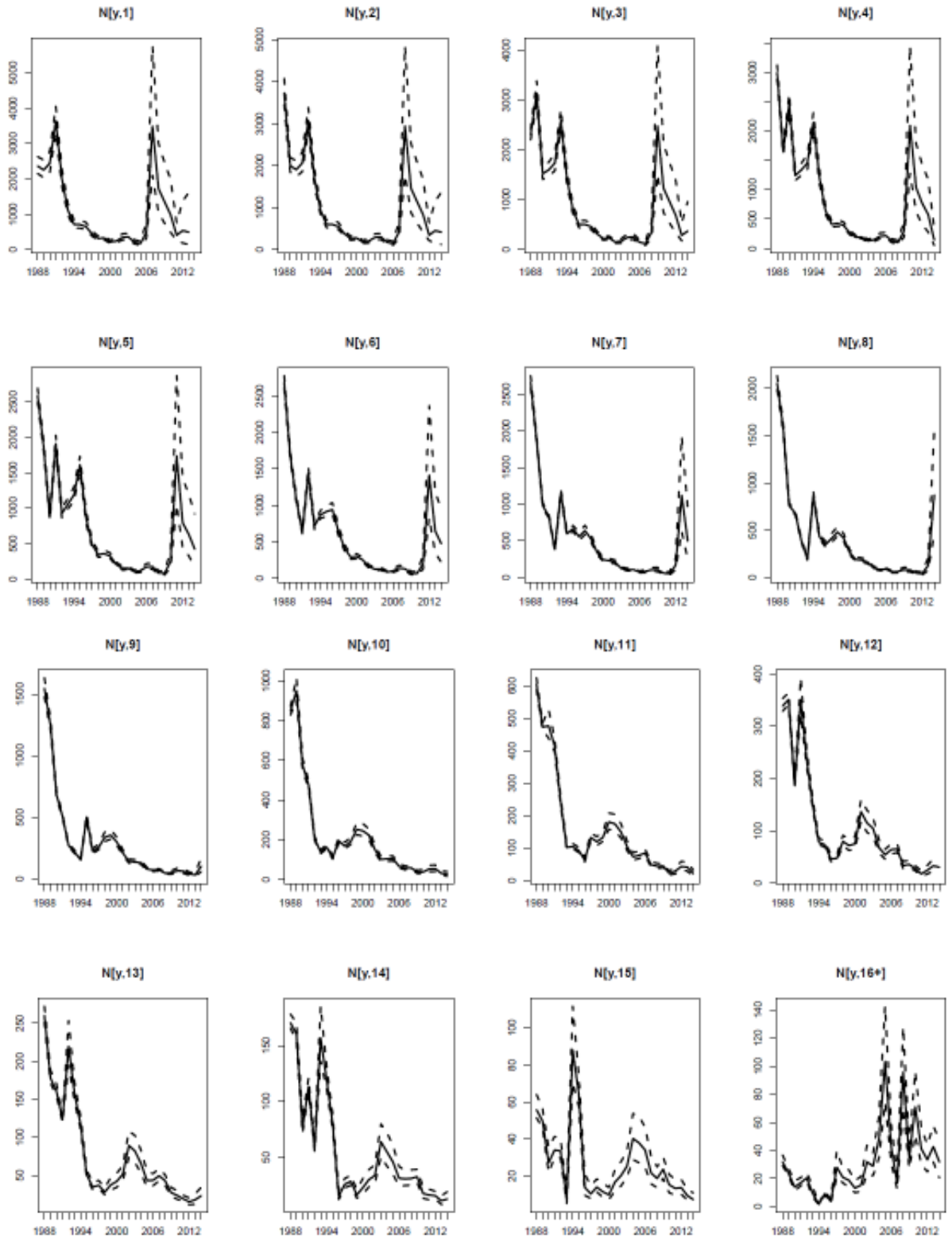


Fig.15: VPA type Bayesian model results: Estimated numbers at age.

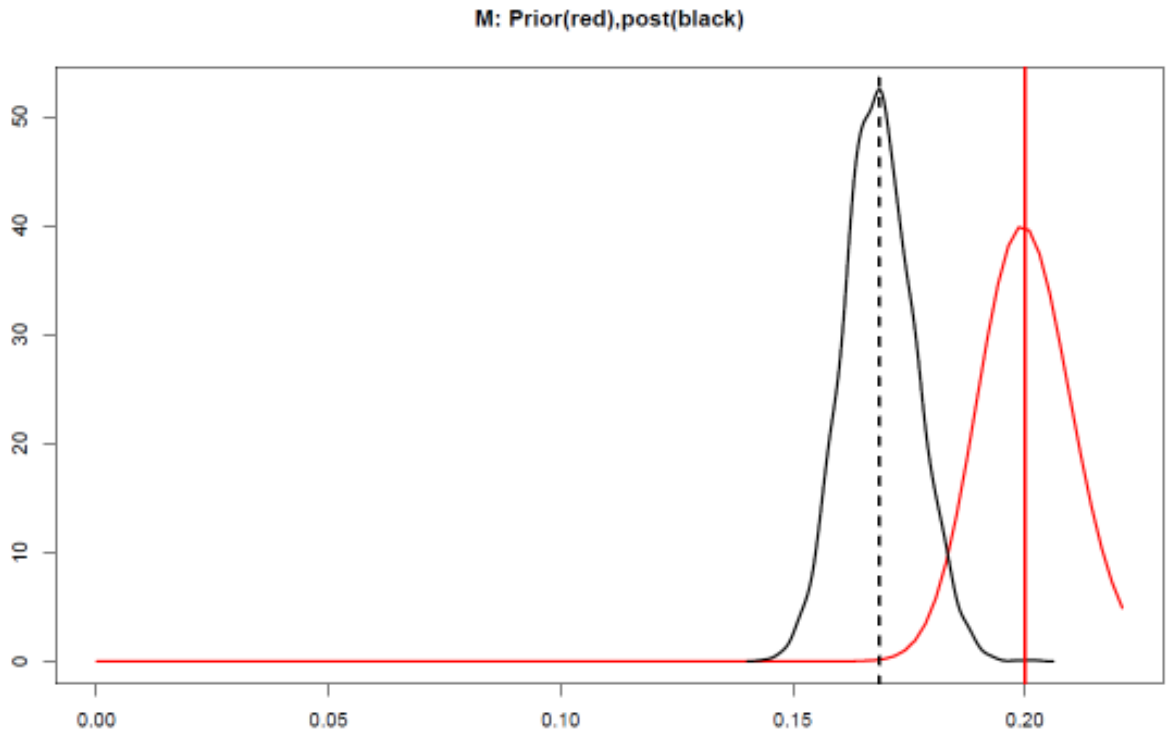


Fig.16: VPA type Bayesian model results: Estimated natural mortality.

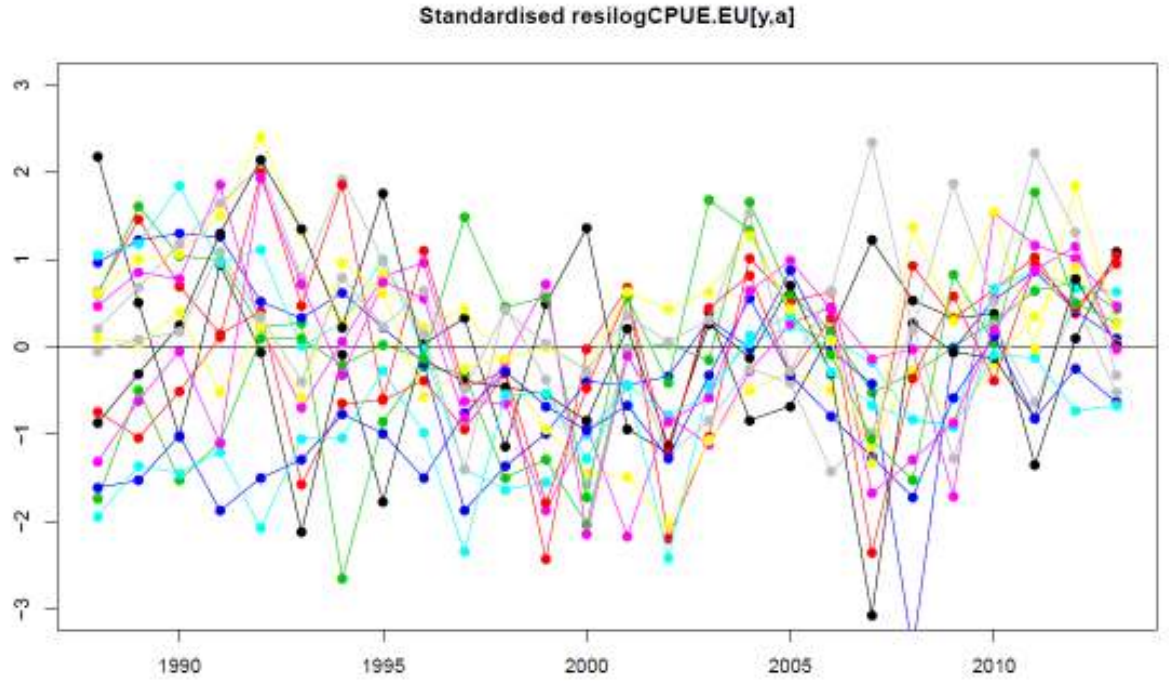


Fig.17: VPA type Bayesian model results: Standardised residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices by age.

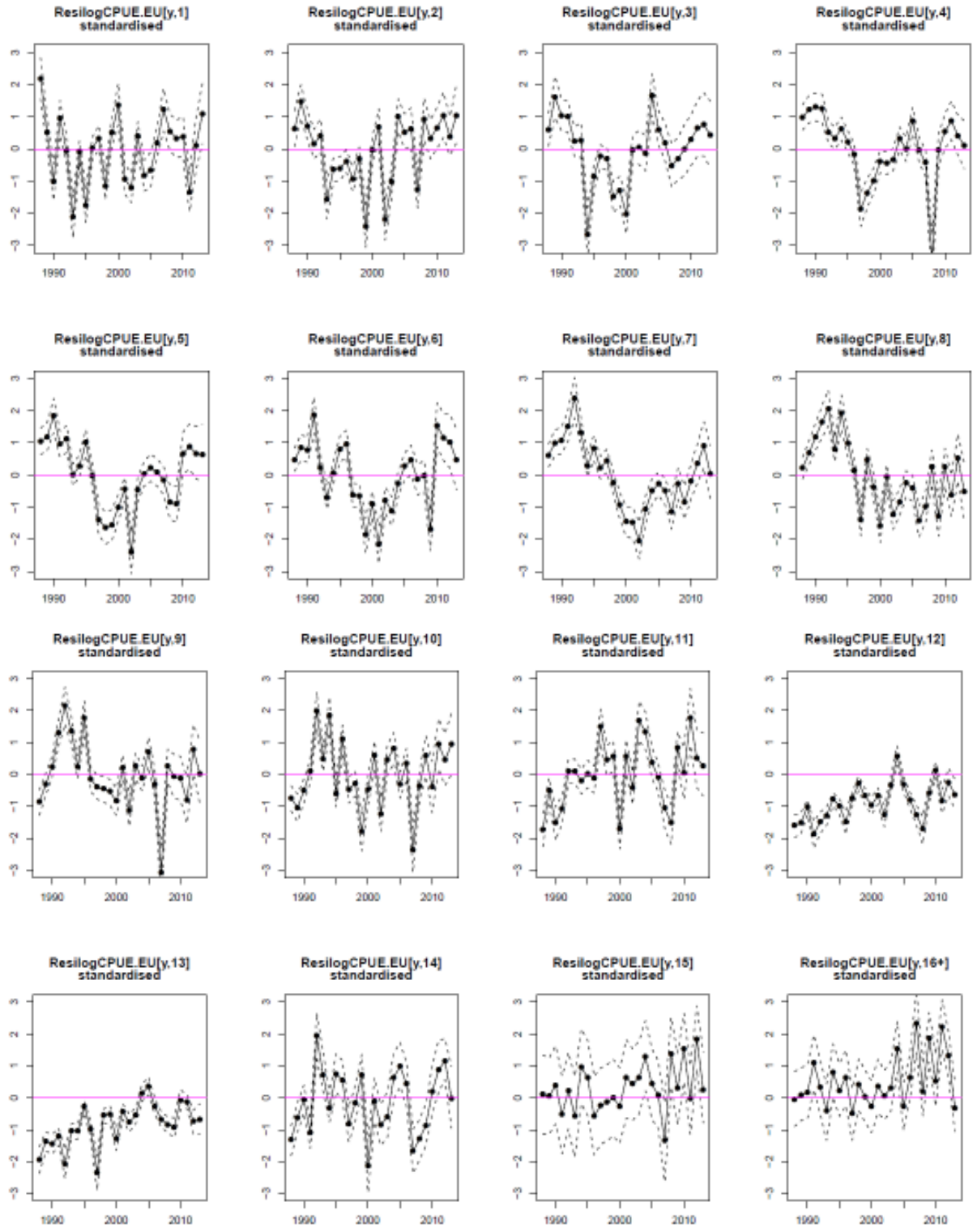


Fig.18: VPA type Bayesian model results: Standardised residuals (observed minus fitted value) in logarithmic scale of EU survey abundance indices by age.

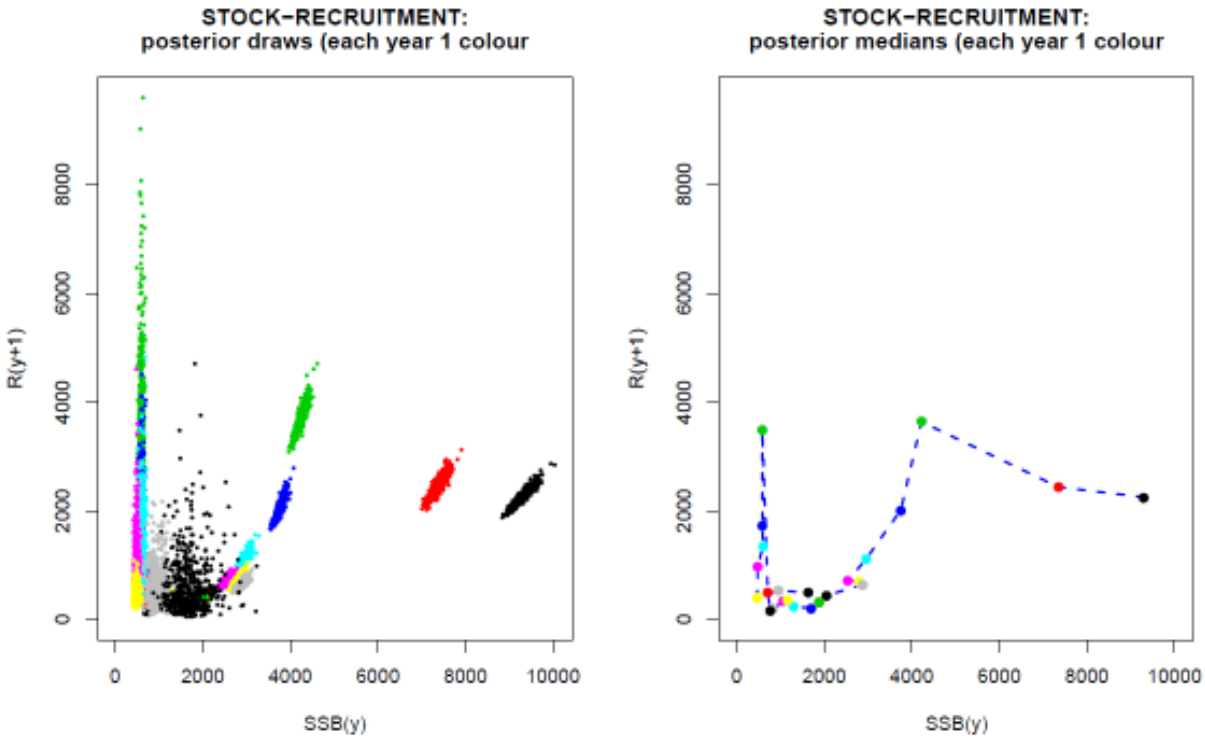


Fig.19: VPA type Bayesian model results: Stock- Recruitment plots.

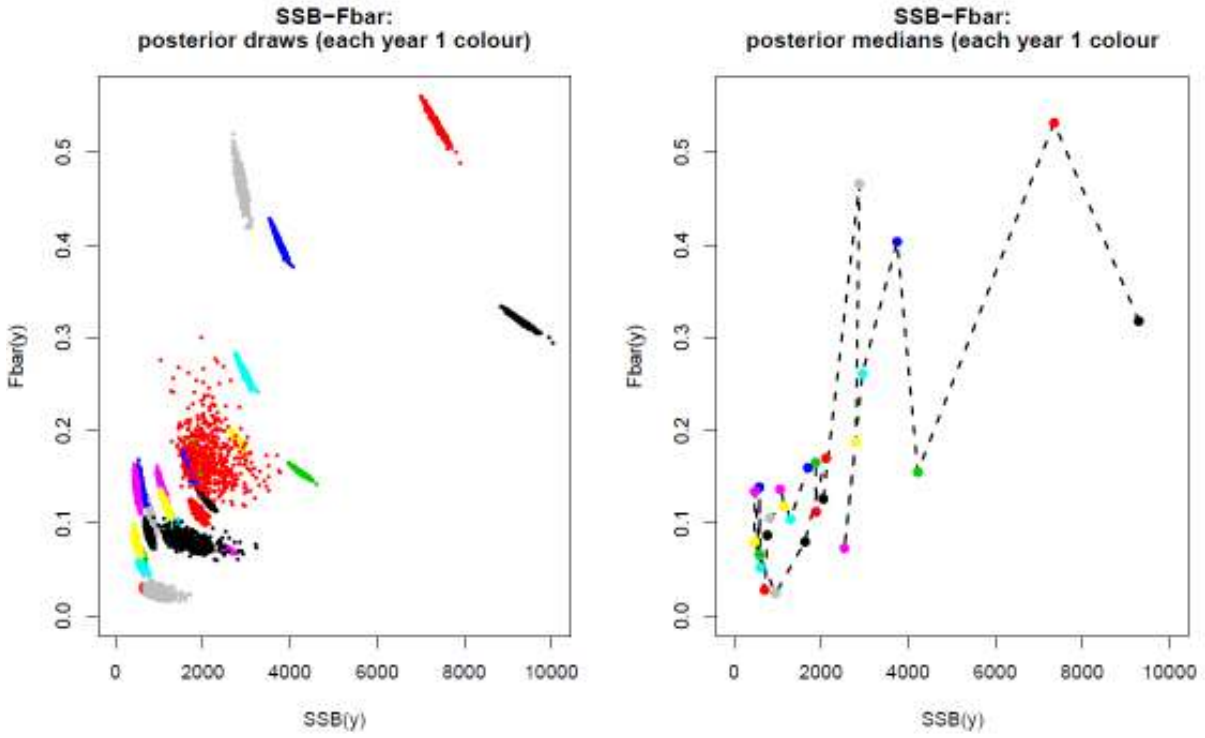


Fig.20: VPA type Bayesian model results: Fbar versus SSB plots.