Northwest Atlantic　　Fisheries Organization

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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 Division 3M American plaice stock. The catch at age matrix, EU survey abundance at age and the respective mean weights were updated. Both surveys and XSA estimated declines to very low values for abundance, biomass and SSB. Both F index (C/B ratio from the EU survey) and XSA fishing mortality were within 0.05 and 0.2 over the last years. There are no changes in the perception of the stock status from last assessment (2002). This stock continues to be in a very poor condition, with only weak year-classes recruiting to SSB for the next five years at least. Although the level of catches is low since 1996, this stock has been kept at a very low level with no sign of recovery.

Introduction

Catch trends and TAC regulation

On Flemish Cap American plaice mainly occurs at depths shallower than 600 m.

In the early-1960's catches were relatively low with the exception of 1961. 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. Catch for 2003 was estimated to be 131 tons (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 last assessment (Alpoim *et al.,* 2002 - SCR 02/62) and in the last update (Alpoim, 2003 - SCR 03/44) of the status of the stock several historical survey data were analised, these analysis is resume in Fig 3. During 2003 only EU-Spain/Portugal survey was conducted. This was the only survey updated and used in this assessment.

EU-Spain/Portugal Survey (1988-2003) (Casas 2004 - SCR Doc 04/21) (Casas, pers. comm. 2004)

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.

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. From the 114 valid hauls made by the VE to cover the nineteen Flemish Cap strata down to 730m, 59 were valid calibration hauls made with the CS. Both vessels were fishing with the same gear, which remained unchanged throughout the series. The calibration between the old and new RV's of the Flemish Cap EU survey will be completed next July 2004 with 10 days of simultaneous and parallel hauls, to consolidate the coverage of the strata of the bank deeper than 250m. In 2003 the survey was extended to 1100 metres depth, but no American plaice was found in these grounds.

Because the calibration is not yet finished this assessment is done with the 2003 survey results from the RV "Vizconde de Eza", without conversion to RV "Cornide de Saavedra" units. The data converted to the RV "Cornide de Saavedra" units by the adjustment of the Warren model (Warren, 1997) are presented in the input data tables just for information.

Biomass and abundance estimates

Estimates for biomass and abundance are presented in Table2 and Fig. 3.

Length composition of the stock.

Length compositions from 1988 to 2003 were given by the EU survey (Casas, *pers. comm.* 2004). (Table 3)

Length weight relationships

Length weight relationships for the 3M American plaice (1988-2003) were calculated with EU survey length/weight data from both males and females (Casas, *pers. comm.*, 2004) 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.

The age-length keys used in 2003 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 1988-2003 (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 criteria 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.

<div align="center">

Commercial Data

</div>

Length composition of the commercial catch and by-catch

The length composition presented in the 2003 Portuguese national report (Vargas *et al.*, 2004) was used to estimate the length composition of the 2003 total catch. From this length distribution a mean weight in the catch was derived in order to transform the correspondent catch in weight into a catch number. The length composition presented in the 2003 Spanish national report (Gonzalez *et al.*, 2003) was not used due to the very small number of fish sampled. 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.

The breakdown of the total catch is presented in Table 7. The commercial catch at length matrix (Alpoim, 2003) was updated with the 2003 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 1988-2003 (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 1988-2003 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 11. 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 1972 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. The 2000 abundance and biomass were the lowest of this series (1 204 tons and 1.6 millions fishes) and improved little since then. Results of the 1996 Canadian survey are comparable with the 1996 EU survey. (Fig. 3). (Alpoim *et al.*, 2002 and Alpoim, 2003)

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). This index fall to a minimum in 1993 and since then fluctuates around 0.1. In 2003 this index declined again to 0.05 (Table 13 and Fig. 6).

Age 12, corresponding to the 1991 year-class, was the best represented in the 2003 EU survey (Table 5). Since 1991, all the recruiting year-classes were poorly represented in the EU survey. Survey spawning biomass is declining as well since 1988 reaching a minimum in 2000 and remaining at a very low level in 2003.

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. Only 13 points are available, showing very poor recruitment for an SSB less than 7 000 tons. (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. Two different periods can be shown in this figure, one before 1991 and the other from 1991 onwards. During the first period, an average of 0.136 recruits at age 3 were produced per Kg of SSB, while in the second period this average was reduced to only 0.014 recruits per Kg of SSB (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 give a very low figures for American plaice (Kulka, 1999).

Mean weights-at-age in the catch showed a moderate decreasing trend from 1988 to 2003 for ages older than 8 (Tab. 10).

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 $F_{max} = 0.355$ (Tab. 12, Fig. 5).

XSA

An XSA was performed using the Lowestoft VPA Suite (Darby and Flatman, 1994). The input files for XSA analysis are presented in Table 15. Natural mortality was assumed constant at 0.2. 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 2003. The survey biomass can be considered representative of the mean annual biomass (EU survey is conducted around the middle of the year). The 2003 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 1988-2003 the selection at age 15 was multiplied by the F index of each year. The rest of the data were already described above. Several XSA frameworks have been tested, and the adopted in this assessment has the following settings:

- No year weights were applied, due to the short time series.
- Age 10 was considered to be the first age at which q is independent of age.
- A shrink survivor estimates with a mean F for the last 5 years and the 5 older true ages was used.

- The Log (S.E.), for the F means to which the estimates are shrunk, was 1.0.
- The earliest year to be used for tuning the VPA was 1994.
- Minimun Log (S.E.) for the terminal population estimates derived from each fleet (Threshold se) was 0.5.

The XSA diagnostics and the plot of the log catchability residuals are presented in Table 16 and in Fig. 9. The XSA outputs are presented in Table 17 and in Fig. 10.

Biomass and spawning stock biomass show a steady decline in the recent years to very low levels. Since 1991 recruitment is kept at a very low level. The rate of exploitation has been relatively constant in recent years at levels close to the assumed natural mortality.

Conclusions

All results 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 same trends are in the XSA results, ending at a very low biomass and SSB on the terminal year.

Indices from the EU survey and XSA indicates no sign of recruitment since 1991 with only weak year-classes expected to be recruited to the SSB within at least five years.

F estimates from the XSA (age 8-11) have been relatively constant in recent years at levels close to the natural mortality (0.2). EU survey F index (age 8-11) is stable at around 0.1 since 1993.

Stock status

This stock continues to be in a very poor condition, with only weak year-classes expected to be recruit to the SSB on the next five years. Although the level of catches since 1996 is low, all the analysis indicates that this stock is kept at a very low level with no sign of recovery.

Acknowledgements

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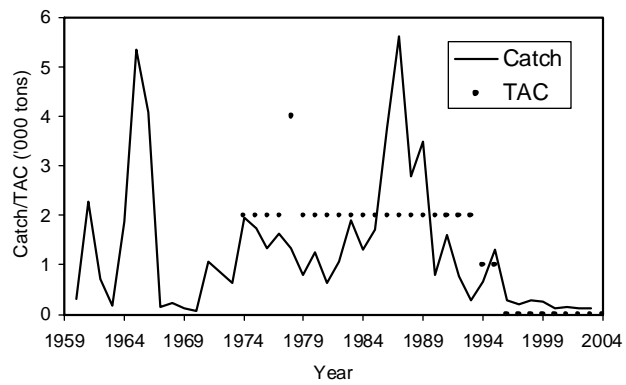
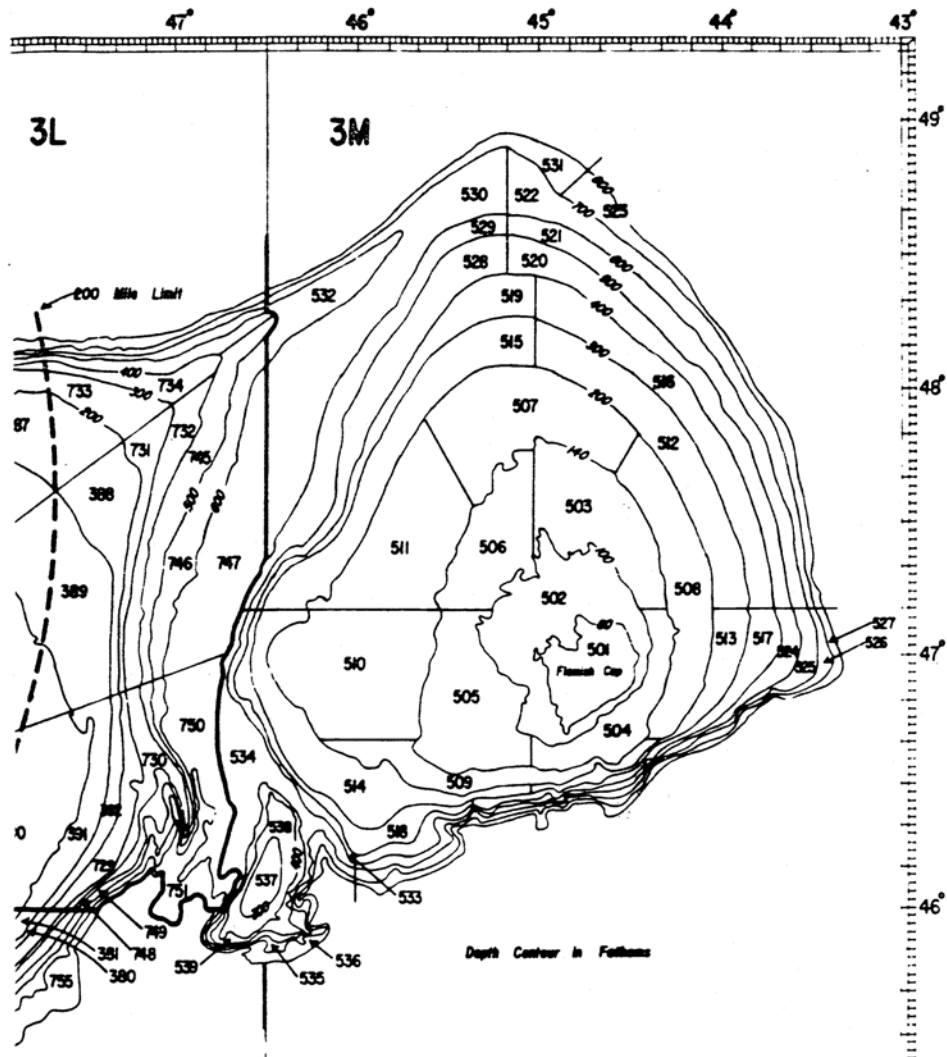Fig.1 . American plaice in Div.3M: nominal catches and agreed TAC's

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

TABLE 1 - Nonimal catches (t) from 1960-2003, Stacfis estimates (t) from 1988-2003 and TAC (t) from 1974-2004 of American plaice from NAFO Division 3M.

Year	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	0	316		
1961	-	-	-	-	-	-	-	-	-	0	2282	0	2282		
1962	14	-	-	-	-	-	-	-	-	14	707	0	721		
1963	-	-	51	108	-	20	-	-	-	179	0	0	179		
1964	-	-	1831	8	-	37	-	-	-	1876	0	0	1876		
1965	19	-	4964	216	-	83	-	-	2	5284	57	0	5341		
1966	-	-	4003	17	-	53	-	-	-	4073	0	0	4073		
1967	57	-	-	63	-	33	-	-	1	154	0	0	154		
1968	100	-	121	-	-	4	-	-	-	225	6	0	231		
1969	12	-	113	-	-	-	-	-	-	125	0	0	125		
1970	-	-	62	-	-	-	-	-	-	62	17	0	79		
1971	-	-	1079	-	-	-	-	-	-	1079	0	0	1079		
1972	-	-	665	8	17	65	-	-	106	861	0	0	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	0	137	1329		2000
1977	30	-	987	7	18	-	457	1	118	1618	0	10	1628		2000
1978	7	49	581	21	36	2	486	100	51	1333	3	0	1336		4000
1979	10	63	457	2	16	-	248	-	-	796	4	0	800		2000
1980	1	1	909	5	3	-	232	34	-	1185	64	0	1249		2000
1981	-	47	309	-	276	-	-	-	-	632	0	0	632		2000
1982	-	53	1002	-	17	-	-	-	-	1072	3	0	1075		2000
1983	-	9	1238	-	434	-	208	-	-	1889	3	0	1892		2000
1984	-	1	711	-	204	-	196	190	-	1302	1	0	1303		2000
1985	-	2	971	-	163	-	266	318	-	1720	0	0	1720		2000
1986	-	3	962	-	1048	-	1741	-	-	3754	0	3	3757		2000
1987	-	-	501	-	4137	-	969	-	-	5607	20	0	5627		2000
1988	-	78	228	-	1608	-	941	-	6	2861	127	1	2989	2800	2000
1989	-	402	88	-	2166	-	1238	-	-	3894	72	0	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	0	1	766	765	2000
1993	-	49	-	-	244	-	231	-	181	705	46	20	771	275	2000
1994	-	-	-	-	3	-	251	-	-	254	0	84	338	669	1000
1995	-	-	-	-	125	-	118	-	-	243	14	0	257	1300	1000
1996	-	-	-	-	105	-	29	-	8	142	2	28	172	300	0
1997	-	-	-	-	56	-	52	-	-	108	0	0	108	208	0
1998	-	-	-	-	140	-	47	-	1	188	3	2	193	294	0
1999 (1)	-	-	4	-	220	-	19	-	1	244	5	0	249	255	0
2000 (1)	-	-	55	-	168	-	27	-	1	251	1	11	263	133	0
2001 (1)	-	-	14	-	22	-	162	-	-	198	25	109	332	149	0
2002 (1)	-	5	4	-	73	-	71	-	1	154	66	33	253	128	0
2003 (1)	-	3	7	-	75	-	28	-	17	130	0	15	145	131	0
2004															0

(1) - Provisional

(2) - Recalculated from NAFO statistical data base using the FISHSTAT Plus program by FAO.

Table 2 A - EU- surveys in Div.3M from 1988-2003: estimates of biomass (t) of A.plaice.

Stratum	Depth range (m)	Area (sq. n. mi.)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Warren 2003
501	128-146	342	979	750	379	808	532	809	496	1672	1096	286	117	279	259	782	106	1292	2013
502	148-183	838	2133	2701	1031	1997	1285	950	899	1001	707	555	1190	1357	732	626	946	725	1008
503	185-256	628	1025	838	1251	935	473	333	244	189	126	371	213	73	16	70	56	17	22
504	185-256	348	1649	346	613	240	418	429	640	367	201	152	257	40	75	64	96		
505	185-256	703	1949	2319	1372	1055	628	968	922	412	375	464	558	55	42	84	142	82	99
506	185-256	496	359	847	715	376	451	229	606	92	24	10	26	30	19	28	47	29	37
507	258-366	822	880	398	628	292	479	239	237	187	54	62	35	14	11	21	39	30	38
508	258-366	646	313	123	197	188	545	365	128	99	42	92	124	2		34	32	14	23
509	258-366	314	77	122	257		280	154	15	375	41	27					1	9	14
510	258-366	951	1742	1118	1500	981	1054	1094	1677	531	311	215	27	54	34	71	27	54	73
511	258-366	806	889	876	987	301	279	219	227	82	51	24	22	28	17	20	44	29	46
512	367-549	670	7	14	34	13	8	11	25	9	24	5				3		11	17
513	367-549	249	2		15					2									
514	367-549	602	6	6	5	292	22	4	18	11	3		3	7					
515	367-549	666	17	74	2	73	28	82	30	51	17	5	5					6	8
516	550-731	634	4			3	7	9	4										
517	550-731	216																	
518	550-731	210																	
519	550-731	414				11	3	4	2	8									
total			12029	10533	8986	7565	6492	5900	6169	5087	3073	2268	2577	1940	1204	1803	1536	2298	3398
s.e.			1387	1533	957	887	719	779	1028	809	681	528	561	654	252	324	546	816	1103
mean catch per tow (kg)			14.96	13.10	11.17	9.41	8.07	7.34	7.67	6.33	3.82	2.82	3.20	2.41	1.50	2.24	1.91	2.76	4.22
s.e.			1.72	1.91	1.19	1.10	0.89	0.97	1.28	1.01	0.85	0.66	0.70	0.81	0.31	0.40	0.68	0.98	1.37

Table 2 B - EU-surveys in Div.3M from 1988-2003: estimates of abundance (000s) of A.plaice.

| Stratum	Depth range (m)	Area (sq. n. mi.)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Warren 2003
501	128-146	342	1875	1433	734	1371	902	1278	661	2635	1718	540	203	431	417	1235	190	1818	2584
502	148-183	838	4679	5969	1921	4128	2036	1579	1223	918	871	572	1140	1188	871	609	783	891	1203
503	185-256	628	2158	2346	2628	1469	795	512	356	246	122	409	225	84	27	102	47	21	30
504	185-256	348	2603	643	1068	408	751	638	668	382	212	141	277	48	80	60	74		
505	185-256	703	5456	4079	2470	2320	974	1244	1113	501	465	526	733	70	53	120	147	91	121
506	185-256	496	1372	1914	1883	894	888	536	895	131	50	31	38	46	31	31	62	35	45
507	258-366	822	1776	915	1148	583	668	479	301	269	102	117	65	21	21	28	49	42	52
508	258-366	646	493	283	294	213	675	497	148	103	54	105	120	7		28	21	24	30
509	258-366	314	151	213	379		496	261	27	695	84	37					8	24	32
510	258-366	951	3430	2140	2634	1890	1729	1647	2537	904	536	356	58	100	78	118	46	92	130
511	258-366	806	1616	1757	1509	578	470	462	410	161	117	51	27	57	47	27	62	64	92
512	367-549	670	26	10	50	27	20	22	36	24	31	8				6		16	25
513	367-549	249	18		18					6									
514	367-549	602	12	7	15	558	44	7	74	22	8		6	15					
515	367-549	666	36	124	6		150	32	125	55	86	15	8	6				6	8
516	550-731	634	14			7	17	23	7										
517	550-731	216																	
518	550-731	210																	
519	550-731	414				20	6	18	9	19									
total			25714	21834	16756	14616	10502	9326	8520	7102	4386	2901	2899	2067	1624	2365	1489	3125	4352
mean number per tow			32	27	21	18	13	12	11	9	5	4	4	3	2	3	2	4	5
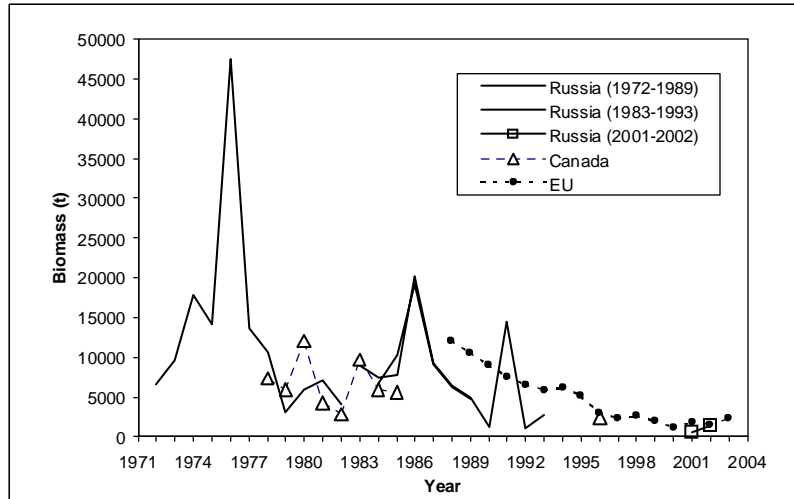
Fig.3A. American plaice in Div. 3M: trends in biomass in the surveys.
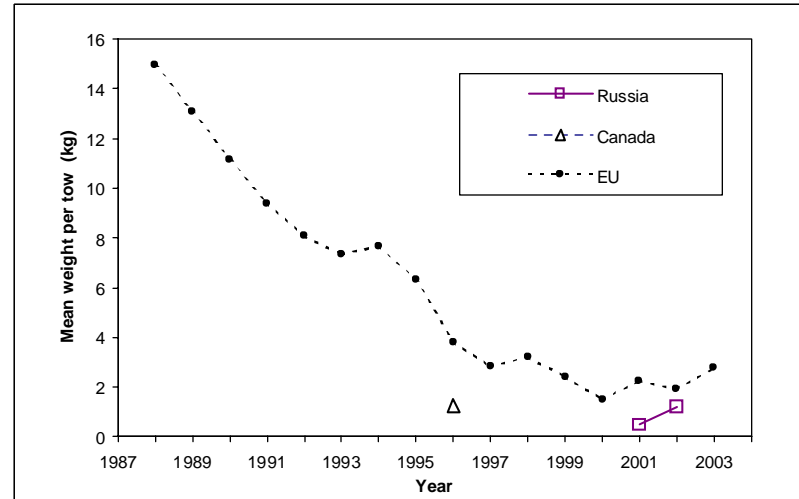

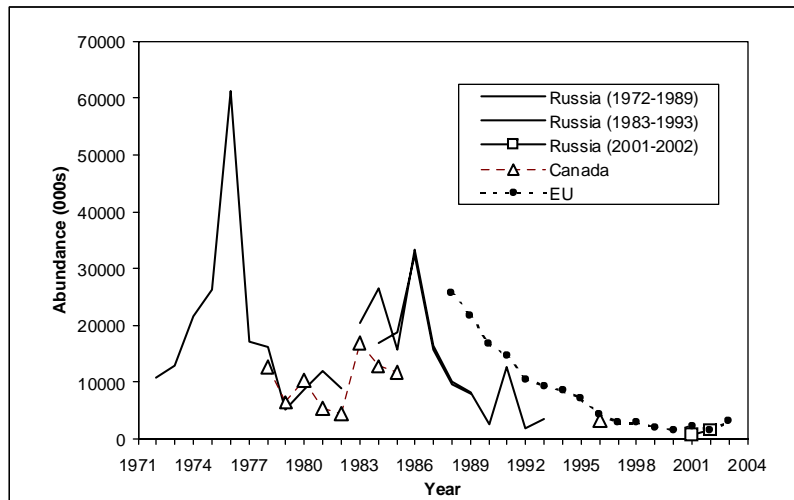Fig.3C. American plaice in Div. 3M: mean weight per tow in the surveys.

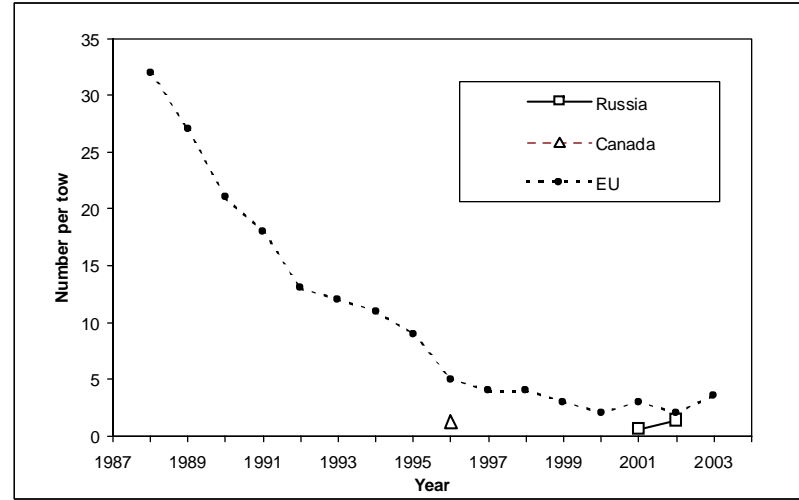Fig.3B. American plaice in Div. 3M: trends in abundance in the surveys.

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 1988-2003.

Length group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Warren 2003	Length group
4							6											4
6				18														6
8				18														8
10		36	6	25									6	7				10
12	70	12		42					7	7			6			8	2	12
14	577	12		44	42													14
16	1325	90	129	124	199		7	12	6	7						7	4	16
18	306	284	356	92	381	17	27	13	28	14			6	7				18
20	58	1047	126	71	218	33	28				14		7	27		8	7	20
22	173	2466	163	421	112	171	27		13		14		14			16	16	22
24	307	2781	339	756	234	506	37	39	33	26	7	7	7	7	8	15	17	24
26	598	1393	597	428	310	555	110	39	21	52	7	13	7	27	6	8	10	26
28	969	434	1127	417	337	322	251	98	61	39	39	28	38	46	26	30	42	28
30	1490	554	2567	714	389	589	618	183	99	26	13	7	27	20	20	81	120	30
32	2556	868	2456	1485	489	504	818	552	254	166	67	47	60	58	26	72	111	32
34	3138	1756	1385	2303	952	533	732	573	314	159	190	105	115	170	61	146	228	34
36	3030	2472	1216	2042	1578	949	801	908	548	303	290	181	177	252	74	379	593	36
38	2243	1860	1262	1688	1432	1020	1181	1187	754	484	282	182	183	473	99	544	838	38
40	2339	1398	1015	1038	1115	1059	1052	1007	715	328	355	225	206	309	133	466	698	40
42	2487	1218	926	600	909	880	420	670	441	234	273	151	181	188	73	424	610	42
44	2359	1492	1101	794	462	714	512	347	270	220	276	152	96	124	68	153	209	44
46	717	887	999	706	456	553	596	341	181	166	256	166	167	103	137	139	179	46
48	439	415	597	481	469	283	560	316	251	226	223	257	122	136	218	153	183	48
50	198	156	236	158	268	334	333	379	195	261	267	212	108	169	242	232	257	50
52	164	140	86	104	101	207	226	236	91	131	199	230	65	156	190	160	162	52
54	77	42	41	26	35	57	102	162	60	26	80	53	19	85	65	51	47	54
56	62	15	20	14	7	23	70	29	32	20	40	33	7		40	24	20	56
58	33	6	6	7		16		6	6	7	6	6		6		9	7	58
60								6	6			6						60
62							6											62
64																		64
66					7													66
Total	25714	21834	16756	14616	10502	9326	8520	7102	4386	2901	2899	2067	1624	2365	1489	3125	4359	Total
mean length	36.1	33.7	36.0	36.2	37.1	38.3	39.8	40.8	40.6	41.7	43.5	44.6	41.5	41.9	46.0	41.8	41.3	

Table 4: Length weight relationships of 3M American plaice (Casas, *pers. comm*. 2004)

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
All period	0.0044	3.2360	12424

Table 5: Population abundance (000s) at age (yrs) of A. plaice from surveys in Div. 3M during EU survey 1988-2003.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1988	503	1391	1683	4080	3511	3057	4445	2664	1608	1024	599	381	217	335	138	77	25714
1989	48	1587	5756	2306	2150	1883	2807	1886	1203	805	502	325	172	258	96	48	21834
1990	6	576	1369	4591	2012	1379	2074	1530	1063	737	485	328	188	262	104	52	16756
1991	140	322	1487	2286	2321	1548	2089	1457	1012	686	452	302	151	213	77	74	14616
1992	20	685	762	1030	1175	1230	1772	1200	840	596	402	274	145	222	87	61	10502
1993		24	1376	970	647	340	3107	351	596	281	197	229	281	861	29	36	9326
1994	6	40	38	1789	779	647	706	2471	241	476	166	163	194	398	397	8	8520
1995		25	99	631	1617	989	986	664	1130	126	143	119	120	242	183	27	7102
1996	7	34	103	227	471	1248	663	415	310	477	114	65	68	95	62	25	4386
1997	7	14	96	22	98	314	903	201	314	224	374	103	20	77	40	93	2901
1998		21	27	40	60	203	459	657	389	269	237	231	74	94	48	90	2899
1999	6		20	57	61	58	181	346	379	192	264	165	100	103	50	83	2067
2000	13	21	6	73	87	118	87	112	289	314	173	140	59	44	38	49	1624
2001		34	45	50	82	45	81	192	311	417	350	311	144	130	92	83	2365
2002			27	54	14	67	47	89	109	136	220	166	192	112	105	151	1489
2003	8	7	36	105	91	66	90	166	338	291	487	480	307	307	167	180	3125

| 2003 Warren | 2 | 4 | 38 | 153 | 136 | 99 | 136 | 248 | 506 | 429 | 703 | 678 | 429 | 406 | 197 | 196 | 4359 |

Table 6 - Weights at age of the 3M American plaice stock (Kg) from EU surveys, 1988-2003

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	0.336	0.485	0.610	0.715	0.784	0.799	0.825	0.888	0.974	1.231	1.247	1.573	1.764
1989	0.013	0.090	0.151	0.292	0.514	0.623	0.720	0.816	0.841	0.864	0.924	1.007	1.201	1.216	1.488	1.663
1990	0.010	0.062	0.189	0.311	0.416	0.550	0.701	0.830	0.859	0.901	0.969	1.044	1.197	1.226	1.436	1.595
1991	0.015	0.070	0.157	0.339	0.469	0.553	0.652	0.768	0.798	0.835	0.897	0.966	1.159	1.185	1.442	1.644
1992	0.029	0.063	0.158	0.312	0.506	0.609	0.681	0.760	0.812	0.842	0.926	1.019	1.199	1.217	1.426	1.787
1993		0.061	0.160	0.295	0.399	0.572	0.726	0.760	0.801	0.885	0.927	0.952	1.098	1.249	1.865	1.629
1994	0.001	0.062	0.163	0.314	0.478	0.557	0.645	0.812	0.961	0.935	1.051	1.049	1.303	1.262	1.565	1.895
1995		0.044	0.191	0.326	0.480	0.620	0.669	0.797	0.901	1.239	1.302	1.482	1.531	1.528	1.571	2.108
1996	0.017	0.055	0.190	0.329	0.461	0.584	0.710	0.828	0.947	0.877	1.104	1.400	1.319	1.540	1.663	1.825
1997	0.017	0.049	0.171	0.236	0.421	0.550	0.668	0.637	0.870	1.017	1.031	1.233	1.277	1.450	1.622	1.526
1998		0.090	0.174	0.259	0.378	0.506	0.647	0.781	0.830	1.043	1.256	1.342	1.544	1.519	1.619	1.665
1999	0.010		0.166	0.315	0.431	0.541	0.560	0.778	0.855	1.013	1.196	1.293	1.470	1.729	1.571	1.599
2000	0.016	0.091	0.115	0.245	0.403	0.511	0.610	0.674	0.760	0.754	0.856	0.960	1.236	1.200	1.316	1.392
2001		0.072	0.211	0.245	0.366	0.426	0.520	0.598	0.621	0.709	0.711	0.866	1.100	1.342	1.451	1.496
2002			0.192	0.287	0.398	0.436	0.665	0.758	0.715	0.880	1.118	1.177	1.318	1.427	1.504	1.535
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	1.315	1.499

| mean | 0.016 | 0.064 | 0.167 | 0.298 | 0.435 | 0.544 | 0.652 | 0.753 | 0.815 | 0.897 | 0.997 | 1.101 | 1.254 | 1.335 | 1.527 | 1.664 |

| 2003 Warren | 0.017 | 0.041 | 0.140 | 0.336 | 0.366 | 0.457 | 0.539 | 0.657 | 0.664 | 0.720 | 0.768 | 0.824 | 0.841 | 0.948 | 1.250 | 1.433 |

| mean - Warren | 0.016 | 0.064 | 0.168 | 0.299 | 0.436 | 0.544 | 0.652 | 0.752 | 0.815 | 0.896 | 0.995 | 1.099 | 1.252 | 1.330 | 1.523 | 1.660 |

Table 7: Criteria applied to convert total catches in weight to total catches in number, 2003.

YEAR	TOTAL CATCH (ton)	BREAKDOWN TOTAL CATCH (ton)	LENGTHS COMPOSITION				Mean Weight (Kg)	TOTAL CATCH IN NUMBER (000's)
			Country	Source	Gear	Paper		
2003	131	131	Portugal	Commercial	OTB	scs 04/5	0.953	137.5
		0	Spain	Commercial	OTB	scs 04/9	0.699	0.000

Table 8: Length composition (absolute frequencies in '000) of the 3M American plaice catches, 1988-2003.

length group	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
16		19.3	0.8				0.7	3.0								
18		60.5	3.9				2.9	3.2								
20	6.9	126.5	2.0		5.3	1.8	3.3									
22	10.4	88.0	8.2	5.8	1.3	6.9	3.2						0.3	0.1		
24	65.6	35.8	10.4	6.6	1.4	14.3	4.8	9.7	5.1		0.2			0.2		
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
58	3.5		0.8	0.002	4.8	0.7		1.5			0.03			0.1		
60					0.01	0.1		1.5						0.04		
62			0.1			0.001	0.6							0.1		1.0
64														0.01		
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
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

Table 9 - Catch at age (000s) of the 3M American plaice, 1988-2003.

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	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

Table 10 - Mean weight at age of the 3M American plaice catch (Kg), 1988-2003.

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
mean		0.084	0.194	0.326	0.436	0.551	0.674	0.779	0.846	0.915	1.006	1.097	1.224	1.316	1.487	1.603

Table11: American plaice exploitaion pattern given by the generalized logit of the 1988-03
observed partial recruitment (See text).

Age	F at age index	Observed PR	Logit PR	Squared difference
1	0.000	0.000	0.013	0.000
2	0.181	0.155	0.142	0.000
3	0.439	0.378	0.441	0.004
4	0.937	0.806	0.716	0.008
5	1.053	0.906	0.874	0.001
6	1.001	0.861	0.948	0.007
7	0.983	0.847	0.979	0.017
8	1.137	0.978	0.991	0.000
9	1.145	0.986	0.997	0.000
10	1.162	1.000	0.999	0.000
11	1.157	0.996	0.999	0.000
12	1.157	0.996	1.000	0.000
13	0.973	0.837	1.000	0.026
14	1.027	0.884	1.000	0.013
15	0.859	0.739	1.000	0.068
16	0.787	0.677	1.000	0.104
		Minimum sum of squares		0.250

Curve parameters		a	b	m
		-0.143	0.918	11.533

Fig. 4: PR curve for 3M American plaice
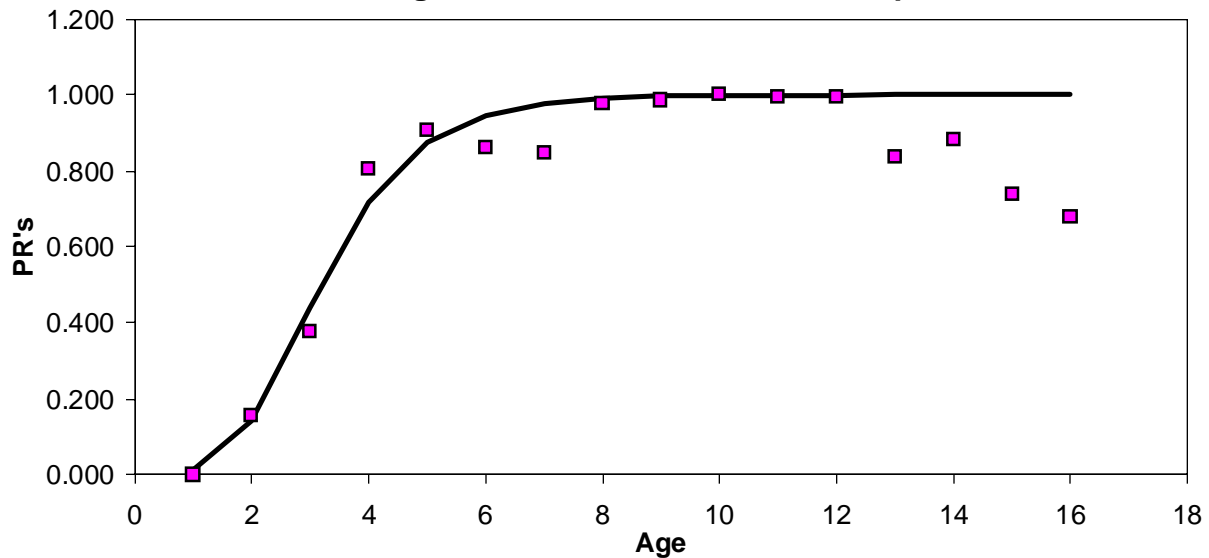
Table 12 A: Yield per recruit parameters for 3M American plaice.

Age	mean weights 1988-03		og mat (%)	PR 88-03	Ref. M
	stock	catch			
1	0.016	*0.016*	0.000	0.013	0.20
2	0.064	*0.074*	0.000	0.143	0.20
3	0.167	*0.194*	0.000	0.442	0.20
4	0.298	*0.326*	0.000	0.717	0.20
5	0.435	*0.436*	0.500	0.875	0.20
6	0.544	*0.551*	1.000	0.948	0.20
7	0.652	*0.674*	1.000	0.979	0.20
8	0.753	*0.779*	1.000	0.991	0.20
9	0.815	*0.846*	1.000	0.997	0.20
10	0.897	*0.915*	1.000	0.999	0.20
11	0.997	*1.006*	1.000	0.999	0.20
12	1.101	*1.097*	1.000	1.000	0.20
13	1.254	*1.224*	1.000	1.000	0.20
14	1.335	*1.316*	1.000	1.000	0.20
15	1.527	*1.487*	1.000	1.000	0.20
16+	1.664	*1.603*	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	2455	0	2013	2,053
	0.000	2455	0	2013	1,570
	0.035	1939	55	1507	922
	0.070	1591	87	1168	562
	0.105	1345	107	930	351
	0.140	1164	119	757	222
F0.1	**0.163**	**1069**	**125**	**668**	**205**
	0.175	1025	127	627	140
	0.210	917	132	527	87
	0.245	831	135	448	51
	0.280	760	137	385	26
	0.315	702	138	334	8
Fmax	**0.355**	**646**	**138**	**285**	**0**
	0.385	610	138	255	-12
	0.420	574	137	225	-19
	0.455	542	137	200	-23
	0.490	514	136	178	-26
	0.525	489	135	159	-29

Fig.5 - Yield, B and SSB per recruit curve for 3M American plaice
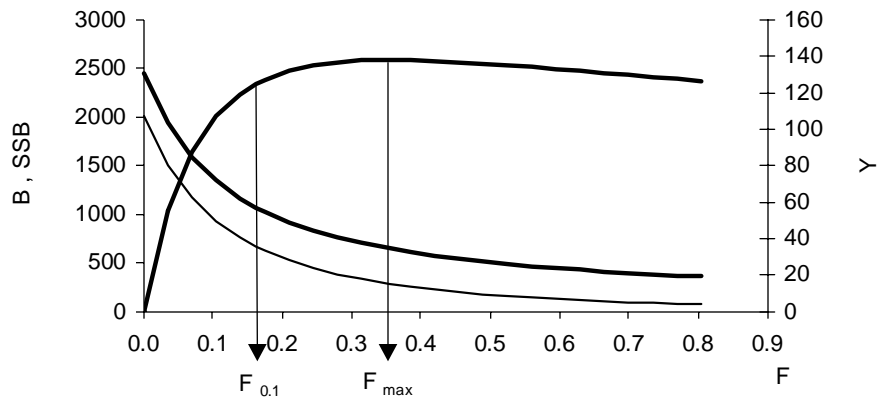
Table 13 - Trend of the 3M American plaice F index
based in EU survey series.

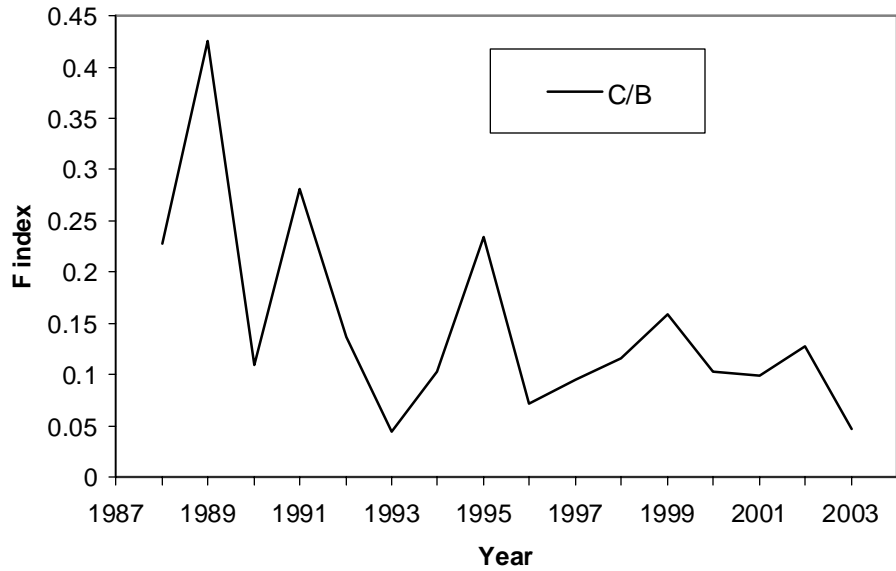| Year	Catch (tons)	Survey (tons)	C/B
1988	1082	4750	0.228
1989	1576	3710	0.425
1990	364	3323	0.110
1991	817	2905	0.281
1992	336	2467	0.136
1993	53	1176	0.045
1994	295	2857	0.103
1995	443	1890	0.234
1996	84	1181	0.071
1997	97	1015	0.096
1998	163	1414	0.115
1999	176	1104	0.159
2000	69	679	0.102
2001	84	852	0.099
2002	65	512	0.128
2003	44	939	0.047

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 1988-2003.

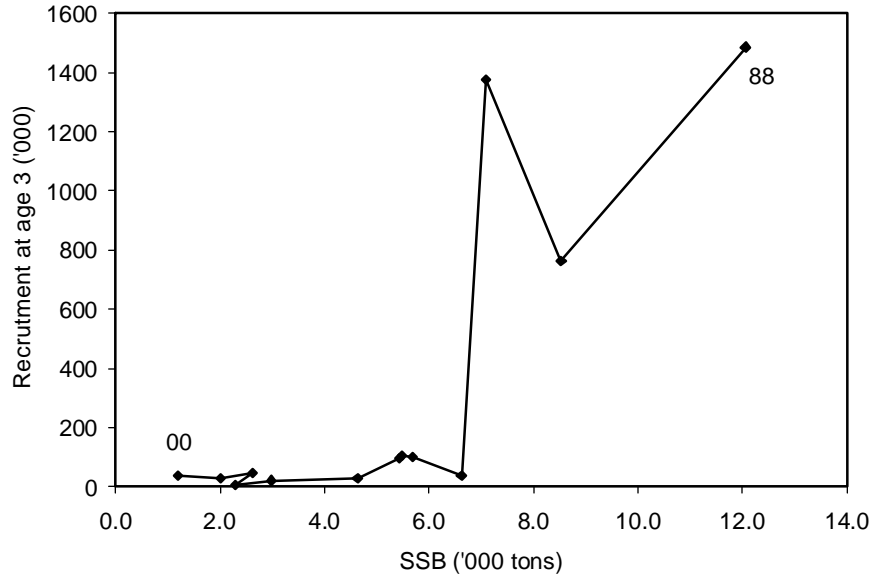| Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
SSB	12.1	8.5	7.1	6.6	5.7	5.5	5.4	4.6	3.0	2.3	2.6	2.0	1.2	1.8	1.6	2.5
Age 3 recruits	1683	5756	1372	1487	762	1376	38	99	103	96	27	20	6	45	27	36

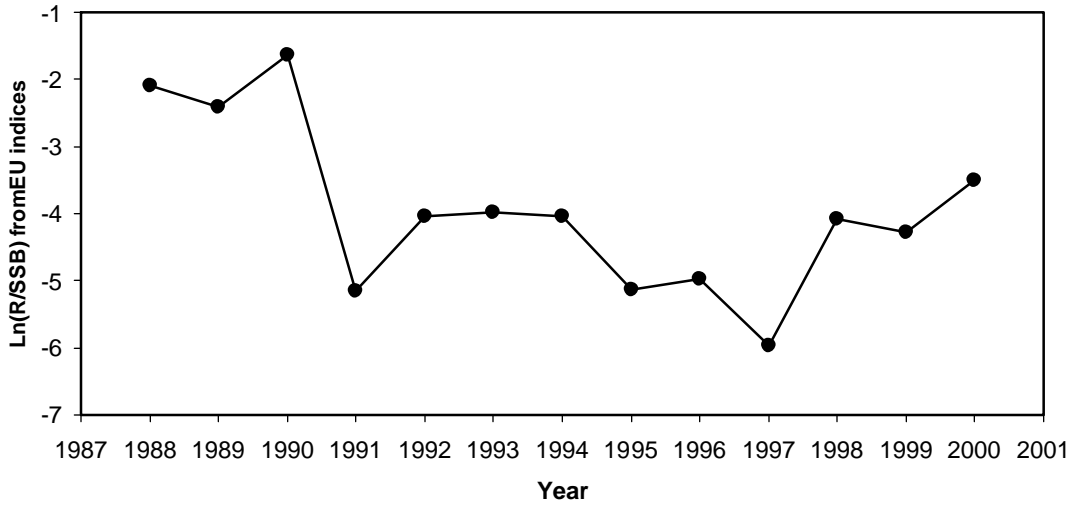Fig. 7. SSB-Recruitment scatter plot based in EU survey series.

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 (2004 assessment)

AMERICAN PLAICE NAFO DIVISION 3M INDEX OF INPUT FILES JUNE 2004

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   2003
1   16
1
5
2800
3500
790
1600
765
275
669
1300
300
208
294
255
133
149
128
131

AMERICAN PLAICE NAFO 3M CATCH NUMBERS thousands

1   2
1988   2003
1   16
1

0	7	311	731	549	440	720	532	386	265	173	118	65	102	43	25
0	175	209	573	527	482	886	715	520	356	230	148	80	118	39	19
0	7	49	183	112	87	158	147	110	78	55	39	24	33	13	7
0	1	19	133	185	168	342	331	243	174	124	84	50	68	23	12
0	4	17	76	75	76	136	124	100	77	60	46	31	45	23	14
0	0	47	42	26	11	112	13	24	12	9	11	15	49	2	2
0	4	6	219	98	77	75	254	24	48	16	17	20	40	43	1
0	6	24	167	458	235	231	155	250	31	35	30	30	58	45	7
0	0	13	60	101	173	63	41	23	34	6	3	3	3	2	0.4
0	0	0	0	4	17	61	12	28	23	35	13	3	9	4	10
0	0	0.3	1	2	7	28	57	36	31	32	33	8	14	7	10
0	0	0	4	6	8	27	59	60	35	40	21	9	5	3	5
0	0.2	0.1	19	25	25	12	13	33	35	17	13	6	3	3	4
0	0	5	6	16	8	10	21	30	41	35	29	10	6	3	3
0	0	1	8	4	17	13	21	22	23	24	17	12	4	3	5
0	0	0	2	2	2	3	6	13	12	23	25	16	15	9	10

AMERICAN PLAICE NAFO 3M CATCH WEIGHT AT AGE kg

1   3
1988   2003
1   16
1

0.016	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
0.016	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
0.016	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
0.016	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
0.016	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
0.016	0.084	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
0.016	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
0.016	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
0.016	0.084	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
0.016	0.084	0.194	0.326	0.445	0.639	0.726	0.682	0.949	1.059	1.097	1.270	1.261	1.509	1.508	1.513
0.016	0.084	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
0.016	0.084	0.194	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
0.016	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
0.016	0.084	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
0.016	0.084	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
0.016	0.084	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

AMERICAN PLAICE NAFO 3M STOCK WEIGHT AT AGE kg

1   4
1988   2003
1   16
1

0.027	0.048	0.152	0.336	0.485	0.610	0.715	0.784	0.799	0.825	0.888	0.974	1.231	1.247	1.573	1.764
0.013	0.090	0.151	0.292	0.514	0.623	0.720	0.816	0.841	0.864	0.924	1.007	1.201	1.216	1.488	1.663
0.010	0.062	0.189	0.311	0.416	0.550	0.701	0.830	0.859	0.901	0.969	1.044	1.197	1.226	1.436	1.595
0.015	0.070	0.157	0.339	0.469	0.553	0.652	0.768	0.798	0.835	0.897	0.966	1.159	1.185	1.442	1.644
0.029	0.063	0.158	0.312	0.506	0.609	0.681	0.760	0.812	0.842	0.926	1.019	1.199	1.217	1.426	1.787
0.016	0.061	0.160	0.295	0.399	0.572	0.726	0.760	0.801	0.885	0.927	0.952	1.098	1.249	1.865	1.629
0.001	0.062	0.163	0.314	0.478	0.557	0.645	0.812	0.961	0.935	1.051	1.049	1.303	1.262	1.565	1.895
0.016	0.044	0.191	0.326	0.480	0.620	0.669	0.797	0.901	1.239	1.302	1.482	1.531	1.528	1.571	2.108
0.017	0.055	0.190	0.329	0.461	0.584	0.710	0.828	0.947	0.877	1.104	1.400	1.319	1.540	1.663	1.825
0.017	0.049	0.171	0.236	0.421	0.550	0.668	0.637	0.870	1.017	1.031	1.233	1.277	1.450	1.622	1.526
0.016	0.090	0.174	0.259	0.378	0.506	0.647	0.781	0.830	1.043	1.256	1.342	1.544	1.519	1.619	1.665
0.010	0.064	0.166	0.315	0.431	0.541	0.560	0.778	0.855	1.013	1.196	1.293	1.470	1.729	1.571	1.599
0.016	0.091	0.115	0.245	0.403	0.511	0.610	0.674	0.760	0.754	0.856	0.960	1.236	1.200	1.316	1.392
0.016	0.072	0.211	0.245	0.366	0.426	0.520	0.598	0.621	0.709	0.711	0.866	1.100	1.342	1.451	1.496
0.016	0.064	0.192	0.287	0.398	0.436	0.665	0.758	0.715	0.880	1.118	1.177	1.318	1.427	1.504	1.535
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	1.315	1.499

Table 15: count.

AMERICAN PLAICE NAFO 3M NATURAL MORTALITY
```
    1      5
 1988   2003
    1     16
    3
  0.2
```

AMERICAN PLAICE NAFO 3M PROPORTION MATURE AT AGE
```
    1      6
 1988   2003
    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   AMERICAN PLAICE NAFO 3M PROPORTION OF M BEFORE SPAWNING
```
    1      7                                          1      8
 1988   2003                                       1988   2003
    1     16                                          1     16
    3                                                 3
 0.42                                              0.42
```

AMERICAN PLAICE NAFO 3M F ON OLDEST AGE GROUP BY YEAR
```
    1      9
 1988   2003
    1     16
    5
 0.168
 0.314
 0.081
 0.208
 0.101
 0.033
 0.076
 0.173
 0.053
 0.071
 0.085
 0.118
 0.076
 0.073
 0.094
 0.035
```

AMERICAN PLAICE NAFO 3M F AT AGE IN LAST YEAR
```
    1     10
 1988   2003
    1     16
    2
```
| 0 | 0.007303 | 0.017769 | 0.037889 | 0.042598 | 0.040479 | 0.039789 | 0.045988 | 0.046329 | 0.047002 | 0.046802 | 0.046828 | 0.039364 | 0.041561 | 0.034753 | 0.031828 |

AMERICAN PLAICE NAFO 3M SURVEY TUNNING DATA
```
  101
```
EU BOTTOM TRAWL SURVEY
```
 1988   2003
    1      1    0.5    0.6
    1     15
```
10555	503	1391	1683	4080	3511	3057	4445	2664	1608	1024	599	381	217	335	138
10555	48	1587	5756	2306	2150	1883	2807	1886	1203	805	502	325	172	258	96
10555	6	576	1369	4591	2012	1379	2074	1530	1063	737	485	328	188	262	104
10555	140	322	1487	2286	2321	1548	2089	1457	1012	686	452	302	151	213	77
10555	20	685	762	1030	1175	1230	1772	1200	840	596	402	274	145	222	87
10555	0	24	1376	970	647	340	3107	351	596	281	197	229	281	861	29
10555	6	40	38	1789	779	647	706	2471	241	476	166	163	194	398	397
10555	0	25	99	631	1617	989	986	664	1130	126	143	119	120	242	183
10555	7	34	103	227	471	1248	663	415	310	477	114	65	68	95	62
10555	7	14	96	22	98	314	903	201	314	224	374	103	20	77	40
10555	0	21	27	40	60	203	459	657	389	269	237	231	74	94	48
10555	6	0	20	57	61	58	181	346	379	192	264	165	100	103	50
10555	13	21	6	73	87	118	87	112	289	314	173	140	59	44	38
10555	0	34	45	50	82	45	81	192	311	417	350	311	144	130	92
10555	0	0	27	54	14	67	47	89	109	136	220	166	192	112	105
10555	8	7	36	105	91	66	90	166	338	291	487	480	307	307	167

Table 16: Extended Survivor Analysis diagnostics for 2004 (Lowestoft VPA Version 3.1)

AMERICAN PLAICE NAFO DIVISION 3M INDEX OF INPUT FILES JUNE 2004
CPUE data from file pla3mtun.txt

Catch data for 16 years. 1988 to 2003. Ages 1 to 16.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU BOTTOM TRAWL SURV	1994	2003	1	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 >= 10

Terminal population estimation :
   Survivor estimates shrunk towards the mean F
   of the final 5 years or the 5 oldest ages.
   S.E. of the mean to which the estimates are shrunk = 1.000
   Minimum standard error for population
   estimates derived from each fleet = .500
   Prior weighting not applied
Tuning converged after 79 iterations
Regression weights

	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0	0	0	0	0	0	0	0	0	0
2	0.003	0.011	0	0	0	0	0.001	0	0	0
3	0.003	0.022	0.029	0	0.001	0	0.001	0.015	0.002	0
4	0.072	0.098	0.072	0	0.002	0.016	0.069	0.051	0.031	0.005
5	0.057	0.212	0.079	0.006	0.007	0.018	0.136	0.077	0.044	0.01
6	0.061	0.189	0.115	0.017	0.013	0.034	0.094	0.058	0.109	0.028
7	0.093	0.262	0.071	0.054	0.035	0.064	0.066	0.049	0.127	0.025
8	0.267	0.282	0.067	0.017	0.065	0.097	0.04	0.157	0.139	0.08
9	0.095	0.46	0.061	0.06	0.066	0.091	0.072	0.121	0.245	0.12
10	0.252	0.172	0.102	0.08	0.087	0.084	0.07	0.12	0.129	0.204
11	0.097	0.295	0.045	0.145	0.152	0.155	0.053	0.093	0.096	0.184
12	0.119	0.266	0.037	0.131	0.198	0.141	0.069	0.121	0.06	0.137
13	0.11	0.318	0.038	0.047	0.111	0.076	0.054	0.069	0.067	0.073
14	0.145	0.531	0.047	0.153	0.317	0.094	0.033	0.071	0.036	0.113
15	0.122	0.242	0.03	0.081	0.17	0.103	0.075	0.041	0.046	0.105

XSA population numbers (Thousands)

YEAR \ AGE	1	2	3	4	5	6	7	8	9	10
1994	7.52E+02	1.47E+03	2.42E+03	3.48E+03	1.95E+03	1.44E+03	9.34E+02	1.20E+03	2.92E+02	2.38E+02
1995	8.52E+02	6.15E+02	1.20E+03	1.98E+03	2.65E+03	1.51E+03	1.11E+03	6.97E+02	7.50E+02	2.17E+02
1996	4.93E+02	6.98E+02	4.98E+02	9.59E+02	1.47E+03	1.76E+03	1.02E+03	6.97E+02	4.30E+02	3.88E+02
1997	5.71E+02	4.04E+02	5.71E+02	3.96E+02	7.31E+02	1.11E+03	1.28E+03	7.78E+02	5.33E+02	3.31E+02
1998	2.41E+02	4.68E+02	3.31E+02	4.68E+02	3.24E+02	5.95E+02	8.95E+02	9.95E+02	6.26E+02	4.11E+02
1999	5.39E+02	1.97E+02	3.83E+02	2.71E+02	3.82E+02	2.64E+02	4.80E+02	7.07E+02	7.63E+02	4.80E+02
2000	7.90E+02	4.41E+02	1.62E+02	3.14E+02	2.18E+02	3.07E+02	2.09E+02	3.69E+02	5.26E+02	5.71E+02
2001	7.54E+02	6.47E+02	3.61E+02	1.32E+02	2.40E+02	1.56E+02	2.29E+02	1.60E+02	2.90E+02	4.01E+02
2002	2.06E+02	6.17E+02	5.30E+02	2.91E+02	1.03E+02	1.82E+02	1.20E+02	1.78E+02	1.12E+02	2.11E+02
2003	6.64E+02	1.69E+02	5.06E+02	4.33E+02	2.31E+02	8.05E+01	1.33E+02	8.67E+01	1.27E+02	7.18E+01

Estimated population abundance at 1st Jan 2004

	1	2	3	4	5	6	7	8	9	10
	0.00E+00	5.44E+02	1.38E+02	4.14E+02	3.53E+02	1.88E+02	6.41E+01	1.06E+02	6.56E+01	9.23E+01

Taper weighted geometric mean of the VPA populations:

	1	2	3	4	5	6	7	8	9	10
	1.12E+03	1.06E+03	1.04E+03	9.57E+02	8.31E+02	7.43E+02	7.06E+02	6.00E+02	5.14E+02	4.06E+02

Standard error of the weighted Log(VPA populations) :

	1	2	3	4	5	6	7	8	9	10
	1.0802	1.1575	1.0825	1.1085	1.1076	1.0903	0.9774	0.9168	0.8399	0.7741

Table 16: count.

XSA population numbers (Thousands)

YEAR	AGE 11	12	13	14	15
1994	1.91E+02	1.67E+02	2.12E+02	3.27E+02	4.13E+02
1995	1.52E+02	1.42E+02	1.22E+02	1.56E+02	2.31E+02
1996	1.50E+02	9.24E+01	8.91E+01	7.24E+01	7.48E+01
1997	2.87E+02	1.17E+02	7.29E+01	7.03E+01	5.66E+01
1998	2.50E+02	2.03E+02	8.42E+01	5.70E+01	4.94E+01
1999	3.09E+02	1.76E+02	1.36E+02	6.17E+01	3.40E+01
2000	3.61E+02	2.17E+02	1.25E+02	1.04E+02	4.60E+01
2001	4.36E+02	2.80E+02	1.66E+02	9.71E+01	8.21E+01
2002	2.91E+02	3.25E+02	2.03E+02	1.27E+02	7.40E+01
2003	1.52E+02	2.16E+02	2.51E+02	1.56E+02	1.00E+02

Estimated population abundance at 1st Jan 2004

	4.80E+01	1.03E+02	1.55E+02	1.91E+02	1.14E+02

Taper weighted geometric mean of the VPA populations:

	3.36E+02	2.57E+02	1.92E+02	1.40E+02	8.97E+01

Standard error of the weighted Log(VPA populations) :

	0.6448	0.6178	0.6322	0.6522	0.6586

Log catchability residuals.
Fleet : EU BOTTOM TRAWL SURV

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.41	99.99	0.16	0.02	99.99	-0.08	0.31	99.99	99.99	0
2	-0.42	-0.02	0.16	-0.18	0.08	99.99	0.14	0.24	99.99	0
3	-1.51	0.16	1.08	0.86	0.14	-0.31	-0.65	0.57	-0.33	0
4	0.92	0.46	0.14	-1.35	-0.91	0	0.13	0.6	-0.12	0.13
5	0.38	0.89	0.17	-0.74	-0.42	-0.56	0.42	0.23	-0.71	0.34
6	0.08	0.53	0.56	-0.41	-0.23	-0.65	-0.06	-0.37	-0.1	0.66
7	0.33	0.59	0.17	0.24	-0.09	-0.38	-0.28	-0.45	-0.31	0.18
8	1.14	0.38	-0.21	-1.07	-0.11	-0.39	-0.9	0.54	-0.35	0.96
9	-0.08	0.73	-0.23	-0.43	-0.38	-0.59	-0.5	0.2	0.17	1.11
10	0.86	-0.42	0.29	-0.32	-0.35	-0.84	-0.53	0.13	-0.34	1.54
11	-0.06	0.13	-0.22	0.37	0.05	-0.05	-0.68	-0.14	-0.2	1.29
12	0.07	0	-0.31	-0.03	0.26	0.04	-0.37	0.2	-0.61	0.9
13	0	0.19	-0.22	-1.24	-0.04	-0.24	-0.7	-0.08	0.01	0.27
14	0.3	0.76	0.32	0.2	0.7	0.59	-0.81	0.36	-0.08	0.77
15	0.05	-0.08	-0.15	-0.28	0.09	0.47	-0.12	0.16	0.4	0.6

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

Age	1	2	3	4	5	6	7	8	9	10
Mean Log q	-13.5732	-12.3368	-11.7965	-10.7003	-10.4186	-9.9958	-9.7146	-9.4259	-9.2173	-9.1803
S.E(Log q)	0.2448	0.2119	0.7595	0.677	0.5616	0.451	0.3505	0.7422	0.5579	0.724

Age	11	12	13	14	15
Mean Log q	-9.1803	-9.1803	-9.1803	-9.1803	-9.1803
S.E(Log q)	0.5177	0.4121	0.5003	0.5805	0.3147

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
1	1.21	-0.272	15.08	0.29	6	0.33	-13.57
2	1.14	-0.935	13.19	0.88	8	0.24	-12.34
3	1.48	-0.935	14.45	0.32	10	1.13	-11.8
4	0.81	1.035	9.86	0.79	10	0.55	-10.7
5	0.8	1.5	9.59	0.88	10	0.42	-10.42
6	0.93	0.497	9.74	0.88	10	0.44	-10
7	0.81	2.151	9.05	0.94	10	0.24	-9.71
8	1.22	-0.634	10.17	0.5	10	0.94	-9.43
9	1.8	-1.855	11.85	0.4	10	0.89	-9.22
10	10.52	-3.176	42.53	0.01	10	5.37	-9.18
11	2.88	-1.596	15.98	0.08	10	1.37	-9.13
12	0.95	0.129	8.98	0.49	10	0.42	-9.17
13	0.6	2.26	7.59	0.8	10	0.22	-9.39
14	1.02	-0.073	8.97	0.55	10	0.52	-8.87
15	1.04	-0.32	9.27	0.87	10	0.32	-9.07

Table 16: count.

Terminal year survivor and F summaries :

Age 1 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	544	0.5	0	0	1	1	0
F shrinkage mean	0	1				0	0
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
544	0.5	0	1	0	0		

Age 2 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	138	0.5	0	0	1	1	0
F shrinkage mean	0	1				0	0
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
138	0.5	0	1	0	0		

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	414	0.797	0	0	1	1	0
F shrinkage mean	0	1				0	0
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
414	0.8	0	1	0	0		

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	417	0.294	0.12	0.41	4	0.92	0.004
F shrinkage mean	52	1				0.08	0.034
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
353	0.28	0.31	5	1.101	0.005		

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	213	0.263	0.112	0.43	5	0.932	0.008
F shrinkage mean	31	1				0.068	0.056
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
188	0.25	0.24	6	0.956	0.01		

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	70	0.31	0.378	1.22	4	0.907	0.026
F shrinkage mean	28	1				0.093	0.062
Weighted prediction :							
Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F		
64	0.3	0.34	5	1.152	0.028		

Table 16: count.

Age 7 Catchability constant w.r.t. time and dependent on age
Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	113	0.212	0.059	0.28	7	0.949	0.024
F shrinkage mean	38	1				0.051	0.069

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
106	0.21	0.11	8	0.514	0.025

Age 8 Catchability constant w.r.t. time and dependent on age
Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	66	0.205	0.148	0.72	8	0.946	0.078
F shrinkage mean	52	1				0.054	0.1

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
66	0.2	0.14	9	0.676	0.08

Age 9 Catchability constant w.r.t. time and dependent on age
Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	92	0.21	0.237	1.13	8	0.942	0.12
F shrinkage mean	93	1				0.058	0.119

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
92	0.21	0.22	9	1.048	0.12

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	46	0.189	0.24	1.27	10	0.938	0.214
F shrinkage mean	105	1				0.062	0.098

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
48	0.19	0.23	11	1.225	0.204

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 10
Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	100	0.191	0.22	1.15	10	0.945	0.189
F shrinkage mean	179	1				0.055	0.11

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
103	0.19	0.21	11	1.101	0.184

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 10
Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	153	0.192	0.191	0.99	10	0.947	0.138
F shrinkage mean	180	1				0.053	0.118

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
155	0.19	0.18	11	0.93	0.137

Table 16: count.

Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 10
Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	191	0.188	0.167	0.89	10	0.954	0.073
F shrinkage mean	184	1				0.046	0.076
Weighted prediction :							

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
191	0.18	0.15	11	0.838	0.073

Age 14   Catchability constant w.r.t. time and age (fixed at the value for age) 10
Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	114	0.184	0.176	0.95	10	0.952	0.113
F shrinkage mean	116	1				0.048	0.11
Weighted prediction :							

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
114	0.18	0.16	11	0.895	0.113

Age 15   Catchability constant w.r.t. time and age (fixed at the value for age) 10
Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU BOTTOM TRAWL SURV	75	0.184	0.122	0.66	10	0.954	0.103
F shrinkage mean	53	1				0.046	0.143
Weighted prediction :							

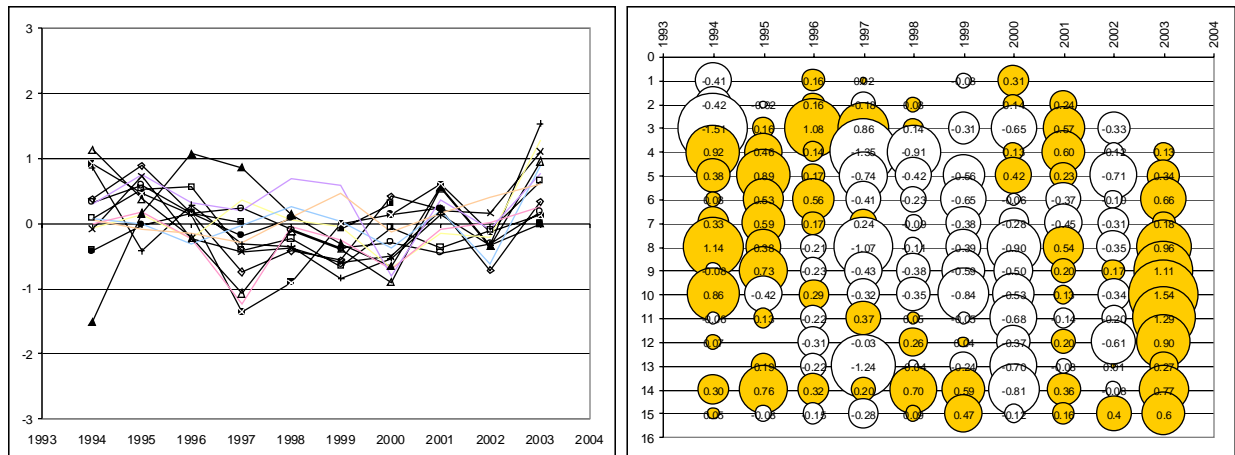| Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
74	0.18	0.12	11	0.636	0.105

Fig.9. Log catchability residuals

Table 17: Extended Survivor Analysis results.

| YEAR	RECRUITS Age 1 (Thousands)	TOTAL BIOMASS (Tonnes)	SPAWNING BIOMASS (Tonnes)	FBAR 3-13	FBAR 8-11
1988	3903	15442	10539	0.2353	0.2539
1989	4163	12466	7929	0.3692	0.4262
1990	4446	8817	5921	0.1039	0.1114
1991	6431	8019	4824	0.2627	0.3885
1992	3617	7223	4512	0.1503	0.2698
1993	1792	6638	4189	0.0414	0.0574
1994	752	7119	4409	0.1115	0.1779
1995	852	6633	4156	0.2342	0.3020
1996	493	4885	3639	0.0650	0.0688
1997	571	4236	3464	0.0505	0.0754
1998	241	3954	3251	0.0670	0.0926
1999	539	3480	2855	0.0705	0.1065
2000	790	2541	2102	0.0658	0.0588
2001	754	2107	1677	0.0848	0.1227
2002	206	2285	1807	0.0953	0.1521
2003	664	1602	1172	0.0786	0.1468
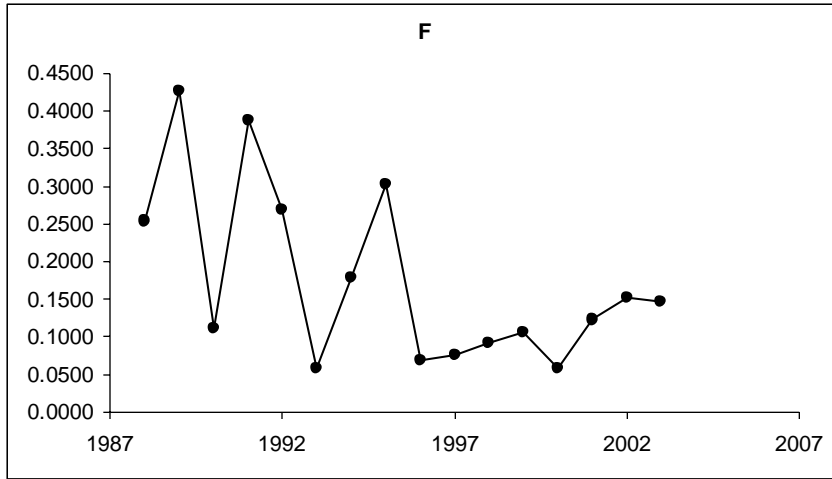
Fig.10 A. Extended Survivor Analysis results for F (age 8-11)
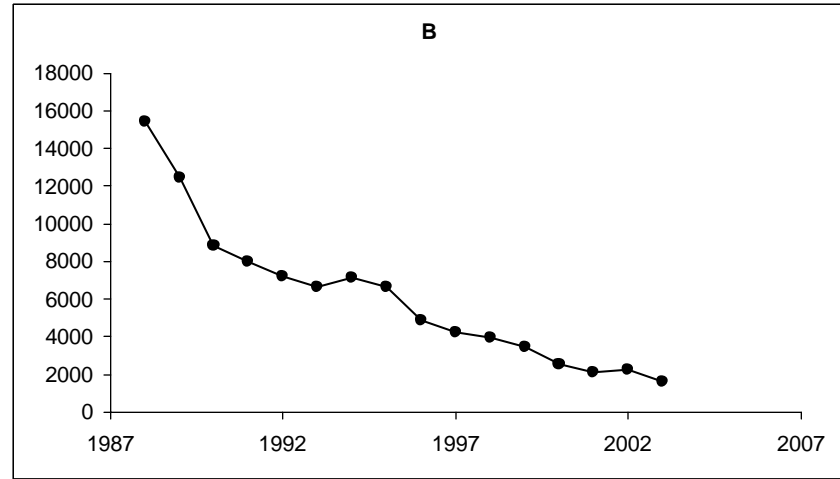
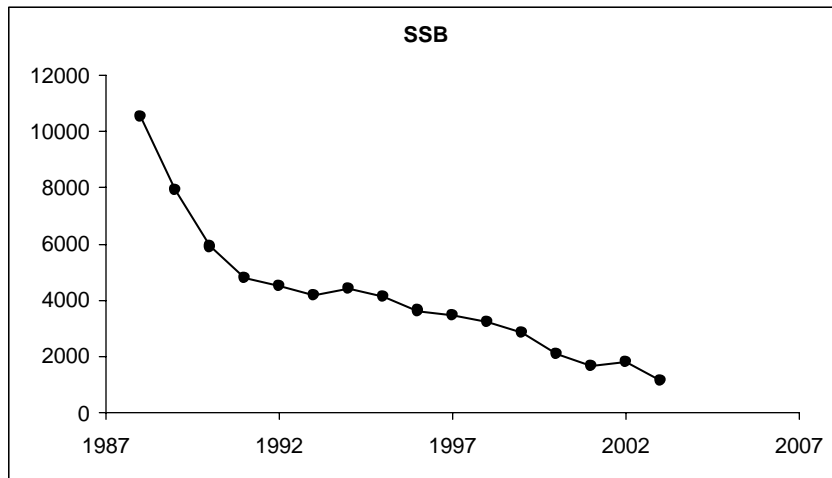Tfig. 10 B. Extended Survivor Analysis results for total biomass (tons)

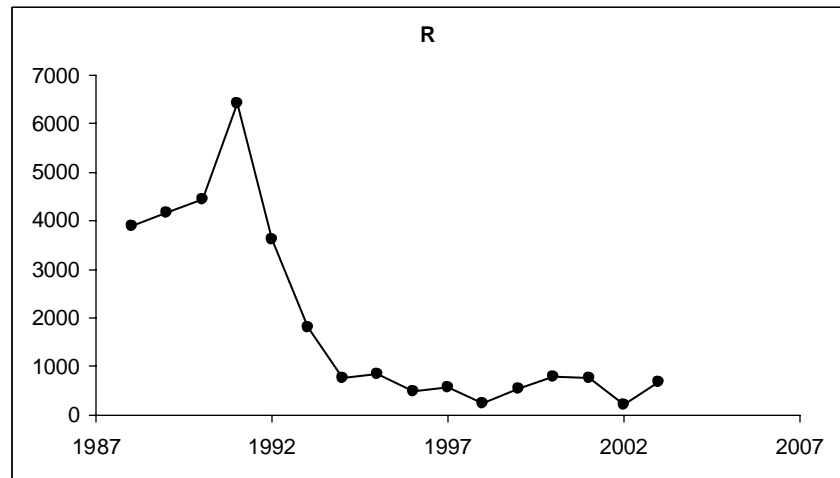Fig. 10 C: Extended Survivor Analysis results for spawning biomass (tons)

Fig.10 D: Extended Survivor Analysis results for recruits at age 1 ('000)