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PART 2 OF 2

REPORT OF THE

HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF 62°N

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International Council for the Exploration of the Sea

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4 CELTIC SEA AND DIVISION VIIJ HERRING

4.1 Introduction

The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purpose of stock assessment and management these areas have been combined since 1982. The areas for which the assessments are now made, together with the area for which the TAC is set by the EU is shown in Figure 4.1.1. It should be noted that, although the management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa, the total Irish catch which constitutes over 95 % of the catch from this entire management unit is taken from the inshore waters along the Irish coast.

4.2 The Fishery in 1997–1998

4.2.1 Advice and management applicable to 1997 and 1998

In 1997 ACFM considered that this stock was within safe biological limits and that the SSB was stable and above the long term average. The TAC recommended was 21,000 t. The TAC subsequently set by the EU for 1998 was 22,000 t compared with TACs of 21,000 t over the period 1991 to 1996.

The spawning box closure system, which was first introduced in the late eighties and which is described in ICES (1989/Assess:15) was again continued during the 1997/98 season - the box closed being that in Division VIIj. This was closed for a fortnight in November 1997. The entire Irish fishery was again closed from mid-February 1997 through to early October 1997.

The total Irish quota was subdivided into boat quotas on a week by week basis. All vessels were again regulated by licences which restrict landings to specific ports and to specific times.

4.2.2 The fishery in 1997/1998

As has been the case for a number of years the major portion of the catches in this area was taken by the Irish fishery during the spawning season which normally lasts from October to February. This fishery is directed to the Japanese roe market.

The main feature of the fishery during 1997/98 was the very poor marketing conditions which prevailed throughout the whole season and as a result the number of vessels participating in the fishery was very much reduced. The maximum number of Irish vessels participating in 1997/1998 fishery was 58 although the average number participating was about 38. This was considerably lower than the number which participated in recent seasons when up to 70 vessels took part.

During the season shoals appeared to be abundant and there were no reports from fishermen of any scarcity of herring.

The distribution of the total international herring catches (t) in Sub-areas VI and VII per quarter per statistical rectangle, based on the logbooks and not corrected for misreporting is shown in Figure 4.2.1 a–d.

4.2.3 The catch data

The estimated national catches from 1988–1997 for the combined areas by year and by season (1 April–31 March) are given in Tables 4.2.1 and 4.2.2 respectively. The total catches for the fishery over the longer period from 1958 to 1997 are shown in Figure 4.2.2. The reported catch including the estimates of discards and unallocated landings, taken during the 1997/1998 season was nearly 20,000 t compared with 19,000 t during the previous season. Some slight revisions have been made to the 1996/97 catches which had the effect of increasing the catch for that season by about 1,400 t.

Discards

The level of discards in this fishery is believed to have decreased considerably in recent years. In 1997/98 because of the poor marketing conditions there was no incentive to discard as fish suitable for the Japanese "roe" market did not command a higher market price than non "roe" fish. There were no reports of discards from the fishery and therefore no landings were raised to include a discard level. This was in contrast to recent years when some of the landings were increased by 10 %-20 %.

4.2.4 Quality of catch and biological data

During 1997/98 there was a major increase in the monitoring of landings from this fishery and the management measures were tightly enforced throughout the season. The accuracy of the landing figures in recent years is now believed to have increased significantly.

Biological sampling of the catches throughout the area continues to be satisfactory and at a high level. Details of the sampling data per quarter are shown in Table 4.2.3, while the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 4.2.4.

4.2.5 Catches in numbers at age

The total catches in numbers at age, including discards, per season from 1958 to 1997 are shown in Table 4.4.2 The age composition in 1997/98 has been dominated by 3 w.ring fish (the 1993/1994 year class) which also dominated the catches in 1996/97. The 4 w.ring fish (1992/93 year class) constituted over 21 % of the catches.

4.3 Mean weights at age

As the major portion of the catch from this fishery continues to be taken during the spawning season the mean weights at age in the catches have traditionally been taken as the mean weights in the stock at spawning time (1 October). The mean weights from 1958 to 1997 are shown in Table 4.4.2. The mean weights appear to be reasonably stable although there has been a decrease of approximately 10 % in the values of the 1 - 3 w. ring fish in recent years.

4.4 Stock assessments

4.4.1 Acoustic surveys

No acoustic surveys have been carried out on this stock in 1997/98 and there is no fishery independent estimate of the stock in the most recent year. Acoustic surveys were carried out in 1990-1996 and two surveys were carried out each year which were designed to estimate the size of the autumn and winter spawning components separately. The separate estimates were then combined to give the estimate of the total stock. The total SSB estimated in 1996 was over 140,000 t and this was consistent with reports from fishermen about unusually dense shoals on the spawning grounds in that season.

The stock biomass estimates and the age disaggregated data for the stock, estimated at the time of the surveys, are shown in Table 4.4.1 The age distribution indicates that the 1993/94 year class was the strongest one to enter the fishery since 1990.

4.4.2 Results of Assessments

The integrated catch analysis program (See Section 1.5) has been used since 1994 to estimate the fishing mortality and the size of the stock. In the present analyses the age-disaggregated data from the acoustic surveys from 1990 to 1996 have again been used as the only tuning index available. The 0 and 1-ring fish have been excluded from the analyses as they are not believed to be fully recruited to the Celtic Sea from Division VIIa (North). The analyses carried out at the 1994 Working Group meeting indicated that the best fit to the ICA model was provided by using the acoustic surveys as a proportional index of stock abundance. The input data for the ICA analysis are shown in Table 4.4.2.

A preliminary ICA run was carried out using the same procedure as that adopted in previous years. The age dissaggregated data from the acoustic surveys was used as the tuning index but with missing values for 1997 in the absence of acoustic surveys for that year. The results showed a decreasing stock size and high values of F in the last three years. The SSB for 1997 was estimated to be 47,000 t and the fishing mortality to be 0.61. These values were considered to be inconsistent with the results from the acoustic surveys from 1994–1996 which showed an increasing trend in SSB. They were also inconsistent with reports from the fishery, which in recent years indicated unusually large concentrations of fish and in which there has been a considerable decrease in effort in 1997/98 because of the collapse of markets.

An examination of the diagnostics from the ICA model showed that there were unusually high residuals for the older age groups in the age structured index for the 1996 surveys. These residuals suggested that these age groups had been inadequately sampled by the surveys in that year. The 1997 WG discussed the results of the 1996 surveys and it was

pointed out that the surveys in that year were restricted to the inshore areas of the Celtic Sea and had not covered any part of Division VIIj. It is therefore possible that the surveys underestimated the numbers of older fish in the population because these older fish tend to be located in the offshore areas and in Div. VIIj. This underestimate would have had the effect of reducing the numbers of fish in the population estimated by ICA and would subsequently have produced the lower stock sizes.

Further ICA runs were carried out in which the SSB values from the acoustic surveys were used as the tuning fleet instead of the age disaggregated data.. These gave values of SSBs in recent years which were over 100,000 t and values of F which were lower than 0.3. It was felt that these values should be treated with caution because of the lack of survey data in 1997.

A further ICA run was then carried out in which fish older than 5 w. rings were omitted from the acoustic tuning index. (It should be pointed out that in 1996/97 and 1997/98 fish in age groups 2-5 constituted over 80 % of the catches throughout the Celtic Sa and Division VIIj.) The results of this run produced values of SSB and F which were similar to those produced by the 1997 assessment. The SSB estimated for 1997 is 69,000 t and the value of F=0.4. This run was considered to be the give the most realistic assessment of the state of the stock because it was based on the age structure of the stock. The results were also consistent with those obtained in the 1997 assessment. The results and the diagnostics are shown in Tables 4.4.3 and in Figures. 4.4.1 - 4.4.7.

Although there must be some uncertainty attached to the values, because of the lack of survey data in 1997, they do indicate some stability in the stock in recent years. The values of the SSBs estimated from ICA analysis since 1994 are shown below.

Season	Acoustic surveys	ICA in 1994	ICA in 1995	ICA in 1996	ICA in 1997	ICA in 1998
1990	91000	65300	57500	65000	66000	69200
1991	77000	55000	45600	55700	56800	58600
1992	71000	61600	44800	57300	59600	57100
1993	90000	62500	41200	55200	58200	55700
1994	50600	59100*	45000	67800	67900	69200
1995	114000	59700*	42700*	86000	71400	80200
1996	142000	60000*	35000*	93000*	67500	74700
1997					69,000	68500

*predicted values

4.5 Recruitment estimates

There are no recruitment indices available for this stock which can be used for predictive purposes. The numbers of 1-ring fish derived from the 1998 ICA model are shown in Figure 4.4.2. There has been no apparent trend in recent years and recruitment has fluctuated considerably. The geometric mean over the period 1983 to 1995 was taken as the most realistic value to be used in the catch predictions. This value was 562 million compared with a similar values of 543 million and 535 million used by the 1997 and 1996 working groups respectively.

4.6 Short term Projection

Because of the uncertainty about the current stock size and the lack of information on recruitment it was decided that projections over a medium or long term basis would be unrealistic. A short term projection was therefore carried out under the following assumptions.:

Average recruitment based on the geometric mean level of numbers of 1 w. ring fish from 1983–1995.

A catch in 1998 equal to 22,200 t which is the agreed TAC.

Mean weights in the stock and catch based on the average levels from 1993–1997.

Population numbers estimated at 1. January 1998 from the ICA analysis.

An SSB in 1997 of 68,500 t.

The input data used in the predictions are shown in Table 4.6.1.

The projections were carried forward to 1999 and 2000, assuming catch levels corresponding to those produced by F values equal to that of 1997, i.e. 0.398.

The catches in 1999 and 2000 are estimated to be around 18,900 t and 19,800 t respectively while the resultant SSB levels would be around 69,900 t and 71,700 t.

The data is summarised in Table 4.6.2 and the detailed output is shown in Table 4.6.3.

A projection was also carried out assuming that the TAC of 22,200 t would be taken in 1998 and that F in 1999 and 2000 would continue at about the same level as that generated by the 1998 TAC (F=0.47). The corresponding catches in 1999 and 2000 would be around 21,900 t and 21,800 t respectively while the resultant SSB levels would be around 69,100 t and 68,000 t. The detailed output of this projection is shown in Table 4.6.4. The prediction with the management options for 1999 is shown in Table 4.6.5.

The predictions indicate that the stock is at present in a stable condition and is likely to remain at about this level in 2000 if catches in 1999 are fixed at about 22,000 t i.e F=0.48.

4.7 Biological reference points and management considerations.

The biological reference points in relation to this stock are discussed in Section 1.6. It is apparent that in this stock recruitment may be independent of stock size. The stock collapsed in the seventies due to a decrease in recruitment which was not detected at the time. At present there is still no method of estimating the recruitment and in this situation a cautious approach is recommended. The stock size is now at a reasonably high level and recruitment in recent years has also been high. The analysis carried out in Section 1.6 suggests that in the present situation the Fpa should be about 0.4 which is in fact about the current level. The corresponding Bpa is estimated to be around 40,000 t.

It should be stressed that these reference require that the stock and recruitment must be monitored very precisely. If there are indications that recruitment is decreasing then immediate measures should be taken to reduce the fishing mortality to about to below 0.13 which is the level corresponding to the lowest observes SSB of 26,000 t which was present during the time of the closure of the main fishery.

Because of the need to monitor this stock closely it is important that the acoustic surveys should be resumed immediately and that adequate resources should be made available in order that they be maintained.

Protection of Spawning Grounds

The main Irish fishery takes place on the spawning grounds along the Irish coast. The spawning grounds are well known and are mainly located in shallow inshore waters. In recent years a number of these spawning grounds have come under threat from possible extraction of gravel, dumping of harbour silt and dredge spoil and from the sighting of fish farms. It is extremely important for the survival of the stock that these spawning grounds are adequately protected.

Table 4.2.1 Celtic Sea and Division VIIj herring landings by calendar year (t), 1987–1997. (Data provided by Working Group members.)

These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1987	800	-	15,500	1,500	-	5,300	4,200	27,300
1988	-	-	16,800	-	-	-	2,400	19,200
1989	+	-	16,000	1,900	-	1,300	3,500	22,700
1990	+	-	15,800	1,000	200	700	2,500	20,200
1991	+	100	19,400	1,600	-	600	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000
1993	-	-	19,000	1,300	+	-1,100	1,900	21,100
1994	+	200	17,400	1,300	+	-1,500	1,700	19,100
1995	200	200	18,000	100	+	-200	700	19,000
1996	1,000	0	18,600	1,000	-	-1,800	3,000	21,800
1997	1,300	0	18,000	1,400		-2,600	700	18,800

[1]Preliminary

Table 4.2.2 Celtic Sea and Division VIIj herring landings (t) by season (1 April–31 March) 1987/1988-1997/1998. (Data provided by Working Group members. 1997/98 figures are preliminary.).

These figures may not in all cases correspond to the offical statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1987/1988	800	-	15,500	1,500	-	4,400	4,000	26,200
1988/1989	-	-	17,000	-	-	-	3,400	20,400
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600
1994/1995	+	200	17,400	1,300	+	-1,500	1,900	19,300
1995/1996	200	200	20,000	100	+	-200	3,000	23,300
1996/1997	1,000	-	17,900	1,000	-	-1,800	750	18,800
1997/1998[1]	1,300		19,900	1,400		-2600	0	20,000

[1] Preliminary

Table 4.2.3 Celtic Sea, Division VIIj (1997–1998). Sampling intensity of commercial catches.

Country		Catch (t)	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t	Estimates of discards
Ireland	Q 4	13,000	40	1293	6898	99	Yes
	Q 1	6,900	27	1219	3807	177	Yes
Netherlands	Q3	1,400	0				
France	Q3	1300	0	-	-	-	-

Table 4.2.4 Celtic Sea and Division VIIj. Length distribution of Irish catches/quarter (thousands) **1997/98.**

Length	Division VIIa South		Division VIIg		Division VIIj	
	Q4 97	Q1 98	Q4 97	Q1 98	Q4 97	Q1 98
19						
						26
20	5	27	26			
	9	14		37	21	9
21	24	54	78		128	26
	9	68	209	37	156	44
22	28	203	183	148	355	61
	52	379	339	333	377	105
23	118	852	313	850	561	157
	198	1028	522	629	490	96
24	656	1947	1724	1811	1442	227
	844	1663	2665	2034	1755	289
25	1481	3826	4859	4252	3027	586
	1533	3245	4232	4659	2558	560
26	2174	4638	5695	6175	2501	743
	1424	3718	4415	5362	1428	507
27	1104	4272	4362	3587	1670	367
	642	2109	1907	1997	1030	218
28	439	1758	1358	1331	1592	105
	208	906	784	444	1037	70
29	179	608	627	222	1293	35
	94	54	105		846	35
30	61	41	105		654	9
	19			37	156	
31	14				36	
	5				7	
32						
Total	11322	31408	34510	33944	23,121	4276
Tonnes	1,700	4,300	5,100	4,600	3,600	600

Table 4.4.1 Total stock numbers at age (10^6) estimated using acoustic surveys estimates.

W.Rs	1990/1991	1991/1992	1992/1993	1993/1994	1994/1995	1995/1996	1996/1997
0	204.8	213.8	141.8	258.8	41.3	5.1	2.8
1	131.6	62.6	426.9	217.1	38.0	279.5	133.6
2	249.0	195.2	117.0	437.9	127.2	550.7	757.0
3	108.6	94.7	87.8	58.7	160.3	138.4	249.9
4	152.5	54.0	49.6	63.4	10.5	93.5	50.6
5	32.4	84.8	22.2	26.0	10.6	7.9	41.9
6	14.9	22.1	24.2	16.3	6.5	9.2	1.1
7	6.1	5.3	9.6	24.6	1.6	8.4	14.2
8	2.5	6.1	1.8	2.3	2.6	9.2	0.5
9+	1.5	-	1.1	1.7	0.5	4.7	1.8
Total	903.9	738.6	882.0	1,106.8	399.1	1106.5	1,253.4
TSB (000't)	103.0	84.4	88.5	104.0	51.8	134.6	151.3
SSB (000't)	91.0	77.0	71.0	90.0	50.6	114.0	145.8

Table 4.4.2 Herring in the Celtic Sea and VIIj
(run: ICACHR15/I15), 16.Mar.98
Output Generated by ICA Version 1.4

Catch in Number (x 10³)

AGE	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	1.64	1.20	2.84	2.13	.77	.30	7.53	.06	7.09	7.60	12.20
2	3.74	25.72	72.25	16.06	18.57	51.94	15.06	70.25	19.56	39.99	54.79
3	33.09	2.27	24.66	32.04	19.91	13.03	17.25	9.37	59.89	20.06	39.60
4	25.75	19.26	3.78	5.63	48.06	4.18	6.66	15.76	9.92	49.11	11.54
5	12.55	11.02	13.70	2.03	8.08	20.69	1.72	3.40	13.21	9.22	22.60
6	23.95	5.83	4.43	5.07	3.58	2.69	8.72	4.54	5.60	9.44	4.93
7	16.09	17.82	6.10	2.83	8.59	1.39	1.30	12.13	3.59	3.94	4.17
8	9.38	3.75	4.38	1.52	3.81	2.49	.58	1.38	8.75	6.51	1.31
9	5.58	7.35	4.15	4.95	5.32	2.79	2.19	7.49	3.84	6.76	4.94

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	9.47	1.32	12.66	8.42	23.55	5.51	12.77	13.32	8.16	2.80	11.34
2	93.28	37.26	23.31	137.69	38.13	42.81	15.43	11.11	12.52	13.39	13.91
3	55.04	50.09	37.56	17.86	55.81	17.18	17.78	7.29	8.61	11.95	12.40
4	33.15	26.48	41.90	15.84	7.01	22.53	7.33	7.01	5.28	5.58	8.64
5	12.22	18.76	18.76	14.53	9.65	4.23	9.01	2.87	1.59	1.58	2.89
6	17.84	7.85	10.44	4.64	5.32	3.74	3.52	4.79	1.90	1.48	1.32
7	4.76	6.35	4.28	3.01	3.35	2.98	1.64	1.98	1.04	.54	1.28
8	2.17	2.18	4.94	2.37	2.33	.90	1.14	1.24	.38	.86	.55
9	3.47	3.37	2.24	1.02	1.21	.83	1.19	1.77	.47	.48	.64

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	7.16	39.36	15.34	13.54	19.52	17.92	4.16	5.98	2.31	8.26	2.70
2	30.09	21.29	42.73	102.87	92.89	57.05	56.75	67.00	82.03	42.41	41.76
3	11.73	21.86	8.73	26.99	41.12	36.26	42.88	43.08	30.96	68.40	24.63
4	6.59	5.51	4.82	3.23	16.04	16.03	32.93	23.01	9.40	19.60	35.26
5	2.81	4.44	1.50	1.86	2.45	2.31	8.79	14.32	5.96	8.21	8.12
6	2.20	3.44	1.89	.33	1.09	.23	1.13	2.72	3.05	3.84	3.81
7	1.18	.80	1.67	.37	.38	.09	.10	1.18	.87	2.59	1.67
8	1.26	.31	.34	.93	.23	.17	.03	.30	.30	.77	.69
9	.56	.87	.60	.31	.18	.13	.01	.46	.09	.68	.46

AGE	1991	1992	1993	1994	1995	1996	1997
1	1.91	10.41	1.61	12.13	9.45	3.48	3.64
2	63.85	26.75	94.06	35.77	79.16	61.92	35.95
3	38.34	35.02	9.37	61.74	22.59	38.24	51.98
4	16.92	27.59	10.22	3.29	36.54	7.94	30.19
5	28.41	10.14	4.49	3.03	3.69	16.11	8.20
6	4.87	18.06	2.79	4.77	3.42	2.08	6.12
7	2.59	3.02	5.93	1.71	2.65	1.59	1.10
8	.95	6.29	.86	1.71	1.86	1.51	.81
9	.59	.69	.51	.47	.84	1.03	.60

Predicted Catch in Number (x 10³)

AGE	1992	1993	1994	1995	1996	1997
1	12075.	3084.	6437.	8734.	3180.	3639.
2	28327.	77317.	29617.	89544.	74884.	36266.
3	34143.	9761.	46083.	25920.	46522.	54308.
4	26510.	8883.	4597.	32120.	10559.	26881.
5	10935.	6700.	4036.	3107.	12633.	5885.
6	16270.	3531.	3814.	3388.	1536.	8780.
7	3121.	4828.	1882.	2997.	1564.	1003.
8	6285.	828.	2326.	1342.	1248.	925.

Table 4.4.2 (Cont'd) Weights at age in the catches (kg)

AGE	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.11500	.11500	.11500	.11500	.09300	.10400	.11200	.09600	.09700	.10600	.09900
2	.17400	.17400	.17400	.17400	.14200	.14000	.15500	.13800	.13200	.12900	.13700
3	.21100	.21100	.21100	.21100	.18500	.17000	.17200	.18600	.16800	.15100	.15300
4	.22900	.22900	.22900	.22900	.21300	.20100	.18700	.19200	.20300	.16900	.16700
5	.24400	.24400	.24400	.24400	.21300	.23400	.21500	.20400	.20900	.19400	.18800
6	.25700	.25700	.25700	.25700	.24500	.24800	.24800	.23100	.21500	.19900	.20800
7	.26000	.26000	.26000	.26000	.24600	.25600	.27600	.25500	.23700	.21000	.20900
8	.26300	.26300	.26300	.26300	.26300	.26000	.28400	.26700	.25700	.22100	.22900
9	.26600	.26600	.26600	.26600	.26200	.26300	.33200	.28400	.28300	.24000	.25100

AGE	1991	1992	1993	1994	1995	1996	1997
1	.09200	.09600	.09200	.09700	.08800	.08800	.09300
2	.12800	.12300	.12900	.13500	.12600	.11800	.12400
3	.16800	.15000	.15500	.16800	.15100	.14700	.14100
4	.18200	.17700	.18000	.17900	.17800	.15900	.15700
5	.19000	.19100	.20100	.19000	.18800	.18500	.17200
6	.20600	.19400	.20400	.21000	.19800	.19600	.19200
7	.22900	.21200	.21000	.21800	.20700	.20700	.20600
8	.23600	.22800	.22500	.21700	.22700	.21900	.21600
9	.25100	.24800	.24000	.22700	.22700	.23100	.22000

Table 4.4.2 (Cont'd) **Weights at age in the stock (kg)**

AGE	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500	.11500
2	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400	.17400
3	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100	.21100
4	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900	.22900
5	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400	.24400
6	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700	.25700
7	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000	.26000
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26300
9	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600	.26600

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.11500	.11500	.11500	.11500	.09300	.10400	.11200	.09600	.09700	.10600	.09900
2	.17400	.17400	.17400	.17400	.14200	.14000	.15500	.13800	.13200	.12900	.13700
3	.21100	.21100	.21100	.21100	.18500	.17000	.17200	.18600	.16800	.15100	.15300
4	.22900	.22900	.22900	.22900	.21300	.20100	.18700	.19200	.20300	.16900	.16700
5	.24400	.24400	.24400	.24400	.21300	.23400	.21500	.20400	.20900	.19400	.18800
6	.25700	.25700	.25700	.25700	.24500	.24800	.24800	.23100	.21500	.19900	.20800
7	.26000	.26000	.26000	.26000	.24600	.25600	.27600	.25500	.23700	.21000	.20900
8	.26300	.26300	.26300	.26300	.26300	.26000	.28400	.26700	.25700	.22100	.22900
9	.26600	.26600	.26600	.26600	.26200	.26300	.33200	.28400	.28300	.24000	.25100

AGE	1991	1992	1993	1994	1995	1996	1997
1	.09200	.09600	.09200	.09700	.08800	.08800	.09300
2	.12800	.12300	.12900	.13500	.12600	.11800	.12400
3	.16800	.15000	.15500	.16800	.15100	.14700	.14100
4	.18200	.17700	.18000	.17900	.17800	.15900	.15700
5	.19000	.19100	.20100	.19000	.18800	.18500	.17200
6	.20600	.19400	.20400	.21000	.19800	.19600	.19200
7	.22900	.21200	.21000	.21800	.20700	.20700	.20600
8	.23600	.22800	.22500	.21700	.22700	.21900	.21600
9	.25100	.24800	.24000	.22700	.22700	.23100	.22000

Table 4.4.2 (Cont'd) **Natural Mortality (per year)**

AGE	1958	1959	1960	1961	etc	1994	1995	1996	1997
1	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000
2	.3000	.3000	.3000	.3000	fixed	.3000	.3000	.3000	.3000
3	.2000	.2000	.2000	.2000	fixed	.2000	.2000	.2000	.2000
4	.1000	.1000	.1000	.1000	fixed	.1000	.1000	.1000	.1000
5	.1000	.1000	.1000	.1000	fixed	.1000	.1000	.1000	.1000
6	.1000	.1000	.1000	.1000	fixed	.1000	.1000	.1000	.1000
7	.1000	.1000	.1000	.1000	fixed	.1000	.1000	.1000	.1000
8	.1000	.1000	.1000	.1000	fixed	.1000	.1000	.1000	.1000
9	.1000	.1000	.1000	.1000	fixed	.1000	.1000	.1000	.1000

Proportion of fish spawning

AGE	1958	1959	1960	1961	etc	1994	1995	1996	1997
1	.5000	.5000	.5000	.5000	fixed	.5000	.5000	.5000	.5000
2	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	fixed	1.0000	1.0000	1.0000	1.0000

Table 4.4.3

AGE-STRUCTURED INDICES: FLT02: celtic combined acc data (Catch in tonnes)

AGE	1990	1991	1992	1993	1994	1995	1996
2	249.00	195.20	117.00	437.90	127.20	550.70	757.00
3	108.60	94.70	87.80	58.70	160.30	138.40	249.90
4	152.50	54.00	49.60	63.40	10.50	93.50	50.60
5	32.40	84.80	22.20	26.00	10.60	7.90	41.90

Fishing Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	.0082	.0019	.0136	.0137	.0025	.0017	.0116	.0002	.0172	.0177	.0230
2	.1225	.2954	.2491	.1667	.2718	.4021	.1884	.2435	.1831	.2148	.2932
3	.3572	.1076	.5503	.1767	.3411	.3319	.2393	.1817	.3601	.3079	.3639
4	.5301	.3447	.2480	.2186	.4110	.1051	.2674	.3392	.2821	.5347	.2771
5	.4103	.4019	.3905	.1833	.4883	.2772	.0517	.1901	.4680	.4068	.4460
6	.5069	.3019	.2487	.2177	.4956	.2638	.1612	.1680	.4787	.6365	.3521
7	.8165	.7802	.5218	.2219	.6056	.3227	.1768	.3128	.1741	.6471	.5700
8	.4719	.3943	.3886	.2104	.4605	.3106	.1919	.2557	.3462	.4789	.4081
9	.4719	.3943	.3886	.2104	.4605	.3106	.1919	.2557	.3462	.4789	.4081

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.0333	.0087	.0231	.0498	.1244	.0651	.1406	.1066	.0767	.0332	.0780
2	.4312	.3056	.3619	.6909	.6060	.6463	.4659	.3042	.2369	.3008	.4022
3	.5786	.4677	.6207	.5613	.7374	.6636	.6694	.4496	.4378	.3977	.5409
4	.5585	.5810	.8694	.5524	.4246	.7243	.6352	.5796	.6530	.5371	.5304
5	.4666	.6307	.9544	.7580	.6850	.4342	.6350	.4854	.2192	.3644	.5220
6	.6720	.5484	.7764	.5770	.6156	.5472	.6923	.7350	.6087	.2904	.5179
7	.5973	.4743	.5789	.4701	.9692	.7453	.4377	.9655	.3044	.3067	.3907
8	.5846	.5322	.7356	.6554	.7184	.6698	.6296	.6128	.4295	.3904	.5177
9	.5846	.5322	.7356	.6554	.7184	.6698	.6296	.6128	.4295	.3904	.5177

Table 4.4.3 (Cont'd)

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.0805	.1628	.0373	.0296	.0557	.0497	.0123	.0093	.0086	.0253	.0096
2	.5541	.6740	.4814	.6923	.5212	.4026	.3845	.4998	.2907	.3758	.2955
3	.7668	1.1663	.7136	.6990	.7258	.4240	.6521	.6120	.4897	.4493	.4182
4	.5889	1.0007	.8517	.5990	1.2064	.6670	.8166	.8585	.2433	.6286	.4178
5	.2907	.9061	.7300	.8533	1.1570	.4686	.8528	.9325	.4951	.3088	.5121
6	.8588	.6058	1.1806	.3017	1.9695	.2561	.3902	.6173	.4520	.6073	.2054
7	1.1129	.7822	.5930	.6782	.5913	.7738	.1494	.7944	.3603	.7663	.5149
8	.7302	.9111	.8037	.6908	1.0899	.5281	.5818	.7658	.4154	.5491	.4196
9	.7302	.9111	.8037	.6908	1.0899	.5281	.5818	.7658	.4154	.5491	.4196

AGE	1991	1992	1993	1994	1995	1996	1997
1	.0157	.0238	.0141	.0121	.0158	.0122	.0125
2	.5885	.6134	.3629	.3131	.4076	.3145	.3234
3	.5203	.8031	.4751	.4099	.5337	.4118	.4234
4	.5375	.7986	.4724	.4076	.5306	.4094	.4210
5	.6180	.7088	.4193	.3617	.4710	.3634	.3736
6	.5855	.7780	.4603	.3971	.5170	.3989	.4101
7	.1879	.8271	.4893	.4221	.5496	.4241	.4360
8	.5531	.8031	.4751	.4099	.5337	.4118	.4234
9	.5531	.8031	.4751	.4099	.5337	.4118	.4234

Population Abundance (1 January) (x 10^6)

AGE	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	316.7	1026.6	332.1	247.2	489.8	275.1	1028.6	366.3	658.8	685.5	848.2
2	37.4	115.5	376.9	120.5	89.7	179.7	101.0	374.0	134.7	238.2	247.8
3	120.9	24.5	63.7	217.7	75.6	50.6	89.1	62.0	217.2	83.1	142.4
4	65.5	69.2	18.0	30.1	149.4	44.0	29.7	57.4	42.3	124.1	50.0
5	39.1	34.9	44.4	12.7	21.9	89.6	35.8	20.6	37.0	28.9	65.8
6	63.0	23.4	21.1	27.2	9.6	12.1	61.4	30.8	15.4	21.0	17.4
7	30.1	34.3	15.7	14.9	19.8	5.3	8.4	47.3	23.6	8.6	10.0
8	26.1	12.0	14.2	8.4	10.8	9.8	3.5	6.4	31.3	17.9	4.1
9	15.5	23.6	13.5	27.3	15.1	10.9	13.2	34.8	13.8	18.6	15.4

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	456.8	241.5	873.8	273.3	315.3	137.5	152.3	206.5	173.7	135.3	237.4
2	305.0	162.6	88.1	314.1	95.7	102.4	47.4	48.7	68.3	59.2	48.1
3	136.9	146.8	88.7	45.4	116.6	38.7	39.8	22.0	26.6	39.9	32.5
4	81.0	62.8	75.3	39.0	21.2	45.7	16.3	16.7	11.5	14.1	22.0
5	34.3	41.9	31.8	28.6	20.3	12.6	20.0	7.8	8.4	5.4	7.4
6	38.1	19.5	20.2	11.1	12.1	9.3	7.4	9.6	4.4	6.1	3.4
7	11.1	17.6	10.2	8.4	5.6	5.9	4.9	3.3	4.2	2.1	4.2
8	5.1	5.5	9.9	5.2	4.8	1.9	2.5	2.8	1.1	2.8	1.4
9	8.2	8.5	4.5	2.2	2.5	1.8	2.7	4.0	1.4	1.6	1.6

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	145.6	409.1	661.2	731.7	567.0	582.2	535.9	1025.1	425.7	522.9	449.4
2	80.8	49.4	127.9	234.3	261.3	197.3	203.8	194.7	373.6	155.2	187.6
3	23.9	34.4	18.7	58.5	86.9	115.0	97.7	102.8	87.5	207.0	79.0
4	15.5	9.1	8.8	7.5	23.8	34.4	61.6	41.7	45.6	43.9	108.1
5	11.7	7.8	3.0	3.4	3.7	6.5	16.0	24.6	16.0	32.4	21.2
6	4.0	7.9	2.8	1.3	1.3	1.1	3.7	6.2	8.8	8.8	21.5
7	1.8	1.5	3.9	.8	.9	.2	.7	2.2	3.0	5.1	4.3
8	2.5	.5	.6	2.0	.4	.4	.1	.6	.9	1.9	2.1
9	1.1	1.5	1.1	.6	.3	.3	.0	.9	.3	1.7	1.4

Table 4.4.3 (cont'd)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	194.5	811.2	348.9	843.3	880.1	414.7	461.6	589.1
2	163.7	70.4	291.4	126.5	306.5	318.7	150.7	167.7
3	103.4	67.3	28.3	150.2	68.5	151.0	172.4	80.8
4	42.6	50.3	24.7	14.4	81.6	32.9	81.9	92.4
5	64.4	22.5	20.5	13.9	8.7	43.4	19.8	48.7
6	11.5	31.4	10.0	12.2	8.8	4.9	27.3	12.3
7	15.8	5.8	13.1	5.7	7.4	4.7	3.0	16.4
8	2.3	11.9	2.3	7.2	3.4	3.9	2.8	1.7
9	1.5	1.3	1.4	1.5	2.1	3.2	1.8	2.7

Weighting factors for the catches in number

AGE	1992	1993	1994	1995	1996	1997
1	.1000	.1000	.1000	.1000	.1000	.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted Age-Structured Index Values: FLT02: celtic combined acc data

AGE	1990	1991	1992	1993	1994	1995	1996
2	316.25	205.97	86.42	459.34	209.65	461.98	527.25
3	123.74	146.28	71.80	41.82	237.26	95.68	238.18
4	152.57	53.29	48.52	33.00	20.51	102.88	46.84
5	22.41	61.29	19.55	23.78	17.13	9.54	53.31

Fitted Selection Pattern

AGE	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	.0230	.0172	.0247	.0776	.0073	.0051	.0486	.0014	.0476	.0574	.0631
2	.3430	2.7443	.4526	.9438	.7968	1.2118	.7871	1.3398	.5084	.6975	.8056
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.4843	3.2021	.4506	1.2373	1.2048	.3166	1.1175	1.8667	.7833	1.7367	.7615
5	1.1486	3.7337	.7097	1.0377	1.4317	.8354	.2160	1.0461	1.2996	1.3211	1.2255
6	1.4193	2.8050	.4519	1.2320	1.4531	.7949	.6735	.9248	1.3292	2.0673	.9675
7	2.2860	7.2487	.9482	1.2559	1.7756	.9722	.7389	1.7213	.4833	2.1016	1.5664
8	1.3214	3.6630	.7062	1.1912	1.3502	.9360	.8020	1.4071	.9612	1.5552	1.1215
9	1.3214	3.6630	.7062	1.1912	1.3502	.9360	.8020	1.4071	.9612	1.5552	1.1215

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.0575	.0185	.0373	.0887	.1686	.0981	.2100	.2372	.1752	.0835	.1443
2	.7452	.6533	.5830	1.2308	.8218	.9740	.6960	.6767	.5411	.7564	.7436
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	.9653	1.2422	1.4007	.9841	.5758	1.0915	.9488	1.2892	1.4914	1.3504	.9806
5	.8064	1.3483	1.5377	1.3505	.9289	.6543	.9486	1.0798	.5005	.9162	.9651
6	1.1614	1.1724	1.2509	1.0279	.8347	.8246	1.0341	1.6348	1.3902	.7301	.9575
7	1.0322	1.0140	.9326	.8375	1.3143	1.1232	.6538	2.1477	.6951	.7712	.7223
8	1.0102	1.1379	1.1852	1.1676	.9742	1.0093	.9404	1.3632	.9809	.9815	.9572
9	1.0102	1.1379	1.1852	1.1676	.9742	1.0093	.9404	1.3632	.9809	.9815	.9572

Table 4.4.3 (Cont'd)

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.1049	.1395	.0522	.0424	.0768	.1172	.0189	.0151	.0176	.0562	.0228
2	.7227	.5779	.6747	.9903	.7181	.9496	.5897	.8167	.5937	.8365	.7065
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	.7681	.8580	1.1936	.8569	1.6622	1.5731	1.2522	1.4028	.4969	1.3990	.9991
5	.3791	.7769	1.0230	1.2207	1.5942	1.1053	1.3078	1.5236	1.0111	.6872	1.2246
6	1.1200	.5194	1.6545	.4316	2.7136	.6039	.5984	1.0086	.9231	1.3517	.4912
7	1.4515	.6706	.8310	.9703	.8148	1.8252	.2291	1.2981	.7358	1.7055	1.2313
8	.9523	.7812	1.1263	.9882	1.5017	1.2456	.8922	1.2513	.8483	1.2220	1.0033
9	.9523	.7812	1.1263	.9882	1.5017	1.2456	.8922	1.2513	.8483	1.2220	1.0033

AGE	1991	1992	1993	1994	1995	1996	1997
1	.0301	.0296	.0296	.0296	.0296	.0296	.0296
2	1.1312	.7638	.7638	.7638	.7638	.7638	.7638
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0331	.9943	.9943	.9943	.9943	.9943	.9943
5	1.1879	.8825	.8825	.8825	.8825	.8825	.8825
6	1.1254	.9688	.9688	.9688	.9688	.9688	.9688
7	.3612	1.0298	1.0298	1.0298	1.0298	1.0298	1.0298
8	1.0631	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0631	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4.4.3 STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 7	SoP (%)
1958	316650	127975	88922	22978	.2584	.4572	73
1959	1026550	192104	99200	15086	.1521	.3720	70
1960	332110	149024	104284	18283	.1753	.3681	67
1961	247180	125671	93833	15372	.1638	.1975	100
1962	489820	141887	90252	21552	.2388	.4356	82
1963	275120	115513	81477	17349	.2129	.2838	85
1964	1028600	192623	101550	10599	.1044	.1808	85
1965	366260	169619	121995	19126	.1568	.2392	75
1966	658800	185735	117078	27030	.2309	.3243	96
1967	685490	190564	118117	27658	.2342	.4580	85
1968	848210	210456	124701	30236	.2425	.3837	96
1969	456800	177601	117596	44389	.3775	.5507	94
1970	241510	124950	89001	31727	.3565	.5013	96
1971	873760	171163	87032	31396	.3607	.6936	94
1972	273340	118563	77403	38203	.4936	.6016	98
1973	315340	93819	56327	26936	.4782	.6730	95
1974	137510	60221	40067	19940	.4977	.6268	99
1975	152260	47302	29316	15588	.5317	.5893	113
1976	206460	47739	26869	9771	.3636	.5866	99
1977	173710	45044	26949	7833	.2907	.4100	104
1978	135290	42101	26913	7559	.2809	.3662	98
1979	237350	52130	28617	10321	.3607	.4840	103
1980	145580	44698	27269	13130	.4815	.6954	108
1981	409080	69845	31065	17103	.5505	.8558	103
1982	661150	107177	47369	13000	.2744	.7584	95
1983	731690	141038	68791	24981	.3631	.6372	93
1984	566980	112480	62075	26779	.4314	1.0285	99
1985	582230	116649	63871	20426	.3198	.4987	102
1986	535910	124512	69754	25024	.3587	.5409	100
1987	1025070	159831	78397	26200	.3342	.7191	99
1988	425650	120822	78426	20447	.2607	.3885	100
1989	522850	124041	73446	23254	.3166	.5227	100
1990	449370	110528	69186	18404	.2660	.3940	99
1991	194470	83125	58628	25562	.4360	.5063	101
1992	811200	120199	57061	21127	.3702	.7548	95
1993	348850	88268	55725	18618	.3341	.4465	100
1994	843300	135049	69201	19300	.2789	.3852	99
1995	880100	147099	80175	23305	.2907	.5016	100
1996	414700	113094	74717	18816	.2518	.3870	100
1997	461590	109053	68533	19987	.2916	.3979	100

```
 IFAP run code: I15
-------------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1958  . . . 1997
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 29
Number of observations : 76

Conventional single selection vector model to be fitted.
-------------------------------------------------------------------
```

Table 4.4.3 (Cont'd)

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	.8031	13	.6213	1.0381	.7045	.9155	.8100
2	1993	.4751	14	.3606	.6259	.4128	.5469	.4798
3	1994	.4099	14	.3080	.5455	.3543	.4742	.4143
4	1995	.5337	15	.3917	.7271	.4558	.6249	.5403
5	1996	.4118	20	.2768	.6124	.3363	.5042	.4203
6	1997	.4234	28	.2435	.7361	.3193	.5614	.4406
Separable Model: Selection (S) by age								
7	1	.0296	40	.0135	.0651	.0198	.0443	.0321
8	2	.7638	15	.5632	1.0360	.6538	.8923	.7731
	3	1.0000		Fixed : Reference Age				
9	4	.9943	14	.7532	1.3127	.8629	1.1457	1.0044
10	5	.8825	13	.6762	1.1519	.7704	1.0110	.8907
11	6	.9688	13	.7496	1.2521	.8499	1.1042	.9771
12	7	1.0298	13	.7962	1.3320	.9032	1.1743	1.0388
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 1997								
13	1	461589	98	67253	3168088	172762	1233282	748135
14	2	150710	35	74778	303746	105402	215492	160659
15	3	172382	24	106953	277839	135122	219917	177571
16	4	81924	22	53193	126172	65723	102117	83937
17	5	19774	21	12925	30250	15918	24563	20244
18	6	27328	21	17999	41491	22084	33816	27955
19	7	2969	22	1893	4655	2360	3735	3048
20	8	2804	25	1702	4618	2174	3617	2896
Separable model: Populations at age								
21	1992	11883	28	6824	20690	8954	15769	12368
22	1993	2289	23	1439	3641	1807	2901	2354
23	1994	7242	21	4773	10988	5854	8958	7407
24	1995	3394	19	2309	4987	2789	4130	3460
25	1996	3871	21	2533	5915	3118	4806	3962

Age-structured index catchabilities: FLT02: celtic combined acc data

Linear model fitted. Slopes at age :								
26	2	Q	.3059E-02	14	.2650E-02	.4757E-02	.3059E-02	.4122E-02	.3591E-02
27	3	Q	.2907E-02	14	.2518E-02	.4530E-02	.2907E-02	.3923E-02	.3415E-02
28	4	Q	.2368E-02	15	.2047E-02	.3714E-02	.2368E-02	.3210E-02	.2789E-02
29	5	Q	.1951E-02	15	.1682E-02	.3080E-02	.1951E-02	.2656E-02	.2304E-02

Table 4.4.3 (Cont'd)

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997
1	-.1484	-.6514	.6335	.0788	.0889	.0000
2	-.0572	.1960	.1887	-.1233	-.1901	-.0089
3	.0253	-.0406	.2924	-.1374	-.1959	-.0439
4	.0400	.1403	-.3349	.1290	-.2846	.1160
5	-.0756	-.4001	-.2885	.1709	.2434	.3318
6	.1044	-.2357	.2244	.0095	.3015	-.3607
7	-.0325	.2060	-.0940	-.1226	.0142	.0955
8	.0000	.0325	-.3105	.3258	.1886	-.1349

AGE-STRUCTURED INDEX RESIDUALS: FLT02: celtic combined acc data

Age	1990	1991	1992	1993	1994	1995	1996
2	-.2391	-.0537	.3030	-.0478	-.4997	.1757	.3617
3	-.1305	-.4348	.2012	.3391	-.3921	.3691	.0481
4	-.0005	.0132	.0220	.6530	-.6694	-.0956	.0773
5	.3685	.3247	.1271	.0894	-.4799	-.1890	-.2409

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 1997

Variance	.0750
Skewness test stat.	-.6187
Kurtosis test statistic	-1.0253
Partial chi-square	.1998
Significance in fit	.0000
Degrees of freedom	23

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT02: celtic combined acc data
Linear catchability relationship assumed

Age	2	3	4	5
Variance	.0589	.0681	.0927	.0614
Skewness test stat.	-.3908	-.2550	-.0746	-.2791
Kurtosis test statisti	-.5312	-.7970	.2053	-.6674
Partial chi-square	.0650	.0876	.1712	.1180
Significance in fit	.0000	.0000	.0001	.0000
Number of observations	7	7	7	7
Degrees of freedom	6	6	6	6
Weight in the analysis	.6250	.6250	.6250	.6250

Table 4.4.3 (Cont'd)

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	5.2006	76	29	47	.1107
Catches at age	2.5015	48	25	23	.1088
Aged Indices					
FLT02: celtic combined acc data	2.6991	28	4	24	.1125

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	2.7803	76	29	47	.0592
Catches at age	1.7259	48	25	23	.0750
Aged Indices					
FLT02: celtic combined acc data	1.0543	28	4	24	.0439

Table 4.6.1

Herring South and South West of Ireland (Celtic Sea + VIIj)

Single option prediction: Input data

Year: 1998								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	560.800	1.0000	0.5000	0.2000	0.5000	92.000	0.0125	92.000
2	167.700	0.3000	1.0000	0.2000	0.5000	126.000	0.3234	126.000
3	80.800	0.2000	1.0000	0.2000	0.5000	152.000	0.4234	152.000
4	92.400	0.1000	1.0000	0.2000	0.5000	171.000	0.4209	171.000
5	48.700	0.1000	1.0000	0.2000	0.5000	187.000	0.3736	187.000
6	12.300	0.1000	1.0000	0.2000	0.5000	200.000	0.4101	200.000
7	16.400	0.1000	1.0000	0.2000	0.5000	210.000	0.4360	210.000
8	1.700	0.1000	1.0000	0.2000	0.5000	221.000	0.4234	221.000
9+	2.700	0.1000	1.0000	0.2000	0.5000	229.000	0.4234	229.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	560.800	1.0000	0.5000	0.2000	0.5000	92.000	0.0125	92.000
2	.	0.3000	1.0000	0.2000	0.5000	126.000	0.3234	126.000
3	.	0.2000	1.0000	0.2000	0.5000	152.000	0.4234	152.000
4	.	0.1000	1.0000	0.2000	0.5000	171.000	0.4209	171.000
5	.	0.1000	1.0000	0.2000	0.5000	187.000	0.3736	187.000
6	.	0.1000	1.0000	0.2000	0.5000	200.000	0.4101	200.000
7	.	0.1000	1.0000	0.2000	0.5000	210.000	0.4360	210.000
8	.	0.1000	1.0000	0.2000	0.5000	221.000	0.4234	221.000
9+	.	0.1000	1.0000	0.2000	0.5000	229.000	0.4234	229.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	560.800	1.0000	0.5000	0.2000	0.5000	92.000	0.0125	92.000
2	.	0.3000	1.0000	0.2000	0.5000	126.000	0.3234	126.000
3	.	0.2000	1.0000	0.2000	0.5000	152.000	0.4234	152.000
4	.	0.1000	1.0000	0.2000	0.5000	171.000	0.4209	171.000
5	.	0.1000	1.0000	0.2000	0.5000	187.000	0.3736	187.000
6	.	0.1000	1.0000	0.2000	0.5000	200.000	0.4101	200.000
7	.	0.1000	1.0000	0.2000	0.5000	210.000	0.4360	210.000
8	.	0.1000	1.0000	0.2000	0.5000	221.000	0.4234	221.000
9+	.	0.1000	1.0000	0.2000	0.5000	229.000	0.4234	229.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : SPRJM01
Date and time: 16MAR98:11:21

Table 4.6.2

Herring South and South West of Ireland (Celtic Sea + VIIj)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.1702	0.4656	143278	22200	983500	116811	703100	91014	520208	70024
1999	1.0000	0.3979	123774	18898	987282	116254	706882	90457	525617	69944
2000	1.0000	0.3979	129401	19751	1002754	118492	722354	92695	537842	71694
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRJM01
Date and time : 16MAR98:11:21
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : F factors

Table 4.6.3

Herring South and South West of Ireland (Celtic Sea + VIIj)

Single option prediction: Detailed tables

Year: 1998 F-factor: 1.1702 Reference F: 0.4656

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0146	5154	474	560800	51594	280400	25797	169574	15601
2	0.3784	46080	5806	167700	21130	167700	21130	133819	16861
3	0.4955	28848	4385	80800	12282	80800	12282	66214	10064
4	0.4925	34338	5872	92400	15800	92400	15800	79648	13620
5	0.4372	16472	3080	48700	9107	48700	9107	42446	7937
6	0.4799	4479	896	12300	2460	12300	2460	10629	2126
7	0.5102	6263	1315	16400	3444	16400	3444	14087	2958
8	0.4955	635	140	1700	376	1700	376	1465	324
9+	0.4955	1008	231	2700	618	2700	618	2326	533
Total		143278	22200	983500	116811	703100	91014	520208	70024
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1999 F-factor: 1.0000 Reference F: 0.3979

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0125	4408	406	560800	51594	280400	25797	169647	15607
2	0.3234	48926	6165	203311	25617	203311	25617	164031	20668
3	0.4234	26809	4075	85092	12934	85092	12934	70743	10753
4	0.4209	13223	2261	40307	6892	40307	6892	35245	6027
5	0.3736	15204	2843	51090	9554	51090	9554	45099	8434
6	0.4101	9142	1828	28460	5692	28460	5692	24940	4988
7	0.4360	2325	488	6887	1446	6887	1446	6004	1261
8	0.4234	2937	649	8909	1969	8909	1969	7787	1721
9+	0.4234	800	183	2426	555	2426	555	2120	486
Total		123774	18898	987282	116254	706882	90457	525617	69944
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.0000 Reference F: 0.3979

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0125	4408	406	560800	51594	280400	25797	169647	15607
2	0.3234	49030	6178	203744	25672	203744	25672	164381	20712
3	0.4234	34341	5220	108999	16568	108999	16568	90618	13774
4	0.4209	14966	2559	45619	7801	45619	7801	39891	6821
5	0.3736	7125	1332	23942	4477	23942	4477	21134	3952
6	0.4101	10221	2044	31817	6363	31817	6363	27882	5576
7	0.4360	5767	1211	17088	3589	17088	3589	14897	3128
8	0.4234	1328	294	4030	891	4030	891	3522	778
9+	0.4234	2214	507	6716	1538	6716	1538	5870	1344
Total		129401	19751	1002754	118492	722354	92695	537842	71694
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRJM01
Date and time : 16MAR98:11:21
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : F factors

Table 4.6.4

Herring South and South West of Ireland (Celtic Sea + VIIj)

Single option prediction: Detailed tables

Year: 1998 F-factor: 1.1702 Reference F: 0.4656

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0146	5154	474	560800	51594	280400	25797	169574	15601
2	0.3784	46080	5806	167700	21130	167700	21130	133819	16861
3	0.4955	28848	4385	80800	12282	80800	12282	66214	10064
4	0.4925	34338	5872	92400	15800	92400	15800	79648	13620
5	0.4372	16472	3080	48700	9107	48700	9107	42446	7937
6	0.4799	4479	896	12300	2460	12300	2460	10629	2126
7	0.5102	6263	1315	16400	3444	16400	3444	14087	2958
8	0.4955	635	140	1700	376	1700	376	1465	324
9+	0.4955	1008	231	2700	618	2700	618	2326	533
Total		143278	22200	983500	116811	703100	91014	520208	70024
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1999 F-factor: 1.2000 Reference F: 0.4775

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0150	5284	486	560800	51594	280400	25797	169562	15600
2	0.3881	57043	7187	203311	25617	203311	25617	161923	20402
3	0.5081	30981	4709	85092	12934	85092	12934	69555	10572
4	0.5051	15274	2612	40307	6892	40307	6892	34657	5926
5	0.4483	17631	3297	51090	9554	51090	9554	44430	8309
6	0.4921	10569	2114	28460	5692	28460	5692	24534	4907
7	0.5232	2682	563	6887	1446	6887	1446	5901	1239
8	0.5081	3392	750	8909	1969	8909	1969	7656	1692
9+	0.5081	923	211	2426	555	2426	555	2084	477
Total		143780	21930	987282	116254	706882	90457	520302	69124
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.2000 Reference F: 0.4775

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0150	5284	486	560800	51594	280400	25797	169562	15600
2	0.3881	57022	7185	203235	25608	203235	25608	161863	20395
3	0.5081	37200	5654	102172	15530	102172	15530	83516	12694
4	0.5051	15884	2716	41915	7168	41915	7168	36040	6163
5	0.4483	7595	1420	22009	4116	22009	4116	19140	3579
6	0.4921	10965	2193	29526	5905	29526	5905	25453	5091
7	0.5232	6129	1287	15743	3306	15743	3306	13487	2832
8	0.5081	1406	311	3693	816	3693	816	3174	701
9+	0.5081	2349	538	6171	1413	6171	1413	5303	1214
Total		143834	21791	985264	115455	704864	89658	517537	68269
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRJM01
Date and time : 16MAR98:11:21
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : F factors

Table 4.6.5

The SAS System 14:38 Wednesday, March 18, 1998

Herring South and South West of Ireland (Celtic Sea + VIIj)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.1702	0.4656	116811	70024	22200	0.0000	0.0000	116253	74234	0	137594	94038
.	.	.	.	.	0.1000	0.0398	.	73790	2212	135346	91340
.	.	.	.	.	0.2000	0.0796	.	73350	4345	133180	88759
.	.	.	.	.	0.3000	0.1194	.	72913	6402	131095	86288
.	.	.	.	.	0.4000	0.1592	.	72479	8386	129086	83923
.	.	.	.	.	0.5000	0.1990	.	72048	10299	127151	81658
.	.	.	.	.	0.6000	0.2387	.	71621	12145	125287	79490
.	.	.	.	.	0.7000	0.2785	.	71197	13925	123492	77413
.	.	.	.	.	0.8000	0.3183	.	70776	15642	121763	75424
.	.	.	.	.	0.9000	0.3581	.	70358	17299	120096	73519
.	.	.	.	.	1.0000	0.3979	.	69944	18898	118491	71694
.	.	.	.	.	1.1000	0.4377	.	69532	20441	116945	69945
.	.	.	.	.	1.2000	0.4775	.	69124	21929	115455	68269
.	.	.	.	.	1.3000	0.5173	.	68719	23366	114019	66663
.	.	.	.	.	1.4000	0.5571	.	68317	24753	112635	65123
.	.	.	.	.	1.5000	0.5969	.	67917	26091	111302	63647
.	.	.	.	.	1.6000	0.6366	.	67521	27383	110018	62232
.	.	.	.	.	1.7000	0.6764	.	67128	28630	108779	60874
.	.	.	.	.	1.8000	0.7162	.	66738	29835	107586	59572
.	.	.	.	.	1.9000	0.7560	.	66351	30997	106436	58323
.	.	.	.	.	2.0000	0.7958	.	65966	32120	105327	57124
.	.	.	.	.	2.1000	0.8356	.	65585	33205	104258	55973
.	.	.	.	.	2.2000	0.8754	.	65206	34252	103228	54869
.	.	.	.	.	2.3000	0.9152	.	64830	35264	102235	53809
.	.	.	.	.	2.4000	0.9550	.	64458	36241	101277	52791
.	.	.	.	.	2.5000	0.9948	.	64087	37185	100354	51813
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANJM01
Date and time : 18MAR98:14:41
Computation of ref. F: Simple mean, age 2 - 7
Basis for 1998 : TAC constraints

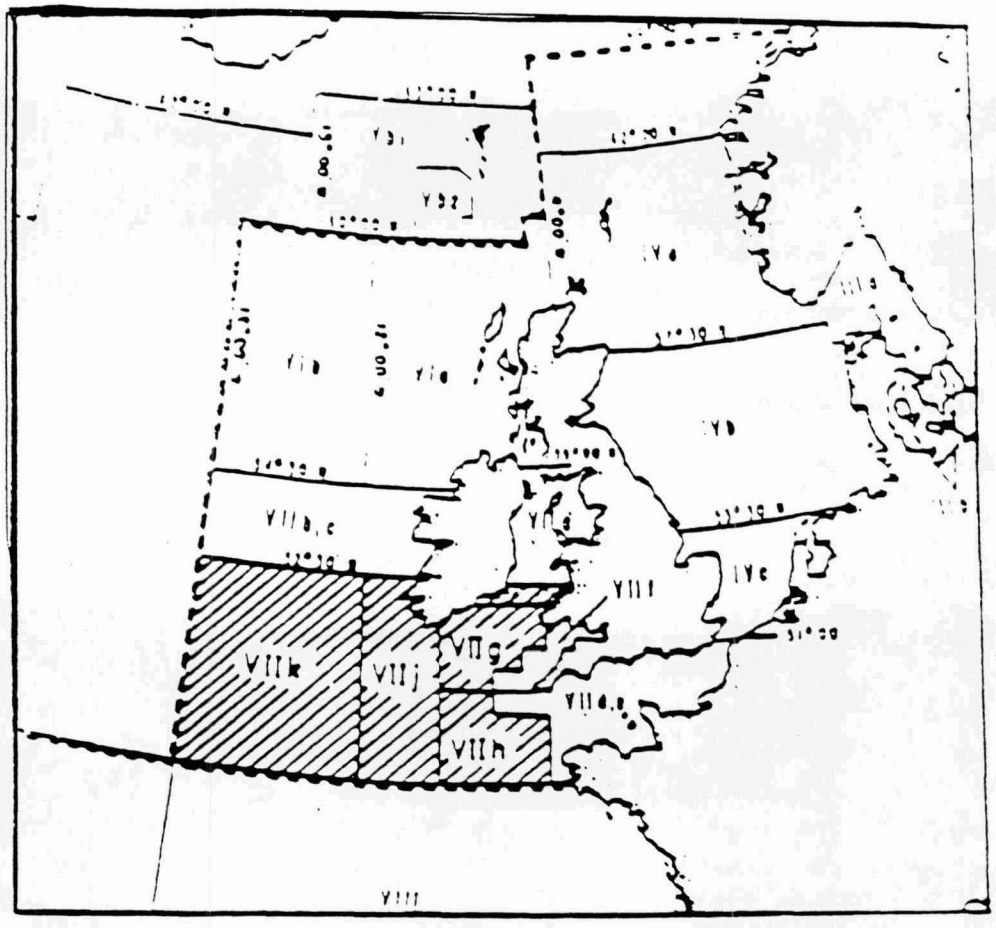

Figure 4.1.1 The assessment cover the area Divisions VIIj and VIIg and that part of Division VIIa below 52°30. TAC is set by EC for Divisions VIIg-k and that section of Division VIIa below 52°30.

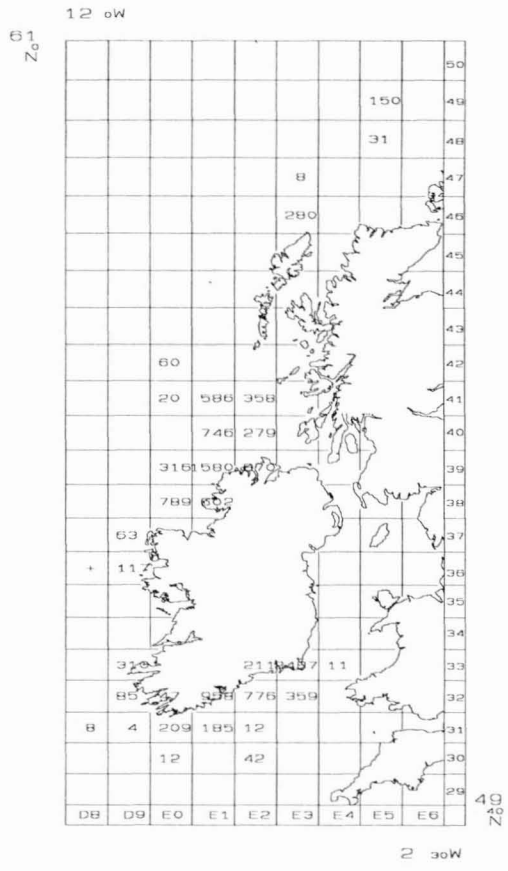

Figure 4.2.1a : Distribution of herring catches - Quarter 1 - 1997.

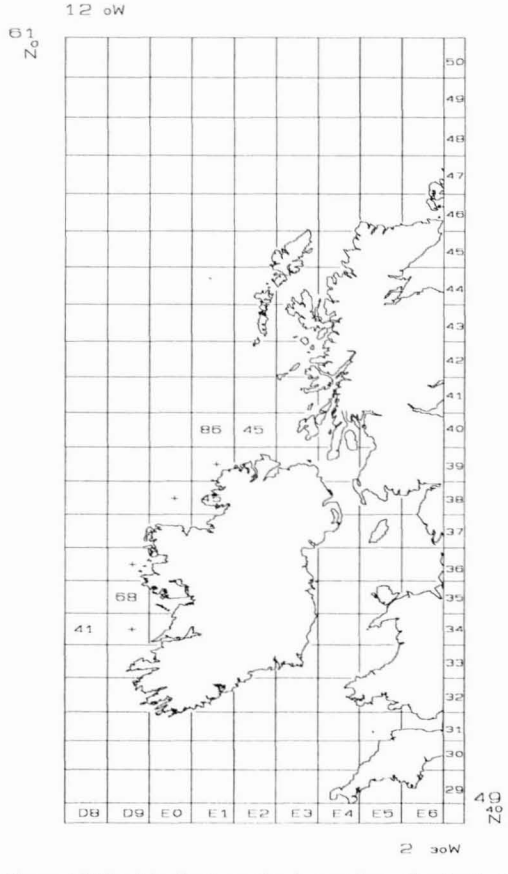

Figure 4.2.1b : Distribution of herring catches - Quarter 2 - 1997.

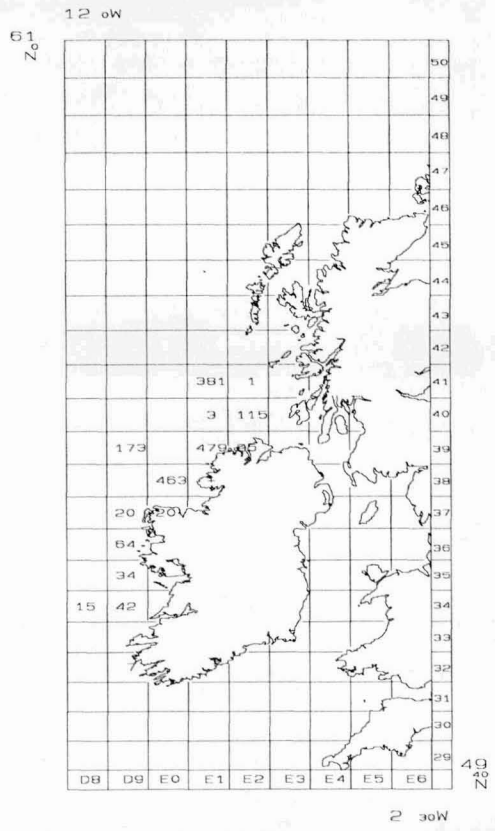

Figure 4.2.1c : Distribution of herring catches - Quarter 3 - 1997.

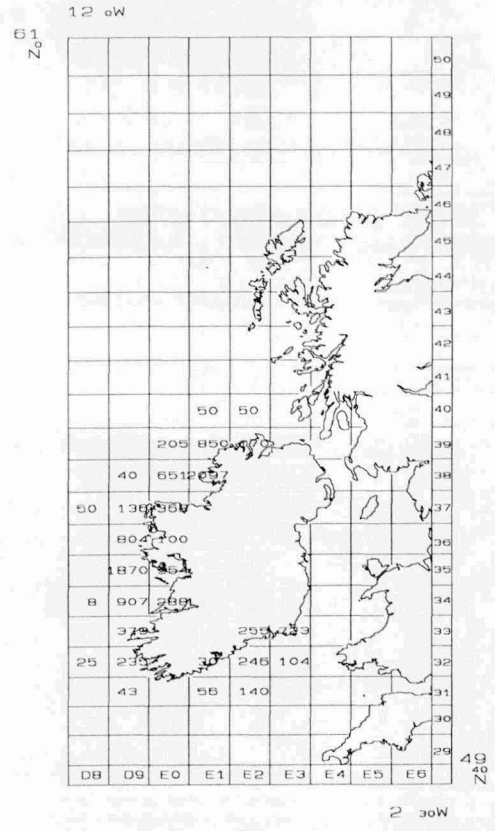

Figure 4.2.1d : Distribution of herring catches - Quarter 4 - 1997.

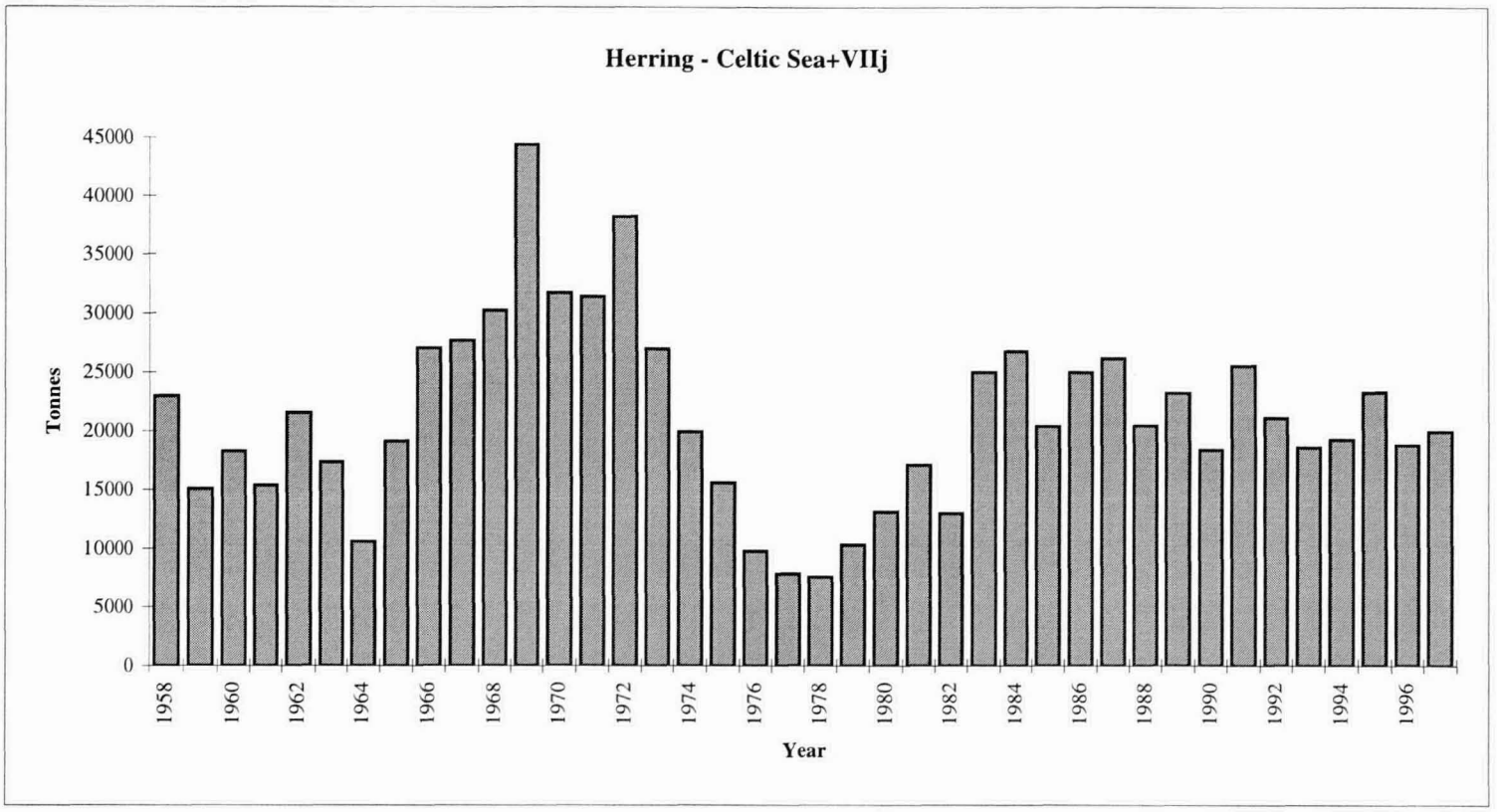

Figure 4.2.2. Herring catches in Celtic Sea and Division VIIj: 1958-1997

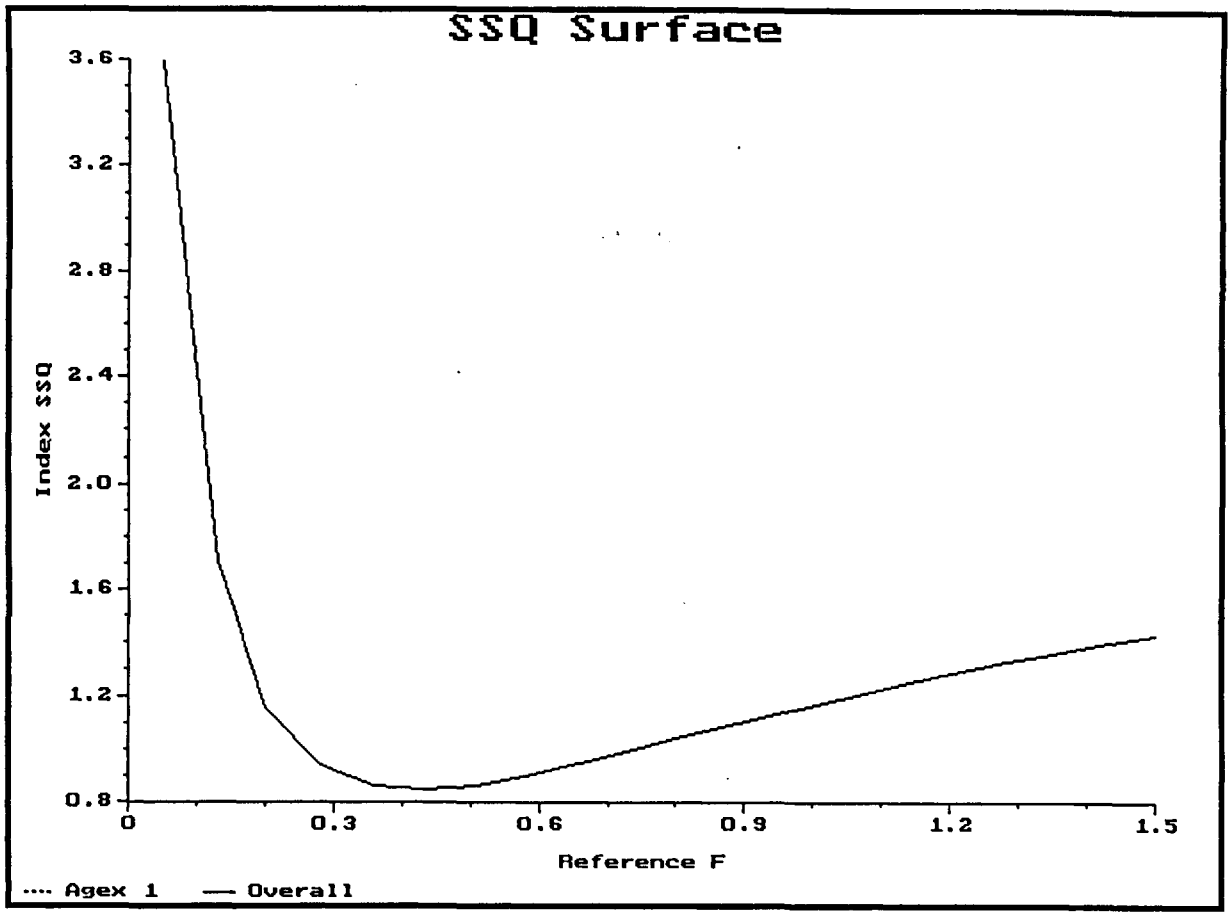

Figure 4.4.1. Herring in Celtic Sea and Div.VIIj. SSQ surface for the baseline assessment.

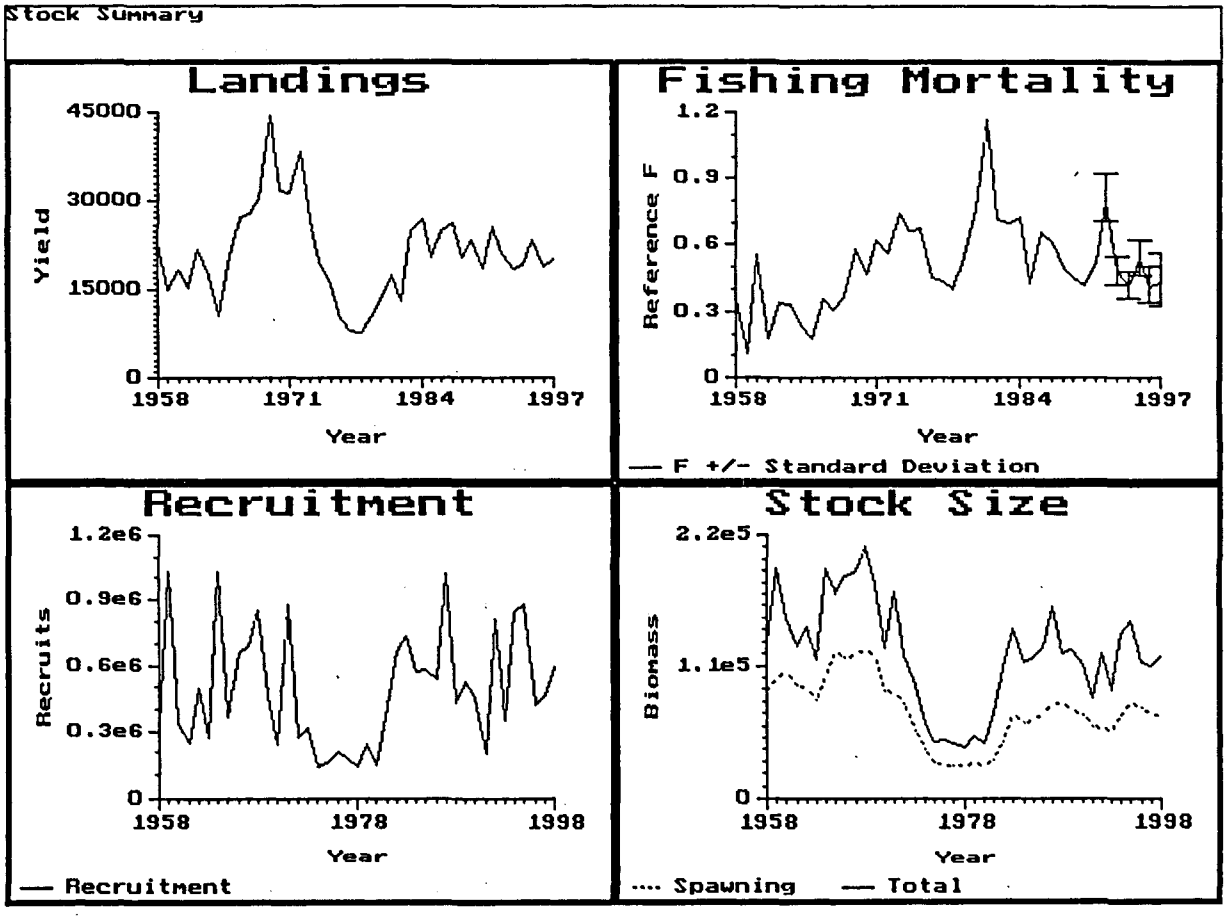

Figure 4.4.2. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

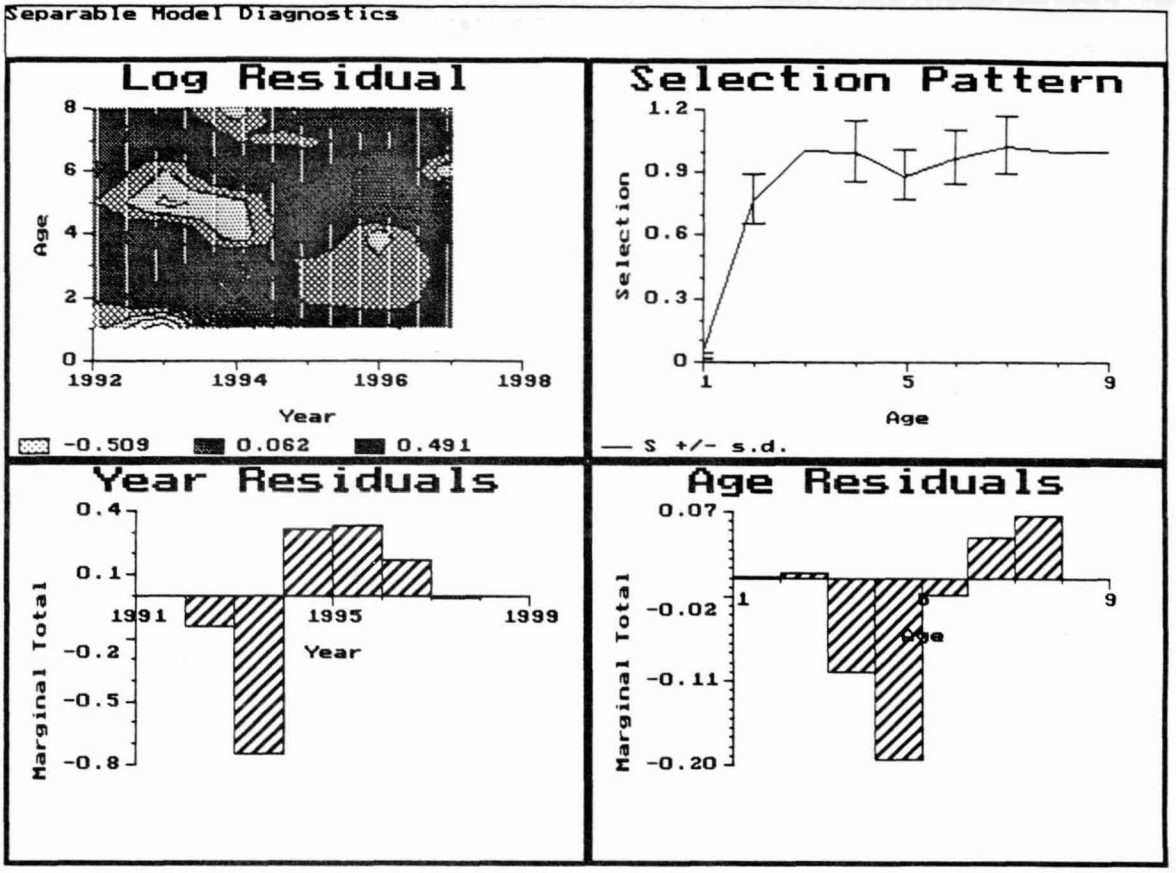

Figure 4.4.3. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

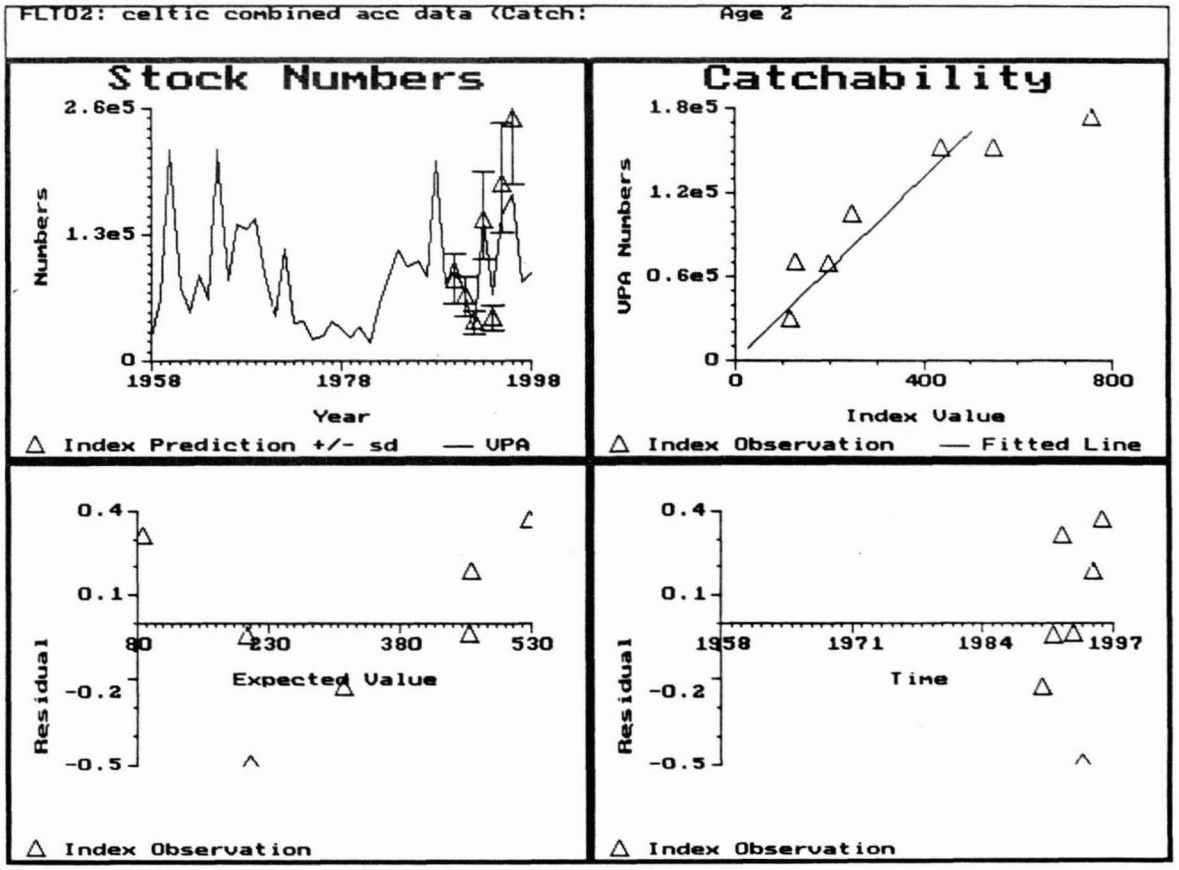

Figure 4.4..4. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 2 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

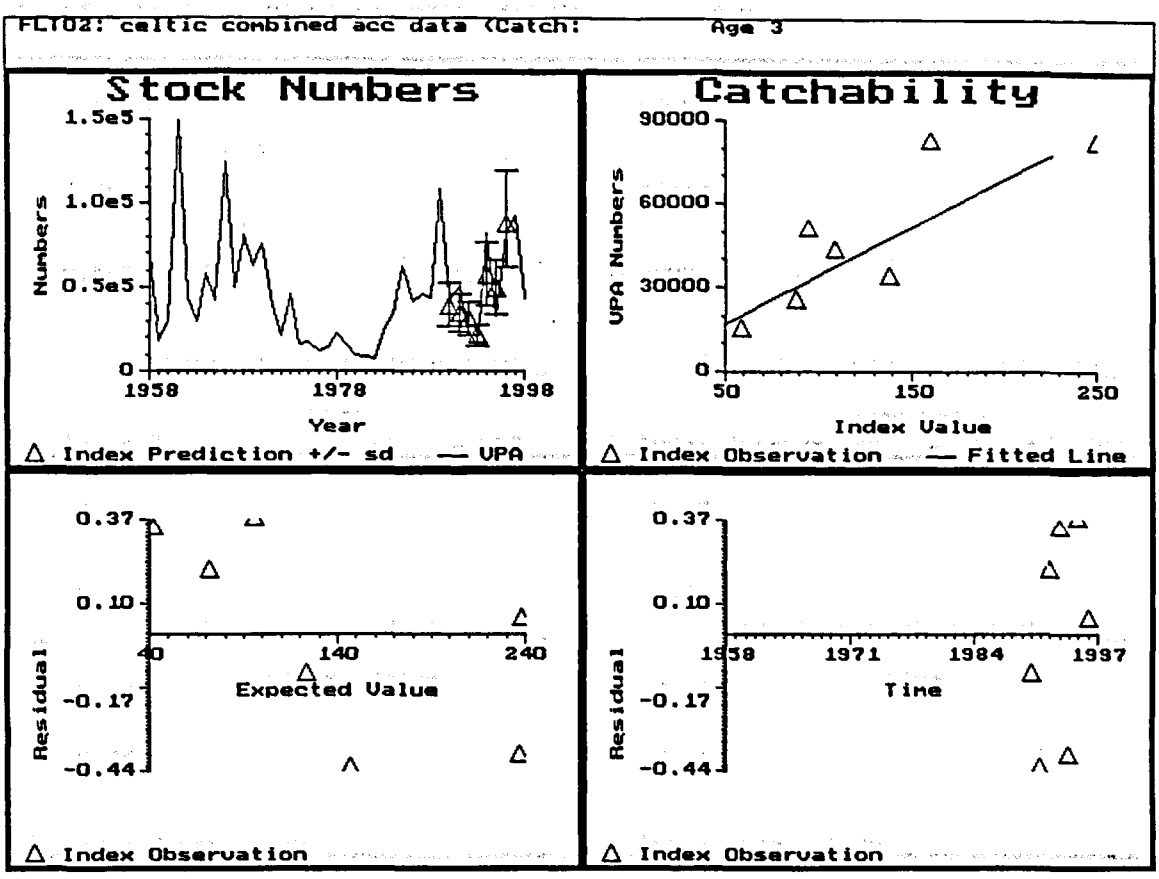

Figure 4.4.5. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic index at age 3 against the estimated populations at age 1-ring. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and 1-ringer survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

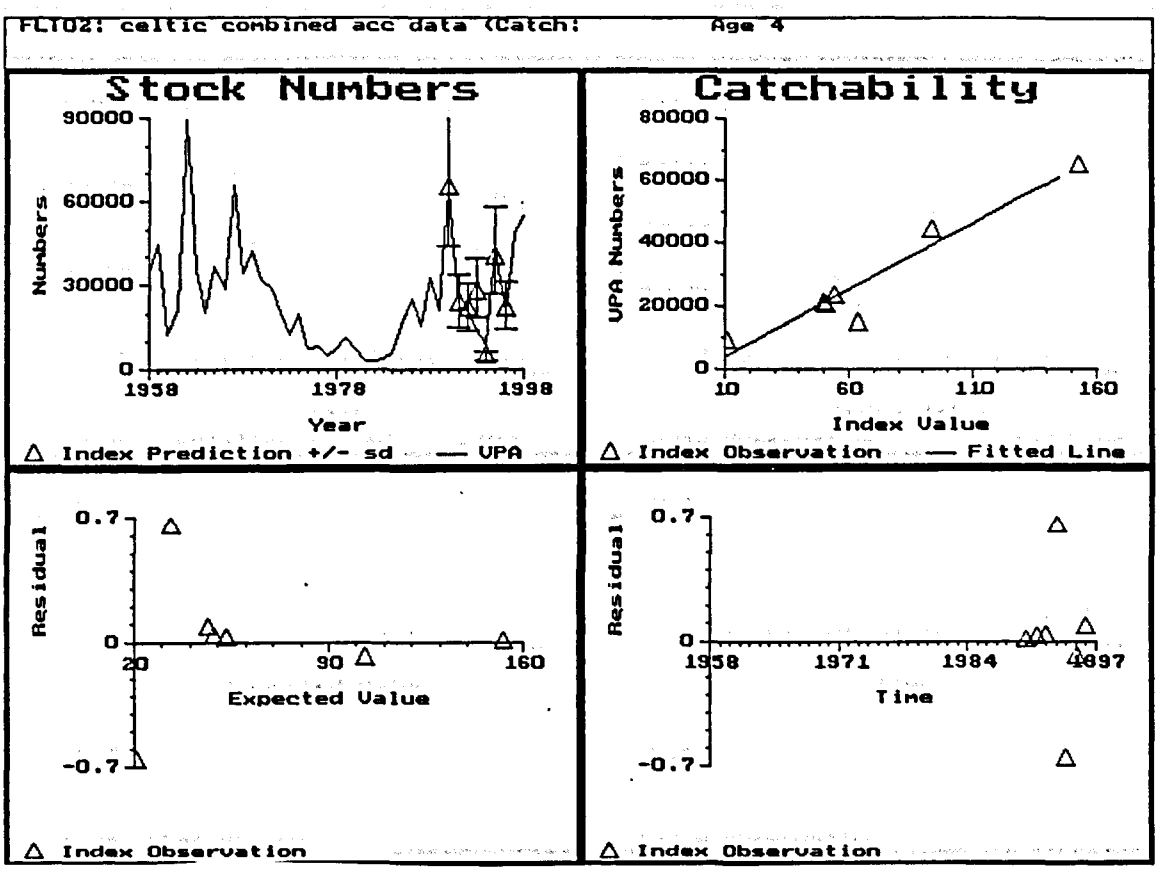

Figure 4.4.6. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 4 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

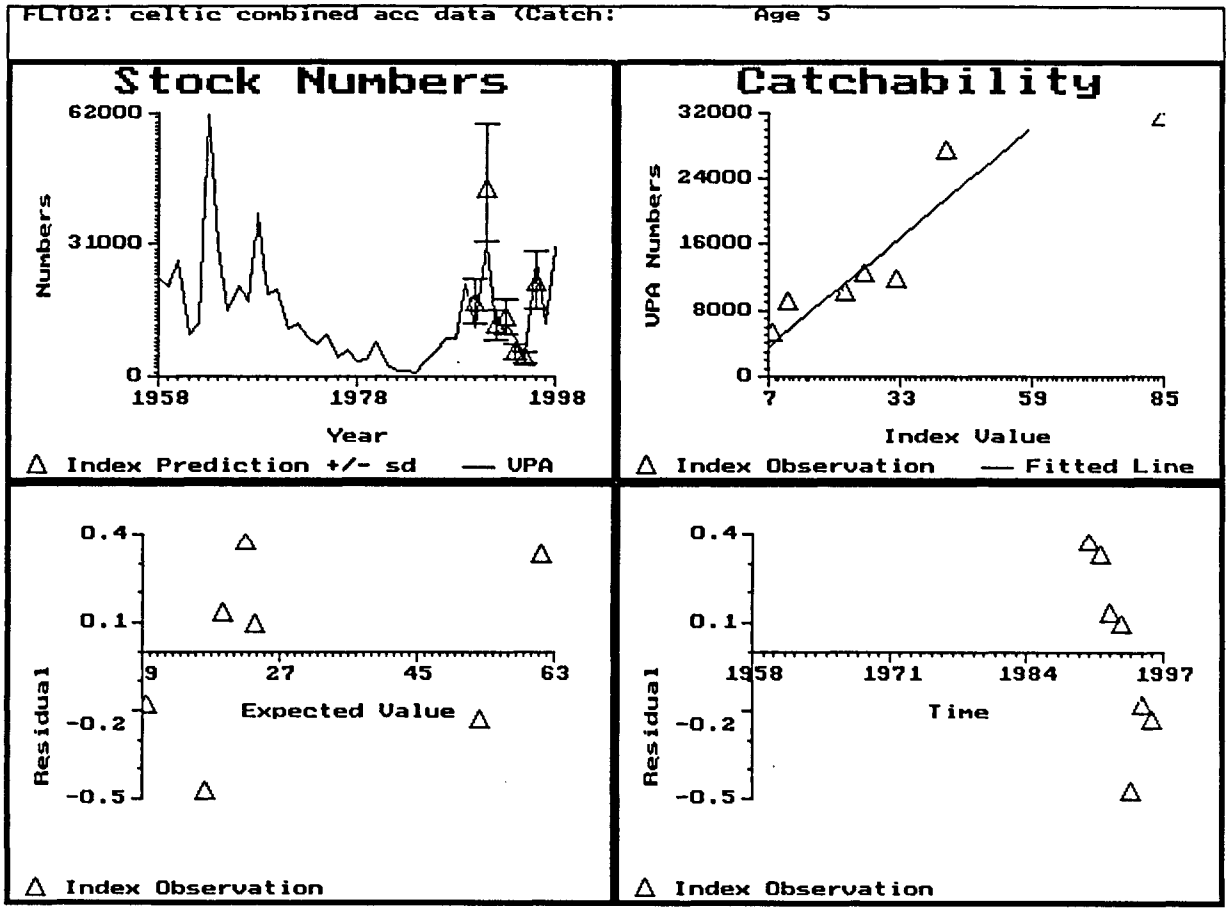

Figure 4.4.7. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

5 WEST OF SCOTLAND HERRING

5.1 Division VIa(North)

5.1.1 ACFM Advice Applicable to 1997 and 1998

ACFM advice in 1997 stated that the stock was considered to be within safe biological limits. Although the estimate of the state of the stock was uncertain, the stock was thought to be lightly exploited. ACFM advised that the stock appeared able to sustain the levels of fishing mortality then thought to be current. At that level of exploitation, the stock was expected to remain within safe biological limits in the medium term.

The agreed TAC for 1998 is 80,370 t compared with a TAC in 1997 of 83,570 t. ACFM recommended a *status quo* F of 0.12.

5.1.2 The Fishery

Catches are taken from this area by three more or less distinct fisheries. The Scottish domestic pair trawl fleet operates in shallower, coastal areas, principally fishing in the Minches and around the Island of Barra in the South. Younger herring are found in these areas. The Scottish and Norwegian Purse Seine fleets target herring mostly in the Northern North Sea, but also operate in the Northern part of VIa(N). An international freezer-trawler fishery has historically operated in deeper water near the shelf edge where older fish are distributed. These vessels are mostly registered in the Netherlands, Germany, France and England.

As a result of perceived problems of misreporting, a new fishery regulation was introduced by Scotland with the intention of improving reporting accuracy. Under this regulation, Scottish vessels fishing for herring were required to hold a license either to fish in the North Sea or in the West of Scotland Area. Only one of these options could be held at any one time. During the months of the peak of the Shetland fishery, vessels requiring West Coast licenses were required to collect them from West Coast ports, and *vice versa* for the North Sea.

5.1.3 Landings Estimates and Allocation of Catches to Area

Preliminary reported catches from the VIa(N) area for 1997 total 72,949 t compared with the TAC of 83,570 t. The Working Group's estimates of unallocated catches are 8,015 t and a further 62t have been reported as discarded. The Working Group has further evidence that 5,039 t were area-misreported, thus giving a Working Group Estimate of 59,957t. However, the Working Group considers that due to area-misreporting of unknown extent, uncertainty exists in the catches in the range 30,165 t to 64,995 t (Table 5.1.1). This is explained further below.

Serious problems with misreporting of catches from this stock have occurred in the past, with many examples of vessels operating and landing herring catches distant from VIa(N) but reporting catches from that area. Fishery-independent information confirmed that large catches were being reported from areas with low abundances of fish, and informal information from the fishery and from other sources confirmed that most catches of fish recorded between 4°W and 5°W were most probably misreported North Sea catches. The problem was particularly acute during the peak months of the Shetland herring fishery (August to October).

The new management measures are believed to have had a significant impact on area-misreporting, but this effect cannot be quantified. Also, survey information suggests significant abundances occurred in the area 4° to 5°W, and may plausibly have supported a significant fishery.

Some errors were discovered in Table 5.1.1 of ICES (1997/Assess:8). Most of the errors were not propagated into the catch estimates used for assessment purposes. The catch estimate table was recreated from previous Working Group reports, taking catch estimates in each year from the Working Group report two years later (e.g., 1986 catch data were taken from ICES (1988/Assess:17) because reports one year later are published with preliminary data. An exception was made for the period 1970–1981, which were taken from the Working Group report in 1982 (ICES (1982/Assess:7). This was the first year in which separate catch statistics for the northern part of VIa were calculated. In cases where the published total did not coincide with the total of national catches this was assumed to be an error in the calculation and a new total calculated. The totals so calculated were then adjusted using the area-misreporting estimates as calculated retrospectively by ICES (1997/Assess: 8). The revised table is given as Table 5.1.1 and a comparison with the catch estimates used in 1997 for assessment purposes is given in Table 5.1.2. The differences are small.

5.1.4 Catch in Numbers at age

Age composition data for the commercial catches for 1997 were available from Scotland (quarters 1, 3 and 4), Germany (quarter 3), Netherlands (quarter 3), Northern Ireland (sampled by Ireland) and Norway (quarters 2 and 3). A summary of sampling information is given in Table 5.1.3. Some inconsistencies in weights-at-age were noted, particularly for samples from purse-seiners taken in quarter 3. The most likely explanation is that some commercial samples from North Sea catches were wrongly allocated to Division VIa(N) because of area-misreporting.

Unsampled freezer-trawler catches (England, France, Germany [Q1, Q2, Q4] were assigned age-distributions recorded in German samples in quarter 3 and weights-at-age from the Dutch sample in Quarter 3. No attempt was made to infer annual changes in weights at age from other fleets. Only 8 samples were available to allocate the freezer-trawler catches to ages compared with 23 samples in 1996. As a result, the age-distributions allocated to these catches are uncertain and agree poorly with the age-structure that was estimated in catches in 1996 (Figure 5.1.1).

New and historic catch in number information is given in Table 5.1.4, raised to the estimate of 59,957t of catch.

Larvae Surveys

Larvae surveys for this stock have been discontinued since 1994. The historical time-series will however be used in assessment model fitting and has been reproduced for convenience (Table 5.1.5.) Documentation of this survey time-series is given in ICES (1994/ Assess: 13).

5.1.5 Acoustic Survey

The survey recorded an unexpectedly low estimate of abundance. Interpretation of survey results is not straightforward because the survey was completed one month earlier than other surveys in the historical time-series.

In previous surveys of this stock, a chartered commercial fishing vessel was used to complete the survey in July at the same time as the North Sea area was being surveyed by the FRV Scotia (Marine Laboratory, Aberdeen), hence ensuring contiguous spatial coverage. In 1997 the survey design was changed and the FRV Scotia was used for both surveys. This required the VIa(N) survey to be completed one month earlier than is usual, which may have resulted in a loss of consistency with earlier surveys in the time series.

The 1997 survey was completed from 16 June to 3 July using a Simrad EK500 38KHz echosounder and echointegrator. Further analysis was completed using Simrad BI500 and Marine Laboratory systems. Prior analysis has shown that the stock size estimate is highly sensitive to a small number of observations of very dense shoals, hence survey precision could be improved substantially if more effort can be allocated to areas of high fish density. On this account and as in the 1996 survey, a three-level stratified sampling design was used with sampling densities selected to cover areas that had high herring abundances in the period 1991 to 1996. The three sampling intensity levels had transect spacings of 4.0, 7.5 and 15 nautical miles. Further details of the transect plan and the sampling scheme are given in Simmonds *et al.* (WD 1998b).

Twenty-nine trawl samples were taken of the denser fish aggregations detected by echo-sounding. Fish in each haul were sampled for length, age, maturity and weight of individual herring. In each haul, up to 350 fish were measured, 50 fish were weighed and 5–10 otoliths per 0.5cm length-class were read. In the whole survey 4564 fish were measured and 1525 otoliths were read. Echo-integrals were calculated in 15 minute time periods, equivalent to 2.5 n.m. distance intervals at 10 Kn, and in the water column from 1m above the sea-bed to 9m below the surface. Echo-traces were allocated among five categories:

1. Herring (79 % of estimate by number)
2. Likely to be herring (21 % of estimate by number)
3. Unlikely to be herring (would add a further 12% by weight)
4. Mackerel traces, known not to be herring (not estimated)
5. Sandeel traces, known not to be herring (not estimated)

There was little evidence of a change in the distribution. As in the 1996 survey, the main concentrations were again between 4°W and 5°W, although there was some evidence of dispersal west of the Hebrides. Abundance in the Barra Head area was lower than in recent years.

From the survey information alone, the following features were apparent:

- Lower maturity, possibly on account of earlier survey date (see Section 5.1.7)
- Lower proportion of older fish in the stock
- Lower abundance, particularly in the Barra Head area, which previously held large abundances of fish.

Abundance estimates by age and in aggregate biomass for 1987–1997 are given in Table 5.1.6.

5.1.6 Mean Weights at Age

Data consistent with the historical time-series are available for 1997 from the commercial fisheries. However, due to the change in the timing of the acoustic survey the new estimates of weight at age in the stock are not consistent with previous estimates (Table 5.1.7).

Measurements of weights at age in the commercial fisheries were available from the Netherlands, Scotland and Norway. Some high weights at age for older fish (around 250g), which is more typical of North Sea fish, were recorded in some purse seine samples in quarter 3, which may indicate that misreporting of catches or stock mixing has obscured the true origin of some of the samples.

Lower weights at age were recorded in the acoustic survey in 1997 compared with earlier years. In order to maintain historically-consistent estimates of spawning biomass, these values were not used for assessment purposes and instead mean values over the period 1992 to 1996 were used.

5.1.7 Maturity ogive

The earlier timing of the acoustic survey also occasioned lower values of maturity to be recorded (Table 5.1.8). As for the weights at age, these values were not used for assessment purposes and a mean value over the years 1992–1996 was used for 1997 and for years prior to 1991.

5.1.8 Data Exploration and Preliminary Modelling

Based on the foregoing, the following features of the data and assessment were perceived to be problematic:

1. Uncertainty as to whether the 1997 survey is consistent with the remainder of the time-series;
2. Uncertainty as to how much misreporting has been reduced in 1997 (i.e., how much of the catches between 4°W and 5°W were genuinely taken from the VIa(N) stock unit.

Four exploratory analyses were calculated in order to assess the sensitivity of the assessment calculation to these two effects:

a) either excluding or including the 1997 survey observation;
b) either including or excluding the catches in 1997 between 4°-5°W.

The assessment model described in ICES (1997/Assess:8) for this stock was used for the comparative analysis. Summary results are shown in Figure 5.1.2. This shows that both the 1997 survey estimate and the inclusion of the catch between 4°-5°W lead to substantially higher estimates of fishing mortality and correspondingly lower stock size. Of the two factors, the new survey estimate has the greater effect. When both are included, the resulting assessment shows a significant change in perception of stock dynamics. The estimate of F=0.57 (95 % C.L 0.3 to 1.2) is substantially higher than the estimate of 0.105 in 1996 (95 % C.L 0.054 to 0.21), previously calculated for this stock (ICES 1997/Assess:8).

The Working Group considered that such a revision in estimates of stock dynamic parameters is not warranted on account of unreliability in recent data. In particular, because of the change in the timing, the acoustic survey is not considered a reliable indicator of changes in the stock. For this reason, it has been removed from subsequent analyses.

A further calculation was made to investigate the sensitivity of the stock assessment to:

a) Treatment of the acoustic survey as age-disaggregated or spawning biomass estimate;
b) Inclusion or exclusion of the very high and possibly unrepresentative survey observation in 1993 (the estimate of 866,190 t is much higher than other values in the time series (range 140,910 to 577,740t). The comparison was made on the basis of the same assessment model, including the 1997 survey, and basing catch estimates on the 'Working Group Estimate' of 59,957t. Larval surveys were excluded for the purposes of this comparison. Summary results are shown in Figure 5.1.3. This shows that the estimates are relatively robust to these alternative treatments, and alternative choices alter perceptions of fishing mortality in the range 0.38 to 0.53. This range is small compared to other sources of uncertainty in the assessment. On this basis, the Working Group found no reason to alter the assessment model assumptions used previously.

However, uncertainty remains as to the extent of misreporting in the area between 4°-5°W. The Working Group decided to incorporate this uncertainty in a stock assessment calculation.

5.1.9 Stock Assessment

5.1.9.1 Assessment Model

The structural model used for the assessment is unchanged from that used in the previous year, but uncertainty was assessed using a Bayesian calculation including the uncertainty in the amount of catches taken in the area between 4°-5°W. The 1997 acoustic survey was excluded from the data set.

Defining:

a,y	age and year subscripts
C	Catch in number at age and year
C'	Catch in number at age and year predicted by a separable fishing model
SSB	Spawning stock size in the structural model
LAI	Larval abundance index
ACOUST	Acoustic Survey estimates of abundance at age
N	Population abundance in the structural model
SSB	Spawning stock biomass in the structural model
Q_{LAI}	Coefficient of proportionality for larvae survey estimates of stock abundance
Q_{ACU}	Coefficient of proportionality for acoustic survey estimates of stock abundance
K	Power coefficient for the LAI estimate of stock abundance
λ	Weighting factor for the acoustic survey =0.1 for age 1 and 1 for all other ages (as the acoustic survey is considered to be a poor indicator of 1 ringers)

The least-squares component of the likelihood function used in the assessment is:

$$\Sigma_{a,y}(\ln(C_{a,y}) - \ln(C'_{a,y}))^2 +$$
$$\Sigma_{y}(\ln(Q_{LAI} SSB_y^K) - \ln(LAI_y))^2 +$$
$$\lambda_a \Sigma_{a,y}(\ln(Q_{ACU,a} N^*_{a,y}) - \ln(ACOUST_{a,y}))^2$$

It is stressed that this assessment should *a priori* be considered unreliable, on account of:

- Uncertainty as to the amount and age composition of the true catches from this stock unit;
- Lack of useable survey index in 1997;
- Poor sampling of catches from the offshore fishery.

Consequences of the first two matters are included in the uncertainty calculation, but the implications of low sampling of age in the catch has not been addressed quantitatively at present. This is believed to be important.

A Bayes Markov-Chain Monte Carlo calculation was initiated based on the model described above, with the same data, parameterisation and likelihood function except that an additional parameter was included to scale the catch in numbers in 1997 with uniform prior probability in the range (1, 0.536) where 0.536 = (64995 - 30165)/64995. The ICA v1.4

software was used with a modification to include this extra parameter and prior assumption. The chain was run with burn-in period of 1000 iterations and 580 samples were taken at intervals of 400 iterations. No formal evaluation of the sufficiency of the burn-in period and of the thinning interval was made, but the sequence of spawning stock size and fishing mortality estimates drawn from the chain is shown in Figure 5.1.4.

Expected values and percentiles of yield, historic stock size, fishing mortality and recruitments so calculated are given in Table 5.1.9 and Figure 5.1.5. This shows that present perceptions of stock dynamics are highly uncertain, with 90% confidence intervals for fishing mortality in 1997 (mean over ages 3 to 6) of 0.13 to 1.83, and for spawning biomass of 19,000 to 309,000t.

5.1.9.2 Assessment excluding uncertainty in catches.

A maximum-likelihood model fit is detailed in Table 5.1.10, in which catch numbers are calculated on the basis of the 'Working Group Estimate' of catches of 59,957 t. Diagnostic graphs are given as Figures 5.1.6 - 5.1.18. This is provided for comparative purposes. The assessment shows a substantial increase in estimated fishing mortality from 0.11 in 1996 to 0.47 in 1997. The increase in the estimate is due partly to an increase in catches from 1996 to 1997 from 26105t to 59 957t, but is also due to an increase in the estimated numbers of fish caught aged between 4 and 7 years old in these years. This is considered most likely to be due to deficiencies in the sampling of the offshore fleet and may not be a reliable feature of the assessment.

5.1.10 Short-term projections

5.1.10.1 Deterministic short-term projections

Conventional short term catch projections were calculated on the following basis:

- The fishing mortality in 1998 was equal to the fishing mortality in 1997;
- Starting population numbers on 1 January 1998 were taken from the population model estimates, except for age 2, where the geometric mean of population abundance from 1986 to 1996 was used. This value was also used for recruitment in 1999 and 2000;
- Historic mean weights at age in the stock from 1994 to 1997 were used for stock weights;
- Historic mean weights at age in the catch from 1994 to 1997 were used for catch weights;
- The exploitation pattern used for the projections was taken from the population model. Fishing mortality in 1997 was used as a reference value for the projections.

Input data for the projections are given in Table 5.1.11, and the consequences of fishing at different levels of fishing mortality (in terms of catch and spawning biomass) are given in Table 5.1.12.

At recent levels of fishing mortality ($F_{(97)}$), *status quo* catches (Table 5.1.13) are predicted to be of the order of 53,000 t in 1999. At this level of fishing mortality it is likely that the SSB will decrease.

5.1.10.2 Stochastic short-term projections

Projections of catch and stock size were made from each draw in the Bayesian assessment (using the MCMC process described in Section 5.1.9.1), under the assumptions described in Section 5.1.10.1, with fishing-mortality multipliers constrained to correspond to the following options:

$F_{1999} = F_{1998} = F_{1997}$; F=0.1, 0.2, 0.3 and 0.4.

The 'ICP' software was used for these calculations (Patterson, WD 1998). Results are given in Table 5.1.14. As for the stochastic assessment calculation, these show lower values for both projected stock and forecast catches than the projections based on the maximum-likelihood fit.

The difference between the expected stock sizes and fishing mortalities from the Bayesian and maximum-likelihood estimates has not been examined in detail. However, previous comparisons of this type have shown that when uncertainty is admitted in many parameters and an integration of the stock sizes and fishing mortalities is made, a difference can arise because the integration under the likelihood surface is not necessarily equal to the maximum-

likelihood point estimate. The likelihood surface is not necessarily symmetric about this point estimate. These differences tend to be larger in cases where information is poor or very noisy, as appears to be the case for this stock.

5.1.11 Medium-term projections

The stochastic medium-term projections were calculated using the same method as for last year's assessment and follows the procedure described in ICES (1996/Assess:10), and based on parameter estimates derived from the deterministic assessment model. A Monte-Carlo method was used with a conventional stock projection for each iteration. Population parameters (vector of abundance at age in 1997, fishing mortality at reference age in 1997 and selection at age) were drawn from a multivariate normal distribution, with the mean equal to the values estimated in the stock assessment model (see Section 5.1.9). Covariance was estimated in the same model fit. Because no useable stock-recruit relationship could be found pseudo-recruitment for subsequent years was generated by calculating a simple geometric mean. Conventional non-parametric bootstrap methods were used to resample randomly from the residuals. The software ICP was used.

The following options are as specified for the short-term options (see Section 5.10):

- maturity ogive, as measured in 1997 is assumed for 1998 and thereafter;
- natural mortality used for the assessment is assumed for 1998 and thereafter;
- proportions of F and M before spawning in the projections were as used in the assessment;
- weight at age in the stock for forecasting purposes was taken as the mean value from 1994 - 1996;
- weight at age in the catch was also taken as the mean values from 1994 –1996;
- projections start from the populations on 1 January 1998 calculated in the assessment procedure. Projections were F-constrained.

In order to make forecasts consistent with last year, a second series of forecasts was made with the fishing mortality in 1996.The two scenarios were based on the assumption of a constant fishing mortality at the level of 1997 (F= 0.42) and at the level of 0.17, from last year's assessment ICES (1996/Assess:10, Table 5.1.9).

The medium-term projection scenarios are summarised in Figures 5.1.19 and 5.1.20. The first scenario indicates a constant risk for the stock if fishing continues at current levels with 80 % chance of falling below 140,000t (MBAL) in 2007. The second projection with the lowered F, constraining last year fishing mortality shows a decline in the risk for the stock with a 38 % chance of falling below 140,000t in 2007.

For comparable purposes a medium term projection based on the stochastic assessment and assuming fishing mortality to be constant at the level of 1997, is given in Figure 5.1.21.

5.1.12 Consistency of Assessments

Assessment of herring in Division VIa(N) is hampered by serious problems with misreporting of catches from this stock.

The catch uncertainty and poor sampling of catches in 1997, combined with the lack of consistent survey data (the acoustic survey was one month earlier than in other years; the larvae survey series stopped in 1994), makes the assessment unreliable. The 95% confidence intervals for the fishing mortality in 1997, averaged over ages 3 to 6, ranges from 0.13 to 1.83. Estimated spawning stock biomass therefore ranges from 19,000 to 309,000t (95 % c.l.).

5.1.13 Management Considerations

There are no reliable fishery independent data for 1997 and, therefore, the assessment is uncertain, and of limited usefulness for forecasting purposes. The Working Group propose to do a new assessment in a sub-group after the survey data of 1998 are available. Results will be provided in a working document to ACFM before November 1998. The Working Group want to stress that in future more efforts should be given to the maintenance of fishery independent estimates and sufficient sampling of the commercial fleet.

5.2 Clyde Herring

5.2.1 Advice and management applicable to 1997 and 1998

Management of herring in the Clyde is complicated by the presence of two virtually indistinguishable stocks; a resident spring-spawning population and the immigrant autumn-spawning component. In recent years management strategies have been directed towards rebuilding the highly depleted spring-spawning component to historical levels.

The measures which remain in force in order to protect the indigenous spring-spawning stock are:

- A complete ban on herring fishing from 1 January to 30 April;
- A complete ban on all forms of active fishing from 1 February to 1 April, on the Ballantrae Bank spawning grounds, to protect the demersal spawn and prevent disturbance of the spawning shoals;
- A ban on herring fishing between 00:00 Saturday morning and 24:00 Sunday night;
- The TAC in 1997 was maintained at the same level as in recent years (1,000 tonnes).

5.2.2 The fishery in 1997

Annual landings from 1955 to 1997 are presented in Table 5.2.1. Landings in 1997 were 490 t which are the second lowest in recent years. Landings by the local fleet dropped from 598 t in 1996 to 371 t in 1997. A total of 119 t was taken by Northern Ireland vessels landing into either Northern Ireland or the Isle of Man. This is the second year since 1985 that landings by UK vessels, other than those from Scotland, have been reported from this area. Most of the landings were in the third and fourth quarters of the year with 282.2 t taken by the directed fishery of Scottish and Northern Irish pair trawlers. The proportions of spring and autumn spawners in these landings could not be estimated.

The sampling levels of the local fishery have been reduced in recent years but are still well above recommended levels (Table 5.2.2). Samples were taken from the Scottish fleets only.

5.2.3 Weight at age and stock composition

The catch in numbers at age for the period 1970 to 1997 is given in Table 5.2.3. In 1995 the catch of aged 2 fish was the highest since 1989 which suggested an improved recruitment of the 1993 year class. The indication from the 1996 and 1997 is that this year class is good with a high number of aged 3 and 4 fish, respectively. However the high number of age 2 fish in 1996, does not appear in the 1997 catches as aged 3 fish.

Weights at age are given in Table 5.2.4. Mean weights in the stock have not been available from research vessel surveys since 1991, therefore the weights in the stock used are the weights at age in the catches.

Once again no attempt has been made to apportion catches between spring and autumn-spawning stocks for 1997. The majority of landings were in the last two quarters suggesting that the fishery was based on the autumn spawners. The small landings in the first half of the year (0.2 t) are mainly taken as by-catch in the demersal trawl fishery.

An index of effort (E), based solely on the Scottish pair trawler fleet, has been calculated for comparison with previous years as follows;

$$E = E_p \cdot L / L_p$$

where E_p = days absent by Scottish pair trawlers.

L = total landings in tonnes.
L_p = landings by pair trawlers in tonnes.

This shows a large increase in the catch per unit effort over the previous year (Table 5.2.5).

5.2.4 Surveys

No demersal egg surveys on the Ballantrae Bank and Brown Head spawning sites, no acoustic surveys in the Clyde and no spring trawl surveys were carried out in 1997. Historical estimates from these surveys are tabulated in (ICES 1995 Assess:13).

5.2.5 Stock Assessment

The structure of the stock in the Clyde remains uncertain. No survey data are available from recent years therefore no analytical assessment could be attempted.

5.2.6 Stock and catch projections

In the absence of an analytical assessment no stock projections can be provided.

5.2.7 Management considerations

The management of this fishery is made difficult by the presence of a mixture of a severely depleted spring-spawning component and autumn spawners from Division VIa south. The management objectives for these two components are necessarily distinct. The absence of fishery independent data from surveys further compounds the problem.

Historically the spring spawning stock supported a fishery with catches up to 15,000 tonnes per year in the 1960's. Landings generally began to decline through the 1970's and 1980's with a rapid decline in effort during the late 1980's up to the present time. A TAC was first set in 1984 (3,000 t.) increasing to a maximum of 3,500 tonnes in 1987 subsequently decreasing to 1,000 tonnes by 1993. Estimated catches, including discards, exceeded the TAC for the first four years. This was followed by a decline in catches to 1990. In 1991 there was a dramatic drop in both landings and effort and since then landings have fluctuated at below 1,000 tonnes.

In the absence of surveys and no stock separation of the catches, nothing is currently known about the state of the spring spawning stock or the origins of the improved year classes. All the management measures, currently in force, need to remain. Catches should be reduced to as low a level as possible and an attempt should be made to apportion those catches to spring and autumn spawning components.

5.2.8 Future research requirements

Provision of some fishery independent survey data for this area is necessary before an analytical assessment of the stock can be attempted. In a similar, but smaller stock, in the Thames estuary, a single pelagic trawl survey each year provides an index of recruitment and a measure of the mixture of spring and autumn spawners in the area. That survey now provides a ten year time series and together with landings data and biological sampling is sufficient for an analytical assessment of the state of this stock.

Further research is required to improve the understanding of the stock structure in the Clyde and in particular to attempt to apportion landings to spring and autumn spawners. If current management advice is required for the spring spawning stock, the otolith structure technique, described by Mosegaard (WD,1996) for separating spring-spawners from autumn spawners in the Baltic, should be investigated.

Table 5.1.1. HERRING in Division VIa (North). Catch in tonnes by country, 1970-1997. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1970	1971	1972	1973	1974	1975
Denmark	0	554	150	932	0	374
Faroes	15100	8100	8094	10003	5371	3895
France	1293	2055	680	2441	411	1244
Germany	11768	6444	3376	9914	8887	6182
Iceland	5595	5416	2066	2532	9566	2633
Netherlands	464	8340	22673	27892	17461	12024
Norway	27250	76721	17400	32557	26218	509
UK	103530	99537	107638	120800	107520	85520
Other	930		2679	3199	2726	1620
Unallocated						
Discards						
Total	165930	207167	164756	210270	178160	114001
Area-Misreported						
WG Estimate	**165930**	**207167**	**164756**	**210270**	**178160**	**114001**
Source (WG)	1982	1982	1982	1982	1982	1982

Country	1976	1977	1978	1979	1980	1981
Denmark	249	626	128	0	0	1580
Faroes	4017	3564	0	0	0	0
France	1481	1548	1435	3	2	1243
FDR	4363	0	26	0	256	3029
Iceland	3273	0	0	0	0	0
Netherlands	16573	8705	5874	0	0	5602
Norway	5183	1098	4462	57	0	3850
UK	53371	25539	10231	0	48	31483
Other	5132	261				
Unallocated						4633
Discards						
Total	93642	41341	22156	60	306	51420
Area-Misreported						
WG Estimate	**93642**	**41341**	**22156**	**60**	**306**	**51420**
Source (WG)	1982	1982	1982	1982	1982	1983

Country	1982	1983	1984	1985	1986	1987
Denmark	0	0	96	0	0	0
Faroes	74	834	954	104	400	0
France	2069	1313	0	20	18	136
FDR	8453	6283	5564	5937	2188	1711
Ireland	0	0	0	0	6000	6800
Netherlands	11317	20200	7729	5500	5160	5212
Norway	13018	7336	6669	4690	4799	4300
UK	38471	31616	37554	28065	25294	26810
Other						
Unallocated	18958	-4059	16588	-502	37840	18038
Discards	0	0	0	0	0	0
Total	**92360**	**63523**	**75154**	**43814**	**81699**	**63007**
Area-Misreported			-19142	-4672	-10935	-18647
WG Estimate	**92360**	**63523**	**56012**	**39142**	**70764**	**44360**
Source (WG)	1984	1985	1986	1987	1988	1989

Table 5.1.1. cont...

Country	1988	1989	1990	1991	1992	1993
Denmark	0	0	0	0	0	0
Faroes	0	0	326	482	0	0
France	44	1342	1287	1168	119	818
FDR/Germany	1860	4290	7096	6450	5640	4693
Ireland	6740	8000	10000	8000	7985	8236
Netherlands	6131	5860	7693	7979	8000	6132
Norway	456	0	1607	3318	2389	7447
UK	26894	29874	38253	32628	32730	32602
Other						
Unallocated	5229	2123	2397	-10597	-5485	-3753
Discards	0	1550	1300	1180	200	
Total	47354	53039	69959	50608	51578	56175
Area-Misreported	-11763	-19013	-25266	-22079	-22593	-24397
WG Estimate	**35591**	**34026**	**44693**	**28529**	**28985**	**31778**
Source (WG)	1990	1991	1992	1993	1994	1995

Country	1994	1995	1996	1997 (preliminary)
Denmark	0	0	0	0
Faroes	0	0	0	0
France	274	3672	2297	3093
Germany	5087	3733	7836	8873
Ireland	7938	3548	9721	1875
Netherlands	6093	7808	9396	9873
Norway	8183	4840	6223	4962
UK	30676	42661	46639	44273
Other				
Unallocated	-4287	-4541	-17753	-8015
Discards	700			62
Total	54664	61721	64359	64995
Area-Misreported	-30234	-32146	-38254	-5039
WG Estimate	24430	29575	26105	59957
Source (WG)	1996	1997	1997 New data	

* In the 1995 WG report, the minus sign on the unallocated catch was omitted.
This error was repeated in subsequent reports.

Other: Official catches by countries other than those named. Unallocated: Catches for which the Working Group has specific reports of an under- or over-reporting of catches. Discards: Estimates of fish discarded or slipped, usuallly from observer records. Area-Misreported: Catches reported in the area beteeen 4 and 5 W and reallocated to IVa.

Table 5.1.2. Comparison of revised catch estimates (Table 5.1.1) with those previously used for assessment purposes by ICES C.M. 1997/Assess:8. Catches in metric tonnes.

Year	Revised	Previous	Difference
1976	93642	93642	0
1977	41341	41341	0
1978	22156	22176	20
1979	60	60	0
1980	306	306	0
1981	51420	51420	0
1982	92360	92361	1
1983	63523	63523	0
1984	56012	56012	0
1985	39142	39142	0
1986	70764	71345	581
1987	44360	44360	0
1988	35591	35591	0
1989	34026	34026	0
1990	44693	44693	0
1991	28529	28527	-2
1992	28985	28992	7
1993	31778	31778	0
1994	24430	24474	44
1995	29575	29575	0
1996	26105	26105	0

Table 5.1.3. Herring in VIa(N). Sampling intensity of commercial catches

Country	Official catch (t)	No. of samples	No. of age readings	No. of fish measured	Estimate of discards
France	2 981	0	0	0	None
Germany	8 873	7	208	2429	None
Ireland *	1 875	2	99	596	None
Netherlands	8 545	1	25	42	Yes
Norway	5 058	16	420	431	No
UK (Scotland)	39 521	18	1130	2967	No
UK (England & Wales)	3 830	0	0	0	No

* Irish samples were of catches made in VIa(N) by Scottish vessels, landed in Northern Ireland and processed in an Irish factory.

Table 5.1.4. Estimated catches at age of herring in Area VIa(N). Catches in number in 1997 are calculated including catches in the area 4 to 5 degrees W.

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	69053	34836	22525	247	2692	36740	13304	81923	2207	40794	33768
2	319604	47739	46284	142	279	77961	250010	77810	188778	68845	154963
3	101548	95834	20587	77	95	105600	72179	92743	49828	148399	86072
4	35502	22117	40692	19	51	61341	93544	29262	35001	17214	118860
5	25195	10083	6879	13	13	21473	58452	42535	14948	15211	18836
6	76289	12211	3833	8	9	12623	23580	27318	11366	6631	18000
7	10918	20992	2100	4	8	11583	11516	14709	9300	6907	2578
8	3914	2758	6278	1	1	1309	13814	8437	4427	3323	1427
9	12014	1486	1544	0	0	1326	4027	8484	1959	2189	1971

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	19463	1708	6216	14294	26396	5253	17719	1728	266	1952	2030
2	65954	119376	36763	40867	23013	24469	95288	36554	82176	37854	94974
3	45463	41735	109501	40779	25229	24922	18710	40193	30398	30899	59502
4	32025	28421	18923	74279	28212	23733	10978	6007	21272	9219	53871
5	50119	19761	18109	26520	37517	21817	13269	7433	5376	7508	39341
6	8429	28555	7589	13305	13533	33869	14801	8101	4205	2501	29780
7	7307	3252	15012	9878	7581	6351	19186	10515	8805	4700	17581
8	3508	2222	1622	21456	6892	4317	4711	12158	7971	8458	8871
9	5983	2360	3505	5522	4456	5511	3740	10206	9787	31108	16819

Table 5.1.5. HERRING in Division VIa (North). Larvae abundance indices (Numbers in billions), larvae mortality rates (Z/K), fecundity estimate (10^5 eggs/g). LPE Biomass estimate in thousands of tonnes.

Year	LAI	10% Trim LAI	Z/K	LPE		
				Larvae	Fecundity	SSB
1973	2 442	46.49	0.74	318	(1.39)	229
1974	1 186	17.44	0.42	238	(1.39)	171
1975	878	22	0.46	157	1.46	108
1976	189	11.04	-	60	1.23	49
1977	787	25	-	223	1.49	150
1978	332	32.8	-	132	1.37	109
1979	1 071	26.94		118	1.49	79
1980	1 436	26.33	0.39	287	2.04	141
1981	2 154	35.61	0.34	448	2.12	211
1982	1 890	32.58	0.39	267	1.95	137
1983	668	24.55	-	112	1.88	60
1984	2 133	45.99	0.57	253	1.75	145
1985	2 710	50.03	0.37	418	(1.86)	225
1986	3 037	45.36	0.24	907	(1.86)	488
1987	4 119	45.47	0.53	423	(1.86)	227
1988	5 947	75.13	0.47	781	(1.86)	420
1989	4 320	82.68	0.40	752	(1.86)	404
1990	6 525	86.2	0.64	426	(1.86)	229
1991	4 430	63.06	0.60	632	(1.86)	340
1992	12 252	41.79	0.66	463	(1.86)	248
1993	2 941	65.01	0.56	538	(1.86)	289

Table 5.1.6 HERRING in Division VIa (North). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age, and spawning biomass (SSB, tonnes).

Age	1987	1991	1992	1993	1994	1995	1996	1997
1	249 100	338 312	74 310	2 760	494 150	441 240	41 220	792 320
2	578 400	294 484	503 430	750 270	542 080	1103 400	576 460	641 860
3	551 100	327 902	210 980	681 170	607 720	473 220	802 530	286 170
4	353 100	367 830	258 090	653 050	285 610	450 270	329 110	167 040
5	752 600	488 288	414 750	544 000	306 760	152 970	95 360	66 100
6	111 600	176 348	240 110	865 150	268 130	187 100	60 600	49 520
7	48 100	98 741	105 670	284 110	406 840	169 080	77 380	16 280
8	15 900	89 830	56 710	151 730	173 740	236 540	78 190	28 990
9+	6 500	58 043	63 440	156 180	131 880	201 500	114 810	24 440
SSB:	273 000*	452 000	351 460	866 190	533 740	452 120	370300	140 910

* - Biomass of 2+ ringers in November.

Table 5.1.7. HERRING in Division VIa (North). Mean weights at age (g).

	Weight in the catch													
(Age, Rings)	1982-1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	90	69	113	73	80	82	79	84	91	89	83	105	81	89
2	140	103	145	143	112	142	129	118	122	128	142	142	134	136
3	175	134	173	183	157	145	173	160	172	158	167	180	178	177
4	205	161	196	211	177	191	182	203	194	197	190	191	210	205
5	231	182	215	220	203	190	209	211	216	206	195	198	230	222
6	253	199	230	238	194	213	224	229	224	228	201	213	233	223
7	270	213	242	241	240	216	228	236	236	223	244	207	262	219
8	284	223	251	253	213	204	237	261	251	262	234	227	247	238
9+	295	231	258	256	228	243	247	271	258	263	266	277	291	263

	Weight in the stock from Acoustic surveys						
(Age, Rings)	Historical	1992	1993	1994	1995	1996	1997
1	90	68	75	52	45	45	57
2	164	152	162	150	144	140	150
3	208	186	196	192	191	180	189
4	233	206	206	220	202	209	209
5	246	232	226	221	225	219	225
6	252	252	234	233	226	222	233
7	258	271	254	241	247	229	248
8	269	296	260	270	260	242	266
9+	292	305	276	296	293	263	287

Table 5.1.8 HERRING in Division VIa (North). Maturity ogive used in estimates of spawning stock biomass taken from acoustic surveys. The historical series is the values used in the assessment where no data are available, and also for 1997. Values measured in 1997 were measured in June whilst other values are measured in July.

Year \Age (W ring)	2	3	>3
Mean 92-96	0.57	0.96	1.00
1992	0.47	1.00	1.00
1993	0.93	0.96	1.00
1994	0.48	0.92	1.00
1995	0.19	0.98	1.00
1996	0.76	0.94	1.00
1997	0.41	0.88	1.00

Table 5.1.9 Herring in VIa(N). Evaluation of uncertainty in stock assessment using Bayes MCMC and assuming uniform prior uncertainty about the proportion of catches reported in the area between 4 and 5 degrees W that are allocated to the stock in 1997. Mean and percentiles of the distributions of spawning stock size, recruitment and fishing mortality.

Spawning Stock Size (Thousand t)

Year / Percentile	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
5	90	108	113	96	78	69	78	75	62	69	19
25	102	125	139	130	109	96	103	96	82	98	37
Median	**117**	**150**	**173**	**170**	**146**	**128**	**128**	**127**	**112**	**143**	**72**
75	141	181	215	212	187	166	172	174	164	221	133
95	201	259	328	350	324	294	282	304	292	409	309
Mean	**127**	**161**	**188**	**184**	**161**	**143**	**147**	**149**	**135**	**180**	**105**

Mean Fishing Mortality over ages 3 to 6

Year / Percentile	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
5	0.23	0.18	0.14	0.18	0.12	0.11	0.10	0.07	0.06	0.05	0.13
25	0.31	0.25	0.20	0.27	0.20	0.17	0.19	0.11	0.11	0.10	0.33
Median	**0.37**	**0.30**	**0.25**	**0.34**	**0.26**	**0.22**	**0.24**	**0.16**	**0.15**	**0.16**	**0.61**
75	0.42	0.34	0.29	0.41	0.32	0.29	0.33	0.22	0.22	0.23	1.07
95	0.48	0.39	0.34	0.50	0.45	0.40	0.43	0.31	0.31	0.34	1.83
Mean	**0.36**	**0.29**	**0.24**	**0.34**	**0.27**	**0.23**	**0.26**	**0.17**	**0.17**	**0.17**	**0.75**

Recruitment at age 1 (Millions)

Year / Percentile	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
5	1651	645	544	322	280	607	492	401	130	190	39
25	1836	822	678	406	383	891	727	594	213	366	68
Median	**2136**	**996**	**827**	**506**	**484**	**1141**	**987**	**860**	**317**	**606**	**141**
75	2584	1240	1030	638	611	1479	1345	1279	492	1043	302
95	4136	1832	1495	937	840	2395	2404	2332	999	2718	965
Mean	**2369**	**1091**	**905**	**547**	**517**	**1251**	**1140**	**1053**	**407**	**894**	**261**

Yield (Thousand t)

Year / Percentile	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
5	44	36	34	45	29	29	32	24	30	26	36
25	44	36	34	45	29	29	32	24	30	26	43
Median	**44**	**36**	**34**	**45**	**29**	**29**	**32**	**24**	**30**	**26**	**50**
75	44	36	34	45	29	29	32	24	30	26	58
95	44	36	34	45	29	29	32	24	30	26	64
Mean	**44**	**36**	**34**	**45**	**29**	**29**	**32**	**24**	**30**	**26**	**50**

Table 5.1.10. HERRING in VIa(N) Results of maximum-likelihood model fit. Details are given in Section 5.1.9.

Output Generated by ICA Version 1.4

Herring in VIa(N)

Catch in Number

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	69.05	34.84	22.52	0.25	2.69	36.74	13.30	81.92	2.21	40.79	33.77
2	319.60	47.74	46.28	0.14	0.28	77.96	250.01	77.81	188.78	68.84	154.96
3	101.55	95.83	20.59	0.08	0.10	105.60	72.18	92.74	49.83	148.40	86.07
4	35.50	22.12	40.69	0.02	0.05	61.34	93.54	29.26	35.00	17.21	118.86
5	25.20	10.08	6.88	0.01	0.01	21.47	58.45	42.53	14.95	15.21	18.84
6	76.29	12.21	3.83	0.01	0.01	12.62	23.58	27.32	11.37	6.63	18.00
7	10.92	20.99	2.10	0.00	0.01	11.58	11.52	14.71	9.30	6.91	2.58
8	3.91	2.76	6.28	0.00	0.00	1.31	13.81	8.44	4.43	3.32	1.43
9	12.01	1.49	1.54	0.00	0.00	1.33	4.03	8.48	1.96	2.19	1.97

x 10 ^ 6

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	19.46	1.71	6.22	14.29	26.40	5.25	17.72	1.73	0.27	1.95	2.03
2	65.95	119.38	36.76	40.87	23.01	24.47	95.29	36.55	82.18	37.85	94.97
3	45.46	41.73	109.50	40.78	25.23	24.92	18.71	40.19	30.40	30.90	59.50
4	32.02	28.42	18.92	74.28	28.21	23.73	10.98	6.01	21.27	9.22	53.87
5	50.12	19.76	18.11	26.52	37.52	21.82	13.27	7.43	5.38	7.51	39.34
6	8.43	28.55	7.59	13.30	13.53	33.87	14.80	8.10	4.21	2.50	29.78
7	7.31	3.25	15.01	9.88	7.58	6.35	19.19	10.52	8.80	4.70	17.58
8	3.51	2.22	1.62	21.46	6.89	4.32	4.71	12.16	7.97	8.46	8.87
9	5.98	2.36	3.50	5.52	4.46	5.51	3.74	10.21	9.79	31.11	16.82

x 10 ^ 6

Predicted Catch in Number

AGE	1992	1993	1994	1995	1996	1997
1	4.61	4.68	2.65	0.89	1.64	2.03
2	37.75	99.32	58.36	54.07	19.37	112.42
3	27.59	22.23	33.23	34.03	33.64	38.62
4	21.97	11.87	5.33	13.78	15.08	53.12
5	20.91	17.30	5.22	3.95	10.90	43.18
6	22.68	17.13	7.91	4.01	3.24	32.66
7	6.53	25.56	10.86	8.41	4.55	12.92
8	4.30	5.01	10.97	7.88	6.52	12.60

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.08000	0.08000	0.08000	0.06900	0.11300
2	0.12100	0.12100	0.12100	0.12100	0.12100	0.12100	0.14000	0.14000	0.14000	0.10300	0.14500
3	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.17500	0.17500	0.17500	0.13400	0.17300
4	0.17500	0.17500	0.17500	0.17500	0.17500	0.17500	0.20500	0.20500	0.20500	0.16100	0.19600
5	0.18600	0.18600	0.18600	0.18600	0.18600	0.18600	0.23100	0.23100	0.23100	0.18200	0.21500
6	0.20600	0.20600	0.20600	0.20600	0.20600	0.20600	0.25300	0.25300	0.25300	0.19900	0.23000
7	0.21800	0.21800	0.21800	0.21800	0.21800	0.21800	0.27000	0.27000	0.27000	0.21300	0.24200
8	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.28400	0.28400	0.28400	0.22300	0.25100
9	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.29500	0.29500	0.29500	0.23100	0.25800

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.07300	0.08000	0.08200	0.07900	0.08400	0.09100	0.08900	0.08300	0.10600	0.08100	0.08900
2	0.14300	0.11200	0.14200	0.12900	0.11800	0.11900	0.12800	0.14200	0.14200	0.13400	0.13600
3	0.18300	0.15700	0.14500	0.17300	0.16000	0.18300	0.15800	0.16700	0.18100	0.17800	0.17700
4	0.21100	0.17700	0.19100	0.18200	0.20300	0.19600	0.19700	0.19000	0.19100	0.21000	0.20500
5	0.22000	0.20300	0.19000	0.20900	0.21100	0.22700	0.20600	0.19500	0.19800	0.23000	0.22200
6	0.23800	0.19400	0.21300	0.22400	0.22900	0.21900	0.22800	0.20100	0.21400	0.23300	0.22300
7	0.24100	0.24000	0.21600	0.22800	0.23600	0.24400	0.22300	0.24400	0.20800	0.26200	0.21900
8	0.25300	0.21300	0.20400	0.23700	0.26100	0.25600	0.26200	0.23400	0.22700	0.24700	0.23800
9	0.25600	0.22800	0.24300	0.24700	0.27100	0.25600	0.26300	0.26600	0.27700	0.29100	0.26300

Weights at age in the stock (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000
2	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400
3	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800
4	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300
5	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600
6	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200

Weights at age in the stock (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.07500	0.05200	0.04200	0.04500	0.05700
2	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16200	0.15000	0.14400	0.14000	0.15000
3	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.19600	0.19200	0.19100	0.18000	0.18900
4	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.20600	0.22000	0.20200	0.20900	0.20900
5	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.22600	0.22100	0.22500	0.21900	0.22500

Table 5.1.10. cont...

6	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.23400	0.23300	0.22700	0.22200	0.23300
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25400	0.24100	0.24700	0.22900	0.24800
8	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26000	0.27000	0.26000	0.24200	0.26600
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.27600	0.29600	0.29300	0.26300	0.28700

Natural Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Proportion of fish spawning

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700
3	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.5700	0.5700	0.5700	0.5700	0.4700	0.9300	0.4800	0.1900	0.7600	0.5700
3	0.9600	0.9600	0.9600	0.9600	0.9600	1.0000	0.9600	0.9200	0.9800	0.9400	0.9600
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS

LPE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	189.0	787.0	332.0	1071.0	1436.0	2154.0	1890.0	668.0	2133.0	2710.0	3037.0

LPE

	1987	1988	1989	1990	1991	1992	1993
1	4119.0	5947.0	4320.0	6525.0	4430.0	*******	2941.0

AGE-STRUCTURED INDICES

West Scotland Summer Acoustic Survey

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	249.1	*******	*******	*******	338.3	74.3	2.8	494.2	460.6	41.2
2	578.4	*******	*******	*******	294.5	503.4	750.3	542.1	1085.1	576.5
3	551.1	*******	*******	*******	327.9	211.0	681.2	607.7	472.7	802.5
4	353.1	*******	*******	*******	367.8	258.1	653.0	285.6	450.2	329.1
5	752.6	*******	*******	*******	488.3	414.8	544.0	306.8	153.0	95.4
6	111.6	*******	*******	*******	176.3	240.1	865.2	268.1	187.1	60.6
7	48.1	*******	*******	*******	98.7	105.7	284.1	406.8	169.2	77.4
8	15.9	*******	*******	*******	89.8	56.7	151.7	173.7	236.6	78.2
9	6.5	*******	*******	*******	58.0	63.4	156.2	131.9	201.5	114.8

x 10 ^ 3

Table 5.1.10. cont...

Fishing Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.1906	0.0903	0.0390	0.0003	0.0047	0.0349	0.0265	0.0405	0.0027	0.0502	0.0535
2	0.7516	0.3436	0.2873	0.0005	0.0007	0.3106	0.6423	0.3722	0.2098	0.1858	0.4874
3	1.1909	0.5730	0.2594	0.0007	0.0004	0.4258	0.5677	0.5670	0.4653	0.2696	0.3973
4	1.0534	0.8849	0.4849	0.0003	0.0006	0.3898	0.7924	0.4501	0.4109	0.2737	0.3407
5	0.8773	0.8842	0.6730	0.0002	0.0002	0.2969	0.6947	0.9331	0.3873	0.2801	0.4781
6	1.0469	1.3836	0.9086	0.0012	0.0002	0.2992	0.5426	0.7298	0.6101	0.2641	0.5480
7	1.0807	0.8284	0.8451	0.0017	0.0014	0.2748	0.4327	0.6853	0.5192	0.8290	0.1393
8	0.8779	0.7870	0.5572	0.0007	0.0005	0.2851	0.5377	0.5759	0.3978	0.3137	0.3509
9	0.8779	0.7870	0.5572	0.0007	0.0005	0.2851	0.5377	0.5759	0.3978	0.3137	0.3509

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0121	0.0020	0.0096	0.0384	0.0811	0.0061	0.0067	0.0041	0.0040	0.0042	0.0184
2	0.2399	0.1605	0.0912	0.1338	0.1340	0.2748	0.3023	0.1823	0.1793	0.1885	0.8266
3	0.2730	0.2499	0.2301	0.1464	0.1209	0.2497	0.2747	0.1657	0.1629	0.1713	0.7512
4	0.2384	0.2598	0.1627	0.2288	0.1359	0.1396	0.1536	0.0926	0.0911	0.0958	0.4201
5	0.2100	0.2029	0.2344	0.3193	0.1550	0.1270	0.1397	0.0842	0.0828	0.0871	0.3820
6	0.3617	0.1592	0.1004	0.2414	0.2386	0.1189	0.1308	0.0789	0.0775	0.0815	0.3576
7	0.3972	0.2058	0.1057	0.1648	0.1887	0.1554	0.1709	0.1031	0.1013	0.1066	0.4674
8	0.2543	0.1794	0.1347	0.1936	0.1487	0.1396	0.1536	0.0926	0.0911	0.0958	0.4201
9	0.2543	0.1794	0.1347	0.1936	0.1487	0.1396	0.1536	0.0926	0.0911	0.0958	0.4201

Population Abundance (1 January)

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	619.7	633.8	928.3	1225.6	916.0	1691.7	801.6	3251.3	1274.9	1313.0	1020.4
2	687.3	188.4	213.0	328.4	450.7	335.4	601.0	287.2	1148.6	467.7	459.4
3	157.9	240.1	99.0	118.4	243.2	333.7	182.1	234.2	146.6	689.8	287.7
4	56.8	39.3	110.8	62.5	96.9	199.0	178.5	84.5	108.8	75.4	431.3
5	45.0	17.9	14.7	61.8	56.6	87.6	122.0	73.1	48.8	65.3	51.9
6	122.5	16.9	6.7	6.8	55.9	51.2	58.9	55.1	26.0	30.0	44.6
7	17.2	38.9	3.8	2.4	6.1	50.5	34.3	31.0	24.0	12.8	20.8
8	7.0	5.3	15.4	1.5	2.2	5.5	34.7	20.2	14.1	12.9	5.1
9	21.4	2.8	3.8	9.9	10.3	5.6	10.1	20.3	6.3	8.5	7.0

x 10 ^ 6

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	2553.6	1327.0	1033.0	598.1	532.5	1196.2	1104.2	1036.2	354.4	618.8	175.9
2	355.8	928.1	487.2	376.4	211.7	180.6	437.4	403.5	379.6	129.9	226.7
3	209.0	207.4	585.6	329.5	243.9	137.2	101.7	239.5	249.1	235.1	79.7
4	158.3	130.3	132.2	380.9	233.0	177.0	87.5	63.2	166.1	173.3	162.2
5	277.6	112.9	90.9	101.7	274.2	184.0	139.2	67.9	52.2	137.2	142.5
6	29.1	203.6	83.4	65.1	66.9	212.5	146.7	109.6	56.5	43.4	113.8
7	23.3	18.3	157.1	68.2	46.2	47.7	170.7	116.4	91.6	47.3	36.2
8	16.4	14.2	13.5	127.9	52.4	34.7	36.9	130.2	95.0	74.9	38.5
9	27.9	15.1	29.2	32.9	33.9	44.4	27.6	121.1	118.0	357.6	51.3

x 10 ^ 6

Population Abundance (1 January)

AGE	1998
1	516.7
2	63.5
3	73.5
4	30.8
5	96.4
6	88.0
7	72.0
8	20.5
9	53.4

x 10 ^ 6

Weighting factors for the catches in number

AGE	1992	1993	1994	1995	1996	1997
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted SSB Index Values

LPE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	687.5	367.7	331.6	727.2	1866.0	2092.3	1521.6	889.2	2003.1	3180.1	2873.8

LPE

	1987	1988	1989	1990	1991	1992	1993
1	2752.1	4100.8	5665.6	5761.1	4352.8	*******	3530.1

Table 5.1.10. cont...

Predicted Age-Structured Index Values

West Scotland Summer Acoustic Survey Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	311.71	*******	*******	*******	63.23	146.37	135.08	126.89	43.41	75.78
2	742.32	*******	*******	*******	460.88	371.60	890.01	861.40	811.46	276.58
3	507.11	*******	*******	*******	628.81	335.95	246.45	606.48	631.50	593.98
4	401.12	*******	*******	*******	614.97	466.35	229.34	169.83	446.46	464.77
5	630.25	*******	*******	*******	636.32	431.93	325.16	162.12	124.60	327.30
6	69.18	*******	*******	*******	166.98	556.63	382.42	291.70	150.44	115.53
7	44.55	*******	*******	*******	95.95	100.19	356.65	249.97	196.84	101.39
8	26.40	*******	*******	*******	88.03	58.47	61.94	223.84	163.51	128.64
9	29.32	*******	*******	*******	37.06	48.77	30.12	135.60	132.23	399.85

x 10 ^ 3

Fitted Selection Pattern

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.1809	0.1020	0.0805	0.9986	8.4189	0.0894	0.0335	0.0901	0.0067	0.1834	0.1571
2	0.7135	0.3883	0.5924	1.5676	1.2953	0.7967	0.8106	0.8268	0.5106	0.6790	1.4304
3	1.1305	0.6476	0.5349	2.2477	0.7791	1.0922	0.7165	1.2596	1.1326	0.9849	1.1661
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8328	0.9993	1.3881	0.6928	0.4365	0.7617	0.8768	2.0731	0.9426	1.0236	1.4033
6	0.9938	1.5636	1.8739	3.8888	0.3060	0.7675	0.6848	1.6214	1.4848	0.9650	1.6084
7	1.0259	0.9362	1.7430	5.3936	2.4834	0.7049	0.5461	1.5226	1.2637	3.0289	0.4088
8	0.8334	0.8894	1.1491	2.2052	0.8609	0.7314	0.6787	1.2796	0.9682	1.1462	1.0298
9	0.8334	0.8894	1.1491	2.2052	0.8609	0.7314	0.6787	1.2796	0.9682	1.1462	1.0298

Fitted Selection Pattern

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0508	0.0078	0.0587	0.1679	0.5967	0.0438	0.0438	0.0438	0.0438	0.0438	0.0438
2	1.0062	0.6178	0.5604	0.5849	0.9856	1.9679	1.9679	1.9679	1.9679	1.9679	1.9679
3	1.1449	0.9620	1.4139	0.6400	0.8896	1.7883	1.7883	1.7883	1.7883	1.7883	1.7883
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8807	0.7811	1.4404	1.3954	1.1405	0.9094	0.9094	0.9094	0.9094	0.9094	0.9094
6	1.5170	0.6128	0.6173	1.0549	1.7554	0.8513	0.8513	0.8513	0.8513	0.8513	0.8513
7	1.6662	0.7924	0.6497	0.7201	1.3884	1.1126	1.1126	1.1126	1.1126	1.1126	1.1126
8	1.0666	0.6905	0.8281	0.8460	1.0937	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0666	0.6905	0.8281	0.8460	1.0937	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1976	619740	269086	76591	93642	1.2226	1.0422	100
1977	633790	168009	55232	41341	0.7485	0.9314	109
1978	928330	176434	52330	22176	0.4238	0.5815	99
1979	1225600	224201	78873	60	0.0008	0.0006	99
1980	915960	262698	129034	306	0.0024	0.0003	99
1981	1691730	373651	136983	51420	0.3754	0.3529	103
1982	801550	316182	115988	92361	0.7963	0.6493	96
1983	3251290	459327	87607	63523	0.7251	0.6700	97
1984	1274880	389325	133901	56012	0.4183	0.4684	105
1985	1313010	388800	170468	39142	0.2296	0.2719	99
1986	1020390	360300	161683	70764	0.4377	0.4411	95
1987	2553640	462764	158070	44360	0.2806	0.2708	102
1988	1327020	437161	194681	35591	0.1828	0.2180	97
1989	1032960	421551	230491	34026	0.1476	0.1819	98
1990	598130	375879	232511	44693	0.1922	0.2340	101
1991	532450	307870	200841	28529	0.1420	0.1626	93
1992	1196240	340440	180162	28992	0.1609	0.1588	99
1993	1104210	317977	180024	31778	0.1765	0.1747	100
1994	1036160	313900	189176	24430	0.1291	0.1054	100
1995	354440	257175	167333	29575	0.1767	0.1036	99
1996	618830	287267	215610	26105	0.1211	0.1089	95
1997	175930	185520	107172	59957	0.5594	0.4777	99

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1976 . . . 1997
Number of indices of SSB : 1
Number of age-structured indices : 1

Parameters to estimate : 36
Number of observations : 128

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	0.1396	23	0.0887	0.2199	0.1108	0.1760	0.1434
2	1993	0.1536	23	0.0976	0.2418	0.1219	0.1936	0.1578
3	1994	0.0926	24	0.0575	0.1494	0.0726	0.1182	0.0954
4	1995	0.0911	25	0.0552	0.1503	0.0706	0.1176	0.0941
5	1996	0.0958	27	0.0555	0.1653	0.0725	0.1265	0.0996
6	1997	0.4201	38	0.1965	0.8980	0.2851	0.6190	0.4528
Separable Model: Selection (S) by age								
7	1	0.0438	27	0.0257	0.0746	0.0334	0.0575	0.0454
8	2	1.9679	23	1.2411	3.1200	1.5555	2.4895	2.0230

Table 5.1.10. cont...

9	3	1.7883	22	1.1603	2.7561	1.4341	2.2299	1.8323
	4	1.0000		Fixed : Reference Age				
10	5	0.9094	19	0.6234	1.3264	0.7500	1.1025	0.9264
11	6	0.8513	18	0.5888	1.2309	0.7053	1.0275	0.8665
12	7	1.1126	19	0.7633	1.6216	0.9180	1.3484	1.1333
	8	1.0000		Fixed : Last true age				

Separable model: Populations in year 1997

13	1	175932	61	52500	589556	94928	326057	212816
14	2	226701	40	101678	505453	150587	341288	246488
15	3	79682	37	37840	167790	54495	116510	85646
16	4	162172	35	80514	326647	113454	231809	172859
17	5	142474	31	76235	266264	103556	196017	149913
18	6	113825	28	65613	197461	85935	150765	118410
19	7	36229	27	21155	62042	27533	47671	37620
20	8	38464	27	22624	65394	29340	50425	39900

Separable model: Populations at age

21	1992	34650	39	15870	75652	23264	51609	37512
22	1993	36916	31	19967	68252	26980	50511	38776
23	1994	130186	26	76866	220495	99498	170340	134977
24	1995	95038	25	57572	156886	73592	122733	98197
25	1996	74913	25	45471	123419	58068	96646	77383

SSB Index catchabilities

LPE

Power model fitted. Slopes (Q) and exponents (K) at age

26	1	Q	6.783	19	5.641	11.98	6.784	9.965	8.376
27	1	K	.3068E-06	19	.2022E-05	.4295E-05	.2432E-05	.3572E-05	.3244E-05

Age-structured index catchabilities

West Scotland Summer Acoustic Survey

Linear model fitted. Slopes at age :

28	1	Q	.1830	129	.5292E-01	8.389	.1830	2.426	1.536
29	2	Q	2.589	43	1.713	9.255	2.589	6.123	4.368
30	3	Q	2.931	43	1.939	10.48	2.931	6.934	4.946
31	4	Q	2.901	42	1.922	10.32	2.901	6.838	4.882
32	5	Q	2.570	42	1.707	9.075	2.570	6.028	4.310
33	6	Q	2.860	42	1.900	10.08	2.860	6.701	4.793
34	7	Q	2.328	42	1.544	8.268	2.328	5.482	3.916
35	8	Q	1.857	43	1.224	6.717	1.857	4.427	3.151
36	9	Q	1.209	43	.7987	4.344	1.209	2.869	2.045

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997
1	0.130	1.331	-0.429	-1.210	0.175	0.000
2	-0.434	-0.041	-0.468	0.419	0.670	-0.169
3	-0.102	-0.173	0.190	-0.113	-0.085	0.432
4	0.077	-0.078	0.120	0.434	-0.492	0.014
5	0.043	-0.265	0.353	0.309	-0.373	-0.093
6	0.401	-0.146	0.024	0.047	-0.259	-0.092
7	-0.028	-0.287	-0.032	0.046	0.032	0.308
8	0.003	-0.061	0.103	0.011	0.261	-0.351

SPAWNING BIOMASS INDEX RESIDUALS

LPE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	-1.291	0.761	0.001	0.387	-0.262	0.029	0.217	-0.286	0.063	-0.160	0.055

LPE

	1987	1988	1989	1990	1991	1992	1993
1	0.403	0.372	-0.271	0.125	0.018	*******	-0.183

AGE-STRUCTURED INDEX RESIDUALS

West Scotland Summer Acoustic Survey

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	-0.224	*******	*******	*******	1.677	-0.678	-3.891	1.360	2.362	-0.609
2	-0.250	*******	*******	*******	-0.448	0.304	-0.171	-0.463	0.291	0.734
3	0.083	*******	*******	*******	-0.651	-0.465	1.017	0.002	-0.290	0.301
4	-0.128	*******	*******	*******	-0.514	-0.592	1.046	0.520	0.008	-0.345
5	0.177	*******	*******	*******	-0.265	-0.041	0.515	0.638	0.205	-1.233
6	0.478	*******	*******	*******	0.055	-0.841	0.816	-0.084	0.218	-0.645
7	0.077	*******	*******	*******	0.029	0.053	-0.227	0.487	-0.151	-0.270
8	-0.507	*******	*******	*******	0.020	-0.031	0.896	-0.253	0.369	-0.498
9	-1.507	*******	*******	*******	0.449	0.263	1.646	-0.028	0.421	-1.248

Table 5.1.10. cont...

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 1997

Variance	0.2764
Skewness test stat.	0.9416
Kurtosis test statistic	5.6396
Partial chi-square	0.7494
Significance in fit	0.0000
Degrees of freedom	23

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR LPE

Power catchability relationship assumed
Last age is a plus-group

Variance	0.2034
Skewness test stat.	-2.0787
Kurtosis test statistic	2.4014
Partial chi-square	0.4593
Significance in fit	0.0000
Number of observations	17
Degrees of freedom	15
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR West Scotland Summer Acoustic Survey

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9
Variance	0.0486	0.0226	0.0344	0.0392	0.0433	0.0384	0.0073	0.0280	0.1293
Skewness test stat.	-0.8290	0.5051	0.7663	0.8366	-1.1867	-0.1907	0.9371	0.7690	-0.1116
Kurtosis test statisti	-0.1292	-0.6147	-0.1812	-0.3702	0.1480	-0.5922	-0.0440	-0.3025	-0.4584
Partial chi-square	0.0255	0.0105	0.0162	0.0187	0.0207	0.0185	0.0036	0.0151	0.0716
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	7	7	7	7	7	7	7	7	7
Degrees of freedom	6	6	6	6	6	6	6	6	6
Weight in the analysis	0.0111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	54.1602	128	36	92	0.5887
Catches at age	6.3562	48	25	23	0.2764
SSB Indices					
LPE	3.0508	17	2	15	0.2034
Aged Indices					
West Scotland Summer Acoustic Survey	44.7532	63	9	54	0.8288

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	9.6386	128	36	92	0.1048
Catches at age	6.3562	48	25	23	0.2764
SSB Indices					
LPE	3.0508	17	2	15	0.2034
Aged Indices					
West Scotland Summer Acoustic Survey	0.2316	63	9	54	0.0043

Table 5.1.11 Herring in Division VIa(N). Input data for short-term deterministic predictions.

The SAS System 11:06 Monday, March 16, 1998

Herring in the Northern part of VIa

Prediction with management option table: Input data

Year: 1998								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	348700.00	0.3000	0.5700	0.6700	0.6700	0.146	0.8266	0.139
3	73500.000	0.2000	0.9600	0.6700	0.6700	0.188	0.7511	0.176
4	30800.000	0.1000	1.0000	0.6700	0.6700	0.210	0.4201	0.199
5	96400.000	0.1000	1.0000	0.6700	0.6700	0.223	0.3820	0.211
6	88000.000	0.1000	1.0000	0.6700	0.6700	0.229	0.3576	0.224
7	72000.000	0.1000	1.0000	0.6700	0.6700	0.241	0.4674	0.251
8	20500.000	0.1000	1.0000	0.6700	0.6700	0.260	0.4201	0.237
9+	53400.000	0.1000	1.0000	0.6700	0.6700	0.285	0.4201	0.274
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	348700.00	0.3000	0.5700	0.6700	0.6700	0.149	0.8266	0.139
3	.	0.2000	0.9600	0.6700	0.6700	0.190	0.7511	0.176
4	.	0.1000	1.0000	0.6700	0.6700	0.209	0.4201	0.199
5	.	0.1000	1.0000	0.6700	0.6700	0.223	0.3820	0.211
6	.	0.1000	1.0000	0.6700	0.6700	0.229	0.3576	0.224
7	.	0.1000	1.0000	0.6700	0.6700	0.243	0.4674	0.251
8	.	0.1000	1.0000	0.6700	0.6700	0.258	0.4201	0.237
9+	.	0.1000	1.0000	0.6700	0.6700	0.282	0.4201	0.274
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	348700.00	0.3000	0.5700	0.6700	0.6700	0.149	0.8266	0.139
3	.	0.2000	0.9600	0.6700	0.6700	0.190	0.7511	0.176
4	.	0.1000	1.0000	0.6700	0.6700	0.209	0.4201	0.199
5	.	0.1000	1.0000	0.6700	0.6700	0.223	0.3820	0.211
6	.	0.1000	1.0000	0.6700	0.6700	0.229	0.3576	0.224
7	.	0.1000	1.0000	0.6700	0.6700	0.243	0.4674	0.251
8	.	0.1000	1.0000	0.6700	0.6700	0.258	0.4201	0.237
9+	.	0.1000	1.0000	0.6700	0.6700	0.282	0.4201	0.274
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANHEN01
Date and time: 16MAR98:11:31

Table 5.1.12 Herring in Division VIa(N). Management option table. Estimated effect on stock biomass at different levels of catches and fishing mortality in the stock

The SAS System 11:06 Monday, March 16, 1998

Herring in the Northern part of VIa

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.4777	150746	81983	56965	0.0000	0.0000	133534	98461	0	177617	137048
.	.	.	.	.	0.1000	0.0478	.	94734	6898	170003	125232
.	.	.	.	.	0.2000	0.0955	.	91162	13363	162893	114542
.	.	.	.	.	0.3000	0.1433	.	87740	19424	156253	104862
.	.	.	.	.	0.4000	0.1911	.	84460	25109	150049	96088
.	.	.	.	.	0.5000	0.2389	.	81316	30443	144251	88127
.	.	.	.	.	0.6000	0.2866	.	78302	35449	138830	80898
.	.	.	.	.	0.7000	0.3344	.	75411	40151	133760	74325
.	.	.	.	.	0.8000	0.3822	.	72639	44568	129016	68344
.	.	.	.	.	0.9000	0.4299	.	69980	48719	124576	62897
.	.	.	.	.	1.0000	0.4777	.	67429	52622	120419	57930
.	.	.	.	.	1.1000	0.5255	.	64982	56294	116525	53398
.	.	.	.	.	1.2000	0.5732	.	62633	59749	112876	49257
.	.	.	.	.	1.3000	0.6210	.	60378	63001	109456	45472
.	.	.	.	.	1.4000	0.6688	.	58213	66065	106248	42008
.	.	.	.	.	1.5000	0.7166	.	56135	68951	103240	38835
.	.	.	.	.	1.6000	0.7643	.	54139	71672	100416	35926
.	.	.	.	.	1.7000	0.8121	.	52222	74238	97766	33256
.	.	.	.	.	1.8000	0.8599	.	50380	76660	95276	30804
.	.	.	.	.	1.9000	0.9076	.	48610	78945	92938	28552
.	.	.	.	.	2.0000	0.9554	.	46910	81103	90739	26479
.	.	.	.	.	2.1000	1.0032	.	45275	83141	88672	24571
.	.	.	.	.	2.2000	1.0509	.	43704	85068	86728	22813
.	.	.	.	.	2.3000	1.0987	.	42194	86890	84898	21192
.	.	.	.	.	2.4000	1.1465	.	40741	88614	83176	19697
.	.	.	.	.	2.5000	1.1943	.	39344	90244	81554	18315
.	.	.	.	.	2.6000	1.2420	.	38000	91789	80026	17039
.	.	.	.	.	2.7000	1.2898	.	36707	93251	78586	15859
.	.	.	.	.	2.8000	1.3376	.	35463	94637	77228	14768
.	.	.	.	.	2.9000	1.3853	.	34266	95951	75947	13757
.	.	.	.	.	3.0000	1.4331	.	33113	97197	74738	12820
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANHEN01
Date and time : 16MAR98:11:31
Computation of ref. F: Simple mean, age 3 - 6
Basis for 1998 : F factors

Table 5.1.13 Herring in Division VIa(N). Estimated catches at maintaining Fsq for 1998 to 2000.

The SAS System 11:06 Monday, March 16, 1998

Herring in the Northern part of VIa

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0000	0.4777	322987	56965	783300	150746	608335	125078	378046	80467
1999	1.0000	0.4777	307253	52622	708401	132392	531855	106427	315427	65613
2000	1.0000	0.4777	290640	48675	653204	119329	476658	93363	275385	56150
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRMDC02
Date and time : 16MAR98:10:44
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors

Table 5.1.14. HERRING in VIa(N) Stochastic projections for various F-multiplier constraints for 1999. F in 1998 is assumed equal to F in 1997.

YIELD in 1999

		Percentiles		
	Expected Yield	25%	50%	75%
Expected F				
0.1	6.93	5.23	6.41	8.01
0.2	12.91	9.81	12.07	14.95
0.3	18.14	13.87	16.74	21.22
0.4	22.7	17.38	21.08	26.33
F99=F97	35.71	25.79	33.05	42.49

SSB in 1999

		Percentiles		
	Expected SSB	25%	50%	75%
Expected F				
0.1	76.33	20.5	44.03	95.48
0.2	73.3	18.07	41.27	91.56
0.3	70.49	15.8	38.67	88.03
0.4	67.91	14.21	36.32	84.64
F99=F97	60.17	9.25	29.21	74.72

YIELD in 1999

		Percentiles		
	Expected	25%	50%	75%
Yield	31.12	19.86	28.88	39.84

SSB in 1999

		Percentiles		
	Expected	25%	50%	75%
SSB	70.32	14.78	39.85	95.33

Table 5.2.1 Catches of HERRING from the Firth of Clyde. Spring and autumn-spawners combined. Catch in tonnes by country, 1955–1995.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Total	4,050	4,848	5,915	4,926	10,530	15,680	10,848	3,989	7,073	14,509	15,096

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Total	9,807	7,929	9,433	10,594	7,763	4,088	4,226	4,715	4,061	3,664	4,139

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Scotland						2,506	2,530	2,991	3,001	3,395	2,895
Other UK						-	273	247	22	-	-
Unallocated[1]						262	293	224	433	576	278
Discards						1,253	1,265	2,308[3]	1,344[3]	679[3]	439[4]
Agreed TAC								3,000	3,000	3,100	3,500
Total	4,847	3,862	1,951	2,081	2,135	4,021	4,361	5,770	4,800	4,650	3,612

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Scotland	1,568	2,135	2,184	713	929	852	608	392	598	371
Other UK	-	-	-	-	-	-	-	-	283	119
Unallocated[1]	110	208	75	18	-	-	-	-	-	-
Discards	245[4]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-	-
Agreed TAC	3,200	3,200	2,600	2,900	2,300	1,000	1,000	1,000	1,000	1,000
Total	1,923	2,343	2,259	731	929	852	608	392	881	490

[1]Calculated from estimates of weight per box and in some years estimated by-catch in the sprat fishery
[2]Reported to be at a low level, assumed to be zero.
[3]Based on sampling.
[4]Estimated assuming the same discarding rate as in 1986.

Table 5.2.2 Sampling levels of Clyde HERRING 1988-1997.

Year	Reported catch (tonnes)	No. of samples	No. of fish measured	No. of fish aged	Discards
1988	1,568	41	5,955	2,574	Based on local
1989	2,135	45	8,368	4,152	reports
1990	2,184	37	5,926	3,803	" "
1991	713	29	4,312	2,992	" "
1992	929	23	4,604	1,579	No information
1993	852	16	3,408	798	No information
1994	608	16	3,903	1,388	No information
1995	392	16	2,727	1,073	No information
1996	881	9	1,915	679	No information
1997	490	3	650	383	No information

Table 5.2.3 Clyde HERRING catch in numbers at age. Spring- and autumn-spawners combined. Thousands of fish.

	Age(Rings)									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	5008	2207	1351	9139	5308	12694	6194	1041	14123	507
2	7551	6503	8983	5258	8841	1876	10480	7524	1796	4859
3	10338	1976	3181	4548	2817	2483	913	6976	2259	807
4	8745	4355	1684	1811	2559	1024	1049	1062	2724	930
5	2306	3432	3007	918	1140	1072	526	1112	634	888
6	741	1090	1114	1525	494	451	638	574	606	341
7	760	501	656	659	700	175	261	409	330	289
8	753	352	282	307	253	356	138	251	298	156
9	227	225	177	132	87	130	178	146	174	119
9+	117	181	132	114	59	67	100	192	236	154

	Age(Rings)									
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	333	312	220	314	4156	1639	678	508	0	845
2	5633	2372	11311	10109	11829	2951	4574	1376	1062	1523
3	1592	2785	4079	5232	5774	4420	4431	3669	1724	9239
4	567	1622	2440	1747	3406	4592	4622	4379	2506	876
5	341	1158	1028	963	1509	2806	2679	3400	2014	452
6	204	433	663	555	587	2654	1847	1983	1319	252
7	125	486	145	415	489	917	644	1427	510	146
8	48	407	222	189	375	681	287	680	234	29
9	56	74	63	85	74	457	251	308	66	16
9+	68	18	53	38	80	240	79	175	16	5

	Age(Rings)							
	1990	1991	1992	1993	1994	1995	1996	1997
1	716	42	145	3	399	118	494	275
2	1004	615	411	418	964	1425	1962	2005
3	839	472	493	261	964	186	1189	429
4	7533	703	385	268	358	189	273	346
5	576	1908	1947	1305	534	149	544	18
6	359	169	333	327	319	130	183	52
7	329	92	91	78	76	66	208	0
8	119	113	69	111	57	35	127	5
9	49	22	32	38	16	15	52	61
9+	16	9	10	0	17	1	9	*

* change to 9+ in 1997.

Table 5.2.4 HERRING in the Firth of Clyde. Mean weights at age in the catch and stock (g).

Age	Weight in the catch													
(rings)	1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-	-	-	-	-	-	-	-	-	-	-	102	90	112
2	225	149	166	149	156	149	170	143	141	141	92	151	146	142
3	270	187	199	194	194	174	186	163	187	174	157	174	184	174
4	290	228	224	203	207	203	202	188	188	198	184	201	203	192
5	310	253	253	217	211	221	216	192	216	213	212	226	233	231
6	328	272	265	225	222	227	237	198	227	216	249	241	255	228
7	340	307	297	236	230	235	234	210	206	229	248	249	257	189
8	345	291	298	247	225	237	234	222	218	261	240	252	255	286
9	350	300	298	255	244	219	257	200	201	233	249	242	284	218
10+	350	300	321	258	230	254	272	203	221	254	294	270	239	*

* change to 9+ in 1997

Table 5.2.5. Catch per unit effort on Clyde Herring 1974 to 1997, catch, Scottish Pair Effort. Pair days absense, raised pair effort (by additional non-pair catch) and estimated CPUE

Year	Catch	Pair Effort	Raised Pair Effort	CPUE
1974	4061	3376	3376	1.20
1975	3664	3209	3209	1.14
1976	4139	3016	3016	1.37
1977	4847	4186	4186	1.16
1978	3862	4379	4379	0.88
1979	1951	2933	2933	0.67
1980	2081	1982	1982	1.05
1981	2135	1529	1529	1.40
1982	4021	1755	1755	2.29
1983	4361	1644	1644	2.65
1984	5770	1401	1401	4.12
1985	4800	1688	1688	2.84
1986	4650	1375	1375	3.38
1987	3612	850	998	3.62
1988	1923	540	626	3.07
1989	2343	582	639	3.67
1990	2259	388	429	5.27
1991	731	169	254	2.88
1992	929	137	165	5.63
1993	852	194	224	3.80
1994	608	104	111	5.48
1995	392	79	89	4.40
1996	881	82	127	6.94
1997	490	12	36	13.60

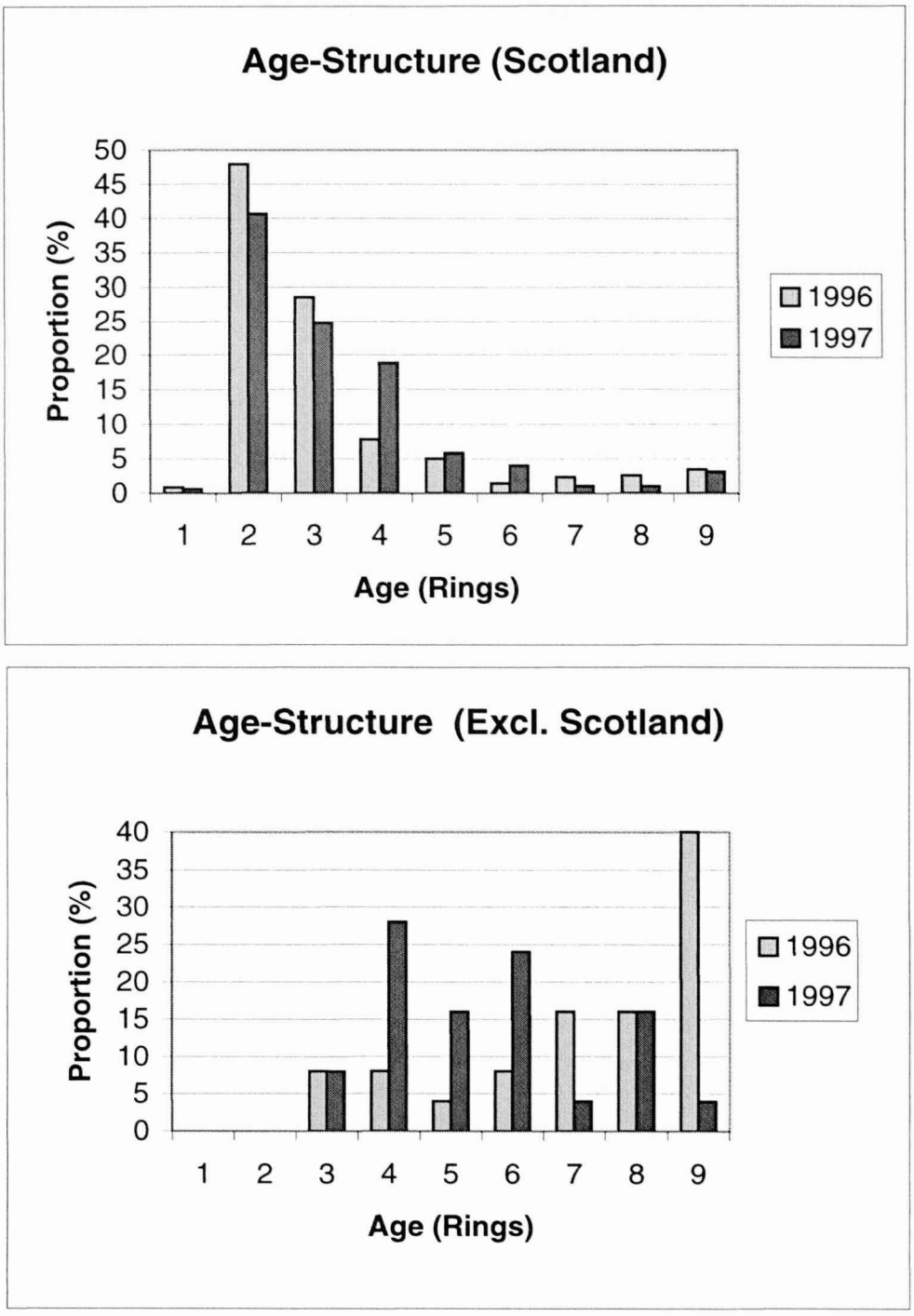

Figure 5.1.1. Comparison of age-structures (proportion of fish by number in 1996 and 1997) in the commercial samples of the Scottish purse-seine fleet, and of the samples by Netherlands (1sample) and Germany (7 samples) in the offshore freezer-trawler fishery.

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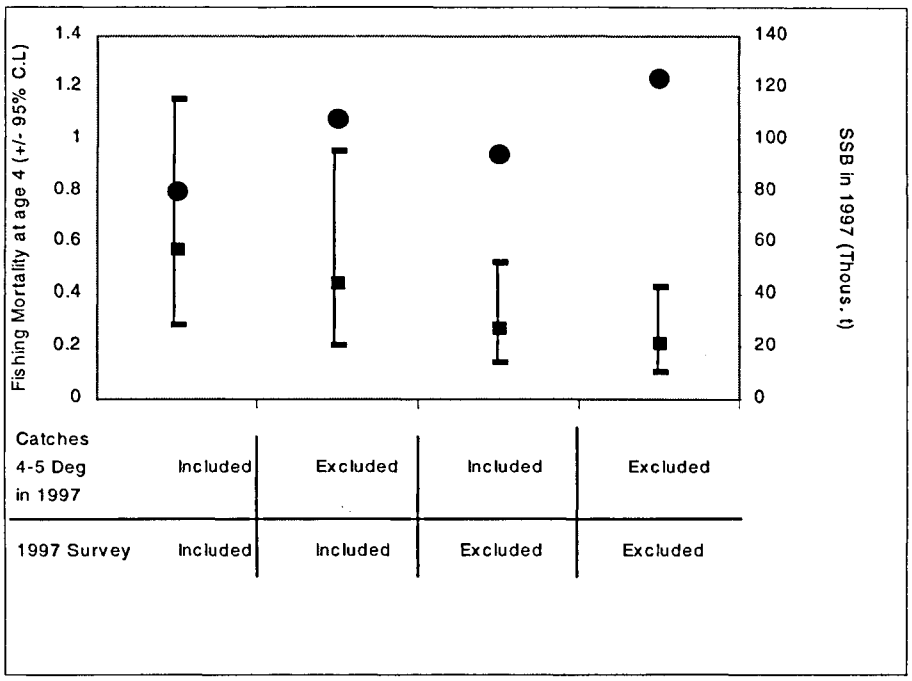


Figure 5.1.2 Comparison of estimates of fishing mortality at age 4 in 1997 (square markers and error bars), and spawning stock size (Round markers) excluding either or both (1) catches reported between 4°W and 5°W; (2) Acoustic survey estimates in 1997.

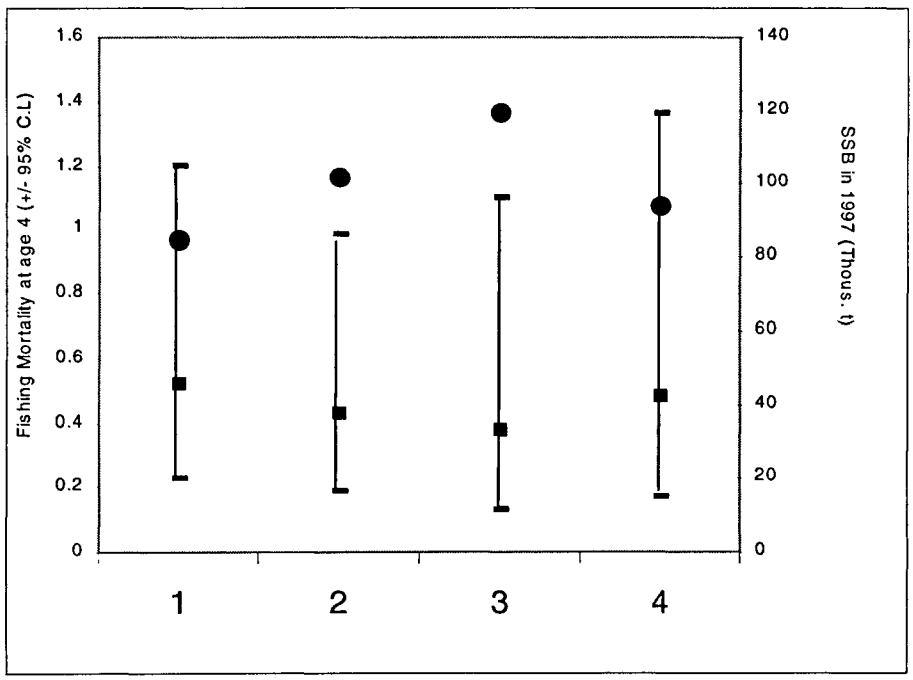


Figure 5.1.3. Comparison of estimates of fishing mortality at age 4 in 1997 (Square markers and error bars) and spawning stock size (Round markers) inferred using each of four treatments of the acoustic surveys. (1) Age-disaggregated, excluding 1993 outlier; (2) Age-disaggregated, all observations. (3) Age-aggregated, including 1993 outlier (4) Age-aggregated, excludes 1993 outlier.

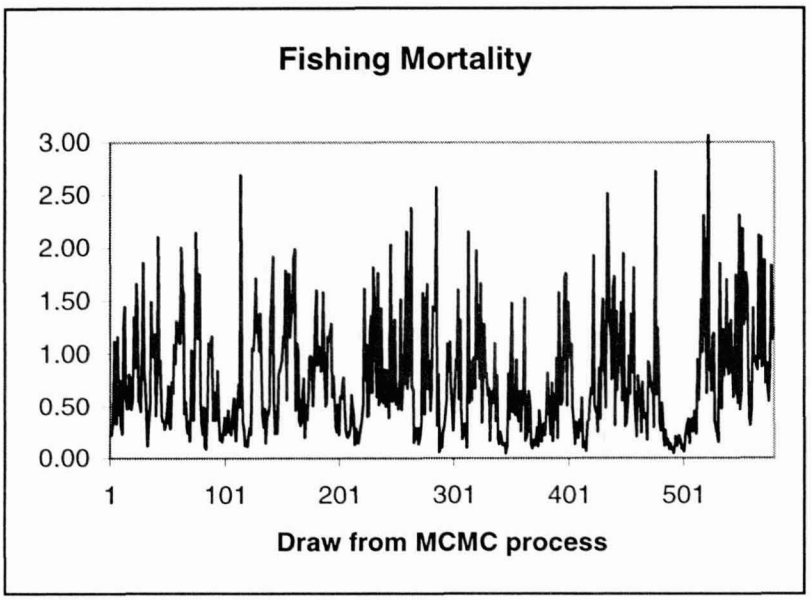


Figure 5.1.4 Values of fishing mortality in 1997 (ages 3 to 6) drawn from the MCMC process at intervals of 400 iterations.

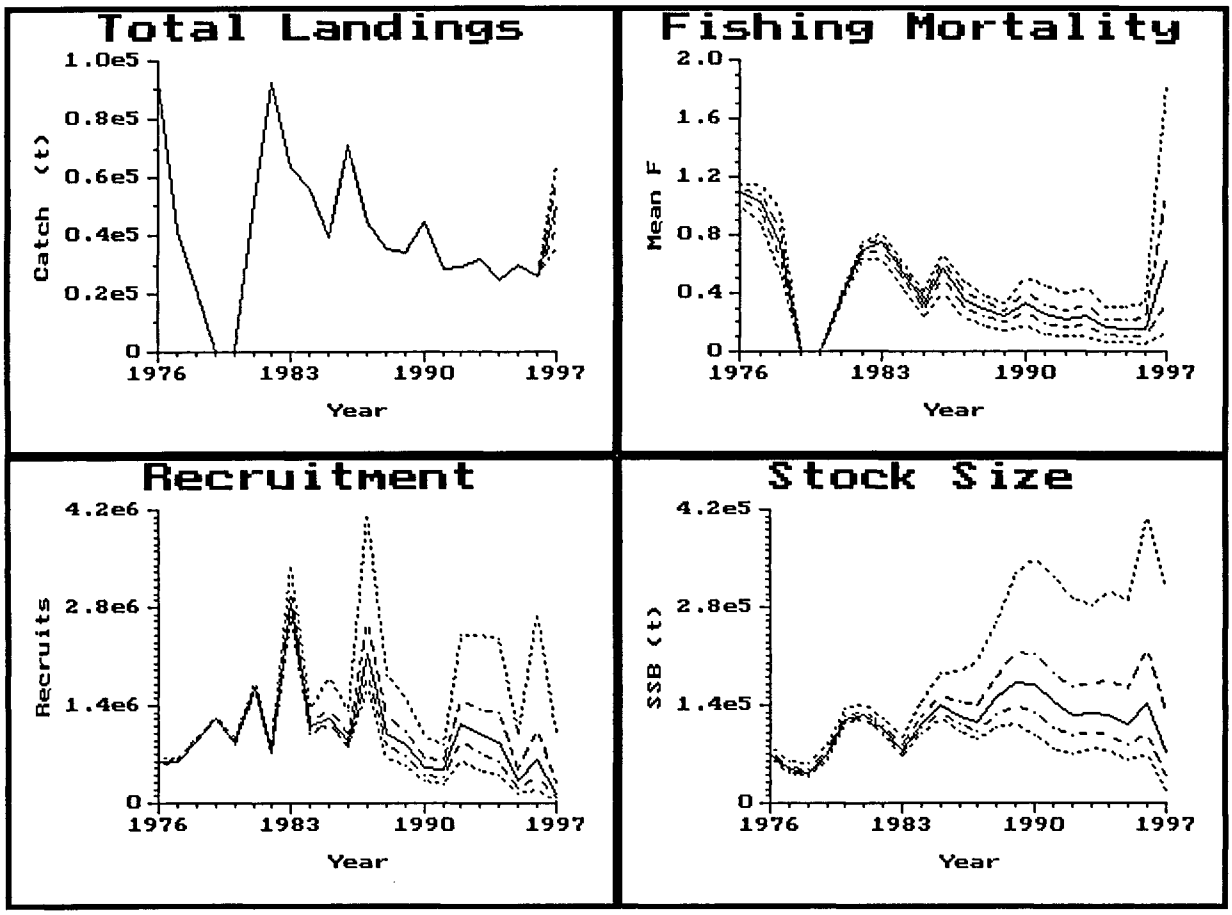


Figure 5.1.5. Herring in VIa(N). Results of stochastic assessment. Summary of estimates of landings, mean fishing mortality, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time. Dotted lines indicate the 10th and 90th percentiles, dashed lines indicate the 25th and 75th percentiles, unbroken line indicate median.

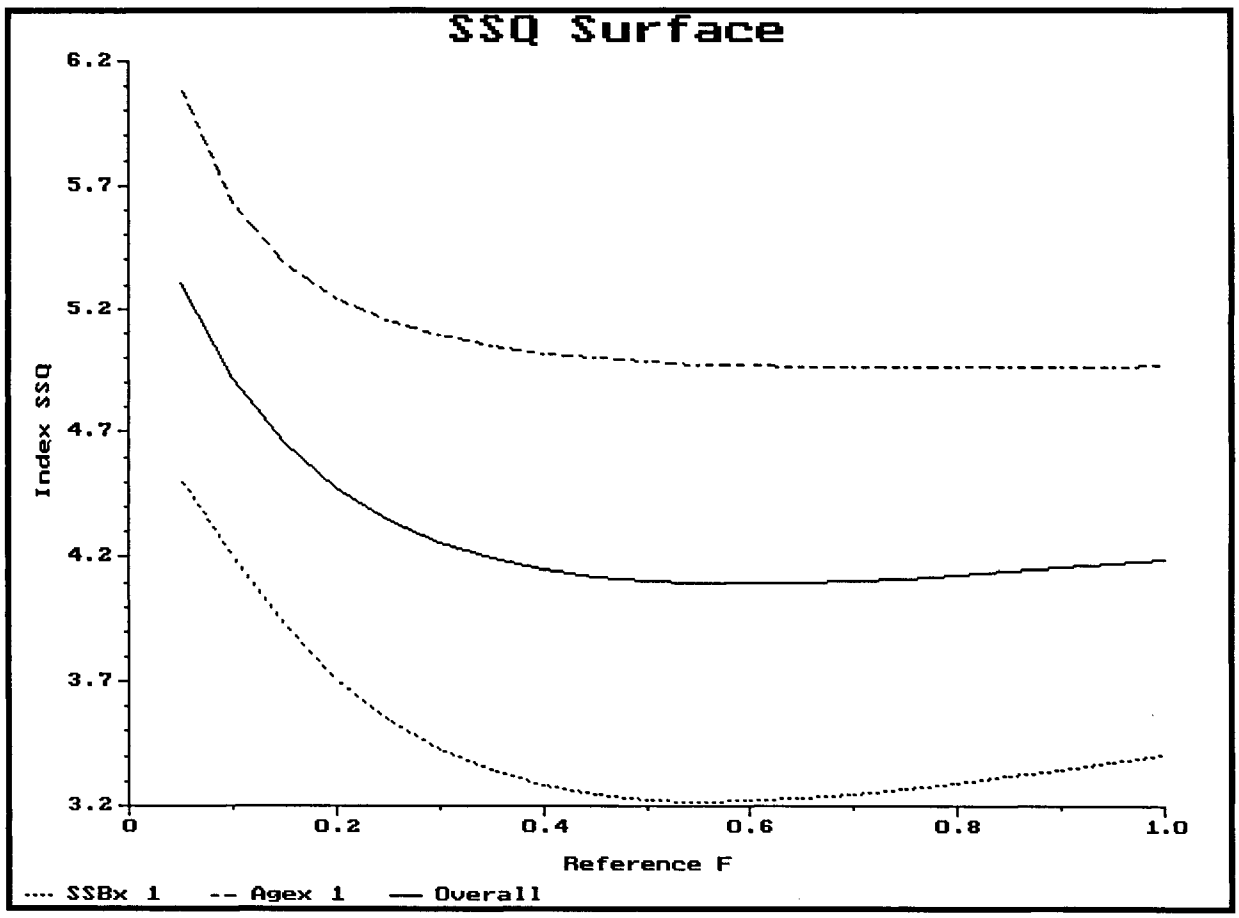


Figure 5.1.6. Herring in VIa(N). SSQ surface for the baseline assessment. SSBx 1 = larvae production estimates from 1973-1993; Agex 1 = age disaggregated acoustic estimates.

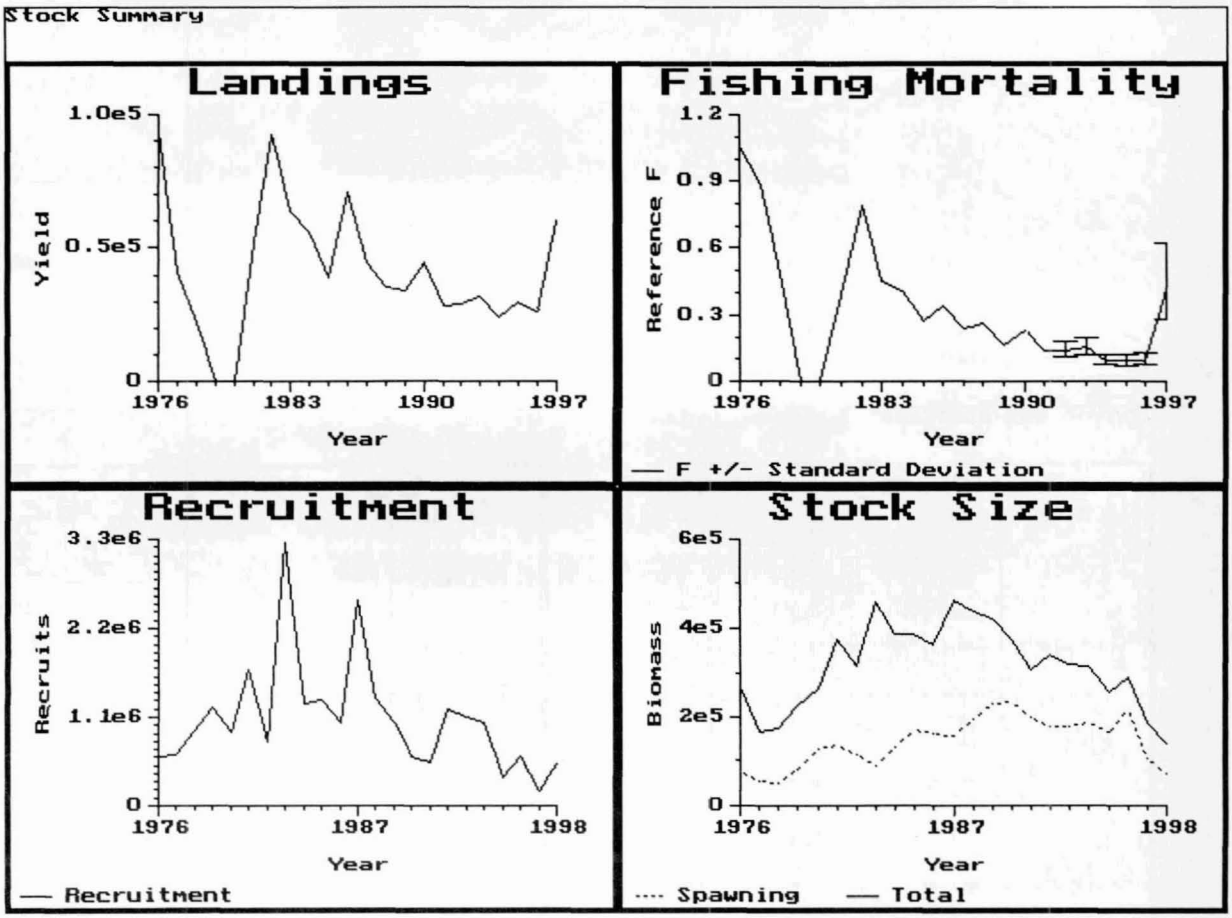


Figure 5.1.7. Herring in VIa(N). Results of deterministic assessment. Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

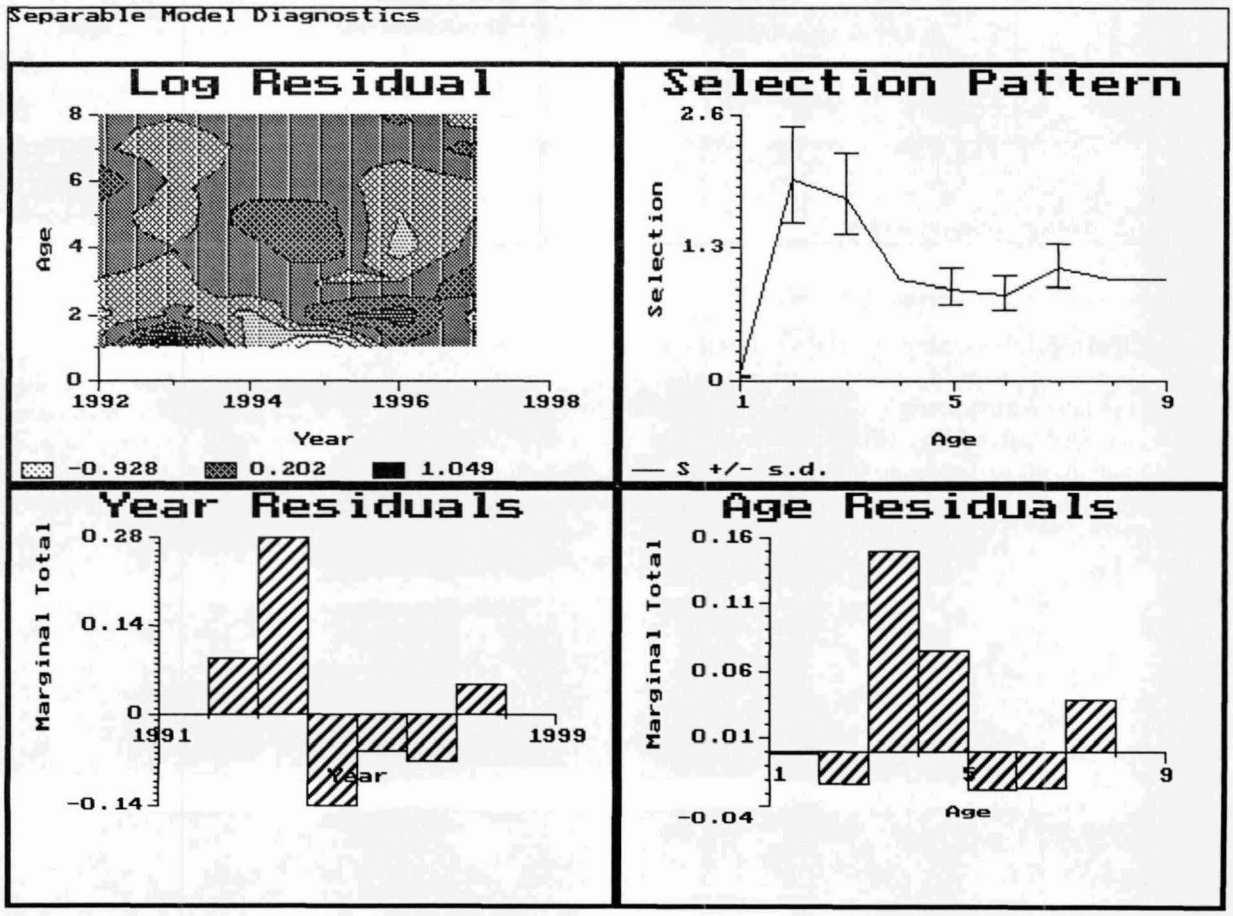


Figure 5.1.8. Herring in VIa(N). Results of deterministic assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

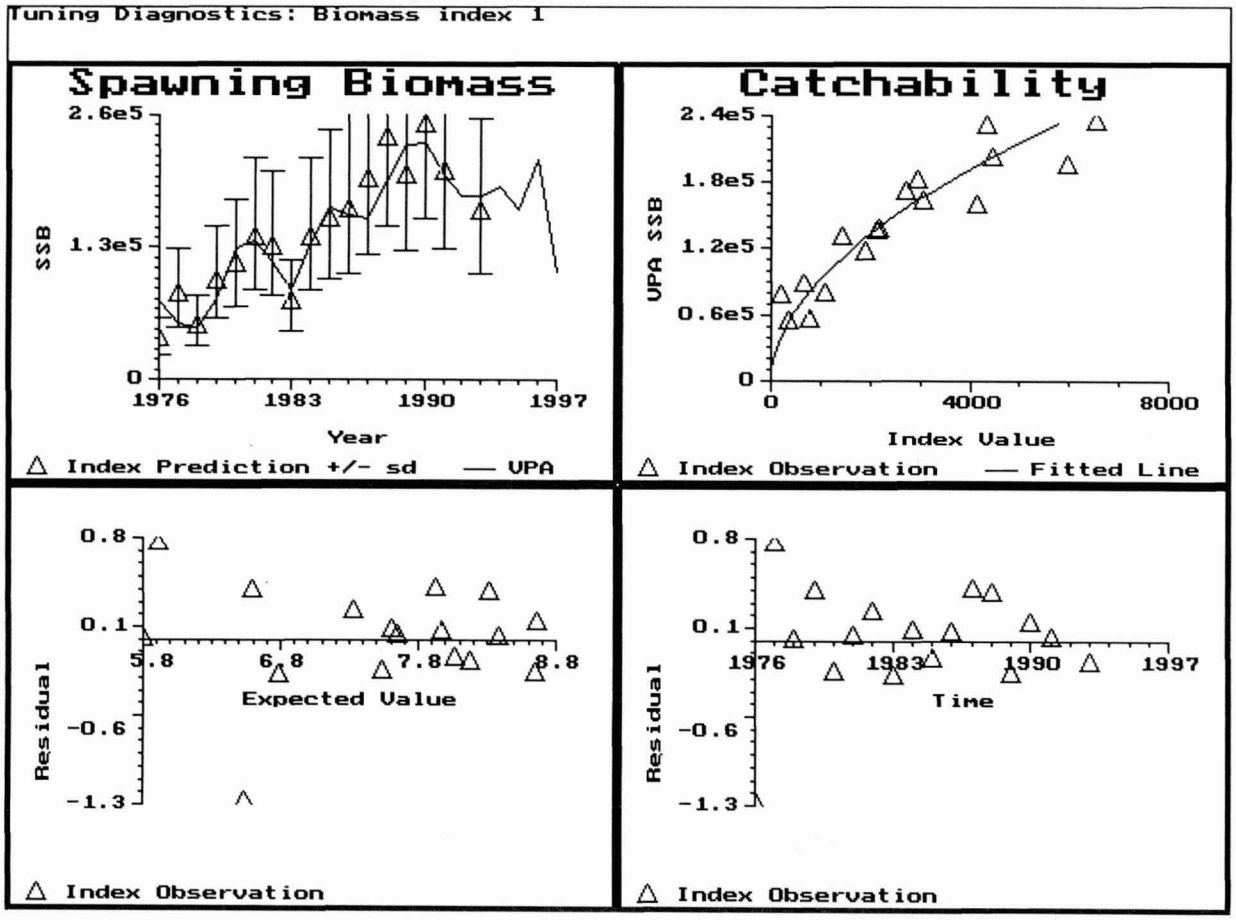


Figure 5.1.9. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the larval abundance index against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

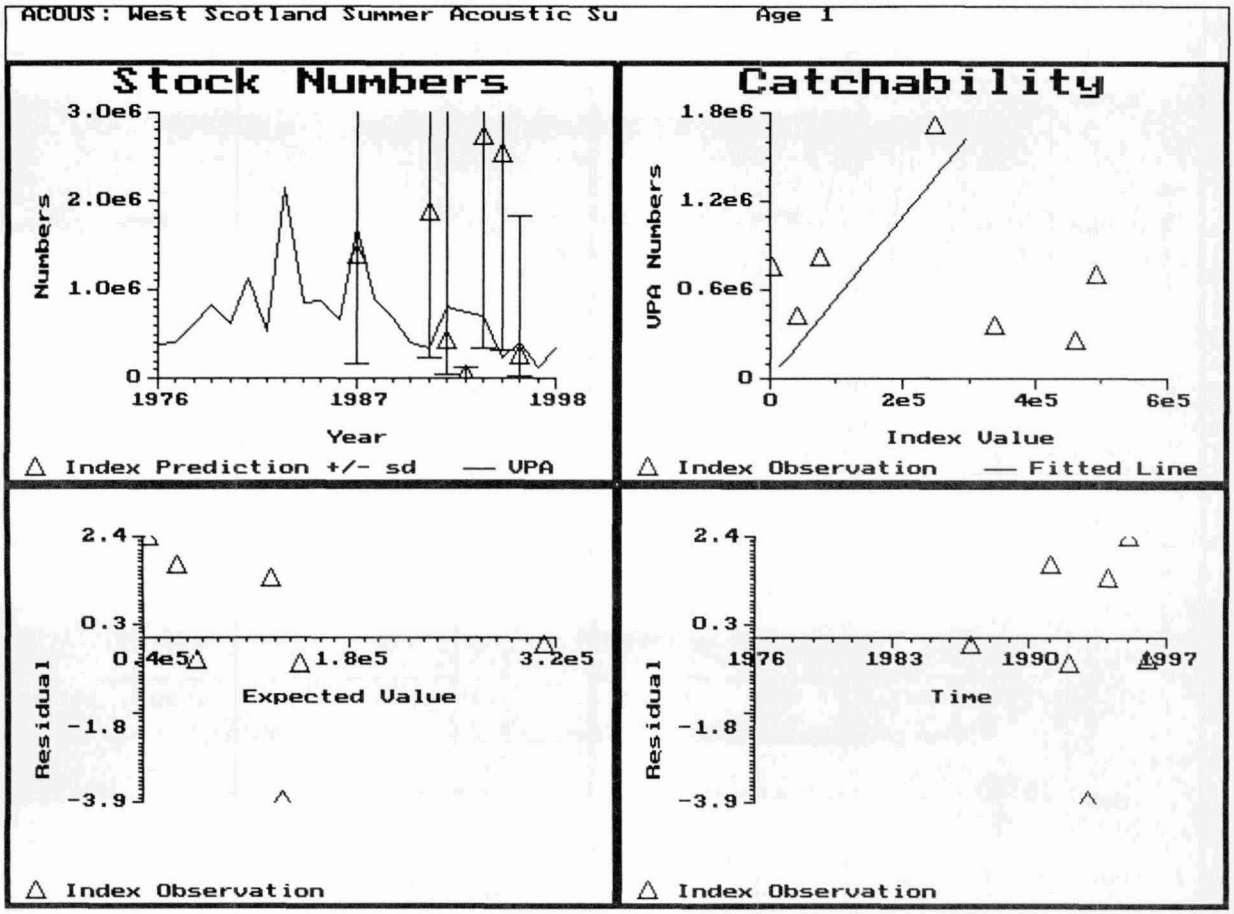


Figure 5.1.10. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 1 index from acoustic surveys against the estimated populations at age 1. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

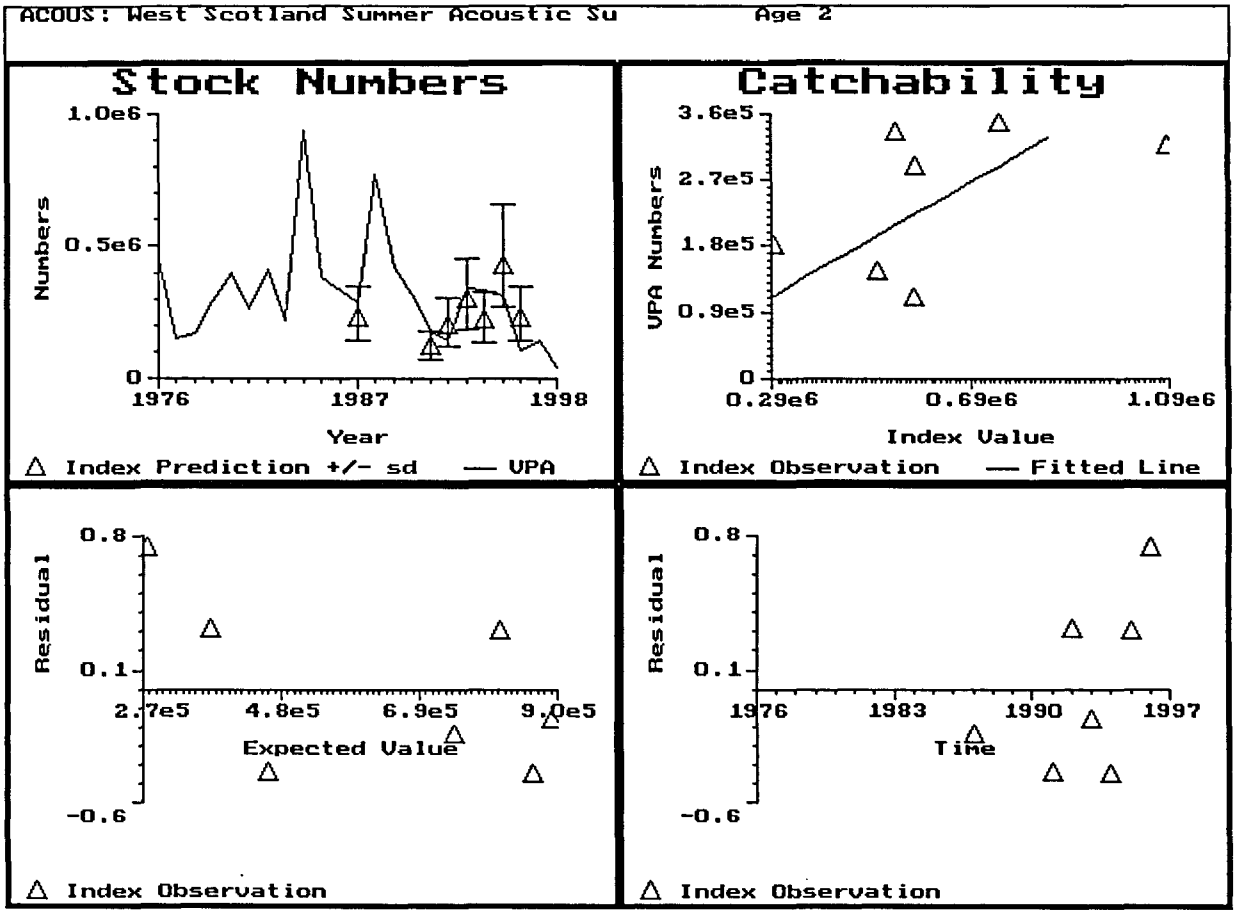


Figure 5.1.11. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 2 index from acoustic surveys against the estimated populations at age 2. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

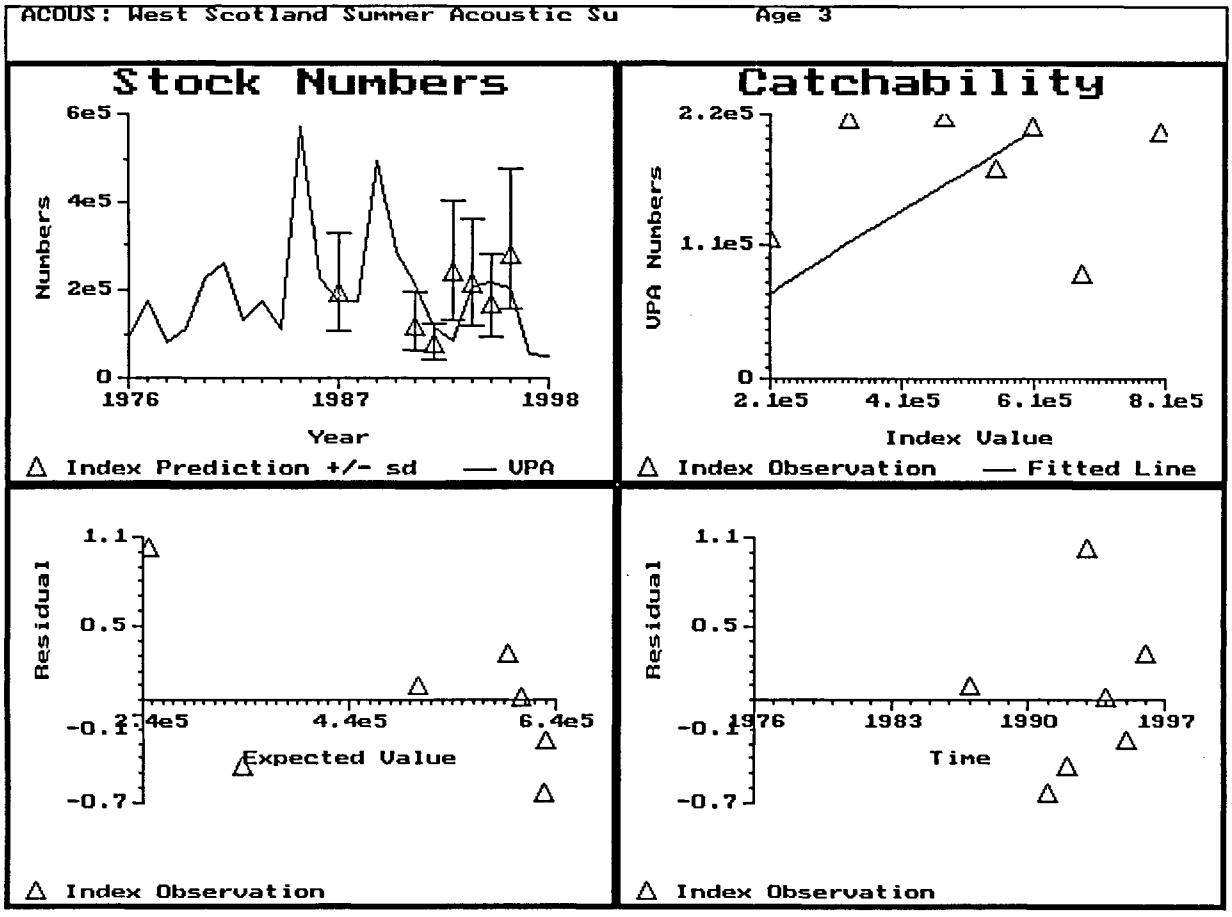


Figure 5.1.12. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 3 index from acoustic surveys against the estimated populations at age 3. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

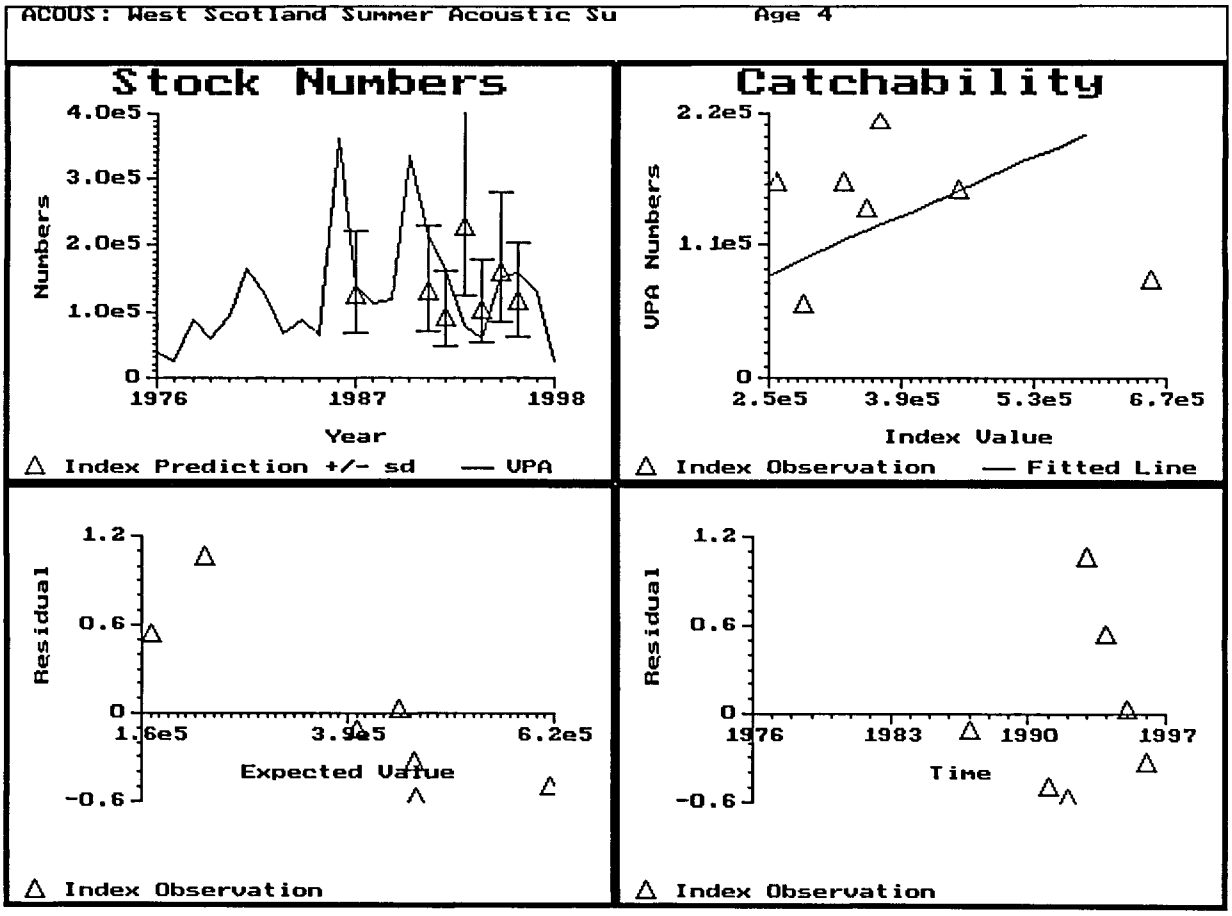


Figure 5.1.13. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 4 index from acoustic surveys against the estimated populations at age 4. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

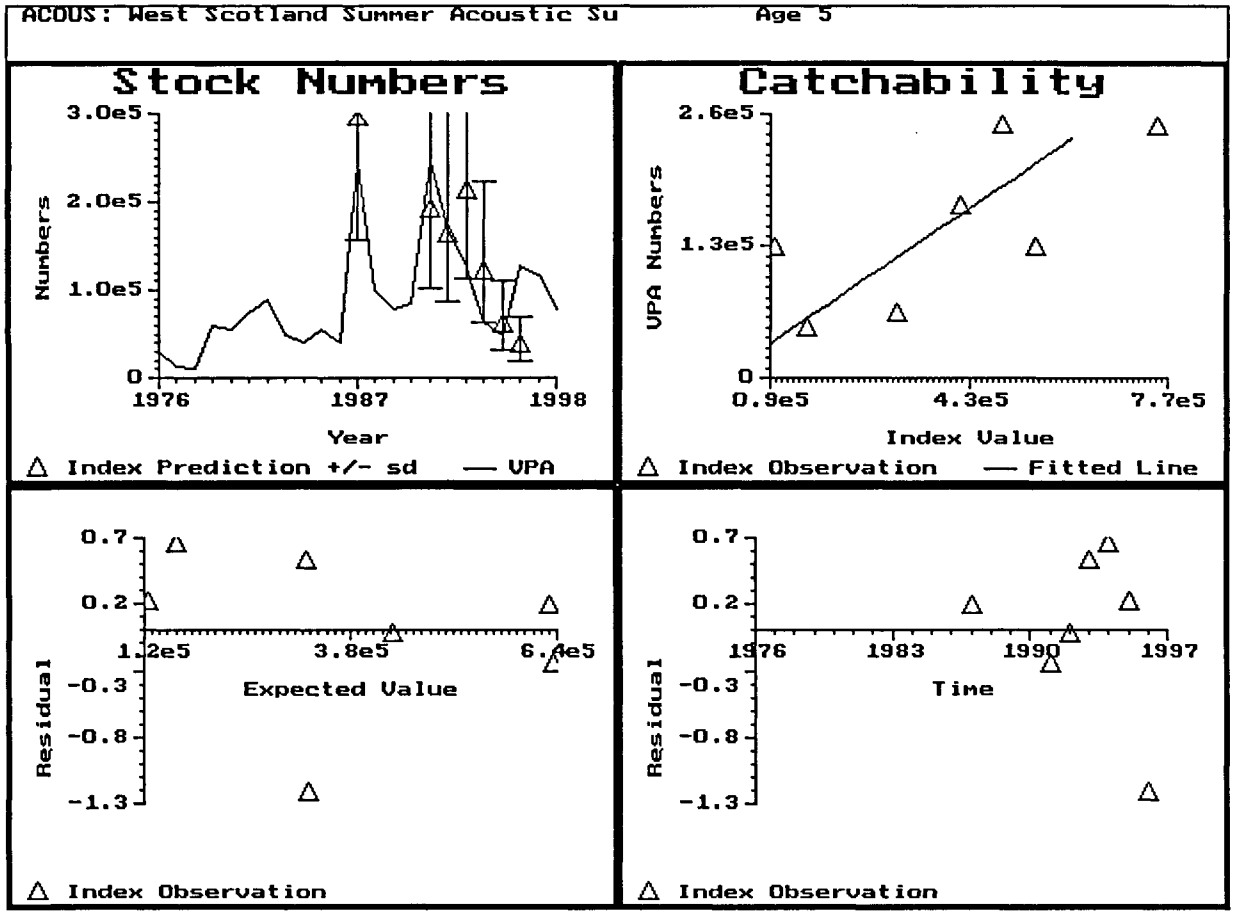


Figure 5.1.14. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 5 index from acoustic surveys against the estimated populations at age 5. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

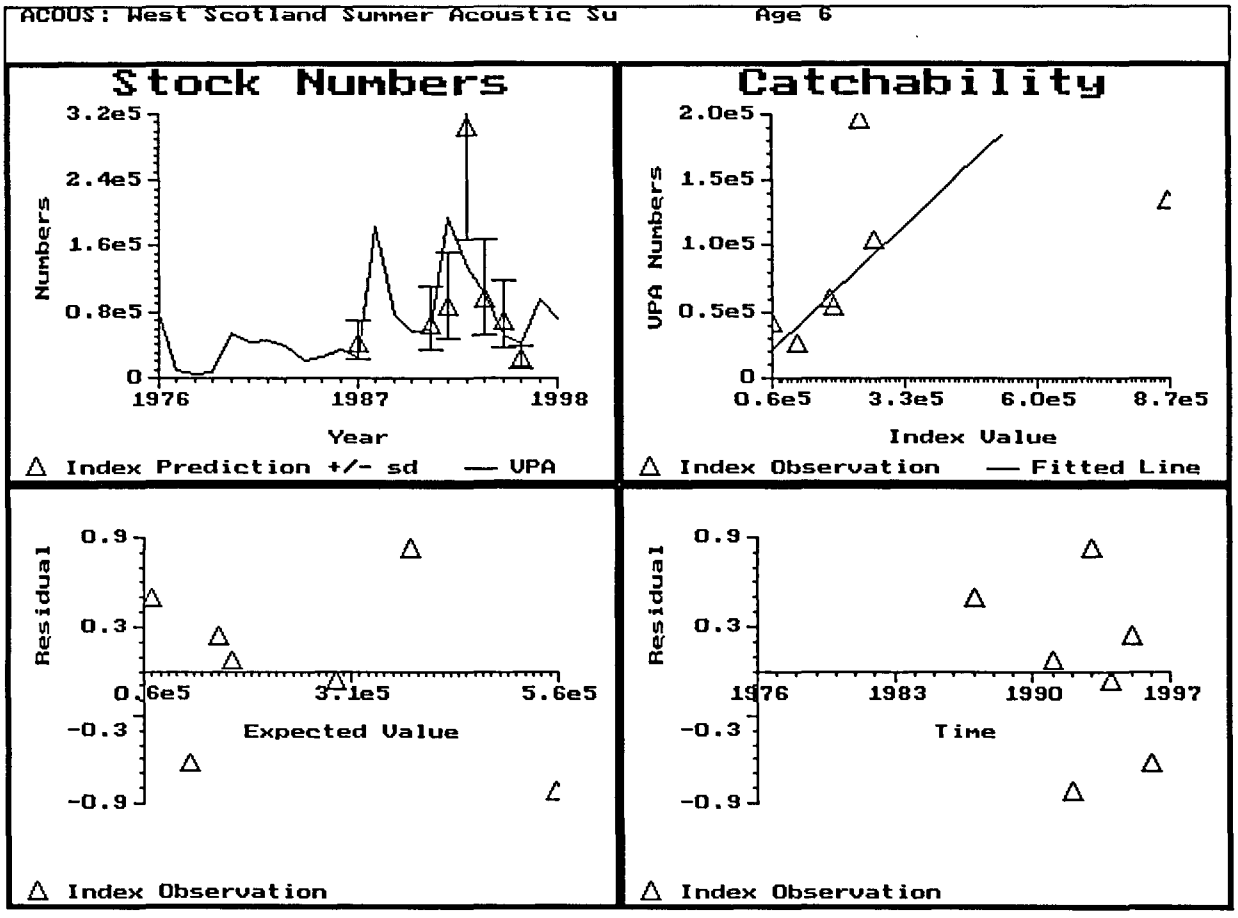


Figure 5.1.15. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 6 index from acoustic surveys against the estimated populations at age 6. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

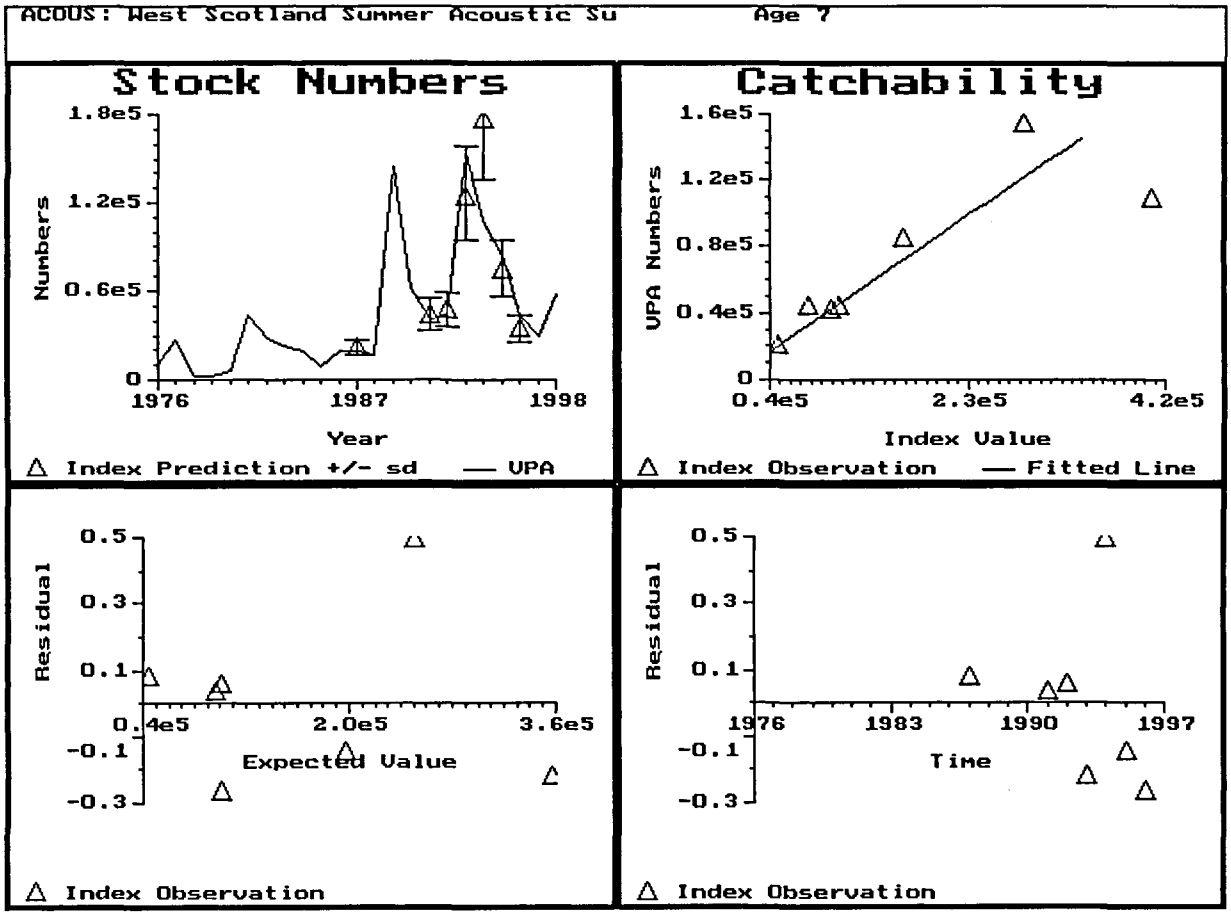


Figure 5.1.16. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 7 index from acoustic surveys against the estimated populations at age 7. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

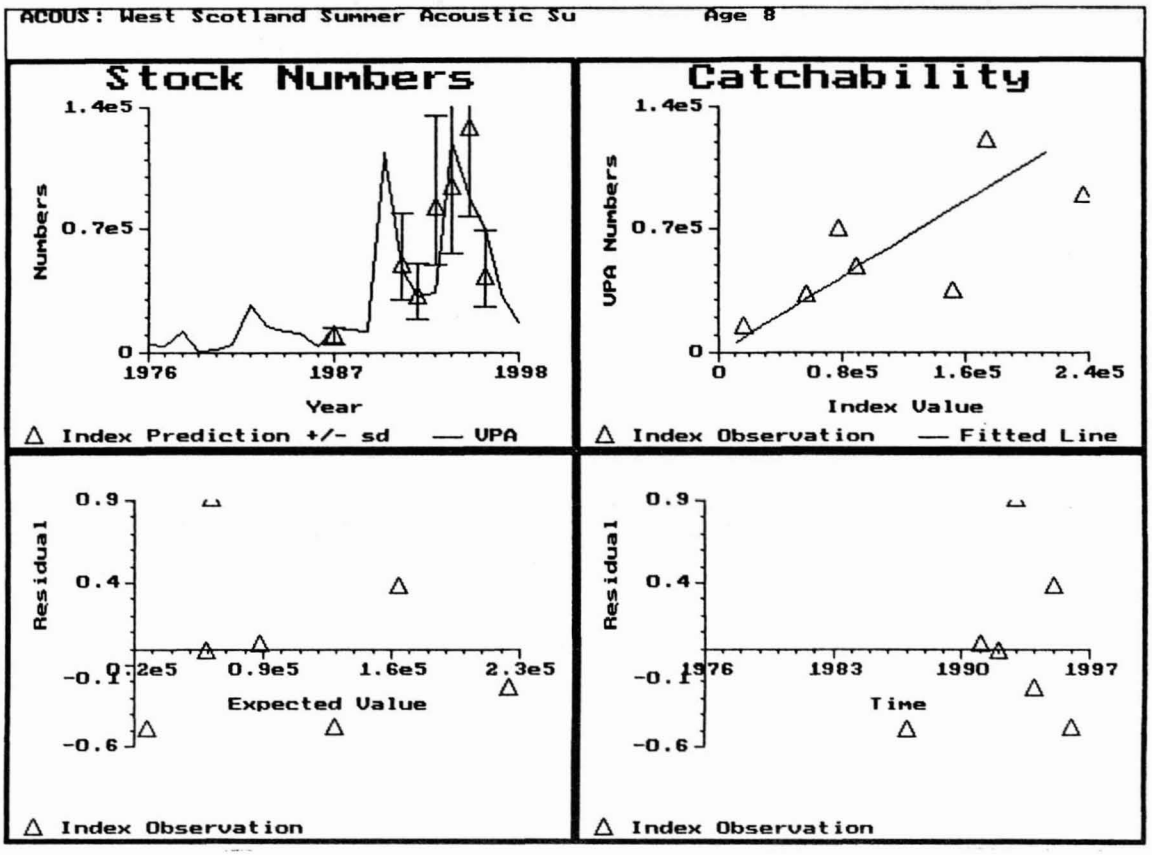


Figure 5.1.17. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 8 index from acoustic surveys against the estimated populations at age 8. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

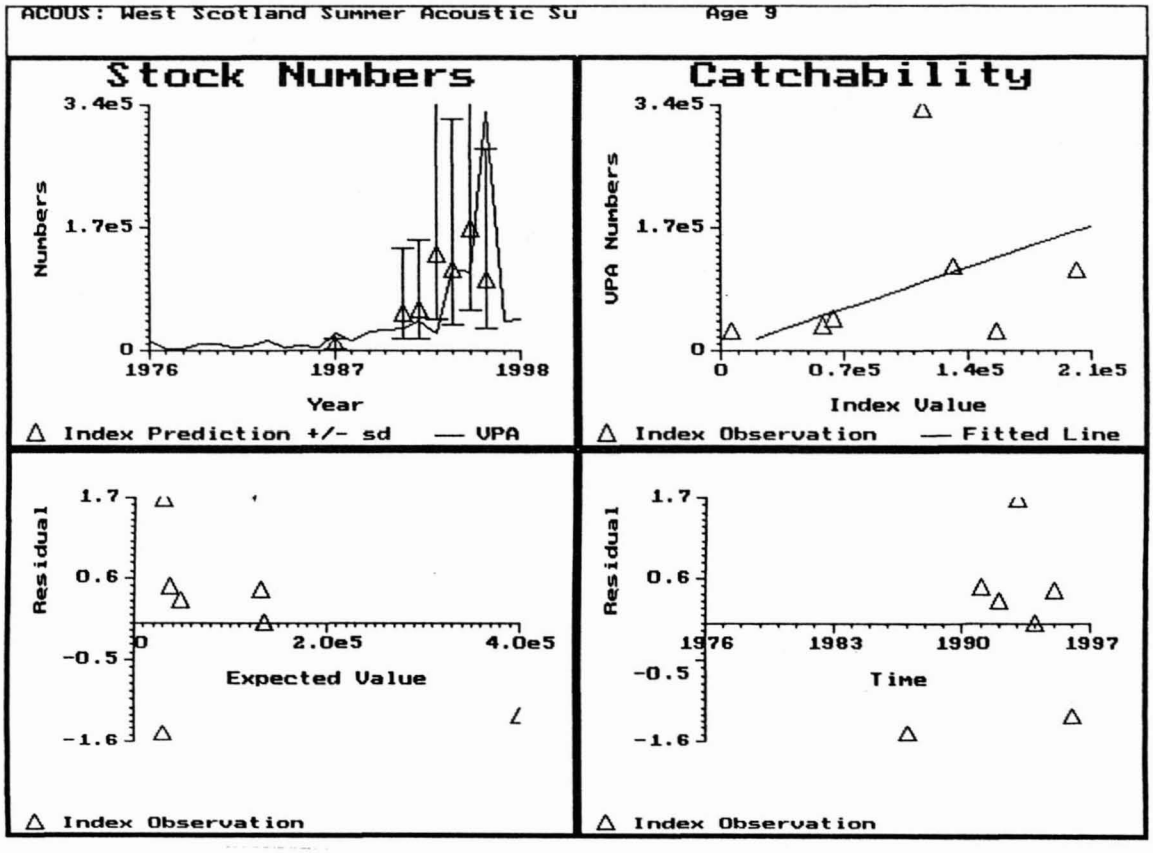


Figure 5.1.18. Herring in VIa(N). Results of deterministic assessment. Diagnostics of the fit of the age 9 index from acoustic surveys against the estimated populations at age 9. Top left, fitted populations (line), and predictions of abundance in each year made from the observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

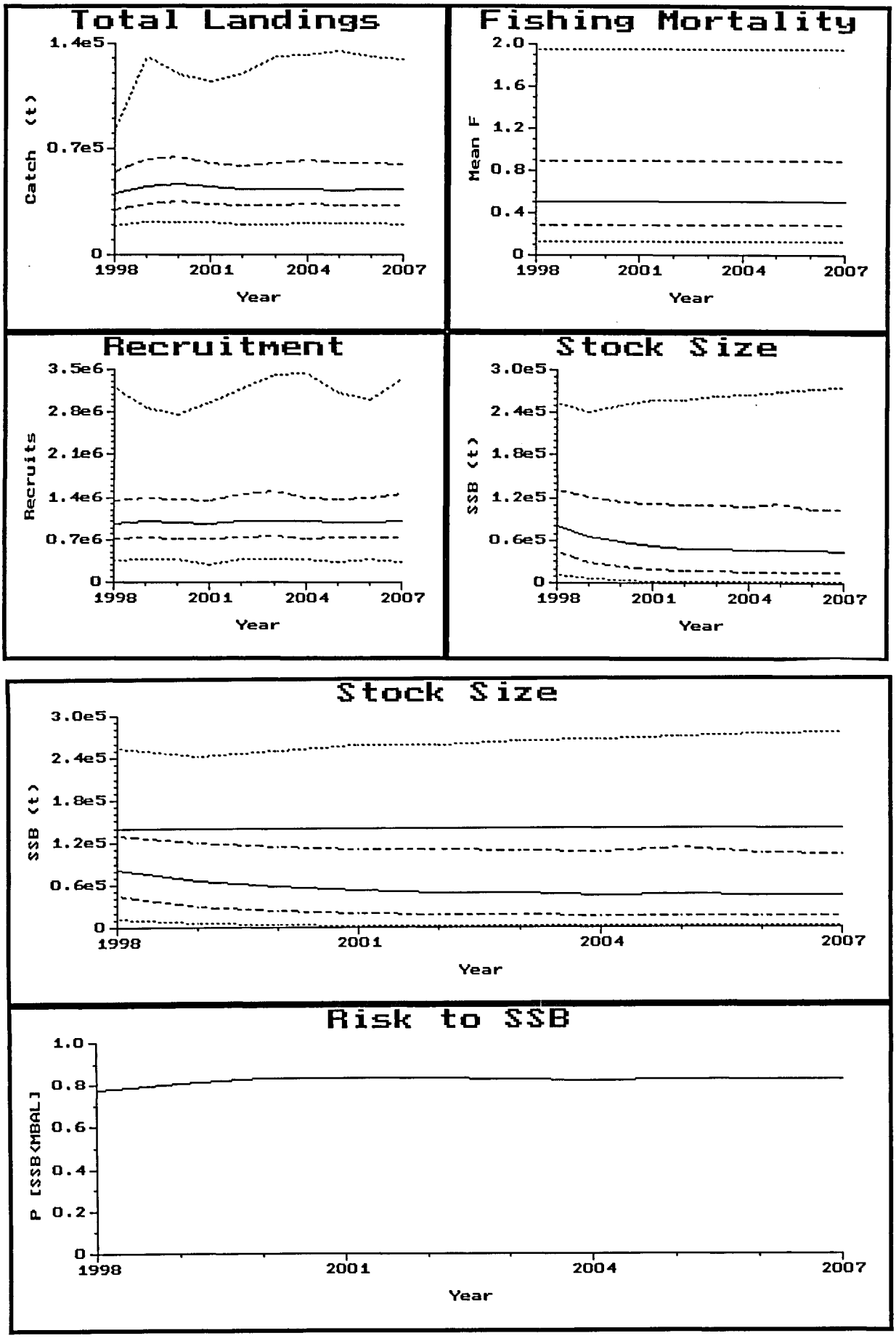


Figure 5.1.19 Herring in Division VIa(N). Medium-term projections based on the deterministic assessment assuming a constant fishing mortality at the level of 1997 (F= 0.42). Dotted lines indicate the 5th and 95th percentiles, dashed lines indicate the 25th and 75th percentiles, unbroken line indicate median. **Upper panel**: Fishing mortality is the mean of ages 3 to 6. Recruitment is at age 0 and spawning stock biomass at spawning time. **Lower panel**: the trajectory of the spawning stock size and the risk that the spawning stock should fall below 140 000 t.

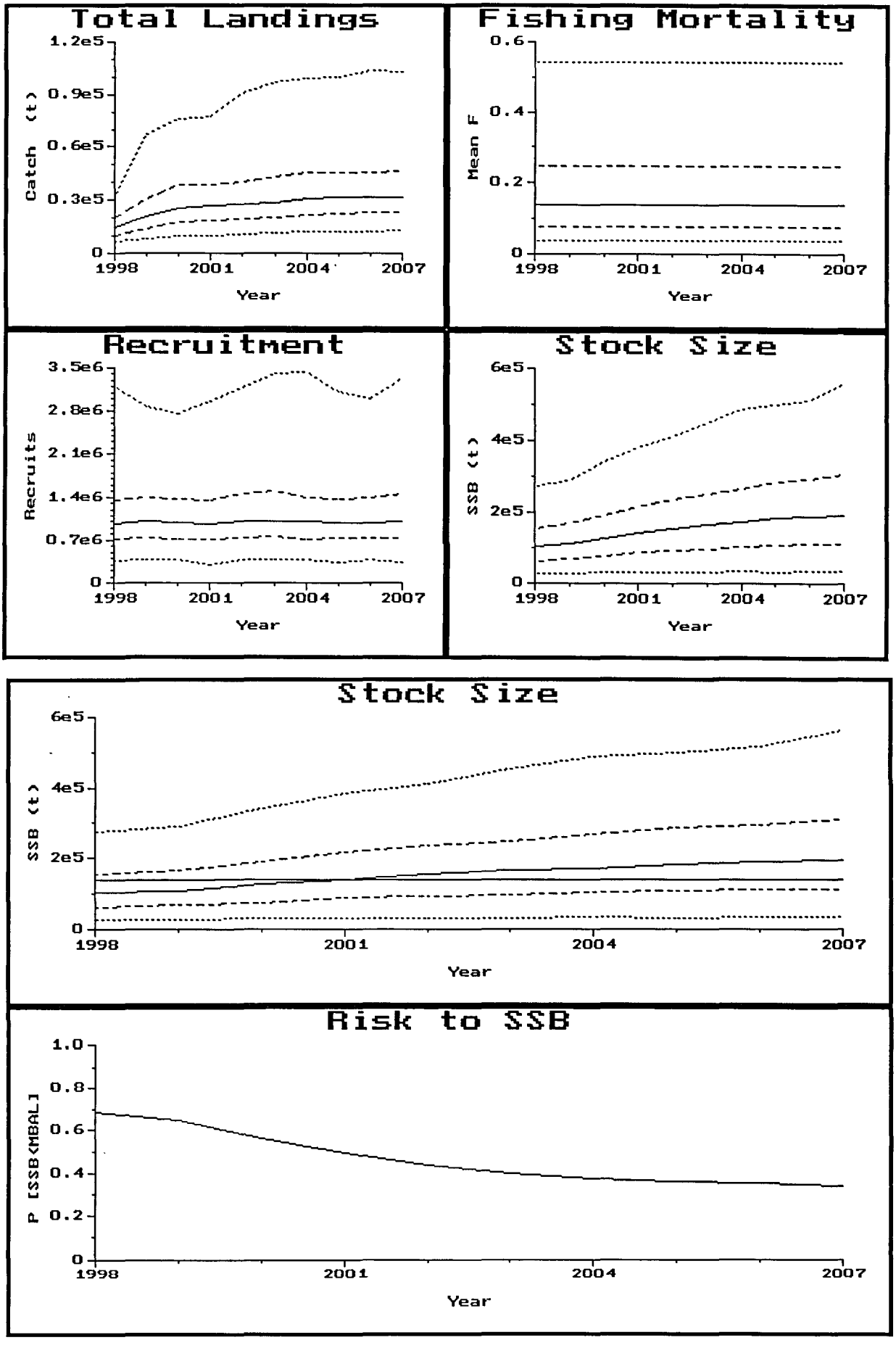


Figure 5.1.20 Herring in Division VIa(N). Medium-term projections based on the deterministic assessment assuming a constant fishing mortality at the level of 1996 (F= 0.17). Dotted lines indicate the 5th and 95th percentiles, dashed lines indicate the 25th and 75th percentiles, unbroken line indicate median. **Upper panel:** Fishing mortality is the mean of ages 3 to 6. Recruitment is at age 0 and spawning stock biomass at spawning time. **Lower panel:** the trajectory of the spawning stock size and the risk that the spawning stock should fall below 140 000 t.

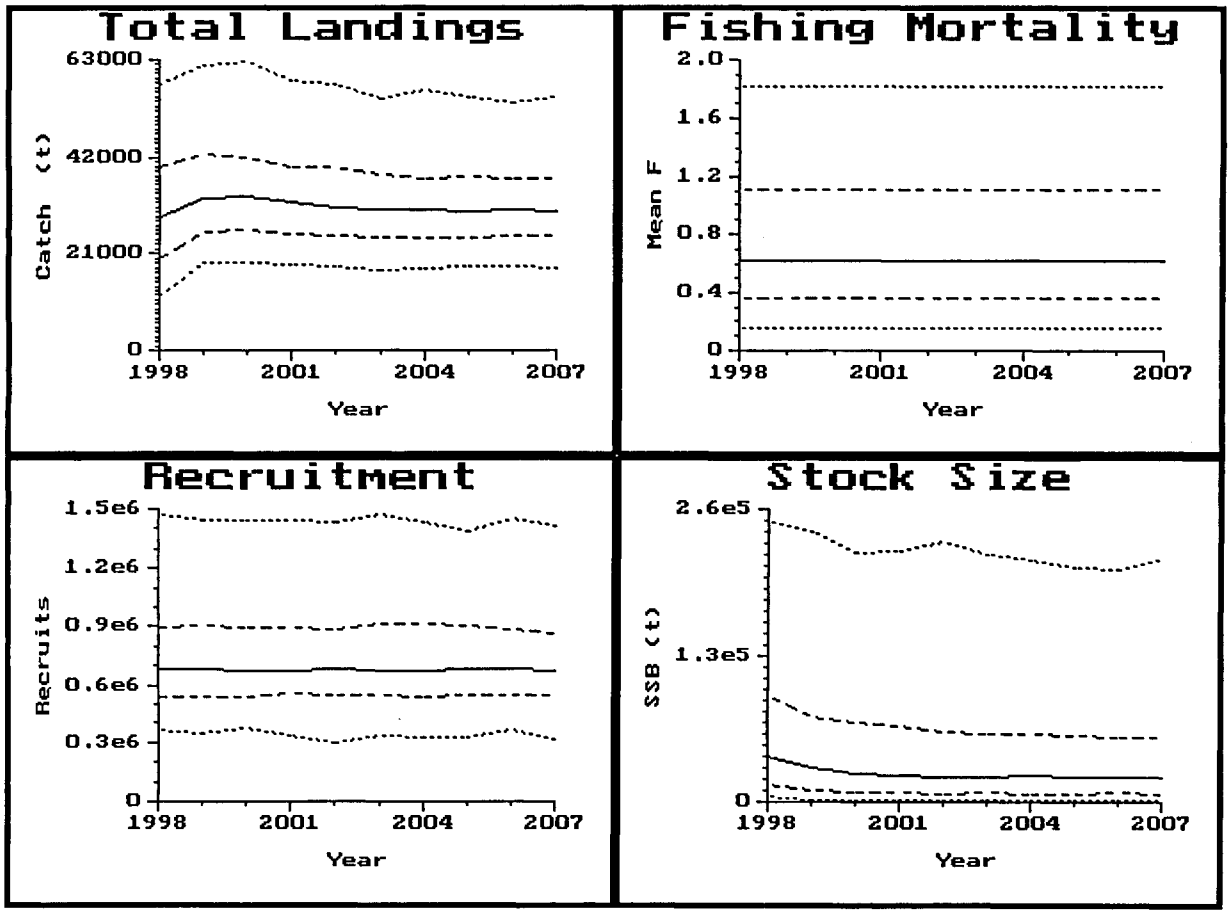


Figure 5.1.21 Herring in Division VIa(N). Medium-term projections based on the stochastic assessment assuming a constant fishing mortality at the level of 1997 (F= 0.42). Dotted lines indicate the 5th and 95th percentiles, dashed lines indicate the 25th and 75th percentiles, unbroken line indicate median. Fishing mortality is the mean of ages 3 to 6. Recruitment is at age 0 and spawning stock biomass at spawning time.

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C

6.1 The fishery

6.1.1 Advice and management applicable to 1997 and 1998

The TAC for this area for 1997 was 28,000 t. This was a precautionary TAC and was the same as that set each year since 1992. The total catch estimated by the Working Group to have been taken from the stock during 1997 was approximately 27,200. This catch was approximately 5,000 lower than that recorded for 1996 and was at about the same level as that for 1995. The 1997 catch was about the lowest recorded from this fishery since 1986. There has been considerable misreporting of catches in this area and the total catch recorded from the area has probably been much lower than the actual catch taken from the stock.

Recent Working Groups have not carried out any analytical assessments for this stock but have suggested that the stock has declined in recent years and that the size of the stock is not known. The 1996 Working Group stated that, because of the extremely high catching power of the pelagic fleet in this area and because of the ability to quickly change the target species, a cautious management should be adopted for this fishery. In 1997 ACFM carried out an assessment of the stock and, assuming that there has been no trend in fishing mortality in recent years, advised that catches in 1998 should not exceed 25,000 t. The TAC subsequently set by the EU was again set at 28,000 t.

6.1.2 Catch data

The main landings in 1997 from this fishery were again taken by Ireland who took over 95 % of the total allocated catches. (Table 6.1.1)

The total amount of unallocated catches in 1997 was 700 t. This was composed of a combination of misreported catches both into and out of the area - with one fleet taking catches in this area and reporting them as having been taken in Division VIa North and another fleet taking catches in the North Sea and reporting them as having been taken in Division VIa S or VIIb. The amount of catches taken from this area but reported as having been taken in the adjoining area Division VIaN decreased during 1997.

The total international catches, from Sub-areas VI and VII per statistical rectangle, based on log book data, but not corrected for "misreporting" are shown in Figures 4.2.1 a-d.

The catches and landings taken by each country fishing in this area from 1988–1997 are shown in Table 6.1.1 and the total catches from 1970 are shown in Figure 6.1.1. There were no estimates of discards reported from 1996 but there are no indications that discarding is a major problem in this fishery even though substantial catches in recent years have been taken in a "roe" fishery. The catches for 1997 are preliminary. It has not been found necessary to make any alterations to the 1996 data.

6.1.3 The fishery in 1997

Reports from the Irish fishery in this area in recent years have suggested that herring shoals have been very scarce, particularly in Division VIIb. As has been the pattern in recent years, catches from the first quarter of 1997 taken from the northern part of Division VIa(South) contained substantial amounts of full and spawning fish. In 1997 these fish amounted to over 90 % of the total catch in the first quarter and had a typical winter/spring vertebral count of 56.87, compared with a vertebral count of 56.51 for full and spawning fish during Quarter 4. Recent Herring Working Groups have commented on the increasing numbers of winter/spring spawning fish which have appeared in the catches from this area in recent years and this pattern has been maintained in the early part of 1998. Herring shoals again appeared to be very scarce on the traditional autumn spawning grounds in Division VIIb in 1997. The main landings by the Irish fleet were taken during Quarter 4 when over 60 % of the total catch was landed.

The decrease in the landings in 1997 was due to a combination of very poor markets which prevailed during the year and also because of a scarcity of shoals particularly during the third and fourth quarters.

Landings by the Irish fleet in 1997 were again regulated by weekly quotas and a closed season was introduced during June and July. This closed season is designed to prevent landings of herrings at a time when marketing difficulties are usually experienced.

6.1.4 Catch in numbers at age

The catches at age for this fishery since 1970 are shown in Table 6.1.2. In recent years the catches in numbers at age have been derived mainly from Irish sampling data. The catches during 1997 were mainly dominated by 2 w.ring fish i.e., the 1994 year class which constituted over 34 % of the total number. This year class appeared to recruit to the fishery during the fourth quarter and was particularly apparent in the catches taken in Division VIaS. The 1992 year class, which dominated the catches during 1996, constituted 23 % of the 1997 catches.

6.1.5 Quality of the catch and biological data

Catch statistics from this fishery are believed to have improved considerably in 1997 and there was tight management of the fishery. Misreporting of catches taken in Division VIa (North) to the adjoining Division VIa (South) decreased in 1997 and it was possible to re-allocate these catches based on information from fishermen.

The numbers of samples and the biological data, together with the length distribution of the catches taken per quarter by the Irish fleet, are shown in Tables 6.1.3 and 6.1.4 respectively. Sampling of catches throughout 1997 increased and was considered satisfactory.

6.2 Mean Weights at Age

The mean weights (g) at age in the catches in 1997 are based mainly on Irish samples, together with three Dutch samples. The mean weights from 1970–1997 are shown in Table 6.2.1. The mean weights in 1997 are rather similar to those of 1996.

The 1997 mean weights at age for the stock at spawning time (1 October) are based on Irish samples of full fish taken during the fourth Quarter. The mean weights from 1970–1997 are shown in Table 6.2.2 and appear to have decreased slightly in recent years. These mean weights are calculated for Quarter 4 but it may be more appropriate to calculate them based on a combination of both Quarter 4 and Quarter 1 because of the increasing catches of spawning fish in the latter quarter. These revised mean weights over a number of years should be presented at the next meeting of the Working Group

6.3 Ground fish Surveys

Ground fish surveys have been carried out during November along the west coast of Ireland from 1993 to 1997. More than 60 stations have been sampled each year with a bottom trawl fitted with fine mesh liner. Although these surveys are designed to obtain an abundance index for demersal fish it is hoped that they will also provide recruitment indices for herring. However, the data has not yet been properly evaluated.

6.4 Stock surveys

No acoustic surveys have been carried out on this stock in 1997 and there is no fishery independent method of stock assessment.

It is important, however, that acoustic surveys should be resumed because at present there is no other method of assessing the stock size and no basis for providing accurate management advice. As pointed out in the previous report herring fisheries are extremely important to the local communities along the Irish coast and there is an extremely high catching capacity of the fleet in the area. The stock appears to have seriously declined in recent years and catches may need to be substantially reduced.

6.5 State of the Stock

Analytical assessments have not been carried out on this stock for a number of years because of the absence of survey data. Recent Working Groups have therefore only carried out VPA analyses to study the development of the stock and no stock projections have been made. The results of those analyses have indicated that the stock has decreased in recent years from a high level in 1988. This high level was as a result of the recruitment of the exceptionally strong 1985 year class which dominated the catches in this area for a long period.

ACFM in May 1997 suggested that, as there was good sampling data for this stock, an analysis of the age structure of the catches may give an indication of the state of the stock. This analysis, carried out by ACFM and assuming no trend in F in recent years, suggested that the stock was stable and capable of sustaining catches of around 25,000 t. A similar analysis was carried out by the present Working Group and is described below.

6.5.1 Analysis of the connection between recruitment and terminal F

The analysis was carried out on the catches in numbers over the period 1987 - 1997.

To determine if it was possible to estimate a sensible fishing mortality for the last few years using only information from the catch data sensitivity tests were carried out. The choice of terminal F on the result of a model assuming separable fishing mortalities was investigated.

A range of terminal F's from 0.1 to 1.0 were used. Catches were calculated and compared to the observed catches. The problem to be solved was:

minimising $\sum_{y=1}^{n}\sum_{i=1}^{9}(\ln(C_{yi} / \hat{C}_{yi}))^2 w_i$.

$\hat{C}_{yi}$ is the calculated catch of age i in year y,

C_{yi} is the observed catch and w_i is an age weight between 0 and 1.

A logistic selection pattern was chosen, so that a_{50} (i.e the half value) and the slope at a_{50} were determined in the optimisation. In most cases a_{50} turned out to be slightly higher than age 2.

The tests were made with downweighting of the catches of age 1 and age 2 and also without downweighting of those ages.

With downweighting $w_1 = 0.01, w_2 = 0.1, w_i = 1$ for other ages.

Without downweighting $w_i = 1$ for all ages.

The downweighting was carried out because of uncertainty in the catch data of the youngest age groups.

Figure 6.5.1 shows the ratio between the catches in successive years along the cohorts. From age 3 there is a remarkable decrease in the catches from 1996 to 1997. $C_{96} / C_{97} \approx 2$ for many ages, and even higher for age 7 and 8.

The separable model for the last 10 years shows the same tendency both with and without downweighting of the youngest. Figures 6.5.2 and 6.5.3 both show that recruitment and survivors at 1 January 98 depend heavily on the terminal F value selected. There also appears to be a threshold terminal F, which suggests that if terminal F is increased above 0.5-0.6, no dramatic change in corresponding recruitment estimates are seen.

Without downweighting the tendency that survivors and recruitment estimate increases with decreasing terminal F is stronger, but the main results are similar. The conclusion is either

1. there has been very good recruitment (far above the average) for the last few years, or
2. there have been a considerable increase in F for the most recent years, so that F in 1997 may be 0.6 or higher.

The most plausible result is that there has been a dramatic increase in fishing mortality on the stock in the most recent years. This is consistent with the reports from the fishery in 1997 when fishermen reported a severe scarcity of herring particularly in the autumn spawning component which is found mainly in Division VIIb. However, this scarcity is not evident in the winter/spring component in the northern part of Division VIaS which is exploited mainly in the first quarter.

In the absence of any information on present stock size it was decided to adopt the procedure of recent working groups and to carry out a series of separable VPAs in order to study the development of the stock This analysis was carried out using the updated catch data and a terminal selection S value of 1.0 and down weighted prior to 1990 to 0.001. Age 4 was taken as reference age.

The resultant exploitation pattern appears to be reasonably flat topped. The results of the separable VPA are shown in Table 6.5.1 with $F_{97,4} = 0.6$.

The terminal populations from the separable VPA were then used to carry out traditional VPAs using input F values =, 0.4, 0.5 and 0.6. These values were selected to reflect the likelihood that fishing mortality has increased significantly on the stock and that it may be as high as 0.6 as indicated in the age structure analysis.

Results from Assessments

The results from the traditional VPA, using F in 1997=0.6 are shown in Tables 6.5.1 and are summarised in Table 6.5.2. These indicate that over the period 1970–1996 the spawning stock was at its maximum level in 1988 and has since declined steadily each year. The very large value of SSB in 1988 of over 313,000 t is the result of the very high 1985 year class which was the strongest recruitment observed over the time series. The SSB estimated for 1997 has been reduced to 58,000 t and this is the lowest value ever recorded. The general trends emerging from the analysis are similar with those highlighted by recent working groups. The development of the stock, estimates as a result of using the different values if input F=0.4, 0.5 and 0.6 in 1997 is shown in Figure 6.5.4.

Although this analysis must be treated with caution it does indicate a seriously low stock size in the area and this is consistent with observations from fishermen in 1997.

There are no indications from the analysis of any high recruitment values in recent years although there are considerable numbers of 1 w.ring fish in the 1997 catches (i.e the 1995 year class).

6.6 Stock Forecasts and Catch Predictions

Although the size of the stock is by no means certain and must be treated with caution a prediction was carried out under the following assumptions.

The SSB in 1997 was about 58.000 t. Population numbers at 1 January were taken from the output of the SVPA. The recruitment was taken as the geometric mean over the period 1986 to 1996. Mean weights in the stock and the catches were taken as the average of the last five years. The number of 2 w. ring fish in the population at 1 January, which was generated by the catches of 1 w. ring fish in 1997 was replaced by the geometric mean over the period 1986 to 1986.

If catches in 1998 are around 27,000 t i.e at an F level equal to that of 1997 then the SSB in 1997 will have fallen slightly to 57,000 t. A continuation of this fishing level in 1999 will produce catches of about 25,000 t and the SSB will fall below 54,000t.

If the TAC of 28,000 t is taken in 1998 then the SSB will fall to 56,000 t. A similar TAC in 1999 will lead to a decrease of the SSB to about 50,000 t.

It must be stressed that these predictions are based on a very uncertain assessment but they do indicate a serious decrease in the stock.

In order to maintain the SSB at around the present level the catches in 1999 must be reduced below 20,000 t.

The input data, used in the predictions and the results are shown in Tables 6.6.1 to 6.6.3. The input data and the yields per recruit summary are shown in Tables 6.6.4 and 6.6.5 and in Figure 6.6.1.

6.7 Management Considerations

Precautionary approach

The results of these non analytical assessments indicate that the spawning stock has declined considerably in recent years and is now at a comparatively low level. This is consistent with observations from fishermen who in recent years have expressed alarm at the scarcity of herring in this area. There has been no substantial recruitment to the stock in recent years and the very strong 1985 year class has now reached the end of it's natural lifespan. The scarcity of herring may be due to a combination of the decline in stock accentuated by a more northerly distribution of the stock in recent years. It is also interesting to note the increasing importance of winter/spring spawning fish in this area. The old traditional fisheries in this area, which were extremely important in the early part of the century, were all based on winter/spring spawning herring.

Precautionary reference points. The precautionary reference points in relation to this stock are discussed in Section 1.6. It is clear that recruitment does not show any clear dependence on the SSB and that apart from the very high 1985 year class has been quite stable. The suggested Floss value is about 0.33 and the Fpa may be about 0.20. The present analysis, uncertain though it is, indicates that the stock is well below the Bpa and that the fishing mortality is well above the Fpa.

6.8 Medium Term Projections and Management considerations.

It has not been possible to carry out medium term projections for this stock because of the absence of information. It appears necessary that urgent management measures are required to reduce the catches as soon as possible to below 20,000 t. More specific advice will not be possible until more information becomes available on stock sizes. In this respect it is important that the following investigations should be carried out:

1. Acoustic surveys should be resumed as soon as possible;
2. An evaluation of the age composition of the autumn and winter/ spring spawning components should be carried out separately to examine if both components are declining at the same rates;
3. Revised mean weights of the stock at spawning time should be presented because of the increasing importance of the winter/spring spawning component.

Table 6.1.1 Estimated Herring catches in tonnes in Divisions VIa (South) and VIIb,c, 1986–1996. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1986	1987	1988	1989	1990	1991
France	-	-	-	-	+	-
Germany, Fed.Rep.	-	-	-	-	-	-
Ireland	15,540	15,000	15,000	18,200	25,000	22,500
Netherlands	1,550	1,550	300	2,900	2,533	600
UK (N.Ireland)	-	5	-	-	80	-
UK (England + Wales)	-	51	-	-	-	-
UK Scotland	-	-	-	+	-	+
Unallocated	11,785	31,994	13,800	7,100	13,826	11,200
Total landings	28,785	48,600	29,100	28,200	41,439	34,300
Discards	-	-	-	1,000	2,530	3,400
Total catch	28,785	48,600	29,100	29,200	43,969	37,700

Country	1992	1993	1994	1995	1996[1]	1997
France	-	-	-	-	-	-
Germany, Fed.Rep.	250	-	-	11	-	
Ireland	26,000	27,600	24,400	25,450	23,800	24,400
Netherlands	900	2,500	2,500	1,207	1,800	3,400
UK (N.Ireland)	-	-	-	-	-	
UK (England + Wales)	-	-	50	24	-	
UK (Scotland)	-	200	-	-	-	
Unallocated	4,600	6,250	6,250	1,100	6,900	-700
Total landings	31,750	36,550	33,200	27,792	32,500	27,100
Discards	100	250	700	-	-	50
Total catch	31,850	36,800	33,900	27,792	32,500	27,150

[1]Provisional

Table 6.1.2

The SAS System 12:02 Tuesday, March 17, 1998

HER-IRLW: Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

CANUM: Catch in Numbers (Total International Catch) (Total) (Thousands)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0	135	35114	26007	13243	3895	40181	2982	1667	1911
1971	0	883	6177	7038	10856	8826	3938	40553	2286	2160
1972	0	1001	28786	20534	6191	11145	10057	4243	47182	4305
1973	46	6423	40390	47389	16863	7432	12383	9191	1969	50980
1974	0	3374	29406	41116	44579	17857	8882	10901	10272	30549
1975	194	7360	41308	25117	29192	23718	10703	5909	9378	32029
1976	823	16613	29011	37512	26544	25317	15000	5208	3596	15703
1977	0	4485	44512	13396	17176	12209	9924	5534	1360	4150
1978	82	10170	40320	27079	13308	10685	5356	4270	3638	3324
1979	4	5919	50071	19161	19969	9349	8422	5443	4423	4090
1980	0	2856	40058	64946	25140	22126	7748	6946	4344	5334
1981	0	1620	22265	41794	31460	12812	12746	3461	2735	5220
1982	0	748	18136	17004	28220	18280	8121	4089	3249	2875
1983	0	1517	43688	49534	25316	31782	18320	6695	3329	4251
1984	0	2794	81481	28660	17854	7190	12836	5974	2008	4020
1985	0	9606	15143	67355	12756	11241	7638	9185	7587	2168
1986	0	918	27110	24818	66383	14644	7988	5696	5422	2127
1987	0	12149	44160	80213	41504	99222	15226	12639	6082	10187
1988	0	0	29135	46300	41008	23381	45692	6946	2482	1964
1989	0	2241	6919	78842	26149	21481	15008	24917	4213	3036
1990	0	878	24977	19500	151978	24362	20164	16314	8184	1130
1991	0	675	34437	27810	12420	100444	17921	14865	11311	7660
1992	0	2592	15519	42532	26839	12565	73307	8535	8203	6286
1993	0	191	20562	22666	41967	23379	13547	67265	7671	6013
1994	0	11709	56156	31225	16877	21772	13644	8597	31729	10093
1995	0	284	34471	35414	18617	19133	16081	5749	8585	14215
1996	43	4776	24424	69307	31128	9842	15314	8158	12463	6472
1997	0	7458	56329	25946	38742	14583	5977	8351	3418	4264

Table 6.1.3 Divisions VIa (South) and VIIb. Sampling intensity of catches in 1997.

Country	Q	Catch[1]	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	6,333	20	889	3,321	140	No
	2	260	2	50	50	191	No
	3	1,778	11	456	2,452	256	No
	4	18,601	20	838	3,493	45	No
Netherlands	1,3	3,432	3	75	334	22	Yes

[1]including Division VIa (North).

Table 6.1.4 **Divisions VIa and VIIb.** Length distributions of Irish catches (pelagic trawlers) per quarter (10^3) in 1997.

Length	1st quarter	2nd quarter	3rd quarter	4th quarter
18.0			5	
18.5			9	
19.0			28	
19.5			23	32
20.0			110	32
20.5			257	130
21.0	11		380	712
21.5	23		380	1036
22.0	91		385	1878
22.5	125		243	1166
23.0	307		316	1846
23.5	295	69	280	2656
24.0	488	69	724	6089
24.5	761	69	843	8388
25.0	1624	346	1137	13828
25.5	1919	346	880	11529
26.0	2714	450	880	8711
26.5	2612	311	642	6444
27.0	3725	35	623	6801
27.5	4055	35	614	6347
28.0	5236		706	9003
28.5	3589		454	7352
29.0	3486		477	7708
29.5	2260		298	5376
30.0	1817		307	3660
30.5	920		170	1619
31.0	647		41	486
31.5	273		9	65
32.0	238		5	194
32.5	136		9	
33.0	114		5	32
33.5	136			
34.0	45			
34.5	57			
35.0	11			
Total	37720	1730	11239	112960
Tonnes	6300	260	1800	18600

Table 6.2.1

The SAS System 12:02 Tuesday, March 17, 1998

HER-IRLW: Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

WECA: Mean Weight in Catch (Total International Catch) (Total) (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1971	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1972	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1973	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1974	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1975	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1976	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1977	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1978	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1979	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1980	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1981	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1982	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1983	-1.000	0.090	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1984	-1.000	0.106	0.141	0.181	0.210	0.226	0.237	0.243	0.247	0.248
1985	-1.000	0.077	0.122	0.161	0.184	0.196	0.206	0.212	0.225	0.230
1986	-1.000	0.095	0.138	0.164	0.194	0.212	0.225	0.239	0.208	0.288
1987	-1.000	0.085	0.102	0.150	0.169	0.177	0.193	0.205	0.215	0.220
1988	-1.000	-1.000	0.098	0.133	0.153	0.166	0.171	0.183	0.191	0.201
1989	-1.000	0.080	0.130	0.141	0.164	0.174	0.183	0.192	0.193	0.203
1990	-1.000	0.094	0.138	0.148	0.160	0.176	0.189	0.194	0.208	0.216
1991	-1.000	0.089	0.134	0.145	0.157	0.167	0.185	0.199	0.207	0.230
1992	-1.000	0.095	0.141	0.147	0.157	0.165	0.171	0.180	0.194	0.219
1993	-1.000	0.112	0.138	0.153	0.170	0.181	0.184	0.196	0.229	0.236
1994	-1.000	0.081	0.141	0.164	0.177	0.189	0.187	0.191	0.204	0.220
1995	-1.000	0.080	0.140	0.161	0.173	0.182	0.198	0.194	0.206	0.217
1996	.	0.085	0.135	0.172	0.182	0.199	0.209	0.220	0.233	0.237
1997	.	0.093	0.135	0.155	0.181	0.201	0.217	0.217	0.231	0.239

Table 6.2.2

The SAS System 12:02 Tuesday, March 17, 1998

HER-IRLW: Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

WEST: Mean Weight in Stock (Total International Catch) (Total) (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1971	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1972	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1973	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1974	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1975	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1976	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1977	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1978	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1979	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1980	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1981	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1982	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1983	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1984	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1985	-1.000	0.100	0.150	0.196	0.227	0.238	0.251	0.252	0.269	0.284
1986	-1.000	0.098	0.169	0.209	0.238	0.256	0.276	0.280	0.287	0.312
1987	-1.000	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1988	-1.000	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1989	-1.000	0.138	0.157	0.168	0.182	0.200	0.217	0.227	0.238	0.245
1990	-1.000	0.113	0.152	0.170	0.180	0.200	0.217	0.225	0.233	0.255
1991	-1.000	0.102	0.149	0.174	0.190	0.195	0.206	0.226	0.236	0.248
1992	-1.000	0.102	0.144	0.167	0.182	0.194	0.197	0.214	0.218	0.242
1993	-1.000	0.118	0.166	0.196	0.205	0.214	0.220	0.223	0.242	0.258
1994	-1.000	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.230	0.247
1995	-1.000	0.090	0.144	0.181	0.203	0.217	0.226	0.227	0.239	0.246
1996	.	0.086	0.137	0.186	0.206	0.219	0.234	0.233	0.249	0.253
1997	.	0.094	0.135	0.169	0.194	0.210	0.224	0.231	0.230	0.239

Table 6.5.1

Title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:09

Separable analysis
from 1970 to 1997 on ages 1 to 8
with Terminal F of .600 on age 4 and Terminal S of 1.000

Initial sum of squared residuals was 580.056 and
final sum of squared residuals is 71.980 after 112 iterations

Matrix of Residuals

Years, Ages	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77
1/ 2,	-.887,	-.045,	-.366,	1.867,	.542,	1.746,	1.553,
2/ 3,	1.733,	-.582,	-.020,	.470,	.261,	.250,	.367,
3/ 4,	.542,	.291,	.199,	.047,	-.090,	-.447,	-.178,
4/ 5,	-.026,	.039,	-.280,	-.172,	.091,	-.356,	-.297,
5/ 6,	-.323,	.051,	-.087,	-.180,	.088,	.073,	-.015,
6/ 7,	-.576,	-.141,	-.137,	-.111,	-.258,	.098,	-.210,
7/ 8,	.042,	.118,	.879,	-.014,	-.166,	.222,	.503,
TOT ,	.001,	.001,	.001,	.001,	.001,	.001,	.002,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87
1/ 2,	.605,	1.478,	1.397,	.694,	.379,	-.591,	-1.586,	1.300,	2.041,	-.195,
2/ 3,	.422,	.955,	.168,	-.184,	.212,	-.389,	-.041,	.365,	-.229,	-.251,
3/ 4,	-.569,	.031,	-.336,	.074,	-.150,	-.259,	.060,	.524,	-.177,	-.146,
4/ 5,	-.207,	-.023,	-.268,	-.084,	-.104,	-.079,	.191,	.077,	-.430,	-.131,
5/ 6,	.262,	-.021,	.137,	-.086,	-.071,	.151,	-.039,	-.327,	.168,	.346,
6/ 7,	.029,	-.523,	-.099,	-.085,	.356,	.106,	-.084,	-.185,	-.132,	-.315,
7/ 8,	-.044,	-.199,	.272,	.395,	-.369,	.453,	.357,	-.417,	.442,	.410,
TOT ,	.002,	.002,	.001,	.001,	.001,	.001,	.001,	.001,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	TOT,	WTS,
1/ 2,	1.700,	-3.252,	.937,	-.625,	-.061,	1.262,	-2.618,	1.954,	-1.131,	.523,	-.001,	.113,
2/ 3,	-.333,	-.835,	-.525,	.083,	.007,	.076,	-.260,	.579,	-.327,	-.070,	.000,	.305,
3/ 4,	-.109,	.266,	-.611,	.160,	-.229,	-.022,	-.062,	.115,	-.030,	.000,	.000,	.562,
4/ 5,	-.313,	.240,	.017,	.020,	-.379,	.002,	.194,	-.634,	.375,	.065,	.000,	.683,
5/ 6,	.010,	.156,	.125,	.031,	.065,	-.096,	.193,	-.089,	.071,	-.079,	.000,	1.000,
6/ 7,	-.237,	.066,	-.268,	-.220,	.244,	-.176,	-.135,	.229,	.295,	-.210,	.000,	.703,
7/ 8,	.960,	.303,	1.266,	.185,	.440,	.182,	.508,	-.287,	-.818,	.409,	.000,	.355,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	10.813,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
F-values,	.1723,	.1517,	.2244,	.3038,	.4497,	.4765,	.5511,	.3410,

,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
F-values,	.2696,	.2799,	.3767,	.2831,	.2198,	.3470,	.1797,	.1674,	.1706,	.3281,

,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
F-values,	.2038,	.1904,	.2592,	.2608,	.2708,	.3730,	.3955,	.4074,	.5823,	.6000,

Selection-at-age (S)

,	1,	2,	3,	4,	5,	6,	7,	8,
S-values,	.0111,	.4879,	.9025,	1.0000,	.9559,	1.0315,	.8580,	1.0000,

Table 6.5.1 (Continued)

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:13

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE								
1,	-.0014,	.0000,	-.0004,	.0154,	.0039,	.0227,	.0314,	.0081,
2,	.2885,	-.0262,	.0053,	.0371,	-.0308,	.0103,	-.0186,	.0608,
3,	.0759,	-.0122,	.0316,	.0231,	-.0960,	-.1710,	-.1104,	-.1220,
4,	-.0084,	-.0161,	-.0781,	-.0128,	.0270,	-.1189,	-.0988,	-.0497,
5,	-.0214,	-.0043,	-.0346,	-.0562,	.0718,	-.0105,	.0034,	.0179,
6,	-.0489,	.0324,	-.0205,	-.0364,	-.0362,	.0730,	-.0715,	.0097,
7,	.0028,	.0364,	.0916,	.0100,	-.0145,	.0890,	.0516,	.0125,
8,	-.0001,	-.0035,	.0406,	-.1190,	.0334,	.0801,	.0174,	-.1185,

Fishing mortality residuals

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
1,	.0119,	.0061,	.0041,	.0005,	-.0008,	-.0028,	.0025,	.0111,	-.0003,	.0021,
2,	.1068,	.0223,	-.0514,	-.0007,	-.0228,	.0399,	.0238,	-.0320,	-.0074,	.0041,
3,	-.0201,	-.0723,	-.0019,	-.0448,	-.0419,	.0552,	.0569,	-.0170,	-.0403,	.0585,
4,	-.0003,	-.0380,	-.0176,	-.0250,	-.0158,	.0001,	.0281,	-.0315,	.0094,	-.0616,
5,	.0069,	.0067,	.0474,	.0084,	-.0004,	-.0014,	-.0319,	.0151,	.0412,	.0794,
6,	-.0560,	.0176,	-.0476,	.0941,	.0289,	-.0594,	.0070,	.0210,	-.0129,	-.0372,
7,	.0010,	.0870,	.0720,	-.0188,	-.0054,	.0104,	-.0200,	.0399,	.0475,	.0881,
8,	.0303,	.0754,	.0405,	-.0459,	.0819,	-.1476,	-.0520,	.0574,	-.0296,	-.0376,

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:13

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
1,	-.0023,	.0029,	-.0012,	-.0008,	.0070,	-.0036,	.0182,	-.0030,	.0030,	.0000,
2,	-.0717,	-.0486,	-.0093,	.0160,	-.0326,	-.0103,	.1299,	-.0554,	.0091,	-.0440,
3,	.0913,	-.0687,	-.0550,	-.0392,	.0358,	-.1180,	.0970,	.0032,	-.0198,	.0828,
4,	.0893,	.0436,	.0199,	-.1036,	.0082,	.0915,	-.1572,	.1031,	.0330,	-.0387,
5,	.0161,	.0377,	.0688,	.0188,	-.0478,	.0140,	.0361,	.0211,	-.0637,	.0068,
6,	.0712,	-.0141,	.0267,	.0915,	.0057,	-.0566,	-.0664,	.1218,	-.0059,	-.0613,
7,	.0204,	.0548,	.0521,	.1027,	.0273,	.0866,	-.0213,	-.1390,	.0170,	.1573,
8,	-.1015,	-.0342,	-.1665,	.0164,	-.0023,	-.0245,	-.0919,	.1246,	.2354,	-.2238,

Table 6.5.1 (Continued)

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:41

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE								
1,	.0005,	.0017,	.0021,	.0188,	.0089,	.0280,	.0375,	.0118,
2,	.3726,	.0478,	.1148,	.1853,	.1886,	.2427,	.2503,	.2272,
3,	.2314,	.1247,	.2342,	.2972,	.3099,	.2591,	.3870,	.1857,
4,	.1640,	.1356,	.1462,	.2909,	.4767,	.3576,	.4522,	.2913,
5,	.1433,	.1407,	.1799,	.2342,	.5017,	.4450,	.5302,	.3438,
6,	.1289,	.1889,	.2110,	.2769,	.4276,	.5645,	.4970,	.3615,
7,	.1506,	.1665,	.2842,	.2706,	.3713,	.4978,	.5244,	.3050,
8,	.1723,	.1482,	.2650,	.1848,	.4832,	.5566,	.5685,	.2225,
+gp,	.1723,	.1482,	.2650,	.1848,	.4832,	.5566,	.5685,	.2225,
FBAR 3- 6,	.1669,	.1475,	.1928,	.2748,	.4290,	.4066,	.4666,	.2956,

Table 8 Fishing mortality (F) at age YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
1,	.0149,	.0092,	.0083,	.0036,	.0016,	.0010,	.0045,	.0129,	.0016,	.0057,
2,	.2383,	.1588,	.1324,	.1374,	.0844,	.2092,	.1115,	.0497,	.0758,	.1642,
3,	.2232,	.1804,	.3381,	.2107,	.1565,	.3684,	.2191,	.1341,	.1136,	.3547,
4,	.2693,	.2419,	.3591,	.2580,	.2040,	.3472,	.2078,	.1360,	.1799,	.2665,
5,	.2646,	.2743,	.4075,	.2790,	.2096,	.3304,	.1398,	.1752,	.2042,	.3931,
6,	.2221,	.3063,	.3410,	.3861,	.2556,	.2986,	.1923,	.1937,	.1630,	.3013,
7,	.2323,	.3271,	.3951,	.2241,	.1831,	.3081,	.1342,	.1835,	.1938,	.3697,
8,	.2999,	.3553,	.4171,	.2372,	.3017,	.1994,	.1276,	.2249,	.1410,	.2906,
+gp,	.2999,	.3553,	.4171,	.2372,	.3017,	.1994,	.1276,	.2249,	.1410,	.2906,
FBAR 3- 6,	.2448,	.2507,	.3614,	.2835,	.2064,	.3361,	.1897,	.1598,	.1652,	.3289,

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:41

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	FBAR 95-97
AGE											
1,	.0000,	.0050,	.0017,	.0021,	.0100,	.0005,	.0226,	.0015,	.0094,	.0066,	.0058,
2,	.0278,	.0443,	.1172,	.1432,	.0995,	.1717,	.3229,	.1434,	.2932,	.2488,	.2285,
3,	.2752,	.1032,	.1790,	.1961,	.2802,	.2186,	.4539,	.3708,	.5057,	.6243,	.5003,
4,	.2931,	.2341,	.2791,	.1572,	.2791,	.4645,	.2383,	.5104,	.6153,	.5613,	.5623,
5,	.2110,	.2198,	.3166,	.2681,	.2111,	.3706,	.4142,	.4105,	.4929,	.5804,	.4946,
6,	.2815,	.1823,	.2941,	.3605,	.2850,	.3282,	.3416,	.5420,	.5947,	.5576,	.5648,
7,	.1953,	.2182,	.2746,	.3264,	.2596,	.4067,	.3181,	.2105,	.5166,	.6721,	.4664,
8,	.1024,	.1562,	.0928,	.2772,	.2686,	.3485,	.3036,	.5319,	.8177,	.3762,	.5753,
+gp,	.1024,	.1562,	.0928,	.2772,	.2686,	.3485,	.3036,	.5319,	.8177,	.3762,	
FBAR 3- 6,	.2652,	.1848,	.2672,	.2455,	.2639,	.3455,	.3620,	.4584,	.5522,	.5809,	

Table 6.5.1 (Continued)

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:41

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year)							Numbers*10**-3	
YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE								
1,	416271,	834137,	749569,	545822,	604765,	421306,	711491,	601811,
2,	129471,	153059,	306349,	275170,	197064,	220518,	150716,	252103,
3,	138355,	66082,	108098,	202336,	169376,	120892,	128156,	86931,
4,	91887,	89873,	47759,	70027,	123061,	101723,	76386,	71256,
5,	30618,	70568,	71010,	37334,	47368,	69130,	64368,	43973,
6,	348759,	24005,	55470,	53671,	26729,	25951,	40083,	34276,
7,	22381,	277406,	17983,	40646,	36817,	15770,	13352,	22065,
8,	11053,	17420,	212501,	12246,	28058,	22980,	8674,	7151,
+gp,	12671,	16460,	19389,	317075,	83446,	78484,	37876,	21822,
TOTAL,	1201466,	1549009,	1588128,	1554326,	1316684,	1076755,	1231102,	1141388,

Table 10 Stock number at age (start of year)							Numbers*10**-3			
YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
1,	1084507,	1022639,	548311,	706245,	725495,	2425906,	985946,	1181497,	915327,	3361295,
2,	218786,	393056,	372766,	200051,	258872,	266460,	891560,	361084,	429064,	336197,
3,	148809,	127711,	248417,	241915,	129175,	176259,	160131,	590809,	254529,	294656,
4,	59109,	97464,	87304,	145047,	160442,	90439,	99835,	105309,	423005,	186014,
5,	48183,	40859,	69240,	55163,	101395,	118387,	57831,	73388,	83173,	319726,
6,	28212,	33461,	28102,	41684,	37760,	74395,	76984,	45499,	55731,	61357,
7,	21606,	20444,	22289,	18081,	25637,	26461,	49939,	57473,	33918,	42843,
8,	14716,	15498,	13338,	13585,	13076,	19315,	17594,	39513,	43283,	25283,
+gp,	13446,	14331,	16377,	25928,	11571,	24664,	35223,	11291,	16980,	42348,
TOTAL,	1637377,	1765463,	1406144,	1447702,	1463422,	3222286,	2375045,	2465862,	2255010,	4669719,

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:41

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year)							Numbers*10**-3					
YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	GMST
AGE												
1,	501942,	711994,	810636,	515318,	412379,	635475,	827609,	300628,	807286,	1784774,	0,	7407
2,	1229484,	184654,	260624,	297707,	189183,	150199,	233667,	297658,	110430,	294206,	652243,	2719
3,	211349,	885858,	130869,	171720,	191122,	126876,	93713,	125337,	191058,	61017,	169950,	1701
4,	169210,	131404,	654181,	89584,	115553,	118236,	83476,	48731,	70822,	94339,	26759,	1100
5,	128936,	114210,	94084,	447757,	69265,	79096,	67234,	59517,	26466,	34635,	48695,	757
6,	195264,	94474,	82954,	62028,	309855,	50747,	49408,	40205,	35723,	14628,	17540,	558
7,	41077,	133338,	71235,	55934,	39136,	210830,	33072,	31770,	21157,	17834,	7579,	373
8,	26785,	30574,	97000,	48980,	36516,	27314,	127025,	21772,	23290,	11420,	8240,	247
+gp,	21195,	22033,	13393,	33170,	27982,	21410,	40407,	36050,	12094,	14247,	15943,	
TOTAL,	2525241,	2308541,	2214978,	1722198,	1390991,	1420183,	1555612,	961668,	1298327,	2327100,	946948,	

Table 6.5.1 (Continued)

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:09

SEPARABLY GENERATED FISHING MORTALITIES

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE								
1,	.0019,	.0017,	.0025,	.0034,	.0050,	.0053,	.0061,	.0038,
2,	.0841,	.0740,	.1095,	.1482,	.2194,	.2325,	.2689,	.1664,
3,	.1555,	.1369,	.2025,	.2741,	.4059,	.4300,	.4974,	.3077,
4,	.1723,	.1517,	.2244,	.3038,	.4497,	.4765,	.5511,	.3410,
5,	.1647,	.1450,	.2145,	.2904,	.4299,	.4555,	.5268,	.3259,
6,	.1778,	.1565,	.2315,	.3133,	.4639,	.4915,	.5684,	.3517,
7,	.1479,	.1302,	.1925,	.2606,	.3859,	.4088,	.4728,	.2925,
8,	.1723,	.1517,	.2244,	.3038,	.4497,	.4765,	.5511,	.3410,

SEPARABLY GENERATED FISHING MORTALITIES

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
1,	.0030,	.0031,	.0042,	.0031,	.0024,	.0038,	.0020,	.0019,	.0019,	.0036,
2,	.1315,	.1366,	.1838,	.1381,	.1072,	.1693,	.0877,	.0817,	.0832,	.1601,
3,	.2433,	.2526,	.3399,	.2555,	.1983,	.3132,	.1621,	.1511,	.1539,	.2962,
4,	.2696,	.2799,	.3767,	.2831,	.2198,	.3470,	.1797,	.1674,	.1706,	.3281,
5,	.2577,	.2676,	.3601,	.2706,	.2101,	.3318,	.1717,	.1601,	.1630,	.3137,
6,	.2781,	.2887,	.3885,	.2920,	.2267,	.3580,	.1853,	.1727,	.1759,	.3385,
7,	.2313,	.2402,	.3232,	.2429,	.1886,	.2978,	.1541,	.1437,	.1463,	.2815,
8,	.2696,	.2799,	.3767,	.2831,	.2198,	.3470,	.1797,	.1674,	.1706,	.3281,

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:09

SEPARABLY GENERATED FISHING MORTALITIES

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
1,	.0023,	.0021,	.0029,	.0029,	.0030,	.0041,	.0044,	.0045,	.0064,	.0066,
2,	.0994,	.0929,	.1265,	.1272,	.1321,	.1820,	.1930,	.1988,	.2841,	.2927,
3,	.1840,	.1719,	.2340,	.2354,	.2444,	.3367,	.3570,	.3677,	.5255,	.5415,
4,	.2038,	.1904,	.2592,	.2608,	.2708,	.3730,	.3955,	.4074,	.5823,	.6000,
5,	.1948,	.1821,	.2478,	.2493,	.2589,	.3566,	.3781,	.3894,	.5566,	.5736,
6,	.2102,	.1964,	.2674,	.2690,	.2794,	.3848,	.4080,	.4202,	.6006,	.6189,
7,	.1749,	.1634,	.2224,	.2238,	.2324,	.3201,	.3393,	.3495,	.4996,	.5148,
8,	.2038,	.1904,	.2592,	.2608,	.2708,	.3730,	.3955,	.4074,	.5823,	.6000,

Table 6.5.1 (Continued)

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:09

SEPARABLY GENERATED POPULATION NUMBERS *10**-2

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE								
1,	3882,	8198,	8179,	6626,	6649,	4632,	6953,	5894,
2,	1043,	1426,	3011,	3002,	2429,	2434,	1695,	2542,
3,	1305,	710,	981,	1999,	1917,	1445,	1429,	960,
4,	907,	915,	507,	656,	1244,	1046,	770,	712,
5,	311,	691,	711,	367,	438,	718,	588,	401,
6,	3388,	239,	541,	519,	248,	258,	412,	314,
7,	224,	2566,	185,	388,	343,	141,	143,	211,
8,	110,	175,	2039,	138,	271,	211,	85,	80,

SEPARABLY GENERATED POPULATION NUMBERS *10**-2

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
1,	11003,	11188,	5698,	6718,	6867,	23021,	10469,	8604,	6760,	37079,
2,	2160,	4036,	4103,	2087,	2464,	2520,	8437,	3844,	3160,	2482,
3,	1595,	1403,	2608,	2529,	1347,	1640,	1576,	5726,	2624,	2154,
4,	578,	1024,	892,	1520,	1604,	904,	981,	1097,	4030,	1842,
5,	458,	399,	700,	554,	1036,	1165,	578,	742,	840,	3075,
6,	262,	320,	276,	442,	382,	760,	756,	441,	572,	646,
7,	200,	180,	217,	170,	299,	276,	481,	569,	336,	434,
8,	143,	144,	128,	142,	120,	224,	185,	373,	446,	262,

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:09

SEPARABLY GENERATED POPULATION NUMBERS *10**-2

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
1,	6175,	7009,	7373,	5872,	3824,	5343,	9072,	2722,	8387,	17843,
2,	13591,	2266,	2573,	2705,	2154,	1403,	1957,	3323,	997,	3066,
3,	1567,	9115,	1530,	1680,	1764,	1398,	866,	1196,	2018,	556,
4,	1311,	1067,	6285,	991,	1087,	1131,	817,	496,	678,	977,
5,	1200,	968,	798,	4388,	691,	750,	705,	498,	299,	343,
6,	2033,	894,	730,	564,	3094,	483,	475,	437,	305,	155,
7,	416,	1491,	665,	505,	390,	2117,	297,	286,	260,	152,
8,	296,	316,	1146,	481,	366,	280,	1391,	192,	182,	143,

Table 6.5.2

Run title : Herring VIa South (run: SEPJM21/S21)

At 15-Mar-98 18:03:41

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 3- 6,
1970,	416271,	214356,	137618,	20306,	.1476,	.8968,	.1669,
1971,	834137,	238909,	126126,	15044,	.1193,	.8707,	.1475,
1972,	749569,	252864,	134641,	23474,	.1743,	.8975,	.1928,
1973,	545822,	309203,	188363,	36719,	.1949,	1.0162,	.2748,
1974,	604765,	227796,	109511,	36589,	.3341,	.9762,	.4290,
1975,	421306,	220951,	114049,	38764,	.3399,	1.1237,	.4066,
1976,	711491,	210459,	81468,	32767,	.4022,	1.0472,	.4666,
1977,	601811,	199896,	90494,	20567,	.2273,	1.0778,	.2956,
1978,	1084507,	250895,	88841,	19715,	.2219,	1.0161,	.2448,
1979,	1022639,	291381,	121497,	22608,	.1861,	1.0664,	.2507,
1980,	548311,	233434,	123232,	30124,	.2444,	.9636,	.3614,
1981,	706245,	253718,	127310,	24922,	.1958,	1.0312,	.2835,
1982,	725495,	254368,	130951,	19209,	.1467,	1.0301,	.2064,
1983,	2425906,	467934,	128534,	32988,	.2566,	1.0042,	.3361,
1984,	985946,	379670,	207743,	27450,	.1321,	.9688,	.1897,
1985,	1181498,	363537,	199721,	23343,	.1169,	.9846,	.1598,
1986,	915327,	380038,	236125,	28785,	.1219,	1.0002,	.1652,
1987,	3361296,	583807,	200784,	48600,	.2421,	.9488,	.3289,
1988,	501942,	444511,	313194,	29100,	.0929,	.9992,	.2652,
1989,	711994,	386648,	234370,	29210,	.1246,	1.0010,	.1848,
1990,	810636,	350296,	202068,	43969,	.2176,	1.0006,	.2672,
1991,	515318,	275549,	172188,	37700,	.2189,	.9971,	.2455,
1992,	412379,	218758,	135784,	31856,	.2346,	.9951,	.2639,
1993,	635475,	237673,	117459,	36763,	.3130,	1.0060,	.3455,
1994,	827609,	224757,	103370,	33908,	.3280,	.9980,	.3620,
1995,	300628,	153436,	88463,	27792,	.3142,	1.0525,	.4584,
1996,	807286,	161894,	58282,	32534,	.5582,	.9955,	.5522,
1997,	(1784773,)	257218,	58840,	27225,	.4627,	1.0016,	.5809,
Arith. Mean	898228,	287284,	143965,	29715,	.2382		.3011,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 6.6.1

Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Prediction with management option table: Input data

Year: 1998								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	583.600	1.0000	0.0000	0.6700	0.6700	97.000	0.0066	90.000
2	205.000	0.3000	1.0000	0.6700	0.6700	148.000	0.2920	138.000
3	169.900	0.2000	1.0000	0.6700	0.6700	185.000	0.5390	161.000
4	26.800	0.1000	1.0000	0.6700	0.6700	203.000	0.5980	177.000
5	48.700	0.1000	1.0000	0.6700	0.6700	215.000	0.5710	190.000
6	17.500	0.1000	1.0000	0.6700	0.6700	225.000	0.6160	199.000
7	7.600	0.1000	1.0000	0.6700	0.6700	228.000	0.5120	204.000
8	8.200	0.1000	1.0000	0.6700	0.6700	238.000	0.5980	221.000
9+	15.900	0.1000	1.0000	0.6700	0.6700	249.000	0.5980	230.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	583.600	1.0000	0.0000	0.6700	0.6700	97.000	0.0066	90.000
2	.	0.3000	1.0000	0.6700	0.6700	148.000	0.2920	138.000
3	.	0.2000	1.0000	0.6700	0.6700	185.000	0.5390	161.000
4	.	0.1000	1.0000	0.6700	0.6700	203.000	0.5980	177.000
5	.	0.1000	1.0000	0.6700	0.6700	215.000	0.5710	190.000
6	.	0.1000	1.0000	0.6700	0.6700	225.000	0.6160	199.000
7	.	0.1000	1.0000	0.6700	0.6700	228.000	0.5120	204.000
8	.	0.1000	1.0000	0.6700	0.6700	238.000	0.5980	221.000
9+	.	0.1000	1.0000	0.6700	0.6700	249.000	0.5980	230.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	583.600	1.0000	0.0000	0.6700	0.6700	97.000	0.0066	90.000
2	.	0.3000	1.0000	0.6700	0.6700	148.000	0.2920	138.000
3	.	0.2000	1.0000	0.6700	0.6700	185.000	0.5390	161.000
4	.	0.1000	1.0000	0.6700	0.6700	203.000	0.5980	177.000
5	.	0.1000	1.0000	0.6700	0.6700	215.000	0.5710	190.000
6	.	0.1000	1.0000	0.6700	0.6700	225.000	0.6160	199.000
7	.	0.1000	1.0000	0.6700	0.6700	228.000	0.5120	204.000
8	.	0.1000	1.0000	0.6700	0.6700	238.000	0.5980	221.000
9+	.	0.1000	1.0000	0.6700	0.6700	249.000	0.5980	230.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANJM04
Date and time: 17MAR98:12:52

Table 6.6.2

The SAS System 12:50 Tuesday, March 17, 1998

Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.5810	145873	56941	27246	0.5000	0.2905	140013	62387	14178	149574	69670
.	.	.	.	.	0.6000	0.3486	.	60468	16625	146825	65493
.	.	.	.	.	0.7000	0.4067	.	58614	18957	144209	61631
.	.	.	.	.	0.8000	0.4648	.	56821	21181	141718	58060
.	.	.	.	.	0.9000	0.5229	.	55088	23301	139346	54754
.	.	.	.	.	1.0000	0.5810	.	53412	25324	137087	51692
.	.	.	.	.	1.1000	0.6391	.	51792	27255	134935	48855
.	.	.	.	.	1.2000	0.6972	.	50225	29097	132886	46223
.	.	.	.	.	1.3000	0.7553	.	48710	30855	130932	43780
.	.	.	.	.	1.4000	0.8134	.	47245	32534	129070	41510
.	.	.	.	.	1.5000	0.8715	.	45828	34137	127295	39401
.	.	.	.	.	1.6000	0.9296	.	44457	35669	125603	37438
.	.	.	.	.	1.7000	0.9877	.	43131	37133	123989	35610
.	.	.	.	.	1.8000	1.0458	.	41849	38531	122450	33907
.	.	.	.	.	1.9000	1.1039	.	40608	39869	120981	32318
.	.	.	.	.	2.0000	1.1620	.	39407	41147	119580	30834
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANJM03
Date and time : 17MAR98:13:03
Computation of ref. F: Simple mean, age 3 - 6
Basis for 1998 : F factors

The SAS System 12:50 Tuesday, March 17, 1998

Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0358	0.6018	145873	56311	28000	0.5000	0.2905	139176	61753	14004	148990	69220
.	.	.	.	.	0.6000	0.3486	.	59859	16421	146274	65084
.	.	.	.	.	0.7000	0.4067	.	58027	18726	143688	61260
.	.	.	.	.	0.8000	0.4648	.	56257	20924	141226	57723
.	.	.	.	.	0.9000	0.5229	.	54545	23020	138882	54448
.	.	.	.	.	1.0000	0.5810	.	52890	25020	136649	51414
.	.	.	.	.	1.1000	0.6391	.	51289	26928	134522	48602
.	.	.	.	.	1.2000	0.6972	.	49742	28749	132495	45993
.	.	.	.	.	1.3000	0.7553	.	48245	30487	130563	43571
.	.	.	.	.	1.4000	0.8134	.	46797	32148	128722	41321
.	.	.	.	.	1.5000	0.8715	.	45397	33733	126967	39229
.	.	.	.	.	1.6000	0.9296	.	44043	35248	125293	37282
.	.	.	.	.	1.7000	0.9877	.	42732	36696	123696	35468
.	.	.	.	.	1.8000	1.0458	.	41465	38080	122173	33778
.	.	.	.	.	1.9000	1.1039	.	40238	39403	120720	32201
.	.	.	.	.	2.0000	1.1620	.	39052	40669	119333	30728
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANJM04
Date and time : 17MAR98:12:52
Computation of ref. F: Simple mean, age 3 - 6
Basis for 1998 : TAC constraints

Table 6.6.3

The SAS System 12:50 Tuesday, March 17, 1998

Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Prediction with management option table: Input data

Year: 1998								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	583.600	1.0000	0.0000	0.6700	0.6700	97.000	0.0066	90.000
2	205.000	0.3000	1.0000	0.6700	0.6700	148.000	0.2920	138.000
3	169.900	0.2000	1.0000	0.6700	0.6700	185.000	0.5390	161.000
4	26.800	0.1000	1.0000	0.6700	0.6700	203.000	0.5980	177.000
5	48.700	0.1000	1.0000	0.6700	0.6700	215.000	0.5710	190.000
6	17.500	0.1000	1.0000	0.6700	0.6700	225.000	0.6160	199.000
7	7.600	0.1000	1.0000	0.6700	0.6700	228.000	0.5120	204.000
8	8.200	0.1000	1.0000	0.6700	0.6700	238.000	0.5980	221.000
9+	15.900	0.1000	1.0000	0.6700	0.6700	249.000	0.5980	230.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	583.600	1.0000	0.0000	0.6700	0.6700	97.000	0.0066	90.000
2	.	0.3000	1.0000	0.6700	0.6700	148.000	0.2920	138.000
3	.	0.2000	1.0000	0.6700	0.6700	185.000	0.5390	161.000
4	.	0.1000	1.0000	0.6700	0.6700	203.000	0.5980	177.000
5	.	0.1000	1.0000	0.6700	0.6700	215.000	0.5710	190.000
6	.	0.1000	1.0000	0.6700	0.6700	225.000	0.6160	199.000
7	.	0.1000	1.0000	0.6700	0.6700	228.000	0.5120	204.000
8	.	0.1000	1.0000	0.6700	0.6700	238.000	0.5980	221.000
9+	.	0.1000	1.0000	0.6700	0.6700	249.000	0.5980	230.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	583.600	1.0000	0.0000	0.6700	0.6700	97.000	0.0066	90.000
2	.	0.3000	1.0000	0.6700	0.6700	148.000	0.2920	138.000
3	.	0.2000	1.0000	0.6700	0.6700	185.000	0.5390	161.000
4	.	0.1000	1.0000	0.6700	0.6700	203.000	0.5980	177.000
5	.	0.1000	1.0000	0.6700	0.6700	215.000	0.5710	190.000
6	.	0.1000	1.0000	0.6700	0.6700	225.000	0.6160	199.000
7	.	0.1000	1.0000	0.6700	0.6700	228.000	0.5120	204.000
8	.	0.1000	1.0000	0.6700	0.6700	238.000	0.5980	221.000
9+	.	0.1000	1.0000	0.6700	0.6700	249.000	0.5980	230.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANJM03
Date and time: 17MAR98:13:03

Table 6.6.4

The SAS System 08:57 Tuesday, March 17, 1998

Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	1.000	1.0000	0.0000	0.6700	0.6700	97.000	0.0066	90.000
2	.	0.3000	1.0000	0.6700	0.6700	148.000	0.2920	138.000
3	.	0.2000	1.0000	0.6700	0.6700	185.000	0.5390	161.000
4	.	0.1000	1.0000	0.6700	0.6700	203.000	0.5980	177.000
5	.	0.1000	1.0000	0.6700	0.6700	215.000	0.5710	190.000
6	.	0.1000	1.0000	0.6700	0.6700	225.000	0.6160	199.000
7	.	0.1000	1.0000	0.6700	0.6700	228.000	0.5120	204.000
8	.	0.1000	1.0000	0.6700	0.6700	238.000	0.5980	221.000
9+	.	0.1000	1.0000	0.6700	0.6700	249.000	0.5980	230.000
Unit	Numbers	-	-	-	-	Grams	-	Grams

Notes: Run name : YLDJM01
Date and time: 17MAR98:10:10

Table 6.6.5

The SAS System 08:57 Tuesday, March 17, 1998

Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	3.985	759.072	2.985	662.072	2.732	609.725
0.1000	0.0581	0.098	19.370	3.029	525.344	2.029	428.344	1.774	377.096
0.2000	0.1162	0.145	27.414	2.590	419.610	1.590	322.610	1.333	272.218
0.3000	0.1743	0.172	31.613	2.336	359.575	1.336	262.575	1.077	212.854
0.4000	0.2324	0.191	34.115	2.170	320.992	1.170	223.992	0.909	174.802
0.5000	0.2905	0.205	35.751	2.053	294.163	1.053	197.163	0.790	148.396
0.6000	0.3486	0.216	36.899	1.966	274.452	0.966	177.452	0.701	129.026
0.7000	0.4067	0.225	37.750	1.898	259.369	0.898	162.369	0.632	114.220
0.8000	0.4648	0.232	38.412	1.843	247.458	0.843	150.458	0.576	102.535
0.9000	0.5229	0.239	38.946	1.799	237.813	0.799	140.813	0.530	93.076
1.0000	0.5810	0.244	39.390	1.762	229.840	0.762	132.840	0.491	85.257
1.1000	0.6391	0.249	39.769	1.730	223.134	0.730	126.134	0.458	78.681
1.2000	0.6972	0.254	40.100	1.703	217.413	0.703	120.413	0.430	73.068
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDJM01
Date and time : 17MAR98:10:54
Computation of ref. F: Simple mean, age 3 - 6
F-0.1 factor : 0.2965
F-max factor : Not found
F-0.1 reference F : 0.1723
F-max reference F : Not found
Recruitment : Single recruit

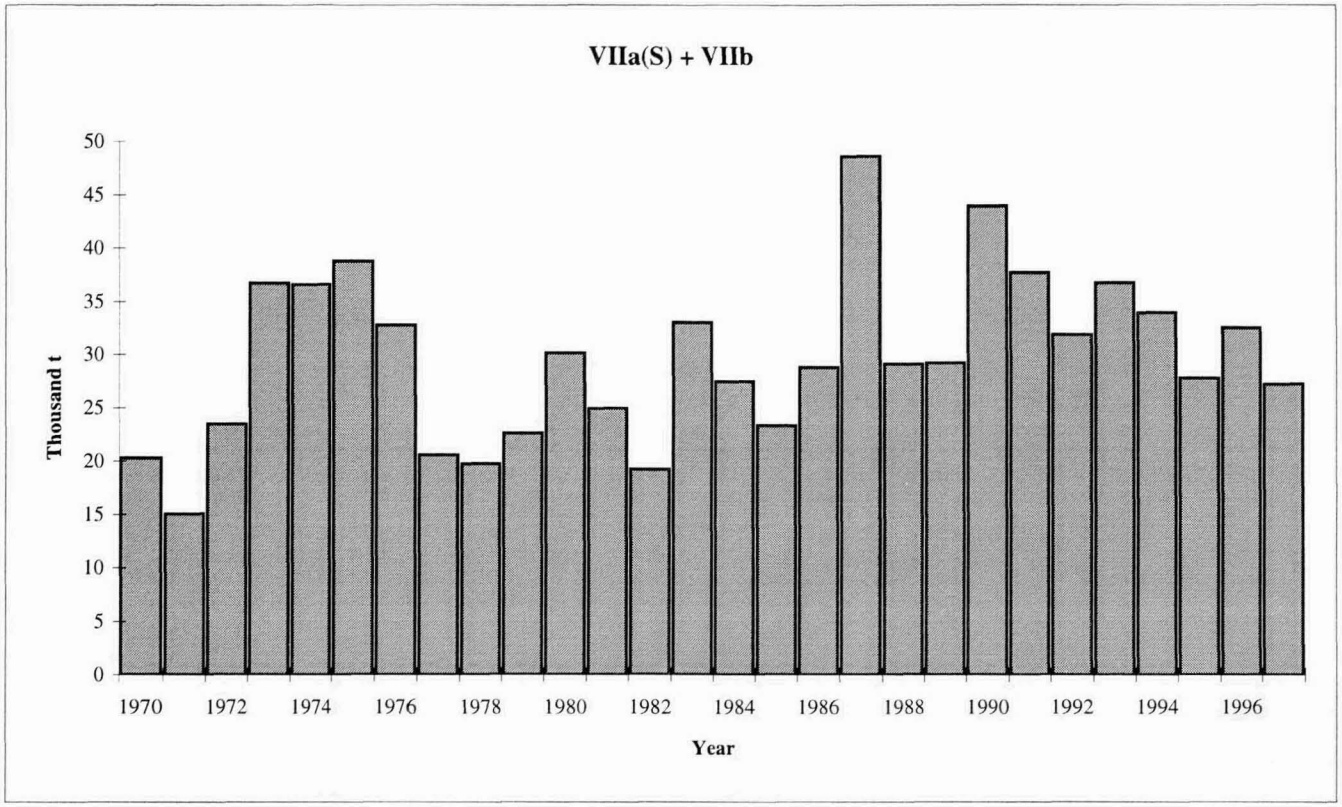


Figure 6.1.1. Herrring VIa(S) + VIIb: Catches.

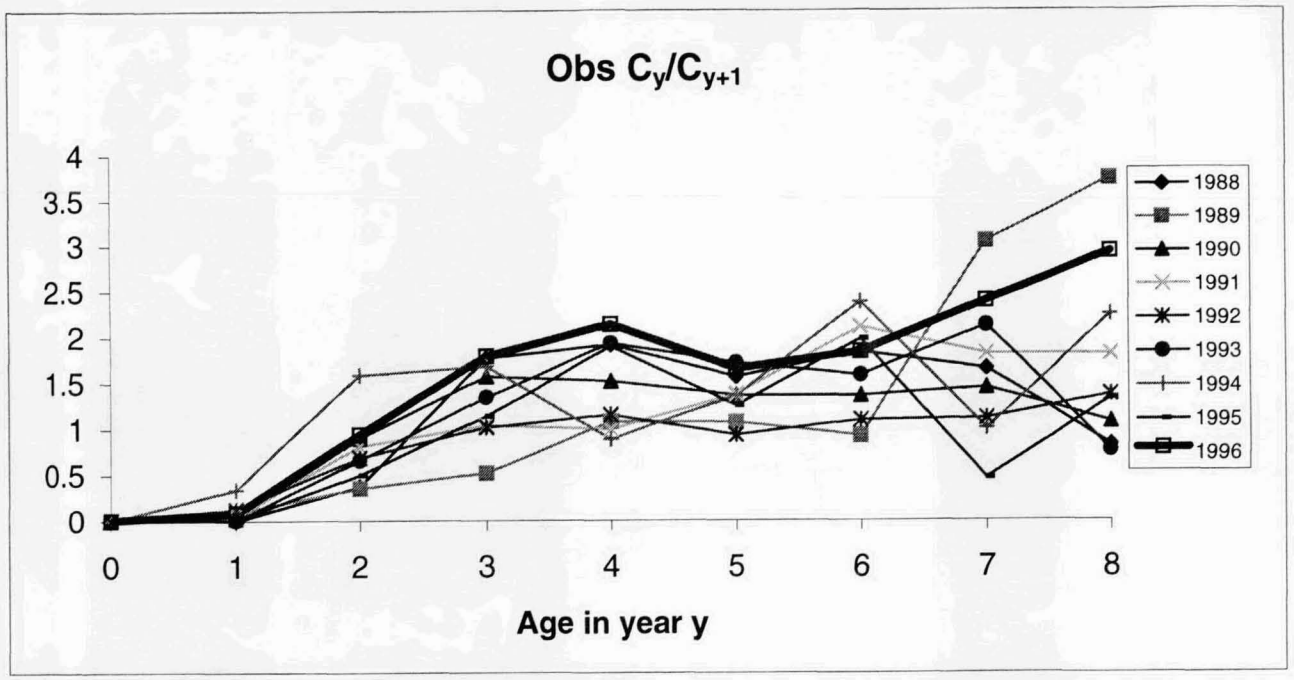


Figure 6.5.1: The ratio of the catches along the cohorts. The age on the axis is the age in the year on the label.

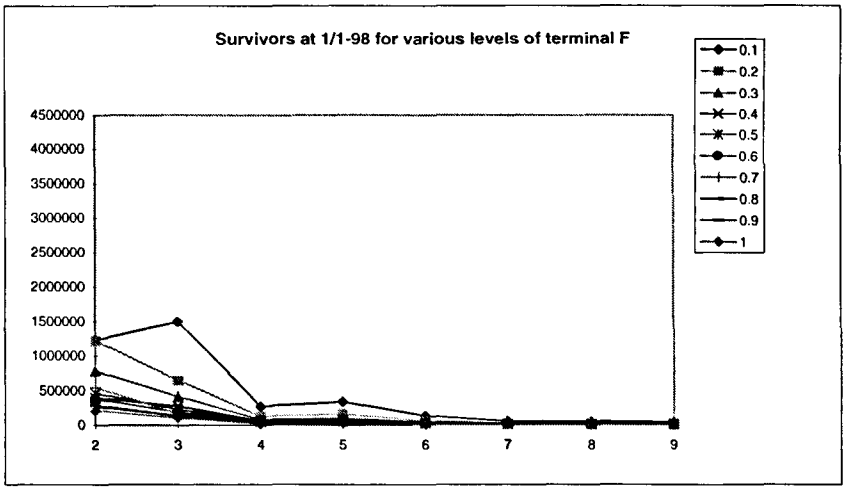


Figure 6.5.2 a: Survivors at age 1/1 98 at different terminal F's. Age 1 has weight 0.01 and age 2 has weight 0.1 in the sum of squares (SSQ). Thus the catch data for age 1 and 2 has little influence on SSQ. SSQ is approximately 5.58 for all terminal F.

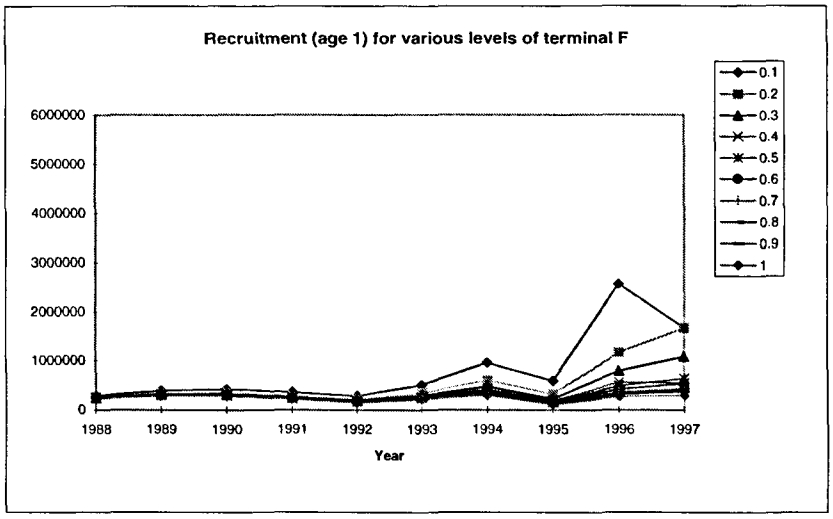


Figure 6.5.2b: Recruitment at age 1 for various levels of t terminal F. The weight ts in the minimized sum are the same as in Figure 6.5.2.a.

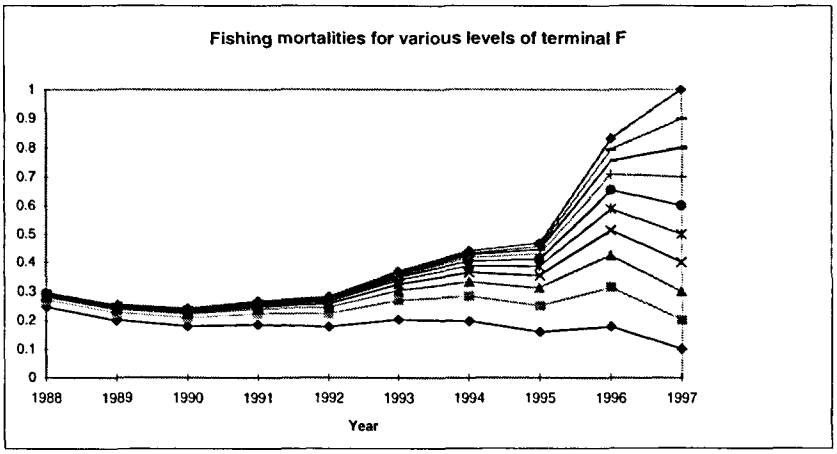


Figure 6.5.2c: Fishing mortality over the last ten years for various levels of terminal F. The weights in the minimized sum is as in figure 6.5.2a. Note that the influence of terminal F is clearly seen back to 1990 for terminal F=0.1-0.2. For the higher values of terminal F the influence is seen back to 1992.

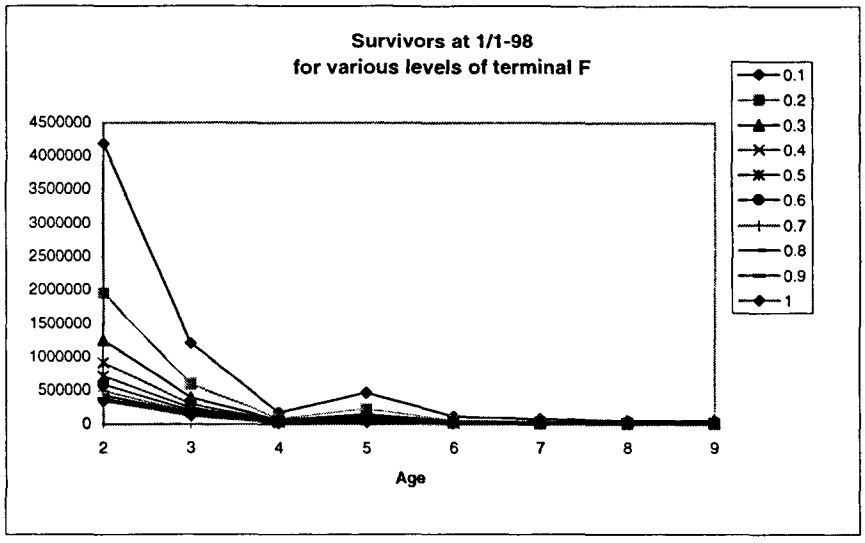


Figure 6.5.3a: Survivors at age 1/1 98 for different terminal F's. No downweighting of ages. SSQ is approximately 15.6 for all terminal F.

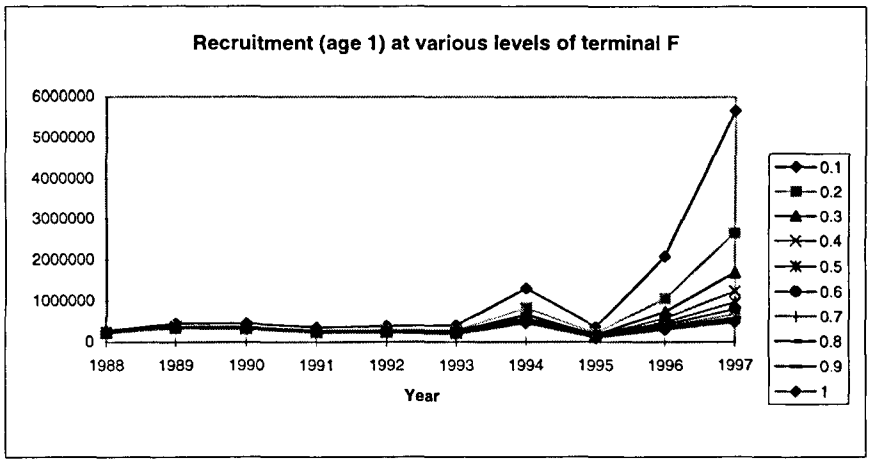


Figure 6.5.3b: Recruitment at age 1 for various level of terminal F.No downweighting of age groups.

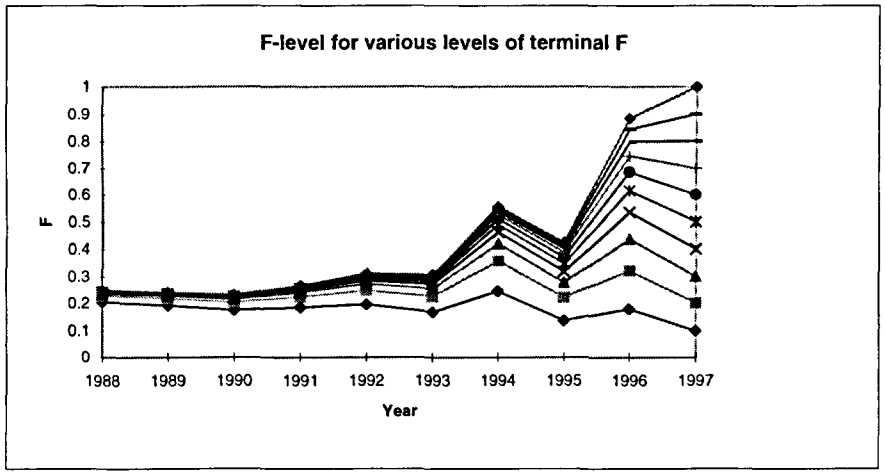


Figure 6.5.3c: Fishing mortality over the last ten years for various levels of terminal F. No downweighting of age groups. Note that the influence of the selected terminal F is seen back to 1991 for terminal F greater than 0.2, and even longer for the smallest values.

F values

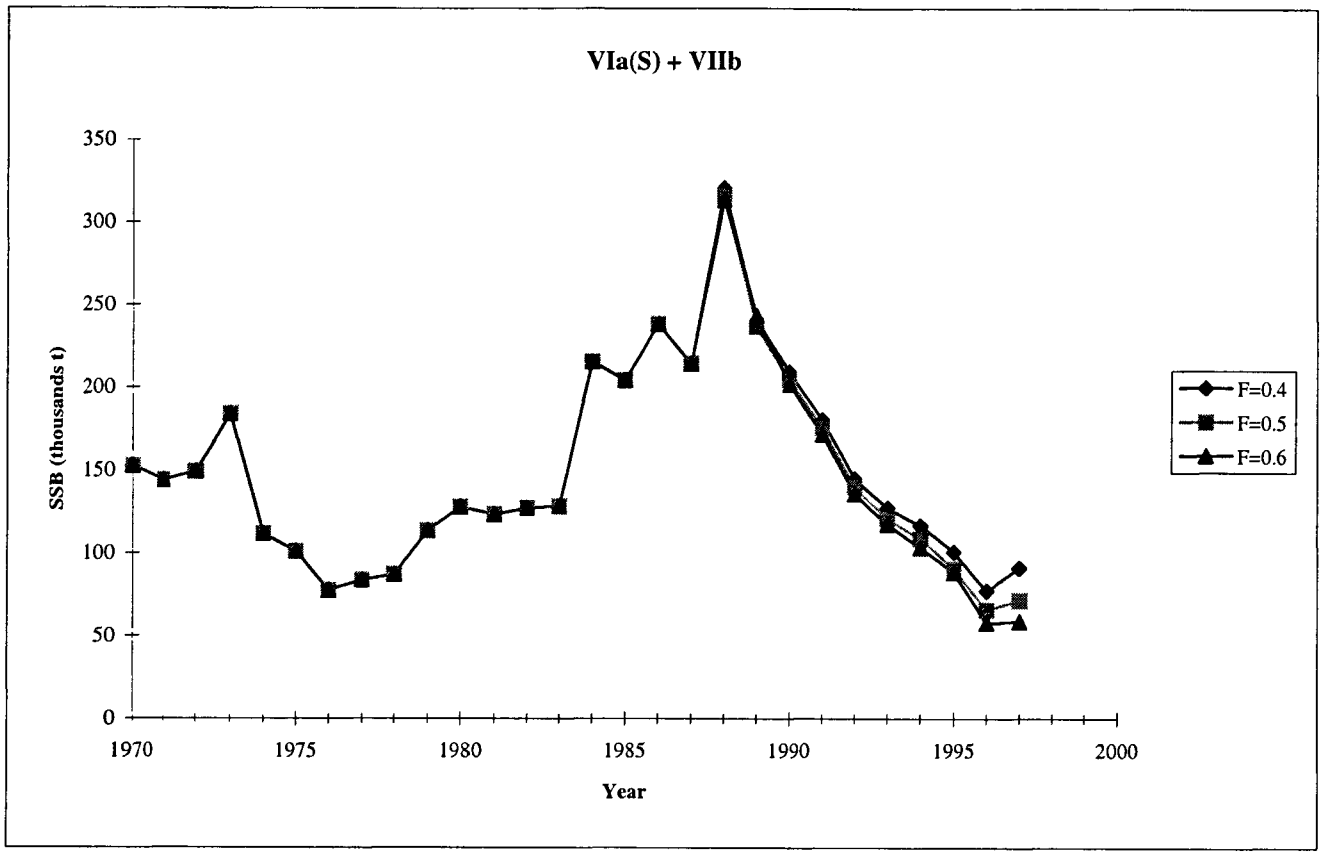


Figure 6.5.4 Herring VIa(S) + VIIb. Variation in SSB with input F values. ..

Fish Stock Summary
; West of Ireland & Porcupine Bank (Fishing Area VIa
17 – 3 – 1998

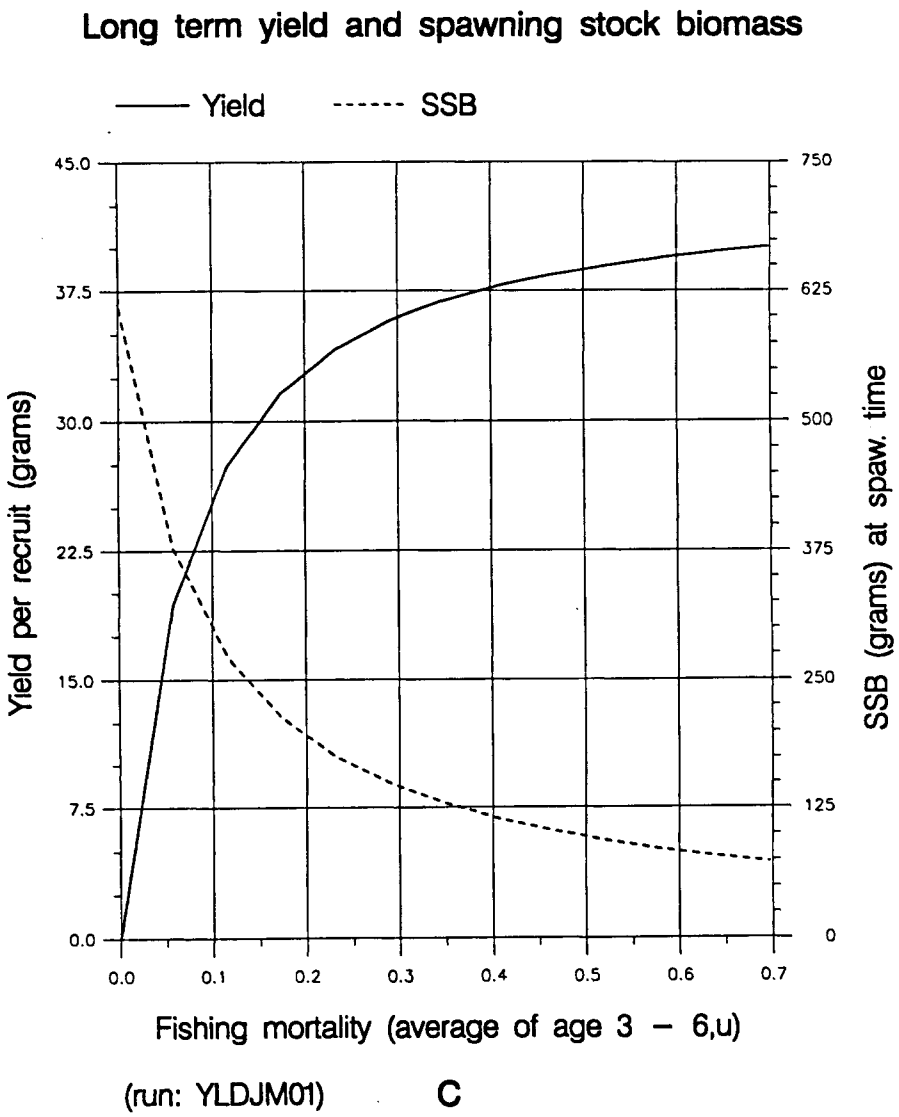


Figure 6.6.1

7 IRISH SEA HERRING (DIVISION VIIA, NORTH)

7.1 The Fishery

7.1.1 Advice and management applicable to 1997 and 1998

In 1996 an analytical assessment was undertaken and ACFM concluded that the stock was within safe biological limits although the precision of the scientific assessment was comparatively low due to the short time series of catch-independent data. ACFM suggested that continued exploitation at 7,000 t would not be detrimental to the stock. A TAC of 9,000 t was adopted for 1997 and partitioned as 2,340 t to the Republic of Ireland and 6,660 t to the UK.

In 1997 the UK fishery opened in the third week in June. Closed areas for herring fishing in the Irish Sea along the east coast of Ireland and within 12 nautical miles of the west coast of Britain were maintained throughout the year. The traditional September, gillnet fishery on the Mourne herring, which has a derogation to fish within the Irish closed box, did not take place in 1997. The area to the east of the Isle of Man (encompassing the Douglas Bank spawning ground) was closed from 21 September to 31 December.

In 1997 the Working Group did not undertake an analytical assessment of this stock due to continued uncertainty about the fishing mortality and level of SSB. ACFM undertook an analysis using RCSEP1 (Cook *et al.* 1991) and concluded that the stock seems able to sustain the current fishing mortality. Consequently ACFM forecast a status quo fishing mortality would give a catch of around 6,500 t in 1998. A TAC of 9,000 t was again adopted for 1998 and partitioned as 2,340 t to the Republic of Ireland and 6,660 t to the UK.

7.1.2 The fishery in 1997

The catches reported from each country, for the period 1984 to 1997 are given in Table 7.1.1 and from 1972 to 1997 in Figure 7.1.1. The total catch of 6,651t was again below the recommended TAC of 9,000 t. As in 1993 to 1996, this was mainly due to the Republic of Ireland not taking any herring from Division VIIa(N). In 1997, 67 % of the total catch was taken in the 3rd quarter, with only a small proportion of the catch in the 2nd quarter (6 %). There were no landings from the Mourne gillnet fishery.

7.1.3 Quality of catch and biological data

There are still no estimates of discarding or slippage of herring in the Irish Sea fisheries. Landing statistics are assumed to be accurate. Biological sampling in this fishery remains fairly high with approximately one sample per 200 t landed (Table 7.1.2). However, there were no samples taken in the 1st and 2nd quarters. Only two samples were obtained from 1,761t (approximately 27 %) landed in the 4th quarter.

7.1.4 Catch in numbers

Catches in numbers at age are given in Table 7.1.3 for the years 1972 to 1997. The predominant year class in 1997 was the 2-ringers (1994 year class). The 1992 year class, which was numerically the most abundant year class in the 1995 catches was still abundant in the 1997 catches. The 1990 year class was also still abundant. The catch in numbers at length is given in Table 7.1.4 for 1988 to 1997. Over this time period there has been a slight reduction of lengths of the predominant numbers of fish in the catches. The distribution of lengths in 1996 was similar to that in the preceding years with a low abundance of fish over 30cm compared with 1988 and 1989, during which the strong 1979 and 1980 year classes were abundant in the catches (see Table 7.1.3).

7.2 Mean length, weight, maturity and natural mortality at age

Mean lengths at age were calculated for the 3rd and 4th quarters using the Northern Ireland and Isle of Man data and are given for the years 1985 to 1997 in Table 7.2.1. In general, mean lengths at age have remained fairly stable since 1988.

Mean weights at age in the catch are given in Table 7.2.2. Mean weights at age in 1997 were, in general, comparable to the mean weights in 1996. Mean weights at age in the third-quarter catches have been used as estimates of stock weights at spawning time.

The maturity ogive used in 1994 (ICES 1994/Assess:13) was used again since there was no evidence to suggest a change: 0.08 for 1-ringers, 0.85 for 2-ringers and 1.00 for 3+-ringers.

As in previous years, natural mortality per year was assumed to be 1.0 on 1-ringers, 0.3 on 2-ringers, 0.2 on 3-ringers and 0.1 on all older age classes.

7.3 Research surveys

7.3.1 Acoustic surveys

The information on the time series of acoustic surveys in the Irish Sea is given in Table 7.3.1.

An acoustic survey was undertaken over the central northern Irish Sea (Division VIIa(N)), centred on the spawning area for Manx herring between 8th and 12th September 1997 by Northern Ireland as part of a time series that commenced in 1994. The survey is described in detail by Armstrong *et al.* (WD 1998a). The survey was carried out using a Simrad EK500 echosounder with a towed 38 kHz split-beam transducer. Targets were identified where possible by midwater trawling, and appropriate ALKs constructed. The majority of adult herring (>22cm) were found to the east of the Isle of Man close to the traditional spawning area for this stock (Figure 7.3.1). The estimated SSB of herring in VIIa(N) (11,800t) is given in Table 7.3.1. The age structure from the acoustic survey is given in Table 7.3.2.

A further acoustic survey was carried out on the east side of the Isle of Man and an aggregation of herring on Douglas Bank on 21-22nd October Armstrong *et al.* WD 1998a). The biomass of the shoal was estimated as 1,393t. This relatively low value indicate a substantial decline in spawning activity by the end of October.

7.3.2 Larvae surveys

Larvae surveys were undertaken by Northern Ireland (Douglas Bank, northern Irish Sea) and the Isle of Man (Douglas Bank, north-eastern Irish Sea). The two Douglas Bank surveys gave similar estimates of production (Dickey-Collas WD 1998, Nash and Hughes WD 1998a) (Table 7.3.3). The differences in estimates reflect the added hatching of eggs between the two surveys. Similarly both north-eastern Irish Sea surveys gave similar estimates of production (Dickey-Collas WD 1998, Nash & Hughes WD 1998b) (Table 7.3.3). The estimated larval production in all series were higher than the previous two years (Table 7.3.3). The distribution of spawning dates, back-calculated from the length at capture, suggested that the majority of the larvae were spawned at the end of September to the beginning of October.

Once again, there were very few Mourne larvae caught in the Northern Irish survey (Dickey-Collas WD 1998). The Mourne larvae constituted 1 % of the Irish Sea larvae in November 1997.

7.3.3 Groundfish surveys of Area VIIa(N).

Groundfish surveys, carried out by Northern Ireland since 1991 in the Irish Sea, were used by the 1996 and 1997 Herring Assessment Working Groups to obtain indices for 0 group and 1-ringer herring in the Irish Sea (ICES 1997/ Assess: 8). These data indicated a strong 1992 year class (1-ringer in 1994) but the large 1990 year class 1-ringer in 1992), found in the catch at age data, was not apparent (Table 7.4.1). This year the 0-ring (September), 1-ring (March, June and September) indices were averaged as a 1-ring recruitment index for the whole Irish Sea, with the values weighted by the inverse of the CVs (Figure. 7.3.2). The rationale for this was to reduce the noise generated by individual indices, reduce problems associated with juvenile Celtic Sea fish in the Irish Sea and ensure that the index was representative of the whole stock (Armstrong *et al.* WD 1998b). This index shows the relatively strong 1992 and 1995 year classes.

7.4 Data exploration and preliminary modelling

In 1997 the Working Group explored the possibility of undertaking an analytical assessment but concluded that none of the tuning indices would provide an objective way of estimating SSB in 1997 (ICES 1997/Assess: 8). Therefore, no analytical assessment was presented. ACFM undertook an assessment of this stock using the method of Cook *et al.* (1991). This analysis gave an SSB_{1997} of 16,650t.

The last analytical assessment of this stock was in 1996. There was a large amount of uncertainty in this assessment. In 1996 the tuning indices used were the Douglas Bank larvae series, acoustic surveys and the June and September Ground

Fish Survey 1-ringer indices. The shrinkage option was used giving a range of $F_{(2-6)}$ of 0.107 to 0.152 for 1995. A value of 0.13 (CV=0.5) was chosen for predictions.

Explorations in 1997 indicated that the Douglas Bank larvae surveys gave questionably low levels of fishing mortality. All other indices showed variation in fishing mortality after 1985 with a general slow decrease over the years. This would be consistent with reported landings remaining stable at relatively low levels from 1991 to the present. With the exception of the Douglas Bank larvae index the tuning indices suggested an SSB in 1996 of between 11,000 and 44,000t (ICES 1997/Assess: 8). This was not inconsistent with the estimate of 38,000t for 1995 (ICES 1996/Assess:10).

This year new data were added to the Douglas Bank larvae series (DBL), Northern Irish larvae series (NINEL) and the Northern Irish acoustic survey (AC-VIIa(N), and ACAGE) for SSB tuning files. All the groundfish indices (GFSOS, GFSIM, GFSIJ and GFS1S) were reworked to provide a single 1-ringer recruitment index (GFS-mean) for the whole Irish Sea (see section 7.3.3) rather than a series of noisy individual estimates. This year, the survey indices were used to initiate an analytical assessment using an integrated catch-at-age analysis (ICA) including a separable constraint (Deriso *et al.* 1985). The Integrated Catch Analysis (ICA) was used. The following short survey series were available for inclusion in an assessment using the ICA package:

1. Larval production estimates from Douglas Bank surveys to provide an SSB index: 1989 - 1997 (**DBL**)
2. Larval production estimates from the Northern Ireland surveys in the north-east Irish Sea: 1993 - 1997 (**NINEL**)
3. Age-aggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 1997 (**AC_VIIa(N)**)
4. Age-aggregated acoustic estimates of Manx herring spawning aggregations in 1989, 1990 and 1994 (**AC_DB**)
5. Age-disaggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 1997 (**ACAGE**)
6. Mean catch of juvenile herring (inverse weighted mean of indices 7–10) as a 1-ringer index (1992 - 1998) (**GFS-mean**)
7. Larval production estimates from Douglas Bank surveys to provide a recruitment index: 1989 - 1995 (**LPER1**)
8. Irish Sea groundfish survey indices of 0-ring herring in September 1991 - 1996 (**GFS0S**)
9. Irish Sea groundfish survey indices of 1-ring herring in March 1992 - 1996 (**GFS1M**)
10. Irish Sea groundfish survey indices of 1-ring herring in June 1991 - 1994 (**GFS1J**)
11. Irish Sea groundfish survey indices of 1-ring herring in September 1991 - 1996 (**GFS1S**)

(NB: Indices 7 to 10 were not considered in 1998 see ICES 1997/ Assess: 8)

The different indices are given in Tables 7.4.1 and 7.4.2. The variability in signals coming from the various SSB tuning indices is highlighted in Figure 7.4.1. For the purposes of data exploration the two larvae indices (DBL and NINEL) were considered as recruitment indices and compared with the Ground Fish Survey 1-ringer index (Figure 7.4.1). There are some similarities but again there is a mismatch with the suggested trends in recruitment.

The ICA model was fitted using each series (1-6). However, the acoustic survey data were analysed together (SSBA) because of the shortness of the AC_DB and AC_VIIa(N) series. The following input values were used:

- Separable constraint over last 6 years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of reference age = 2
- Last age for calculation of reference age = 6
- Weighting on 1-ringers = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.05 and 2.0
- All survey weights fitted by hand i.e., 1.0
- Correlated errors assumed i.e., = 1.0
- No shrinkage applied

The Division VIIa(N) acoustic survey estimates were not considered as absolute because of discrepancies between acoustic estimates and tuned SSB estimates seen in other stocks. Solutions were found with all indices with DBL giving a very low mean F(2-6) = <<0.01 and ACAGE, NINEL and AC_VIIa(N) giving mean Fs of >1.0 (Figure 7.4.2). There was some doubt about the 1996 data for the NINEL series (the value was very low due to the spawning period being 3 weeks later than expected) so the analysis was rerun without this index value. This made very little change to the

perceived mean F in 1997 although the spread was greatly reduced. Precision was generally poor. In an attempt to explore the performance of these tuning indices the NINEL index was combined with GFS-mean. The analysis with this combination of indices gave similar results in perceived F(97) to the NINEL index on its own.

Due to concern about the wide range of F(97) from the different tuning indices a series of Separable VPAs were run using an input F of 0.05 to 0.8. The differences in perception of development of the stock are shown in Figure 7.4.3. The separable populations were then compared with the survey indices for minimisation of sums of squares. In general, as with the ICA output, the different tuning indices gave a range of F(1997) with none showing a clear minimum in SSQ surface. The SSB tuning indices suggested input Fs of; AC_VIIa(N) = 0.20 and NINEL (minus 1996) = 0.15 (Figure 7.4.4). These results are in contrast to the higher Fs suggested by ICA. The 1-ringer index (GFS-mean) did not have a minimum <1.0.

In view of the conflicting signals from the available tuning data and the variability in perceptions of mean $F_{(2-6)}$ it was decided to continue with an ICA run using the NINEL (minus 1996) biomass and the GFS-mean 1-ringer indices and to use the shrinkage option. The removal of the 1996 data from the NINEL series was due to spawning being late in that year and the range in larvae length being less than in all previous years. This could bias the production estimates for 1996. The removal of the 1996 data also reduced the 95 % confidence limits on the F(1997) (Figure 7.4.2). The choice of using the shrinkage option was used in the 1996 assessment when faced with a similar degree of uncertainty in the perception of the SSB in Division VIIa(N). This option is consistent with the underlying principals used by ACFM in the assessment in 1997 and the method used here is consistent with the principles applied to all other herring stocks assessed by this Working Group.

7.5 Stock assessment

The structural model used for the baseline assessment, based on the results given in Section 7.4, is given as:

$$\Sigma_{a,y}(\ln(C_{a,y}) - \ln(C'_{a,y}))^2 +$$
$$\Sigma_{y}(\ln(Q_{NINEL} SSB_{y}) - \ln(NINEL_{y}))^2 +$$
$$\Sigma_{1,y}(\ln(Q_{GFS-mean} N_{1,y}) - \ln(GFS-mean_{1,y}))^2$$

where:

a,y	age and year subscripts
C	Catch in number at age and year
C'	Catch in number at age and year predicted by a separable fishing model
SSB	Spawning stock size in the structural model
NINEL	Larval production index
GFS-mean	Ground Fish Survey estimates of 1-ringers
N	Population abundance in the structural model
Q	Coefficients of proportionality for survey indices

The results of the baseline model fit are shown in Figures 7.5.1 -7.5.5. The SSQ surfaces for each index show shallow minima at intermediary levels of fishing mortality. The estimate for $F_{(2-6)}$ for 1997 was 0.70 (Table 7.5.1) with a corresponding SSB estimate of approximately 6,000 t. This assessment shows a substantial increase in estimated fishing mortality from what was perceived in 1996 and a substantial decrease in estimated SSB from both 1996 and 1997.

Due to the uncertainty of the assessment the shrinkage option in ICA was applied. It was decided to shrink the model estimate of the 1997 F to the mean of 1987 to 1997. A number of runs were carried out following the initial fit of the ICA model. CVs of 0.0 to 1 were explored. The effect on estimates of $F_{(2-6)}$ was as follows:

Minimum shrinkage CV	Mean $F_{(2-6)}$
0.0	0.40
0.1	0.40
0.2	0.42
0.5	0.51
0.7	0.56
0.9	0.59
no shrinkage	0.70

An examination of the variance of the historic mean F showed that it was not until minimum CVs of 0.2 or less were considered that the true variance of the mean F was visible (see Table 7.5.2). Since there was no objective way of choosing between CVs at 0.0 and 0.1, the run with a minimum CV of 0.0 was chosen for making short-term predictions. This assessment gave a mean $F_{(2-6)}$ for 1997 as 0.403 and an SSB of 8,200t. The population estimates, fishing mortalities and stock summary table for the shrunk assessment are given in Table 7.5.3.

7.6 Stock and Catch Projection

Short-term predictions were carried out using the shrunk ICA estimates of population numbers and fishing mortalities (Section 7.5). The numbers of 1-ringers in 1998 was taken from the ICA output as this reflected the perception of recruitment for this year from the 1-ringer tuning index (GFS-mean) and the ages in the acoustic surveys (Table 7.3.2). The numbers of 1-ringers in 1999 and 2000 were assumed to be a geometric mean of the recruitment over the period 1982–1997 (Table 7.6.1). Mean weights in the catch and in the stock were taken as a mean for the years 1995–1997. The shrunk ICA estimates of F at age in 1997 were used for the exploitation pattern. Predictions of stock and yield were made assuming $F_{status\ quo}$ in 1998, and TAC constraint of either UK landings reaching quota (6,660t) or the complete TAC (9,000t) being taken up in 1998. The full TAC option is necessary as there is a possibility that the Irish fleet could rejoin the fishery. Predictions for 1999 and 2000 were made for a range of F-multipliers.

An $F_{status\ quo}$ in 1998 would result in a catch of 5,760t (Table 7.6.2). The UK catch of 6,600t in 1998 suggests an F of 0.45 which is an increase from F(1997). There would be a small increase in SSB. The full TAC constraint (9,000t) would result in an F(1998) = 0.68 with a concomitant increase in F and decline in SSB. An $F_{status\ quo}$ for the years 1999 to 2000 gives a relatively stable SSB for $F_{status\ quo}$ and F=0.45 in 1998 but a decline in SSB with F=0.68 in 1998 (Table 7.6.3). Details of stock structure in 1998-2000, assuming a catch of 6,600t in 1998, are given in Table 7.6.4. Status quo catch in 1999 is between 4,400 and 5,400t depending on the catch in 1998.

7.7 Medium-term predictions of stock size

The present assessment is based on the assumption of stability in the stock. Therefore, the Working Group decided that there was no real basis for undertaking a meaningful medium term projection of stock size.

7.8 Management considerations

7.8.1 Precision of the assessment

The current time-series of survey data are very short and, as seen here, prone to providing variable perceptions of stock development. In an effort to provide a basis for advice, the Working Group resorted to providing a view of stability in the stock over the last few years. The SSB presented here is lower than perceived by ACFM in 1997 due to the differences in analyses. The analysis presented here is consistent with the ICA method used by this Working Group. There have probably been changes in this stock since the early 1990s with the possible severe reduction in the Mourne component of VIIa(N). The consequence of this is that the SSB in VIIa(N) may be lower than when both components are present. This change in stock dynamics and the variability in the tuning data mean that this assessment should be treated with caution. It is likely that an analytical assessment will be possible in the future with longer time-series from this area.

All indices suggest a relatively stable SSB from 1994 to the present. Therefore, maintaining catch levels, in the short-term, of approximately 5,000 t should not be detrimental to the stock. The consequences of catches above 5,000 t on SSB are at present unknown.

7.8.2 Spawning and Juvenile Fishing Area Closures

The present arrangement of closed boxes in Division VIIa(N) are discussed in detail in ICES (1996/Assess:10). The closed areas consist of: all year juvenile closures along the east coast of Ireland, and the west coast of Scotland, England and Wales; spawning closures along the east coast of the Isle of Man, and along the east coast of Ireland.

In view of the uncertainties in the size of the stock in Division VIIa(N) the Working Group recommends that any alterations to the present closures are considered carefully, in the context of this report, to ensure protection for all components of this stock.

Table 7.1.1. Irish Sea HERRING (Division VIIa(N)). Catch in tonnes by country, 1984-1997. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1984	1985	1986	1987	1988	1989	1990
Ireland	1,084	1,000	1,640	1,200	2,579	1,430	1,699
UK	2,982	4,077	4,376	3,290	7,593	3,532	4,613
Unallocated	-	4,110	1,424	1,333	-	-	-
Total	4,066	9,187	7,440	5,823	10,172	4,962	6,312

Country	1991	1992	1993	1994	1995	1996	1997
Ireland	80	406	0	0	0	100	0
UK	4,318	4,864	4,408	4,828	5,076	5,180	6,651
Unallocated	-	-	-	-	-	22	-
Total	4,398	5,270	4,408	4,828	5,076	5,302	6,651

Table 7.1.2 Irish Sea HERRING. Sampling intensity of commercial landings for Division VIIa (N) in 1997.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
	Ireland	0	-	-	-	-
	UK (N. Ireland)	1	0	0	0	No
1	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	0	-	-	-	-
	UK (N. Ireland)	246	0	0	0	No
2	UK (Isle of Man)	157	0	0	0	No
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	0	2	473	50	No
	UK (N. Ireland)	3877	23	2603	1049	No
3	UK (Isle of Man)	608	7	2246	340	No
	UK (Scotland)	0	-	-	-	No
	UK (England & Wales)	+	0	0	0	No
	Ireland	0	-	-	-	-
	UK (N. Ireland)	1556	2	297	150	No
4	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	205	-	234	76	No
	UK (England & Wales)	0	-	-	-	-

+ < 1t

Table 7.1.3 Herring in the North Irish Sea (Manx plus Mourne VIIa(N)). Catch in numbers (thousands) by year.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1972	40640	46660	26950	13180	13750	6760	2660	1670
1973	42150	32740	38240	11490	6920	5070	2590	2600
1974	43250	109550	39750	24510	10650	4990	5150	1630
1975	33330	48240	39410	10840	7870	4210	2090	1640
1976	34740	56160	20780	15220	4580	2810	2420	1270
1977	30280	39040	22690	6750	4520	1460	910	1120
1978	15540	36950	13410	6780	1740	1340	670	350
1979	11770	38270	23490	4250	2200	1050	400	290
1980	5840	25760	19510	8520	1980	910	360	230
1981	5050	15790	3200	2790	2300	330	290	240
1982	5100	16030	5670	2150	330	1110	140	380
1983	1305	12162	5598	2820	445	484	255	59
1984	1168	8424	7237	3841	2221	380	229	479
1985	2429	10050	17336	13287	7206	2651	667	724
1986	4491	15266	7462	8550	4528	3198	1464	877
1987	2225	12981	6146	2998	4180	2777	2328	1671
1988	2607	21250	13343	7159	4610	5084	3232	4213
1989	1156	6385	12039	4708	1876	1255	1559	1956
1990	2313	12835	5726	9697	3598	1661	1042	1615
1991	1999	9754	6743	2833	5068	1493	719	815
1992	12145	6885	6744	6690	3256	5122	1036	392
1993	646	14636	3008	3017	2903	1606	2181	848
1994	1970	7002	12165	1826	2566	2104	1278	1991
1995	3204	21330	3391	5269	1199	1154	926	1452
1996	5335	17529	9761	1160	3603	780	961	1364
1997	9551	21387	7562	7341	1641	2281	840	1432

Table 7.1.4 HERRING in Division VIIa (North). Catch at length for 1988-1997. Numbers of fish in thousands

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
14	1									
	1									
15	1				95					
	10				169					
16	13		6		343			21	21	17
	16		6	2	275			55	51	94
17	29		50	1	779		84	139	127	281
	44	24	7	4	1,106		59	148	200	525
18	46	44	224	31	1,263		69	300	173	1,022
	85	43	165	56	1,662		89	280	415	1,066
19	247	116	656	168	1,767	39	226	310	554	1,720
	306	214	318	174	1,189	75	241	305	652	1,263
20	385	226	791	454	1,268	75	253	326	749	1,366
	265	244	472	341	705	57	270	404	867	1,029
21	482	320	735	469	705	130	400	468	886	1,510
	530	401	447	296	597	263	308	782	1,258	1,192
22	763	453	935	438	664	610	700	1,509	1,530	2,607
	1,205	497	581	782	927	1,224	785	2,541	2,190	2,482
23	2,101	612	2,400	1,790	1,653	2,016	1,035	4,198	2,362	3,508
	3,573	814	1,908	1,974	1,156	2,368	1,473	4,547	2,917	3,902
24	5,046	1,183	3,474	2,842	1,575	2,895	2,126	4,416	3,649	4,714
	5,447	1,656	2,818	2,311	2,412	2,616	2,564	3,391	4,077	4,138
25	5,276	2,206	4,803	2,734	2,792	2,207	3,315	3,100	4,015	5,031
	4,634	2,720	3,688	2,596	3,268	2,198	3,382	2,358	3,668	3,971
26	4,082	3,555	4,845	3,278	3,865	2,216	3,480	2,334	2,480	3,871
	4,570	3,293	3,015	2,862	3,908	2,176	2,617	1,807	2,177	2,455
27	4,689	2,847	3,014	2,412	3,389	2,299	2,391	1,622	1,949	1,711
	4,124	2,018	1,134	1,449	2,203	2,047	1,777	990	1,267	1,131
28	3,406	1,947	993	922	1,440	1,538	1,294	834	906	638
	2,916	1,586	582	423	569	944	900	123	564	440
29	2,659	1,268	302	293	278	473	417	248	210	280
	1,740	997	144	129	96	160	165	56	79	59
30	1,335	801	146	82	70	83	9	40	32	8
	685	557	57	36	36	15	27	5	0	5
31	563	238	54	12	2	4		1	2	
	144	128	31	3						
32	80	57	29							
	7	7								
33	2	5								
	1	6								
34		0								
		5								

Table 7.2.1 HERRING in Division VIIa (North). Mean length at age.

Year	Lengths at age (cm)							
	Age (rings)							
	1	2	3	4	5	6	7	8
1985	22.1	24.3	26.1	27.6	28.3	28.6	29.5	30.1
1986	19.7	24.3	25.8	26.9	28.0	28.8	28.8	29.8
1987	20.0	24.1	26.3	27.3	28.0	29.2	29.4	30.1
1988	20.2	23.5	25.7	26.3	27.2	27.7	28.7	29.6
1989	20.9	23.8	25.8	26.8	27.8	28.2	28.0	29.5
1990	20.1	24.2	25.6	26.2	27.7	28.3	28.3	29.0
1991	20.5	23.8	25.4	26.1	26.8	27.3	27.7	28.7
1992	19.0	23.7	25.3	26.2	26.7	27.2	27.9	29.4
1993	21.6	24.1	25.9	26.7	27.2	27.6	28.0	28.7
1994	20.1	23.9	25.5	26.5	27.0	27.4	27.9	28.4
1995	20.4	23.6	25.2	26.3	26.8	27.0	27.6	28.3
1996	19.8	23.5	25.3	26.0	26.6	27.6	27.6	28.2
1997	19.6	23.6	25.1	26.0	26.5	27.1	27.7	28.2

Table 7.2.2 HERRING in Division VIIa (North). Mean weights at age.

Year	Weights at age (g)							
	Age (rings)							
	1	2	3	4	5	6	7	8
1985	87	125	157	186	202	209	222	258
1986	68	143	167	188	215	229	239	254
1987	58	130	160	175	194	210	218	229
1988	70	124	160	170	180	198	212	232
1989	81	128	155	174	184	195	205	218
1990	77	135	163	175	188	196	207	217
1991	70	121	153	167	180	189	195	214
1992	61	111	136	151	159	171	179	191
1993	88	126	157	171	183	191	198	214
1994	73	126	154	174	181	190	203	214
1995	72	120	147	168	180	185	197	212
1996	67	116	148	162	177	199	200	214
1997	64	118	146	165	176	188	204	216

Table 7.3.1 Herring: Summary of acoustic survey information for Division VIIa(N) for the period 1989-1996. Small clupeoids include sprat and 0-ring herring unless otherwise stated. CVs are approximate. Biomass in t. All surveys carried out at 38kHz except December 1996, which was at 120kHz.

Year	Area	Dates	herring biomass (1+ years)	CV	herring biomass (SSB)	CV	small clupeoids biomass	CV
1989	Douglas Bank	25-26 Sept			18000	-	-	-
1990	Douglas Bank	26-27 Sept			26600	-	-	-
1991	Western Irish Sea	26 July - 8 Aug	12760	0.23			66000[1]	0.20
1992	Western Irish Sea + IOM east coast	20 - 31 July	17490	0.19			43200	0.25
1994	Area VIIa(N)	28 Aug - 8 Sep	31400	0.36	26190	-	68600	0.10
	Douglas Bank	22-26 Sept			28200	-	-	-
1995	Area VIIa(N)	11-22 Sept	53200	0.32	34040	-	344700	0.13
	Douglas Bank	10-11 Oct		-	9840	-	-	-
	Douglas Bank	23-24 Oct			1750	0.51	-	-
1996	Area VIIa(N)	2-12 Sept	24500	0.24	23390	0.25	49120	0.13
	Eastern Irish Sea (closed box)	9-12 Dec	12800	0.49	11880	0.49	6810	0.13
1997	Area VIIa(N)-reduced	8-12 Sept	20100	0.28	11300	0.28	-	-

[1] sprat only

Table 7.3.2 Age structure of herring in Division VIIa(N) from the Northern Ireland Acoustic surveys in September.

Age (rings)	1994	1995	1996	1997
1	66830	313869	11340	134146
2	68290	133802	42372	49977
3	73529	21637	67473	14812
4	11860	54804	8954	10985
5	9299	8551	26469	1751
6	7550	6588	4171	4553
7	3867	9174	5911	571
8+	10118	12716	5815	1910

Table 7.3.3 Irish Sea HERRING larval production (10^{11}) indices for the Manx component of Division VIIa(N). Brackets denote one standard error.

Year	Douglas Bank		North East Irish Sea	
	Isle of Man	Northern Ireland	Isle of Man	Northern Ireland
1989	3.39			
1990	1.92			
1991	1.56			
1992	15.64		128.86	
1993	4.81		1.10	38.3 (18.4)
1994	7.30		12.50	71.2 (8.4)
1995	1.58		-[1]	15.1 (9.3)
1996	-[1]		0.30	4.7 (1.4)
1997	5.59	8.46 (1.6)	35.90	29.1 (3.2)

[1]No assessment

Table 7.4.1 Tuning indices used for the Irish Sea (VIIa(N)) herring assessment. Values and approximate CVs are given. na = not available. GFS-mean = Weighted mean of groundfish survey, 0 and 1 group abundance for the whole Irish Sea; GFS-mean E = Weighted mean of groundfish survey, 0 and 1 group abundance for the eastern Irish Sea; SSBA = Spawning stock biomass by acoustic techniques (AC_DB = Douglas Bank acoustic surveys covering only the spawning stock, AC_VIIa(N) = Irish Sea acoustic surveys covering 2+ ringers); DBL = larvae production on Douglas Bank. (October); NINEL=larvae production in the north-eastern Irish Sea (November).

Year	GFS-mean[1]	GFS-mean E[1]	DBL[2]	NINEL[2]	AC_DB[3]	AC_VIIa(N)[4]
1989			3.39 (0.49)		18000 (na)	-
1990			1.92 (0.24)		26000 (na)	-
1991			1.56 (0.22)		-	-
1992	27	171	15.64 (0.55)		-	-
1993	94	98	4.81 (0.18)	38.3 (0.48)	-	-
1994	191	190	7.30 (0.58)	71.2 (0.12)	28200 (na)	26190 (na)
1995	85	32	1.58 (0.42)	15.1 (0.62)	-	34040 (na)
1996	36	68	-	4.7* (0.30)	-	23390 (0.25)
1997	139	103	5.59 (-)	29.1 (0.11)		11300 (0.28)
1998	77	42				

1. Mean of numbers per 3nm trawl from juveniles aged 0 in September and aged 1 in March and the following September. Weighted by the inverse of the CV.
2. Numbers of larvae at 6mm x 10^{-11}
3. Biomass of spawning aggregation, tonnes.
4. Biomass of SSB, tonnes.

Table 7.4.2 Age structure of herring in Division VIIa(N) from the Northern Ireland Acoustic surveys in September.

Age (rings)	1994	1995	1996	1997
1	66830	313869	11340	134146
2	68290	133802	42372	49977
3	73529	21637	67473	14812
4	11860	54804	8954	10985
5	9299	8551	26469	1751
6	7550	6588	4171	4553
7	3867	9174	5911	571
8+	10118	12716	5815	1910

Table 7.5.1. Herring in VIIa(N): Results of baseline assessment.

Output Generated by ICA Version 1.4

Herring N.Irish Sea (run: ICAMDC36/I36)

Catch in Number x 10 ^ 6

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	40.64	42.15	43.25	33.33	34.74	30.28	15.54	11.77
2	46.66	32.74	109.55	48.24	56.16	39.04	36.95	38.27
3	26.95	38.24	39.75	39.41	20.78	22.69	13.41	23.49
4	13.18	11.49	24.51	10.84	15.22	6.75	6.78	4.25
5	13.75	6.92	10.65	7.87	4.58	4.52	1.74	2.20
6	6.76	5.07	4.99	4.21	2.81	1.46	1.34	1.05
7	2.66	2.59	5.15	2.09	2.42	.91	.67	.40
8	1.67	2.60	1.63	1.64	1.27	1.12	.35	.29

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	5.84	5.05	5.10	1.31	1.17	2.43	4.49	2.23
2	25.76	15.79	16.03	12.16	8.42	10.05	15.27	12.98
3	19.51	3.20	5.67	5.60	7.24	17.34	7.46	6.15
4	8.52	2.79	2.15	2.82	3.84	13.29	8.55	3.00
5	1.98	2.30	.33	.45	2.22	7.21	4.53	4.18
6	.91	.33	1.11	.48	.38	2.65	3.20	2.78
7	.36	.29	.14	.26	.23	.67	1.46	2.33
8	.23	.24	.38	.06	.48	.72	.88	1.67

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	2.61	1.16	2.31	2.00	12.15	.65	1.97	3.20
2	21.25	6.39	12.84	9.75	6.89	14.64	7.00	21.33
3	13.34	12.04	5.73	6.74	6.74	3.01	12.16	3.39
4	7.16	4.71	9.70	2.83	6.69	3.02	1.83	5.27
5	4.61	1.88	3.60	5.07	3.26	2.90	2.57	1.20
6	5.08	1.25	1.66	1.49	5.12	1.61	2.10	1.15
7	3.23	1.56	1.04	.72	1.04	2.18	1.28	.93
8	4.21	1.96	1.62	.81	.39	.85	1.99	1.45

AGE	1996	1997
1	5.34	9.55
2	17.53	21.39
3	9.76	7.56
4	1.16	7.34
5	3.60	1.64
6	.78	2.28
7	.96	.84
8	1.36	1.43

x 10 ^ 6

Predicted Catch in Number (x 10 ^ 3)

AGE	1992	1993	1994	1995	1996	1997
1	3797.	1370.	5146.	3307.	2482.	10505.
2	8518.	13619.	8572.	23436.	15912.	16221.
3	7057.	2776.	8339.	3579.	10399.	9603.
4	5179.	2651.	1950.	4033.	1840.	7381.
5	3585.	2725.	2568.	1314.	2883.	1798.
6	4855.	1499.	2122.	1381.	751.	2274.
7	1036.	2280.	1304.	1282.	887.	666.

Table 7.5.1. (cont.)

Weights at age in the catches (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400
2	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500
3	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500
4	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900
5	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200
6	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100
7	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800
8	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	.07400	.07400	.07400	.07400	.07600	.08700	.06800	.05800
2	.15500	.15500	.15500	.15500	.14200	.12500	.14300	.13000
3	.19500	.19500	.19500	.19500	.18700	.15700	.16700	.16000
4	.21900	.21900	.21900	.21900	.21300	.18600	.18800	.17500
5	.23200	.23200	.23200	.23200	.22100	.20200	.21500	.19400
6	.25100	.25100	.25100	.25100	.24300	.20900	.22800	.21000
7	.25800	.25800	.25800	.25800	.24000	.22200	.23900	.21800
8	.27800	.27800	.27800	.27800	.27300	.25800	.25400	.22900

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	.07000	.08100	.09600	.07300	.06200	.08900	.07000	.07500
2	.12400	.12800	.14000	.12300	.11400	.12700	.12300	.12100
3	.16000	.15500	.16600	.15500	.14000	.15700	.15300	.14600
4	.17000	.17400	.17500	.17100	.15500	.17100	.17000	.16400
5	.18000	.18400	.18700	.18100	.16500	.18200	.18000	.17600
6	.19800	.19500	.19500	.19000	.17400	.19100	.18900	.18100
7	.21200	.20500	.20700	.19800	.18100	.19800	.20200	.19300
8	.23200	.21800	.21800	.21700	.19700	.21200	.21200	.20700

AGE	1996	1997
1	.06700	.06400
2	.11600	.11800
3	.14800	.14600
4	.16200	.16500
5	.17700	.17600
6	.19900	.18800
7	.20000	.20400
8	.21400	.21600

Weights at age in the stock (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	.07400	.07400	.07400	.07400	.07400	.07400	.07400	.07400
2	.15500	.15500	.15500	.15500	.15500	.15500	.15500	.15500
3	.19500	.19500	.19500	.19500	.19500	.19500	.19500	.19500
4	.21900	.21900	.21900	.21900	.21900	.21900	.21900	.21900
5	.23200	.23200	.23200	.23200	.23200	.23200	.23200	.23200
6	.25100	.25100	.25100	.25100	.25100	.25100	.25100	.25100
7	.25800	.25800	.25800	.25800	.25800	.25800	.25800	.25800
8	.27800	.27800	.27800	.27800	.27800	.27800	.27800	.27800

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	.07400	.07400	.07400	.07400	.07600	.08700	.06800	.05800
2	.15500	.15500	.15500	.15500	.14200	.12500	.14300	.13000
3	.19500	.19500	.19500	.19500	.18700	.15700	.16700	.16000
4	.21900	.21900	.21900	.21900	.21300	.18600	.18800	.17500
5	.23200	.23200	.23200	.23200	.22100	.20200	.21500	.19400
6	.25100	.25100	.25100	.25100	.24300	.20900	.22900	.21000
7	.25800	.25800	.25800	.25800	.24000	.22200	.23900	.21800
8	.27800	.27800	.27800	.27800	.27300	.25800	.25400	.22900

Table 7.5.1. (cont.)

Weights at age in the stock (Kg)

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	.07000	.08100	.07700	.07000	.06100	.08800	.07300	.07200
2	.12400	.12800	.13500	.12100	.11100	.12600	.12600	.12000
3	.16000	.15500	.16300	.15300	.13600	.15700	.15400	.14700
4	.17000	.17400	.17500	.16700	.15100	.17100	.17400	.16800
5	.18000	.18400	.18800	.18000	.15900	.18300	.18100	.18000
6	.19800	.19500	.19600	.18900	.17100	.19100	.19000	.18500
7	.21200	.20500	.20700	.19500	.17900	.19800	.20300	.19700
8	.23200	.21800	.21700	.21400	.19100	.21400	.21400	.21200

AGE	1996	1997
1	.06700	.06300
2	.11500	.11900
3	.14800	.14800
4	.16200	.16700
5	.17700	.17800
6	.19500	.18900
7	.19900	.20600
8	.21200	.21400

Natural Mortality (per year)

AGE	1972-1997
1	1.0000
2	.3000
3	.2000
4	.1000
5	.1000
6	.1000
7	.1000
8	.1000

Proportion of fish spawning

AGE	1972-1997
1	.0800
2	.8500
3	1.0000
4	1.0000
5	1.0000
6	1.0000
7	1.0000
8	1.0000

INDICES OF SPAWNING BIOMASS

INDEX1

	1993	1994	1995	1996	1997
1	38300.	71200.	15100.	999990.	29100.

AGE-STRUCTURED INDICES

FLT01: GFS mean Irish Sea (Catch: Thousa

AGE	1992	1993	1994	1995	1996	1997	1998
1	27.00	94.00	191.00	85.00	36.00	139.00	77.00

Table 7.5.1. (cont.)

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	.1659	.1042	.2137	.1520	.2292	.1572	.1031	.1417
2	.3610	.3434	.8238	.7507	.7899	.8544	.5330	.7482
3	.5169	.6123	1.0080	.9047	.9715	.9877	.9168	.8565
4	.5228	.4116	.9970	.8151	1.0931	.9817	.8938	.8165
5	.5863	.5084	.7347	.9344	.8860	1.0534	.6477	.7312
6	.5823	.3937	.7488	.6430	.9414	.6991	.9477	.9321
7	.4676	.4080	.7762	.7256	.8491	.8212	.7198	.7382
8	.4676	.4080	.7762	.7256	.8491	.8212	.7198	.7382

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	.0599	.0361	.0353	.0089	.0141	.0261	.0422	.0127
2	1.0593	.4010	.2628	.1864	.1215	.2765	.3973	.2836
3	1.3033	.3670	.2603	.1458	.1710	.4168	.3633	.2930
4	.8572	.6038	.4268	.1893	.1340	.5071	.3536	.2301
5	1.0468	.5206	.1152	.1302	.2002	.3521	.2867	.2605
6	.6789	.4189	.4534	.2203	.1406	.3453	.2322	.2550
7	.8764	.4200	.2800	.1578	.1381	.3459	.2902	.2361
8	.8764	.4200	.2800	.1578	.1381	.3459	.2902	.2361

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	.0367	.0126	.0326	.0459	.0425	.0312	.0419	.0411
2	.2772	.2004	.3250	.3234	.5023	.3685	.4953	.4856
3	.5669	.2658	.2957	.3016	.4395	.3224	.4334	.4249
4	.6184	.3785	.3366	.2215	.3786	.2777	.3733	.3660
5	.5771	.2858	.4913	.2630	.4248	.3116	.4189	.4107
6	.5095	.2686	.3907	.3444	.3830	.2809	.3776	.3702
7	.4667	.2557	.3320	.2599	.3786	.2777	.3733	.3660
8	.4667	.2557	.3320	.2599	.3786	.2777	.3733	.3660

AGE	1996	1997
1	.0430	.0698
2	.5074	.8239
3	.4440	.7209
4	.3824	.6209
5	.4292	.6968
6	.3869	.6281
7	.3824	.6209
8	.3824	.6209

Population Abundance (1 January) x 10 ^ 6

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	414.84	667.97	349.48	369.41	263.34	325.01	248.78	139.32
2	176.65	129.28	221.41	103.83	116.74	77.03	102.17	82.55
3	73.04	91.22	67.94	71.97	36.31	39.25	24.29	44.42
4	33.87	35.66	40.48	20.30	23.84	11.25	11.97	7.95
5	32.41	18.17	21.38	13.52	8.13	7.23	3.81	4.43
6	16.02	16.32	9.89	9.28	4.80	3.03	2.28	1.81
7	7.45	8.10	9.96	4.23	4.41	1.70	1.36	.80
8	4.68	8.13	3.15	3.32	2.32	2.09	.71	.58

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	158.11	224.75	232.00	233.00	131.83	148.89	171.30	277.79
2	44.48	54.78	79.75	82.39	84.96	47.82	53.36	60.41
3	28.94	11.42	27.18	45.42	50.65	55.74	26.87	26.57
4	15.44	6.44	6.48	17.15	32.15	34.95	30.08	15.30
5	3.18	5.93	3.18	3.83	12.84	25.44	19.05	19.11
6	1.93	1.01	3.19	2.57	3.04	9.51	16.19	12.94
7	.64	.89	.60	1.83	1.86	2.39	6.09	11.61
8	.41	.73	1.63	.42	3.90	2.59	3.65	8.33

Table 7.5.1. (cont.)

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	114.21	146.20	113.84	70.19	143.76	70.37	197.52	129.45
2	100.90	40.50	53.11	40.54	24.66	50.68	25.09	69.68
3	33.70	56.65	24.56	28.43	21.73	11.06	25.97	11.33
4	16.23	15.65	35.56	14.96	17.21	11.46	6.56	13.79
5	11.00	7.91	9.70	22.98	10.85	10.67	7.86	4.08
6	13.33	5.59	5.38	5.37	15.98	6.42	7.07	4.68
7	9.07	7.25	3.86	3.29	3.44	9.86	4.38	4.38
8	11.83	9.09	5.99	3.73	1.30	3.67	6.70	4.96

AGE	1996	1997	1998
1	93.03	245.22	134.92
2	45.70	32.78	84.13
3	31.76	20.38	10.66
4	6.06	16.68	8.12
5	8.65	3.74	8.11
6	2.45	5.10	1.69
7	2.92	1.51	2.46
8	4.50	3.24	2.31

Weighting factors for the catches in number

AGE	1992	1993	1994	1995	1996	1997
1	.1000	.1000	.1000	.1000	.1000	.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted SSB Index Values

INDEX1

	1993	1994	1995	1996	1997
1	40863.	33649.	35817.	999990.	24331.

x 10 ^ -3

Predicted Age-Structured Index Values

FLT01: GFS mean Irish Sea (Catch: Thous Predicted

AGE	1992	1993	1994	1995	1996	1997	1998
1	82.21	40.28	112.96	74.04	53.20	139.95	77.00

Fitted Selection Pattern

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	.3174	.2532	.2143	.1864	.2097	.1602	.1154	.1735
2	.6904	.8342	.8263	.9210	.7226	.8703	.5963	.9163
3	.9888	1.4874	1.0110	1.1099	.8887	1.0061	1.0257	1.0489
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1214	1.2351	.7369	1.1464	.8105	1.0731	.7246	.8955
6	1.1137	.9563	.7511	.7889	.8611	.7121	1.0603	1.1415
7	.8944	.9911	.7785	.8903	.7767	.8365	.8053	.9041
8	.8944	.9911	.7785	.8903	.7767	.8365	.8053	.9041

Table 7.5.1. (cont.)

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	.0699	.0598	.0827	.0470	.1052	.0514	.1194	.0554
2	1.2357	.6641	.6159	.9846	.9068	.5453	1.1238	1.2326
3	1.5203	.6078	.6100	.7699	1.2761	.8218	1.0275	1.2733
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.2211	.8623	.2699	.6875	1.4939	.6943	.8108	1.1320
6	.7919	.6938	1.0624	1.1634	1.0494	.6810	.6568	1.1081
7	1.0223	.6956	.6560	.8336	1.0302	.6821	.8207	1.0259
8	1.0223	.6956	.6560	.8336	1.0302	.6821	.8207	1.0259

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	.0593	.0332	.0968	.2074	.1124	.1124	.1124	.1124
2	.4483	.5294	.9656	1.4603	1.3269	1.3269	1.3269	1.3269
3	.9168	.7024	.8786	1.3621	1.1611	1.1611	1.1611	1.1611
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	.9332	.7551	1.4598	1.1877	1.1222	1.1222	1.1222	1.1222
6	.8238	.7096	1.1607	1.5550	1.0116	1.0116	1.0116	1.0116
7	.7547	.6756	.9865	1.1738	1.0000	1.0000	1.0000	1.0000
8	.7547	.6756	.9865	1.1738	1.0000	1.0000	1.0000	1.0000

AGE	1996	1997
1	.1124	.1124
2	1.3269	1.3269
3	1.1611	1.1611
4	1.0000	1.0000
5	1.1222	1.1222
6	1.0116	1.0116
7	1.0000	1.0000
8	1.0000	1.0000

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1972	414840	94504	34713	27350	.7879	.5139	112
1973	667960	107723	33446	22600	.6757	.4539	100
1974	349470	93181	24998	38640	1.5457	.8625	99
1975	369410	69388	17229	24500	1.4220	.8096	102
1976	263330	54758	13022	21250	1.6317	.9364	99
1977	325010	49566	9628	15410	1.6004	.9153	95
1978	248780	43610	11112	11080	.9970	.7878	92
1979	139310	35356	9846	12338	1.2530	.8169	92
1980	158100	29122	5805	10613	1.8282	.9891	97
1981	224740	30821	7998	4377	.5472	.4622	90
1982	231990	38395	13306	4855	.3648	.3037	98
1983	232990	44749	19298	3933	.2038	.1744	98
1984	131830	43491	24375	4066	.1668	.1535	96
1985	148880	42509	18278	9187	.5026	.3796	102
1986	171300	39606	18075	7440	.4116	.3266	97
1987	277790	41758	17616	5823	.3305	.2644	103
1988	114210	37942	16647	10172	.6110	.5098	105
1989	146190	34543	15521	4949	.3189	.2798	100
1990	113830	31138	14078	6312	.4483	.3679	101
1991	70180	23257	12196	4398	.3606	.2908	100
1992	143750	22384	8388	5270	.6283	.4256	101
1993	70370	22189	10101	4409	.4365	.3122	101
1994	197520	27810	8318	4828	.5804	.4197	102
1995	129440	25179	8854	5076	.5733	.4115	99
1996	93020	20716	8133	5301	.6518	.4300	100
1997	245210	27784	6015	6651	1.1057	.6981	100

IFAP run code: I36

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 8
Year range in the analysis : 1972 . . . 1997
Number of indices of SSB : 1
Number of age-structured indices : 1

Parameters to estimate : 26
Number of observations : 53

Conventional single selection vector model to be fitted.

Table 7.5.1. (cont.)

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	.3786	32	.2020	.7094	.2748	.5216	.3985
2	1993	.2777	33	.1442	.5347	.1988	.3879	.2936
3	1994	.3732	34	.1896	.7347	.2642	.5273	.3962
4	1995	.3660	38	.1712	.7824	.2483	.5393	.3945
5	1996	.3824	44	.1597	.9160	.2449	.5972	.4224
6	1997	.6209	59	.1916	2.0122	.3408	1.1312	.7433
Separable Model: Selection (S) by age								
7	1	.1124	62	.0332	.3805	.0603	.2094	.1364
8	2	1.3269	29	.7465	2.3585	.9894	1.7794	1.3853
9	3	1.1611	27	.6795	1.9839	.8834	1.5260	1.2052
	4	1.0000		Fixed : Reference Age				
10	5	1.1222	23	.7094	1.7752	.8881	1.4181	1.1534
11	6	1.0116	22	.6491	1.5768	.8067	1.2687	1.0379
	7	1.0000		Fixed : Last true age				
Separable model: Populations in year 1997								
12	1	245214	48	94025	639505	150365	399892	276365
13	2	32782	38	15354	69990	22262	48272	35331
14	3	20382	42	8818	47110	13292	31253	22332
15	4	16680	45	6803	40896	10556	26358	18521
16	5	3742	48	1441	9715	2300	6089	4213
17	6	5095	53	1794	14472	2991	8679	5872
18	7	1505	55	504	4492	861	2629	1758
Separable model: Populations at age								
19	1992	3442	51	1264	9371	2065	5738	3922
20	1993	9859	44	4118	23603	6315	15391	10887
21	1994	4383	41	1953	9836	2902	6621	4772
22	1995	4383	45	1799	10678	2782	6903	4859
23	1996	2921	48	1121	7610	1792	4761	3291
Recruitment in year 1998								
24	1997	134919	51	49268	369470	80696	225574	153970

SSB Index catchabilities

INDEX1
Linear model fitted. Slopes at age :

25 1 Q .4045E-02 40 .2733E-02 .1355E-01 .4045E-02 .9154E-02 .6614E-02

Age-structured index catchabilities
FLT01: GFS mean Irish Sea (Catch: Thous

Linear model fitted. Slopes at age :
26 1 Q .6184E-03 27 .4762E-03 .1384E-02 .6184E-03 .1066E-02 .8424E-03

RESIDUALS ABOUT THE MODEL FIT
Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997
1	1.163	-.752	-.960	-.032	.765	-.095
2	-.213	.072	-.202	-.094	.097	.276
3	-.045	.080	.378	-.054	-.063	-.239
4	.256	.129	-.066	.267	-.461	-.005
5	-.096	.063	-.001	-.091	.223	-.091
6	.054	.069	-.008	-.180	.038	.003
7	.000	-.045	-.020	-.326	.080	.231

SPAWNING BIOMASS INDEX RESIDUALS
INDEX1

	1993	1994	1995	1996	1997
1	-.0648	.7495	-.8637	*******	.1790

Table 7.5.1. (cont.)

AGE-STRUCTURED INDEX RESIDUALS

FLT01: GFS mean Irish Sea (Catch: Thous

Age	1992	1993	1994	1995	1996	1997	1998
1	-1.113	.847	.525	.138	-.391	-.007	.000

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 1997

Variance	.0739
Skewness test stat.	-.1262
Kurtosis test statistic	-.0354
Partial chi-square	.1737
Significance in fit	.0000
Degrees of freedom	19

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1
Linear catchability relationship assumed

Variance	.4480
Skewness test stat.	-.2283
Kurtosis test statistic	-.4354
Partial chi-square	.3794
Significance in fit	.0555
Number of observations	4
Degrees of freedom	3
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES
DISTRIBUTION STATISTICS FOR FLT01: GFS mean Irish Sea (Catch: Thous
Linear catchability relationship assumed

Age	1
Variance	.4009
Skewness test stat.	-.5238
Kurtosis test statisti	-.2138
Partial chi-square	.5767
Significance in fit	.0032
Number of observations	7
Degrees of freedom	6
Weight in the analysis	1.0000

ANALYSIS OF VARIANCE

Unweighted Statistics
Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	8.2453	53	26	27	.3054
Catches at age	4.4959	42	23	19	.2366
SSB Indices					
INDEX1	1.3440	4	1	3	.4480
Aged Indices					
FLT01: GFS mean Irish Sea (Catch: Thou	2.4054	7	1	6	.4009

Weighted Statistics
Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	5.1545	53	26	27	.1909
Catches at age	1.4050	42	23	19	.0739
SSB Indices					
INDEX1	1.3440	4	1	3	.4480
Aged Indices					
FLT01: GFS mean Irish Sea (Catch: Thou	2.4054	7	1	6	.4009

Table 7.5.2. Herring in VIIa(N): Shrinkage diagnostics.

Conventional VPA with Fishing Mortality Shrinkage

Shrinkage Diagnostics, Fs shrunk over 10 years

Minimum CV of the mean taken as 0.00000

F from model fit		Historic Mean F			Shrunk estimate
Estimate	Variance	Estimate	Variance	Wt for F from Model	
0.070	0.539	0.037	0.019	0.034	0.038
0.824	0.281	0.401	0.016	0.053	0.417
0.721	0.307	0.403	0.010	0.031	0.410
0.621	0.360	0.378	0.010	0.027	0.383
0.697	0.356	0.413	0.009	0.025	0.419
0.628	0.396	0.383	0.006	0.015	0.386
0.621	0.360	0.359	0.007	0.020	0.357
*****	0.426	0.359	0.007	0.017	0.357

Minimum CV of the mean taken as 0.10000

F from model fit		Historic Mean F			Shrunk estimate
Estimate	Variance	Estimate	Variance	Wt for F from Model	
0.070	0.539	0.037	0.019	0.034	0.038
0.824	0.281	0.401	0.016	0.053	0.417
0.721	0.307	0.403	0.010	0.032	0.410
0.621	0.360	0.378	0.010	0.027	0.383
0.697	0.356	0.413	0.010	0.027	0.419
0.628	0.396	0.383	0.010	0.025	0.387
0.621	0.360	0.359	0.010	0.027	0.357
*****	0.426	0.359	0.010	0.023	0.357

Minimum CV of the mean taken as 0.20000

F from model fit		Historic Mean F			Shrunk estimate
Estimate	Variance	Estimate	Variance	Wt for F from Model	
0.070	0.539	0.037	0.040	0.069	0.039
0.824	0.281	0.401	0.040	0.125	0.439
0.721	0.307	0.403	0.040	0.115	0.431
0.621	0.360	0.378	0.040	0.100	0.397
0.697	0.356	0.413	0.040	0.101	0.436
0.628	0.396	0.383	0.040	0.092	0.400
0.621	0.360	0.359	0.040	0.100	0.371
*****	0.426	0.359	0.040	0.086	0.371

Table 7.5.3. Herring in VIIa(N): Conventional VPA with Fishing Mortality Shrinkage

Fs shrunk over 10 years
Minimum CV of the mean taken as 0.00000

Shrinkage Diagnostics

F from model fit		Historic Mean F			Shrunk estimate
Estimate	Variance	Estimate	Variance	Wt for F from Model	
0.070	0.539	0.037	0.019	0.034	0.038
0.824	0.281	0.401	0.016	0.053	0.417
0.721	0.307	0.403	0.010	0.031	0.410
0.621	0.360	0.378	0.010	0.027	0.383
0.697	0.356	0.413	0.009	0.025	0.419
0.628	0.396	0.383	0.006	0.015	0.386
0.621	0.360	0.359	0.007	0.020	0.357
*****	0.426	0.359	0.007	0.017	0.357

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.1660	0.1043	0.2135	0.1518	0.2292	0.1566	0.1030	0.1407	0.0602	0.0350	0.0349	0.0087	0.0141	0.0263	0.0422
2	0.3616	0.3437	0.8245	0.7498	0.7888	0.8540	0.5300	0.7463	1.0454	0.4038	0.2536	0.1840	0.1193	0.2757	0.4012
3	0.5255	0.6141	1.0099	0.9064	0.9689	0.9844	0.9159	0.8469	1.2940	0.3576	0.2629	0.1395	0.1684	0.4069	0.3617
4	0.5342	0.4226	1.0039	0.8189	1.0990	0.9748	0.8863	0.8147	0.8350	0.5932	0.4108	0.1917	0.1274	0.4962	0.3414
5	0.6303	0.5272	0.7704	0.9513	0.8958	1.0699	0.6377	0.7177	1.0406	0.4949	0.1124	0.1238	0.2032	0.3303	0.2776
6	0.6623	0.4438	0.8028	0.7080	0.9858	0.7160	0.9884	0.9008	0.6542	0.4140	0.4182	0.2139	0.1328	0.3523	0.2134
7	0.6590	0.5079	0.9793	0.8439	1.0567	0.9203	0.7560	0.8148	0.8079	0.3945	0.2754	0.1417	0.1333	0.3218	0.2982
8	0.6590	0.5079	0.9793	0.8439	1.0567	0.9203	0.7560	0.8148	0.8079	0.3945	0.2754	0.1417	0.1333	0.3218	0.2982

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0127	0.0370	0.0119	0.0328	0.0437	0.1087	0.0170	0.0171	0.0384	0.0899	0.0378
2	0.2836	0.2754	0.2026	0.3054	0.3263	0.3624	0.3223	0.4568	0.4587	0.5467	0.4171
3	0.2971	0.5669	0.2636	0.2999	0.2773	0.4211	0.2832	0.5216	0.4497	0.4219	0.4101
4	0.2288	0.6323	0.3784	0.3328	0.2256	0.4606	0.3198	0.2636	0.4259	0.2577	0.3830
5	0.2485	0.5720	0.2959	0.4913	0.2590	0.3871	0.3297	0.4367	0.2471	0.5124	0.4187
6	0.2445	0.4756	0.2650	0.4103	0.3443	0.4003	0.2982	0.3749	0.3181	0.2251	0.3856
7	0.2124	0.4396	0.2316	0.3261	0.2783	0.4675	0.2578	0.3282	0.3392	0.4187	0.3568
8	0.2124	0.4396	0.2316	0.3261	0.2783	0.4675	0.2578	0.3282	0.3392	0.4187	0.3568

Table 7.5.3. (cont).

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	414.56	667.64	349.70	369.71	263.40	326.22	249.18	140.26	157.24	231.74	234.68	237.03	132.19	147.72	171.30
2	176.38	129.18	221.29	103.91	116.85	77.05	102.61	82.70	44.83	54.46	82.32	83.37	86.44	47.95	52.93
3	72.12	91.01	67.86	71.88	36.37	39.33	24.30	44.74	29.05	11.67	26.94	47.33	51.38	56.83	26.97
4	33.32	34.91	40.32	20.24	23.77	11.30	12.03	7.96	15.71	6.52	6.68	16.96	33.70	35.55	30.98
5	30.74	17.67	20.70	13.37	8.07	7.17	3.86	4.49	3.19	6.17	3.26	4.01	12.67	26.85	19.59
6	14.59	14.81	9.44	8.67	4.67	2.98	2.22	1.84	1.98	1.02	3.40	2.64	3.21	9.35	17.46
7	5.76	6.81	8.60	3.83	3.86	1.58	1.32	0.75	0.68	0.93	0.61	2.03	1.93	2.54	5.95
8	3.62	6.83	2.72	3.00	2.03	1.94	0.69	0.54	0.43	0.77	1.66	0.47	4.03	2.76	3.57

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	279.33	113.12	154.12	112.98	73.77	184.85	60.42	183.47	134.26	97.49	245.12	134.86
2	60.41	101.47	40.10	56.03	40.22	25.98	61.00	21.85	66.35	47.53	32.78	86.83
3	26.25	33.70	57.07	24.26	30.58	21.50	13.39	32.74	10.25	31.07	20.38	16.00
4	15.38	15.97	15.65	35.90	14.72	18.98	11.55	8.26	15.91	5.35	16.68	11.08
5	19.92	11.07	7.68	9.70	23.29	10.63	10.83	7.59	5.74	9.40	3.74	10.29
6	13.43	14.06	5.65	5.17	5.37	16.26	6.53	7.05	4.44	4.06	5.10	2.23
7	12.76	9.51	7.91	3.92	3.10	3.44	9.86	4.38	4.38	2.92	2.93	3.14
8	9.16	12.40	9.92	6.08	3.52	1.10	3.91	7.46	5.29	4.18	5.00	5.02

x 10 ^ 6

Table 7.5.3. (cont).

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1972	414560	92661	33028	27350	0.8281	0.5428	112
1973	667630	106292	32138	22600	0.7032	0.4703	100
1974	349690	92386	24237	38640	1.5942	0.8823	99
1975	369700	69012	16852	24500	1.4538	0.8269	102
1976	263390	54507	12775	21250	1.6634	0.9477	99
1977	326210	49586	9564	15410	1.6111	0.9198	95
1978	249170	43702	11155	11080	0.9933	0.7917	92
1979	140250	35514	9922	12338	1.2435	0.8053	92
1980	157240	29220	5940	10613	1.7864	0.9739	97
1981	231740	31436	8118	4377	0.5392	0.4527	90
1982	234670	39071	13662	4855	0.3554	0.2915	98
1983	237030	45651	19807	3933	0.1986	0.1706	98
1984	132190	44249	24993	4066	0.1627	0.1502	96
1985	147720	43034	18843	9187	0.4875	0.3723	102
1986	171300	40081	18532	7440	0.4015	0.3191	97
1987	279320	42510	18240	5823	0.3192	0.2605	103
1988	113110	38277	17011	10172	0.5980	0.5044	105
1989	154110	35485	15832	4949	0.3126	0.2811	100
1990	112980	31468	14348	6312	0.4399	0.3679	101
1991	73760	23731	12400	4398	0.3547	0.2865	100
1992	184850	25245	8687	5270	0.6066	0.4063	101
1993	60420	23101	11182	4409	0.3943	0.3106	101
1994	183470	27826	8966	4828	0.5384	0.4107	102
1995	134260	25649	9182	5076	0.5528	0.3799	99
1996	97490	21386	8348	5301	0.6350	0.3928	100
1997	245120	28450	8191	6651	0.8119	0.4029	100

Table 7.6.1

The SAS System 08:40 Tuesday, March 17, 1998

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Prediction with management option table: Input data

Year: 1998								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	134.860	1.0000	0.0800	0.9000	0.7500	0.067	0.0380	0.069
2	86.830	0.3000	0.8500	0.9000	0.7500	0.118	0.4170	0.118
3	16.000	0.2000	1.0000	0.9000	0.7500	0.148	0.4100	0.147
4	11.080	0.1000	1.0000	0.9000	0.7500	0.166	0.3830	0.164
5	10.290	0.1000	1.0000	0.9000	0.7500	0.178	0.4190	0.176
6	2.230	0.1000	1.0000	0.9000	0.7500	0.190	0.3860	0.189
7	3.140	0.1000	1.0000	0.9000	0.7500	0.201	0.3570	0.199
8+	5.020	0.1000	1.0000	0.9000	0.7500	0.213	0.3570	0.212
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	147.252	1.0000	0.0800	0.9000	0.7500	0.067	0.0380	0.069
2	.	0.3000	0.8500	0.9000	0.7500	0.118	0.4170	0.118
3	.	0.2000	1.0000	0.9000	0.7500	0.148	0.4100	0.147
4	.	0.1000	1.0000	0.9000	0.7500	0.166	0.3830	0.164
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.4190	0.176
6	.	0.1000	1.0000	0.9000	0.7500	0.190	0.3860	0.189
7	.	0.1000	1.0000	0.9000	0.7500	0.201	0.3570	0.199
8+	.	0.1000	1.0000	0.9000	0.7500	0.213	0.3570	0.212
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	147.252	1.0000	0.0800	0.9000	0.7500	0.067	0.0380	0.069
2	.	0.3000	0.8500	0.9000	0.7500	0.118	0.4170	0.118
3	.	0.2000	1.0000	0.9000	0.7500	0.148	0.4100	0.147
4	.	0.1000	1.0000	0.9000	0.7500	0.166	0.3830	0.164
5	.	0.1000	1.0000	0.9000	0.7500	0.178	0.4190	0.176
6	.	0.1000	1.0000	0.9000	0.7500	0.190	0.3860	0.189
7	.	0.1000	1.0000	0.9000	0.7500	0.201	0.3570	0.199
8+	.	0.1000	1.0000	0.9000	0.7500	0.213	0.3570	0.212
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANRDN01
Date and time: 17MAR98:08:58

Table 7.6.2.a

The SAS System 08:40 Tuesday, March 17, 1998

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.4030	27480	10309	5755	0.2000	0.0806	27006	13422	1248	30942	16763
.	.	.	.	.	0.3000	0.1209	.	12956	1838	30335	15697
.	.	.	.	.	0.4000	0.1612	.	12506	2406	29752	14704
.	.	.	.	.	0.5000	0.2015	.	12072	2953	29191	13778
.	.	.	.	.	0.6000	0.2418	.	11653	3480	28652	12915
.	.	.	.	.	0.7000	0.2821	.	11250	3988	28133	12110
.	.	.	.	.	0.8000	0.3224	.	10861	4477	27634	11359
.	.	.	.	.	0.9000	0.3627	.	10486	4949	27154	10658
.	.	.	.	.	1.0000	0.4030	.	10124	5403	26692	10004
.	.	.	.	.	1.1000	0.4433	.	9775	5841	26248	9394
.	.	.	.	.	1.2000	0.4836	.	9438	6263	25820	8825
.	.	.	.	.	1.3000	0.5239	.	9114	6669	25409	8293
.	.	.	.	.	1.4000	0.5642	.	8800	7061	25013	7797
.	.	.	.	.	1.5000	0.6045	.	8499	7439	24632	7333
.	.	.	.	.	1.6000	0.6448	.	8207	7804	24265	6900
.	.	.	.	.	1.7000	0.6851	.	7926	8155	23912	6495
.	.	.	.	.	1.8000	0.7254	.	7656	8495	23573	6116
.	.	.	.	.	1.9000	0.7657	.	7394	8822	23245	5763
.	.	.	.	.	2.0000	0.8060	.	7142	9137	22930	5432
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANRDN03
Date and time : 17MAR98:08:48
Computation of ref. F: Simple mean, age 2 - 6
Basis for 1998 : F factors

Table 7.6.2.b

The SAS System 08:40 Tuesday, March 17, 1998

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.1979	0.4827	27480	9614	6660	0.2000	0.0806	26079	12663	1183	30143	16074
.	.	.	.	.	0.3000	0.1209	.	12223	1742	29568	15057
.	.	.	.	.	0.4000	0.1612	.	11799	2280	29015	14110
.	.	.	.	.	0.5000	0.2015	.	11390	2799	28483	13227
.	.	.	.	.	0.6000	0.2418	.	10996	3298	27971	12403
.	.	.	.	.	0.7000	0.2821	.	10615	3780	27479	11635
.	.	.	.	.	0.8000	0.3224	.	10249	4244	27006	10918
.	.	.	.	.	0.9000	0.3627	.	9895	4691	26550	10249
.	.	.	.	.	1.0000	0.4030	.	9554	5121	26112	9624
.	.	.	.	.	1.1000	0.4433	.	9225	5536	25691	9042
.	.	.	.	.	1.2000	0.4836	.	8908	5937	25285	8497
.	.	.	.	.	1.3000	0.5239	.	8602	6322	24894	7989
.	.	.	.	.	1.4000	0.5642	.	8307	6694	24519	7515
.	.	.	.	.	1.5000	0.6045	.	8022	7053	24157	7071
.	.	.	.	.	1.6000	0.6448	.	7748	7399	23809	6657
.	.	.	.	.	1.7000	0.6851	.	7483	7733	23474	6269
.	.	.	.	.	1.8000	0.7254	.	7228	8054	23151	5907
.	.	.	.	.	1.9000	0.7657	.	6982	8365	22841	5568
.	.	.	.	.	2.0000	0.8060	.	6745	8664	22541	5251
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANRDN02
Date and time : 17MAR98:08:56
Computation of ref. F: Simple mean, age 2 - 6
Basis for 1998 : TAC constraints

Table 7.6.2.c

The SAS System 08:40 Tuesday, March 17, 1998

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.7886	0.7208	27480	7812	9000	0.2000	0.0806	23700	10716	1015	28094	14306
.	.	.	.	.	0.3000	0.1209	.	10346	1495	27599	13417
.	.	.	.	.	0.4000	0.1612	.	9988	1957	27123	12587
.	.	.	.	.	0.5000	0.2015	.	9643	2403	26666	11813
.	.	.	.	.	0.6000	0.2418	.	9310	2832	26225	11091
.	.	.	.	.	0.7000	0.2821	.	8989	3245	25801	10417
.	.	.	.	.	0.8000	0.3224	.	8680	3644	25394	9787
.	.	.	.	.	0.9000	0.3627	.	8382	4028	25002	9199
.	.	.	.	.	1.0000	0.4030	.	8094	4399	24624	8650
.	.	.	.	.	1.1000	0.4433	.	7817	4756	24261	8137
.	.	.	.	.	1.2000	0.4836	.	7549	5100	23911	7658
.	.	.	.	.	1.3000	0.5239	.	7291	5433	23574	7210
.	.	.	.	.	1.4000	0.5642	.	7043	5753	23250	6791
.	.	.	.	.	1.5000	0.6045	.	6803	6062	22938	6400
.	.	.	.	.	1.6000	0.6448	.	6571	6360	22638	6033
.	.	.	.	.	1.7000	0.6851	.	6348	6647	22349	5691
.	.	.	.	.	1.8000	0.7254	.	6133	6925	22070	5370
.	.	.	.	.	1.9000	0.7657	.	5925	7193	21802	5070
.	.	.	.	.	2.0000	0.8060	.	5725	7451	21543	4789
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANRDN01
Date and time : 17MAR98:08:58
Computation of ref. F: Simple mean, age 2 - 6
Basis for 1998 : TAC constraints

Table 7.6.3.a

The SAS System 08:40 Tuesday, March 17, 1998

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0000	0.4030	43693	5755	269450	27480	132354	17589	75721	10309
1999	1.0000	0.4030	39330	5403	265597	27006	122961	17038	71356	10124
2000	1.0000	0.4030	38420	5282	263093	26692	119798	16647	70113	10004
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRRDN02
Date and time : 17MAR98:08:59
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 7.6.3.b

The SAS System 08:40 Tuesday, March 17, 1998

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.1979	0.4828	50618	6660	269450	27480	132354	17589	70733	9614
1999	1.0000	0.4030	37545	5121	259765	26079	117182	16118	67803	9554
2000	1.0000	0.4030	37417	5108	259792	26112	116497	16067	67954	9624
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRRDN04
Date and time : 17MAR98:09:27
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 7.6.3.c

The SAS System 08:40 Tuesday, March 17, 1998

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.7886	0.7208	68627	9000	269450	27480	132354	17589	57816	7812
1999	1.0000	0.4030	32959	4399	244773	23701	102348	13758	58691	8094
2000	1.0000	0.4030	34841	4660	251317	24624	108022	14579	62416	8650
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRRDN05
Date and time : 17MAR98:09:29
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 7.6.4

The SAS System 08:40 Tuesday, March 17, 1998

Herring in the North Irish Sea (Manx plus Mourne VIIa North)

Single option prediction: Detailed tables

Year: 1998 F-factor: 1.1979 Reference F: 0.4828

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0455	3808	261	134860	9081	10789	726	4892	329
2	0.4995	29862	3534	86830	10246	73806	8709	37595	4436
3	0.4911	5674	832	16000	2363	16000	2363	8851	1307
4	0.4588	3895	637	11080	1836	11080	1836	6802	1127
5	0.5019	3880	684	10290	1835	10290	1835	6077	1084
6	0.4624	789	149	2230	423	2230	423	1365	259
7	0.4277	1043	208	3140	630	3140	630	1982	398
8+	0.4277	1668	354	5020	1068	5020	1068	3169	674
Total		50618	6660	269450	27480	132354	17589	70733	9614
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1999 F-factor: 1.0000 Reference F: 0.4030

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0380	3482	239	147252	9915	11780	793	5377	362
2	0.4170	14110	1670	47404	5594	40294	4755	22107	2609
3	0.4100	11981	1757	39034	5764	39034	5764	23230	3430
4	0.3830	2435	399	8016	1328	8016	1328	5269	873
5	0.4190	2071	365	6337	1130	6337	1130	4032	719
6	0.3860	1723	326	5636	1069	5636	1069	3695	701
7	0.3570	364	72	1271	255	1271	255	855	172
8+	0.3570	1380	293	4814	1024	4814	1024	3239	689
Total		37545	5121	259765	26079	117182	16118	67803	9554
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.0000 Reference F: 0.4030

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0380	3482	239	147252	9915	11780	793	5377	362
2	0.4170	15523	1837	52151	6154	44328	5231	24321	2870
3	0.4100	7103	1042	23144	3418	23144	3418	13773	2034
4	0.3830	6442	1054	21209	3514	21209	3514	13940	2309
5	0.4190	1617	285	4945	882	4945	882	3147	561
6	0.3860	1153	218	3771	715	3771	715	2472	469
7	0.3570	993	198	3467	696	3467	696	2333	468
8+	0.3570	1104	234	3853	819	3853	819	2592	551
Total		37417	5108	259792	26112	116497	16067	67954	9624
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRRDN04
Date and time : 17MAR98:09:27
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

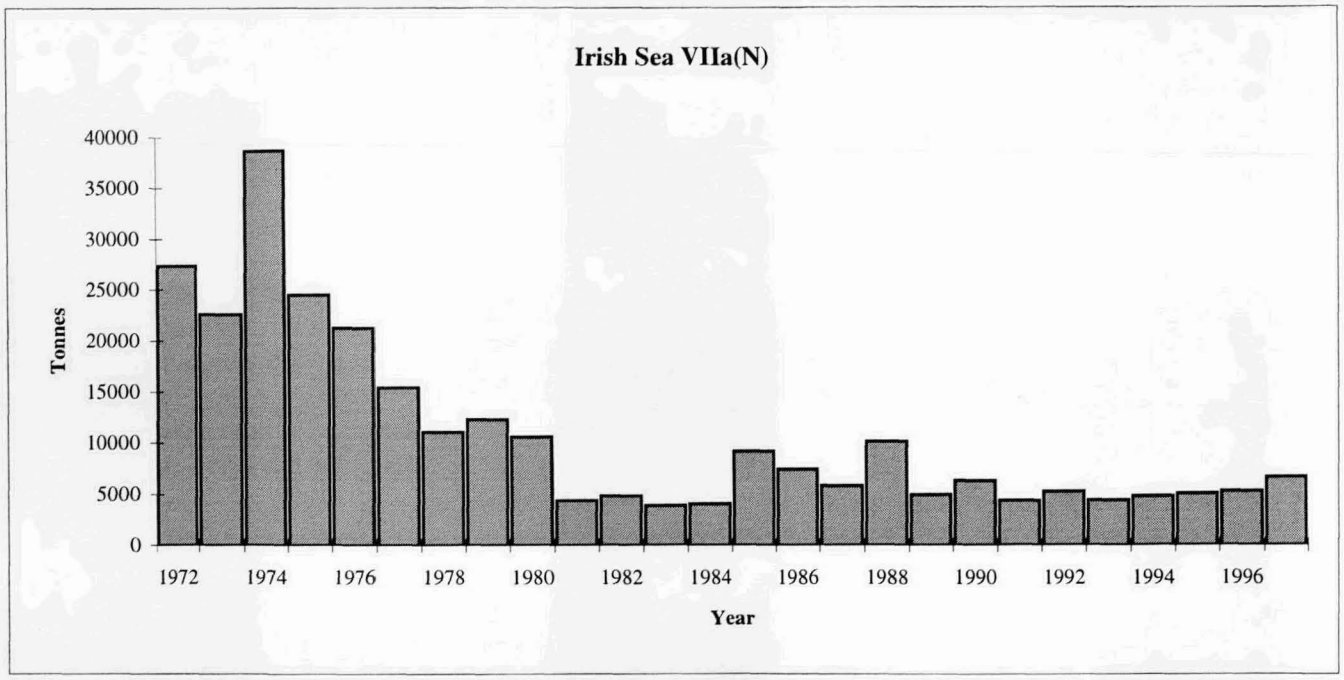


Figure 7.1.1. Herring Irish Sea VIIa(N): Landings (t)

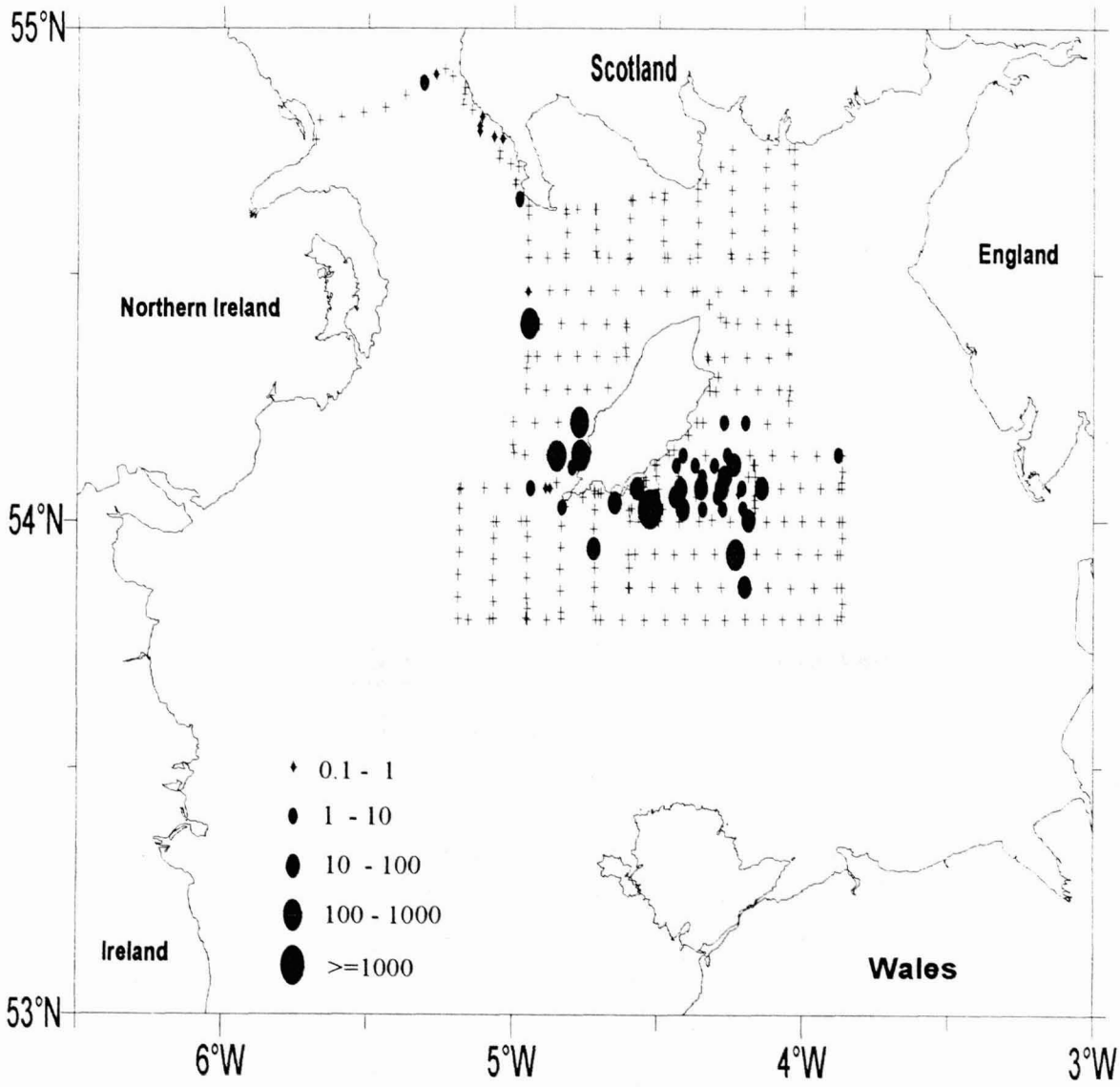
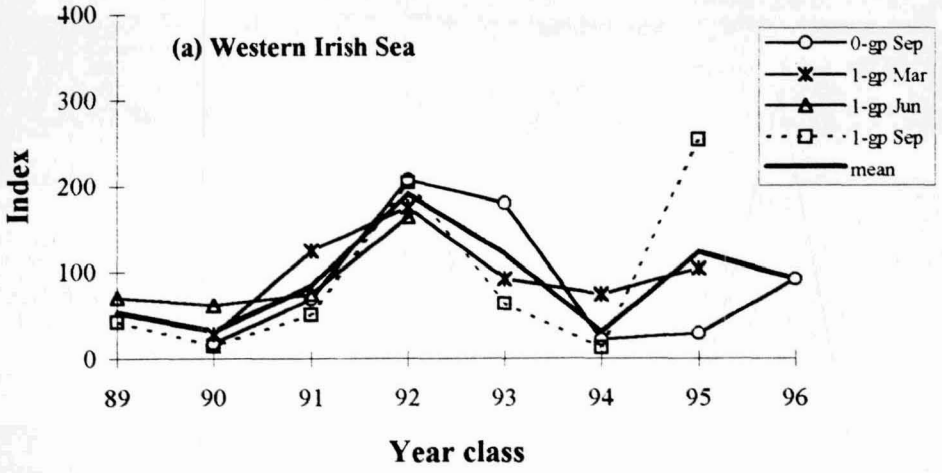
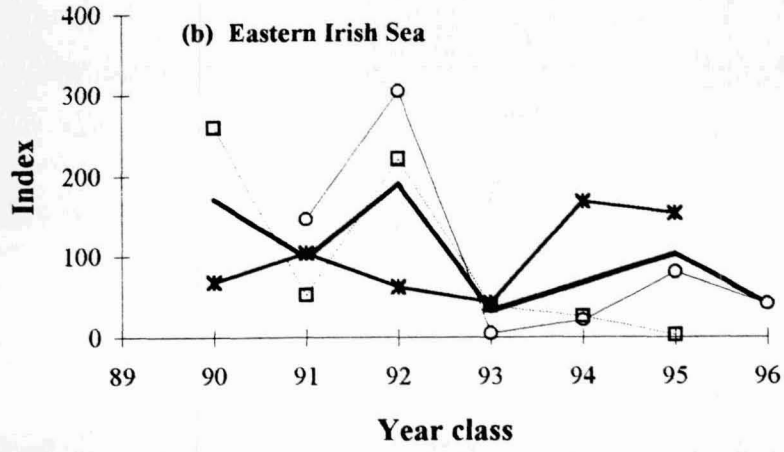


Figure 7.3.1 Density distribution of adult (22 cm+) herring during cruise LF3697 (tonnes per square nautical mile). Crosses mark staring positions for 15-minute intervals.





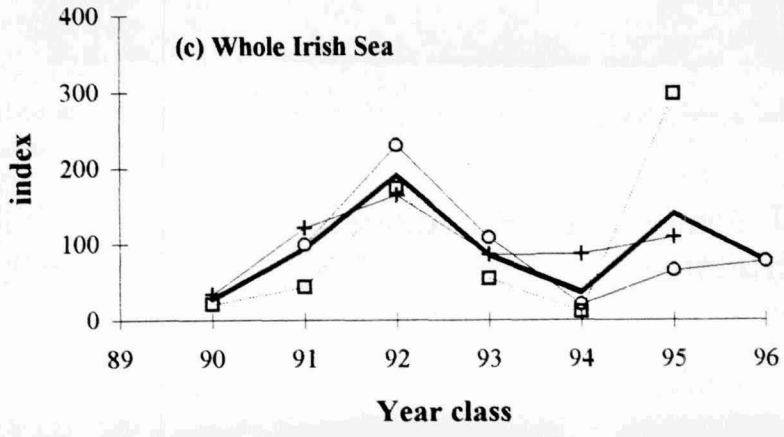
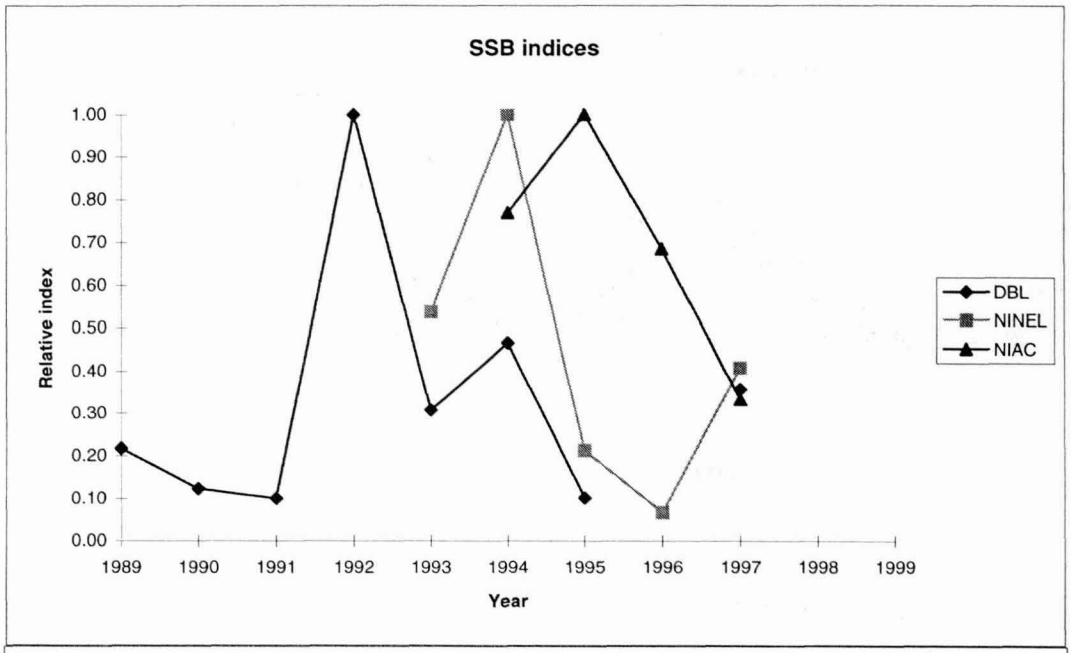


Figure 7.3.2 Mean catch-rate of 0-gp and 1-gp herring in Irish Sea groundfish surveys from 1991 to 1997. Indices are expressed as percentage of series mean. Surveys in 1991 covered only the western region. Mean of indices is obtained by weighting individual means by inverse of their CV's.

a.



b.

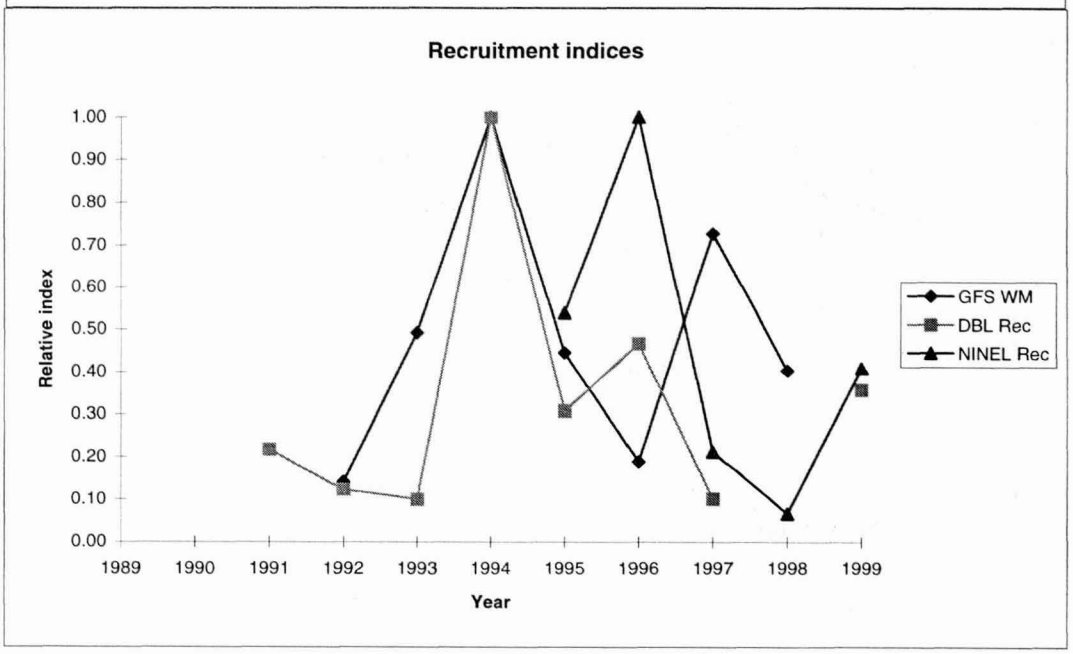


Figure 7.4.1 'Irish Sea (VIIa(N)): Relative SSB and recruitment indices.

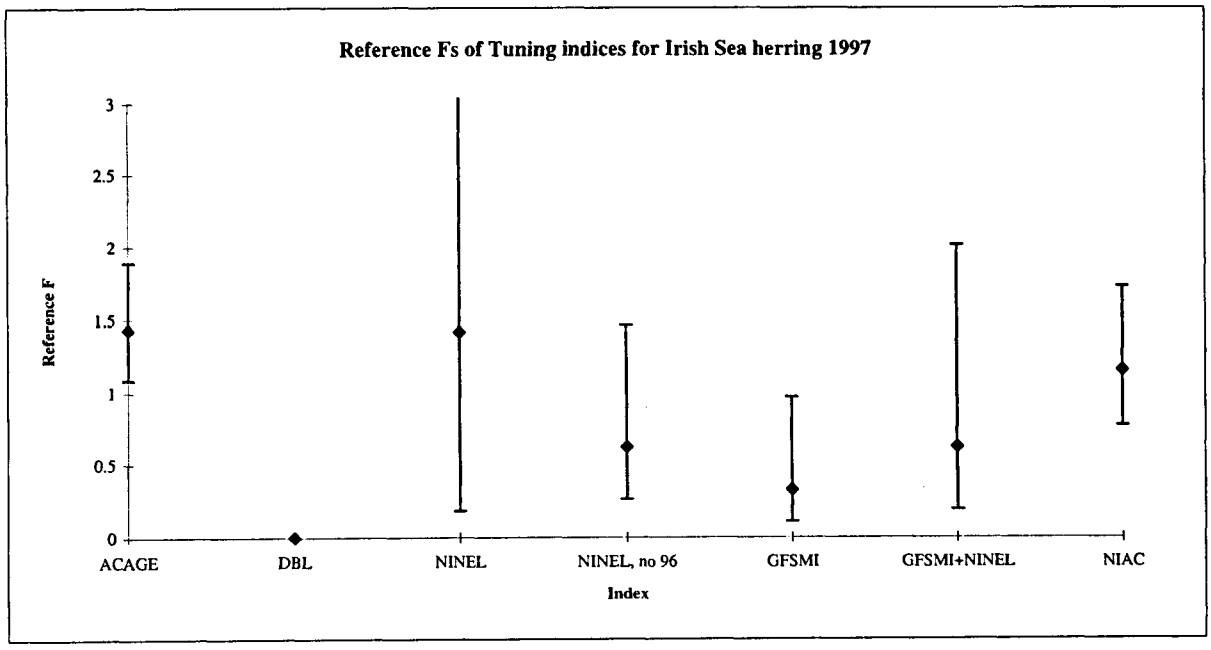


Figure 7.4.2. Herring Irish Sea VIIa(N): Tuning indices and reference F. 1 SD shown, see Table above for large confidence intervals.

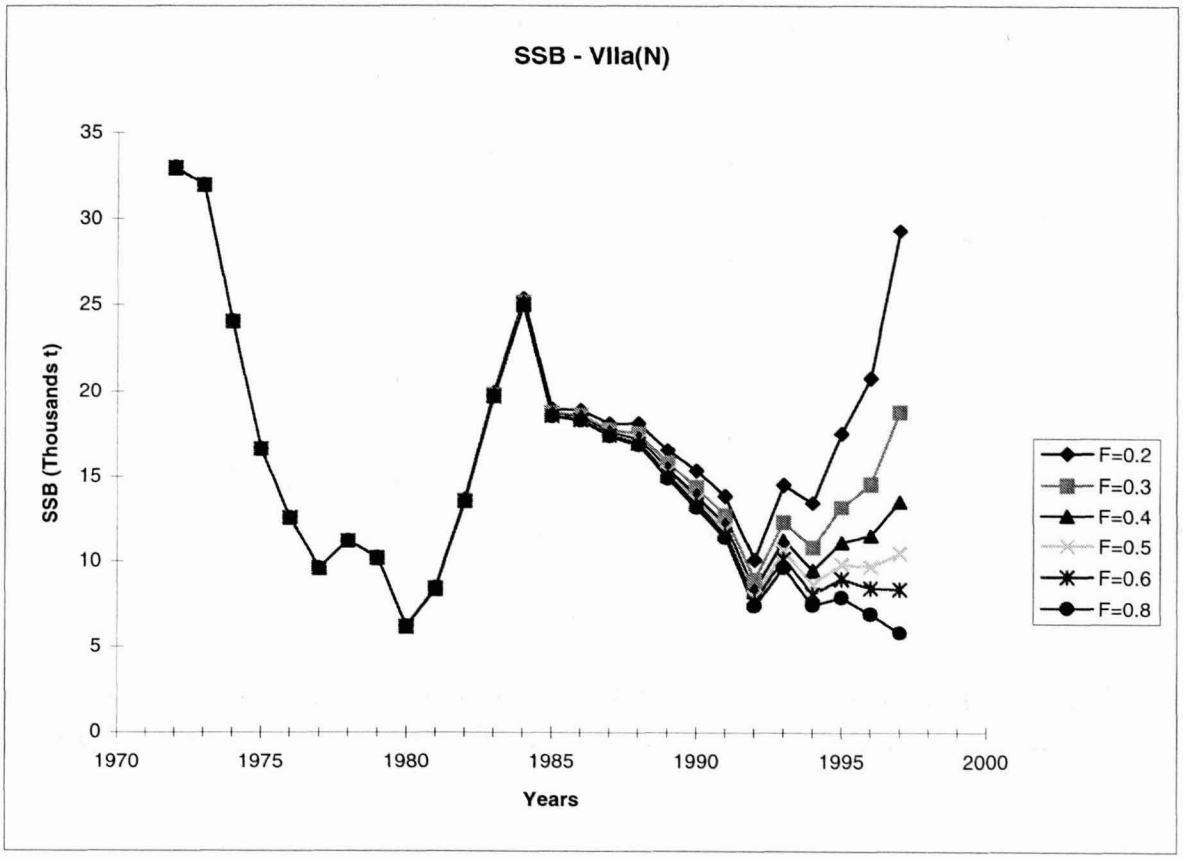


Figure 7.4.3. Herring Irish SEa VIIa(N): SSB over a range of input F into a separable model.

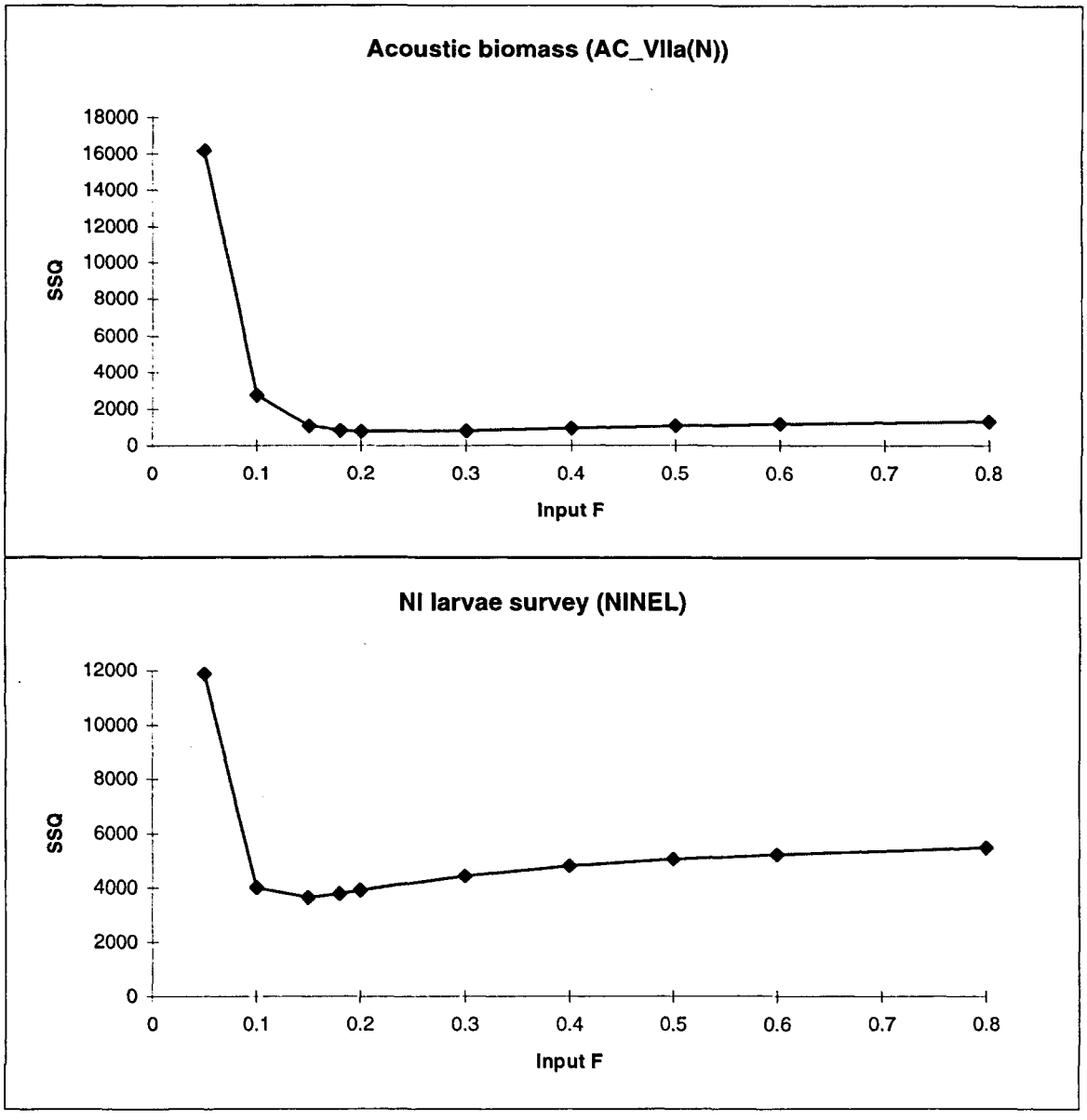


Figure 7.4.4. Herring Irish Sea VIIa(N): SSQ surfaces for tuning indices with separable outputs.

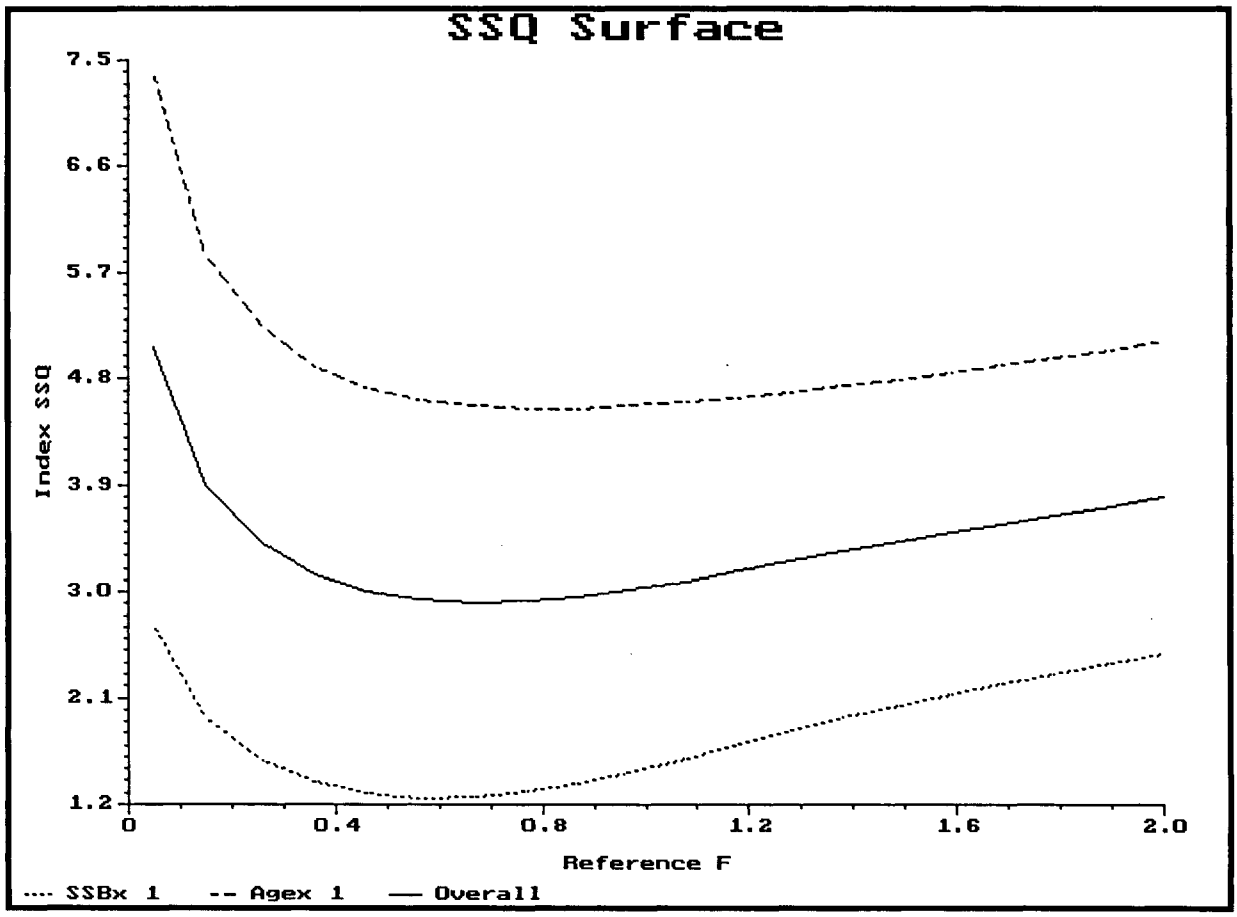


Figure 7.5.1. Herring in VIIa(N). SSQ surface for the baseline assessment. SSBx 1 = larvae production estimates for the north-eastern Irish Sea (NINEL); Agex 1 = I-ringer index in the Irish Sea (GFS-mean).

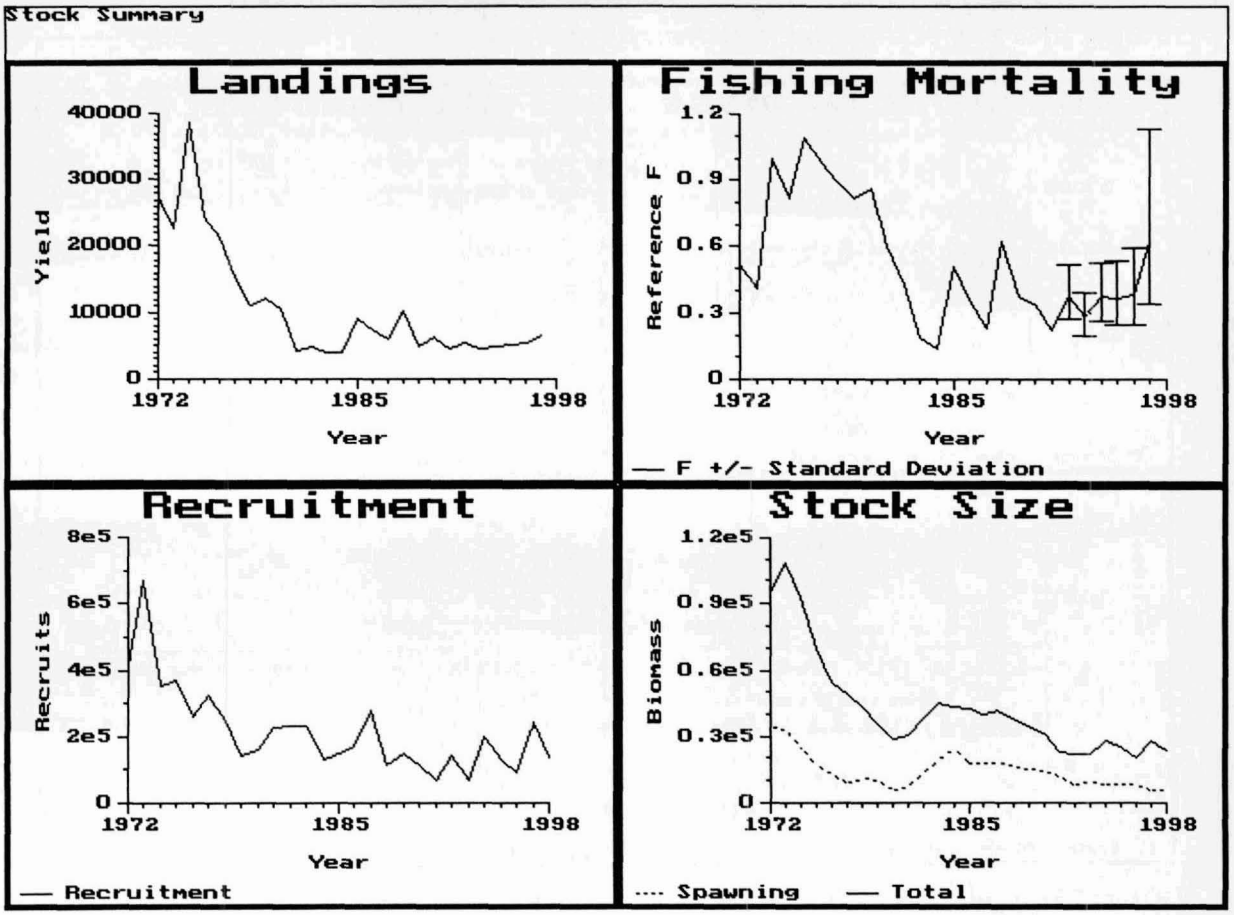


Figure 7.5.2. Herring in VIIa(N). Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

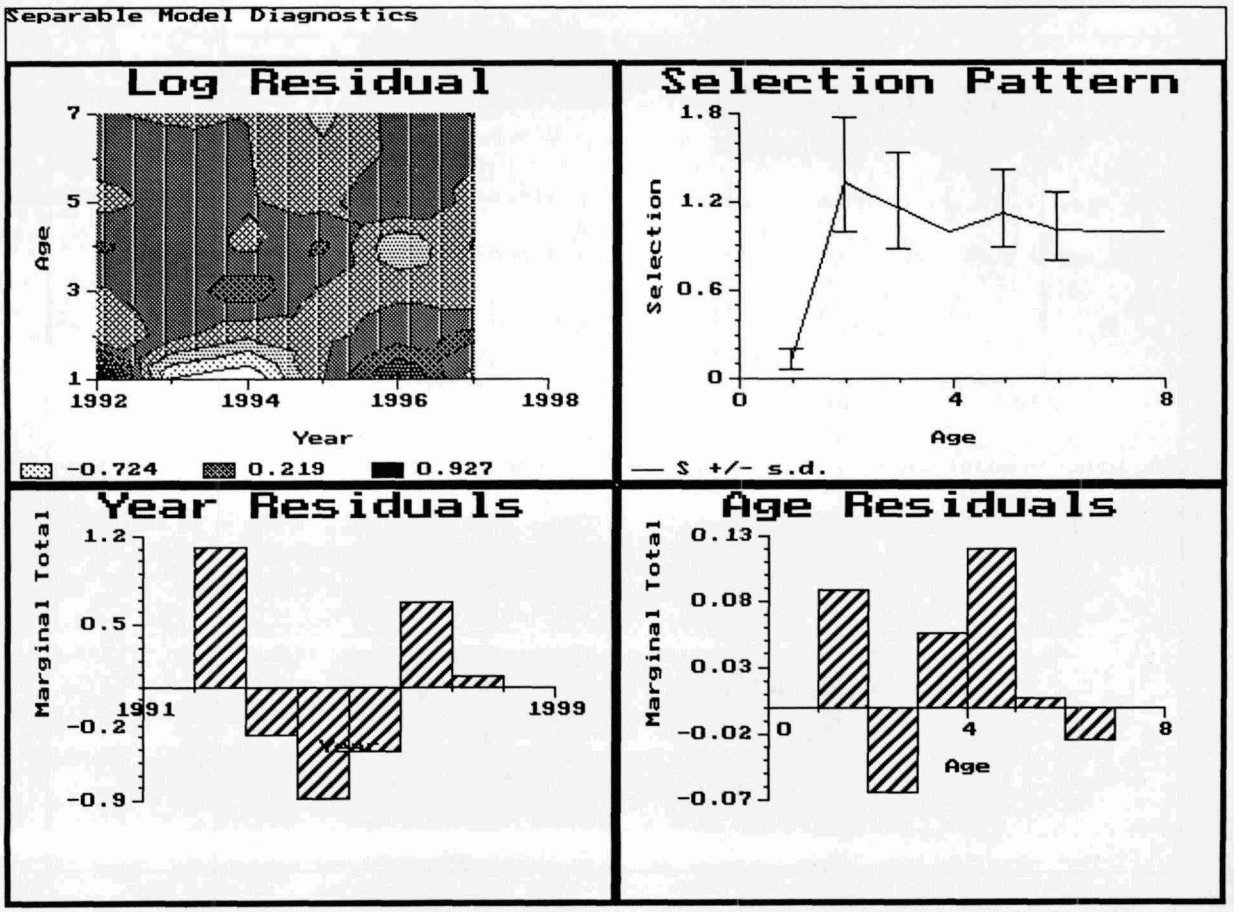


Figure 7.5.3. Herring in VIIa(N). Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

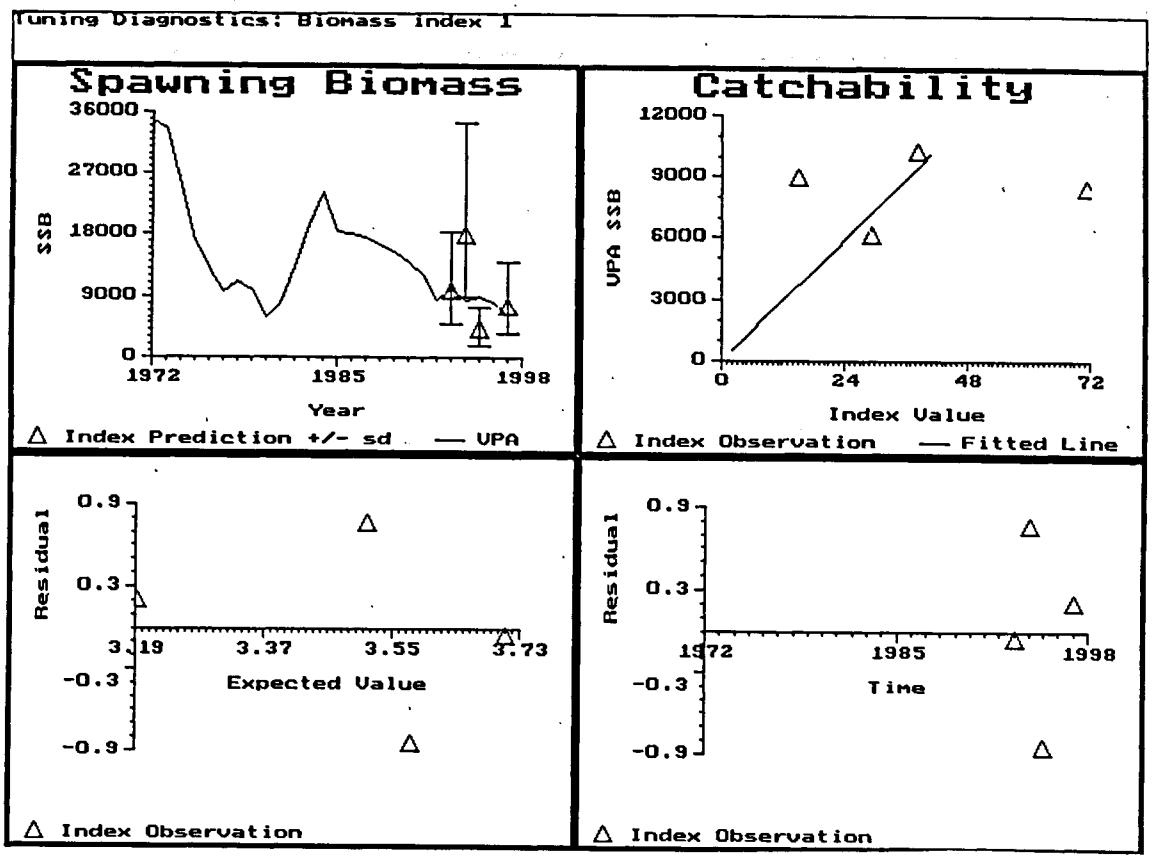


Figure 7.5.4. Herring in VIIa(N). Results of baseline assessment. Diagnostics of the fit of the larval abundance index NINEL against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

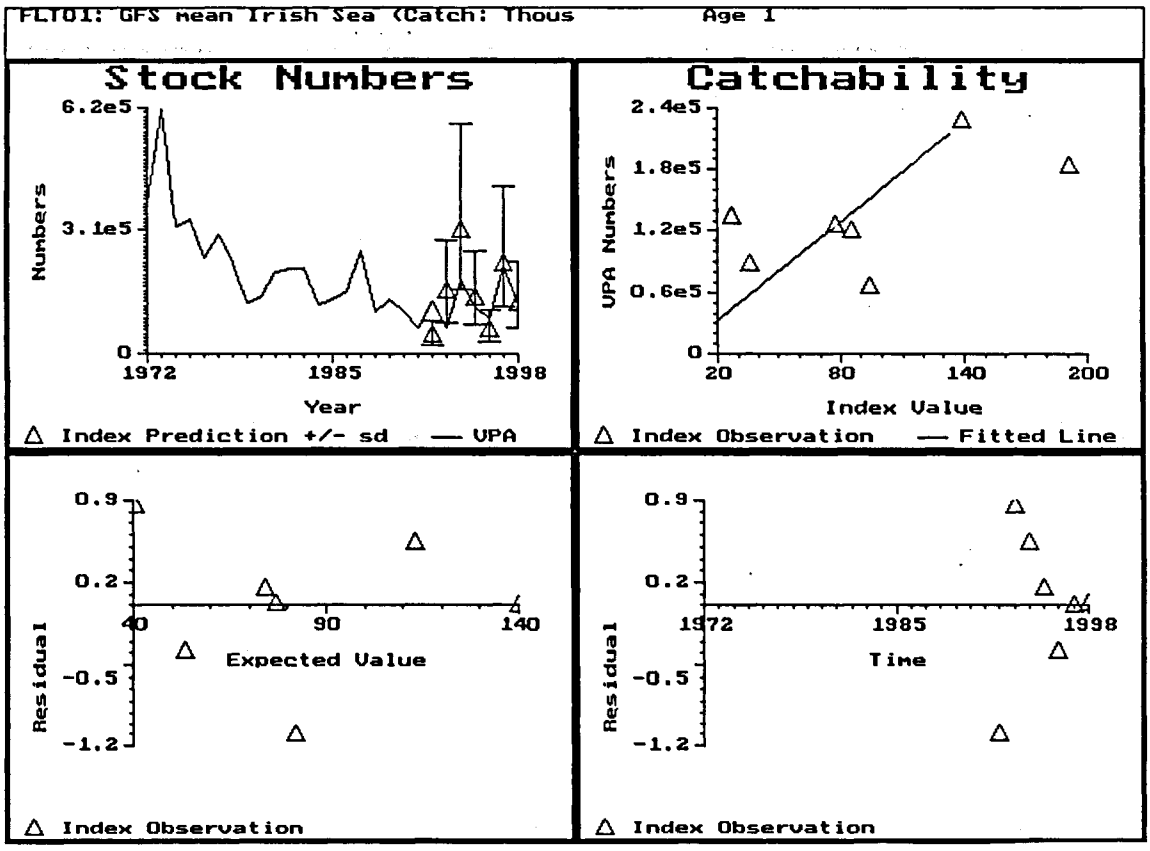


Figure 7.5.5. Herring in VIIa(N). Results of baseline assessment. Diagnostics of the fit of the 1-ringer index GFS-mean against the estimated populations at age 1-ring. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and 1-ringer survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 1997 and 1998

No ACFM advice on sprat TAC has been given in recent years. The TAC set by the management bodies was 200,000 t for 1996 [Sub-area IV(EU zone) + Division IIa (EU zone)] and 150,000 t for 1997. The agreed TAC for 1998 is 150,000 t.

8.1.2 Catches in 1997

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1984–1997. As in previous years, sprats from the fjords of western Norway are not included in the landings for the North Sea. Landings from the fjords are presented separately (Table 8.1.2) due to uncertainty concerning their stock identity.

The monthly and annual distributions of catches by rectangle for Sub-area IV are shown in Figures 8.1.1-8.1.13. Norwegian catches reported in the rectangles 42F3 seems highly unlikely and are probably misreported from other rectangles in Division IVb.

Catch statistics for Denmark, Norway and UK(England and Wales) indicate that 103,400 t sprat were landed from the North Sea in 1997, which was a decline in landings from 1996 of about 25 %. After considerable increases in landings from about 10,000 t in 1986 to a peak of 320,600 t in 1995. The Danish landings decreased to 81,000 t but increased in 1997 to nearly 100,000 t. During the last years, 60-70 % of the Danish sprat landings has been reported from the third quarter. In 1997, a major part was landed in the fourth quarter. To reduce the herring by-catches in the small-meshed fishery, Denmark in 1996 banned sprat fishing from 1 July to 15 August. The same ban was maintained again in 1997. The Norwegian landings in 1997 were 3,200 t, the lowest recorded since 1990. In 1997, the Norwegian sprat fishery was closed in second and third quarter and all catches were landed in the end of December.

8.1.3 Fleets

In 1997 the sprat was only taken in a directed sprat fishery carried out by trawlers (Denmark and UK(England and Wales) and by purse seiners (Norway).

8.2 Catch Composition

8.2.1 Catches in number

The estimated quarterly catch-at-age in numbers is presented in Table 8.2.1. Age composition data of commercial landings in 1997 were provided by Denmark, Norway and UK(England and Wales). In Division IVb the landings in 4th quarter by both the Danish and the Norwegian fleets, were dominated by 1-group fish. The distribution of number per age group in third quarter indicates that only one age group were landed. This may be related to low sampling intensity for ageing (see Table 8.2.3).

8.2.2 Mean Weight at age

The mean weights (g) at age in catches taken in 1994 - 1997 are presented by quarter in Table 8.2.2. Weights were estimated from commercial catch data as provided by Working Group members. Catch at age data from commercial landings in IVb was available for quarter 3 and 4. The landings from these quarters constitute 90% of the total landings from the North Sea. Landings from the 2nd quarter are negligible.

8.2.3 Quality of catch and biological data

The sampling intensity for biological samples, i.e age and weight at age, is given in Table 8.2.3. The total number of samples decreased in 1997 and is much below the recommended level of one sample per 1,000 t landed. In Denmark 28 samples from commercial landings were analysed, length measured and aged. These samples were used to estimate age composition and weight at age of sprat. From the Norwegian landings 8 samples were taken which gives 2.5 sample per 1,000t. These samples are well covered by age reading as well.

The sampling of Danish landings for industrial purposes for estimating species composition, increased substantial in 1996 (round 50 % compared to 1995) and with the intensity and coverage largely unchanged in 1997 compared to 1996. Sampling intensity for species compositions is presented in Section 2.15. No sprat was reported as by-catch in the landings from the Norwegian small meshed fishery targeted at sandeel and Norway pout.

8.3 Recruitment

8.3.1 Abundance

The IBTS(February) sprat indices, no per hour, are used as an index of abundance. The historical data were revised by the Working Group in 1995 (ICES 1995/Assess:13). The IBTS-indices are presented in Table 8.3.1 for age groups 1-4, 5+ and total, along with the number of rectangles sampled and the number of hauls considered.

Table 8.3.1 indicates an increase in the 1-group index by a factor of nearly two compared with the 1997-index. The index is well above the 1-group index 1981–1997. It also indicates a strong increase in the 2- group. From the IBTS-survey's age-length key, a strong 2-group is probably a result of problems in otolith readings. The total 1998-abundance index (3,696) is the fourth highest for the period.

The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1, 2 and 3+. Age 1-group were found to be concentrated in the south-eastern areas of Division IVb and in IVc. The mean lengths in mm of age-group 1 by rectangle, are presented in Fig. 8.3.2.

8.4 Acoustic Survey

Sprat abundance was estimated from the ICES Coordinated Herring Acoustic survey in June-July 1997 (WD Simmonds *et al.* 1998b). Sprat were mainly detected west of 1°W (R/V Tridens).The acoustic estimates of sprat biomasses were 210,000 t in 1996 and 60,000 t in 1997. The difference is probably due to inappropriate coverage of the distribution area in the south-eastern areas (Anon.1998b). Samples for ageing were either not available or there were difficulties in interpreting the otoliths.

8.5 State of the Stock

8.5.1 Catch-Survey Data Analysis

The IBTS surveys do not fully reflect strong and weak cohorts for sprat, which was also demonstrated by previous Working Groups (see ICES 1997/Assess: 8). The 1-group:2-group ratio varies between 0.32 (1981 year class) and 7.57 (1988 year class) and does not adequately reflect the age structure of the stock. These problems may be due to difficulties in age reading and/or a possible prolonged spawning and recruitment season. However, the IBTS-survey may still be a useful indicator of the stock biomass which enables the use of production models.

To improve the analysis a model for stock development was included: The Biomass Dynamic Model. This model was fitted using the CEDA program, see ICES (1993/ Assess:15). The data were total catch and IBTS(February) abundance indices for 1981 to 1998. The initial state of the stock in 1981 was assumed to be that the biomass was 0.25 of the carrying capacity K. The 1989 observation was again considered as an outlier. A new run was done excluding the 1989-index. The run was consistent with the analyses done in 1997 (ICES 1997/Assess: 8), still showing a biomass at a very low level and considerable log residuals on the abundance IBTS indices. Analyses started in 1993 have consistently shown a declining trend in biomass, with a lower rate in decline the last year. For 1998 the estimated biomass is about 70,000 tonnes.

8.6 Projections of Catch and Stock

The regression of the total catches and the IBTS indices for 1981–1997, excluding the 1989-index (r^2=0.81), has a predicted a yield for 1998 of 260,000 t, see Figure 8.6.1. The Working Group has, however, doubt in this high level of yield for 1998.

The total IBTS-indices was used to do a SHOT-estimate (see ICES 1992/Assess:9). The estimated landings for 1998 was found around 215,000 tonnes, Table 8.6.1. Other runs using the 1-group indices and the combined 1-and 2-group indices gave 170,000 and 210,000 tonnes, respectively, for the 1998 yield.

8.7 Management Considerations

The Working Group was asked by ACFM to investigate the possibility of a simple management or catch control rule taking into account the uncertainties. One possibility suggested was to use the type of model used for capelin fisheries. This model use acoustic surveys specially designed for capelin to advice on a preliminary TAC. There is one acoustic survey in the North Sea which estimates sprat, the North Sea Herring Surveys in June-July, which have included sprat since 1996. The experience so far have demonstrated the need for better coverage of the south-south-eastern areas of the North Sea and for the addition of directed sampling of sprat to give biological data; i.e., age data. There is also a need for better knowledge of spawning seasons and recruitment from possible autumn spawners.

It was also indicated that the sprat data from the IBTS-surveys might be useful in this context. The HAWG-reports from the last 10–15 years and the predictions presented in the present report, should clearly demonstrate the shortcomings in these data. However, the Working Group recommends that the data from the IBTS-surveys are reviewed for length distributions which might be useful in cohort analyses.

The stock shows signs of heavy exploitation as both catch and biomass appear to be decreasing. There is indication of a good 1997-year class recruiting to the 1998 fishery.

The current management regime with protection of juvenile herring, will probably present a limitation on the sprat fishery at its present stock size.

Table 8.1.1 Sprat catches in the North Sea ('000 t) 1984-1997. Catch in fjords of western Norway excluded (Data provided by Working Group members except where indicated). These figures do not in all cases correspond to the offical statistics and cannot be used for management purposes.

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997[1]
Division IVa West														
Denmark	-	0.9	0.6	0.2	0.1	+	-		0.26	0.6	-	-	-	-
Germany	-	-	-	-	-	-	-		-	-	-	-	-	-
Netherlands	-	6.7	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-
UK (Scotland)	+	6.1	+	+	-	-	+	-	-	-	0.1	+	-	-
Total	+	13.7	0.6	0.2	0.1	+	+	0.1	0.26	0.6	0.1	+	-	-
Division IVa East (North Sea) stock														
Denmark	-	+	0.2	+	+	+	-	-	-	+	+	+	0.3	+
Norway	-	-	-	-	-	-	-	-	0.54	2.5	+	+	-	-
Sweden	-	-	-	-	-	-	+	2.5	-	-	-	-	-	-
Total	-	+	0.2	+	+	+	+	2.5	0.64	2.5	+	+	0.3	+
Division IVb West														
Denmark	5.6	1.8	0.4	3.4	1.4	2.0	10.0	9.4	19.9	13.0	19.0	26.0	1.8	82.2
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	0.5	-	-	-	3.5	0.1	1.2	4.4	18.4	16.8	12.6	21.0	1.9	2.3
UK (England & Wales)	+	-	-	-	-	-	-	-	0.48	0.5	-	+	+	-
UK (Scotland)	+	-	-	0.1	-	-	-	-	-	0.5	-	-	-	-
Total	6.1	1.8	0.4	3.5	4.9	2.1	11.2	13.8	38.26	30.5	31.6	47.0	3.7	84.5
Division IVb East														
Denmark	62.1	36.6	10.3	28.0	80.7	59.2	59.2	67.0	66.56	136.2	251.7	283.2	74.7	10.9
Germany	0.6	0.6	0.6[3]	-	-	-	-	-	-	-	-	-	-	-
Norway	3.1	-	-	-	0.6	-	0.6	25.1	9.5	24.1	19.1	14.7	50.9	0.8
Sweden	-	-	-	-	-	-	+[2]	+[2]	-	-	-	0.2	0.5	-
Total	65.8	37.2	10.9	28.0	81.3	59.2	59.8	92.1	76.49	160.3	270.8	298.1	125.9	11.7
Division IVc														
Belgium	-	+	+	+	-	+[2]	+[2]	+[2]	-	-	-	-	-	-
Denmark	0.5	+	0.1	+	0.1	0.5	1.5	1.7	2.49	3.5	-	11.4	3.9	5.7
France	-	-	+	-	-	+[2]	-	+[2]	-	+	+	+	-	-
Netherlands	0.1	-	-	-	0.4	0.4[2,3]	-	+[2,3]	-	-	-	-	-	-
Norway	3.4	-	-	-	-	-	-	-	-	0.4	4.6	0.4	-	0.1
UK (England and Wales).	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.12[1]	2.0	2.9	0.2	2.6	1.4
Total	4.9	3.4	4.3	0.7	1.1	1.8	1.7	3.5	8.61	5.9	21.2	12.0	6.5	7.2
Total North Sea														
Belgium	-	+	+	+	-	+	+[2]	+[2]	-	-	-	-	-	-
Denmark	68.1	39.5	11.7	31.7	82.3	61.9	69.2	78.1	89.1	153.3	284.4	320.6	80.7	98.8
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	-	-	+	-	-	+	-	+[2,3]	-	+	-	+	-	-
Germany	0.6	-	0.6	-	-	-	-	-	-	-	-	-	-	-
Netherlands	0.1	0.6	-	0.5	0.4	0.4	-	+[2,3]	-	-	-	-	-	-
Norway	7.0	6.1	-	-	4.1	0.1	1.8	29.6	28.5	43.8	36.3	36.2	54.8	3.2
Sweden	-	-	-	-	-	-	+[2]	+[2]	-	0.1	-	0.2	0.5	-
UK (England and Wales)	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.6	2.6	2.9	0.2	2.6	1.4
UK (Scotland)	+	-	+	0.2	-	-	+	-	-	0.5	0.1	+	-	-
Total	76.7	49.6	16.4	33.1	87.4	63.3	71.2	109.5	124.2	200.3	323.7	357.2	136.6	103.4

[1]Preliminary.
[2]Official statistics.
[3]Includes Division IV a-c.

Table 8.1.2 Sprat catches ('000 t) in the fjords of western Norway, 1984–1997.

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996[1]	1997[1]
4.4	7.1	2.2	8.3	5.3	2.4	2.7	3.2	3.8	1.9	5.3	3.7	3.3	3.1

[1]Preliminary.

Table 8.1.3. Sprat catches (tonnes) in the North Sea by quarter*. Catches in fjords of Western Norway excluded.

Year	Quarter	Area					Total
		IVaW	IVaE	IVbW	IVbE	IVc	
1994	1	0	42	2616	17227	16091	35976
	2	0	0	242	10857	2	11101
	3	0	0	10479	184747	3572	198798
	4	97	0	18224	57959	1325	77605
	Total	97	42	31561	270790	20990	323480
1995	1	0	0	17752	16900	7324	41976
	2	0	0	1138	5752	1	6891
	3	0	86	25305	183500	6	208897
	4	0	5	2826	92054	4693	99578
	Total	0	91	47021	298206	12024	357342
1996	1	0	459	2471	81020	6103	90053
	2	0	0	615	2102	18	2735
	3	0	0	242	6259	0	6501
	4	0	353	411	36273	386	37423
	Total	0	812	3739	125654	6507	136712
1997	1	0	0	1025	147	7089	8261
	2	0	0	189	1054	0	1243
	3	0	3	27487	569	0	28059
	4	0	81	55814	9878	0	65773
	Total	0	84	84515	11648	7089	103336

* 1994 Data from Denmark and Norway
1995-1996 data from Denmark, Sweden, Norway and the UK
1997 data from Denmark, Norway and the UK (England and Wales)

Table 8.2.1 North Sea Sprat. Catch in numbers (millions) taken by quarter in 1994 and 1995 (Denmark and Norway) and in 1996 and 1997 (Denmark, Norway and UK-England).

Country	Fishing area	Quarter	Age					
			0	1	2	3	4	5+
1994								
Denmark	IVa	4	0.54	2.13	0.61	0.06		0
Denmark	IVb	1		485.02	670.18	268.1		
		2		2983.51	15	0		
		3		24541.41	272.95	0		
		4	887.11	4528.93	1289.6	144.85	2.97	5.38
Norway	IVb	1			794.57	172.58	12.82	
Denmark	IVc	1		22.74	673.41	150.43	27.99	
		2		0.27	0			
		4	1.26	85.25	23.6	4.12	0.23	
1995								
Denmark	IVa	4		0.23	0.17	0.02		
Denmark	IVb	1		5.78	1133.81	360.51		
		2		2.17	552.92	169.57		
		3	513.23	11686.05	7402.48	138.18		
		4		4327.87	3179.02	361.97		
Norway	IVb	1			1278.16	518.37	43.56	
		3			315.84	115.49	3.22	
Denmark	IVc	1			537.11	98.77	9.68	
		2			0.08	0.01		
		3		0.26	0.16	0.02		
		4		206.66	125.95	15.31		
1996								
Denmark	IVa	1		0.01	0.07	0.02		
		4		8.44	7.59	2.41		
Denmark	IVb	1		285.02	2278.78	634.29	63.97	8.73
		2		1.92	239.9	32.46	15.41	0.26
		3		400.52	100.72	22.94	0.33	
		4		1167.75	1050.05	333.66	5.41	
Norway	IVb	1		38.96	1984.32	1891.40	241.29	1.50
Denmark	IVc	1		33.55	268.22	74.66	7.53	1.03
		2		0.01	1.59	0.21	0.1	
		4		10.28	9.25	2.94	0.05	
UK(England)	IVc	1		167.2	84	21.49	3.63	
		4		4.21	2.12	0.54	0.09	
1997								
Denmark	IVb	3		1991.88				
		4	127.6	3597.21	996.22	117.78	58.1	
Norway	IVb	4	3.87	189.67	50.87	10.60	1.99	
UK(England)	IVc	1		12.1	51.1	37.3	9	0.4

Table 8.2.2. North Sea Sprat. Quarterly mean weight (g) at age in the landings in 1992-1997. Weight were estimated from data provided by Working Group members.

Year/	Age					
Quarter	0	1	2	3	4	5+
1992						
1		3.1	11.0	15.0	24.0	
2		6.6	14.6	19.0	22.7	
3	6.8	8.9	14.0	16.7	20.3	18.0
4	5.2	12.2	17.8	22.9	19.0	17.7
1993						
1			4.2	12.0	14.9	20.0
2						
3						
4	2.6	11.4	14.2	13.7		
1994						
1		1.8	9.6	12.8	17.4	
2		3.7	8.0			
3		7.0	10.8			
4	8.4	10.4	13.7	18.5	24.7	
Total	8.4	7.1	11.0	13.9	18.1	
1995						
1		3.0	9.4	12.9	19.4	
2		3.0	8.4	10.3		
3	2.4	7.6	13.9	16.4	20.7	
4		10.5	13.9	16.2		
Total	2.4	8.4	12.8	14.0	19.5	
1996						
1		3.9	9.3	14.9	15.3	16.1
2		6.9	8.4	11.6	20.0	15.2
3		11.6	14.2	18.2	21.5	
4		12.1	15.9	17.2	20.5	
Total		10.6	10.6	15.2	15.6	16.0
1997						
1		8.0	10.0	15.0	17.0	19.0
2						
3		14.2				
4	3.7	11.9	16.4	19.1	19.6	
Total	3.7	11.9	16.1	18.2	17.5	19.0

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Table 8.2.3 North Sea Sprat. Sampling commercial landings for biological samples in 1996 and 1997.

Country	Quarter	Landings 000t	No samples	No fish meas.	No fish aged
1996					
Denmark	1	34.2	13	2635	743
	2	2.7	11	109	
	3	8.5	5	115	
	4	37.3	3	314	337*
Total		80.7	32	3,173	743
Norway	1	55.8	36	3459	2774
	2	0			
	3	0			
	4	0			
Total		55.8	36	3,459	2,774
Total North Sea		137	68	6632	3517
1997					
Denmark	1	6.8	4	408	0
	2	1.2	4	13	0
	3	28.1	4	278	77
	4	62.7	16	1,774	184
Total		98.8	28	2,473	261
Norway	1	0.1	0	0	0
	2				
	3				
	4	3.1	8	800	785
Total		3.2	8	800	785
Total North Sea		102	36	3273	1046

Table 8.3.1 North Sea Sprat. Abundance indices by age group from IBTS(February), 1981-1997, in the standard sprat area (Div. IVb).

Year	No rect.	No hauls	Age					
			1	2	3	4	5+	Total
1981	70	146	957.28	1414.02	341.79	4.11	0.31	2717.51
1982	67	155	245.91	510.86	125.42	5.64	0.19	888.02
1983	79	211	201.21	764.08	192.43	8.26	0.85	1166.83
1984	80	251	383.63	393.57	47.43	6.66	0.41	831.70
1985	79	289	675.49	305.00	38.22	4.32	0.90	1023.93
1986	78	285	68.22	104.77	29.38	1.31	0.26	203.94
1987	78	299	758.28	74.68	24.80	3.61	0.21	861.58
1988	78	208	152.29	1410.52	109.66	8.78	0.00	1681.25
1989	79	236	4293.66	445.72	318.65	4.10	13.44	5075.57
1990	78	192	115.16	567.46	149.83	30.79	0.59	863.83
1991	78	179	834.45	104.89	27.84	2.63	1.17	970.98
1992	79	185	1562.20	344.08	38.25	5.51	0.45	1950.49
1993	79	181	1732.54	602.01	84.12	4.35	0.06	2423.08
1994	78	173	4084.89	1397.77	129.96	2.79	0.67	5616.08
1995	79	166	1059.30	2643.93	134.01	3.23	1.12	3841.59
1996	78	146	346.37	483.45	141.96	23.64	0.56	995.98
1997	79	159	887.43	389.35	33.80	3.42	0.15	1314.15
1998	79	197	1650.35	1744.60	286.34	12.14	2.32	3695.75

Table 8.6.1 North Sea Sprat. SHOT forecast of landings in 1998 using total landings and the total IBTS-indices as input data.

North Sea Sprat — SHOT forecast spreadsheet version 7
Total Index — Mars 1998

running recruitment weights

older	0.00	G-M =	0.00
central	1.00	exp(d)	1.00
younger	0.00	exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1981	209	2718		0.77	0.23				271		
1982	154	888	888	0.77	0.23	138			200		
1983	88	1167	1167	0.77	0.23	68	362	314	114		
1984	77	832	832	0.77	0.23	74	125	117	100		
1985	50	1024	1024	0.77	0.23	42	99	94	65	122	94
1986	16	204	204	0.77	0.23	6	17	24	21	32	24
1987	33	862	862	0.77	0.23	38	69	56	43	73	56
1988	87	1681	1681	0.77	0.23	103	123	103	113	133	103
1989	63	5076	5076	0.77	0.23	56	357	295	82	383	295
1990	71	864	864	0.77	0.23	73	39	44	92	57	44
1991	110	971	971	0.77	0.23	122	46	52	143	67	52
1992	125	1950	1950	0.77	0.23	129	103	105	162	136	105
1993	200	2423	2423	0.77	0.23	222	133	131	260	170	131
1994	324	5616	5616	0.77	0.23	361	335	304	421	395	304
1995	357	3842	3842	0.77	0.23	367	234	254	464	330	254
1996	137	996	996	0.77	0.23	71	65	132	178	172	132
1997	103	1314	1314	0.77	0.23	93	87	98	134	127	98
1998		3696	3696	0.77	0.23		244	212		275	212

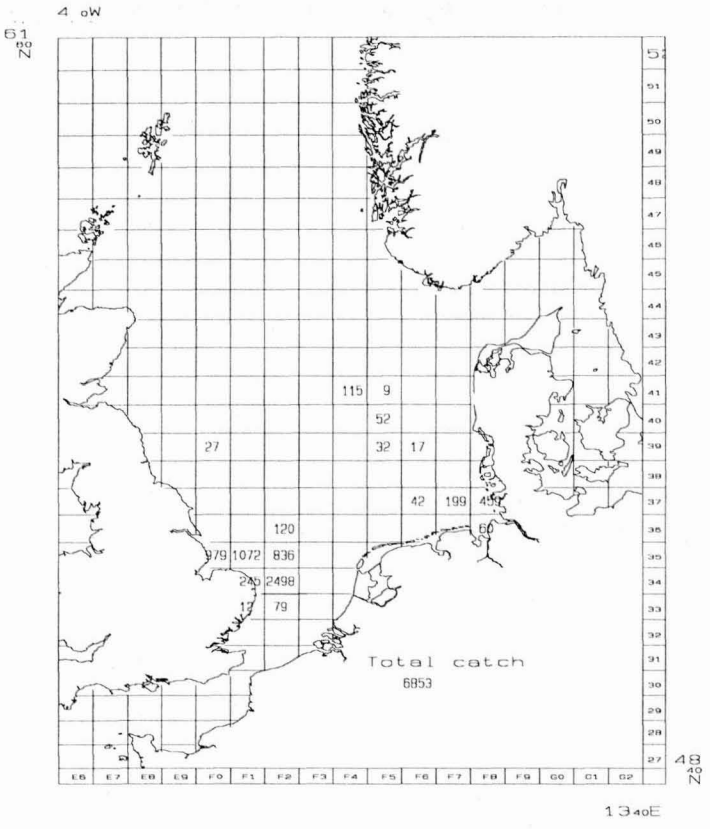


Figure 8.1.1. Sprat North Sea catches (in tonnes) - January 1997

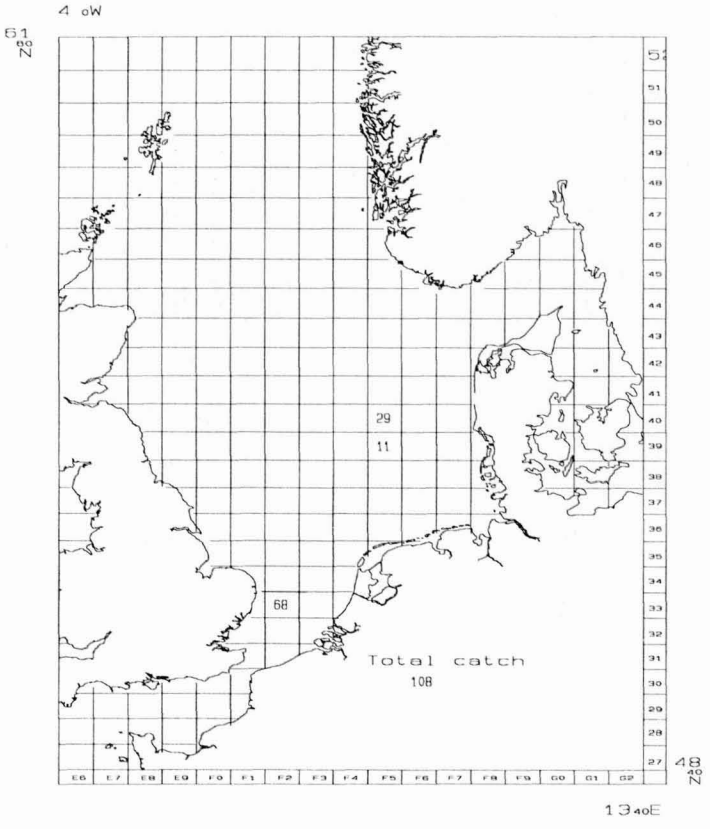


Figure 8.1.2. Sprat North Sea catches (in tonnes) - February 1997

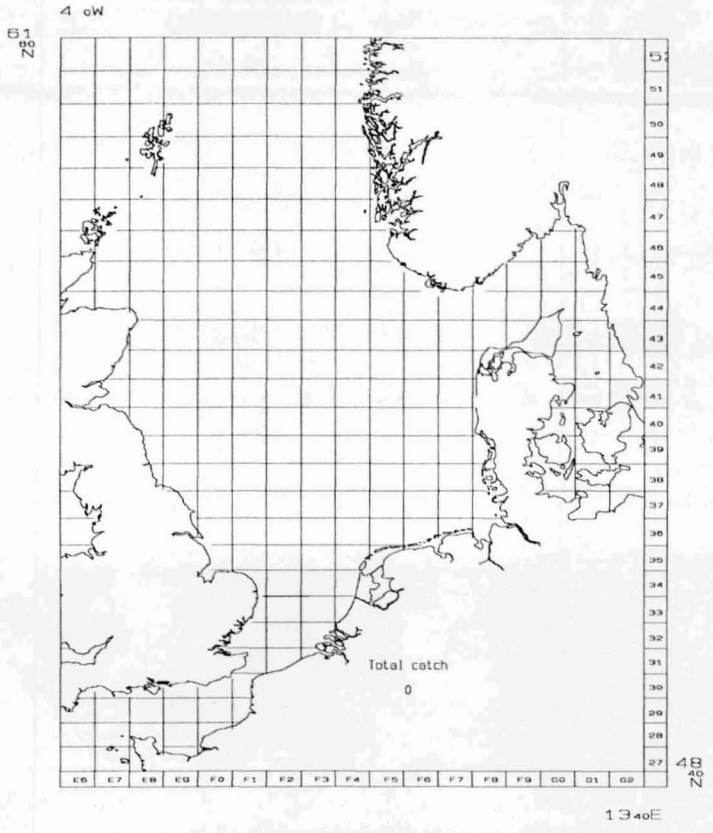


Figure 8.1.3. Sprat North Sea catches (in tonnes) - March 1997

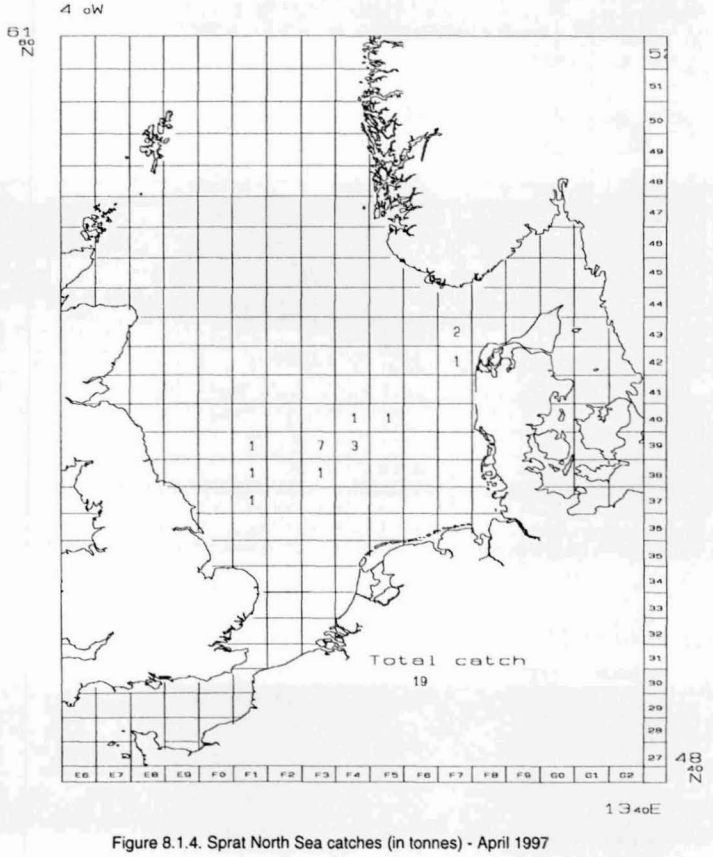


Figure 8.1.4. Sprat North Sea catches (in tonnes) - April 1997

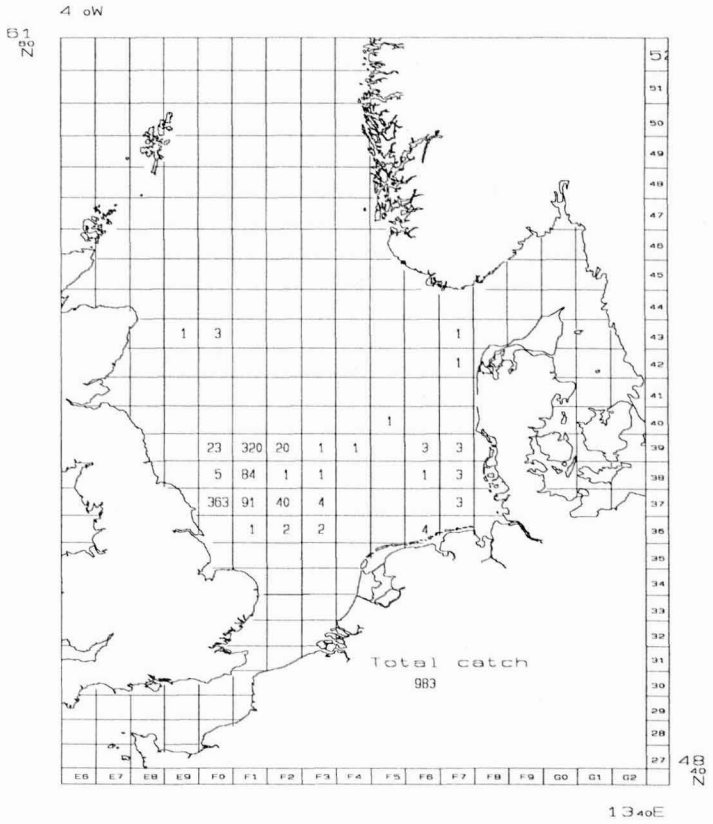


Figure 8.1.5. Sprat North Sea catches (in tonnes) - May 1997

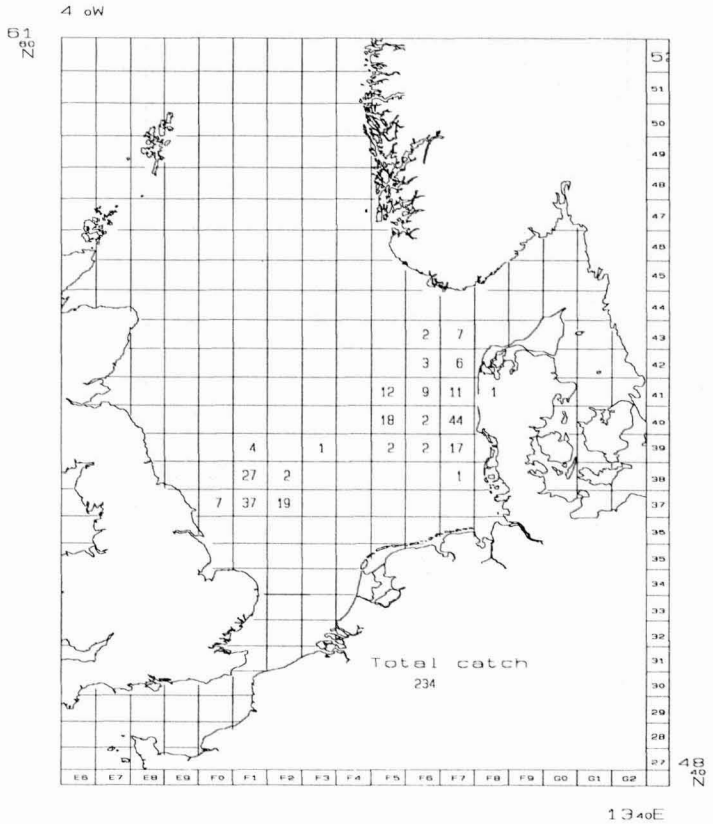


Figure 8.1.6. Sprat North Sea catches (in tonnes) - June 1997

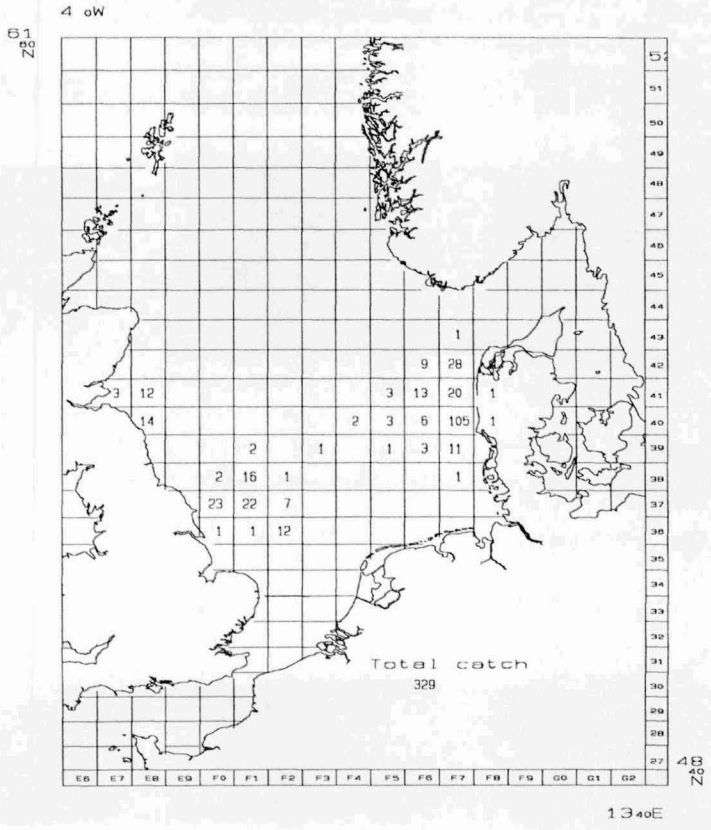


Figure 8.1.7. Sprat North Sea catches (in tonnes) - July 1997

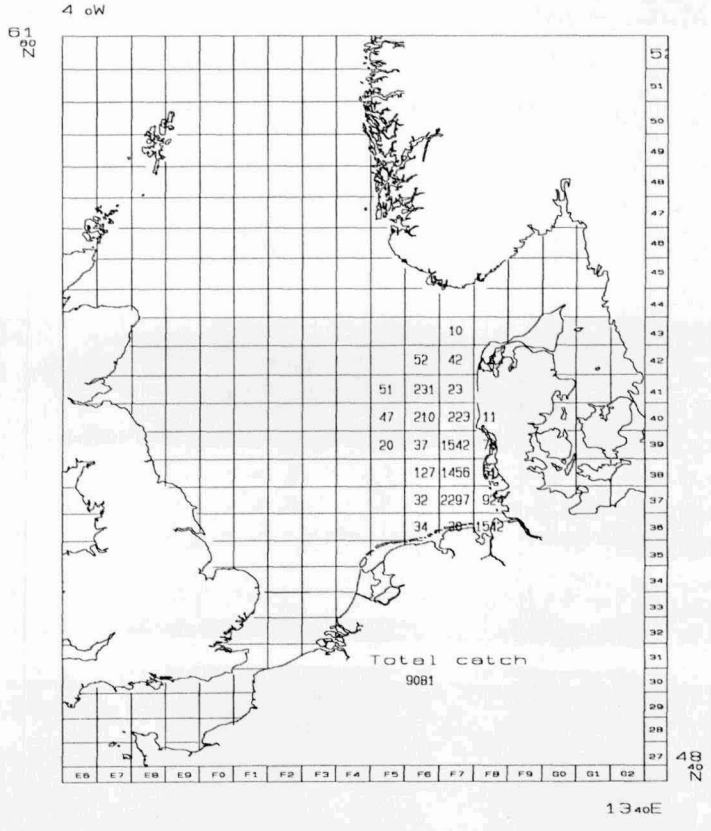


Figure 8.1.8. Sprat North Sea catches (in tonnes) - August 1997

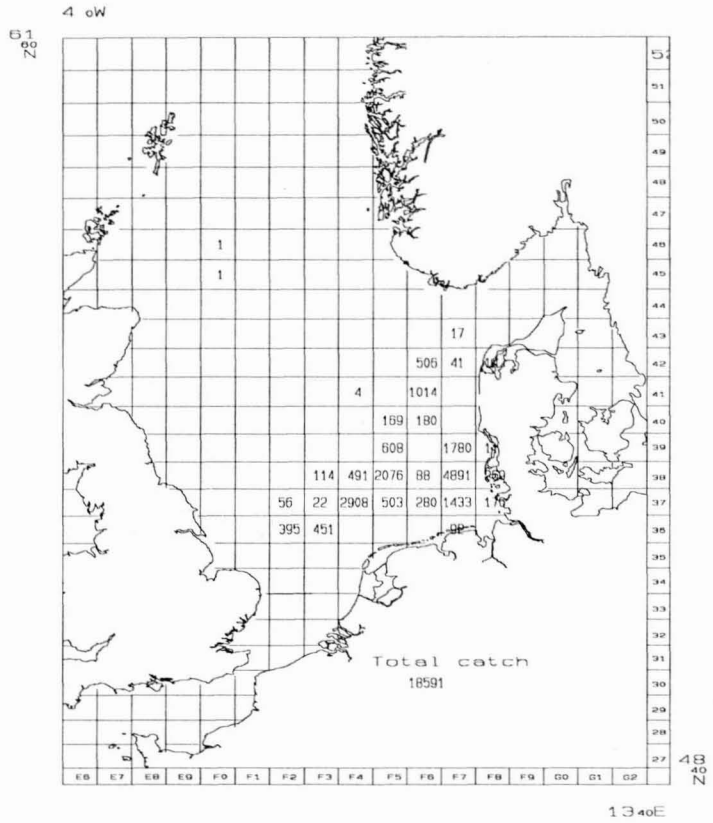


Figure 8.1.9. Sprat North Sea catches (in tonnes) - September 1997

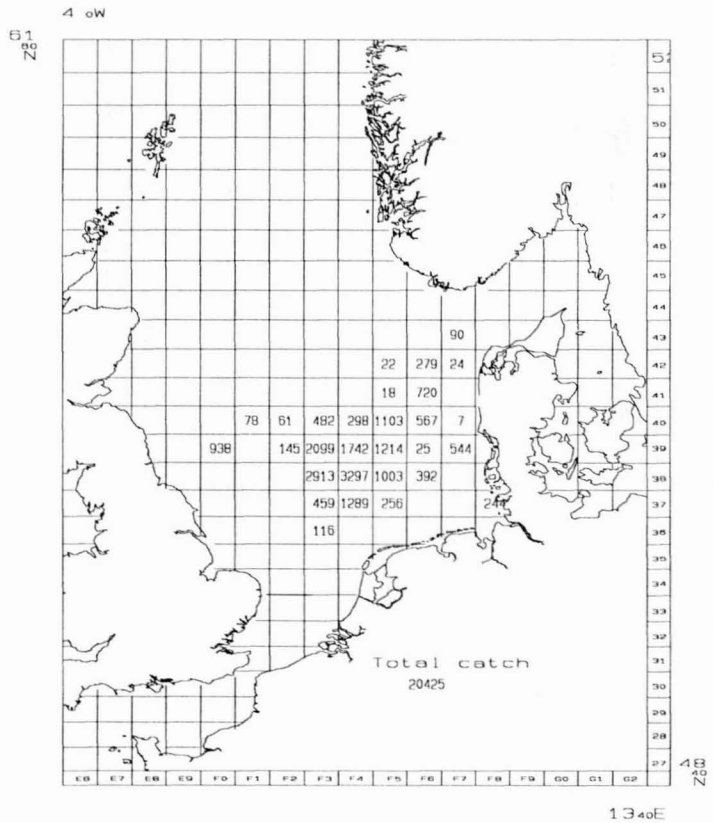


Figure 8.1.10. Sprat North Sea catches (in tonnes) - October 1997

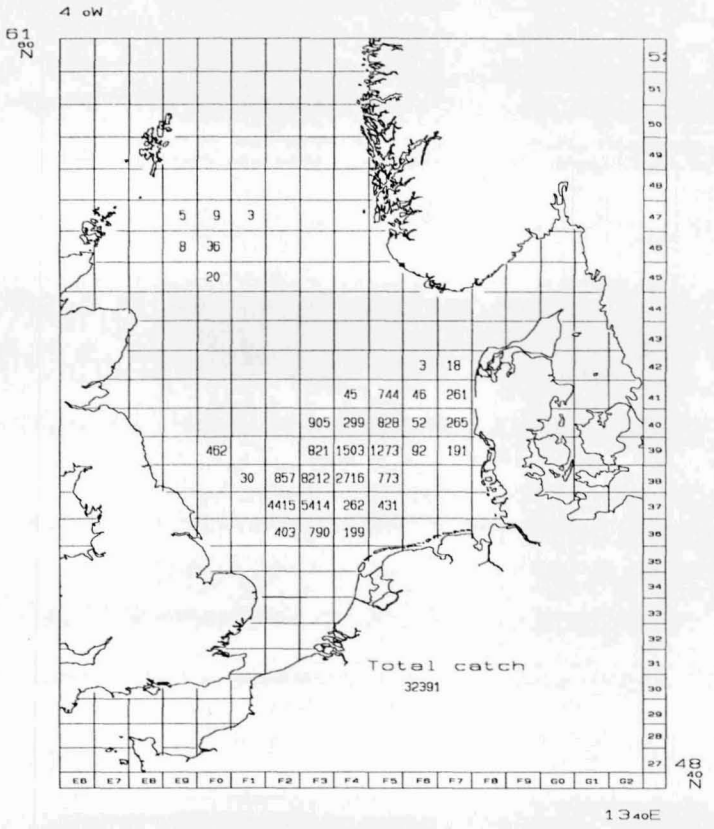


Figure 8.1.11. Sprat North Sea catches (in tonnes) - November 1997

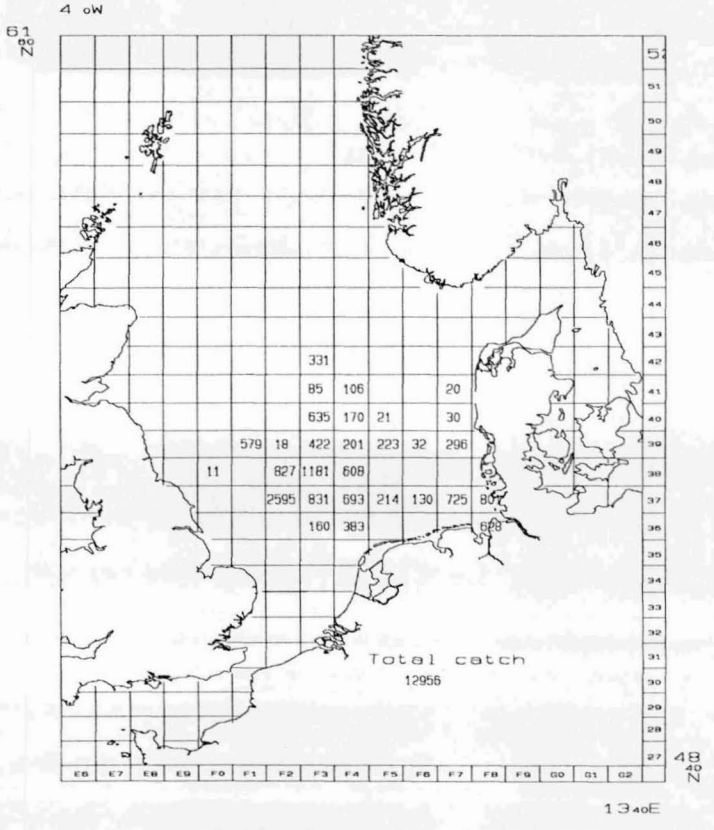


Figure 8.1.12. Sprat North Sea catches (in tonnes) - December 1997

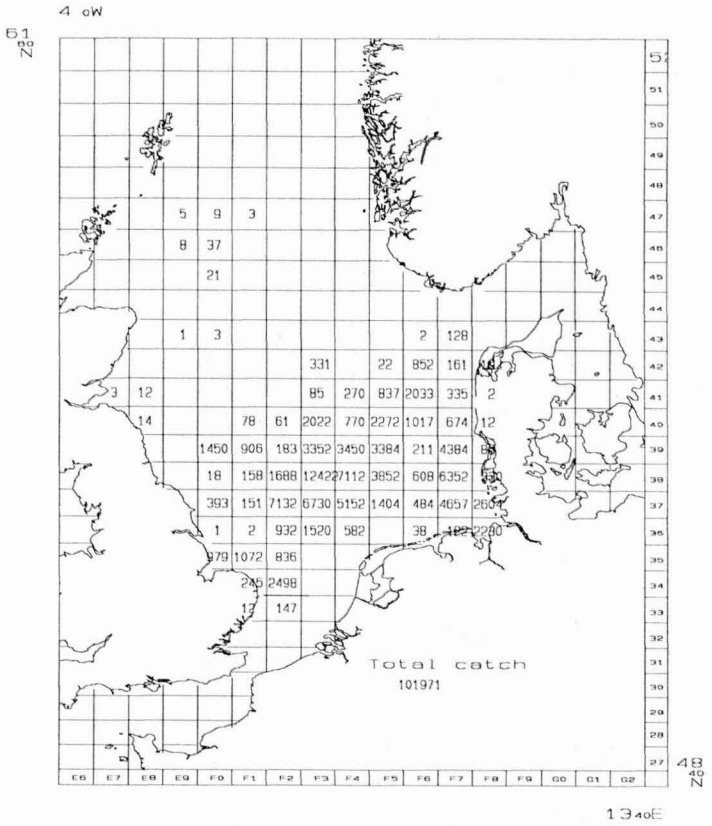
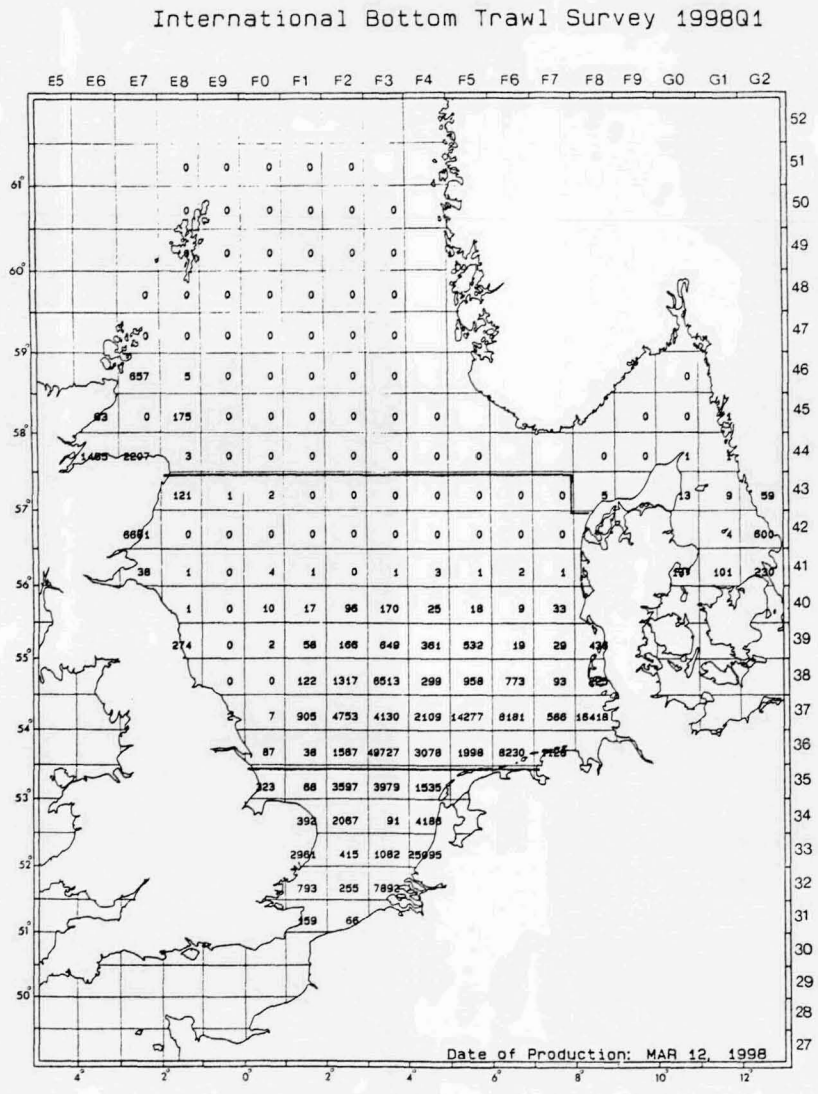


Figure 8.1.13. Sprat North Sea catches (in tonnes) - Year 1997



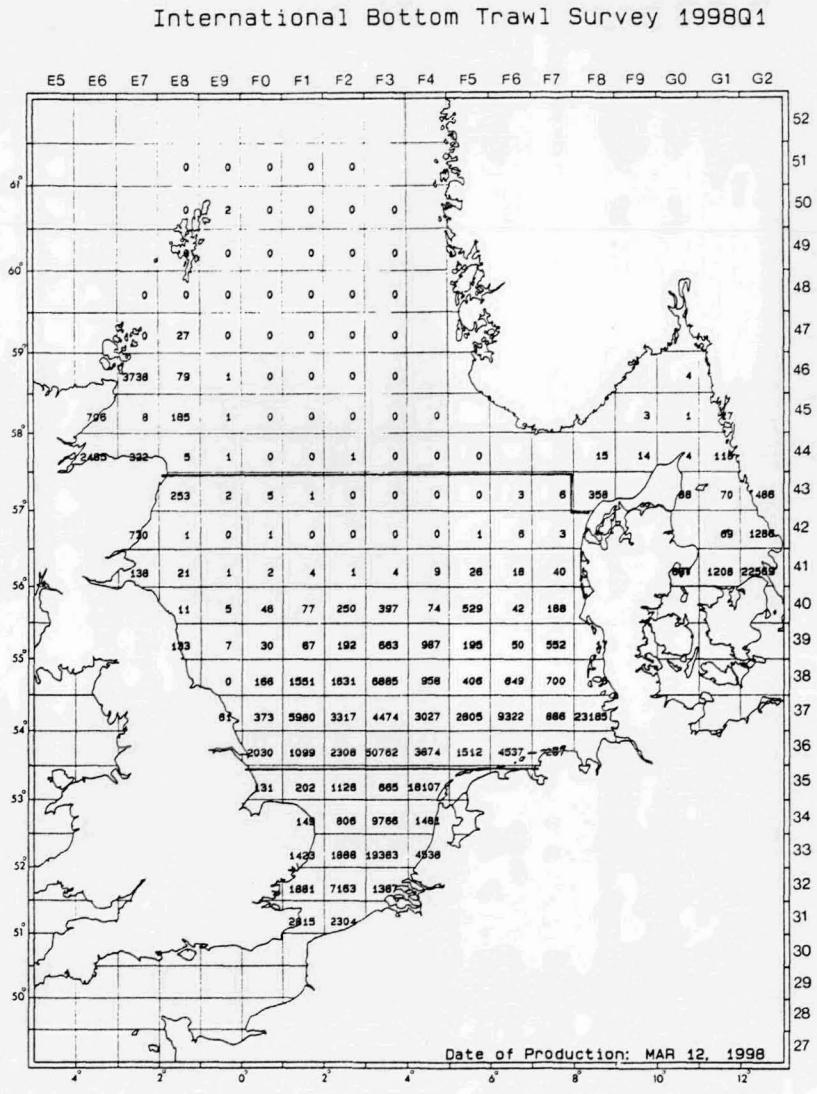


Figure 8.3.1. SPRAT. Distribution by age groups in the IBTS(February) 1998, in the North Sea and Division IIIa.

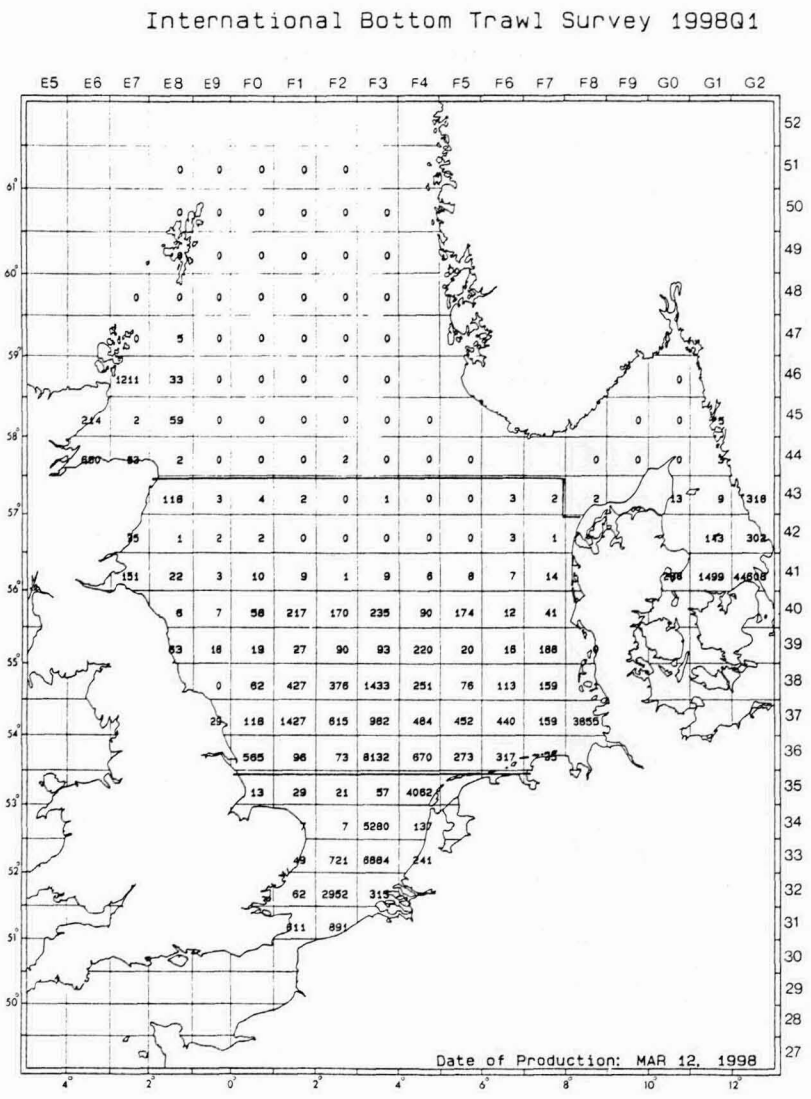


Figure 8.3.1. (continued).

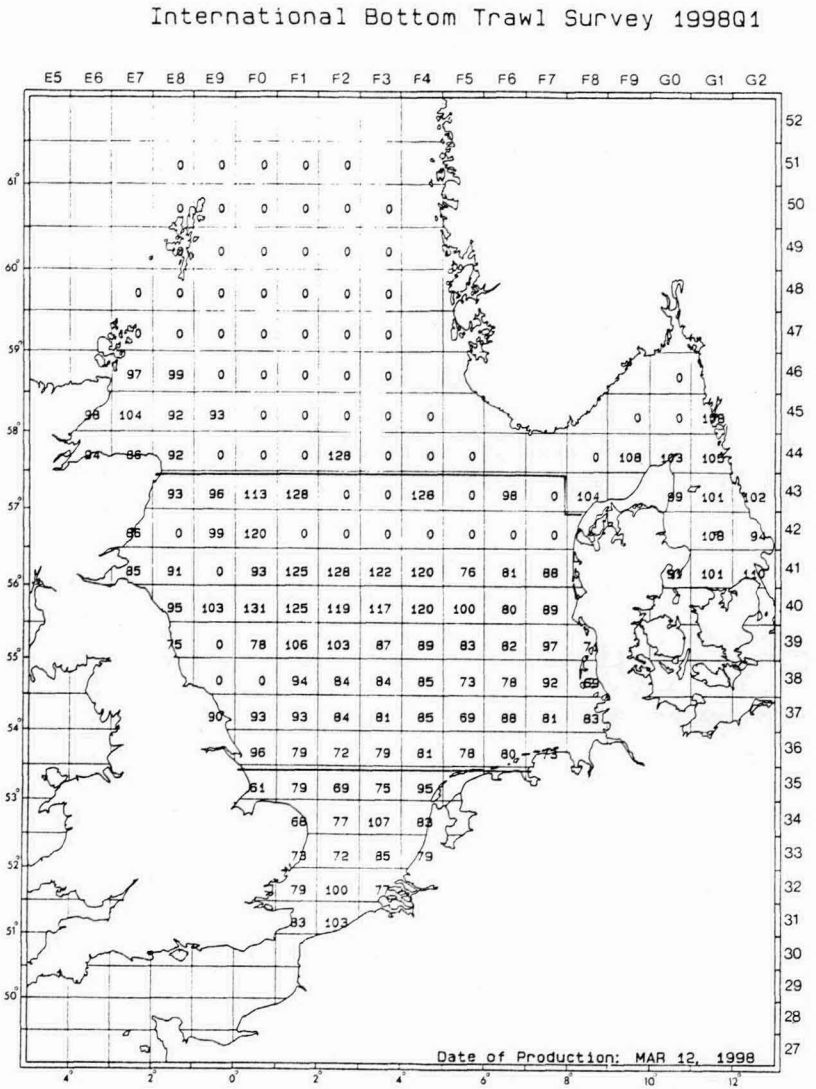
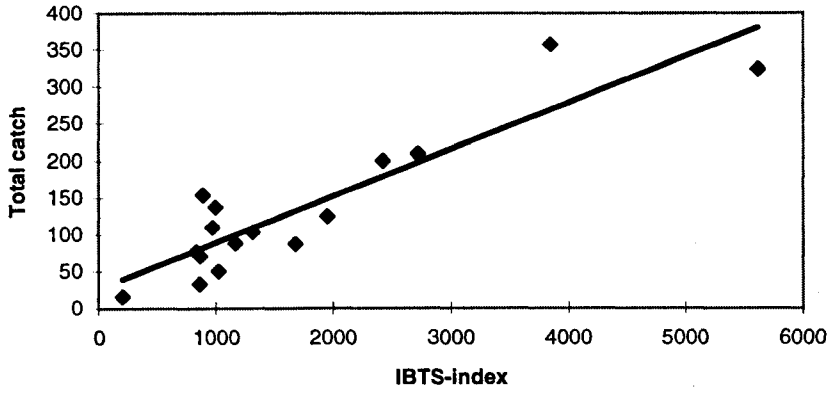


Figure 8.3.2. SPRAT. Mean length (mm) of age group 1 in the IBTS(February) 1998, in the North Sea and Division IIIa.

Figure 8.6.1. North Sea Sprat. IBTS indices vs total catches in 1981-1996, excl. 1989-index. (rsq=0.81)



9 SPRAT IN DIVISION VIID,E

9.1 The fishery

9.1.1 ACFM advice applicable for 1998

The TAC for this fishery was set to 12 000t for 1997 and 1998. No ACFM advice has been provided in recent years.

9.1.2 Catches in 1997

Table 9.1.1 shows the nominal landings in 1983–1997. The landings in 1997, as reported by UK(England and Wales), were at the same low level as in the last years. Monthly catches for the Lyme Bay sprat fishery show that the catches are mainly taken in the third quarter (Table 9.1.2). Monthly and annual distributions of catches by rectangle are shown in Figures 8.1.1-8.1.13.

9.2 Catch Composition

Catch compositions and the mean weights for 1991–1997 are given in Table 9.2.1 and Table 9.2.2. In 1997 the catches were dominated by 2-and 3-group sprat.

Table 9.1.1 Nominal catch of sprat (t) in Divisions VIId,e, 1984-1997.

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996[1]	1997[1]
Belgium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	1,417	-	15	250	2,529	2,092	608	-	-	-	-	-	-	-
France	47	14	-	23	2	10	-	-	35	2	1	+	-	-
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	589	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Engl.& Wales)	2,402	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790	1,798	3,177	1,515	1,789	1,621
Total	4,455	3,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825	1,800	3,177	1,515	1,789	1,621

[1]Preliminary

Table 9.1.2 Lyme Bay sprat fishery. Monthly catches (t). (UK vessels only).

Season	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
1991/92	0	0	0	205	450	952	60	358	258	109	51	0	2443
1992/93	0	0	0	302	472	189	294	248	284	158	78	0	2025
1993/94	0	8	0	156	82	302	529	208	417	134	53	0	1889
1994/95	0	0	0	299	834	545	608	232	112	68	0	0	2698
1995/96	0	0	0	154	409	301	307	151	15	80	28	4	1449
1996/97	0	0	0	309	452	586	47	243	239	74	30	0	1980
1997/98	2	0	14	259	625	105	255	19					1279

Table 9.2.1. Lyme Bay sprat fishery. Number caught by age group (millions).

Season	0/1	1/2	2/3	3/4	4/5	5/6
1991/92	1.7	56.03	44.69	16.24	0.57	0.03
1992/93[1]	0.22	28.23	48.61	12.94	1.56	0
1993/94[2]	0	0.83	44.81	15.7	1.95	0.58
1994/95	No data					

	0	1	2	3	4	5	6
1995[3]		0.33	5.20	2.31	0.23	0.03	
1996	0.72	12.60	71.35	22.00	1.24	0.20	
1997		8.81	42.88	31.87	5.43	0.10	

[1] August to December only (samples in August and December only, so these are best estimates

[2] August to December only (samples in August, September and November only, so these are best estimates

[3] Only September (one sample)

Table 9.2.2 Lyme Bay area SPRAT. 1991–1997 mean weight (g) at age.

		Age						
Season	Quarter	0/1	1/2	2/3	3/4	4/5	5/6	Overall mean
1991/91	3	4.7	16.6	22.6	25.4	29.2	34.6	20.7
	4	6.6	17.1	23	26.3	30.9		21.0
	1	5.7	13.3	17.5	20.2	24.1		14.4
1992/93	3	4.2	12.1	22.8	24.6	32.4		21.8
	4		15.8	20.0	23.8	24.8		21.0
	1		13.2	17.1	21.2			14.2
1993/94	3			19.1	22.2	20.8		19.8
	4[1]		14.2	18.9	24.5	28.1	25.5	20.6

		Age							
Season	Quarter	0	1	2	3	4	5	6	Overall mean
1995	3[2]	-	-	12.0	17.0	19.0	21.0	29.0	-
1996	1			8.0	11.0	13.0	13.0		-
	4	8.0	15.0	19.0	23.0	28.0			-
1997	1		10.0	15.0	19.0	22.0	28.0		
	3		13.0	17.0	19.0	24.0			
	4		17.0	20.0	22.0	23.0			

[1]Based on November samples only.
[2]Based on September sample only.

10 SPRAT IN DIVISION IIIA

10.1 The Fishery

10.1.1 ACFM advice applicable for 1997 and 1998

ACFM advice on a sprat TAC has not been provided in recent years. Sprat has been landed under the TAC for the mixed-clupeoid fishery, including all catches of all species taken in this fishery. This mixed-clupeoid quota was closed after negotiation between Norway and EU in 1997 and does therefore not exist in 1998.

The TAC for this fishery, as adopted by the management bodies, were 40,000t in 1997. The TAC for 1998 is 40,000 t, with a restriction in by- catches of herring not to exceed 12,000 t.

10.1.2 Landings

The proportion of sprat in the mixed-clupeoid fishery increased substantially between 1993 and 1994. In 1994 and in 1995 there was, for the first time in several years, a directed sprat fishery for industrial purposes in Skagerrak and the northern part of Kattegat. The high sprat catches were not seen in 1996 and in 1997.

The total annual landings for Division IIIa by area and country in 1974–1997 are given in Table 10.1.1. The total landings in 1997 were 16,000 t. There has been a reduction in total landings from the peak of 96,000 t in 1994. The Norwegian and Swedish landings in 1997 were low and include the coastal and fjord fisheries.

Landings by countries and by quarter are shown in Table. 10.1.2. About 70 % of the total landings were taken in the fourth quarter. Insignificant catches were landed for industrial purposes in the second half of September. There was again in 1997 a total ban on the directed Danish sprat fishery (mixed-clupeoid) from 16 March to 30 September.

10.1.3 Fleet

Fleets from Denmark, Norway and Sweden conduct the sprat fishery in Division IIIa.

The Danish landings are taken by two fleet categories:

1. a directed sprat (mixed-clupeoid) trawl fishery, prior to 1997 using minimum mesh size of 32 mm but in 1997 it was allowed to use 16 mm mesh size and,
2. by catches from the small meshed (16 mm) fisheries for Norway pout, blue whiting and sandeel. The landings are all used for reduction purposes.

The Swedish sprat fishery can be divided into three categories:

1. by-catches in a directed herring trawl fishery with minimum mesh size of 32 mm and by purse seines (see herring fleet C defined in section 2.10),
2. directed sprat fishery for human consumption carried out by purse seines (see herring fleet D) and
3. a directed sprat (mixed-clupeoid) trawl fishery with mainly 16, 18 or 22 mm mesh size, for human consumption and for reduction purposes, (see herring fleet D).

The Norwegian sprat fishery in Div. IIIa is an inshore purse seine fishery for human consumption.

10.2 Catch composition

10.2.1 Catches in number and weight at age

No weight-at-age data in the catches were available for 1983-1991. For 1992–1993 only Denmark supplied data, in 1994 and 1995 by Denmark and Sweden, and in 1996 and 1997 only by Denmark.

The numbers and the mean weight by age in the industrial landings in 1992–1997 are presented in Tables 10.2.1 and Table 10.2.2, respectively. Sprat of the 1996-year class dominated the landings. In 1997, 0-gr sprat were represented in the catches in the third and fourth quarter.

10.2.2 Quality of catch and biological data

Denmark introduced an improved monitoring system for management and scientific purposes in 1996. The high sampling level in 1996 was continued in 1997. Denmark provided samples used for estimation of sprat age and mean weight at age, for the industrial/"mixed-clupeoid" fisheries. The amount of sampling has improved and is considered as adequate. As in previous years, no samples of sprat were taken from the fisheries for human consumption. Details on the sampling for biological data are shown in Table 10.2.3.

10.3 Recruitment

10.3.1 Abundance of 1-group and older sprat from IBTS

The IBTS(February) indices for 1984–1995, were revised by the 1995 Herring Working Group (ICES 1995/Assess:13). The indices, calculated as mean cpue (no./hr) weighted by the area with water depths between 10 and 150 m of the rectangle, are presented in Table 10.3.1. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1,2 and 3+, and the mean length (mm) of 1-gr sprat in Figure 8.3.2.

The 1998 IBTS index of the 1-group is the lowest recorded while the index of 2- gr appears to be very high compared with the 1-gr index in 1997. The age/length keys from the 1998 IBTS-survey indicate difficulties in separating 1-and 2-group sprat. Age determination problems might as well be the reason for the high 4-gr index. The total 1998 index for Div. IIIa was higher than in 1997 and at a level around the mean for the period.

The indices from the 1998 survey confirm that the age structure of sprat from the survey is rather variable, with difficulties in following strong and weak cohorts from year to year. The ratio 1-gr/2-gr has varied between 0.04(1998) and 2.91(1984).

10.4 Acoustic Survey

Acoustic estimates of sprat has been included in the ICES Co-ordinated Herring Acoustic surveys since 1996. In 1996 the total estimates was 7.9 x 10^8 fish or 14,267 tonnes. About 95 % of the biomass was recorded in Kattegat. During the 1997-acoustic surveys only single specimens of sprat were found (Anon. 1998b).

10.5 State of the Stock

No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year is no exception. The Working Group concluded that the data available do not allow any assessment which could be helpful for management.

10.6 Projection of Catch and Stock

IBTS(February) index plotted vs the catch in the same year (r^2=0.04) is shown in Figure 10.6.1. The 1994 and 1995 observations are anomously high.

The estimated landings for 1997 using the total IBTS-indices in a SHOT-estimate (Shepherd, 1991) was found around 20,000 tonnes, Table 10.6.1. Other runs using the 1-group indices and the combined 1-and 2-group indices gave yields for 1998 in the range of 5–12,000 tonnes.

10.7 Management Considerations

The recruitment between years does not appear to be driven directly by fishing effort. The sprat stock has in recent years been mainly fished together with herring, except from 1994 and 1995 when a directed sprat fishery was implemented. The human consumption fishery is only a minor part of the total catch. The natural variability in the stock is high. The current management regime with protection of juvenile herring, will probably present a limitation on the sprat fishery at its present stock size.

10.8 Research Recommendations. See Section 1.8

Table 10.1.1 Landings of SPRAT in Division IIIa Catch (in tonnes 10^{-3}). (Data provided by Working Group members). These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	Skagerrak				Kattegat			Div. IIIa total
	Denmark	Sweden	Norway	Total	Denmark	Sweden	Total	
1974	17.9	2.0	1.2	21.1	31.6	18.6	50.2	71.3
1975	15.0	2.1	1.9	19.0	60.7	20.9	81.6	100.6
1976	12.8	2.6	2.0	17.4	27.9	13.5	41.4	58.8
1977	7.1	2.2	1.2	10.5	47.1	9.8	56.9	67.4
1978	26.6	2.2	2.7	31.5	37.0	9.4	46.4	77.9
1979	33.5	8.1	1.8	43.4	45.8	6.4	52.2	95.6
1980	31.7	4.0	3.4	39.1	35.8	9.0	44.8	83.9
1981	26.4	6.3	4.6	37.3	23.0	16.0	39.0	76.3

Year	Skagerrak			Kattegat		Div. IIIa	Division IIIa Total
	Denmark	Sweden	Norway	Denmark	Sweden	Sweden	
1982	10.5	-	1.9	21.4	-	5.9	39.7
1983	3.4	-	1.9	9.1	-	13.0	26.4
1984	13.2	-	1.8	10.9	-	10.2	36.1
1985	1.3	-	2.5	4.6	-	11.3	19.7
1986	0.4	-	1.1	0.9	-	8.4	10.8
1987	1.4	-	0.4	1.4	-	11.2	14.4
1988	1.7	-	0.3	1.3	-	5.4	8.7
1989	0.9	-	1.1	3.0	-	4.8	9.8
1990	1.3	-	1.3	1.1	-	6.0	9.7
1991	4.2	-	1.0	2.2	-	6.6	14.0
1992	1.1	-	0.6	2.2	-	6.6	10.5
1993	0.6	4.7	1.3	0.8	1.7	-	9.1
1994	47.7	32.2	1.8	11.7	2.6	-	96.0
1995	29.1	9.7	0.5	11.7	4.6	-	55.6
1996	7.0	3.5	1.0	3.4	3.1	-	18.0
1997[1]	7.0	3.1	0.4	4.6	0.7	-	15.8

[1]Preliminary.

Table 10.1.2. Div. IIIa Sprat. Landings of sprat ('ooo t) by quarter by the three countries. (Data provided by the Working Group members)

	Quarter	Denmark	Norway	Sweden	Total
1994	1	0.3	0.0	0.5	0.8
	2	6.0	0.0	0.3	6.3
	3	37.0	0.1	23.0	60.1
	4	16.1	1.7	11.0	28.8
	Total	59.4	1.8	34.8	96.0
1995					
	1	4.8	0.1	4.8	9.7
	2	10.4	0.0	0.9	11.3
	3	19.3	0.0	2.3	21.6
	4	6.3	0.4	6.3	13.0
	Total	40.8	0.5	14.3	55.6
1996					
	1	5.6	+	4.2	9.8
	2	3.4		0.2	3.6
	3	+	0.4	+	0.4
	4	1.4	0.6	2.2	4.2
	Total	10.4	1.0	6.6	18.0
1997					
	1	0.7	-	0.3	1.0
	2	0.4	-	1.2	1.6
	3	2.3	-	0.1	2.4
	4	8.2	0.4	2.2	10.8
	Total	11.6	0.4	3.8	15.8

Table 10.2.1 Division IIIA Sprat. Landed numbers (millions) of sprat by age groups in 1994-1997.

Country	Fishing area	Quarter	Age					
1994			0	1	2	3	4	5+
Denmark	Skagerrak	1		16.28				
		2		1191.33				
		3		4221.72	21.21			
		4	16.47	874.75	23.79			
Denmark	Kattegat	1		5.02	7.39	3.48	0.31	
		2		0.92	36.53	6.30		
		3	3.69	632.38	5024.00	42.11		
		4	5.73	287.74	42.28	21.50		
Sweden	Skagerrak	1						
		2						
		3	18.49	2135.32	37.64	8.21	2.08	6.53
		4	1.51	911.44	7.30	7.10	0.32	
Total Div.IIIa		1	0.00	21.30	7.39	3.48	0.31	0.00
		2	0.00	1192.25	36.53	6.30	0.00	0.00
		3	22.18	6989.42	5082.85	50.32	2.08	6.53
		4	23.71	2073.93	73.37	28.60	0.32	0.00
1995								
Denmark	Skagerrak	1		66.07	199.32	8.77		
		2		1026.38	758.87	34.58		
		3		1304.54	108.83			
		4		255.41	2.32			
Denmark	Kattegat	1		205.54	194.92	32.79	21.25	7.38
		2		124.37	117.94	19.84	12.86	4.48
		3		315.11	16.64	13.31		
		4		277.62	19.66		0.60	
Sweden	Div.IIIa	1		21.54	342.64	8.70	4.39	1.08
		2		22.37	56.35	2.94	1.46	
		3						
		4		315.08	109.50	28.14	9.34	
TOTAL	Div. IIIa	1		293.15	736.88	50.26	25.64	8.46
		2		1173.12	933.16	57.36	14.32	4.48
		3		1619.65	125.47	13.31	0.00	0.00
		4		848.11	131.48	28.14	9.94	0.00
1996								
Denmark	Skagerrak	1		125.22	128.11	7.88	1.31	0.00
		2		0.00	232.44	23.83	0.00	0.00
		3		0.20	1.04	0.17	0.01	0.00
		4		11.15	59.22	9.78	0.73	0.00
Denmark	Kattegat	1		40.54	185.99	27.82	7.68	2.91
		2		0.51	5.55	0.74	0.41	0.04
		3		0.00	0.00	0.00	0.00	0.00
		4		6.77	35.98	5.94	0.44	0.00
TOTAL	Div.IIIa	1		165.76	314.10	35.69	9.00	2.91
		2		0.51	237.99	24.57	0.41	0.04
		3		0.20	1.04	0.17	0.01	0.00
		4		17.92	95.20	15.72	1.17	0.00
1997								
Denmark	Skagerrak	1		0.00	0.75	3.99	4.49	1.00
		2		0.67	1.85	13.11	1.01	0.17
		3	0.59	115.08	2.24	0.24	0.00	0.00
		4	12.05	301.24	21.42	0.00	0.00	0.00
Denmark	Kattegat	1		0.00	1.75	9.37	10.54	2.35
		2		0.06	0.16	1.16	0.09	0.01
		3	2.58	37.57	4.70	1.16	4.55	0.00
		4	11.58	168.77	21.12	5.22	20.44	0.00
TOTAL	Div.IIIa	1	0	0	2.5	13.36	15.03	3.35
		2	0	0.73	2.01	14.27	1.1	0.18
		3	3.17	152.65	6.94	1.4	4.55	0
		4	23.63	470.01	42.54	5.22	20.44	0

Table 10.2.2. Div. IIIa Sprat. Quarterly mean weight (g) at age in the landings in 1994-1997. (1994-1995 Danish and Swedish data, 1996-1997 Danish data)

Quarter	Age					
1994	0	1	2	3	4	5+
1		4.5	18.3	20.3	24.7	
2		4.3	20.0	22.8		
3	7.8	8.1	17.4	21.6	22.1	17.6
4	4.2	11.2	17.1	22.3	31.0	
Total	6.0	8.4	17.8	21.9	27.2	17.6
1995						
1		2.3	8.9	18.8	22.9	26.1
2		2.9	7.3	12.4	23.7	27.0
3		10.5	18.4	15.5		
4		11.5	15.6		18.2	
Total		7.8	9.2	15.3	22.2	26.4
1996						
1		9.2	10.6	14.2	17.4	17.7
2		8.6	12.5	15.1	17.4	17.0
3		4.2	10.9	15.5	21.0	
4		4.2	10.9	15.5	21.0	
Total		8.7	7.6	14.8	19.6	17.7
1997						
1			17.3	18.6	21.8	26.0
2		8.3	17.6	20.0	22.1	31.0
3	4.1	13.6	17.2	21.1		
4	4.7	14.7	17.5		19.5	
Total	4.6	14.4	17.5	19.6	20.4	26.3

Table 10.2.3 Division IIIa Sprat. Sampling commersial landings for biological samples in 1996 and 1997.

Country	Quarter	Landings ('000 t)	No. samples	No. meas.	No. aged
1996					
Denmark					
Skagerrak	1	2.8	15	1206	199
	2	3.3	4	312	172
	3		5	13	
	4	0.9	5	251	
Total		7.0	29	1,782	371
Kattegat	1	2.7	17	1,533	562
	2	0.1	2	196	196
	3		1	116	116
	4	0.5	1	24	24
Total		3.3	21	1,869	898
Denmark		10.3	50	3651	1269
Norway		1	0	0	0
Sweden		6.6	0	0	0
Total		17.9	50	3651	1269
1997					
Denmark					
Skagerrak	1	0.2	4	309	0
	2	0.3	4	68	0
	3	1.6	6	591	56
	4	4.9	16	1609	160
Total		7.0	30	2,577	216
Kattegat	1	0.5	2	41	40
	2	+	1	100	46
	3	0.7	1	63	68
	4	3.3	2	256	126
Total		4.5	6	460	280
Denmark		11.5	36	3651	496
Norway		0.4	0	0	0
Sweden		3.8	0	0	0
Total		15.7	36	3651	496

Table 10.3.1. Div. IIIa Sprat. Revised indices of sprat per age group from IBTS(February) 1984-1997. (Mean number per hour per rectangle weighted by area. Only hauls taken in depths of 10-150 m are included).

Year	No Rect	No hauls	Age Group					
			1	2	3	4	5+	Total
1984	15	38	5779.73	854.30	207.60	80.09	61.47	6983.19
1985	14	38	2397.24	2395.15	368.76	128.50	49.11	5338.76
1986	15	38	664.99	1918.53	1786.59	116.20	31.91	4518.22
1987	16	38	2244.33	2501.38	2224.94	1655.66	78.69	8705.00
1988	13	38	939.91	5461.23	1519.15	2130.02	459.41	10509.72
1989	14	38	437.60	994.37	1077.13	603.41	147.86	3260.37
1990	15	38	502.83	237.76	69.90	65.65	49.04	925.18
1991	14	38	636.17	456.74	493.57	86.03	215.58	1888.09
1992	16	38	6016.26	605.99	272.13	215.45	79.26	7189.09
1993	16	38	1789.73	4623.70	996.75	218.97	260.08	7889.23
1994	16	38	1546.88	614.35	961.44	299.48	67.58	3489.73
1995	17	38	2282.92	1828.84	37.24	47.86	4.53	4201.39
1996	15	38	176.15	5800.45	794.23	135.95	228.51	7135.29
1997	16	41	200.80	409.84	1307.35	147.36	144.17	2209.52
1998	15	39	75.09	1742.73	680.95	1793.92	579.34	4872.03

Table 10.6.1 Division IIIa Sprat. SHOT forecast of landings in 1998 using total landings and the total IBTS-indices as input data.

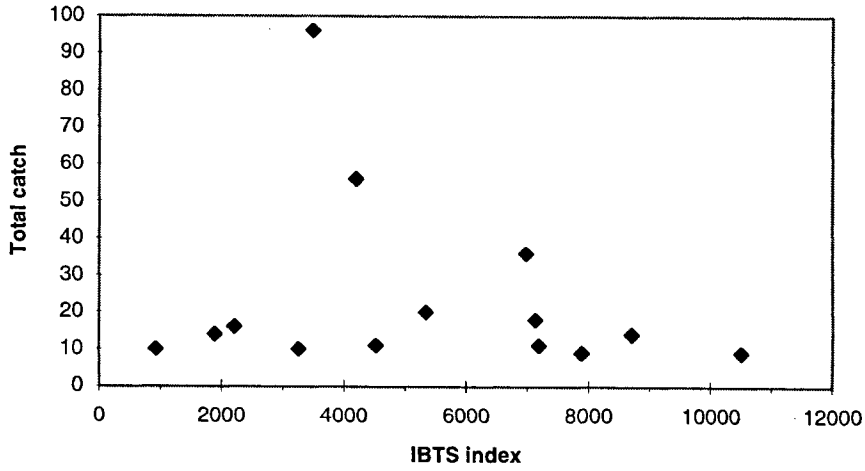
Div.IIIa sprat — SHOT forecast spreadsheet version 6
Total index — Mars 1998

running recruitment weights

older	0.00	G-M =	0.00
central	1.00	exp(d)	1.00
younger	0.00	exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984	36	6983		0.77	0.23				47		
1985	20	5339	5339	0.77	0.23	15			26		
1986	11	4518	4518	0.77	0.23	8	26	24	14		
1987	14	8705	8705	0.77	0.23	15	31	27	18		
1988	9	10510	10510	0.77	0.23	8	22	20	12	26	20
1989	10	3260	3260	0.77	0.23	10	5	6	13	8	6
1990	10	925	925	0.77	0.23	10	2	4	13	5	4
1991	14	1888	1888	0.77	0.23	15	4	5	18	7	5
1992	11	7189	7189	0.77	0.23	10	17	16	14	21	16
1993	9	7889	7889	0.77	0.23	8	17	16	12	20	16
1994	96	3490	3490	0.77	0.23	122	7	7	125	10	7
1995	56	4201	4201	0.77	0.23	44	17	35	73	46	35
1996	18	7135	7135	0.77	0.23	7	33	38	23	49	38
1997	16	2210	2210	0.77	0.23		9	11	21	15	11
1998		4872	4872	0.77	0.23		21	20	0	26	20

Figure 10.6.1. Div.IIIa sprat. IBTS total indices vs total catches in 1984-1998. (rsq=0.04)



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